CRESP

Consortium For Risk Evaluation with Stakeholder Participation

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HANFORD SITE-WIDE RISK REVIEW PROJECT

INTERIM PROGRESS REPORT

REVISION 0

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Acknowledgements and Disclaimer

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Executive Summary

Project Goal

In January 2014, the Department of Energy (DOE) asked the Consortium for Risk Evaluation with Stakeholder Participation (CRESP) to conduct an independent Hanford Site-wide evaluation of human health, nuclear safety, environmental and cultural resource risks (hereinafter referred to as the "Risk Review Project") associated with existing hazards, environmental contamination and remaining cleanup activities. The overarching goal of the Risk Review Project is to carry out a screening process for risks and impacts to human health and resources.[7] The results of the Risk Review Project are intended to provide the DOE, regulators, Tribal Nations and the public with a more comprehensive understanding of the remaining cleanup at the Hanford Site to help inform (1) decisions on sequencing of future cleanup activities, and (2) selection, planning and execution of specific cleanup actions, including which areas at the Hanford Site should be addressed earlier for additional characterization, analysis, and remediation[8].

Background

Hanford Site is located along the Columbia River in Southeast Washington and is comprised of an area 586 square-miles (half the size of the State of Rhode Island). For over 40 years, the Site played a major role in the development and production of plutonium and other defense materials as part of the Manhattan Project during World War II and afterwards during the Cold War.

In 1989, Hanford's mission shifted from supporting weapons development to environmental cleanup of facilities, soil, and groundwater. Today, Hanford Site consists of waste management and former production areas, active and closed research facilities, waste storage and disposal sites, and huge swaths of natural resources and habitat. A map (Figure ES-1) showing Hanford Site may be found at the end of the Executive Summary. Cleanup at the Site has proven to be more costly, has taken longer, and is more technically challenging than expected when cleanup began. DOE's near term vision calls for reduction of the active cleanup footprint to 75 square miles in the center of the Site, reducing overhead costs, and shifting resources that would allow full scale cleanup of the Central Plateau. To date, considerable progress has been made in achieving this vision. For example, hazards near the Columbia River have been eliminated by completing cleanup of most of the River Corridor and treating contaminated groundwater near the Columbia River. While significant cleanup progress has been achieved, more than $100 billion are expected to be spent on cleanup at Hanford during the next 50 years.

Overview

Approximately 60 units, referred to as "evaluation units" (EUs) and composed primarily of geographically co-located areas of existing facilities, waste storage and environmental contamination, are to be evaluated and rated during the execution of the Risk Review Project. These units consist of remaining cleanup sites at Hanford Site as of October 1, 2015. The Risk Review Project will also provide a description of the remaining inventories of radionuclides and chemicals, including their forms, spatial

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[7] In this Risk Review Project, human health and resources evaluated include groundwater and the Columbia River, facility workers, co-located people, the public, and ecological and cultural resources. Collectively, humans and these resources also are referred to as "receptors".

[8] Additionally, while earlier studies have evaluated portions of the Hanford Site, there has never been a comprehensive, site-wide review of the risks to human health and resources from contamination, waste management, and cleanup activities.

distribution and barriers to future environmental contamination at the Hanford Site at the conclusion of cleanup based on current agreements and decisions. For example, several decisions have been made that necessitate that some areas of the Hanford Site will be dedicated to long-term waste management.

This interim progress report presents both the results for the first set of 25 EUs and the interim observations from the Risk Review Project to date.

For this report, the most recent, available information about hazards (i.e., contaminant inventories, physical chemical forms) and existing environmental contamination within each of the 25 EUs being reviewed has been gathered, described, and analyzed. At certain points in time and under various circumstances, such as facility degradation, seismic activity, accidents or fire, the identified hazards and environmental contamination may lead to the movement of radionuclides and chemical contaminants along multiple pathways, thereby potentially creating exposure or impact (referred to as "risk") to human health and resources. This is the "risk" that is to be evaluated and rated for the Risk Review Project, which is discussed in this report.

The screening process used, along with uncertainties and information gaps, necessarily focus the evaluation on order of magnitude factors that distinguish risks between EUs and receptors. Risks are considered in the context of each EU's current status, during cleanup activities and after cleanup activities. This includes taking account of current barriers to dispersion of contaminants, including engineered systems, natural systems and institutional controls, the mechanisms of barrier failures, and the likelihood and magnitude of adverse consequences to receptors. A map (Figure ES-1) showing the locations at Hanford Site of all EUs evaluated except groundwater EUs for this interim progress report may be found at the end of the Executive Summary; a separate map (Figure ES-2) provides an overview of the existing groundwater contamination and groundwater EUs.

WHAT THE PROJECT IS AND IS NOT

DOE, the State of Washington, and the Environmental Protection Agency (EPA) clearly recognize that the Risk Review Project results, including evaluations of hazards, current environmental contamination, and risks, are only one of many inputs to prioritization of future cleanup activities at Hanford.

The Risk Review Project focuses on risk characterization based on analysis and integration of existing information. Risk characterization is a necessary predecessor to risk management, but does ***not*** dictate risk management decisions. This review does not provide a rank ordered priority list of cleanup actions but rather provides groupings of relative risk (e.g., "high", "medium", etc.). The development of a prioritized list of future actions is the sole purview of DOE and its regulators, with consideration of many additional factors. Instead, the Risk Review Project is limited to considering a plausible range of current and future cleanup actions for different types of contaminant sources to better understand the range of potential risks and impacts to receptors that those cleanup actions may cause.

It is also important to be clear what the Risk Review Project is not. The Risk Review Project is neither intended to be a substitute for, nor preempt, any requirement imposed under applicable federal or state laws or treaties. As important, the Risk Review Project is not intended to make or replace any decisions made under the Hanford Federal Facility Agreement and Consent Order (Tri-Party Agreement) and/or 2010 Consent Order, or amendments. Furthermore, the Risk Review Project is neither a CERCLA (Comprehensive Environmental Response, Compensation, and Liability Act) risk assessment nor a Natural Resources Damage Assessment evaluation. The Risk Review Project is not intended to interpret treaty rights that exist between the United States and Native American Tribes.

APPROACH USED

The Risk Review Project is led by a team of CRESP researchers in regular dialogue with a Core Team, comprised of senior management from DOE, EPA and the State of Washington Departments of Ecology and Health, which provides advice and guidance on the development and execution of the Risk Review Project. Pacific Northwest National Laboratory provides research, analytical, and other assistance to CRESP as part of the Risk Review Project.

For the first several months of the project, the focus was on developing an evaluation approach that would accomplish the Risk Review Project's goal of providing the DOE, regulators, and the public with a more comprehensive understanding of the current and future risks to receptors and to help inform decisions on sequencing of future cleanup activities, as well as associated selection, planning, and execution elements of the process. The draft methodology was made available for agency and public comment in September 2014 and then revised in response to the comments received. The methodology used to evaluate the 25 EUs discussed in this report, reflects the revisions made in response to input received on the draft methodology. The methodology also reflects the lessons learned from the pilot case studies completed in the summer of 2014, to test the draft version of the methodology, as well as input received from independent experts.

The methodology consists of the following elements[9]:

1. **Identification of Evaluation Units.** The remaining cleanup sites at Hanford as of October 1, 2015, have been divided into approximately 60 EUs, which are composed of geographically co-located sites to the extent possible, considering commonality among source types and the overlapping of impacts and risks to receptors[10]. There are five categories[11]: (1) legacy source sites, such as past practice liquid waste disposal and buried solid waste sites; (2) tank waste and farms and associated legacy contamination sources; (3) groundwater plumes; (4) inactive facilities undergoing decommissioning, deactivation, decontamination and demolition (D4); and (5) operating facilities used as part of the cleanup process. *See Chapter 2 for a complete list of all EUs and maps of their locations, including the 25 evaluated for this report; also Chapter 3 of the methodology (CRESP 2015).*
2. **Summary Evaluation Templates.** Each EU is described in detail using existing information as of January 2014, including regulatory documents, maps, and studies.[12] Information gathered on each EU includes the unit description and history; an inventory of waste and contamination history; selected or the potential range of cleanup approaches; and the ratings of risks to human resource and environmental receptors, by providing rough order of magnitude relative grouping or binning of risks to each different type of receptor. The primary groupings are Very High, High, Medium, Low, and Not Discernible. *See Chapter 3 and Appendices D-I for the completed*

[9] The entire methodology document may be found on CRESP's website: www.cresp.org
[10] The EU concept was developed by the Risk Review Project to provide a tractable basis for reviewing the myriad of cleanup challenges at the Hanford Site. Groupings of facilities, wastes and existing environmental contamination within each EU is based primarily on geographic location because the potential to impact receptors is fundamentally based on geographic location and spatial relations that may lead to exposure of receptors to hazards from specific sources. Thus, EU groupings are not based on, and may not correspond with, either the process history that produced the wastes or environmental contamination, nor the groupings used for regulatory purposes (e.g., operable units).
[11] The EU groupings used here were developed by the Risk Review Project to understand potentially overlapping risks and are not common practice at the Hanford Site.
[12] The information available for each EU is highly variable, depending on documentation of past site practices, the current regulatory status, currently planned near-term cleanup activities and other factors.

summary evaluation templates for each of the 25 EUs discussed in this report; Appendix B of the methodology (CRESP 2015) for the Summary Evaluation Template.

3. **Risk Ratings.** The receptors being rated or binned are facility workers, co-located people, public, groundwater and the Columbia River, and ecological resources. The groupings of risk ratings (e.g., "high", "medium", etc.) for each type of receptor are determined by application of the specific methodology developed for that receptor. Demarcation between ratings uses recognized regulatory or literature thresholds applicable to the specific receptor, if they exist, as screening levels, as well as other factors. This approach is intended to provide relative risk ratings *within* receptor categories (i.e., relative binning of risks to the Columbia River, groundwater, ecology, etc.). Risk ratings for each receptor are then used to inform the urgency of addressing specific hazards. An overall risk rating is not provided for cultural resources; however, information about cultural resources within each EU and near (within 500 m) each EU is gathered, described, and analyzed as a planning guide or tool for future cleanup activities.

   Although the integration across receptor categories is assumed to be inherently driven by individual and collective values, the Risk Review Project will provide examples illustrating how grouping or binning that integrates the ratings across receptor categories (e.g., integrated risk binning that combines risks to human health with risks to ecology and groundwater) could be carried out.[13] *See Chapter 2 for summaries of each receptor methodology; Chapters 5 through 8 of the methodology (CRESP 2015) for detailed descriptions of each receptor methodology.*

4. **Temporal Evaluation Periods.** Risks are evaluated based on distinct time periods: the current status of the EU, typically prior to cleanup although cleanup has been initiated for some EUs; active cleanup period (or until 2064); near-term post-cleanup (until 2164, or assuming a 100 year duration for institutional controls associated with areas transferred from federal control); and long-term post-cleanup (or until 3064).[14] Each EU and selected EU components are evaluated as if cleanup were not to occur for 50 years to provide insights into the potential risks of delay, which will help inform sequencing of cleanup actions. However, this is not to infer that delay of cleanup for 50 years is recommended. *See Chapter 2 for a more detailed description of the evaluation periods.*

5. **Initiating Events.** The likelihood of initiating events, both localized and regional in scale, which may occur during any or all of the evaluation periods, such as fire, volcanic eruptions, loss of power, and loss of cooling water, are described. This is to establish a consistent basis for identifying and categorizing phenomena that may remove or degrade barriers thus placing receptors at risk from contaminants. Nuclear safety is considered in the context of potential initiating events and risks to receptors. *See Chapter 2 for a summary of initiating events; Chapter 4 of the methodology (CRESP 2015) for a detailed analysis.*

RESULTS AND INTERIM OBSERVATIONS

The Risk Review Project relies primarily on previously obtained primary data, safety analyses, risk analyses, environmental impact assessments, remedial investigations, and other sources of information. Tens of thousands of pages of information and electronic databases have been reviewed and integrated to form the basis for this report. The methodology used reflects input from state and federal regulatory agencies, Tribal Nations, non-governmental agencies, the public, and independent experts (CRESP 2015).

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[13] This will be included in the final report but is not in the interim progress report.

[14] Where information is available that indicates risks that may be present beyond the year 3064, such information is noted (such as with slow groundwater migration of contaminants).

Still, important uncertainties and data gaps remain that required assumptions to carry out the project and are indicated in the detailed analysis provided in the main body of this report and its appendices.

The major current risks that have been identified within the EUs considered in this report are as follows:

The current risks that are in the highest risk rating group are at specific EUs from (1) loss of nuclear safety controls from major natural hazards (e.g., from seismic events, volcanic ashfall, or wildfire) or other external events (e.g., prolonged loss of power or water), or operational accidents (including facility fires) that can effect human health and a broad range of receptors; and (2) contamination of groundwater from further spread of existing groundwater contamination, migration of contaminants from legacy surface disposal sites and the vadose zone, or unplanned release of contaminants from engineered facilities (e.g., waste tanks).

Current significant threats to the Columbia River from contaminants in the River Corridor are being treated, and significant threats from groundwater contaminants to the Columbia River from the Central Plateau are either being treated, or would not be realized for a long time and only if they are not treated during the active cleanup period (i.e., over the next 50 years).

The highest rated risks during cleanup are (1) to workers, co-located people, and controlled access groups from operational accidents; and (2) to ecological and cultural resources from physical disruption or introduction of invasive species, either because of insufficient planning, selected cleanup methods, or lack of a prior knowledge.

The major risks remaining after cleanup are from potential failure of institutional or engineered controls, which may impact human health, water resources, and ecological resources. In addition, ***safety of consumptive practices*** (such as those associated with some Tribal Nation cultural practices and some recreational activities) cannot be assured without both risk assessment and appropriate biomonitoring.

Several interim observations can be made from the work completed to date. Observations fall into one of three categories that are offered to inform management considerations surrounding (1) sequencing of cleanup, (2) planning for and activities associated with cleanup, and (3) key information gaps that have affected the completion of evaluations. These observations must be regarded as preliminary because they may be altered for the final report after all EUs have been evaluated for risks and impacts to human resources, groundwater and the Columbia River, and ecological and cultural resources. However, they have been carefully formulated from the evaluations completed for this interim progress report, and therefore may be considered in conjunction with the full range of other factors that affect cleanup decisions at the Hanford Site. *See Chapter 5 for detailed results and observations for the first set of 25 units evaluated.*

In addition to specific observations, five general interim observations can be made at this point in the Risk Review Project.

General Observations

1. At the Hanford Site, current hazard and risk conditions reflect the inventory, site access controls that are in place, and cleanup actions already completed. These controls and completed actions have greatly reduced threats to human health and ecological resources, as well as addressing some of the groundwater contamination. When considering future cleanup, different hazard and risk considerations are important for different decisions as follow:
    a. **To inform sequencing of cleanup activities –** *nuclear, chemical, and physical safety* (i.e., hazards, initiating events and accident scenarios) *and the threats to groundwater* and the Columbia River *are the primary risk considerations*.

b. **To inform selection, planning and execution of specific cleanup actions –** potential *risks and impacts to worker safety, ecological resources, and cultural resources are the primary risk considerations*.
c. **To inform cleanup criteria** (i.e., cleanup levels to meet regulatory standards) **–** *future land use, protection of water resources, land ownership and control, durability of institutional and engineered controls, and legal/regulatory requirements are the primary considerations that influence future human health risk estimates*. Risks to human health should be considered in combination with risks to environmental and ecological resources for establishing cleanup criteria. The establishment of end-state cleanup criteria is not the focus of the Risk Review Project.

2. Currently, members of the public, whether located at the official Hanford Site boundary or at the controlled access boundary (river and highways), usually have Low to ND (non–discernible) risks, even if postulated radioactive contaminant releases are realized.

3. Timing of cleanup of a specific EU **may reduce** worker risk (e.g., by radioactive decay) **or may increase worker risk** (e.g., by facility deterioration, workforce availability with institutional knowledge, repetitive or chronic exposures due to maintenance, potential for complacency).
    a. Worker risk varies with respect to the nature of hazards, complexity, duration of project, technical approaches, and controls or mitigation measures in-place to ensure worker health and safety.
    b. DOE and its contractors have accident rates approximately two-thirds less than comparable non-DOE work. Ongoing vigilance is needed to maintain this excellent record.

4. The ecological resources on the Hanford Site are very important to the Columbia River Basin Ecoregion, where the shrub-steppe habitat has decreased at a far greater rate region-wide than on the Hanford Site. Stewardship by the DOE has helped protect these resources.

5. The historical and cultural significance of the Hanford Site to Tribal Nations stretches over 10,000 years. The Hanford Site also is considered to have important historical significance to western settlement, which began in the early 1800s and only ended at the site to make way for the Manhattan Project. Finally, the site played a major role during the Manhattan Project Era and after World War II during the Cold War Era. DOE's stewardship helps assure that the site's historical and cultural significance will continue to be recognized.

INFORMING CLEANUP SEQUENCING

The following is a list of interim observations related to sequencing of cleanup only, with additional details provided in Chapters 3 and 4. All other observations may be found in Chapter 5 of this report. Detailed discussions of each EU are provided in appendices as noted. However, with regard to planning for and activities associated with cleanup, observations cover a wide range of issues from identifying the greatest risks to workers to the most important pathways and mechanisms for impacts to ecological resources and cultural resources (e.g., by contaminants and physical disruption).

1. **Address parts of specific EUs earlier.** For several EUs, specific activities, hazards, or risk characteristics warrant being addressed before the EU as a whole.
2. **Highest priority group based on evaluation of potential risks to human health and the environment.** For the facilities and activities evaluated under the Risk Review Project to date,

the major cleanup activities that are in the highest priority group based on evaluation of potential risks to human health and the environment are as follows (*not in any specific order*):

a. **Reduction of threats posed by tank wastes.** (Appendix E) Hydrogen gas generation[15] poses a threat to nuclear safety and human health through hydrogen flammability events that may result in atmospheric or subsurface release of waste or contaminants from containment (worker risk from tank vapors are discussed below). Tc-99 and I-129, both being persistent and highly mobile in the subsurface, pose threats to groundwater through potential leakage from tanks[16]. Risks posed by hydrogen gas generation can be somewhat reduced through removal of water soluble Cs-137. Groundwater threats can be substantially reduced by removal of water-soluble constituents from a selected set of tanks[17]. This interim observation is consistent with the priority given by the agencies to treat LAW at WTP as early as possible if Cs-137, Tc-99 and I-129 separated from the waste are not returned to the tanks. However, the risk profile will not be reduced significantly nor increased if Cs-137, Tc-99 and I-129 are returned to the tanks during LAW treatment.

b. **Reduction or elimination of risks associated with external events and natural phenomena (severe seismic events, fires, loss of power for long duration).** Facilities affected are the Waste Encapsulation and Storage Facility (WESF) (cesium and strontium capsules), Central Waste Complex, and Plutonium Uranium Extraction Plant (PUREX) waste storage tunnels.

    i. **For WESF** (Appendix H.4)**:**

    The primary scenario that causes release of radionuclides from capsules stored in the WESF pool cells is an accident that results in the loss of all water from the pools cells, which provides cooling and radiation shielding. The design basis seismic event alone cannot cause the loss of all pool cell water by itself: release of significant quantities of radionuclides can only be caused if multiple root causes occur (some in sequence, some in parallel) that include man-made errors, natural events, and external events. The storage pool structures have been exposed to high radiation fields for an extended period of time. An initial assessment completed indicates that the storage pools currently are safe, although the long-term integrity of the structures is uncertain.[18] DOE proposes to over-pack and then transfer cesium and strontium capsules to onsite dry storage.[19]

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[15] Hydrogen generation rate is primarily related to Cs-137 and Sr-90 content of the waste.

[16] The threat to groundwater from tank leakage has been mitigated in the near-term through interim stabilization of single shell tanks (SSTs) by removal of pumpable liquids.

[17] For hydrogen generation – 200 East DSTs, 200 West DST SY-103 and single shell tanks East B-202, B-203, B-204, and West T-201 have times to 25% of the lower flammability limit of less than 6 months under unventilated conditions. Cs-137 removal would most significantly increase time to 25 percent of the lower flammability limit for tanks AZ-101, AN-102, AN-107, AP-101, AP-103 and AP-105. For groundwater threat, greater than 70% of the GTM is from – 200 East DSTs, SY-101 and SY-103 (200 West DSTs) and single shell tanks, AX-101, S-105, S-106, S-108, S-109, SX-106, TX-105*, TX-113*, TX-115*, U-109, U-105 (* indicates assumed SST leaker).

[18] A separate DOE-initiated review of the condition of the WESF concrete structure and the reliability of the initial DOE estimate is in progress.

[19] The capsules may experience significantly higher temperatures in dry storage than in pool storage. The elevated temperatures, combined with the variable and uncertain chemical composition of some capsules, could raise concerns about the integrity of the capsules over time as storage is likely for at least decades (see Appendix H.4). This concern would be addressed as part of the safety analysis associated with the dry storage design process.

ii. **For Central Waste Complex** (Appendix H.3)**:**
Estimated unmitigated doses from incident scenarios to the co-located person exposed to the worst design basis event at the Central Waste Complex is from a large fire involving more than eight drums or 82.5 Ci (dose equivalent) of material with 770 rem. The risk may increase because the Central Waste Complex continues to receive wastes, but currently is unable to ship wastes to off-site disposal, due to WIPP being closed and also because budgets have been insufficient to support repackaging wastes into standard containers. Localized accumulation of material at risk without a disposition pathway can increase overall risk. Consideration also should include reductions in the amount of material at risk for similar facilities that require interaction with other offsite facilities that may not be available.

iii. **For PUREX** (Appendix D.4)**:**
1. A design basis seismic event could lead to a total structural failure of the 202-A building and both tunnels, causing an estimated unmitigated combined 250 rem dose to the co-located person.
2. The wood ceiling and wall structure of Tunnel #1 are vulnerable to collapse in about 30 years[20] due to ongoing degradation occurring from continued exposure to the gamma radiation from equipment being stored, or due to a fire. These events could release a large fraction of the 21,200 Ci radiological inventory to the environment.[21]

c. **Dependence on active controls (e.g., reliance on power, cooling water, active ventilation) to maintain safety for additional facilities with large inventories of radionuclides.** These conditions are (1) air handling ducts at WESF, and (2) sludge at K-Basins (sludge treatment project; Appendix H.2).
   i. During the design basis event earthquake, contaminants from WESF's hot cell and ventilation system are the hazard sources that produce doses to the co-located person [Co-located person: 21 rem].
   ii. Current safe storage relies on maintaining the K-Basin sludge submerged under water to reduce radiation exposure to workers and prevent fires of reactive metal fragments. Safe processing of K-Basin sludge also requires keeping it wet during retrieval, transfer, interim storage, and processing to prevent pyrophoric constituents from igniting.

3. **Cleanup actions that could cause substantial human health risks.** The following cleanup activities themselves could cause substantial risks to human health and therefore warrant consideration of interim actions, and different cleanup approaches and timing (recognizing that mitigation measures would be both necessary and implemented before and during remedial actions):
   a. **Retrieval, treatment, and disposal of contaminated soils underlying Building 324 and disposal of the building after grouting the contaminated soils in the building** (Appendix F.2)**.** Currently, no migration of soil contamination to groundwater has been indicated, suggesting that required cleanup is not urgent. In addition, the excavation and transfer of the soils through the B-Cell floor may not be technically feasible and/or may present

[20] The time estimate of 30 years has large uncertainty, and can be shorter or longer.
[21] The documented safety analysis for this facility provides a detailed analysis of potential upset events (see Appendix F.4).

challenging risk scenarios. As a result, approaches that allow for immobilization and in situ decay of the soil contaminants (Cs-137, Sr-90) warrant further consideration.

b. **Retrieval, treatment, and disposal of materials from 618-11 within caissons, vertical pipe units, and burial grounds** (Appendix D.2) because of the characteristics of wastes (high activity, pyrophoric, poorly characterized) to be retrieved. The possible event of a fire and/or release from 618-11, jeopardizes continued operations and worker safety at the Columbia Northwest Generating Station because of the proximity of the two facilities. The current cover over the buried wastes, but not present over the caissons and vertical pipe units, is effective in limiting water infiltration to the wastes where the cover is present. These conditions warrant consideration of instituting interim mitigation measures and delaying waste retrieval until closure of the generating station.

4. **Groundwater threats** (Appendix G)**.** Many of the threats and current impacts to groundwater are being interdicted and/or treated. The greatest threats and impacts to groundwater that are not currently being addressed are from:

   a. **Groundwater plumes not currently being actively addressed.** Tc-99 and I-129 are already in groundwater in 200 East Area (200-BP-5; EU CP-GW-1). The 200-BP-5 I-129 plume extends to the southeast (200-PO-1; EU CP-GW-1), but may be too dispersed for effective remediation other than natural attenuation.

   b. **Vadose zone threats to groundwater not currently being addressed.** Tc-99, I-129, and Cr(VI) are in the vadose zone associated with BC Cribs and Trenches (EU CP-LS-1; Appendix D.4) and the legacy sites associated with B-BX-BY tank farms (EU CP-TF-6; Appendix E.7), both located in the 200 East Area. Sr-90 results in a very high rating in B-BX-BY because of the large inventory but also is relatively immobile and will naturally decay. Infiltration control (e.g., capping) and other approaches may reduce the flux of these contaminants from the vadose zone into groundwater. Uranium currently is being extracted from perched water in B-Complex.

   c. **324 Building, where relatively modest interim actions could reduce threat.** The largest risk for migration of Cs-137 and Sr-90 from the soils until cleanup can be completed (through a combination of D4, soil treatment and/or removal and natural attenuation) is from breakage of a main water pipe and infiltration of precipitation and run off in close vicinity of the building. Building 324 is currently being maintained in a safe surveillance and maintenance mode pending completion and evaluation of a pilot project and assurances that resources are available to complete a multi-year soil remediation and D4 activities. Current risks from potential water infiltration and resultant contaminant migration may be mitigated through water supply modifications, infiltration controls, and additional groundwater monitoring[22].

   d. **618-11 waste site, where relatively modest interim actions could reduce threat**. At 618-11, the potential for release of additional contaminants to groundwater can be mitigated by providing a cover that prevents infiltration but maintains gas venting over the caissons and vertical pipe units (currently gravel covered area).

5. **Operating facilities have a time-dependent risk, which create additional challenges.** Unplanned changes in inventory can occur over time, with delays in planned processing resulting in increased risk. The hazard and risk profiles change as funding is available to

[22] While groundwater monitoring does not prevent infiltration or contaminant migration, it does mitigate risks by providing early warning of a change in the subsurface contaminant spatial distribution.

implement identified plans. For example, with processing delays along with aging infrastructure and without sufficient maintenance, waste storage conditions will deteriorate and/or additional waste may accumulate. In addition, operating facilities rely on interfaces with existing facilities (e.g., WIPP, T Plant, off-site processing and disposition facilities) and planned facilities (e.g., dry capsule storage for cesium and strontium capsules, Phase 2 K-Basin Sludge Processing). Outages or delays in availability of interfacing facilities will likely result in processing disruptions.

WHY THE RISK REVIEW PROJECT IS UNIQUE

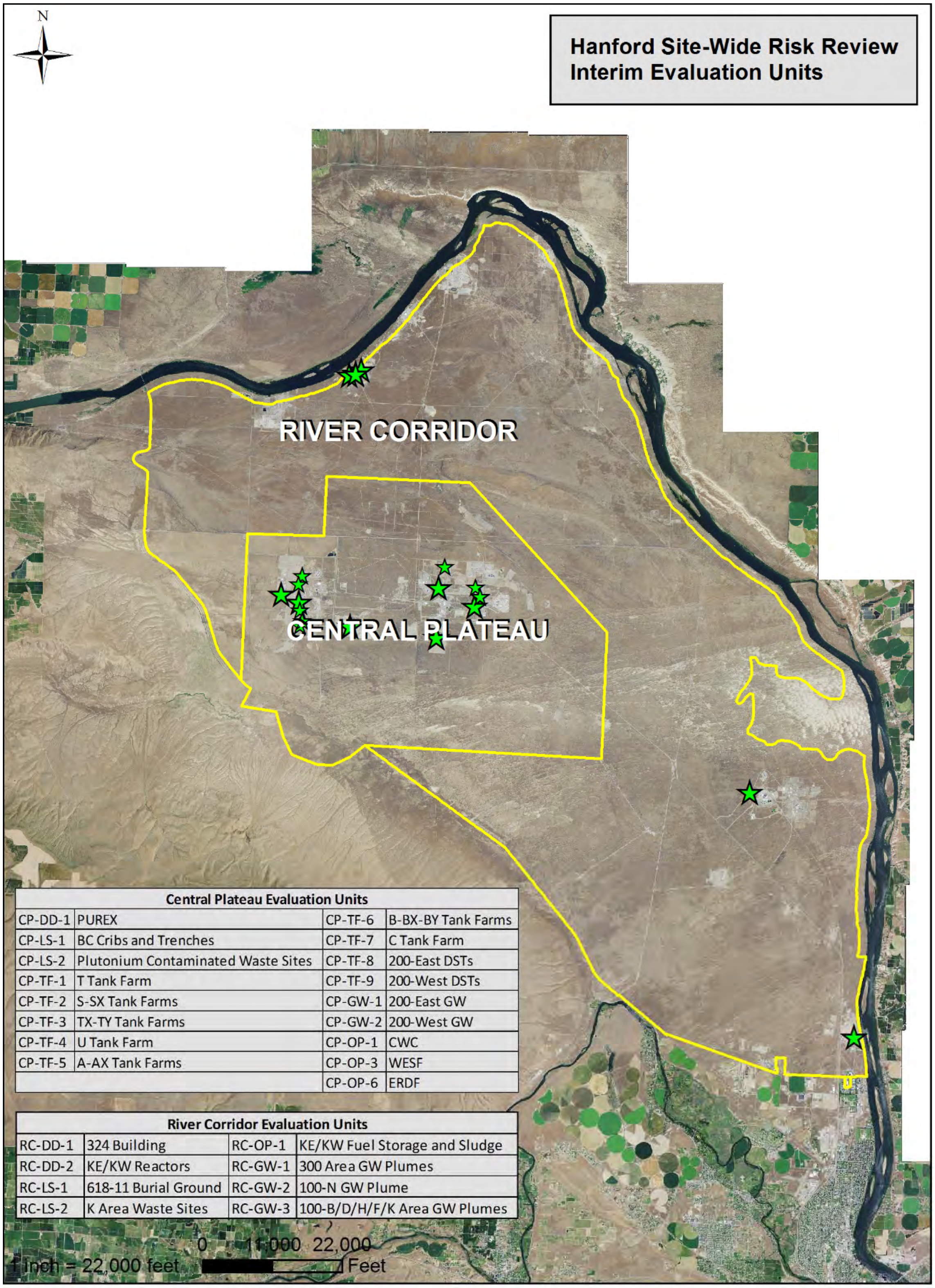
For the Hanford Site, the overall Risk Review Project provides DOE and its regulators with risk evaluations on EUs awaiting remediation gathered from existing information and using a new approach. Not only are sources, inventories, pathways, and receptors documented and evaluated for each EU using this approach, but the results provided by the Risk Review Project include integrated analyses of the quantity and location of contamination sources, present state of containment, potential releases, and risks to receptors. Receptors evaluated include groundwater and the Columbia River, facility workers, co-located people, the public, and ecological and cultural resources. Specifically, the Risk Review Project should be considered unique because it provides for the remaining cleanup areas within the Hanford Site on a consistent basis:

1. An in-depth examination of diverse EU categories (legacy waste sites, facilities for decontamination and decommissioning, tank waste and farms, operating units, and groundwater plumes), with comparisons within EU categories (e.g., tank waste and farms) provided, where practical.
2. The first compilation of potential risks to a broad range of receptors in their current conditions, during cleanup (to 2064), and in the 100 years following cleanup (to 2164).
3. The potential effects of different initiating events and releases on risks to receptors.
4. A compilation of the range of cleanup options and methods being considered (or selected) for each EU.
5. Consideration of groundwater movement and the potential risk from groundwater plumes to the riparian zone and benthic organisms in the Columbia River (benthic organisms are more sensitive than other biota or humans to chemicals and radionuclides).
6. Evaluation of the potential risk to humans in different categories (facility workers, co-located individuals, and the public outside the controlled access boundary).
7. A list of functional effects of remediation on biota and ecosystems and cultural resources.
8. A field evaluation and compilation of the percent of each ecological resource level in both the EUs and the surrounding buffer for all 25 EUs considered in this interim progress report.
9. A review by a professional archaeologist of information in existing records about cultural resources within an EU and the buffer area of up to 500 m from the EU boundary that is compiled in a publicly available report for that EU.
10. A comparison of the risks (current, during active cleanup, near-term post-cleanup) for each EU for the range of receptor groups.
11. Summary tables that allow quick comparison of contamination sources and receptor risk ratings.

PROJECT CONSULTATION AND EXTERNAL REVIEW

CRESP is a multi-disciplinary consortium of universities with a mission to advance environmental cleanup by finding ways to improve the scientific and technical basis for management decisions, and to engage stakeholders and the public. CRESP has completed risk-informed characterization projects involving complex issues at DOE Office of Environmental Management sites around the country.

Written comments on this interim report will be solicited from Tribal Nations, governmental entities, stakeholders, and interested members of the public. Independent experts also will provide review of this report. Comments received are expected to inform the final report prepared on the Risk Review Project. The final report is planned to include evaluations and results of all remaining units not evaluated for this report as well as final observations. Written public comments will be solicited on the draft final report. All three major products of this Risk Review Project (the methodology report, interim progress report, and the final report) will be public documents.



Central Plateau Evaluation Units			
CP-DD-1	PUREX	CP-TF-6	B-BX-BY Tank Farms
CP-LS-1	BC Cribs and Trenches	CP-TF-7	C Tank Farm
CP-LS-2	Plutonium Contaminated Waste Sites	CP-TF-8	200-East DSTs
CP-TF-1	T Tank Farm	CP-TF-9	200-West DSTs
CP-TF-2	S-SX Tank Farms	CP-GW-1	200-East GW
CP-TF-3	TX-TY Tank Farms	CP-GW-2	200-West GW
CP-TF-4	U Tank Farm	CP-OP-1	CWC
CP-TF-5	A-AX Tank Farms	CP-OP-3	WESF
		CP-OP-6	ERDF

River Corridor Evaluation Units			
RC-DD-1	324 Building	RC-OP-1	KE/KW Fuel Storage and Sludge
RC-DD-2	KE/KW Reactors	RC-GW-1	300 Area GW Plumes
RC-LS-1	618-11 Burial Ground	RC-GW-2	100-N GW Plume
RC-LS-2	K Area Waste Sites	RC-GW-3	100-B/D/H/F/K Area GW Plumes

Figure ES-1. General location all evaluation units included in this interim report except groundwater EUs.

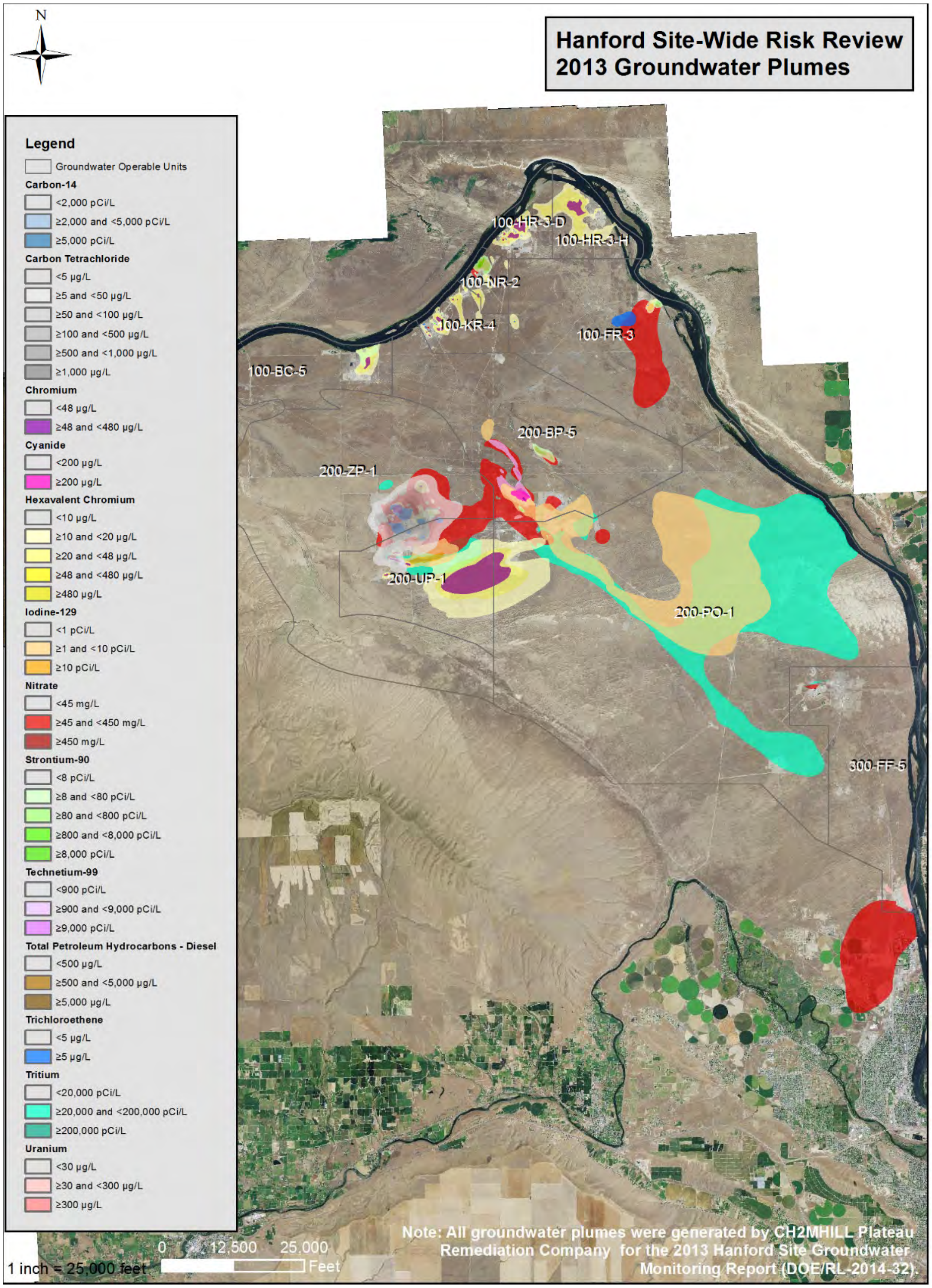


Figure ES-2. Hanford Site-Wide Risk Review 2013 Groundwater Plumes

Table of Contents

List of Appendices

List of Figures

List of Tables

Abbreviations and Acronyms

AWQC	ambient water quality criteria
BCG	Biota Concentration Guide
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CHPRC	CH2M Hill Plateau Remediation Company
CLUP	Comprehensive Land Use Plan
CRESP	Consortium for Risk Evaluation with Stakeholder Participation
CSB	Canister Storage Building
CSM	conceptual site model
CWC	Central Waste Complex
D&D	deactivation (decontamination) and decommissioning
D4	deactivation, decontamination, decommissioning, and demolition
DOE	Department of Energy
DSA	documented safety analysis
DST	double-shell tank
ECRTS	Engineered Container Removal and Transfer System
EIS	environmental impact statement
EPA	Environmental Protection Agency
ERDF	Environmental Restoration Disposal Facility
EU	evaluation unit
GIS	Geographic Information System
GTM	groundwater threat metric
GW	groundwater
HA	hazard analysis
HAMMER	Volpentest Hazardous Materials Management and Emergency Response Federal Training Center
HGR	hydrogen generation rate
HLW	high-level waste
IS	insufficient information
LAW	low-activity waste
LFL	lower flammability limit
LIGO	Laser Interferometer Gravitational Wave Observatory
MOI	maximally exposed offsite individual
NA	not applicable
NP	Not present at significant quantities for indicated EU
NRC	Nuclear Regulatory Commission
OU	operable unit
PAC	protective action criteria
PC	primary contaminant
PCB	polychlorinated biphenyl
PFP	Plutonium Finishing Plant
PNNL	Pacific Northwest National Laboratory
PUREX	Plutonium Uranium Extraction Plant
RCRA	Resource Conservation and Recovery Act
REDOX	Reduction-Oxidation Plant
ROD	record of decision

RTD	remove, treat, dispose
SARAH	Safety Analysis and Risk Assessment Handbook
SHPO	State Historic Preservation Officer
SSE	safe storage enclosure
SST	single-shell tank
TBD	to be determined
TC&WM	Tank Farm Closure and Waste Management
TCE	trichloroethylene
TED	total effective dose
TEDE	total effective does equivalent
TRU	transuranic
UCL	upper confidence limit
WCH	Washington Closure Hanford
WESF	Waste Encapsulation and Storage Facility
WMA	waste management area
WIPP	Waste Isolation Pilot Plant
WQS	water quality standard
WRAP	Waste Receiving and Processing Facility
WRPS	Washington River Protection Solutions
WTP	Waste Treatment and Immobilization Plant

List of Radionuclides and Other Contaminants

Am-241	americium-241
C-14	carbon-14
Cl-36	chlorine-36
Cr(VI)	chromium, hexavalent
Cr (total)	chromium, total
Cs-137	cesium-137 (radionuclide)
CT or CCl_4	carbon tetrachloride
H-3 or ^3H_2O	tritium or tritiated water
Hg	mercury
I-129	iodine-129 (radionuclide)
NO_3	nitrate
Pb	lead
PCBs	polychlorinated biphenyls
PCE	tetrachloroethene
Pu	plutonium (either specific isotopes or total, as indicated)
Sr-90	strontium-90 (radionuclide)
Tc-99	technetium-99 (radionuclide)
TCE	trichloroethylene
TPH-diesel	diesel as total petroleum hydrocarbons
U (total)	uranium, total

Probability and Consequence Ratings

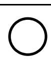
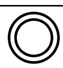
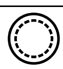
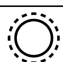
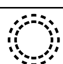
A	Anticipated
BEU	Beyond Extremely Unlikely
EU	Extremely Unlikely
H	High
L	Low
M	Moderate
ND	Not Discernible
U	Unlikely
VH	Very High
	Not Anticipated

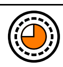
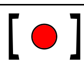
Risk Review Project Risk Ratings

	Low
	Medium
	High
	Very High
ND	Not Discernible

Symbology Used For Risk Review Project Summary Rating Tables

Symbols used in the rating tables indicate the highest rating when a rating range is present. Symbols within each entry in rating tables are a combination of a risk rating symbol and additional symbols used to indicate 1) the presence of engineered barriers to prevent release to the environment or further dispersion of radionuclides and chemicals, 2) when treatment, waste retrieval or remediation is in progress, and 3) if interim stabilization has occurred (only applicable to single-shell tanks; through removal of pumpable liquid).

Symbol	Meaning
	Risk Rating Symbols
	ND Rating
	Low Rating
	Medium Rating
	High Rating
	Very High Rating
	Barrier Symbols
	One engineered barrier, Intact (barriers include tanks, covers, liners, buildings, etc.)
	One engineered barrier, barrier compromised (e.g., leaking tank)
	Two engineered barriers, both barriers intact
	Two engineered barriers, inner barrier compromised and outer barrier intact
	Two engineered barriers, inner barrier intact and outer barrier compromised
	Two engineered barriers, both barriers compromised.
	Treatment, Remediation and Waste Treatment Symbols
[ ]	Treatment, remediation or waste retrieval in progress
ŧ	Interim stabilized (single shell tank, stabilization through removal of pumpable liquid)

Symbol	Meaning
	Examples of Combined Rating, Barrier and Treatment Symbols
	Low rating, no engineered barriers or treatment present
	Medium rating, no engineered barriers or treatment present
	High rating, no engineered barriers or treatment present
	High rating, one engineered barrier that is compromised (i.e., leaking)
	High rating, two engineered barriers, inner barrier compromised, outer barrier intact
	High rating, one engineered barrier present (i.e., single shell tank) with interim stabilization
	Very high rating, currently undergoing treatment

Terminology and Definitions

The primary objective of the Risk Review Project is to characterize risks and impacts to human health (facility worker, co-located persons, and public) ecological resources, cultural resources, groundwater, and the Columbia River. These terms are collectively referred to as “receptors.” For the purposes of this document, the following definitions apply:

Bioindicator – species (species group) or characteristic of a species (or species group) that is used to assess the condition of a species, population, community, or ecosystem.

Biomonitoring – regular, periodic assessment of human or ecological health and well-being.

Buffer – area around the evaluation unit (EU), equal to the widest diameter of the EU. It is an area potentially impacted by remediation activities on the EU.

Co-Located Person – a hypothetical onsite individual located at the distance from the point of potential contaminant release at which the maximum dose occurs (at a point equal to or greater than 100 m from the point of release, the boundary of the facility *or the activity boundary)*. If the release is elevated, the onsite individuals assumed to be at the location of greatest dose, which is typically where the plume touches down. (*This is functionally equivalent to the “Co-located Worker” as defined and used in the* DOE-STD-3009-2014 and the *DOE Safety Analysis and Risk Assessment Handbook (SARAH).*)

Completed Pathway – the transport (transfer or movement) of radionuclides or chemical contaminants from existing environmental contamination sources, hazards (i.e., contained contaminant inventories, physical-chemical forms), or facilities (including those used for materials and waste processing, storage, and disposal) through air, water, or soil to any receptor through a specific set of mechanisms or transport paths. If the transfer is currently occurring, the pathway is referred to as “complete.” If the transfer may occur in the future, the pathway may become complete. Other potential pathways may never become “complete” if there is cleanup or interdiction (barriers) or if receptors are kept out of harm’s way, for example, by future land use restrictions or institutional controls.

Conceptual Site Model – a comprehensive depiction of sources, potential initiating events, and completed or potential pathways that may result in (or prevent) exposure, risks, and/or impacts to receptors and resources, as well as barriers that interdict the exposure or mitigate the impacts.

Contaminant Sources (or Sources) – chemical and/or radiological contaminants or waste present in a specific form and geographic location. Example sources include contaminated soils, vadose zone, groundwater, buildings, tanks and drums, as well as historical, current, and future waste disposal areas, waste storage, and processing facilities.

Controlled Access Person – an individual, who is granted limited access to the site, within the current site security boundary, for a specific purpose or set of activities. (*This is functionally equivalent to the “Onsite Public” as defined and used in the DOE-STD-3009*.)

Criticality – an inadvertent self-sustaining nuclear chain reaction, with the potential release of high levels of radiation.

Cultural Resources – a collective term applicable to 1) pre-historic and historic archaeological sites and artifacts designating past Native American use of the Hanford Site; 2) historic archaeological sites and artifacts indicating post Euro-American activities relating to the pre-

Hanford period; 3) Hanford Site Manhattan Project and Cold War Era buildings, structures, and artifacts; 4) landscapes, sites, and plants and animals of cultural value to the Native American community; and 5) landscapes, sites, and materials of traditional cultural value to non-Native Americans.

D&D or D4 – D&D officially refers to deactivation and decommissioning of facilities that are no longer used. D4 is a more comprehensive term including deactivation, decommissioning, decontamination, and demolition of excess facilities.

Ecological Resources – any living resource, including species, populations, communities, and ecosystems.

Ecosystem – the physical and living resources in a defined area, including topography, physical structures, water resources, plants, and animals (species to communities).

Evaluation Period – the timeframe considered over which risks or impacts may occur. This Risk Review Project considers three time intervals in addition to the current condition: 1) active cleanup, 2) near-term post-cleanup, and 3) long-term post-cleanup.

Evaluation Unit Summary Template (or Evaluation Template) – a standardized format used to summarize information and risk ratings for each evaluation unit.

Evaluation Units (EUs) – groupings of sources, aggregated for evaluation as part of this Risk Review Project. Sources may be aggregated into an EU based on potential impacts to a common set of receptors or receptor geographic area, common past waste management practices, or integration in the waste management process. The grouping of sources to form specific EUs is discussed in Chapter 3.

Facility Worker – any worker or individual within the facility or activity geographic boundary as established for DSA and located less than 100 m from the potential contaminant release point. This definition is consistent with the DOE-STD-3009-2014 and SARAH definition of a facility worker (HNF-8739 2012).

Groundwater – the water located beneath the earth's surface in soil pore spaces and in the fractures of rock formations.

Groundwater Sites – groundwater areas at the Hanford Site that have been adversely impacted by contamination.

Hazard – any source of potential damage, harm, or adverse health effects. Hazard must be distinguished from risk, since risk should reflect any actions that may have been implemented to reduce the hazard and exposure to receptors.

Impacts – the damage or consequences (death, illness, reduced reproduction, resource impairment, or access limitation) from current or post-remediation residual contamination, or from cleanup, including degradation of resources (including ecosystems, cultural resources, economic assets, groundwater, and surface water above defined thresholds).

Indicator – a physical or biological endpoint used to assess the health and well-being of humans, other species, or ecosystems.

Initiating Events – natural or anthropogenic (man-made) events or processes that may result in the release or accelerated movement of contaminants from a source. Examples include water infiltration, earthquakes, fires, cleanup activities, volcanic eruptions, and sudden structural collapses or failures. Initiating events relevant to this Risk Review Project are discussed in Chapter 4.

Insufficient Information (IS) – adequate data or other forms of information are not available to complete the indicated part of the Evaluation Template.

Key Sources – the set of contaminated areas, wastes, and facilities within an EU that pose the primary risks from the EU. Key sources would not include minor contributors to the overall risks.

Legacy Source Sites – sites containing contaminant releases to the ground, surface, or subsurface resulting from prior actions, including waste disposal actions that are no longer being carried out at a particular location and that are potentially subject to cleanup.

Maximally Exposed Offsite Individual (MOI) – hypothetical individual defined to allow dose or dosage comparison with numerical criteria for the public. This individual is an adult typically located at the point of maximum exposure on the DOE site boundary nearest to the facility in question (ground level release), or may be located at some farther distance where an elevated or buoyant radioactive plume is expected to cause the highest exposure (airborne release). (*MOI used here is not the same as the Maximally Exposed Individual or the Representative Person used in DOE Order 458.1 for demonstrating compliance with DOE public dose limits and constraints.*)

Mitigated Hazards, Exposures, or Risks – there are many hazardous facilities and materials that could reach and harm receptors (see Unmitigated Hazards, Exposures, or Risks). Before and during remediation a variety of engineered and administrative controls are used to reduce sources and interdict exposure pathways, thereby mitigating exposures and reducing risks.

Monitoring – the regular, periodic assessment of the condition of humans or ecosystems (and their component parts). Usually involves surveillance for humans, and bioindicators for ecosystems.

Not Applicable (NA) – the indicated part of the Evaluation Template that is not applicable to the specific EU or evaluation period being considered.

Not Discernible (ND) – the indicated risk or potential impact is not distinguishable from surrounding conditions.

Novel Remediation Approach – a remedial approach that is unprecedented or contains components that are unprecedented.

Operable Units (OU) – group of land disposal sites placed together for the purposes of a remedial investigation/feasibility study and subsequent cleanup actions under CERCLA. The primary criteria for placing a site into an operable unit includes geographic proximity, similarity of waste characteristics and site type, and the possibility for economies of scale. NOTE: OU can also be applied to areas of groundwater contamination.

Operating Sites – operating facilities at the Hanford Site that are currently being used as part of the cleanup process.

Primary Contaminants (PCs) – contaminants that are considered either risk drivers from specific contaminant sources or site-wide contaminants (uranium, plutonium, technetium, etc.) for the Hanford Site. The terminology "primary contaminants" is used to differentiate the usage in this Risk Review Project from the regulatory usage of the terminology of "contaminants of potential concern."

Primary Sources – the origin of a potential or known release of contaminants to the environment (e.g., tanks, buildings, burial grounds, lagoons, cribs, plants that carry contaminants).

Public – represented by the MOI, a hypothetical receptor located at or beyond the Hanford Site boundary at the distance and in the direction from the point of release at which the maximum dose occurs. (*This is functionally equivalent to the "Offsite Public" as defined and used in the DOE-STD-3009-2014 and SARAH.)*

Pyrophoric – the property of some compounds (such as fine metal shavings of uranium) to spontaneously ignite in air.

Receptors – human populations, biota and ecological systems, environmental resources (ground and surface water), and cultural resources that may be exposed to contaminants via one or more contaminant transport and uptake pathways or otherwise adversely impacted by the contamination or cleanup actions.

Resources – a source, either material or non-material, that is considered an asset or from which a benefit is produced or derived. Resources have three main characteristics: utility, limited availability, and potential for depletion or consumption.

Risk – the potential (likelihood and magnitude) for adverse consequences to receptors. For human health, risks originate from exposure to contaminants or trauma associated with the presence of contaminants and/or cleanup of contaminant sources. For other receptors, such as groundwater and ecological and cultural resources, risks reflect the potential for damages or losses of the resource. Risk does not exist in the absence of exposure, although exposure and risks can be identified as "potential" (see also Mitigated and Unmitigated). Mitigated risk reflects those actions that have been implemented to reduce hazards, probability, and consequences of adverse events (e.g., source reduction or engineered barriers that prevent or reduce the transport of contaminants of concern from a source to a receptor).

Risk Assessment – used to characterize the nature and magnitude of health risks to humans (e.g., residents, workers, recreational visitors) and ecological receptors (e.g., birds, fish, wildlife) from radiological and chemical contaminants and other stressors that may be present in the environment.

Risk Characterization – a review of available information, including identification of key information gaps, to provide a comparative qualitative and semi-quantitative (order of magnitude) evaluation of relative risks to a set of receptors posed by a wide range of existing contamination of environmental media and sources of potential future additional environmental contamination. Risk characterization is in contrast to a regulatory risk assessment, which provides quantitative estimates of human health risks.

Risk Evaluation – an evaluation of the available information to evaluate potential harm to receptors and their ecosystems. It falls short of a formal risk assessment, and relies on available information.

Rough Order of Magnitude Relative Rating – binning to distinguish major differences in a risk to a specific receptor (i.e., human health, ecology, etc.) between multiple EUs by assigning values of Very High, High, Medium, Low, or ND (i.e., relative risks posed when comparing amongst EUs).

Secondary Sources – locations in the environment that have received material from a primary source such that they can also act as sources (e.g., soil, groundwater, sediments).

Tank Waste Sites – areas at the Hanford Site (often referred to as tank farms) that contain single- and double-shell underground tanks that house high-level radioactive and chemical wastes that are the byproduct of "reprocessing" spent nuclear fuel.

Unmitigated Hazards, Exposures, or Risks – there are many hazardous facilities and materials that could reach and harm receptors if not mitigated. The Risk Review Project considers these in terms of probability and consequence, assuming no effective mitigation measures (engineered and administrative controls) are in place (see Mitigated Hazards, Exposures, or Risks).

Urgency – higher urgency refers to projects where the risks or impacts to receptors are likely to increase due to degradation at the source, further dispersion of contamination in groundwater, loss of structural integrity, or loss of institutional memory. Lower urgency refers mainly to passively stable hazard configurations and when radiologic decay significantly reduces risk depending on the half-life of each radionuclide.

Vadose Zone – zone of soil or rock between the land surface and the subsurface water table. Pore spaces in the vadose zone are partly filled with water and partly filled with air. The vadose zone is bounded by the land surface above and by the water table below.

CHAPTER 1. INTRODUCTION, PROJECT GOAL, OBJECTIVES, AND SCOPE

1.1. BACKGROUND

In January 2014, the Deputy Under Secretary of the Department of Energy (DOE) asked the Consortium for Risk Evaluation with Stakeholder Participation (CRESP) to conduct a Hanford Site-wide evaluation of human health, nuclear safety, environmental, and cultural resource risks associated with existing hazards, environmental contamination and cleanup activities (See Appendix A); hereinafter referred to as the "Risk Review Project." This report provides the results of the first set of evaluations completed for the project, as well as preliminary observations. A final report is expected to be issued in 2016.

From the beginning, the Risk Review Project's goal has been to carry out a screening process to help inform future cleanup sequencing at Hanford. Accomplishing this goal includes identifying and characterizing potential risks to the public, workers, groundwater and the Columbia River, and ecological and cultural resources (collectively referred to as "receptors").

Project results are expected to provide DOE and regulators with a common understanding of the risks posed by hazards (i.e., contained radionuclide and chemical contaminant inventories, physical-chemical forms, structural integrity, vulnerability to initiating events), existing environmental contamination, and cleanup actions (including mitigation measures that offset or reduce risk associated with cleanup). Specific objectives of the Risk Review Project are to:

- Review hazards and existing environmental contamination site-wide and determine the potential for contaminants and cleanup actions to cause risks to receptors, and identify key uncertainties and data gaps;
- Provide relative ratings of risks to receptors from hazards and existing environmental contamination, and identify the most urgent risks to be addressed, to better enable the Tri-Parties (DOE, the Environmental Protection Agency (EPA), State of Washington) to make decisions on the sequencing of Hanford cleanup activities; and,
- Provide context for understanding how the hazards, existing environmental contamination, current risks and risks posed by cleanup at the Hanford Site compare to risks and impacts posed by other large-scale regional sites and analogous cleanup activities[23]

Meeting all three objectives described above is daunting. Within the Risk Review Project, risk characterization relies on existing information about the Hanford Site that then is assembled and evaluated to characterize risks. These risks are grouped or binned for each type of receptor as "Very High," "High," "Medium," "Low," or "Not Discernible" (ND). This approach is intended to provide relative risk ratings *within* receptor categories (i.e., relative binning of risks to human health, groundwater, ecology, etc.). However, the Risk Review Project ratings are not normalized across receptor categories (i.e., a rating of "Very High" for groundwater should not be equated to a rating of "Very High" for ecology).

The Risk Review Project is being carried out in multiple stages, which are:

[23] This part of the Risk Review Project objective is not covered in this interim progress report, but will be addressed as part of the final report.

- Development of the risk characterization methodology and testing the developed methodology on pilot case sites representing the primary sources of contamination at Hanford (e.g., operating facilities and tank waste and tank farms). The methodology has been adapted from prior risk characterization approaches used at Hanford and elsewhere and suitably tailored to fit the Hanford Site's unique cleanup and waste management activities and diversity of information, as well as the goal and objectives of the Risk Review Project. The methodology document may be found on CRESP's website (www.cresp.org/hanford) (CRESP 2015).
- Completion of an interim progress report that provides risk characterization of approximately half of the contaminant sources at the Hanford Site. As noted, results of the characterizations are the subject of this report.
- Completion of a final report that includes risk characterization of the full set of contaminant sources at the Hanford Site included in the Risk Review Project. The final report is expected to be completed in 2016.

Beginning in 1943, the area now known as Hanford Site, which is located along the Columbia River in southeast Washington and covers 586 square miles, was transformed from primarily an agricultural area into an industrial complex designed to produce plutonium to use as a military deterrent during World War II. This mission continued until the Cold War ended, and in 1989 the mission evolved to waste management and cleanup of the contamination remaining on Hanford Site from work conducted during the Manhattan Project and Cold War eras.

Cleanup at the Hanford Site has several goals, but three of the most important are protecting human health and the Columbia River and restoring groundwater to its beneficial use. Cleanup consists of three major components: River Corridor, Central Plateau, and tank waste. Cleanup activities for all three are considered complex, involve multiple projects, and will cost billions of dollars before requirements can be considered met. In fact, cleanup at Hanford has proven to be much lengthier, more complex, more technically challenging, and more expensive than was envisaged in 1989, when Hanford's mission was refocused to waste management and cleanup. Additionally, in some areas at the site, cleanup will continue for many years and active systems may need to remain operational for long periods. Despite the difficulties, considerable progress has been made in cleaning up the Site (e.g., treating contaminated groundwater near the Columbia River). (DOE/RL-2014-11 2014*)*

The Hanford Site is located along the Columbia River in southeast Washington. It covers 586 square miles, which is about half the size of Rhode Island.

Since the early 1990s, cleanup urgency in the River Corridor has been driven by the threats to the Columbia River posed by hundreds of waste sites and contaminated facilities, including nine retired plutonium production reactors. The corridor consists of 220 square miles, but considerable portions were never directly involved in or affected by weapons production activities.

The Central Plateau is composed of 75 square miles and located, as the name suggests, in the central portion of the Hanford Site. The Central Plateau contains waste sites, active treatment and disposal areas, historical waste disposal (burial) grounds, and surplus facilities. Additionally, there are areas with deep soil contamination and an estimated 60 square miles of contaminated groundwater. About 10 square miles comprise the inner area within the Central Corridor and the remaining acreage is referred to as the outer area. The inner area serves as the area for long-term waste management and containment of residual contamination.

The third component of Hanford cleanup is tank waste, which is found in so-called tank farms in the inner area of the Central Plateau. The farms contain approximately 55 million gallons of radioactive waste stored in 177 tanks that are scattered throughout the inner area of the Central Plateau and intermingled with other waste sites. Intentional discharges, unintentional discharges and leaks have occurred and some releases have reached groundwater; furthermore, some tanks are known or assumed to be currently leaking at a very slow rate. In addition to containment and retrieval, the tank waste strategy includes treatment and disposal (Hanford Site Cleanup Completion Framework, DOE/RL-2009-10, Rev. 1).

Cleanup at the Hanford Site is governed by environmental laws, primarily the Comprehensive Environmental Response, Compensation and Liability Act (CERCLA), P.L. 96-510, 42 U.S.C. 9601 (1980, et seq.) and the Resource Conservation and Recovery Act (RCRA) and their regulations and guidance documents. The purpose of both statutes is to reduce the risk from contamination at sites to levels that protect human health and the environment. Under CERCLA, cleanup is DOE's responsibility and implementation is overseen by EPA and state regulatory agencies through federal facility agreements and regulatory permits. The legal framework relied on at Hanford is the 1989 Tri-Party Agreement executed by the DOE and its regulators, EPA and the State of Washington Department of Ecology. That federal facility agreement document establishes milestones for completing agreed-upon cleanup activities and is regularly updated. Another important legal document is the 2010 consent decree, which establishes milestones for cleanup of tank waste and farms.

Since cleanup began, DOE has maintained a dialogue with a broad spectrum of interested community members, neighboring state Oregon, four Native American Tribes having historical and cultural ties to the Hanford Site (Nez Perce, Confederated Tribes of the Umatilla Indian Reservation, Confederated Tribes and Bands of the Yakama Nation, and Wanapum), local governments, and stakeholder groups. Federal law, including CERCLA, also gives individuals, Tribes, governments, and stakeholder groups the opportunity to comment on documents that guide cleanup.

The Risk Review Project is being carried out in regular dialogues with senior management from DOE, EPA, and the State of Washington Departments of Ecology and Health through a Core Team that provides advise on the development and execution of the Risk Review Project. Pacific Northwest National Laboratory (PNNL) provides analytical and research assistance, which includes gathering existing information on each unit being evaluated.

The Risk Review Project is led by CRESP, and CRESP is responsible for its execution, results, conclusions, and recommendations. CRESP is a consortium of universities supported by DOE through a cooperative agreement.[24] The CRESP mission is to advance environmental cleanup by improving the scientific and technical basis for management decisions while fostering opportunities for public participation. CRESP has completed risk-informed characterization projects involving complex issues at both large and small DOE Office of Environmental Management sites.

1.2. PURPOSE OF THE INTERIM PROGRESS REPORT

The purpose of this interim progress report for the Risk Review Project is to present the results of 25 of the approximately 60 units identified for evaluation. The evaluation results for the remaining units will be in the final report. Results include completed templates for each evaluation unit (EU) (Appendix) together with the qualitative and order-of-magnitude relative rating and binning of risks to receptors that include human health, groundwater and the Columbia River, and ecological resources. An overall

[24] CRESP is supported by DOE under Cooperative Agreement Number DE-FC01-06EW07053, titled The Consortium for Risk Evaluation with Stakeholder Participation III, and awarded to Vanderbilt University.

risk rating is not provided for cultural resources; however, information about cultural resources has been gathered, described, and analyzed as a planning guide or tool for future activities. Details on the outcomes of the ratings or binning of risks to receptors are given in Chapter 4.

Cleanup sites remaining at Hanford have been divided into approximately 60 EUs organized into five categories: (1) legacy source sites, (2) tank waste and farms, (3) groundwater plumes, (4) inactive facilities undergoing D&D, (5) and operating facilities. Chapter 3 of this report provides results from each category and makes comparisons where appropriate (e.g., tank waste and farms). Chapter 3 also compares inventories and physical/chemical states and provides a table of the impacts of the most important initiating events.

An important feature of this interim progress report is the interim observations from project work completed to date, which are described in Chapter 5.

In addition to the results of the remaining units identified for evaluation under the Risk Review Project, the final report will include the status of contaminants likely to be present during the long-term, post-cleanup evaluation period.

Integration across receptor categories will not occur. However, the final report will include examples of ways to carry out difficult grouping or binning that integrates the ratings across receptor categories (e.g., integrated risk binning that combines risks to human health with risks to ecology and groundwater).

The Hanford Site needs to be viewed in the context of the regional economy, important onsite or adjacent economic assets, and the multiple relevant sources of human health risks and impacts to resources near the Hanford Site. Examples include the Energy Northwest Columbia Generating Station (nuclear) and PNNL facilities in the Hanford 300 Area, the U.S. Ecology waste disposal site in the Central Plateau, and discharges from non-Hanford sources to the Columbia River of contaminants found on the Hanford Site (e.g., discharges from agricultural and industrial activities). The Risk Review Project will also seek to put the Hanford risks, potential impacts, and cleanup in context with other large cleanup efforts in the region. In addition, the Risk Review Project in the final report will provide a regional context for the relationships between the Hanford Site cleanup and the regional economy.

Finally, the final report will include overall observations and final recommendations.

1.3. WHAT THE RISK REVIEW PROJECT IS AND IS NOT

To better understand the context for the interim progress report, it is important to describe the parameters for the Risk Review Project, including what the project is not:

- The Risk Review Project is neither intended to substitute for nor preempt any requirement imposed under applicable federal or state environmental laws. As important, the Risk Review Project is not intended to make or replace any decision made under the Hanford Federal Facility Agreement and Consent Order (Tri-Party Agreement) and/or 2010 Consent Order, or amendments.
- The Risk Review Project is not intended to interpret treaty rights that exist between the United States and Native American Tribes.
- The Risk Review Project is focused only on portions of the Hanford Site where cleanup or waste management activities are ongoing and will continue past October 1, 2015, or where cleanup or waste management activities will occur beginning October 1, 2015, or later. Cleanup actions

considered completed by the Tri-Parties are not part of the Risk Review Project and therefore will not be evaluated. Specific areas of the Hanford Site that are included as well as those that are excluded from the Risk Review Project are described in Chapter 3 of this document.

- The Risk Review Project is focused on risk characterization, which is a necessary predecessor to risk management, but does not focus on risk management decisions. Nonetheless, cleanup actions can cause risks to receptors, which are a part of risk management decisions. The Risk Review Project, however, will not recommend which cleanup option should be selected. Instead, the Risk Review Project considers a plausible range of cleanup actions for different types of hazards and existing environmental contamination to better understand the range of potential risks that may be caused by future cleanup actions.
- The Risk Review Project is not carrying out a CERCLA risk assessment or a Natural Resources Damage Assessment evaluation. Evaluations of hazards, existing environmental contamination, and rough order-of-magnitude estimates of risks to receptors using existing information are the basis for developing groupings, or bins, of risk and identifying the most urgent risks to be addressed.

CHAPTER 2. METHODOLOGY OVERVIEW

2.1. OVERARCHING METHODOLOGY AND APPROACH

To accomplish the Risk Review Project's goal of carrying out a screening process to help inform future cleanup sequencing at Hanford, the most recent, available information about hazards (i.e., contaminant inventories, physical chemical forms), existing environmental contamination, and events that may adversely impact receptors at the Hanford Site is gathered, described, and analyzed. The Risk Review Project is using information and reasonable planning assumptions that are available as of January 2015 for the interim progress report.

The general risk characterization paradigm that is being used to evaluate risks to human health and other receptors includes the following steps (Figure 2-1):

- **Identification of EUs.** The remaining cleanup sites[25] at Hanford as of October 1, 2015, have been divided into approximately 60 EUs, which have been organized into five categories composed of geographically co-located sites to the extent possible, considering commonality among source types and the overlapping of impacts and risks to receptors.[26] The five categories are (1) legacy source sites, such as past practice liquid waste disposal and buried solid waste sites; (2) tank waste and farms and co-located legacy contamination sources; (3) groundwater plumes; (4) inactive facilities undergoing decommissioning, deactivation, decontamination, and demolition (D4); and (5) operating facilities used as part of the cleanup process. Table 2-1 lists all the EUs and Figure 2-2 provides a map showing the locations of EUs evaluated in this interim report. Further descriptions of the grouping methodology and sources included in each EU are provided in Chapter 3 of the methodology document (CRESP 2015).

- **Summary Evaluation Templates.** Each EU will be described in detail using existing information, including regulatory documents, maps, and studies (environmental impact statements (EISs), CERCLA remedial investigations, preliminary documented safety analyses (DSAs), etc.). Information gathered on each EU includes the unit description and history; an inventory of waste and contamination history; and selected or the potential range of cleanup approaches. The ratings of risks to receptors then are based on a rough order of magnitude relative grouping[27] or binning of risks to each different type of receptor. The primary groupings are Very High, High, Medium, Low, and Not Discernible. A standardized summary report structure, referred to as an Evaluation Template, is used to present the resulting information about each EU. The EU template may be found in Appendix B of the methodology document (CRESP 2015).
- **Risk Ratings.** Potential receptors that may be at risk are characterized and rated using a defined rating scale derived from the evaluation methodology developed for each receptor type. The rating scale for each type of receptor is determined from the specific methodology developed for that receptor using recognized thresholds, if they exist, as screening levels, as well as other

[25] The Hanford Site has been divided into more than 2500 individual contaminated areas (i.e., operable units) and RCRA permitted facilities for regulatory purposes.
[26] The EU concept was developed by the Risk Review Project to provide a tractable basis for reviewing the myriad of cleanup challenges at the Hanford Site.
[27] "Rough order of magnitude grouping" refers to drawing distinctions between groupings that are approximately a factor of 10 different when based on quantitative information (or substantially different for qualitative assessments), recognizing the inherent uncertainties and data gaps.

factors. The receptors being rated using a defined rating scale are facility workers, co-located people, public, groundwater and the Columbia River, and ecological resources. Non-human receptors are also referred to as resources. This approach is intended to provide relative risk ratings *within* receptor categories (i.e., relative binning of risks to the Columbia River, groundwater, ecology, etc.), which will be used to inform urgency of addressing specific hazards and existing environmental contamination. An overall risk rating will not be provided for cultural resources; however, information about cultural resources within or near (within 500 m of) each EU will be gathered, described, and analyzed as a planning guide or tool for future activities. Although the integration across receptor categories is considered inherently driven by individual and collective values, the Risk Review Project will provide examples that illustrate how grouping or binning that integrates the ratings across receptor categories (e.g., integrated risk binning that combines risks to human health with risks to ecology and groundwater) could be carried out.[28] Economic assets are described briefly at the end of this chapter, but identified economic assets are not evaluated individually in detail in this document. EU evaluations indicate when the current status, delay, or cleanup activities may affect DOE or non-DOE economic assets directly. The receptor methodologies or approaches are summarized in Section 2.3 of this chapter. More detailed descriptions of the methodologies for each receptor are in Chapters 5 through 8 of the methodology document (CRESP 2015).

- **Initiating Events.** The likelihood of initiating events, both localized and regional, which may occur during any or all of the evaluation periods, including operational events such human error and external episodic events such as fire, volcanic eruptions, and loss of power, are described. This is to establish a consistent basis for identifying and categorizing phenomena that may remove or degrade barriers, thus placing receptors at risk from contaminants. Nuclear safety is considered in the context of potential initiating events and risks to receptors and is described in more detail in Chapter 4 of the methodology document (CRESP 2015). Furthermore, contaminants in environmental media (e.g., soils, vadose zone, groundwater) will flow, move, diffuse, and disperse under long-term prevailing conditions without the presence of specific episodic initiating events.
- **Temporal Evaluation Periods.** Risks are evaluated based on distinct time frames or evaluation periods. The evaluation periods are (1) active cleanup period (or until 2064), including the current status of the EU prior to cleanup, where applicable, and during active cleanup (or until 2064); (2) near-term post-cleanup (until 2164, or assuming a 100-year duration for institutional controls associated with areas transferred from federal control); and (3) long-term post-cleanup (or until 3064). Each EU and selected EU components are evaluated as if cleanup were not to occur for 50 years to provide insights into the potential risks of delay to help inform sequencing of cleanup actions. However, this is not to infer that delay of cleanup for 50 years is recommended. Section 2.4 of the methodology document provides additional assumptions relative to each evaluation period (CRESP 2015). Using the specific methodology to rate risks for each receptor (described in Chapters 5 through 8 of the methodology document (CRESP 2015)), each EU will receive a rating for each applicable receptor during the active cleanup period (including current status and as a result of cleanup actions where applicable) and the near-term post-cleanup period.[29] The long-term post-cleanup period will be considered for the remaining

[28] This will be included in the final report but not this interim progress report.
[29] The human health risks associated with potential failure of institutional controls during the near-term post-cleanup period will be evaluated in the final report but not in this interim report.

contaminant inventory and physical/chemical form, engineered and natural containment barriers to contaminant release, and potential risk pathways. However, a rating for specific receptors will not be assigned to the long-term post-cleanup period.

- **Economic Assets.** The Hanford Site and its vicinity include a range of economic assets that may be impacted by cleanup activities at Hanford. DOE economic assets include the Hanford Site infrastructure. Commercial activities on the Hanford Site include the U.S. Ecology low-level waste disposal facility, Energy Northwest nuclear power generation, and multiple PNNL research laboratories. Furthermore, the regional economy may be impacted by public perceptions of cleanup activities at the Hanford Site. EU evaluations indicate when the current status, delay, or cleanup activities may directly affect DOE and non-DOE economic assets.

The overall methodology is illustrated in Figure 2-1 below and brief descriptions of the methodology followed for each of the receptors evaluated are discussed later in this chapter.

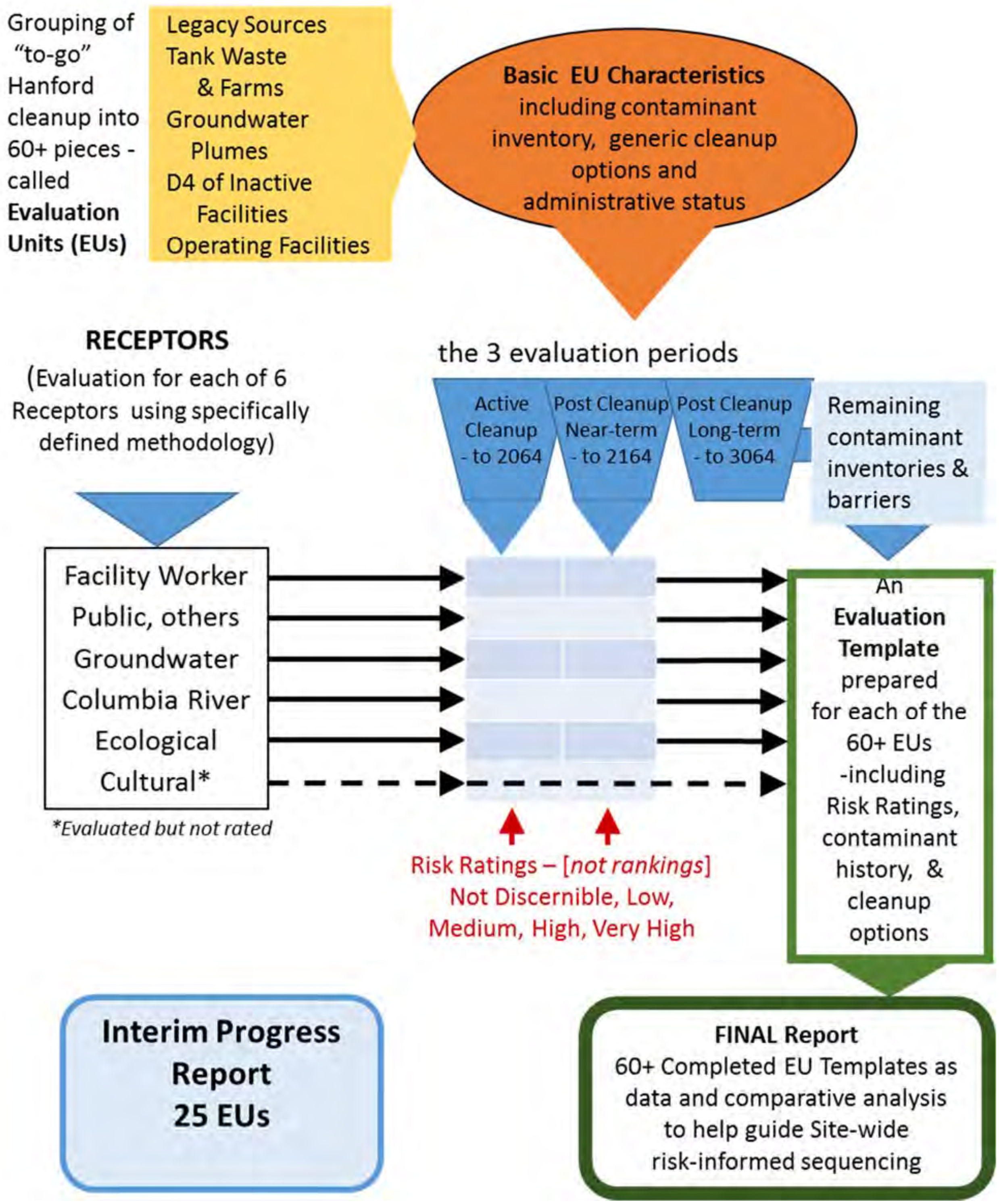


Figure 2-1. Methodology overview for the Hanford Site-wide Risk Review Project.

LIST OF EVALUATION UNITS / MAPS OF EVALUATION UNIT LOCATIONS

Table 2-1. Listing of evaluation units. (EUs highlighted in blue are included in the interim report.)

The general locations of the EUs, except the groundwater EUs analyzed in this report, are shown in Figure 2-2. More detailed maps of all EU locations can be found in Chapter 3.

EU ID	Group	EU Name	Description & Comments	Operable Unit Crosswalk	Related EUs
			Legacy Sites		
RC-LS-1	Legacy Source	618-11 Burial Ground	618-11 Burial Ground	300-FF-2	CP-GW-1
RC-LS-2	Legacy Source	K Area Waste Sites	Legacy waste sites within the fence at 100-K, where remediation is post 2015	100-KR-1, 100-KR-2	RC-DD-2
RC-LS-3	Legacy Source	Orchard Lands	Pre-Hanford orchard lands	100-OL-1	
RC-LS-4	Legacy Source	618-10 Burial Ground	618-10 Burial Ground	300-FF-2	
CP-LS-1	Legacy Source	BC Cribs and Trenches	Cribs, trenches, and tank located to the south of the 200 E Area	200-BC-1	CP-LS-17, CP-GW-1
CP-LS-2	Legacy Source	Plutonium Contaminated Waste Sites	Plutonium (Pu) contaminated cribs and trenches associated with the Plutonium Finishing Plant (PFP) in central part of 200 W Area	200-PW-1,3,6 200-CW-5	CP-DD-5, CP-GW-2
CP-LS-3	Legacy Source	U Plant Cribs and Ditches	Liquid waste discharges in the central part of 200 W Area associated with U Plant operations	200-DV-1, 200-WA-1	CP-LS-7, CP-DD-3, CP-GW-2
CP-LS-4	Legacy Source	REDOX Cribs and Ditches	Liquid waste discharges in the southern part of 200 W Area associated with Reduction-Oxidation Plant (REDOX) (S Plant) operations	200-WA-1, 200-DV-1	CP-DD-4, CP-GW-2
CP-LS-5	Legacy Source	U and S Pond	Liquid waste discharges in the southern part of 200 W and outside the fence of 200 W associated with U and S ponds and closely related trenches, ditches, and cribs	200-CW-1, 200-OA-1	CP-GW-2
CP-LS-6	Legacy Source	T Plant Cribs and Ditches	Liquid waste sites on the northern end of 200 W Area (associated with T Plant operations)	200-WA-1, 200-DV-1	CP-GW-2

EU ID	Group	EU Name	Description & Comments	Operable Unit Crosswalk	Related EUs
CP-LS-7	Legacy Source	200 Area HLW Transfer Pipeline	High-level waste (HLW) pipelines outside of tank farm EUs. Includes 200 East-West transfer lines, IMUSTS, catch tanks, diversion boxes, etc.	200-IS-1	CP-TF-1 through -9
CP-LS-8	Legacy Source	B plant Cribs and Trenches	Liquid waste sites on the west side of 200 E (associated with B Plant operations)	200-EA-1, 200-DV-1, 200-OA-1	CP-DD-2, CP-GW-1
CP-LS-9	Legacy Source	PUREX Cribs and Trenches (inside 200 E)	Liquid waste sites on the east side of 200 E (associated with PUREX (Plutonium Uranium Extraction Plant) operations and immediately surrounding PUREX)	200-EA-1, 200-PW-3	CP-DD-1, CP-GW-1
CP-LS-10	Legacy Source	PUREX and Tank Farm Cribs and Trenches (outside 200 E)	Liquid waste sites on the east side of 200 E (associated with PUREX and tank farm operations, but outside the 200 E Area fence)	200-EA-1	CP-GW-1
CP-LS-11	Legacy Source	B Pond	B Pond and associated ditches, where liquid wastes were discharged in the northern and western part of 200 E and outside the fence of 200 E	200-EA-1, 200-CW-1, 200-OA-1, 200-IS-1	CP-LS-7, CP-GW-1
CP-LS-12	Legacy Source	200 West Burial Grounds	Past practice radioactive waste burial grounds, including retrievable stored transuranic (TRU) trenches	200-SW-2	
CP-LS-13	Legacy Source	200 West Miscel-laneous Waste Sites	Waste sites, buildings, and structures associated with maintenance operations, laundry, and coal power plant in the west/central portion of 200 W	200-QA-1, 200-WA-1, 200-IS-1	CP-LS-7
CP-LS-14	Legacy Source	200 East Burial Grounds	Past practice radioactive waste burial grounds	200-SW-2	
CP-LS-15	Legacy Source	200-East Miscel-laneous Waste Sites	Waste sites, buildings, and structures associated with maintenance operations and coal power plant in the southern portion of 200 E	200-OA-1, 200-EA-1	
CP-LS-16	Legacy Source	Grout Vaults	Grout vaults located west of the Hanford Waste Treatment and Immobilization Plant (WTP)	NA	

EU ID	Group	EU Name	Description & Comments	Operable Unit Crosswalk	Related EUs
CP-LS-17	Legacy Source	BC Control Zone	Surface contamination area to the south of 200 E (excluding the BC Cribs and Trenches)	200-OA-1	CP-LS-1
CP-LS-18	Legacy Source	Outer Area Sites	Outer area solid waste disposal sites (e.g., NRDWL, SWL, etc.) and other outer area waste sites, miscellaneous buildings, and structures	200-CW-1, 200-CW-3, 200-OA-1, 200-SW-1	
RC-LS-4	Legacy Source	618-10 Burial Ground	618-10 Burial Ground	300-FF-2	
Tank Farms					
CP-TF-1	TF	T Tank Farm	T tank farm, ancillary structures, associated liquid waste sites, and soils contamination	200-DV-1, WMA T, 200-WA-1	CP-LS-7, CP-GW-2
CP-TF-2	TF	S-SX Tank Farms	S-SX tank farms, ancillary structures, associated liquid waste sites, and soils contamination. Includes 242-S Evaporator	WMA S/SX, 200-DV-1, 200-WA-1	CP-LS-7, CP-TF-9, CP-GW-2
CP-TF-3	TF	TX-TY Tank Farms	TX-TY tank farms, ancillary structures, associated liquid waste sites, and soils contamination. Includes 242-T Evaporator	WMA TX/TY, 200-DV-1, 200-WA-1	CP-LS-7, CP-GW-2
CP-TF-4	TF	U Tank Farm	U tank farm, ancillary structures, associated liquid waste sites, and soils contamination	WMA U, 200-WA-1	CP-LS-7, CP-GW-2
CP-TF-5	TF	A-AX Tank Farms	A-AX tank farms, ancillary structures, associated liquid waste sites, and soils contamination	WMA A/AX, 200-EA-1, 200-PW-3	CP-LS-7, CP-TF-8, CP-GW-1
CP-TF-6	TF	B-BX-BY Tank Farms	B-BX-BY tank farms, ancillary structures, associated liquid waste sites, and soils contamination	WMA B/BX/BY, 200-DV-1, 200-EA-1	CP-LS-7, CP-GW-1
CP-TF-7	TF	C Tank Farms	C tank farm, ancillary structures, associated liquid waste sites, and soils contamination	WMA C	CP-LS-7, CP-GW-1
CP-TF-8	TF	200 East Double-Shell Tanks (DSTs)	AN, AP, AW, AY, AZ tank farms, ancillary structures, associated liquid waste sites, and soils contamination	NA	CP-LS-7, CP-TF-5
CP-TF-9	TF	200 West DSTs	SY tank farm, ancillary structures, associated liquid waste sites, and soils contamination	WMA S/SX	CP-LS-7, CP-TF-2

EU ID	Group	EU Name	Description & Comments	Operable Unit Crosswalk	Related EUs
Groundwater					
RC-GW-1	GW	300 Area Ground-water (GW) Plumes	300 Area uranium and associated contaminant plumes	300-FF-5	RC-DD-1
RC-GW-2	GW	100-N GW Plume	100-N strontium and associated contaminant plumes	100-NR-2	
RC-GW-3	GW	100-B/D/H/F/K Area GW Plumes	100-B/D/H/F/K Area chromium and associated contaminant plumes, includes pump and treat systems	100-BC-5, 100-KR-4, 100-HR-3, 100-FR-3	
CP-GW-1	GW	200 East Ground-water	Existing groundwater plumes emanating from 200 E Area	200-BP-5, 200-PO-1	CP-LS-1, -8, -9, -10, -11, CP-TF-5, -6, -7
CP-GW-2	GW	200 West Ground-water	Existing groundwater plumes emanating from 200 W Area, includes pump and treatment systems	200-ZP-1, 200-UP-1	CP-LS-2 through -6, CP-TF-1 through -4
Deactivation (Decontamination) and Decommissioning (D&D)					
RC-DD-1	D&D	324 Building	324 Building and associated soil contamination under the building	300-FF-2	RC-GW-1
RC-DD-2	D&D	KE/KW Reactors	KE/KW Reactors, basin, ancillary buildings, sludge, associated soil contamination	TBD, 100-KR-1, 100-KR-2	RC-LS-2, RC-GW-3
RC-DD-3	D&D	Final Reactor Disposition	C, D, DR, F, H, KE, KW, and N Reactors	TBD	
RC-DD-4	D&D	FFTF	Fast Flux Test Facility and ancillary buildings and structures	NA	
CP-DD-1	D&D	PUREX	PUREX Canyon, tunnels, ancillary buildings, structures, and associated near-surface contaminated soils	200-CP-1	CP-LS-9
CP-DD-2	D&D	B Plant	B Plant Canyon, ancillary buildings (e.g., 224-B), structures, and associated near-surface contaminated soils, includes the D&D of the Waste Encapsulation Storage Facility (WESF) after the capsules are moved into dry storage	200-CB-1	CP-LS-8

EU ID	Group	EU Name	Description & Comments	Operable Unit Crosswalk	Related EUs
CP-DD-3	D&D	U Plant	U Plant Canyon, ancillary buildings, structures, and associated near-surface contaminated soils	200-CU-1	CP-LS-3
CP-DD-4	D&D	REDOX	REDOX Canyon (S Plant), ancillary buildings, except 222-S laboratory, structures, and associated near-surface contaminated soils	200-CR-1	CP-LS-4
CP-DD-5	D&D	PFP	PFP ancillary buildings, structures, and associated near-surface contaminated soils	200-WA-1	CP-LS-2
Operating Facilities					
RC-OP-1	Ops	KW Basin Sludge	KW sludge, basin, and ancillary buildings	100-KR-1, 100-KR-2	RC-DD-2, RC-LS-2
RC-OP-2	Ops	Retained Facilities	Retained Office of Science facilities including the 318, 320, 325, 331, and 350 buildings	300-FF-2	RC-GW-1
CP-OP-1	Ops	CWC	Central Waste Complex (CWC) operations, closure, and D&D	NA	
CP-OP-2	Ops	T Plant	T Plant Canyon, ancillary buildings, structures. Evaluate through operations, then will be preserved as a historical site or undergo D&D	NA	
CP-OP-3	Ops	WESF (only Cs/Sr capsules)	WESF – Evaluate for the storage and removal of Cs/Sr Capsules. D&D included with B Plant EU	NA	CP-DD-2
CP-OP-4	Ops	WRAP	Waste Repackaging and Processing (WRAP) facility operations, closure, and D&D	NA	
CP-OP-5	Ops	CSB	Canister Storage Building (CSB) operations and closure (including adjacent spent fuel dry storage pad)	NA	
CP-OP-6	Ops	ERDF	Environmental Restoration Disposal Facility (ERDF) operations and closure	NA	
CP-OP-7	Ops	IDF	Integrated Disposal Facility (IDF) operations and closure	NA	
CP-OP-8	Ops	Mixed Waste Trenches	Mixed waste trenches (Trenches 31 and 34, next to WRAP) operations and closure	200-SW-2	CP-LS-14
CP-OP-9	Ops	Naval Reactors Trench	Naval reactors disposal trench operations and closure	200-SW-2	CP-LS-14
CP-OP-10	Ops	242-A Evaporator	Operations and D&D of the 242-A Evaporator	NA	CP-TF-5

EU ID	Group	EU Name	Description & Comments	Operable Unit Crosswalk	Related EUs
CP-OP-11	Ops	LERF	Operations and closure of the Liquid Effluent Retention Facility (LERF)	NA	
CP-OP-12	Ops	TEDF	Operations and closure of the Treated Effluent Disposal Facility (TEDF)	NA	
CP-OP-13	Ops	SALDS	Operations and closure of the State Approved Land Disposal Sites (SALDS)	NA	
CP-OP-14	Ops	WTP	WTP operations and D&D. Includes new tanks (if needed), preconditioning, four major facilities, and interim storage elements	NA	
CP-OP-15	Ops	222-S Laboratory	Operations and D&D of the 222-S Laboratory	NA	
CP-OP-16	Ops	ETF	Effluent Treatment Facility	NA	CP-OP-11 CP-OP-12 CP-OP-13
CP-DD-17	Ops	WSCF	Waste Sampling and Characterization Facility and ancillary buildings and structures	200-ZP-1	CP-GW-2

Notes for River Corridor: Includes Energy Northwest, PNNL, HAMMER, and LIGO as a comparator – but not as an EU. Includes infrastructure discussion as context, but not as an EU. Source remediation and D&D (RTD) being completed in FY15 are not included.
Notes for Central Plateau: Includes U.S. Ecology as a comparator – but not an EU. Includes infrastructure discussion as context, but not as an EU. T Plant is an operating facility and an historic site that is eligible for inclusion in the Manhattan Project National Historical Park Act that establishes the park at Hanford Site (S.1847, section 3039 (2014)).

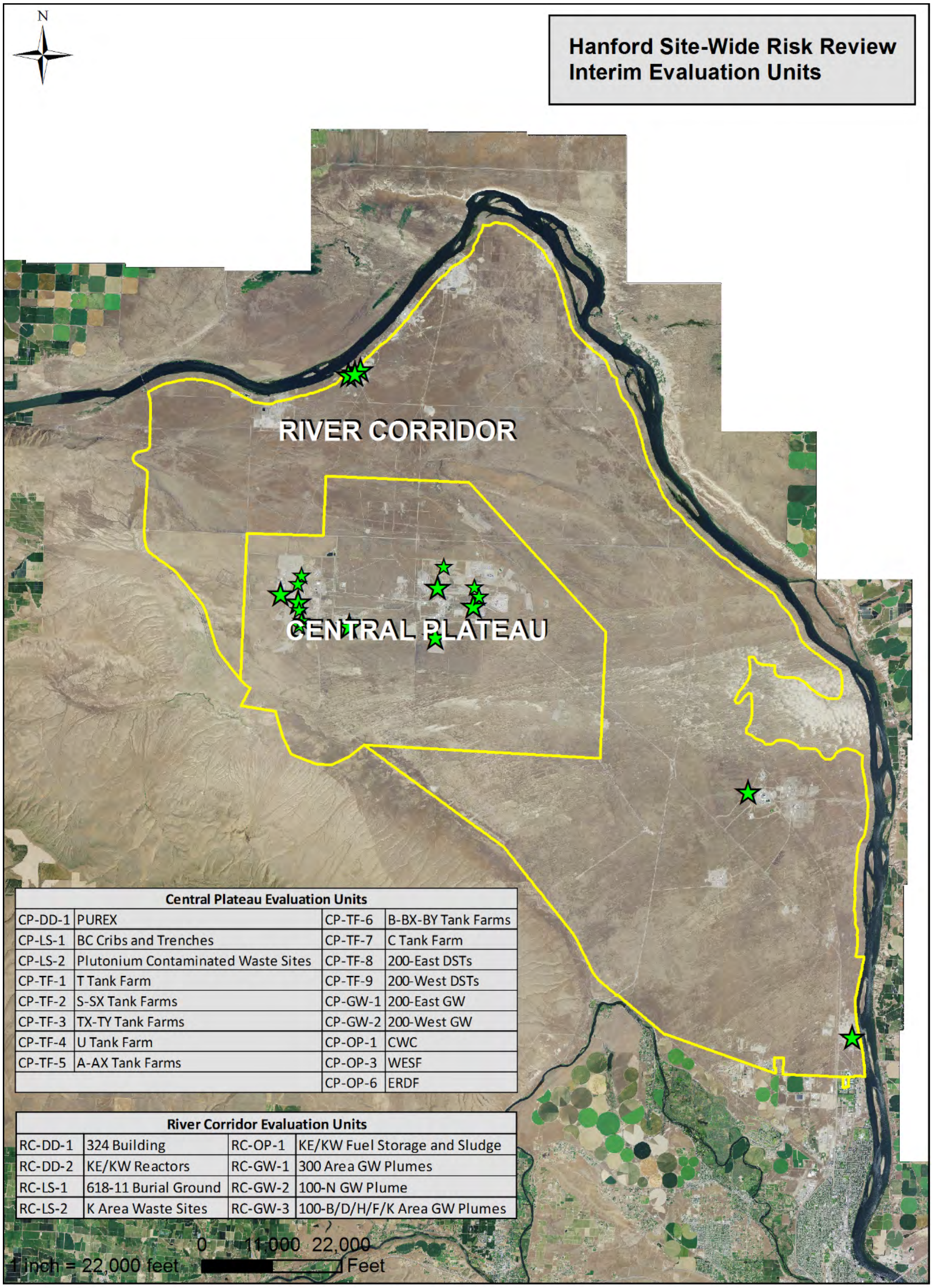


Figure 2-2. General location evaluation units included in this interim report except groundwater EUs.

RADIONUCLIDES AND OTHER CONTAMINANTS CONSIDERED

The Risk Review Project focuses on radionuclides and contaminants that have been of large, site-wide significance and public concern or are the major contributors to receptor risks at specific EUs (i.e., risk drivers). Collectively, the set of radionuclides and contaminants being considered may differ for specific EUs (because of either presence or absence of specific radionuclides and contaminants and different risk and impact drivers), but are collectively referred to as primary contaminants.[30] In most cases, the list of primary contaminants for each EU will be more limited than the regulatory list of contaminants of potential concern. The radionuclides and other contaminants that are considered to have site-wide significance and are of large public concern at the Hanford Site for the interim report are:

- Radionuclides – cesium-137 (Cs-137); iodine-129 (I-129); isotopes of plutonium (Pu) including Pu-238, Pu-239, Pu-240, Pu-241, Pu-242; strontium-90 (Sr-90); technetium-99 (Tc-99); tritium (H-3 or ^3H_2O); and americium-241 (Am-241)
- Other contaminants – carbon tetrachloride (CT or CCl_4), trichloroethylene (TCE), hexavalent chromium [Cr(VI)], total chromium [Cr(total)], total uranium [U(total)][31], and nitrate (NO_3)

Examples of additional primary contaminants at specific or limited EUs are cyanide (CN), which is present in the B-Complex groundwater plume within the Central Plateau, diesel as total petroleum hydrocarbons (TPH-diesel), lead (Pb), and tributyl phosphate (TBP). Examples of radionuclides include carbon-14 (C-14), which is present in 100 K Area groundwater plume, chlorine-36 (Cl-36), and selected isotopes of nickel and europium. Additional details are provided in the methodology Report (CRESP 2015).

Mercury is considered in inventory estimates and potential impacts through groundwater. However, vapor exposure and impact pathways have not been considered in this report, but will be included for the final report.

DURABILITY OF INSTITUTIONAL CONTROLS

Institutional controls are assumed to be effective for the duration of federal control of designated land areas and the EUs contained therein. Furthermore, institutional controls are assumed only to be effective for 100 years after the transfer of land areas from federal to non-federal control. Some areas of the Hanford Site are currently planned to be under federal control for very long periods (e.g., greater than 300 years for permitted disposal areas in the Central Plateau). Periods of planned federal control may change over time in response to changes in public policy or other decisions. Changes in assumptions of institutional controls may necessitate changes in the end-states of an EU (i.e., changes in final barriers or physical-chemical forms or amounts of remaining contaminants) and cannot be predicted.

EVALUATION PERIODS

Three evaluation periods are considered for each EU in this Risk Review Project:

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[30] The terminology of "primary contaminants" is specific to the Hanford Risk Review Project, with the specific radionuclides and contaminants included based on Hanford history, prior evaluations, and with input from the Core Team.

[31] In the Risk Review Project, the chemical toxicity of uranium tends to drive the risk from this element. The various major uranium isotopes are also tracked for completeness. These include U-232, U-233, U-234, U-235, U-236, and U-238.

- Active cleanup (50 years or until 2064), including the current status and during cleanup actions
- Near-term post-cleanup (2064 to 2164)
- Long-term post-cleanup (2164 to 3064)

The rationale and description for each of these evaluation periods are provided below.

Active Cleanup

The active cleanup period for Hanford is defined as 50 years (i.e., until the year 2064). During this timeframe, all currently planned cleanup is assumed to be completed, except groundwater cleanup, natural attenuation processes when selected as a remedy (for vadose zone and groundwater), and final disposition of entombed reactors and facilities along the Columbia River Corridor. The current designated actions for the entombed reactors are to evaluate the final timeline and removal of these facilities to the Central Plateau in the future with ca. 75 years for reactor entombment to allow for radioactive decay and therefore increased safety associated with future actions.[32] Final onsite disposal units may require very long-term monitoring.

The goal of the Risk Review Project is to help inform decisions by DOE and regulators concerning future sequencing of cleanup activities, including which areas should be focused on earlier for additional characterization and analysis. Thus, the Risk Review Project does not assume a fixed sub-interval in time for cleanup of any specific EU or EU component. Rather, each EU and selected components are evaluated as if cleanup were not to occur for 50 years to provide insights into the risks that may be incurred through delay to help inform sequencing of cleanup actions. However, this is not to infer that delay of cleanup for 50 years is recommended.

Cleanup activities at Hanford are ongoing and are not static. Since the Risk Review Project is being completed in a short timeframe, this means that (1) risks to receptors may change as a result of changing contamination distributions, (2) risk to receptors may change as a result of nearby cleanup activities, and (3) currently undetermined cleanup methods or timing may affect risk in EUs or adjacent EUs.

Although characterization of each EU will include the risks posed by the current and projected contamination, the risk profile for each EU's sources may change significantly during, or as a result of, cleanup activities. Possible changes in the risk profile include increases in risks to workers, accidental or consequential dispersion of contaminants, disruption of biota and ecosystems, disruptions to or exposure of cultural resources, and impacts to nearby operating facilities. The final approach and timing selected for cleanup of each source area where there has not been a regulatory decision is typically, and by definition, not known at this time. Therefore, for EUs where regulatory determinations have not been made, a range of cleanup approaches is examined for each generic type of source when considering risks and impacts from cleanup.

The primary distinctions among different cleanup approaches are the amount of contaminant inventory remaining, barriers that prevent dispersion of residual contamination, and the types of activities required to achieve cleanup (potentially impacting worker safety and surrounding ecology and cultural resources). The range of possible cleanup approaches for any EU will emerge from information on the sources and risks/impacts at specific EUs. Hence, any list of probable cleanup approaches reflects how

[32] The EIS (DOE/EIS-0119D 1989) and its Addendum (DOE/EIS-0222-F 1992) for the disposition of eight surplus Hanford reactors.

the sources might be addressed. The list below provides several examples of the types of different remedial options for the major contaminant sources:

Legacy Source Sites

- Removal (excavation), transport, and onsite disposal
- In situ immobilization (e.g., grouting or injections to form low-solubility minerals)
- In situ treatment resulting in contaminant removal (e.g., in situ biodegradation or natural attenuation)
- In situ phytoremediation (e.g., use of plants to remove contaminants)
- Capping and restoration

Tank Waste and Farms

- Retrieval of waste
- Grouting of tanks and ancillary equipment

Groundwater and Deep Vadose Contamination

- Natural attenuation (e.g., by radioactive decay or biodegradation processes)
- In situ immobilization (e.g., grouting, desiccation, or injections to form low-solubility minerals)
- Capping (i.e., to limit infiltration and recharge)
- Groundwater recovery with or without active flushing ("pump and treat")

D4 of Inactive Facilities

- Decommissioning and demolition, including in situ D&D
- Full or partial permanent entombment
- Interim entombment followed by further D&D (i.e., allowance for radioactive decay to reduce worker risks and potential impacts)

In addition, disposition of materials and wastes to an offsite federal or commercial disposal site or a national geologic repository is the disposition pathway for several sources of contamination (e.g., TRU, HLW).

For those sources where the cleanup plan has been determined by a final remedial action record of decision (ROD) (EPA 2013), such as for the 300 Area (EPA 2013), or evaluated in an EIS (e.g., DOE/EIS-0391 2012), such as for the tank farms, the selected remedy will be considered the baseline cleanup scenario in the Risk Review Project risk ratings. For sources where there has not been a final remedial decision, the DOE planning basis assumed for each EU is considered as a baseline reference for the range of potential cleanup approaches for each EU and is summarized in Appendix C.

The current status, potential initiating events, and pathways that cause or exacerbate risks are diverse because the EUs contain multiple sources and types of hazards, contaminant inventories, and existing environmental contamination. Initiating events can cause contaminants to move or migrate. Conceptual site models (CSMs) are provided for each EU category to help explain the potential initiating events and pathways to relevant receptors (Chapter 3). Nuclear safety analysis, which is embodied in the DSA process, including hazards analysis (HA), preliminary DSA, and final DSA, provides a detailed evaluation of external and operational initiating events and scenarios that can result in risks to human health from existing hazards. In addition to episodic events evaluated as part of nuclear safety analysis, prevailing conditions, including infiltration and subsurface contaminant transport with groundwater flow, are considered as mechanisms for dispersion of existing environmental contamination and for potential impacts to receptors.

Near-Term Post-Cleanup

The near-term post-cleanup period is for 100 years after cleanup is completed (until the year 2164). This period was selected because it is the interval over which institutional controls are assumed to be in effect for land areas no longer maintained under federal control. During this period, maintenance activities also are assumed to occur as necessary to maintain the integrity of the remaining engineered systems (landfill caps, liners, entombment, etc.), along with active monitoring to detect any new releases and confirm the efficacy of remaining remedial activities (natural attenuation, groundwater containment, etc.). Periodic regulatory reviews are also required by federal law to be continued as long as institutional controls are in place (e.g., CERCLA 5-year reviews).

Post-cleanup does not mean that all contamination has been removed from an EU or the Hanford Site. Thus, there will be a diversity of end-states that constitute "completion" at the EUs. The following are examples that illustrate the range of end-states for "sources" to be achieved at the completion of active cleanup:

- Legacy Source Sites: Cleanup to unrestricted use; cleanup to industrial use standards, or cleanup consistent with other land use designations
- Tank Waste and Farms: Removal of up to 99% of the waste contained in tanks, followed by grouting of tanks and ancillary equipment and capping of the tank farm[33]
- Groundwater and Deep Vadose Zone Contamination: Natural attenuation (e.g., by radioactive decay or biodegradation processes); removal or immobilization of a certain percent of the initial inventory; capping (i.e., to limit infiltration and recharge)
- D4 of Inactive Facilities: Decommissioning and demolition completed; final permanent entombment achieved

The presence of residual contaminants in remediated areas and engineered disposal facilities typically is evaluated through performance assessments under DOE Order 435.1.

Long-Term Post-Cleanup

The long-term post-cleanup period is assumed to extend for 900 years after the near-term post-cleanup period (until the year 3064) for a total post-closure assessment period of 1000 years. This interval was selected to be consistent with current DOE Order 435.1 for performance assessments, evolving Nuclear Regulatory Commission (NRC) recommendations for evaluation of closure of near-surface LAW disposal (ACRS Letter 2014), and the basis of prior contaminant transport modeling information. The same end-states associated with the end of the active cleanup period are assumed to apply until the year 3064, where reasonable. Associated uncertainties, uncertainty ranges, and impacts that may occur beyond this time frame will be clearly identified, where possible.

For many remaining sources, the only reasonable characterization for EUs will be (1) the remaining contaminant inventory along with the physical state and location; (2) the degradation, prevailing natural

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33 According to the Tri-Party Agreement (Ecology, EPA, and DOE, 1998), retrieval limits for residual wastes are 360 ft^3 and 30 ft^3 for 100-Series and 200-Series tanks, respectively, corresponding to the 99% waste retrieval goal as defined in TPA Milestone M-45-00.

processes (contaminant transport and dispersion associated with recharge and groundwater flow, etc.), or failure modes that can result in dispersal or migration of contaminants from the remaining engineered systems or subsurface contamination; and (3) the probability of significant initiating events. The assumed set of infiltration and recharge rates for the long-term post-cleanup period will be the same as for the near-term, post-cleanup period because they bracket very low to very high infiltration rates that may be possible under a range of land cover and climate conditions.

LAND-USE AND GROUNDWATER USE

For the purposes of the Risk Review Project, it is assumed that all reasonably available land uses at the Hanford Site will have been realized when the near-term post-cleanup period begins or by 2064. This means that land use will be a factor to be considered as part of the evaluation for each EU for two periods: near-term post-cleanup (until 2164) and long-term post-cleanup (until 3064). However, while future land use is an important consideration for determining the extent of cleanup, it is not a direct factor in the urgency or sequencing of cleanup activities from a risk perspective (although it may be for other factors including community preferences). Additionally, in this Risk Review Project, the human health risks associated with land use have been separated between (1) surface (i.e., facilities, soils and waste disposal sites) and near-surface exposures associated with the land use scenario, and (2) use of groundwater. This separate consideration is important because (1) cleanup of facilities and surface and near-surface contamination is most frequently a separate effort from groundwater remediation; (2) treatment or alternate forms of water supply can be provided to facilitate desired land use when the groundwater within the unit being evaluated is not suitable; and (3) groundwater remediation timeframes may be much longer than required to achieve near-surface remediation and alternative land uses.

Direction for the Risk Review Project states, "The review should place Hanford environmental and nuclear safety hazards and risks in context with currently designated future uses of the Hanford site and nearby land uses and activities that have a potential to impact risks, natural resources and cultural resources." (Appendix A). The DOE NEPA determination for future land use at the Hanford Site is defined in the preferred land use alternative under the Comprehensive Land Use Plan EIS and ROD (DOE/EIS-0222-F 1999, DOE/EIS-0222 1999). See Figure 2-3 and Table 2-2 for more specific information on each designation. However, specific exposure scenarios that correspond with the EIS and ROD land use categories have not been developed through past Tri-Party[34] efforts and therefore are not currently available for evaluating risks under those future land use designations.

The State of Washington currently recognizes only "unrestricted use"[35] and "industrial use" as standard land use designations with established exposure scenarios (WAC 173-340-200, 2007). The EPA has recognized the following land uses as available following completion of remedial actions: any combination of unrestricted uses, restricted uses, and use for long-term waste management (OSWER Directive No.9355.7-04, p. 2).

The Core Team has requested that the Risk Review Project consider "unrestricted use," which also has been referred to as "residential land use" to serve as a second basis for assessment along with the primary designation from the land use EIS whenever the primary future land use designation would

[34] Tri-Party refers to The State of Washington, DOE and EPA.

[35] "...has determined that residential land use is generally the site use requiring the most protective cleanup levels and that exposure to hazardous substances under residential land use conditions represents the reasonable maximum exposure scenario." WAC 173-340-740(1)(a)

conflict with the "unrestricted use" designation or is not designated for industrial use. The alternative land use designation or "unrestricted use" does not apply to EUs located within the Central Plateau.[36]

The Risk Review Project is using "unrestricted use" and "industrial use" scenarios and cleanup levels to understand the risks when land is cleaned up to a less restrictive standard but then failure of institutional controls leads to land usage consistent with a more restrictive exposure scenario (e.g., areas cleaned up to industrial land use and then used in a manner consistent with the residential use scenario). This assessment will be part of the final report.

Results from a limited set of additional alternative land use exposure scenarios also are being used for comparison.

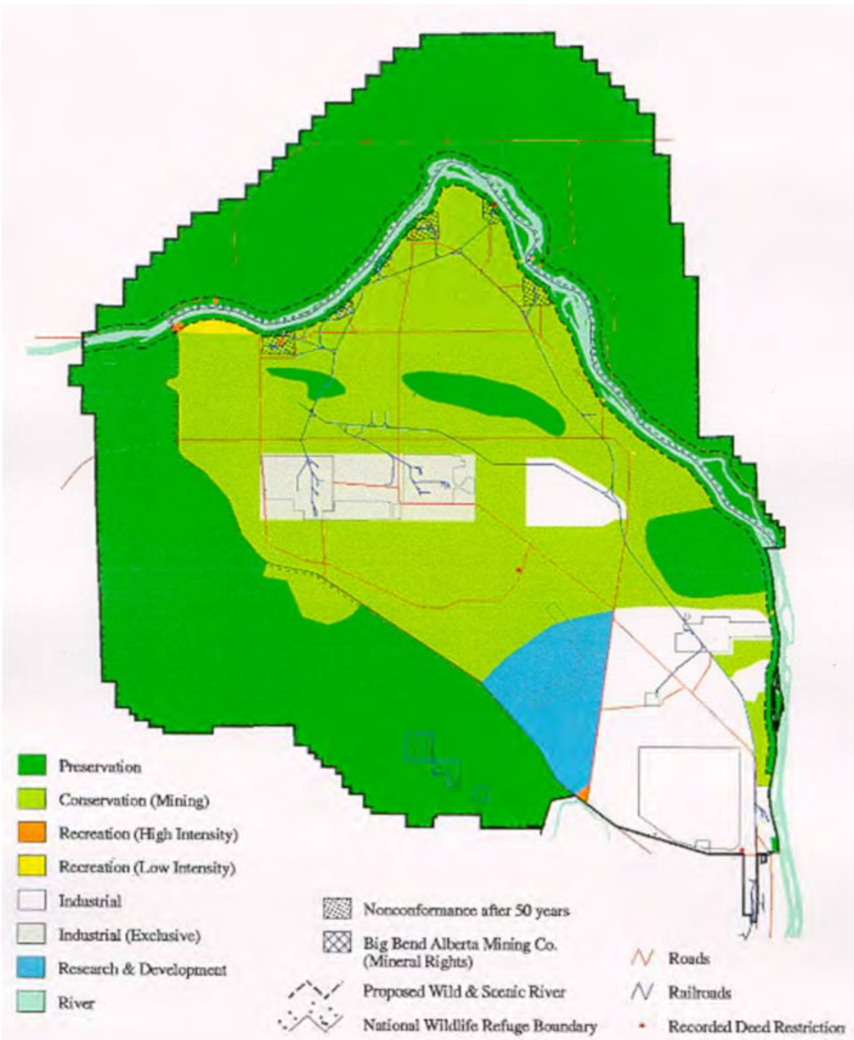


Figure 2-3. Future land use designations from the CLUP (DOE/EIS-0222-F, Figure 3.3).

[36] However, it should be noted that the T Plant (221-T Process Building) has been specifically identified as one of the buildings eligible to be protected under the legislation that establishes a Manhattan Project National Historical Park (see Chapter 8). This designation may require additional considerations with respect to cleanup requirements.

Table 2-2. Definitions of land use designations in the land use EIS and ROD (DOE/EIS-0222-F 1999, DOE/EIS-0222 1999).

Industrial Exclusive	An area suitable and desirable for treatment, storage, and disposal of hazardous, dangerous, radioactive, and nonradioactive wastes. Includes related activities consistent with Industrial-Exclusive uses.
Industrial	An area suitable and desirable for activities, such as reactor operations, rail, barge transport facilities, mining, manufacturing, food processing, assembly, warehouse, and distribution operations. Includes related activities consistent with Industrial uses.
Research and Development	An area designated for conducting basic or applied research that requires the use of a large-scale or isolated facility, or smaller scale time-limited research conducted in the field or within facilities that consume limited resources. Includes scientific, engineering, technology development, technology transfer, and technology deployment activities to meet regional and national needs. Includes related activities consistent with Research and Development.
High-Intensity Recreation	An area allocated for high-intensity, visitor-serving activities and facilities (commercial and governmental), such as golf courses, recreational vehicle parks, boat launching facilities, Tribal fishing facilities, destination resorts, cultural centers, and museums. Includes related activities consistent with High-Intensity Recreation.
Low-Intensity Recreation	An area allocated for low-intensity, visitor-serving activities and facilities, such as improved recreational trails, primitive boat launching facilities, and permitted campgrounds. Includes related activities consistent with Low-Intensity Recreation.
Conservation (Mining)	An area reserved for the management and protection of archeological, cultural, ecological, and natural resources. Limited and managed mining (e.g., quarrying for sand, gravel, basalt, and topsoil for governmental purposes) could occur as a special use (i.e., a permit would be required) within appropriate areas. Limited public access would be consistent with resource conservation. Includes activities related to Conservation (Mining), consistent with the protection of archeological, cultural, ecological, and natural resources.
Preservation	An area managed for the preservation of archeological, cultural, ecological, and natural resources. No new consumptive uses (i.e., mining or extraction of non-renewable resources) would be allowed within this area. Limited public access would be consistent with resource preservation. Includes activities related to Preservation uses.

EVALUATION TEMPLATE

Each Evaluation Template provides a consistent, cohesive, and useful portrayal of the multiple source types within each EU considered. Completed templates for each of the 25 units evaluated for this report may found in Appendices D through H. (See Appendix B of the methodology (CRESP 2015) for a copy of the Evaluation Template.) The Evaluation Template contains the following sections:

- Part I – Executive Summary provides an overview of the EU and its risk evaluations.
- Part II – Administrative Information allows cross-walking of EUs used in this Risk Review Project with regulatory operable units (OUs).
- Part III – Summary Description includes location and layout maps, primary EU components, and land use information.
- Part IV – Unit Description and History includes former and current uses, current extent of environmental contamination, ecological resources setting, and cultural resources setting.
- Part V – Waste and Contamination Inventory summarizes the inventory and physical-chemical form of contaminants present
- Part VI – Potential Risk Pathways and Events summarizes the current conceptual model, cleanup approaches, initiating events, and pathways that can result in risks to receptors over the three evaluation periods.
- Part VII – Supplemental Information and Considerations may include co-location of facilities, sequencing considerations, linkages to other required facilities or unique skills, loss of facility integrity, etc.

External Review

It is important that a broad spectrum of stakeholders, the public, Tribes, and government agencies have an opportunity to comment on documents prepared for the Risk Review Project.

In early September 2014, a draft methodology was posted on a CRESP web page (www.cresp.org/hanford), which is dedicated to the Risk Review Project, and was made available for written comment. In addition, CRESP team members met with the Hanford Advisory Board (public invited), Tribal Nation representatives, affected government agencies, and local elected officials to explain the methodology and encourage feedback. Finally, Core Team members and their staff reviewed the draft methodology, as did a peer-review group of experts. All written input received on the draft document was acknowledged and considered, and provided important input for improving the Risk Review Project methodology. A list of the comments received and an overview of revisions reflected in the methodology report (CRESP 2015) are available as a separate summary document.

Written comment will be solicited from a broad spectrum of stakeholders, the public, Native American Tribes, and government entities after release of the interim progress report (concurrent with the release of the methodology (CRESP 2015)) and after release of the draft final report prepared for the Risk Review Project.

2.2. A PRESUMPTIVE SET OF POTENTIAL PATHWAYS FROM CONTAMINANT RELEASE TO RECEPTORS

Despite the diversity of sources and receptors, there is a limited set of potential contaminant release mechanisms and pathways from source areas to receptors that constitute the focus of the Risk Review Project. The list below identifies the relevant contaminant release and impact pathways of primary importance for each source type. Hence, the following may be considered a "checklist" for evaluating sources within each EU.

Pathways

- Risks from Contaminated Near-Surface Soils – the primary pathways are (1) direct human exposure through land use; (2) transport to the subsurface and groundwater through infiltration; (3) contaminant transport through erosion, biotic processes, or atmospheric dispersion; (4) biota exposure and biotic transport; and (5) exposure to cultural resources.
- Risks from Vadose Zone Contamination – infiltration-induced transport through the subsurface to groundwater and the Columbia River.
- Risks from Engineered Waste Management Facilities (either currently operational or inactive) – initiating events (external or operational) that cause loss of waste/contaminant containment followed by either (1) direct human exposure, (2) atmospheric dispersion, (3) near-surface soil contamination, (4) impaired or precluded use of other resources and facilities, (5) damage to biota or ecosystems, or (6) damage to or destruction of cultural resources.
- Risks from D4 Facility Activities – occur primarily from unanticipated facility conditions and accidents during cleanup and maintenance activities. Accidents or other initiating events prior to completion of decommissioning may cause loss of waste/contaminant containment followed by combinations of (1) direct human exposure; (2) atmospheric dispersion; (3 near-surface soil contamination; (4) impaired or precluded use of other resources and facilities; or (5) damage to biota, ecosystems, or cultural resources.
- Risks from Groundwater Contamination – only may occur when there is active or projected use and/or consumption of contaminated groundwater, or as a consequence of contaminant discharge to the Columbia River. However, groundwater is a protected resource under Washington State and federal regulations, so risks or impacts to groundwater itself are also considered.

Receptors

- Worker Health Risks – occur primarily from unanticipated circumstances and accidents during cleanup and maintenance activities. Occupational health exposures and traumas may occur as a consequence of existing conditions, maintenance, monitoring, or cleanup activities.
- Public Health Risks – occur from exposures to contaminants in air, water, or near-surface soils or consumption of food grown in or harvested from contaminated soils. Potential exposure due to routine excavation or other activities is considered to a depth of 5 m. Groundwater contamination is evaluated separately from other pathways because groundwater use can be (and often is) managed separately from land use.
- Risks to Groundwater – either from waste currently in engineered facilities, near-surface contaminated soils, vadose zone contamination, or through the movement, diffusion, and dispersion of contaminants already present in groundwater. Sources currently in engineered facilities require an initiating event (e.g., cover or liner failure, corrosion or other induced leakage, infrastructure failure causing large water release, large precipitation event, earthquake, accident) to release contaminants to the soil surface or subsurface. Contaminants in near-surface soils and the vadose zone are transported to the groundwater as a function of prior moisture conditions and infiltration rate (location and surface condition dependent), individual contaminant sorption/transport characteristics (subsurface stratigraphy and contaminant dependent), and the distance to groundwater (location dependent). Further spreading of

contaminants in the groundwater depends on contaminant concentration, groundwater flow rate and dispersion, and the individual contaminant sorption/transport characteristics.

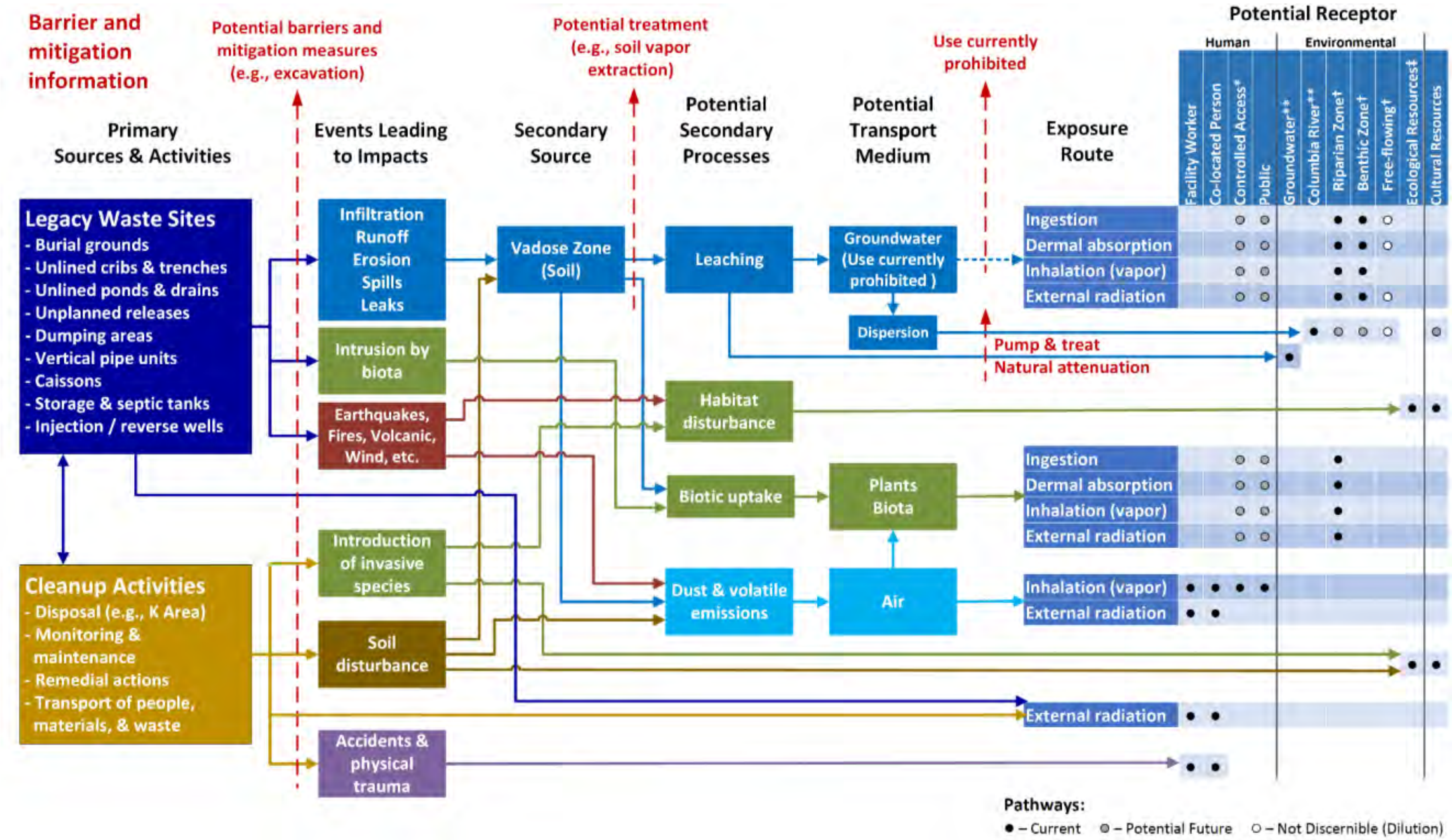
- Risks to the Columbia River – either from current or projected contaminated groundwater discharge through the riverbed or seepage, direct waste discharges, or overland flow and erosion that discharges to surface water. Risks of contaminant exposure in the riparian zone (through seeps) and benthic zone (through groundwater upwellings) originating from the Hanford Site are considered. Human health risks associated from potential surface water contamination originating from the Hanford Site are considered in the context of Columbia River use.
- Risks to Biota and Ecosystems – from physical disruption of an ecosystem, contaminant dispersion and uptake, fragmentation of habitats, or introduction of invasive species resulting from contaminant releases or cleanup activities (either near sensitive ecosystems or as a result of transit pathways to/from remediation activities). Physical disruptions, such as soil compaction, introduction of barriers (e.g., roads), and soil removal, have major impacts on species distribution and ecosystems.
- Risks to Cultural Resources – from physical disruption, destruction, exposure, impaired access, or precluded access resulting from contaminant releases or cleanup activities. Indirect impacts from impairment of view sheds are also considered. Risks to cultural resources will be described but not rated.

There are also potential risks to economic assets as a consequence of cleanup activities, but they are limited to EUs where either the presence of contamination or cleanup activities may directly impact other DOE or non-DOE facilities. Thus, the consideration of economic assets will be constrained to (1) the intersection of specific EUs with specific facilities, and (2) a description of the general economic context of the Hanford Site.

Many EUs may have multiple sources that are aggregated to provide a clearer picture of the risks associated with a geographic area. Evaluations of risks to certain receptors then lend themselves to consideration in the context of individual EUs. These include risks to human health, impacts to groundwater, and risks to the Columbia River. In addition, some receptors require consideration from broader perspectives: (1) a site-wide perspective and (2) the potential risk or impact based on the geographic location of the EU and surrounding areas. These broadly geographically defined receptors include sensitive biota and ecosystems, cultural resources (notably indirect impacts), and economic assets.

Furthermore, cumulative risk assessments are often performed to evaluate the combined fate and effects of multiple contaminants from multiple sources through multiple exposure pathways (MacDonell et al. 2013). However, the risk assessment for this review is very different from that of a baseline risk assessment or performance assessment. First, it is already assumed that there are unacceptable risks associated with contamination on the Hanford Site that must be addressed. Second, isolating single contaminants for EUs through a single exposure pathway (e.g., groundwater) allows the most urgent risks to be identified and helps inform sequencing of remedial actions across the Hanford Site.

A convenient representation of how sources are linked to potential receptors is a CSM (ASTM 1995; Brown 2008). For an environmental system, a CSM represents (often in block form) the biological, physical, and chemical processes that determine contaminant transport from sources through environmental media to potential receptors. Examples of CSMs for each of the five EU types were developed (Figure 2-4 through Figure 2-8) to help elucidate the sources, pathways, and receptors considered in this review. For example, legacy sources (and associated cleanup activities) are common to three of the five EU types, including the Tank waste and farms and inactive facilities (D4) EUs. And, as shown in Figure 2-4, legacy sources typically include sources such as burial grounds, unlined cribs and trenches, unplanned releases, events such as infiltration leading to further contamination of the vadose zone, and other pathways leading to exposure via ingestion and other routes of both human and ecological receptors. Impacts from cleanup activities are also included. The groundwater EU CSM (Figure 2-7) only considers contaminants already in the saturated zone (and potential impacts to groundwater, the Columbia River, and related receptors). The operating facilities EU CSM (Figure 2-6) only considers facilities that do not include legacy sources although many of the pathways and receptors are common to all EU types. The detailed approaches, including assumptions regarding sources, pathways, and receptors, used in the Risk Review Project evaluations are provided in the methodology document (CRESP 2015).



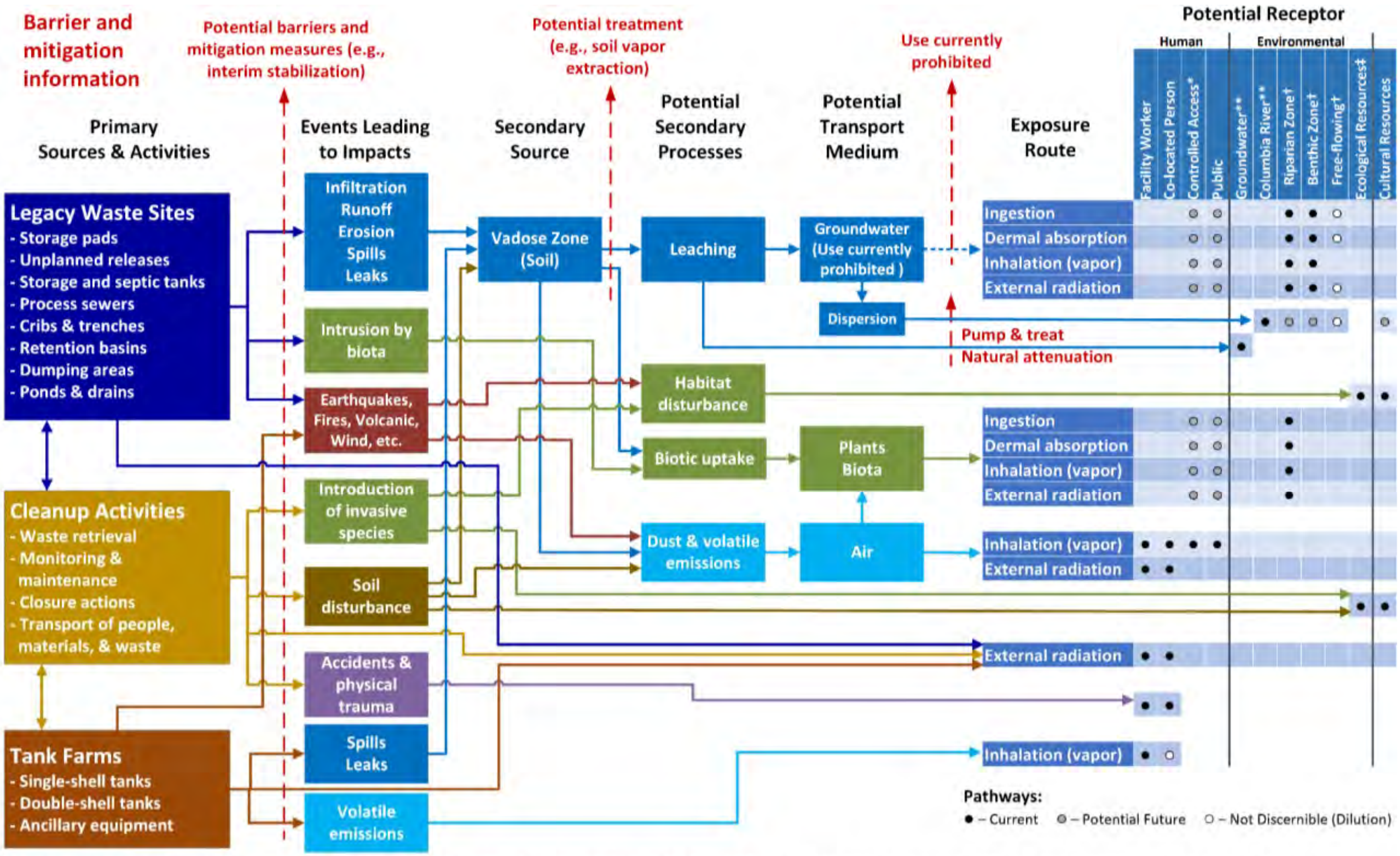
* Activities by members of Tribal Nations are considered a Controlled Access group within human health, recognizing the potential for different exposures as a result of specific cultural practices.

** These are evaluated as protected resources, independent of use.

† Threats to the Columbia River specifically include potential contaminant impacts to the ecology of the Riparian Zone, Benthic Zone, and Free-Flowing River component.

‡ Threats indicated within Ecological Resources focus on habitant disruption and potential impacts to endangered and sensitive species.

Figure 2-4. Legacy source evaluation unit conceptual site model.



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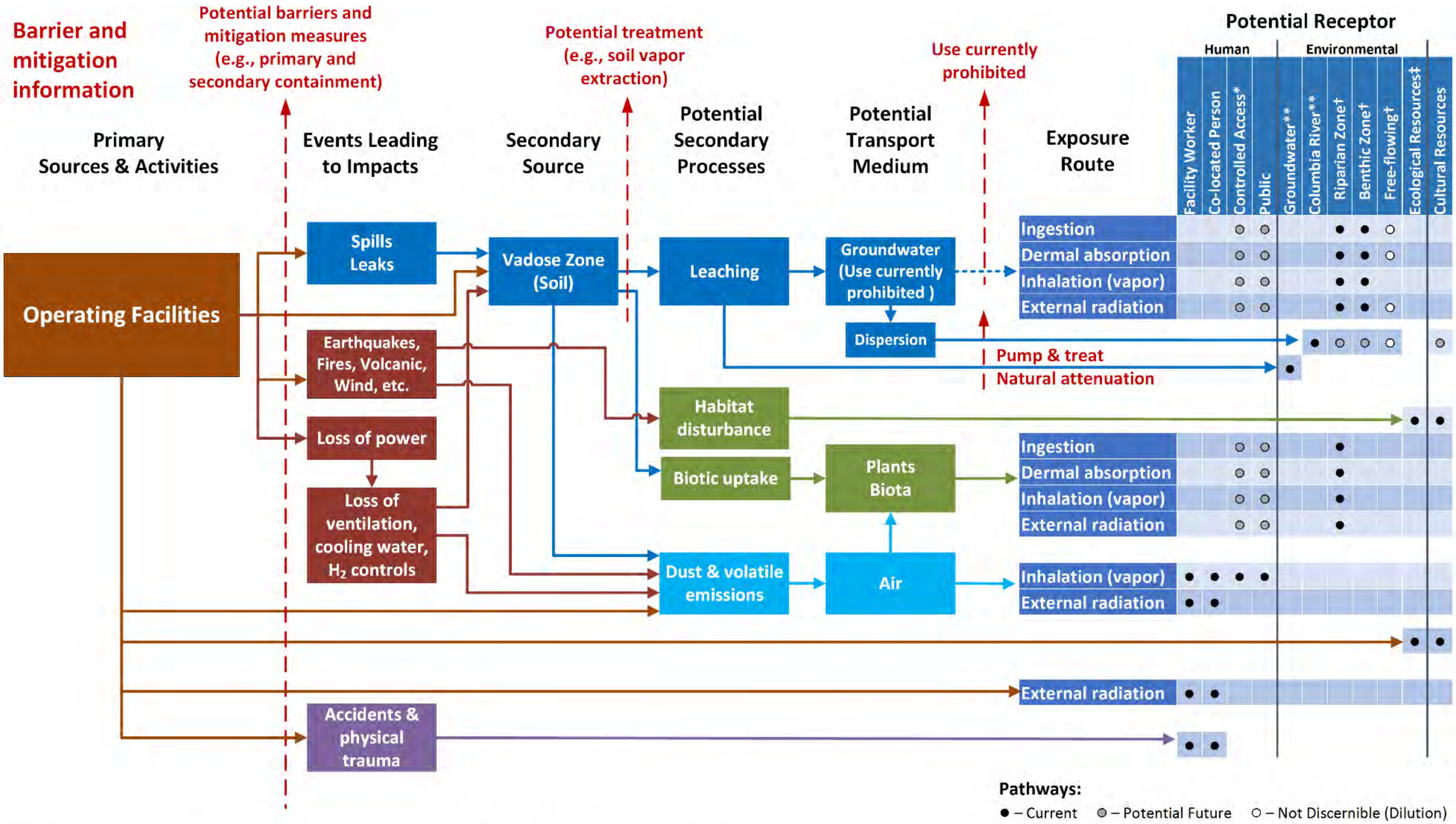
** These are evaluated as protected resources, independent of use.

† Threats to the Columbia River specifically include potential contaminant impacts to the ecology of the Riparian Zone, Benthic Zone, and Free-Flowing River component.

‡ Threats indicated within Ecological Resources focus on habitant disruption and potential impacts to endangered and sensitive species.

Figure 2-5. Tank waste and farms evaluation unit conceptual site model.



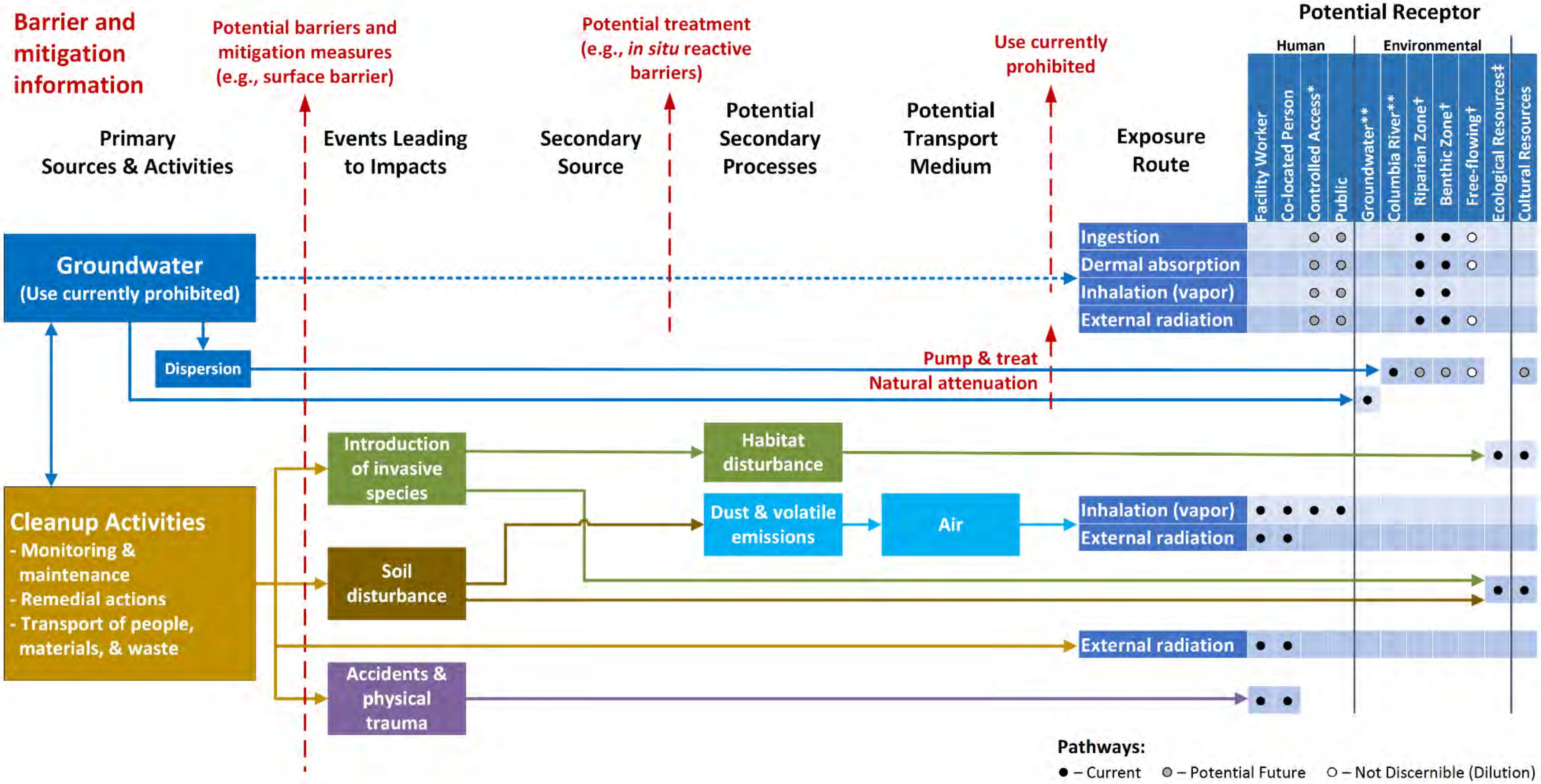
* Activities by members of Tribal Nations are considered a Controlled Access group within human health, recognizing the potential for different exposures as a result of specific cultural practices.

** These are evaluated as protected resources, independent of use.

† Threats to the Columbia River specifically include potential contaminant impacts to the ecology of the Riparian Zone, Benthic Zone, and Free-Flowing River component.

‡ Threats indicated within Ecological Resources focus on habitant disruption and potential impacts to endangered and sensitive species.

Figure 2-6. Operating facilities evaluation unit conceptual site model.



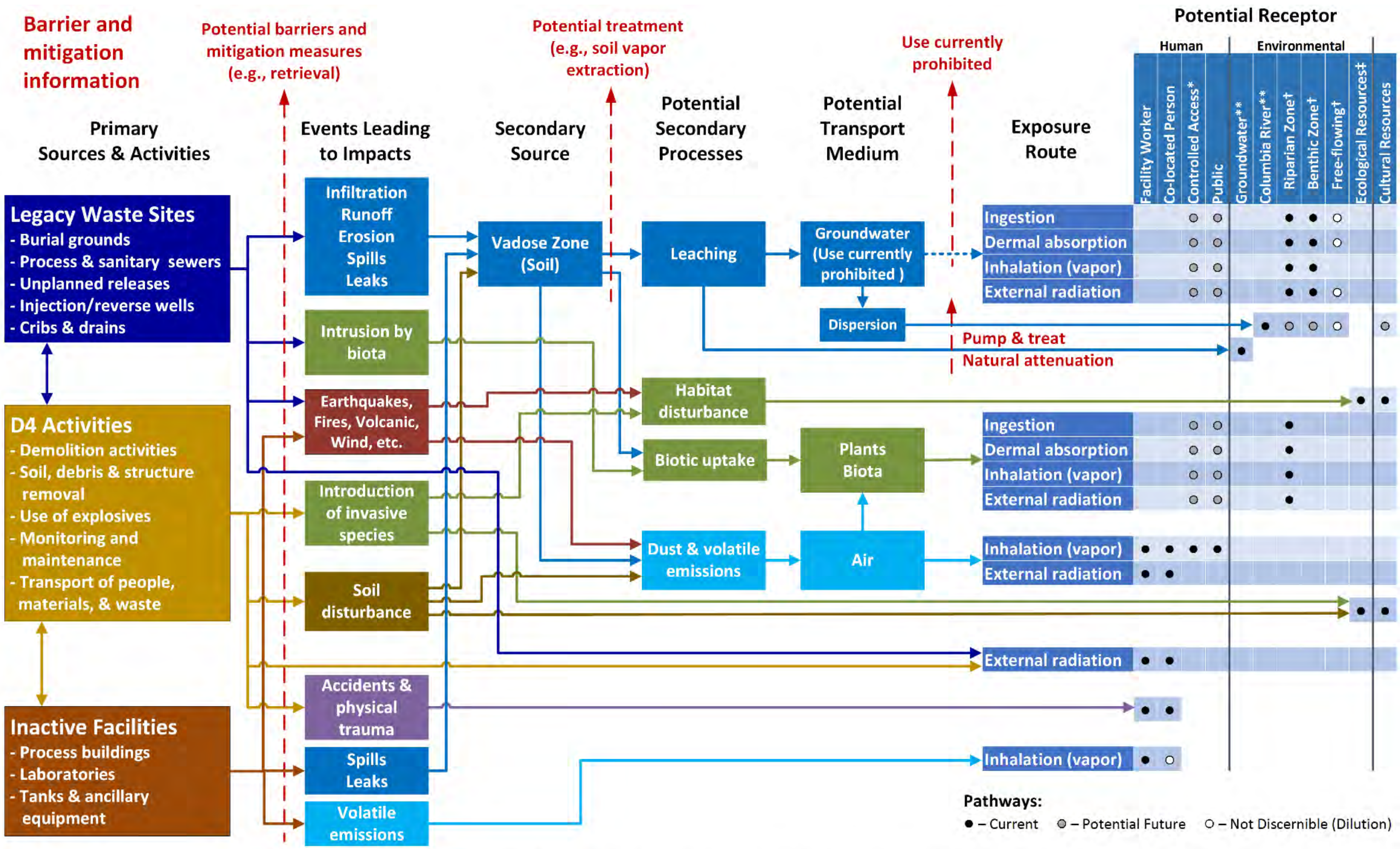
* Activities by members of Tribal Nations are considered a Controlled Access group within human health, recognizing the potential for different exposures as a result of specific cultural practices.

** These are evaluated as protected resources, independent of use.

† Threats to the Columbia River specifically include potential contaminant impacts to the ecology of the Riparian Zone, Benthic Zone, and Free-Flowing River component.

‡ Threats indicated within Ecological Resources focus on habitant disruption and potential impacts to endangered and sensitive species.

Figure 2-7. Groundwater evaluation unit conceptual site model.



* Activities by members of Tribal Nations are considered a Controlled Access group within human health, recognizing the potential for different exposures as a result of specific cultural practices.

** These are evaluated as protected resources, independent of use.

† Threats to the Columbia River specifically include potential contaminant impacts to the ecology of the Riparian Zone, Benthic Zone, and Free-Flowing River component.

‡ Threats indicated within Ecological Resources focus on habitant disruption and potential impacts to endangered and sensitive species.

Figure 2-8. Inactive facilities (D4) evaluation unit conceptual site model.

2.3. EVALUATION APPROACHES FOR SPECIFIC RECEPTORS

USE OF METRICS AND ASSIGNMENT OF RISK RATINGS

A system for categorizing the magnitude and likelihood of risks to each receptor forms the basis for assigning risk ratings to receptors for each EU, within each evaluation period. The risk rating assumes that nuclear safety hazards are assessed based on unmitigated dose estimates because the unmitigated dose integrates across the radionuclide inventory as a *relative* risk metric, and acknowledges that some mitigation measures may be subject to failure, while the Risk Review Project recognizes that typical DOE/contractor mitigation actions substantially reduce most risks, typically to Low or ND.

Specific metrics for each receptor type that provide the basis for the risk ratings are identified in Chapters 5 through 8 of the methodology document (CRESP 2015). Risks and potential impacts are categorized into 5 ratings: Not-discernible (ND), Low, Medium, High, or Very High, where Very High is used only for exceptional cases. Further, for many receptors, the risk rating for an equivalent impact during the active cleanup period is higher than in the near-term post-cleanup period. This rating reduction is considered appropriate for most cases because of the additional response time available before preventative action would be required, and therefore addressing the risk or potential impact is less urgent. In addition, within similar types of EUs, the risk ratings are expected to differ. Risks that are rated higher, therefore, should suggest that remediation should proceed more quickly.

As discussed earlier, the final report for the Risk Review Project will provide a final list the risk ratings for each receptor group, except cultural resources. For example, a final set of tables will provide the risk ratings by receptor for all EUs. There is no scientifically accepted method of normalizing ratings between and among receptors. That is, high risk may mean different things for human health, ecological resources, and groundwater. The final risk ratings will explain the meaning of the risk rating designation with respect to each receptor.

Also, as noted, risks to receptors will not be integrated across different receptor types. The balancing and relative importance of risks to different receptors are driven by individual and collective values, which vary considerably and therefore make integration across different receptor types the domain of DOE and its regulators with input from their constituencies. However, the final report for the Risk Review Project will provide examples that illustrate ways to carry out difficult grouping or binning that integrates the ratings across receptor categories (e.g., integrated risk binning that combines risks to human health with risks to ecology and groundwater).

The methodologies for evaluating risk to receptors are summarized in Section 2.3 of this report and are detailed in separate chapters of the methodology document (CRESP 2015). Descriptions or characterization of the receptors vary somewhat depending on the receptor. For example, ecological receptors are examined in terms of both species and ecosystems of value, cultural receptors include several key periods (Native American (10,000 years ago to present), pre-Hanford Era (1805-1943), and the Manhattan Project/Cold War Era (1945-1990)), and the Columbia River is described with groundwater because it is the groundwater that has the potential to discharge radionuclides and other contaminants to the river. The characterization of resources at risk forms an important basis for developing the methodology for each resource, as well as the basis for determining the risk rating.

The methodology for evaluating each receptor varies because the nature of the receptor varies (e.g., groundwater vs. facility workers). For example, workers and the public include only people, while ecological receptors include thousands of species and many different kinds of ecosystems, and cultural receptors includes many kinds of resources (e.g., artifacts, traditional cultural places, and historic buildings). Further, the Risk Review Project recognizes that risk to any individual is important, while for ecosystems the important consideration is the population of a given species (except in the case of federally or state-listed species).

INITIATING EVENTS

The initiating event methodology provides a basis for assigning the likelihood of loss or degradation of barriers and guidance, which is used to assign impacts (consequences) due to the loss of barrier based on the event being considered. For EUs for which there is a DSA, HA, or other document that provides initiating event likelihoods and consequence estimates, these documents are used.

Initiating events are typically episodic events that may occur over short time frames (less than a day) and are considered in addition to natural prevailing processes (i.e., groundwater flow) that may result either by themselves or in combination with initiating events, in risks to receptors from contaminants already in environmental media (e.g., soils, vadose zone, groundwater).

The consideration of initiating events includes those directly attributed to human initiators and natural phenomena. Human-initiated events include human errors or omission or commission leading to accidents, loss of institutional controls, failure of engineered systems, and external events from anthropogenic (man-made) sources (e.g., nearby transportation accidents, aircraft impacts, events at other EUs). Natural events include natural phenomena hazards (e.g., earthquake, high winds, volcanic ashfall, and wildfires) and processes such as structural decay of barriers and facilities exposed to the environs, changes in water table, and drought/climate change that may occur over time. Severe natural phenomena hazards (e.g., seismic events, 1000 year flooding, large geomagnetic disturbances) can result in site-wide or regional impacts leading to additional releases and limit the availability and capability to respond to the event.

Initiating events are qualitatively binned within the following likelihood ranges, which is consistent with DOE and Hanford contractor guidance (e.g., DOE-STD-3009, HNF-8739, TFC-ENG-DESIGN-C-47) for the development of safety analysis:

- Anticipated (A) – events expected to occur $>10^{-2}$/yr
- Unlikely (U) – events expected to occur within the range of 10^{-2} - 10^{-4}/yr
- Extremely Unlikely (EU) – events expected to occur within the range of 10^{-4} - 10^{-6}/yr
- Beyond Extremely Unlikely (BEU) – events expected to occur $<10^{-6}$/yr

The initiating event methodology also provides guidance related to the damage to a barrier the event is expected to cause. Note: The consequence determinations within HAs and DSAs and the hazardous material exposures are usually limited to short durations (e.g., less than 8 hours) and do not include food or water pathways. For the Risk Review Project, longer-term consequences and the additional receptor pathways are also considered. Event consequences are categorized as having the following impacts:

- (Low) Localized Impacts – events associated with damage to individual barriers, which may result in release of material and immediately impact the nearby worker but which are not expected to have impacts outside the facility/area boundary. Environmental impacts are expected to be limited and able to be mitigated and remediated. From a radiological inventory standpoint, these are events associated with less than Hazard Category 3 (DOE-STD-1027, CN1) quantities of material. Within a Documented Safety Analysis or Hazards Analysis, these events are typically identified as having High or Significant consequences to the Facility Worker and

Low or Negligible consequences to a Co-located Person (e.g., < 25-100 rem, < Protective Action Criteria (PAC)-2/3) and to the Public (e.g., < 1-5 rem, <PAC-1/2).

- (Moderate) Facility Impacts – events associated with damage to many barriers or entire facility/systems, which may result in release of material and have an immediate impact on receptors outside the EU site or facility/area boundary but not the overall Hanford Site boundary. Environmental impacts would be expected to be limited to the Hanford Site boundary but could include potential impacts to groundwater. Within a DSA or hazards analysis, these events are typically identified as having High or Significant consequences to the facility worker, Moderate to High consequences (e.g., >25 rem, >PAC-3) to a co-located person and Low or Negligible and consequences to the public.
- (High) Offsite Impacts – Events associated with damage to multiple facilities/systems, which may result in release of material and have an immediate impact on receptors outside the Hanford Site boundary. Environmental impacts would be expected to be seen offsite and could include potential impacts to groundwater and surface water. Within the DSA or hazards analysis, these events are typically identified as having High or Significant consequences to the facility worker and co-located person and Moderate to High (e.g.,>1-5 rem, >PAC-2) consequences to the public.

HUMAN HEALTH

The following categories of potentially exposed persons or populations are defined for evaluation purposes: (1) facility worker, (2) co-located person, (3) controlled access persons, and (4) public. Assumptions and methodology are described in detail in the methodology report (CRESP 2015) for relative rating of each category of potentially exposed persons during (1) the active cleanup period (or until 2064), including the current status of the EU prior to cleanup, where applicable, and during active cleanup (or until 2064); and (2) the near-term post-cleanup (until 2164, or assuming a 100-year duration for institutional controls associated with areas transferred from federal control).

Hanford can be considered as multiple entities: large areas of uncontaminated or minimally contaminated landscape and a mosaic of former industrial lands and disposal areas subject to cleanup. In addition, some areas have near-surface contamination from non-DOE uses (e.g., former orchard lands contaminated from agricultural use of lead arsenic pesticide). Public occupancy is currently prohibited at the Hanford Site, current non-worker exposure is minimal, and access is highly controlled (however, substantial resources are needed annually to maintain this condition).

The mosaic of planned future land uses depends in part on existing contamination, cleanup objectives, and potential future exposure pathways. In the post-cleanup period, some land (e.g., the Central Plateau) may be owned and controlled by DOE or another federal agency, and may have controlled access. Many of the EUs evaluated will likely be remediated in place or have some residual contamination inventory. For this interim report, these are primarily EUs considered part of the "industrial-exclusive" or core zone of the Central Plateau, and are anticipated to remain under federal control. Other parts of the Hanford site after cleanup may be transferred from federal control for other uses (e.g., recreational, industrial, other forms of development or preservation). Future risk assessments may be needed to address uncertainties in current modelling (Scott et al. 2005) or additional cleanup actions may be needed if land use changes.

For the purposes of the Risk Review Project, near-surface contamination is defined as being within the uppermost 5 m of soil or the depth of the constructed facility if it is deeper than 5 m. Groundwater is evaluated separately from land use because (1) groundwater use can be, and often is, managed separately from land use; (2) groundwater is considered a protected resource by the State of Washington, with a goal of restoration to the highest potential use; and (3) there is short-term potential for provision of alternate or treated water supply commensurate with the anticipated uses, until groundwater quality can meet relevant water quality standards (WQSs).

The Risk Review Project considers potential exposures (and their associated risks/impacts) prior to remediation, during remediation, and after completion of remediation. Following cleanup of specific areas, land associated with some EUs may be released for designated land uses with or without associated institutional controls. Other areas (e.g., ERDF and portions of or the entire 200 Area) will probably be maintained by the federal government in perpetuity with controlled access consistent with residual contamination and hazards, intended uses, and mitigation measures to protect human health.

The Risk Review Project is not performing an independent risk assessment, but rather an order-of-magnitude rating or binning of potential risks to human health based on hazards, accident or exposure scenarios, and consequences to different categories of people who may be present on or adjacent to the Hanford Site.

Categories of People Used for Evaluation

The following are definitions for different categories of people used in the Risk Review Project:

- **Facility Worker** – any worker or individual within the facility or activity geographic boundary as established for DSA and located less than 100 m from the potential contaminant release point. This definition is consistent with the DOE definition of a facility worker under the DOE-STD-3009-2014and the Safety Analysis and Risk Assessment Handbook (SARAH) (HNF-8739, 2012).
- **Co-located Person** – a hypothetical onsite individual located at the distance (not less than 100 m or at the boundary of the facility *or activity boundary*) from the point of potential contaminant release at which the maximum dose occurs. If the release is elevated, the person is assumed to be at the location of greatest dose, which is typically where the plume touches down. This definition is consistent with the DOE definition of a co-located worker, but also is expanded to represent any person at the postulated location, independent of that person's activity or employer.
- **Controlled Access Person** – an individual who is granted limited access to the site, within the current site controlled access boundary, for a specific purpose or set of activities. The general location of the site controlled access boundary is indicated in Figure 2-9 and is generally demarcated as the area between Highways 240 and 24 and the towns of Richland and West Richland on the south and west and the south bank of the Columbia River on the north and east. Individuals or groups of people are assumed to be granted access within these boundaries with restrictions. These include risk mitigation measures to provide adequate protection of human health such that resultant health risks would be *Non-discernible* to *Low*.

  Depending on the nature of the access purpose or activities, the restrictions may include any of the following: location, age, or health restrictions; activity restrictions (flora or fauna collection or consumptive practices, excavation, etc.); training; personal protection equipment; and communications and/or notification requirements. This definition has been developed for the purpose of the Risk Review Project. Specific controlled access groups may include (1) people granted access for work-related visits, (2) people granted access for educational activities (e.g., site tours or visiting the B Reactor), and (3) people granted access for recreational activities. Site access for practicing Tribal cultural activities represents a unique controlled access group that will require a clear definition of safety and mitigation measures that may include biomonitoring of collected flora and fauna and should consider unique Tribal use and consumptive practices.

Some groups of controlled access persons will have risks similar to the general onsite workforce (e.g., onsite office workers) if a postulated upset event or scenario occurs based on the controlled access person's location and restrictions (e.g., if children are allowed, risks may be greater). In other cases, groups of controlled access persons will have different risks (e.g., less) than the general onsite workforce because of greater restrictions on where they can be located on site and when they are permitted on site (e.g., restricting access while higher risk activities are occurring). However, the actual risks to controlled access persons under non-work-related activities are not well established at this time because the specific exposure scenarios and mitigation measures are not part of the currently analyzed cases under DOE HAs and DSAs or environmental risk assessments. Thus, further risk analysis most likely will be required, along with evaluation of specific risk mitigation strategies considered as part of granting access to parts of the Hanford Site for non-work-related activities.

Recommending specific controls and mitigation measures for any of the controlled access groups, including for Tribal cultural activities, is beyond the scope of the Risk Review Project.

- **Public** – people present for any purpose outside the Hanford Site controlled access boundary (see Figure 2-9), where access to the surface soil to a depth of 5 m is not restricted.

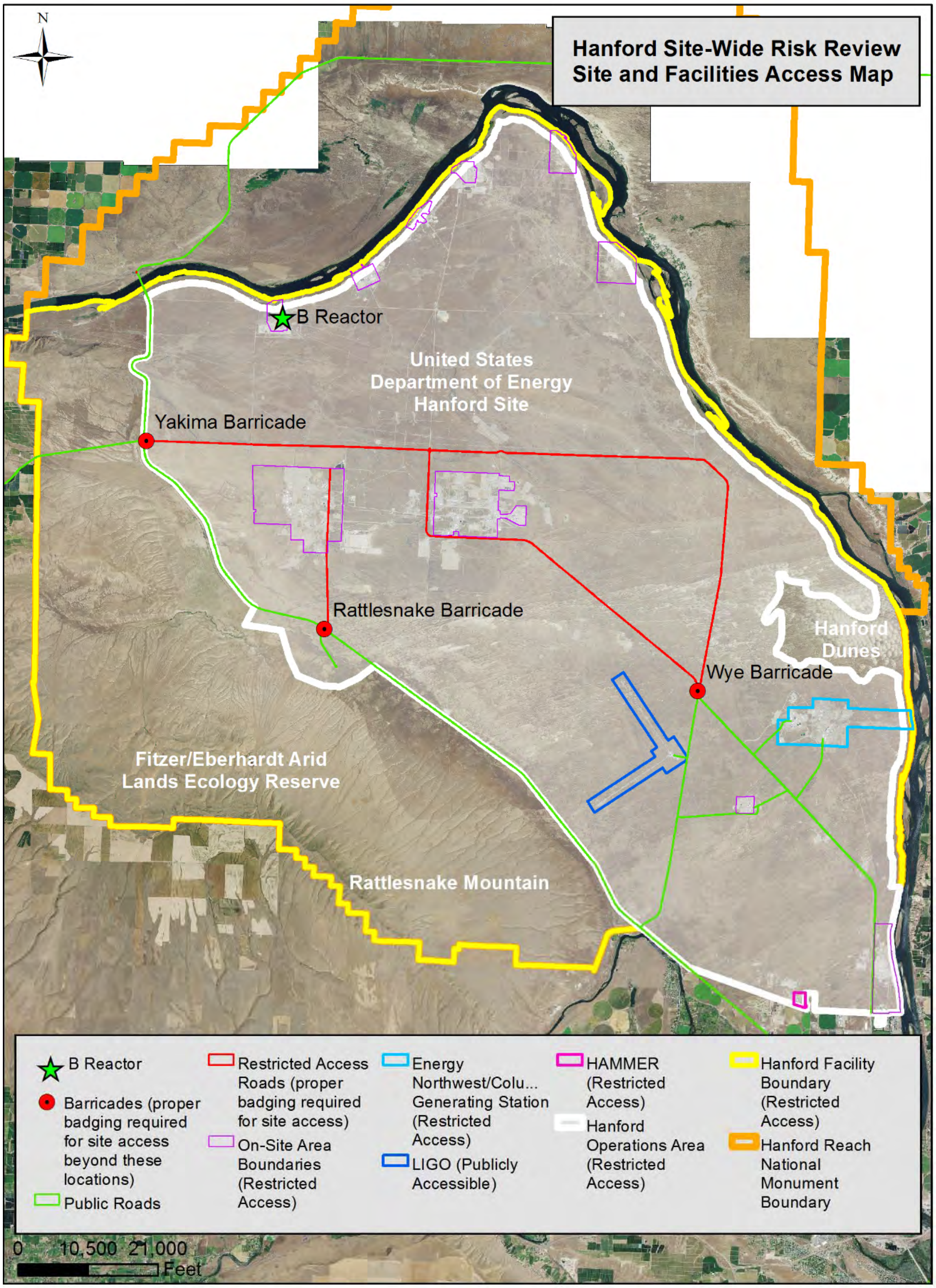


Figure 2-9. Hanford Site boundaries, public roads, and access control points. The shaded area between the river and the highways indicates the controlled access portion of the site. People outside of the lighter gray shaded area would be considered "public."

Health Risk Ratings

A basic assumption is that worker risk only exists when work is actually occurring. Some facilities are intrinsically hazardous due to the inventory and condition of the site. Some tasks are intrinsically hazardous due both to the inventory and to the activities that must be conducted.

The Risk Review Project considers three types of facility worker risk:

- **Type 1** – acute events or upset conditions (i.e., from explosions, fires, earthquakes, structural failures) resulting in blast injuries, fires, collapses, and sudden radiation and chemical releases. These are low probability, high consequence events that may result in death, injury, or exposure of individual or large numbers of facility workers, co-located persons, controlled access persons, or potentially the public. These events or scenarios range greatly in probability and are captured in hazard assessments or DSAs, which should be available (at least in draft) for most of the EUs. The initiating events may be natural disasters or anthropogenic.
- **Type 2** – potential threats associated with occupational hazards from subacute or chronic exposure (hours to days) to site-specific radioactive or chemical hazards (intermediate probability and consequence). Worker safety programs strive to prevent these exposures under "normal" operating conditions. Specific types of hazards in addition to radiation and chemical hazards are known to exist in many Hanford facilities (e.g., asbestos, beryllium, polychlorinated biphenyls (PCBs)) and are considered as part of analyses.
- **Type 3** – industrial accidents and injuries, including, for example, transportation accidents, falls, struck by objects, crush injuries, machinery injuries, and heat stress. These are relatively frequent events, particularly in construction activities, that may result in death or injury, but usually to one or a few individuals, and can be considered higher probability and lower consequence events compared to Type 1 (above).

The three types of worker risk are considered individually to develop a risk rating, since the risks are not additive. Type 2 and Type 3 risks are the domain of industrial safety and are part of the safety culture emphasized in DOE's Integrated Safety Management. As a result, fatalities have been rare in DOE's environmental management program, and lost-time injuries (per job hour) occur at a rate about one-third that of comparable outside work. Thus, mitigated Type 2 and Type 3 risks are *Low* or *ND* for most EUs. An overview of unmitigated hazards to workers, related to the five types of EUs considered in the risk-rating is provided in the methodology report (CRESP 2015).

The hazard assessments and DSAs develop worst-case assessments of unmitigated risks, varying in probability and consequence. These documents also address measures used to prevent (reduce the probability of an event) or mitigate the consequences. Nuclear safety engineering plays a primary role in anticipating, evaluating, preventing, and mitigating the Type 1 hazards. As a result, the mitigated risks are usually *Low* or even *ND*. For each EU, the scenarios that result in the highest unmitigated dose (including the dose estimate) and the primary mitigation measures are summarized in the EU template.

For remediation projects and/or operating facilities that have hazards assessments or DSAs, the rating for Type 1 risks relies on the unmitigated dose estimates to the co-located person as the primary differentiating characteristic. This is because dose estimates usually are not directly calculated for facility workers, and the unmitigated dose to the co-located person considers all significant radiological and chemical hazards present in a facility. *The scenarios that result in significant unmitigated dose are the result of initiating events that may occur with a high uncertainty with respect to probability of occurrence, and therefore the consequence rating is assumed to be the risk rating.* Scenarios with the greatest unmitigated dose to the co-located worker (including the dose estimates) and the mitigation measures are summarized in the EU template.

Radiation Dose Considerations and Risk Review Project Ratings

Table 2-3 summarizes various dose limits, standards, guidelines, benchmarks, and recommendations regarding human exposure to radiation. The discussion that follows only refers to whole body doses. The exposures being considered in the Risk Review Project are from Type I events, with ***theoretical scenarios constructed for safety analysis causing postulated exposures*** lasting hours or days. The dose limits and standards provided in the following table refer most frequently to the dose delivered over a year—referred to as the annual dose. The doses are expressed as "total effective dose". This consists of summing the dose from all external exposures and adding it to the dose commitment due to oral or respiratory intakes during the year. This distinction is made between internal and external radiation exposure because internally deposited radionuclides deliver their dose over time following the intake. An estimate of the dose that will be received from the annual external exposure and intake is calculated, and then assigned in the year of exposure. This is the standard method of accounting for radiation dose that will be received by the individual as a consequence of the long-term decay and elimination of the radioactive material from their body.

Doses from natural background, therapeutic and diagnostic medical radiation, and participation as a subject in medical research programs are not included in dose records or in the assessment of compliance with the occupational dose limits.

The values in Table 2-3 include the regulatory levels such as dose limits set by DOE (DOE 10 CFR 835) and the NRC (NRC 10 CFR 20) and standards set by the U.S. Occupational Safety and Health (OSHA). Two advisory bodies, the International Commission on Radiological Protection (ICRP) and the National Council on Radiation Protection and Measurements (NCRP) make recommendations regarding allowable or excessive exposure for consideration by regulatory authorities. Some of their recommendations are noted.

These doses are (or would be if an event occurred) superimposed on a background signal of radiation from cosmic rays, terrestrial sources (primarily radon), and internal radionuclides. The average U.S. background radiation (excluding medical uses) was estimated at 360 mrem/yr (BEIR 1990). More recent estimates place the average at 310 mrem/yr (NRC 2014). Background radiation in radon-rich areas can exceed 1000 mrem/yr.

The primary applicable DOE document for controlling radiation exposure of workers at DOE installations is *Occupational Radiation Protection* (10 CFR 835), which defines the radiation protection standard "applicable to DOE, its contractors, and persons conducting DOE activities" and includes equivalent dose limits. In addition to radiation protection limits, DOE establishes "administrative control levels." These are below the dose limits and are intended to ensure that the DOE limits and control levels are not exceeded. They also help reduce the collective dose to individuals and the worker population. The DOE dose limits take into account information provided by the ICRP, NCRP, and EPA. The whole body dose limit is 5 rem/yr (5 rem=5000 mrem=0.05 Sv = 50 mSv). The DOE administrative level is 2 rem/yr. DOE also has a dose limit applicable to the public of 0.1 rem (100 mrem) per year.

The NRC has similar standards that limit maximum radiation exposure to individual members of the public to 100 mrem (1mSv) per year above background, and limit occupational radiation exposure to adults working with radioactive material to 5 m (50 mSv) per year (NRC 10 CFR 20). The OSHA worker standard is also 5 rem/yr.

Table 2-3. Criteria, standards, guidelines, benchmarks, and recommendations from various U.S. and international agencies for human exposure to radiation (1 mSV = 100 millirem).

Estimated Total Effective Dose (TED[e])	DOSE Limits, Standards, Guidelines, Benchmarks, and Recommendations
0.012 rem (12 mrem or 0.12 mSv)	EPA recommends a 12 mrem/yr dose (effective dose equivalent), corresponding to an estimated 3 x 10^{-4} excess lifetime cancer risk (incidence) for 30 yr residential land use at CERCLA sites.[a]
0.025 rem (25 mrem or 0.25 mSv)	NRC's License Termination Rule (LTR) specifies 25 mrem/yr dose (TED) for unrestricted use from all exposure pathways combined to an average member of the critical group. (http://www.nrc.gov/reading-rm/doc-collections/cfr/part020/full-text.html#part020-1402
0.1 rem (100 mrem or 1mSv)	Expressed as an annual dose limit for public. (DOE 10 CFR 835.207) It is set at 0.1 rem (100 mrem or 1 mSv) per year above background. Other federal agencies (OSHA, NRC 10 CFR 20) use the same limit for public exposures.
0.3 rem (300 mrem[a] or 3 mSv)	Average annual U.S. background radiation from natural sources is about 0.3 rem per year (NRC 2014) NOT including medical uses.[b] An individual's dose depends on many factors including location, altitude, geology, and lifestyle.
2 rem (or 2,000 mrem or 20 mSv)	Occupational dose as recommended by the ICRP[b] is 2 rem (or 0.02 Sv or 20 mSv) per year. DOE establishes an Administrative Control at an occupational dose of 2 rem/yr.
5 rem (or 5,000 mrem or 50 mSv)	Annual occupational dose limit as set by the DOE (10 CFR 835, DOE *Occupational Radiation Protection)* rule for radiation workers specifies a dose limit of 5 rem (or 5,000 mrem or 50 mSv) per year. This is equivalent to both the NRC and the OSHA occupational radiation exposure standard of 5 rem/yr for non-DOE workplaces.
25 rem (or 25,000 mrem or 250 mSv)	If from *a single short-term event*, the 25 rem DOE dose limit applies to a worker who is protecting large populations or critical infrastructure or performing life-saving efforts in emergency circumstances. This one-time qualified worker dose requires DOE prior authorization to proceed.
100 rem (or 100,000 mrem or 1000 mSv)	A 100 rem dose, occurring from a single short-term event, may cause acute symptoms (nausea and vomiting with 4 h) in 5% to 30%of the exposed population. The risk of fatal cancer is increased by up to 8% (the lifetime risk of fatal cancer without radiation exposure is approximately 24% (NCRP 2005)). A 100 rem dose, accumulated over a working lifetime yields the ICRP[c] recommended maximum lifetime dose for a radiation worker: 1 Sv (or 100 rem). This dose, accumulated over a long period, will not cause acute symptoms in the exposed population. Because the dose is spread out over time, the estimated risk of cancer is cut in half to approximately 4% (In contrast, the NCRP[d] recommends a maximum permissible dose of 0.65 Sv (or 65 rem, which is 10 mSv × age).

a="Although radiation may cause cancers at high doses and high dose rates, currently there are no data to establish unequivocally the occurrence of cancer following exposure to low doses and dose rates – below about 10,000 mrem (100 mSv)". From the USNRC, http://www.nrc.gov/reading-rm/doc-collections/fact-sheets/bio-effects-radiation.html

b=Average background varies with elevation up to about 500 mrem

c=ICRP= International Council on Radiation Protection=consensus body with no regulatory authority

d=NCRP=National Council on Radiation Protection

e= The term TED, which is replacing the earlier TEDE, reflects current international, industry and federal standards and reflects DOE STD 3009-14. Some of the documents cited in this report specify doses using TEDE. For most circumstances, the differences in are not substantial.

Table 2-4 presents the Risk Review Project ratings for facility workers and co-located persons that are based on *unmitigated* dose estimates from DSA or hazard assessments using the estimated unmitigated dose to the co-located worker as the metric for Risk Review Project rating. Similarly, Table 2-5 presents the Risk Review Project ratings for the public. Rating categories for the public are more stringent than for facility workers and co-located persons because of increased training and informed consent associated with worker and onsite activities. Note that rating definitions used by the Risk Review Project are different from DOE-STD-3009 risk rating assignments. These differences were to facilitate more effective risk communication with a general audience in context with information provided in Table 2-3.

Table 2-4. DOE-STD-3009-2014 and Risk Review Project "worker" and "co-located person" risk rating basis for unmitigated Type 1 design basis events (single event unmitigated dose estimates).

Unmitigated Estimated TED[b]	DOE-STD-3009-2014 Rating (corresponding to DSA or HA ratings)	Risk Review Project Rating
≤0.1 rem		ND[a]
>0.1 rem to ≤5 rem	Low	Low
>5 rem to ≤25 rem	Low	Medium
>25 rem	Medium	High
>100 rem	High	

a. "ND" or "Not Discernible" does not exist in the DOE nuclear safety risk or consequence levels (DOE-STD-3009-2014 or SARAH). This rating is added for binning purposes.
b. The term TED, which is replacing the earlier TEDE, reflects current international, industry and federal standards and reflects DOE STD 3009-14. Some of the documents cited in this report specify doses using TEDE. For most circumstances, the differences in are not substantial.

Table 2-5. DOE-STD-3009-2014 and Risk Review Project "public" risk rating basis for unmitigated Type 1 design basis events (single event unmitigated dose estimates).

Unmitigated Estimated TED[b]	DOE-STD-3009-2014 Rating (corresponding to DSA or HA ratings)	Risk Review Project Rating
≤0.1 rem		ND[a]
>0.1 rem to ≤1 rem	Low	Low
1 to ≤5 rem	Medium	Medium
>5 rem	Medium	High
>25 rem	High	

a. "ND" or "Not Discernible" does not exist in the DOE nuclear safety risk or consequence levels (DOE-STD-3009-2014 or SARAH). This rating is added for binning purposes.
b. The term TED, which is replacing the earlier TEDE, reflects current international, industry and federal standards and reflects DOE STD 3009-14. Some of the documents cited in this report specify doses using TEDE. For most circumstances, the differences in are not substantial.

GROUNDWATER AND THE COLUMBIA RIVER

Many of the EUs being considered involve discharges of contaminants into the environment that either have 1) resulted in current groundwater contamination, or 2) may in the future impact groundwater, or 3) the groundwater may serve as a contaminant transport pathway for threats to the Columbia River. Threats to groundwater evaluated are:

1. Groundwater currently contaminated and the potential for increased extent of contaminated groundwater from the spread of contaminants already in groundwater;
2. The potential for existing environmental contamination present in the near surface or vadose zone to increase the extent of contaminated groundwater; and,
3. The potential for contaminants currently in engineered facilities (i.e., tank wastes) to increase the extent of contaminated groundwater.

Threats considered to the Columbia River from discharges of contaminated groundwater through springs and upwellings are as follows:

1. Threats to the riparian zone ecology;
2. Threats to the Columbia River benthic zone ecology; and,
3. Threats to the free stream ecology.

The approach used was developed in the context of the highly variable degrees of uncertainty and information gaps in contaminant distributions and subsurface contaminant transport at the many contamination sources within the Hanford Site. Thus, the methodology focuses on groundwater evaluation metrics that may lead to rough-order of magnitude (ROM) differences and thereby allow relative binning of potential impacts and risks from EUs (CRESP 2015). This focus is in contrast to the information needed for a performance assessment or a baseline risk assessment, or the basis for remedial process selection and design.

The primary contaminant groups used in this review that relate to the EUs evaluated in this interim report

[37] are described in Table 2-6, which categorizes them according to their mobility and persistence in the Hanford environment. The categorization was done on a relative basis among the primary contaminants that pertain to the 25 interim report EUs. Mobility relates to the primary contaminant's relative ability to be transported in the subsurface environment (as represented by the contaminant transport retardation factor, R) and is mainly a function of the contaminant's chemistry and sorption with the Hanford subsurface geology. For the radioactive contaminants, the persistence category is based on the radionuclide's half-life. The persistence category of the organic and inorganic contaminants is based on their chemical degradation and biodegradation potential. Chromium, being non-degrading and not radioactive, is classified as having a high persistence in the subsurface.

For the purposes of this site-wide review, the primary contaminants were divided into four groups based on their persistence and mobility. Group A contains technetium-99, iodine-129, carbon-14, hexavalent chromium, and carbon tetrachloride. Group B contains strontium-90, TCE, PCE, uranium, total chromium, and cyanide. Group C contains tritium, nitrate, and TPH-diesel. Group D contains cesium-137 and plutonium. Additional contaminants may be added to the groupings based on review of the full set of EUs. The groups are ranked relative to one another with respect to potential for threats water

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[37] Additional contaminants will likely be added to the current group of contaminants indicated here when the remaining EUs are evaluated.

resources, with Group A being the highest (highly mobile and highly persistent) and Group D being the lowest (low mobility and highly persistent) for the purpose of this study.

Table 2-6. Primary contaminant groups used in this risk review project.

		Mobility*		
		Low (R>500)	Medium (5<R<500)	High (R<5)
Persistence	Low		TPH-diesel	$^{3}H_2O$, NO_3
	Medium	Cs-137, Am-241	Sr-90	Cyanide, TCE
	High	Pu, Eu, Ni (all isotopes)	$U^{(total)}$, $Cr^{(total)}$	Tc-99, I-129, C-14, Cl-36, Cr^{6+}, Carbon Tetrachloride

Group A Primary Contaminants (red)
Group B Primary Contaminants (yellow)
Group C Primary Contaminants (green)
Group D Primary Contaminants (blue)

* Assume most mobile form of contaminant
R = retardation factor

The major steps of the evaluation process are (1) identifying EUs that either are impacting or may impact groundwater; (2) compiling relevant information concerning the source, vadose zone, and saturated zone for each EU; (3) calculating the evaluation metrics for each EU; and (4) comparing the evaluation metrics. Information gaps, uncertainties, and data gaps will be described for each EU. The methodology considers the three evaluation time frames defined for the Risk Review Project: active cleanup (50 years, to 2064), near-term post-cleanup (100 years post cleanup, to 2164), and long-term post-cleanup (1000 years post-cleanup, to 3064 or beyond where indicated) (CRESP 2015). Three possible recharge rates (i.e., surface barrier (0.5 mm/yr), undisturbed plant communities (5 mm/yr), and disturbed soil (50 mm/yr)) are considered to reflect uncertainties and a range of potential local surface conditions over the indicated time frames as a result of ground cover, closure covers, climate variation, and localized surface hydrologic effects.[38]

The evaluation metrics for risks to groundwater from current groundwater plumes and near-surface or vadose zone sources are as follows:

1. The estimated time interval until groundwater would be *impacted* by a primary contaminant where a current plume does not exist over the three evaluation periods. Groundwater is considered *impacted* when a primary contaminant concentration exceeds a threshold value, e.g., a drinking water standard or maximum contaminant level.

[38] A value of 100 mm/yr is used when needed to reflect specific conditions (e.g., gravel cover).

2. The estimated amount of groundwater (e.g., areal extent) currently *impacted* by the primary contaminants with existing plumes.
3. The *groundwater threat metric (GTM)*, defined as the volume of groundwater potentially contaminated at the reference threshold concentration (e.g., drinking water standard) based on the estimated contaminant inventory over the three evaluation periods.

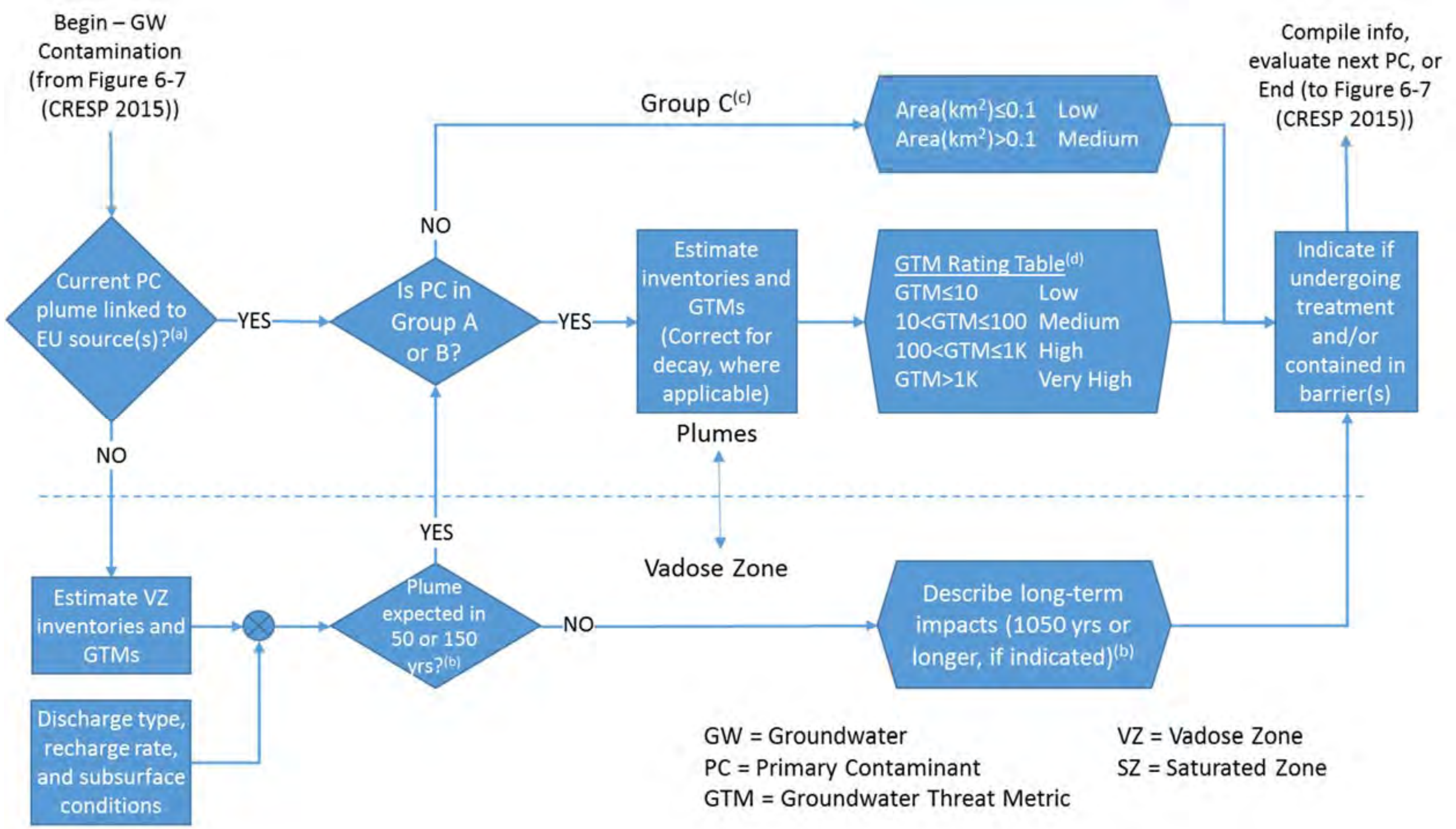
The decision logic for assigning Risk Review Project ratings for existing groundwater contamination and contaminants in the vadose zone and engineering systems is provided in Figure 2-10.

The selected evaluation metrics for risks to the Columbia River from near surface, vadose zone, and groundwater contamination sources are as follows:

1. The estimated time interval until the Columbia River is *impacted* over the three evaluation periods. The Columbia River is considered *impacted* when a primary contaminant concentration exceeds a benthic or free-flowing threshold value.
2. The ratio (R1) of the maximum primary contaminant concentration within the plume to the reference threshold screening value (e.g., Biota Concentration Guide (BCG) for radionuclides or ambient water quality criterion (AWQC) for chemicals).
3. The ratio (R2) of the upper 95th percentile upper confidence limit (UCL) on the log-mean plume concentration to the reference threshold screening value.
4. For benthic impacts, the length of river shoreline estimated to be impacted by the plume above a reference threshold.[39]
5. For riparian zone impacts, the area of the riparian zone estimated to be impacted by the plume above a reference threshold.

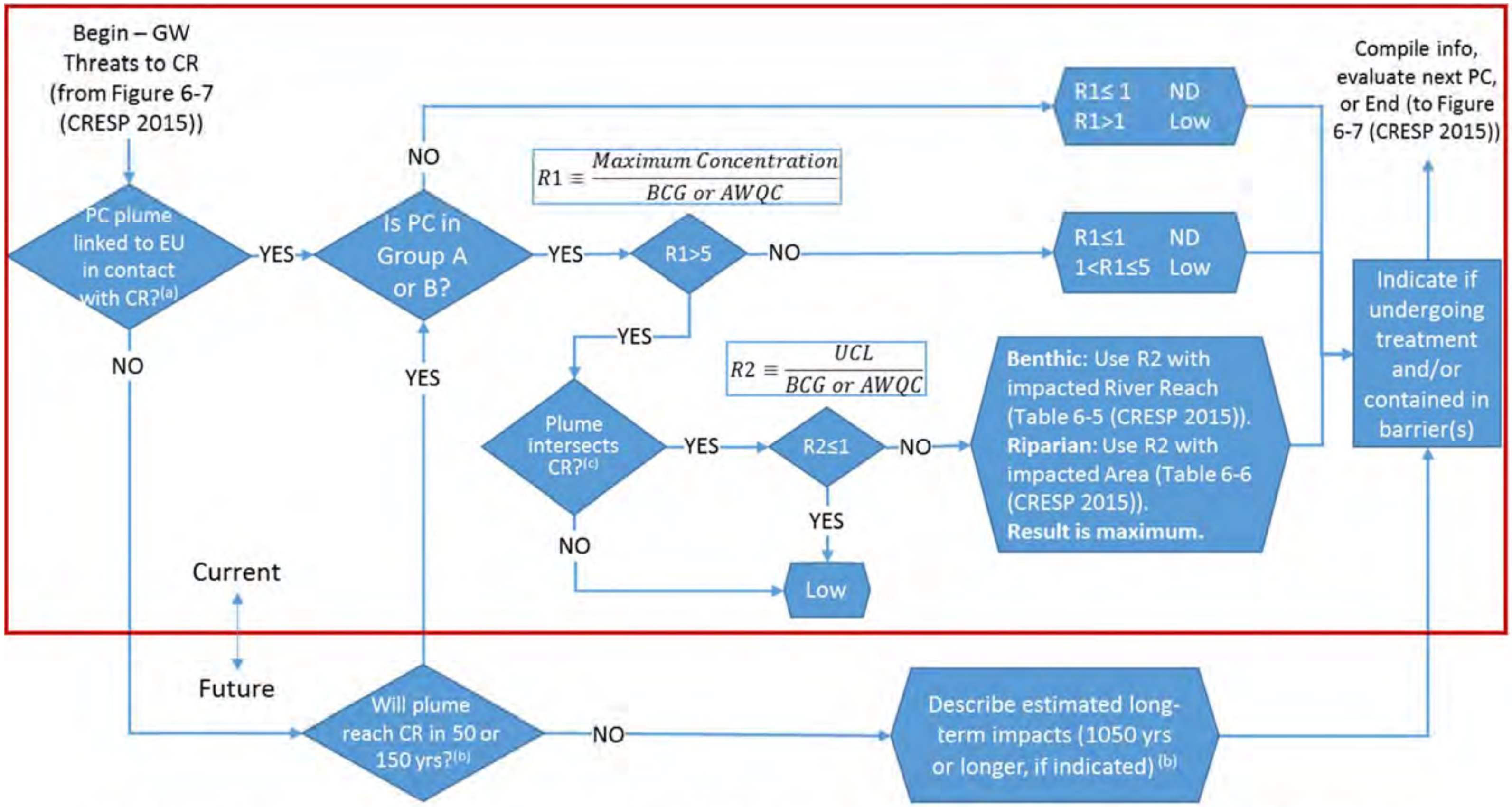
The decision logic for assigning Risk Review Project ratings for threats to the Columbia River is provided in Figure 2-11. The tables for assigning ratings for Group A and Group B primary contaminants for riparian zone and benthic zone threats are provided in Table 2-7 and Table 2-8, respectively.

[39] The impact area of the Columbia River for the benthic ecology is inherently more uncertain than the length of river reach because the specific area of the groundwater discharge into the river is unknown for most cases. Rather, the length of the river reach can be estimated based on the plume intersection with the river edge. Furthermore, the impacted river length and impacted area are highly correlated based on limited available data (CRESP 2015).



a. Based on plume area above a threshold (e.g., Water Quality Standard (WQS) from 2013 Annual GW Monitoring Report (DOE/RL-2014-32 Rev. 0)). Note plume areas and corresponding estimated plume volumes are (highly) positively correlated.
b. Use available information (e.g., environmental impact statements, risk assessments) to evaluate.
c. Note, no Group D contaminants have been identified as groundwater threats.
d. GTM Rating Table for Group A and B PCs (Table 6-3 (CRESP 2015)).

Figure 2-10. Decision logic for characterizing threats to groundwater as a protected resource with respect to existing groundwater contamination and vadose zone contamination. Note: No Group D contaminants have been identified as groundwater threats.



PC = Primary Contaminant
GTM = Groundwater Threat Metric
UCL = Upper 95% confidence limit (log-mean)
VZ = Vadose Zone
CR = Columbia River
AWQC = Ambient Water Quality Criterion (chemicals)
BCG = Biota Concentration Guide (radionuclides)
ND = Not discernible

a. Based on plume area above a threshold (e.g., Water Quality Standard (WQS) from 2013 Annual GW Monitoring Report (DOE/RL-2014-32 Rev. 0)). Note plume areas and corresponding estimated plume volumes are (highly) positively correlated.
b. Use available information (e.g., environmental impact statements, risk assessments) to evaluate.
c. Based on either aquifer tube data or contours exceeding the threshold (e.g., from PHOENIX at http://phoenix.pnnl.gov/).

Figure 2-11. Decision logic for rating threats to the Columbia River from groundwater contaminants (where steps in red box are for current impacts and those below are for potential future impacts to the river).

Table 2-7. Riparian zone ratings for contaminants based on the area of the potentially impacted riparian zone and the ratio R2 (i.e., (log-mean concentration, 95th UCL)/AWQS)).

	(Log-Mean Concentration, 95th UCL)/(AWQS)			
Area (hectacres)	< 1	1 to < 5	5 to < 10	> 10
<0.5	ND	Low	Medium	Medium
0.5 to < 5	ND	Medium	Medium	High
5 to < 15	ND	Medium	High	High
> 15	ND	Medium	High	Very High

ND = Not discernible
BCG = biota concentration guide for radionuclides
AWQC = ambient water quality criterion for chemicals

Table 2-8. Benthic zone ratings for contaminants based on the estimated length of potentially impacted river reach and the ratio R2 (i.e., (log-mean concentration, 95th UCL)/BCG or AWQC)).

	(Log-Mean Concentration, 95th UCL)/(BCG or AWQC)			
River Reach (m)	< 1	1 to < 5	5 to < 10	> 10
<50	ND	Low	Medium	Medium
50 to < 500	ND	Medium	Medium	High
500 to < 1500	ND	Medium	High	High
> 1500	ND	Medium	High	Very High

ND = Not discernible
BCG = biota concentration guide for radionuclides
AWQC = ambient water quality criterion for chemicals

Ecological Resources

The Risk Review Project methodology for evaluating ecological resources on the Hanford Site is an independent evaluation that encompasses evaluations of site resources in comparison to the Columbia Basin ecoregion; evaluations by DOE, the State of Washington, the State of Oregon, Nature Conservancy, and Tribes (where available); and onsite field evaluations in 2014-2015 (CRESP 2015). It uses the level of resource values designed by DOE (DOE/RL-96-32 2013) in conjunction with information from the State of Washington, Tribes, and others. The resource values are modified by field work evaluations of current resource levels and landscape features (patch size, patch shape, connectivity), and exotic/alien species, and considerations of contamination (potential exposure during active cleanup or in the 100 years thereafter). A major contribution of the ecological risk evaluation is the acquisition of new field data on resource level values for the EUs and the surrounding buffer areas.

The risk that the ecological resources experience is a function of contaminants that are present, as well as ecological accessibility, remediation types, functional remediation parameters (e.g., number of people, cars, trucks, heavy equipment, capping, excavation), and scales (temporal, spatial). Ecological resources are at risk not only from contaminants and onsite activities, but from the activities on adjacent habitat. That is, people, cars, and trucks moving through a non-target site to reach the target remediation site can affect adjacent, not-target sites (defined as buffer areas). These effects can be direct (e.g., traffic and habitat disruption, exposure to contaminants) or indirect (e.g., disturbance to animals, dispersal of seeds). Laydown areas can have an important effect, and must be selected carefully to minimize disruption to both EUs and the buffer zone. Post-cleanup risks to ecological receptors include contamination left in place.

This methodology is designed to use available, Geographic Information System (GIS)-based information on ecological resources on the Hanford Site, in addition to field data gathered in 2014 and 2015 (CRESP 2015). The information relates to individual species (which are at risk), species groups (e.g., native grasses and shrubs), and key unique habitats or ecosystems that could be at risk. The methodology was developed so that it could be applied to different EUs, and could be applied by personnel with basic ecological knowledge. While landscape features can be determined from maps, they must be checked in the field, and other necessary field work includes determining the percent of alien/exotic species present on the site, as well as the occurrence of endangered/threated/species of special concern.

The rating scale of Low to Very High used for ecological resources is described briefly below, and is based on the resource levels defined by DOE (DOE/RL-96-32 2013):

- Low = Little probability to disrupt or impact level 3-5 ecological resources.
- Medium = Potential to disrupt or impair level 3-5 ecological resources.
- High = Likely to disrupt and impair level 3-5 ecological resources of high value or resources that have restoration potential, and may cause permanent disruption.
- Very High = High probability of impairing (or destroying) ecological resources of high value (levels 3-5) that have typical (and healthy) shrub-steppe species, low percent of exotic species, and may have federally listed species. Likely to cause permanent degradation or disruption.

CULTURAL RESOURCES

The methodology for evaluating cultural resources at risk at Hanford Site during the active cleanup and near-term post-cleanup periods is an independent analysis that encompasses a thorough review of existing documentation for each unit being evaluated (and buffer area) (Chapter 8 of methodology report (CRESP 2015)). The definition of the term "cultural resources" is identical to the definition used in the Hanford Cultural and Historic Resources Management Plan, which states:

> *Cultural resources is a collective term applicable to: 1)prehistoric-and historic-archaeological sites and artifacts designating past Native American utilization of the Hanford Site; 2) historic-archaeological sites and artifacts indicating post Euro-American activities relating to the pre-Hanford period; 3)Hanford Site Manhattan Project and Cold War era buildings, structures, and artifacts; 4) landscapes, sites, and plants and animals of cultural value to the Native American community; and 5) landscapes, sites, and materials of traditional cultural value to non-Native Americans (DOE/EIS/RL-98-10, Rev 0 Appendix A 2003).*

An overall risk or impact rating or binning for cultural resources is not provided for any of the evaluation periods. This is because cultural resources risks cannot be estimated in the same way that risks, for example, to groundwater can be characterized. Additionally, federal law requires that a cultural resources review be completed before any project activity may begin, including those associated with remediation, regardless of any rating that may be provided (National Historic Preservation Act and Section 106 reviews, 16 U.S.C. 470 et. seq.; 36 CFR Part 800 (2004)). A similar mandate is not imposed for other receptors being evaluated.

At the Hanford Site, this required cultural resources review is carried out for each project activity consistent with federal statutory and regulatory requirements. Requirements include identification, evaluation, and assessment of the potential effects of remediation on cultural resources. And, if adverse impacts to cultural resources are anticipated from the activity, the regulatory process calls for an agreement to be negotiated that outlines mitigation measures intended to minimize and/or avoid any adverse impacts, including those resources located subsurface. The process also mandates procedures for consultation with Washington Department of Archaeology and Historic Preservation, State Historic Preservation Officer (SHPO), Native American Tribes (Tribes), and interested parties or stakeholders.

While the analysis does not include an overall impact rating of Not Discernible, Low, Medium, High, or Very High, the cultural resources impacts (both direct and indirect) during current operations, active cleanup (until 2064), and near-term post-cleanup are made and expressed as known, unknown, or none to cultural resources within the unit being evaluated (and the buffer area). These assignations are based on existing cultural resources documentation from DOE and Washington State records for the unit being evaluated (and immediate surrounding area) or other information made available by Tribes and/or historical societies to establish whether cultural resources are or have been present within that EU. Such a determination is made for each of the three overlapping landscapes that comprise the cultural resource setting at Hanford Site (i.e., Native American (10,000 years ago to present), Pre-Hanford Era (1805-1943), and Manhattan Project and Cold War Era (1943-1990)). Additionally, as noted, direct and indirect impacts are provided. 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.

The purpose of the cultural resources documentation review is to provide guidance to DOE and regulatory agencies as remediation options for the EU are considered. And, if the remediation option has already been determined, the purpose is to provide additional insights to DOE, regulatory agencies, SHPO, Tribes, and other interested parties or stakeholders on the extent to which remediation activities may adversely affect cultural resources. Finally, the analysis of cultural resource-related documentation is intended to provide insights into the residual effects that may remain after completion of cleanup.

The third period, long-term post-cleanup (until 3064), is not being evaluated for risks to cultural resources. This is because it is difficult to predict the presence of cultural resources for a period so remote as no tools exist to determine which of the resources considered significant today and in the near future will have the same level of significance hundreds of years from now.

2.4. CONSIDERATION OF UNCERTAINTY IN THE HANFORD RISK REVIEW

The Hanford Risk Review is not a regulatory risk assessment; however, the Review has many elements in common with regulatory risk assessment especially in terms of the uncertainties in the information used, including that from prior assessments. For example, each step in the risk assessment process incurs several types of uncertainties, and these uncertainties encumber discussions of risk and communication of risk. Uncertainty is inherent in the process even when using the most accurate data and the most sophisticated models (EPA 2005). Sources of uncertainty include 1) intrinsic variability in the processes or variables being studied or analyzed, 2) model variability (parameter estimates), 3) decision-rule variability (choices of processes or variables for inclusion and standards for comparison), and 4) residual variability due to random errors, systematic errors, and inadequate sampling or data. In some cases uncertainties can be estimated or bounded, while in other cases they are unknown. Some information is unknown, and some is unknowable, although more data points can reduce these uncertainties (EPA 2005).

For the Risk Review Project, a central uncertainty results from the unevenness in terms of extent and detail, and frequently very limited or incomplete (and in some cases inconsistent), information available for individual EUs. Identifying key data gaps is also an important part of characterizing risk. The variability in available data is a direct result of the long time period and step-wise process being taken for cleanup of the Hanford Site and that different EUs are at different stages of investigation and cleanup. There are also uncertainties in the natural chemical, hydrologic, and biological systems themselves, as well as the waste characterization and distribution of current environmental contamination. The Risk Review Project has used consistent sources of information wherever possible and has selected a rough order-of-magnitude (ROM) basis for comparing risks (i.e., ratings for different receptors[40]) as a way of managing the large uncertainties and differing states of information as described below. The major contaminated sites were grouped into 60 EUs to make the Risk Review Project and its results tractable. There is an inherent trade-off between grouping contaminated areas into EUs (with the concomitant loss of information, specificity, and variability due to aggregation of source information) and the ability to complete the Review and provide sufficient information to support decision making in a timely and efficient manner. Contaminated areas were grouped in a way to minimize the loss of information and to not mask major risk factors (considering the ROM basis used for comparison). Where found necessary, evaluations were focused on a much finer gradation, including consideration of individual Operable Units for potential groundwater impacts and individual Tank Farms (and individual waste tanks and constituents) for evaluating impacts from Hanford tanks.

Additional information on key uncertainties and the approaches used in the Risk Review Project evaluations is provided in the Methodology, section 2.14.

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[40] For example, ratings of Not Discernible to Very High for impacts to groundwater as a protect resource *or* ecological impacts are intended to represent the same comparative ratings; however, ratings are not intended to represent the same results across impacts (e.g., a Low rating for potential impacts to groundwater as a protected resources does not have the same meaning as a Low rating for ecological impacts).

CHAPTER 3. RESULTS FROM REVIEW FOR EACH CATEGORY OF EVALUATION UNITS

3.1. LEGACY SOURCE EVALUATION UNITS

The Hanford legacy EUs represent sites containing contaminant releases to the ground surface or subsurface resulting from prior actions, including waste disposal actions that are no longer being carried out at a particular location and are potentially subject to cleanup. They include past practice liquid waste disposal sites (e.g., cribs, ponds, and ditches), buried solid waste sites (including retrievably stored TRU waste sites), unplanned releases, and associated underground piping and infrastructure. Legacy EUs may affect human health and environmental resources primarily either through near-surface soil-borne contamination or through potential impacts to groundwater.

Evaluations have been completed on the current condition and cleanup alternatives for four of the approximate 24 legacy source EUs: (1) BC Cribs and Trenches, (2) 618-11 Burial Ground, (3) K Reactor Area Waste Sites, and (4) the Plutonium-Contaminated Waste Sites. A comparison of findings is provided below. Figure 3-1 is a map of the Hanford Site showing the location of each of these EUs, with green stars identifying the four EUs included in this interim report and red stars identifying the EUs remaining to be evaluated as part of the final report.

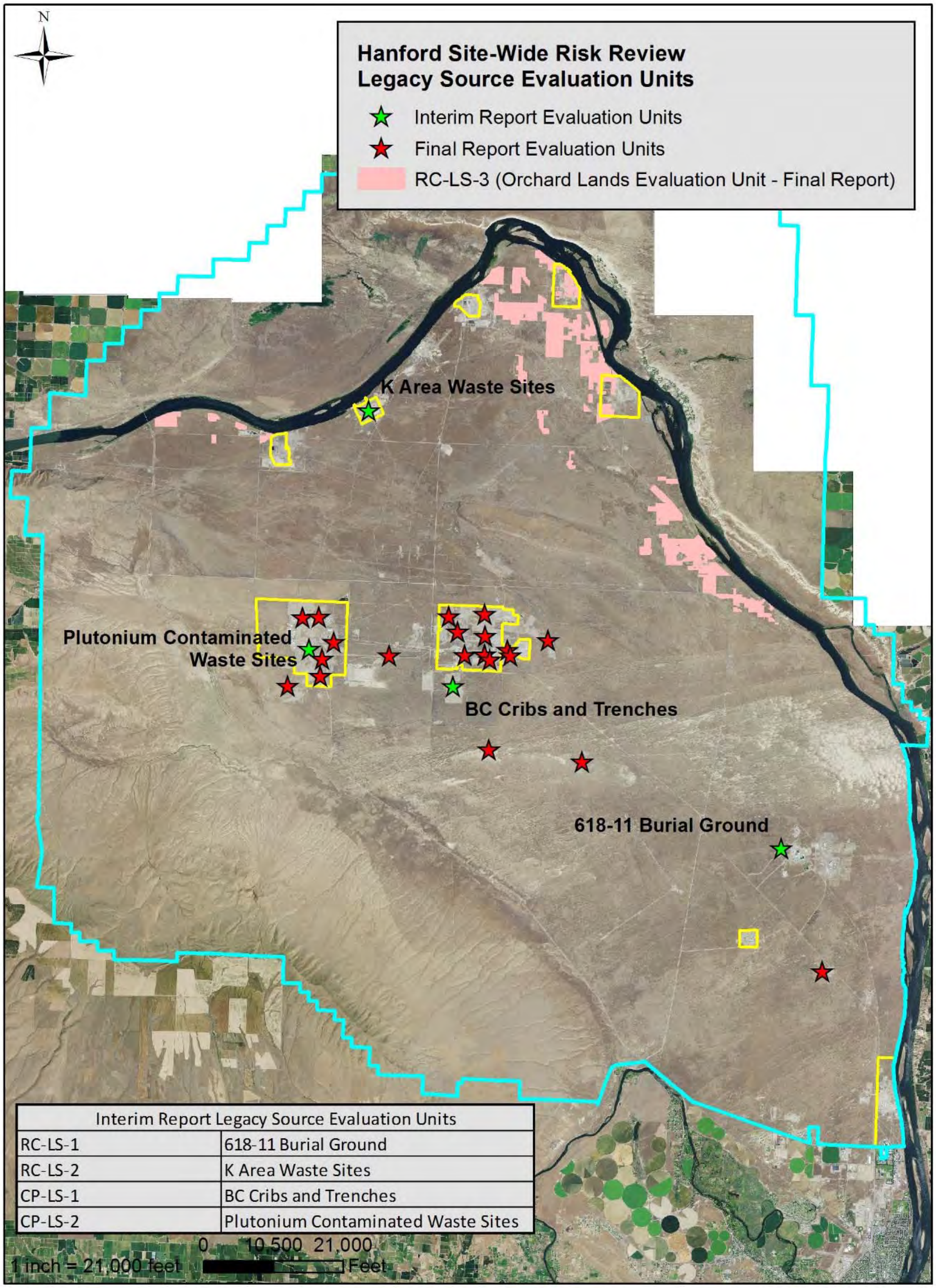


Figure 3-1. Map of legacy evaluation unit locations.

Description of Legacy Evaluation Units

The following are short overview summaries of the Hanford legacy group of EUs considered in this report:

- 618-11 Burial Ground (RC-LS-1)
- BC Cribs and Trenches (CP-LS-1)
- K Reactor Area Waste Sites (RC-LS-2)
- Plutonium Contaminated Waste Sites (CP-LS-2)

618-11 Burial Grounds (RC-LS-1)

The 618-11 Burial Ground (Figure 3-2) received TRU and mixed fission waste from March 1962 until December 1967 from all of the 300 Area radioactive material handling facilities. The burial ground consists of three trenches, approximately 900 ft long, 25 ft deep and 50 ft wide, laid out in an east-west direction. The trenches comprise 75% of the site area. There are 50 vertical pipe units (storage units) that consist of five 55-gallon steel drums welded together and placed vertically in the soil. These are buried in three rows in the northeast corner of the site. There are also approximately five 8-foot-diameter caissons situated at the west end of the center row of the vertical pipe units (Figure 3-3).

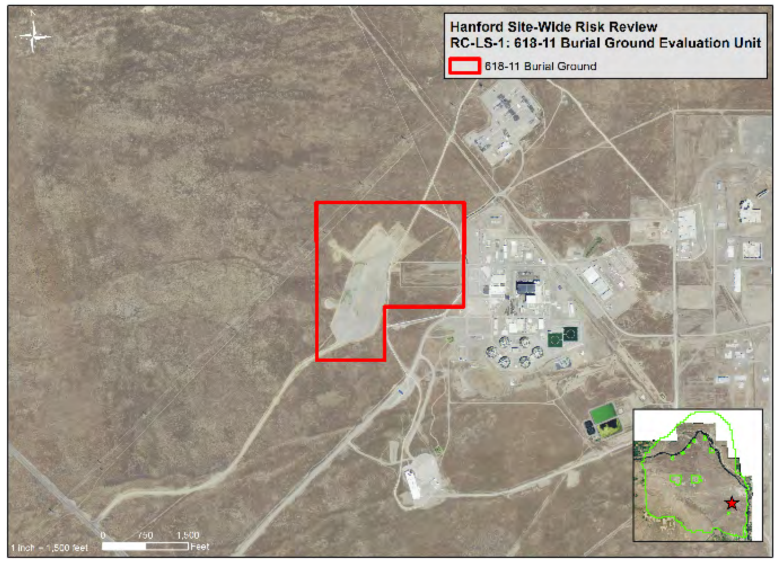


Figure 3-2. Aerial view of 618-11 Site.

Current Status: The 618-11 Burial Ground is closed, covered with soil, and vegetated. It is currently embedded with unconsolidated sands and gravels of the Hanford formation and covered with eolian silts characteristic of this region that have been vegetated with crested wheatgrass. The vegetated silt acts as hydraulic barrier that limits percolation of meteoric water into the waste to minute amounts (1 to 3 mm/yr). However, there is gravel cover over the vertical pipe units and caissons that facilitates elevated levels of infiltration and may drive future contaminant release to the groundwater.

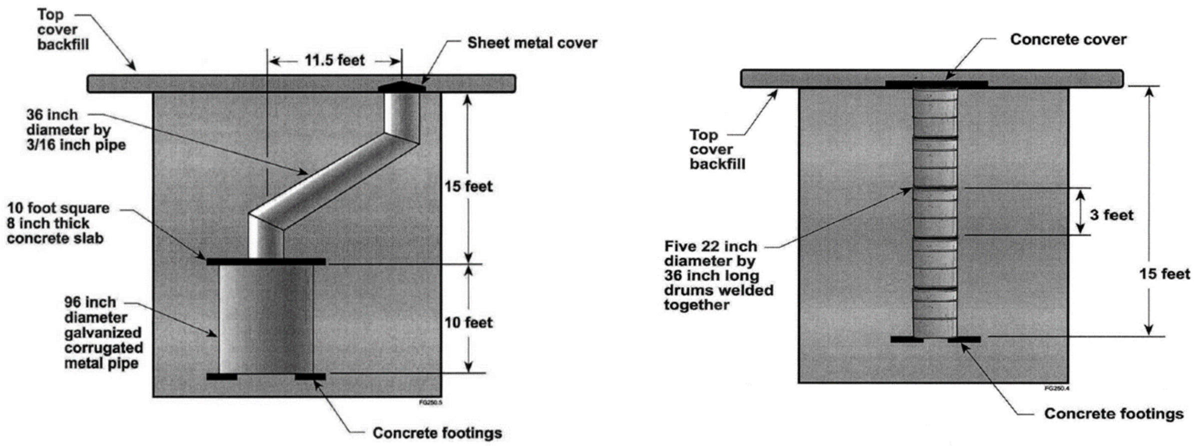


Figure 3-3. Illustration of caissons and vertical pipe units in the ground at 618-11 site (DOE CP-14592, 2003).

A plume containing tritium and nitrate is beneath the site. Concentrations are diminishing due to natural dilution, dispersion, and decay such that the tritium concentration is not expected to exceed drinking water standards when the plume reaches the Columbia River. That is, natural attenuation processes are managing the plume effectively. Additional releases of tritium may occur in the future as a result of leakage from disposed containers.

Primary Contaminants: The waste material was generated during laboratory examinations and studies, including analyses of fuel reactor samples, characterization of the chemical and physical properties of immobilized forms of plutonium, and analysis of ruptured reactor fuel (Table 3-1) (Dunham 2012). Specific waste items may include wipes, towels, protective clothing, cardboard, metal cans, high efficiency particulate air (HEPA) filters, stainless steel tubing, plastic pipe, lead (bricks and sheeting), polyethylene bottles, failed machinery, used lab ware (beakers, pipettes, vials, and tubing), gloves, lab equipment (balances, drying ovens, heating mantles, pumps, and reaction vessels), thermometers, concrete, soil, plumbing fixtures, and tools (screw drivers, wrenches, and shears). Some drums disposed in trenches contain oil. Also included are sample residues from fuel pellets, ruptured fuel elements, ceramics, and grouted plutonium in cans.

Table 3-1. 618-11 Burial Ground (RC-LS-1) radionuclide inventory (Dunham 2012).

Radionuclides	Group	Curies (Ci)
Americium-241	D	230
Carbon-14	A	NP[(a)]
Chlorine-36	A	NP
Cobalt-60	C	NP
Cesium-137	D	5,300
Europium-152	D	NP
Europium-154	D	NP
Tritium	C	Inventory information not available
Iodine-129	A	NP
Nickel-59	D	NP
Nickel-63	D	NP
Plutonium-Total Rad[(b)]	D	770
Strontium-90	B	4,200
Technetium-99	A	NP
Uranium- Total Rad[(c)]	B	NP

a. Not present at significant quantities for the indicated EU
b. Sum of plutonium isotopes 238, 239, 240, 241, and 242
c. Sum of uranium isotopes 232, 233, 234, 235, 236, and 238

Table 3-2. 618-11 Burial Ground (RC-LS-1) chemical inventory (Dunham 2012).

Chemical	Group	kg
Beryllium	---	330
Carbon Tetrachloride	A	NP
Cyanide	B	NP
Chromium	B	NP
Chromium-VI	A	NP
Mercury	D	NP
Nitrate	C	NP
Lead	D	NP
TBP	---	NP
Trichloroethene	B	NP
Uranium	B	NP

Surficial contamination was noted in 1980 after the site was initially closed and covered with soil. The entire site was subsequently regraded, backfilled with an additional 2 ft of soil, and seeded with crested wheat grass. The seed was irrigated for 6 weeks to establish the vegetation. The current barriers to release include an intact soil cover over the waste site. The depth varies based on what is covered (trench, caisson, vertical pipe units), but the cover is at least 2 m of clean soil. In addition, specific waste disposal units such as the vertical pipe units and caissons contain the higher activity wastes. Boxes containing low-level wastes that were disposed in the trenches probably have degraded.

Primary Risks: The primary risks associated with 618-11 arise from sampling, characterization, and removal operations because of the poorly characterized, high activity and pyrophoric wastes that were disposed. A primary concern is that an upset event during cleanup activities may disrupt operations at the Energy Northwest Columbia Generating Station, which borders 618-11.

Cleanup and Disposition: Remediation of this site is currently slated for completion by 2018, with industrial exposure criteria set as the cleanup level. Buried wastes and associated hard infrastructure (caissons, vertical pipe units) will be removed and disposed in ERDF. During remediation, the primary pathways are likely to be air releases from energetic events and/or accidental fires (the site has a mixture of potentially explosive and or pyrophoric constituents). This pathway probably would have effects to a limited distance from the area, and potentially may be further reduced through secondary containment (work area enclosures) during removal operations.

BC Cribs and Trenches (CP-LS-1)

The BC Cribs and Trenches (Figure 3-4) site lies within the 200-BC-1 OU, south of the 200 East Area. The 200-BC-1 OU consists of 28 waste sites, including 26 cribs and trenches, one siphon tank, and one pipeline. These waste sites were used in the 1950s to dispose of more than 140 million L (38 million gal) of tank waste supernatant from the B, BX, BY, and C Tank Farms. Four trenches received smaller quantities of liquid waste that were generated in the 300 Area and transferred by tanker truck to the 200 Area. The largest volume of waste at these sites was disposed of in six cribs and 16 trenches and was conveyed by an underground pipeline from the B, BX, BY, and C Tank Farms.

Current Status: The BC Cribs and Trenches waste sites are separated into the following four distinct groups based on waste site configuration, primary waste source, and relative volume of waste received: (1) high-volume scavenged waste cribs and trenches; (2) specific retention scavenged waste trenches; (3) specific retention 300 Area waste trenches; and (4) one underground storage tank (200-E-14). An additional contaminant source is derived from the contaminated vadose zone underneath the cribs and trenches. The area is currently covered with clean soil backfill.

Primary Contaminants: The primary contaminants present at the BC Cribs and Trenches include nitrate (NO3-), chromium, Tc-99, Sr-90, Cs-137, U-238 and Pu (Table 3-1 and Table 3-2). According to Ward et al. (2004), the BC Cribs and Trenches are believed to have received approximately 30 Mgal of scavenged tank waste containing an estimated 400 Ci of 99Tc as well as large quantities of NO3- and 238U.

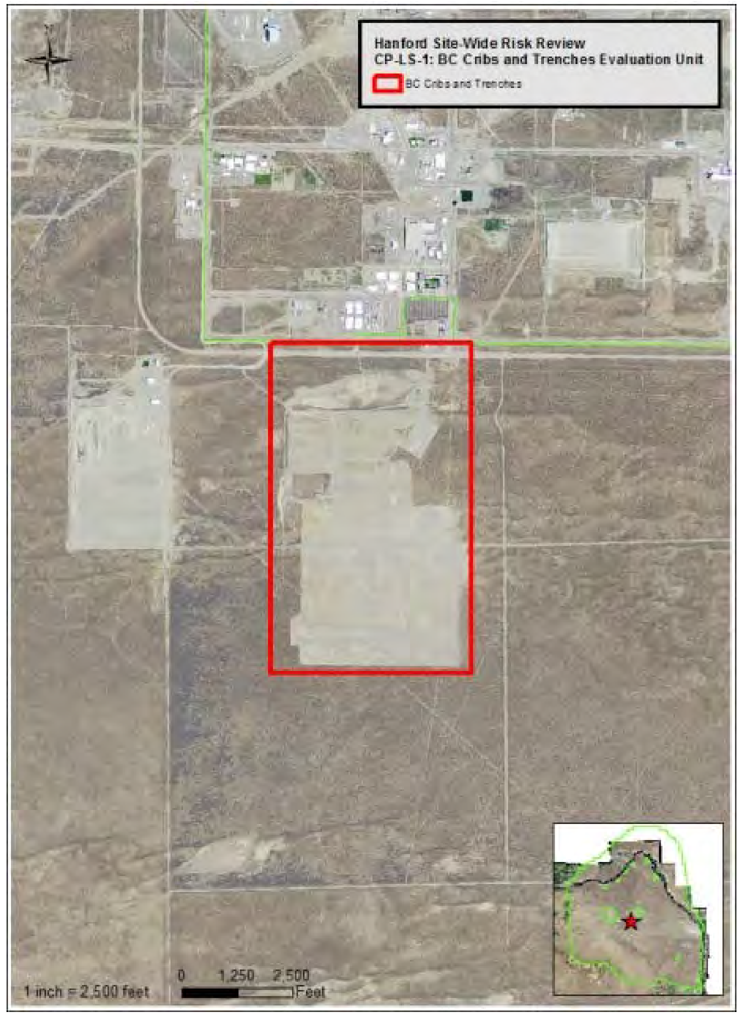


Figure 3-4. Aerial view of BC Cribs and Trenches.

The physical states of the primary contaminants are adsorbed in the contaminated soil and present in crib and trench debris, and the depth of contamination varies by waste site and contaminant. Serne et al. (2009, pp. 9.2 – 9.3) indicate that there is an approximately 15 ft thick layer of sandy silt and fine silty sand at a depth of approximately 120 to 130 ft below ground surface that contains "elevated technetium-99 and EC (electrical conductivity)," and that "the most elevated nitrate concentrations are found from 28 to 245 ft bgs". According to Ward et al. (2004, p. 1.1), "^{99}Tc at concentrations over 75,000 pCi/L were recently reported for a monitoring well near SX-115" although the exact source is unknown. In contrast, some 3.686 x 10^6 L (9.737 × 10^6 gal) of supernatant fluid containing 128 Ci of ^{99}Tc were discharged to seven trenches over a period of about 1.5 years in the BC Cribs and Trenches area, yet there is no evidence of groundwater contamination from the cribs or trenches. The current distribution of ^{99}Tc in the vadose zone beneath 216-B-26 is therefore not easy to explain using current conceptual models. Recent sampling at the 216-B-26 Trench shows a zone of ^{99}Tc contamination between 18 and 53 m. The peak soil concentration exceeds 100 pCi/g, while the pore water concentration is approximately 1.4·x 10^6 pCi/L, both at a depth of about 30 m."

Primary Risks: The primary risk to human health would be through direct contact with the waste, particularly cesium-137 and strontium-90, because high concentrations of cesium-137 and strontium-90 are at relatively shallow depths in the cribs and trenches. However, casual contact with the waste is prevented by site access controls and the layer of clean soil over the buried wastes. The primary vadose zone risks to groundwater (rated as High) are Tc-99, I-129, Cr(total) and Cr(VI). A significant quantity of Sr-90 is present but not anticipated to contaminate groundwater within the 150 year evaluation period.

Table 3-3. BC Cribs and Trenches (CP-LS-1) radionuclide inventory.

Radionuclides	Group	Curies (Ci)
Americium-241	D	190
Carbon-14	A	28
Chlorine-36	A	NP
Cobalt-60	C	27
Cesium-137	D	5,000
Europium-152	D	1.7
Europium-154	D	130
Tritium	C	740
Iodine-129	A	0.65
Nickel-59	D	1.1
Nickel-63	D	95
Plutonium-Total Rad[(a)]	D	170
Strontium-90	B	4,400
Technetium-99	A	410
Uranium- Total Rad[(b)]	B	2.9

a. Sum of plutonium isotopes 238, 239, 240, 241, and 242
b. Sum of uranium isotopes 232, 233, 234, 235, 236, and 238

Table 3-4. BC Cribs and Trenches (CP-LS-1) chemical inventory.

Chemical	Group	kg
Carbon Tetrachloride	A	NP
Cyanide	B	NP
Chromium	B	23,000
Chromium-VI	A	23,000
Mercury	D	35
Nitrate	C	22,000,000
Lead	D	61
TBP	---	NP
Trichloroethene	B	NP
Uranium	B	3,700

Cleanup and Disposition: The designated future land use is Industrial Exclusive. For the BC Cribs and Trenches Area waste sites, five remedial alternatives were identified for detailed and comparative analyses: (1) no action; (2) maintain existing soil cover, institutional controls, and monitored natural attenuation; (3) removal, treatment, and disposal; (4) capping; and (5) partial removal, treatment, and disposal with capping.

K-Area Waste Sites (RC-LS-2)

The K-Area Waste Sites (Figure 3-5) consist of a variety of sites within the fence at the 100 K Area associated with the original plant facilities constructed to support K Reactor operation. Included within the EU are 4 burial grounds, (includes pits, dumping areas, burial grounds), 33 cribs (subsurface liquid disposal, includes French drains, cribs, sumps), 2 infrastructure buildings, 10 pipelines and associated valves, 1 pond/ditch, 6 process buildings, 10 septic systems, 19 storage pads, 11 underground storage tanks, and 9 unplanned release sites. Many of the sites have no contamination, but need to be removed as part of larger K Reactor area remediation efforts.

Figure 3-5. Aerial view of K-Area Waste Site.

Current Status: Most of the waste sites around the K-East Reactor Building have been remediated, those around the K-West Reactor Building must wait for removal of the sludge in the K-West fuel basin and demolition of the basin and remaining ancillary buildings.

Primary Contaminants: Table 3-5 and Table 3-6 list the primary radionuclide and chemical contaminants present and estimated quantities in the K Area waste sites**.** Most of the contamination resides in the soil and is sorbed onto sediments and soils.

Primary Risks: Many of the sites, such as underground pipelines, were never used with radioactive materials and so remediation is not likely to expose radioactive contamination. Other sites are considered to have minimal contamination. An HA identified 18 potential scenarios. The postulated unmitigated hazardous conditions result in Low consequences to the onsite and offsite receptors and no significant impact to the facility worker. Several scenarios were identified as presenting a standard industrial hazard to the facility worker, which are consistent with the nature of the activities.

Cleanup and Disposition: This waste site remediation needs to be coordinated with the K-West Sludge removal project and cocooning of the K-East and K-West Reactor Buildings. Many of the waste sites identified with this EU will be remediated through the process of "confirmatory sampling, no action," also known as CNSA. Others will be remediated through the process of remove-treat-dispose (RTD). For these sites, excavation, coupled with removal of underground structures such as piping, will take place, samples will confirm that cleanup criteria are met, and the site will be backfilled with clean and compacted soil. The contaminated soil will be disposed of at ERDF or elsewhere if it contains hazardous materials that exceed ERDF acceptance criteria. Where contamination must be left in place to maintain structural integrity, soils will be remediated to 15 ft below ground surface. To the extent practical, the current plan is for the soils to be cleaned such that unlimited future use is allowed. Where not practical, institutional controls and long-term monitoring will be required.

The known/likely presence of tribal cultural resources complicates remediation efforts.

Table 3-5. K Area Waste Sites (RC-LS-2) radionuclide inventory.

Radionuclides	Group	Curies (Ci)
Americium-241	D	NP
Carbon-14	A	110
Chlorine-36	A	NP
Cobalt-60	C	11
Cesium-137	D	0.67
Europium-152	D	0.0026
Europium-154	D	0.17
Tritium	C	82
Iodine-129	A	NP
Nickel-59	D	NP
Nickel-63	D	NP
Plutonium-Total Rad[(a)]	D	0.019
Strontium-90	B	2.1
Technetium-99	A	NP
Uranium- Total Rad[(b)]	B	0.0022

a. Sum of plutonium isotopes 238, 239, 240, 241, and 242
b. Sum of uranium isotopes 232, 233, 234, 235, 236, and 238

Table 3-6. K Area Waste Sites (RC-LS-2) chemical inventory.

Chemical	Group	kg
Carbon Tetrachloride	A	NP
Cyanide	B	NP
Chromium	B	NP
Chromium-VI	A	NP
Mercury	D	NP
Nitrate	C	NP
Lead	D	NP
TBP	---	NP
Trichloroethene	B	NP

Uranium	B	NP

Plutonium-Contaminated Waste Sites (CP-LS-2)

This EU consists of a variety of plutonium-contaminated cribs, trenches, piping, burn pits, and ancillary structures associated with PFP in the central part of the 200 West Area (Figure 3-6). CP-LS-2 is one of seven EUs situated in the 200 West Area of the Hanford Site. The 200 West Area is located is in the middle of the Central Plateau, which encompasses the region where chemical processing and waste management activities occurred. Pipes conveyed the liquid waste from nuclear processing facilities to the waste sites. At the cribs, tile field, and French drain, liquid waste was discharged into a layer of gravel that drained into the underlying soil and may have drained laterally as well as downward. As a consequence, the soils in, or underlying, these sites contain substantial amounts of radionuclides including plutonium and cesium, as well as large quantities of chemical constituents such as carbon tetrachloride, chromium, and nitrate.

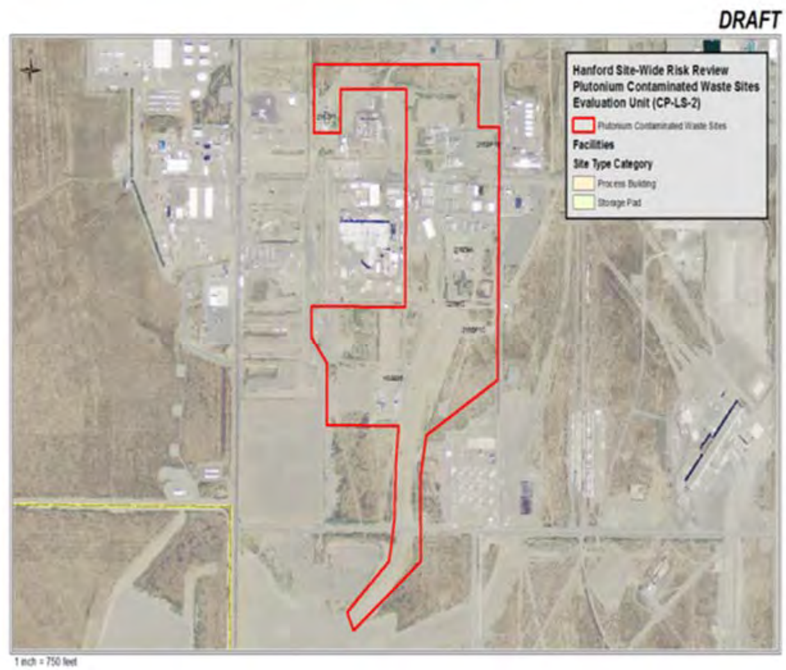


Figure 3-6. Aerial view of Pu-Contaminated Waste Site.

Current Status: Most of the area is currently stabilized and covered with clean soil backfill, and many areas area are marked and posted as an underground radioactive material area. Soil vapor extraction was implemented as an interim action in 1992 to remove carbon tetrachloride from the vadose zone in 200-PW-1 overlying the 200-ZP-1 groundwater (DOE/RL-2014-32, Rev. 0). The system has removed 80,000 kg of carbon tetrachloride to date; however, the mass removed each year was decreasing and therefore shutdown. The system did not operate in 2013 (DOE/RL-2014-32, Rev. 0). The 200-West pump and treat system to remediate groundwater was started in 2012 and removed 3,600 kg of carbon tetrachloride, 91 kg of chromium, 0.00024 µCi of I-129, 244,000 kg of nitrate, 98 g (1.5 Ci) of Tc-99, and 15 kg of TCE, and 1.1 kg of U[41] by 2013 (DOE/RL-2014-32, Rev. 0).

Contaminants: The primary radionuclide and chemical contaminants and inventory estimates for this collection of sites are provided in Table 3-7. Compared to other EUs evaluated in this report, this EU contains a substantial amount of mercury and TBP.

Primary Risks: Many of the principal contaminants of concern (plutonium, cesium, strontium, and uranium) are relatively immobile in soils in the absence of significant amounts of water to mobilize them. However, other contaminants such as carbon tetrachloride may pose a long-term threat to

[41] Uranium is not a contaminant of concern for the 200-ZP-1 OU; it is including to track 200-UP-1 groundwater treated.

groundwater unless they are further reduced in concentration.[42] No hazard assessment or DSA has been found for these specific sites, but it is estimated that the principal hazard would be collapse of trenches with potential for small localized release of radioactive materials. The primary threat to groundwater is from carbon tetrachloride (rated Very High), although it has been treated by vapor extraction and is currently being treated by the 200 West pump and treat system. Chromium also is considered a threat to groundwater (rated Medium). A significant amount of Sr-90 is present in the vadose zone but is not anticipated to impact groundwater because of retention in the vadose zone and radioactive decay.

Table 3-7. Plutonium Contaminated Waste Sites (CP-LS-2) radionuclide inventory.

Radionuclides	Group	Curies (Ci)
Americium-241	D	27,000
Carbon-14	A	0.000015
Chlorine-36	A	NP
Cobalt-60	C	0.026
Cesium-137	D	160
Europium-152	D	0.000069
Europium-154	D	0.007
Tritium	C	0.0015
Iodine-129	A	0.0037
Nickel-59	D	0.00014
Nickel-63	D	0.013
Plutonium-Total Rad[a]	D	47,000
Strontium-90	B	160
Technetium-99	A	0.0036
Uranium- Total Rad[b]	B	1.7

a. Sum of plutonium isotopes 238, 239, 240, 241, and 242
b. Sum of uranium isotopes 232, 233, 234, 235, 236, and 238

[42] Approximately 910,000 kg of carbon tetrachloride was discharged to waste sites associated with the CP-LS-2 EU (Table 3-8). Treatment activities in the Central Plateau removed approximately 10% of the amount discharged, including pump and treat and soil vapor extraction operations through 2013 (DOE/RL-2014-32, Rev. 0).

Table 3-8. Plutonium Contaminated Waste Sites (CP-LS-2) chemical inventory.

Chemical	Group	kg
Beryllium	---	330
Carbon Tetrachloride	A	910,000
Cyanide	B	NP
Chromium	B	3,500
Chromium-VI	A	3,500
Mercury	D	760,000
Nitrate	C	7,900,000
Lead	D	480
TBP	---	110,000
Trichloroethene	B	NP
Uranium	B	220

Cleanup and Disposition: Because this EU contains multiple sites, a series of remedial actions have been identified based on their specific characteristics and inventories. Groundwater remediation is in-progress using the 200 West pump and treat system. Clean soil covers will be added back over sites to provide at least 5m (15 ft) of cover over cesium-contaminated soils. Institutional controls and long-term monitoring will be required for sites where contamination is left in place, and to assure that land use is consistent with the ROD. The large volume of waste associated with these sites and structures makes complete retrieval and disposal infeasible. Where possible, TRU waste will be recovered and disposed of at the Waste Isolation Pilot Plant (WIPP). Other contaminated soils will be disposed at the ERDF. However, there will be residual waste left in place that is not feasible to retrieve.

COMPARISON OF INVENTORIES AND PHYSICAL/CHEMICAL STATES OF WASTES AND CONTAMINANTS, BARRIERS

The 618-11 Burial Ground and BC Cribs and Trenches have similar inventories of cesium-137 and strontium-90, but differ in terms of total plutonium and technetium-99 (Table 3-9 and Table 3-10**Error! Reference source not found.**). The 618-11 site has substantially more plutonium (in curies) than the BC Cribs site, while BC Cribs and Trenches has technetium-99 and the 618-11 site reports no significant quantity of technetium-99. The Plutonium-Contaminated Waste Sites have significant inventories (in kg) of carbon tetrachloride, chromium (total and hexavalent), beryllium, mercury, tri-butyl phosphate and nitrate.

Many of the principal contaminants of concern (plutonium, cesium, strontium, mercury and uranium) are relatively immobile in soils in the absence of significant amounts of water to mobilize them. However, other contaminants such as Tc-99 and carbon tetrachloride will continue to pose a long-term further threat to groundwater until they are substantially reduced in concentration through continued use the 200 West pump and treat system.

No DSAs of radiological dose consequences for accidents or other initiating events have been prepared except for the 618-11 Burial Ground. Most of these legacy waste sites are stable and covered with clean soils, and thus represent Not Discernible to Low risks unless physically disturbed. Remediation of the 618-11 site is currently slated for completion by 2018 with industrial exposure criteria set as the cleanup level. Buried wastes and associated hard infrastructure (caissons, VPUs) will be removed and disposed in ERDF. During remediation, the primary pathways are likely to be air releases from energetic events and or accidental fires (the site has a mixture of potentially explosive and or pyrophoric constituents). This pathway probably would have limited distance from the area. Several activities related to characterization of the site (not remediation) have anticipated frequencies of occurrence in the 1 in 100 per year, maximum unmitigated facility worker risk from characterization is categorized as moderate (≥25 rem TEDE).

Table 3-9. Primary radiological inventories (curies).

Evaluation Unit	Cs^{137}	Sr^{90}	Pu (total)	Tc^{99}
618-11 Burial Ground	5,300	4,200	770	NP
K Area Waste Sites	0.67	2.1	0.019	NP
BC Cribs and Trenches	5,000	4,400	170	410
Pu-Contaminated Waste Sites	160	160	47,000	0.0036

Table 3-10. Primary chemical inventories (kg).

Evaluation Unit	CCl_4	Cr (total)	NO_3	Other
BC Cribs and Trenches	NP	23,500	22,000,000	NP
618-11 Burial Ground	NP	NP	NP	330[(a)]
K Area Waste Sites	NP	NP	NP	NP
Pu-Contaminated Waste Sites	911,000	3520	7,930,000	4400[(a)] 760,000[(b)] 110,000[(c)]

a. Beryllium
b. Mercury
c. TBP

CONSIDERATIONS FOR TIMING OF THE CLEANUP ACTIONS

Many of the principal contaminants of concern (plutonium, cesium, strontium, and uranium[43]) are relatively immobile in soils in the absence of significant amounts of water to mobilize them. Delay of cleanup for several decades will allow reduction in activity of the moderate lived radionuclides present at the site (e.g., ^{90}Sr and ^{137}Cs). At 618-11, careful consideration should be given to interim measures to reduce water infiltration over the vertical pipe units and caissons and delay excavation of the wastes until after the Energy Northwest Columbia Generating Station is closed. Carbon tetrachloride and other Group A and B contaminants in the vadose zone and groundwater will pose a long-term threat to further groundwater contamination unless they are further reduced in concentration through active mitigation

[43] Uranium has very complex environmental chemistry in some areas of the Hanford Site and is not well represented as a linear partitioning process, but in some cases is better represented as an ongoing secondary source, where the rate of release is controlled by other factors (oxidation, carbonate, etc.).

measures (e.g., groundwater recovery and treatment; removal, capping or immobilization). For example, soil vapor extraction (SVE) has been effective at treating the upper vadose zone (removing approximately 80,000 kg of carbon tetrachloride); however, there is a large groundwater plume that is currently being treated and apparently a secondary source of carbon tetrachloride in the deeper part of the vadose zone where the existing SVE treatment system coverage has not provided effective treatment[44]. For example, treatment processes have removed approximately 10% of the carbon tetrachloride discharged into the Central Plateau waste sites.[45]

If near-surface sites with relatively immobile contaminants (Group D) remain unremediated (e.g., by removal, immobilization or placement of durable caps) in the long term, erosion may compromise the surficial soils, allowing exposure of the waste and ingress of meteoric water. Inadvertent intruders could also access the waste site if it is not subject to institutional controls.

COMPARATIVE SUMMARY

Comparing differences between the four legacy waste sites necessitates consideration of failure of one or more passive or active safety controls, and thus the unmitigated radiological dose exposures to on- and off-site persons as represented by a hypothetical individual located 100 m from the EU boundary (co-located person) and another individual located at the Hanford Site controlled access boundary (public or maximally exposed offsite individual (MOI)). As revealed by the comparison of these four legacy sites, human health risks are driven by the following factors:

- Quantity of radionuclide (in Ci) and chemical inventory of the contaminants;
- Mobility of the contaminant (sorbed, presence in vadose zone or groundwater);
- Whether cleanup work is occurring or failure of safety systems could cause accidental dispersal of radionuclides or chemical contaminants; and
- For the public or MOI, the distance between the initiating event and the Hanford Site boundary

The 618-11 waste site is closed, with most of the site covered with soil and vegetated. The vegetated silt acts as hydraulic barrier that limits percolation of meteoric water into the waste to minute amounts, except in the area of the caissons and vertical pipe units, which are covered with gravel that facilitates increased percolation of precipitation and runoff. Beneath the site is a groundwater plume containing tritium and nitrate, whose concentrations are diminishing such that the tritium concentration is not expected to exceed drinking water standards when the plume reaches the Columbia River (Vermeul et al. 2005). The primary risk drivers for this site will derive from active remediation activities associated with air releases from energetic events and or accidental fires, with the potential to impact operations at the adjacent Energy Northwest Columbia Generating Station. The potential risks from waste retrievals may possibly be mitigated by temporary enclosing structures or delaying waste removals until after the nuclear generating station is no longer active. Except for reduction of the infiltration over the caissons and vertical pipe units, there is not a risk-based urgency to clean up the site.

The BC Cribs and Trenches waste sites are closed and are currently covered with clean soil backfill. The primary risk to human health derives from potential direct contact with the waste, particularly cesium-137 and strontium-90, because high concentrations of cesium-137 and strontium-90 are at relatively shallow depths in the cribs and trenches. The large depth of the vadose zone and limited surface water

[44] Expansion of the SVE treatment system potentially may address carbon tetrachloride in the deeper vadose zone.
[45] The extent of evaporation of carbon tetrachloride after discharge is uncertain but has been estimated at between 21 and 38% (DOE/RL-2007-22 2007, p. 4-3)

infiltration reduces contaminant migration to very small rates. Active remediation of this site poses the greatest potential risk of human exposure for this EU.

The Plutonium-Contaminated Waste Site contains the largest radiological inventory, but the cesium-137 and plutonium very low mobility in the vadose zone, and thus contaminant migration of these constituents is expected to be minimal. Further, most of the area is currently stabilized and covered with clean soil backfill, and many areas are marked and posted as an Underground Radioactive Material area. Because this EU contains multiple sites, a series of remedial actions have been identified based on their specific characteristics and inventories. Clean soil covers will be added back over sites to provide at least 15 ft over cesium-contaminated soils. Institutional controls and long-term monitoring will be required for sites where contamination is left in place, and to ensure that land use is consistent with the ROD. The large volume of waste associated with these sites and structures makes complete retrieval and disposal infeasible.

Most of the waste sites around the K-East Reactor Building have been remediated; and those small amounts that remain are primarily immobile in the soils and sediments where "confirmatory sampling, no action" or limited removal actions are the anticipated outcomes for these limited waste sites. The contaminated soil will be disposed of at ERDF or elsewhere if it contains hazardous materials. Where contamination must be left in place to maintain structural integrity, soils will be remediated to 15 ft below ground surface. The primary risk drivers for this site will derive from active remediation activities associated with air releases during RTD and direct human contact during sampling and transport of contaminants to the ERDF.

3.2. TANK WASTE AND FARMS EVALUATION UNITS

DESCRIPTION OF TANK WASTE AND FARMS EVALUATION UNITS

Nine tank waste and farms EUs have been identified for inclusion in the interim progress report as indicated in Table 3-11. These EUs represent all 149 Hanford Site single-shell tanks (SSTs) and 28 double-shell tanks (DSTs) as well as ancillary equipment and geographically co-located legacy disposal sites. They are located in the Central Plateau within the 200 West and 200 East Areas. All current land-use activities in the 200 West and 200 East Areas are *industrial* in nature (Hanford 200 Area ROD[46]) and the land-use designations contained in the land use EIS and ROD indicate that the 200 West and 200 East Areas are 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).

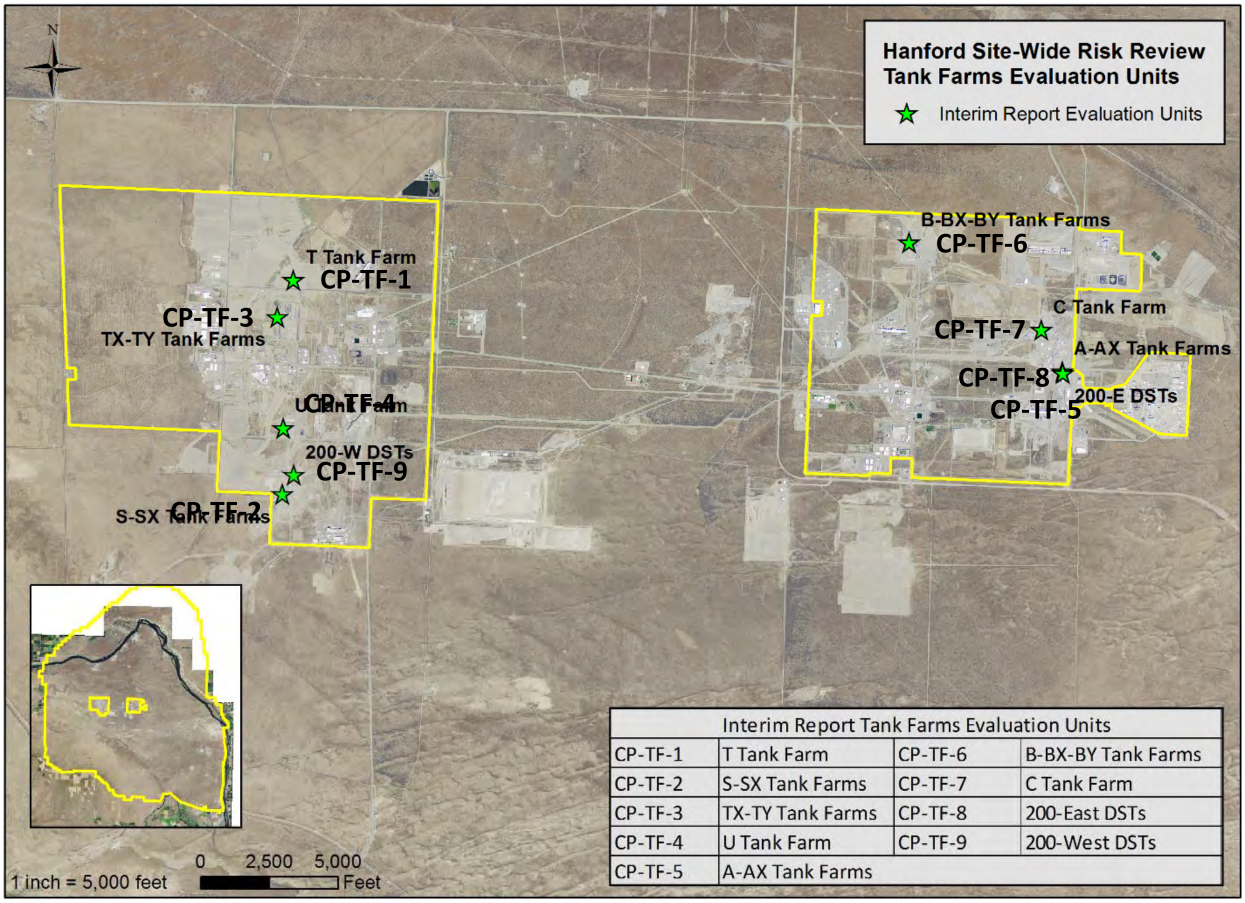
[46] http://www.epa.gov/region10/pdf/sites/hanford/200/hanford_200_rod.pdf

Table 3-11. Tank waste and farms EUs and tank information included in the interim report (corresponding co-located legacy sites not listed). All Hanford single- and double-shell tank farms are included in the tank farm evaluation units.

Evaluation Unit	Tank Farm(s)	Waste Management Area(s) (WMAs)	Tank Type	Tanks	Location
CP-TF-1	241-T (T)	WMA T	Single-shell	16	200 West
CP-TF-2	241-S/SX (S-SX)	WMA S-SX	Single-shell	27	200 West
CP-TF-3	241-TX/TY (TX-TY)	WMA TX-TY	Single-shell	24	200 West
CP-TF-4	241-U (U)	WMA U	Single-shell	16	200 West
CP-TF-5	241-A/AX (A-AX)	WMA A-AX	Single-shell	10	200 East
CP-TF-6	241-B/BX/BY (B-BX-BY)	WMA B-BX-BY	Single-shell	40	200 East
CP-TF-7	241-C (C)	WMA C	Single-shell	16	200 East
CP-TF-8	241-AN/AP/AW/AY/AZ (AN-AP-AW-AY-AZ)	Not applicable	Double-shell	25	200 East
CP-TF-9	241-SY (SY)	Not applicable	Double-shell	3	200 West

Figure 3-7 shows the locations of the tank waste and farms EUs within the Central Plateau. The 177 underground waste storage tanks at the Hanford Site were constructed in groups of similarly designed structures called "tank farms." Eighteen tank farms are distributed between the 200 East and 200 West Areas and are connected by a cross-site transfer line that allows for waste transfers between the two areas. Over 50 million gallons of waste are stored in the tank farms. The tanks contain a mixture of liquid, sludge, and saltcake (precipitated solid salts) waste with both radioactive and chemically hazardous constituents. Liquids in the tanks exist as supernatant (liquid above solids) and interstitial liquid (liquid filling the voids between solids). Sludge consists primarily of solids (hydrous metal oxides) that were precipitated by the neutralization of acid wastes. Saltcake, when present, generally exists from evaporation of water from the waste. These waste types do not necessarily exist as distinct layers but may be intermingled at the interfaces between layers (RPP-13033).

Detailed maps and characteristics of the waste tanks, ancillary equipment, and legacy source units in each tank waste and farm EU are provided in the relevant EU description (see Appendices E-1 through E-10).



Interim Report Tank Farms Evaluation Units			
CP-TF-1	T Tank Farm	CP-TF-6	B-BX-BY Tank Farms
CP-TF-2	S-SX Tank Farms	CP-TF-7	C Tank Farm
CP-TF-3	TX-TY Tank Farms	CP-TF-8	200-East DSTs
CP-TF-4	U Tank Farm	CP-TF-9	200-West DSTs
CP-TF-5	A-AX Tank Farms		

Figure 3-7. General location of the Hanford tank farm evaluation units (where CP-TF-5 and CP-TF-8 are both represented by the star in the southeastern part of 200 East). The location of the 200 East and 200 West Areas in relation to the Hanford Site boundary is shown in the inset.

Hanford Single-Shell Tanks

Of the 18 tank farms, 12 are SST farms that contain 149 of the 177 tanks. The SST farms, constructed between 1943 and 1964, are in groups of 4 to 18 tanks and are divided between the 200 East and 200 West Areas. The original SST design was a reinforced concrete shell and dome with an internal liner (structurally independent from the reinforced concrete tank) of mild carbon steel covering the bottom and sidewalls. The first SSTs were designed with operating volumes of 530,000 gallons. The succeeding generations of SSTs were built with operating volumes of 758,000 gallons and 1 million gallons. Included among the 149 SSTs are 16 smaller tanks that have the same design as the larger tanks, but have operating volumes of only 55,000 gallons. A typical SST configuration is shown in Figure 3-8 (RPP-13033). A congressional mandate prohibited waste additions to Hanford SSTs after January 1, 1981.[47]

[47] Berman presentation on July 29, 2009, titled "Hanford Single-Shell Tank Integrity Program." Available at www.em.doe.gov.

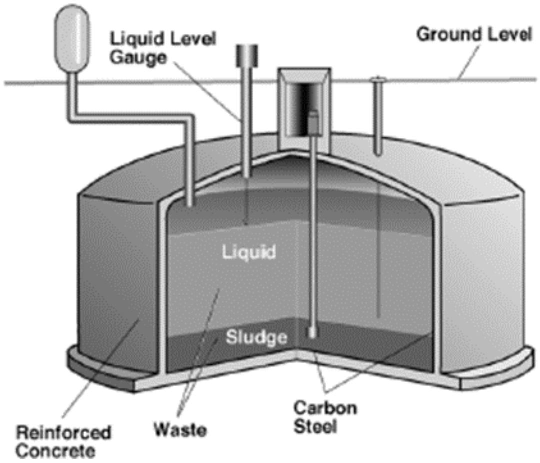


Figure 3-8. Typical Hanford single-shell tank design.

Hanford Double-Shell Tanks

To provide additional storage capacity, 28 DSTs were built in six tank farms between 1968 and 1986. Some SST waste has been transferred to the DSTs for subsequent treatment elsewhere on the Hanford Site starting after 2019. DSTs will also be used for future staging of SST wastes for treatment. Five of the DST farms are located in the 200 East Area, and one is located in the 200 West Area. All DSTs are similar in design and each has a storage capacity of approximately 1 million gallons. A typical DST configuration is shown in Figure 3-9 (RPP-13033).

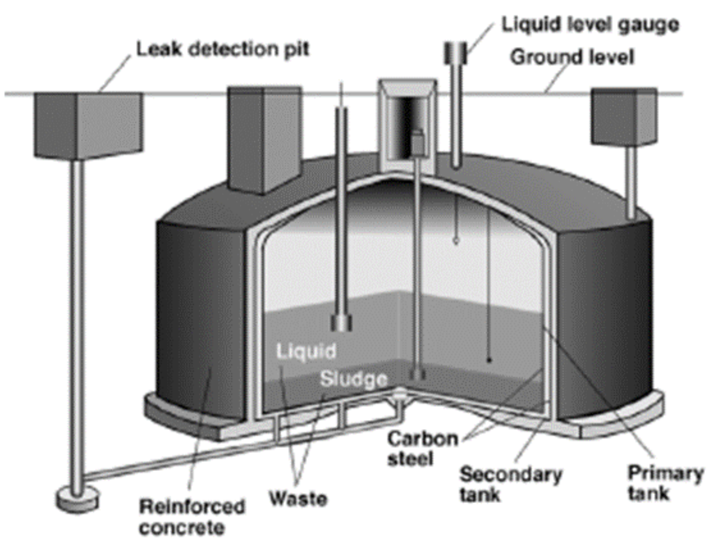


Figure 3-9. Typical Hanford double-shell tank design.

Each DST consists of a carbon-steel primary tank and a carbon-steel secondary tank within a protective reinforced concrete shell. The primary tank contains waste, is freestanding, and rests on an insulating concrete pad. The insulating pad rests on the secondary tank and was cast with air distribution and drain grids to provide for leak detection, maintain a uniform tank bottom temperature, facilitate heat removal, and eliminate pockets of water condensation. The secondary tank is 5 ft larger in diameter than the primary tank, providing an air space, or annulus, that separates the two steel tank walls. The secondary tank serves as a barrier to the environment in the event that the primary tank leaks. AY-102 has been observed to leak small waste quantities only through the primary tank (and not through the secondary tank). No DSTs are known to have leaked to the environment.

Tank Waste Retrieval and Tank Farm Closure

Between 1978 and 1996, 147 of the 149 SSTs[48] were interim stabilized (Weyns 2015), where pumpable liquids (both drainable interstitial liquid and supernatant) were removed to reduce the hydraulic pressure on the tanks and thereby reduce the potential for leakage.

The SSTs in WMA C (i.e., CP-TF-7 in 200 East as illustrated in Figure 3-7) were previously interim stabilized (i.e., liquid transferred to DSTs to <50 kgal drainable interstitial liquid and <5 kgal of supernatant) and waste retrieval initiated to remove waste from the tanks, thereby leading to final tank closure. Tank waste retrieval currently is in progress in the C tank farm (Weyns 2015):

- Retrieval has been completed in nine of the C tank farm tanks (C-103, C-104, C-106, C-110, C-112, and C-201 through C-204).
- Retrieval has been completed to various limits of technology in four tanks (C-101, C-107, C-108, and C-109).
- Retrieval is in progress in the remaining tanks (C-102, C-105, C-111).

Final retrievals have not yet begun at other SST farms.

The preferred tank closure alternative includes 99% retrieval of waste from the SSTs for staging in DSTs and treatment elsewhere onsite; operations and necessary maintenance, waste transfers and associated operations, and upgrades to existing tanks or construction of waste receipt facilities (DOE/EIS-0391 2012, Chapter 2, p. 2-321). SST closure operations include filling the tanks and ancillary equipment with grout to immobilize residual waste contaminants. Disposal of contaminated equipment and soil would occur on site. Decisions on the extent of soil removal and/or treatment would be made on a tank farm or WMA[49] basis through the RCRA closure permitting process. Under this process, the tanks would be stabilized by filling with grout, and an engineered modified RCRA Subtitle C barrier put in place followed by post-closure care.

Thus, workers and the public would be isolated from the residual contamination in the tanks by the tank structure, grout and soil cover. Tank waste contamination already in the vadose and saturated zones would experience reduced infiltrating water (the primary driver for the release and transport of contaminants) because of the surface barrier.

Legacy Disposal Sites and Unplanned Contaminant Releases Associated with Tank Waste and Farms EUs

Each EU associated with SST waste and farms also has geographically co-located legacy disposal sites as well as subsurface contamination from tank leaks and other unplanned releases. Furthermore, each of the SST farms is being regulated under RCRA as part of a corresponding WMA. In general the tank farm and tanks are within the WMA, which is within the EU (the EU also includes geographically co-located legacy sites and underlying vadose zone contamination, some of which may not be part of the WMA). A summary of past disposal practices and releases that have resulted in subsurface contamination within the boundary of the EU follows. There are no subsurface contamination inventories associated with the

[48] Tank 241-C-106 went straight to retrieval and was not interim stabilized and Tank 241-S-102 was again considered interim stabilized in 2010 (Weyns 2015).

[49] A waste management area, or WMA, is a grouping of tanks and waste sites for regulatory purposes, which may not correspond with the EU groupings used in this report.

200-West DST waste and farm EU (from two unplanned release sites without known inventories) and a small source associated with the 200-East DST waste and farm EU (from one crib and some unplanned release sites); therefore, those two EUs are not described below. The small 200-East DST waste and farm EU sources and 200-West unplanned release sites are described in Appendix E.10, and E.9, respectively.

EU CP-TF-1: T Tank Farm, WMA T, and Associated Legacy Sites (200 West)

Historical liquid waste disposal practices as well as leaks and unplanned release have resulted in contamination near the T tank farm (Horton 2006, p. 2.2-2.3) and within the boundary of the T tank farm EU:

- 216-T-7 crib operated from 1948 to 1955 and received 110×10^6 L of second-cycle, T-Plant cell drainage waste, and plutonium concentrator waste.
- 216-T-32 crib operated from 1946 to 1952 and received 29×10^6 L of waste from the 224-T building by way of the 241-T-201 SST.
- 216-T-14 through 216-T-17 specific retention trenches each received 785,000 to 1×10^6 L of first-cycle waste in 1954.
- 216-T-36 crib southwest of the T tank farm received about 522,000 L of decontamination waste and condensate in 1967 and 1968.
- 216-T-5 crib, located just west of the T tank farm, received about 2.6×10^6 L of second cycle waste in 1955.
- Seven of the T tank farm SSTs are "assumed leakers" with leaks estimates ranging from <1,000 gallons (T-103, T-108, and T-109) to 115,000 gallons (T-106 in 1973) (Weyns 2015, pp. 18-22).
- Nine unplanned releases have been documented in or near WMA T that also fall within the T tank farm EU boundary.

EU CP-TF-2: S-SX Tank Farms, WMA S-SX, and Associated Legacy Sites (200 West)

Various cribs in the area around the S-SX tank farms (and within the S-SX tank farm EU boundary) received large volumes of slightly contaminated waste and other waste streams (Wood et al. 1999), where the largest include:

- 216-S-8 trench (east of WMA SX) received 2.6×10^6 gallons of REDOX waste (including unirradiated uranium) between 1951 and1952.
- 216-S-23 trench (northeast of S tank farm) received 76×10^6 gallons of evaporator condensate between 1973 and 1995.
- 216-S-1 crib (east of WMA SX) received 42×10^6 gallons of process condensate between 1952 and 1956.
- 216-S-3 crib (east of WMA SX) received 1.1×10^6 gallons of stream condensate between 1953 and 1956.
- 216-S-5 crib (southwest of WMA SX) received $1{,}100\times10^6$ gallons of stream condensate between 1954 and 1957.
- 216-S-6 crib (southwest of WMA SX) received $1{,}200\times10^6$ gallons condenser waste (REDOX) between 1954 and 1957.

- 216-S-7 crib (east of WMA SX) received 82×10^6 gallons of stream condensate between 1956 and 1965.
- 216-S-9 crib (east of S tank farm) received 13×10^6 gallons of redistilled process condensate between 1965 and 1975 (replacing 216-S-7 crib).
- 216-S-21 crib (west of S tank farm) received 23×10^6 gallons of stream condensate between 1954 and 1970.
- 216-S-25 crib (west of S tank farm) received 76×10^6 gallons of evaporator condensate between 1973 and 1995.
- Nine of the S-SX tank farm SSTs are declared "assumed leakers," with leaks estimates ranging from <5,000 gallons (SX-114 and SX-107) to 50,000 gallons (SX-115 in 1965) (Weyns 2015, pp. 18-22).
- Twenty-five unplanned releases have been documented in or near WMA S-SX that also fall within the S-SX tank farm EU boundary.

It appears that tank wastes were not directly cascaded from the S-SX tank farm tanks to the cribs.

EU CP-TF-3: TX-TY Tank Farms, WMA TX-TY, and Associated Legacy Sites (200 West)

Past practices and unplanned disposals have resulted in legacy (vadose zone) contamination near the WMA TX-TY (Horton 2007, p. 2.3-2.6)[50] and that fall within the TX-TY tank farm EU boundary:

- 216-T-21 through T-24, specific retention trenches were used in 1954 and received a total of 5×10^6 L of first cycle supernatant waste from TX tank farm tanks.
- 216-T-25 trench was active during September 1954 and received 3×10^6 L of evaporator waste from the 242-T Evaporator.
- 216-T-28 crib was active from 1960 to 1966 and received 42.3×10^6 L of waste including steam condensate decontamination waste, miscellaneous waste from 221-T Building, and decontamination waste from the 2706-T Building and 300 Area laboratory waste.
- 216-T-19 crib and tile field, located south of the TX tank farm, operated from 1951 to 1980 and received 455×10^6 L of effluent from the 242-T Evaporator and T Plant operations.
- Thirteen of the TX-TY tank farm's 24 SSTs are declared "assumed leakers" (Weyns 2015, p. 19), with leaks estimates ranging from <1,000 gallons (TY-101 in 1973) to 35,000 gallons (TY-105 in 1960).
- Eleven unplanned releases have been documented in or near WMA TX-TY that also fall within the TX-TY EU boundary.

EU CP-TF-4: U Tank Farm, WMA U, and Associated Legacy Sites (200 West)

Waste was cascaded among the U tank farm waste tanks; however, it appears none was released to cribs or ditches related to the U tank farm EU. The 216-U-3 french drain (located south of WMA U and within the U tank farm EU) received 7.9×10^6 L of liquid from steam condensers on waste tanks in the U tank farm and likely contains nitrate and minor amounts of fission products and actinides.

[50] The wastes disposed to some of the cribs and trenches adjacent to WMA TX-TY were similar to the wastes stored in the SSTs, making it difficult to distinguish waste sources for existing groundwater contamination.

Four of the tanks in the U tank farm (U-101, U-104, U-110, and U-112) are "assumed leakers" (Weyns 2015, p. 20), ranging from 5000 to 8100 gallons (U-110 in 1975) to 55,000 gallons (U-104 in 1961). All four "assumed leakers" have been stabilized and contain little or no pumpable liquid.

Four unplanned releases have been documented associated with the U tank farm EU with unknown waste volumes. Three unplanned releases that may have significant impacts are beta contamination in diversion boxes east of the U tank farm, a "violent chemical reaction" in a vault (244-UR) that spread first-cycle metal waste contaminants over an unspecified area, and a ruptured waste line at tank U-103 (Hodges and Chou 2000, p. 2.3).

EU CP-TF-5: A-AX Tank Farms, WMA A-AX, and Associated Legacy Sites (200 East)

Various non-tank sources that received large volumes of slightly contaminated waste and other waste streams have resulted in extensive vadose zone and groundwater contamination in the areas around the WMA A-AX (Narbutovskih and Horton 2001, p. 3.4-3.5) that fall within the A-AX tank farm EU boundary:

- Surface spills associated with leaks from transfer lines, diversion boxes, catch tanks, and vaults.
- Liquid disposal facilities including cribs, trenches, and french drains were used to discharge from 1600 gallons to 304 Mgal of volume effluents, including condensate and condenser cooling water, depleted uranium waste, cell and stack drainage waste, and tributyl phosphate (TBP)-kerosene organic waste from PUREX.
- Two of the A-AX tank farm SSTs are declared "assumed leakers," with leak estimates ranging from 500 to 2500 gallons (from A-104 in 1975) to 10,000 to 270,000 gallons (from A-105 in 1963, which occurred when a steam explosion ruptured the tank bottom), not including leaks from transfer lines, other ancillary equipment, surface spills, or overflow amounts (Weyns 2015, pp. 18-21).

EU CP-TF-6: B-BX-BY Tank Farms, WMA B-BX-BY, and Associated Legacy Sites (200 East)

Various non-tank sources (e.g., cribs, trenches, tile fields, and reverse wells) that received large volumes (7.2 to 36.8 Mgal) of contaminated waste and other waste streams have resulted in extensive vadose zone and groundwater contamination in the areas around the WMA B-BX-BY (PNNL-13022) and fall within the B-BX-BY tank farm EU:

- Liquid wastes that vary from high-level metals waste to large quantities of ferrocyanide scavenged uranium recovery waste taken directly from tanks in the 241-BY tank farm
- Large volumes of tritium-rich tank condensate generated during the in-tank solidification program that began in 1965

EU CP-TF-7: C Tank Farm, WMA C, and Associated Legacy Sites (200 East)

Various non-tank sources that received large volumes of contaminated waste and other waste streams have resulted in vadose zone and groundwater contamination in the areas around the C tank farm EU, including 14 documented, unplanned releases (i.e., surface spills and leaks from transfer lines, diversion boxes, catch tanks, and vaults) (Horton and Narbutovskih 2001) that fall within the C tank farm EU.

INVENTORIES OF KEY WASTE CONSTITUENTS AND PRIMARY CONTAMINANTS

Operations at the Hanford Site included multiple processes for recovery of specific nuclear materials from irradiated fuel elements, and thus many different waste streams were delivered to the tank farms over several decades. Furthermore, additional processing was carried out on some wastes contained in tanks to recover specific constituents (uranium, Cs-137, Sr-90, etc.) and additional waste transfers were made between tanks (within and between tank farms) as part of tank farms management. For this review, several models have been used to estimate characteristics of the Hanford tank wastes as they exist today. These models were developed from historical information (Remund et al. 1995). For example, the Hanford Defined Wastes/Tank Layering Model (HDW/TLM) (Agnew 1994) was used to estimate tank contents for all 149 SSTs (Brevick et al. 1994). Tank wastes are categorized based on the major waste types (primary and secondary) that were deposited in each tank and based on process histories. A chemical composition is specified for each waste type, and tanks are identified by volume percentages of all possible waste types (derived from historical information). The chemical compositions are then volume averaged to obtain a final waste composition estimate for each SST. The tank wastes in the tank waste and farms EUs can be summarized (Remund et al. 1995) as:

- CP-TF-1 (T tank farm) in 200 West – first cycle decontamination from bismuth phosphate process, lanthanum fluoride finishing waste, and PUREX and REDOX cladding wastes
- CP-TF-2 (S-SX tank farms) in 200 West – redox wastes and salt and slurry cake from evaporator campaigns
- CP-TF-3 (TX-TY tank farms) in 200 West – salt cake from evaporator campaigns T1 and T2
- CP-TF-4 (U tank farms) in 200 West – aluminum cladding REDOX wastes, salt and slurry cake from evaporator campaigns
- CP-TF-5 (A-AX tank farms) in 200 East – salt cake and slurry from evaporator campaigns A1 and A2 and washed PUREX sludge
- CP-TF-6 (B-BX-BY tank farms) in 200 East – salt cake from evaporator campaigns B and BY, metal waste from bismuth phosphate process, first/second cycle decontamination from the bismuth phosphate process, and lanthanum fluoride finishing waste
- CP-TF-7 (C tank farm) in 200 East – First cycle decontamination from bismuth phosphate process, aluminum cladding PUREX wastes, metal waste from bismuth phosphate process, and ferrocyanide sludge

More recent, detailed compositional estimates of what is currently in the Hanford waste tanks are available in the Best Basis Inventory,[51] which also was used to specify inventories of specific constituents for the EUs.

The primary constituents evaluated for the tank waste and farms EUs include (1) radionuclides - tritium (H-3); Sr-90; Tc-99; I-129; Cs-137; the sum of U-233, U-234, U-235, U-236, and U-238 (for completeness although risk is driven by uranium toxicity); and the sum of Pu-238, Pu-239, Pu-240, Pu-241, and Pu-242; and (2) chemicals – Cr (total), Cr(VI), nitrate (NO_3), U (total), and TCE. Subsurface inventories of some contaminants (e.g., tritium, TCE, Cr) may have resulted from legacy disposal practices within the defined EU rather than from tank leaks or unplanned releases.

Figure 3-10 compares the relative amount of radionuclides (Ci) for tritium (H-3), Sr-90, Tc-99, I-129, Cs-137, the sum of U-233, 234, 235, 236, 238, and the sum of Pu-238-239-240-241-242 by tank farm. Sr-90 and Cs-137 dominate the overall amount of radionuclide inventory. However, since this comparison is based on individual radionuclide activity, this does not directly relate to the dose consequence, due to the very different dose conversion factors for the individual radionuclides listed.

[51] Best Basis Inventory (BBI) Summary (March 24, 2014) provided in spreadsheet form by Mark Triplett (PNNL). The current version of the BBI is stored online and can be accessed using the Tank Waste Information Network System (TWINS) at: https://twinsweb.labworks.org/ (July 2015).

Figure 3-11 through Figure 3-20 represent a set of pie diagrams summarizing several of the primary constituents and the total activity estimated to be within each tank and waste farm EU. "Slices" of each pie diagram represent the relative amounts of an identified primary constituent (e.g., tritium) estimated to be within the specified tank farm tanks in the EU, as well as from leaks and legacy disposal practices for each EU. The area for each EU pie is scaled relative to the total amount of the constituent present across all nine tank farm EUs. The primary radioactive contaminants represent much of the total activity (Figure 3-17) in the waste tanks, with the notable exceptions of Y-90 (which is in secular equilibrium with Sr-90) and Ba-137m (which is in secular equilibrium with Cs-137). These two isotopes (Y-90 and Ba-137m) account for approximately 48% of the activity in the Hanford tanks (which is also approximately equal to that represented by Sr-90 and Cs-137). Other tanks have significant proportions of Sm-151 (a U-235 fission product), Pu-241 (formed by neutron capture), Am-241 (primarily from beta decay of Pu-241), and Ni-63 (an activation product). However, these other isotopes are not risk drivers in the evaluations used to support this review.

One message from these figures is that the identified constituents are unevenly distributed across the individual tanks within an EU as well as across the set of tank farm EUs. For example, the inventory of tritium is dominated by intentional discharges to cribs in EUs CP-TF-2 (S-SX), CP-TF-3 (TX-TY), and CP-TF-5 (A-AX), and relatively small quantities of tritium remain in the tanks compared to prior releases.

The vast majority of the radionuclide and chemical inventory shown in the figures is contained in the tanks with the following exceptions:

- I-129 and Tc-99 in the T (CP-TF-1), TX-TY (CP-TF-3), and B-BX-BY (CP-TF-6) tank farm EUs, where significant releases occurred either through leaks or discharges to cribs; however, the total inventory of Tc-99 and I-129 is relatively small compared to other EUs (Figure 3-14 and Figure 3-15)
- Cr(total) inventory in the T tank farm EU (CP-TF-1) is dominated (ca. 75%) by intentional discharges to cribs and trenches, and significant amounts have been intentionally discharged also at tank farm EUs S-SX, TX-TY, and B-BX-BY (Figure 3-18)
- Uranium in the A-AX tank farm EU (CP-TF-5), where disposal through trenches and cribs contribute more than half of the inventory within the EU, and B-BX-BY and TX-TY, where significant releases occurred through leaks and cribs (Figure 3-19);
- Nitrate in EUs T and B-BX-BY where greater than 50% of the inventory has been through intentional discharges, as well as a significant fraction in EUs S-SX and TX-TY (Figure 3-20)

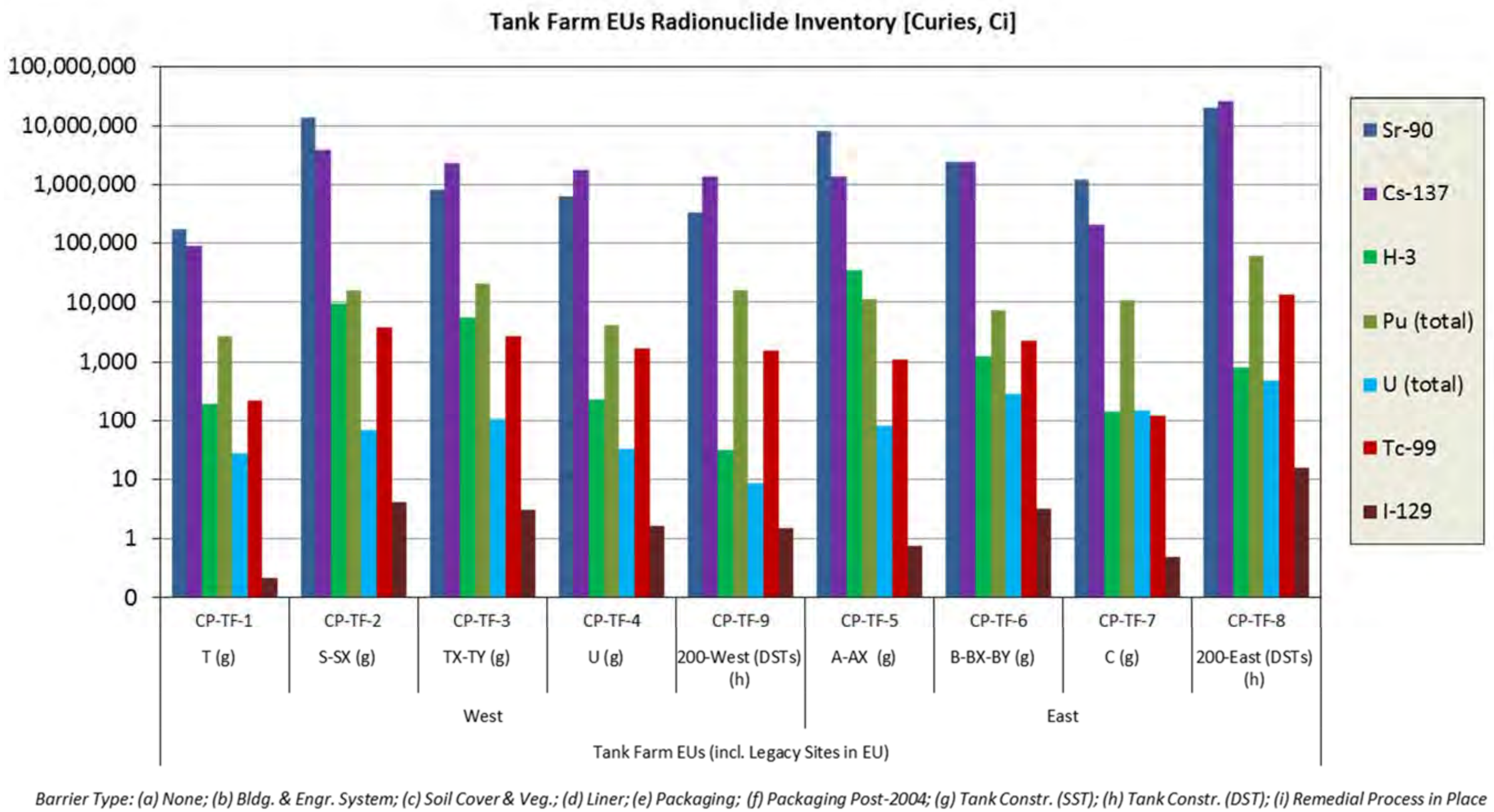


Figure 3-10. Radionuclide inventories by tank farm EUs.

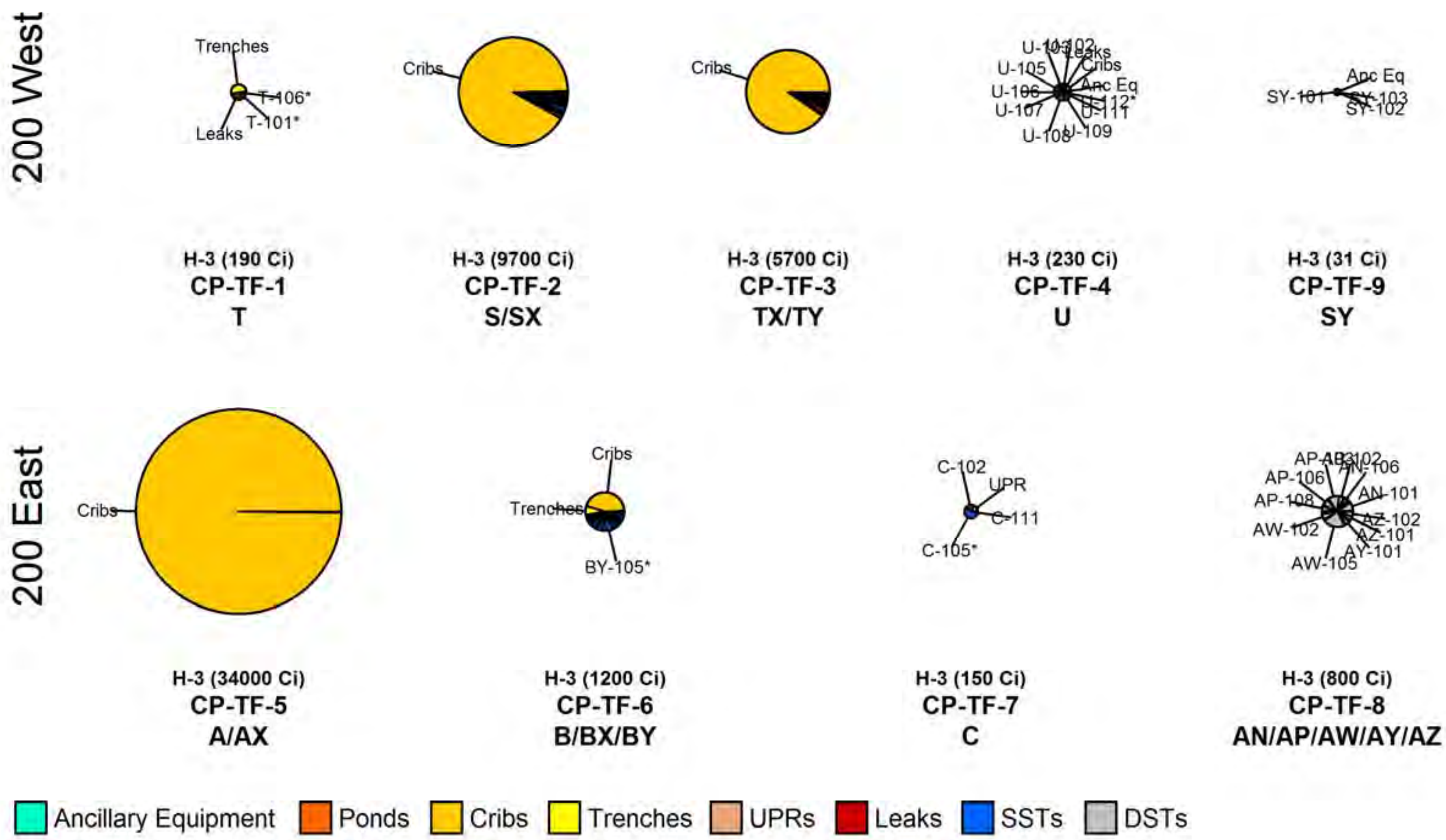


Figure 3-11. Tritium (H-3) as tritiated water (^3H_2O): Inventory distribution between waste within tanks and existing environmental contamination from past disposal practices (i.e., discharges to cribs and trenches) and leaks. Each pie represents a single tank waste and farm EU. The relative inventory within each EU is scaled by relative area for each pie. Asterisk (*) indicates an assumed leaker tank.

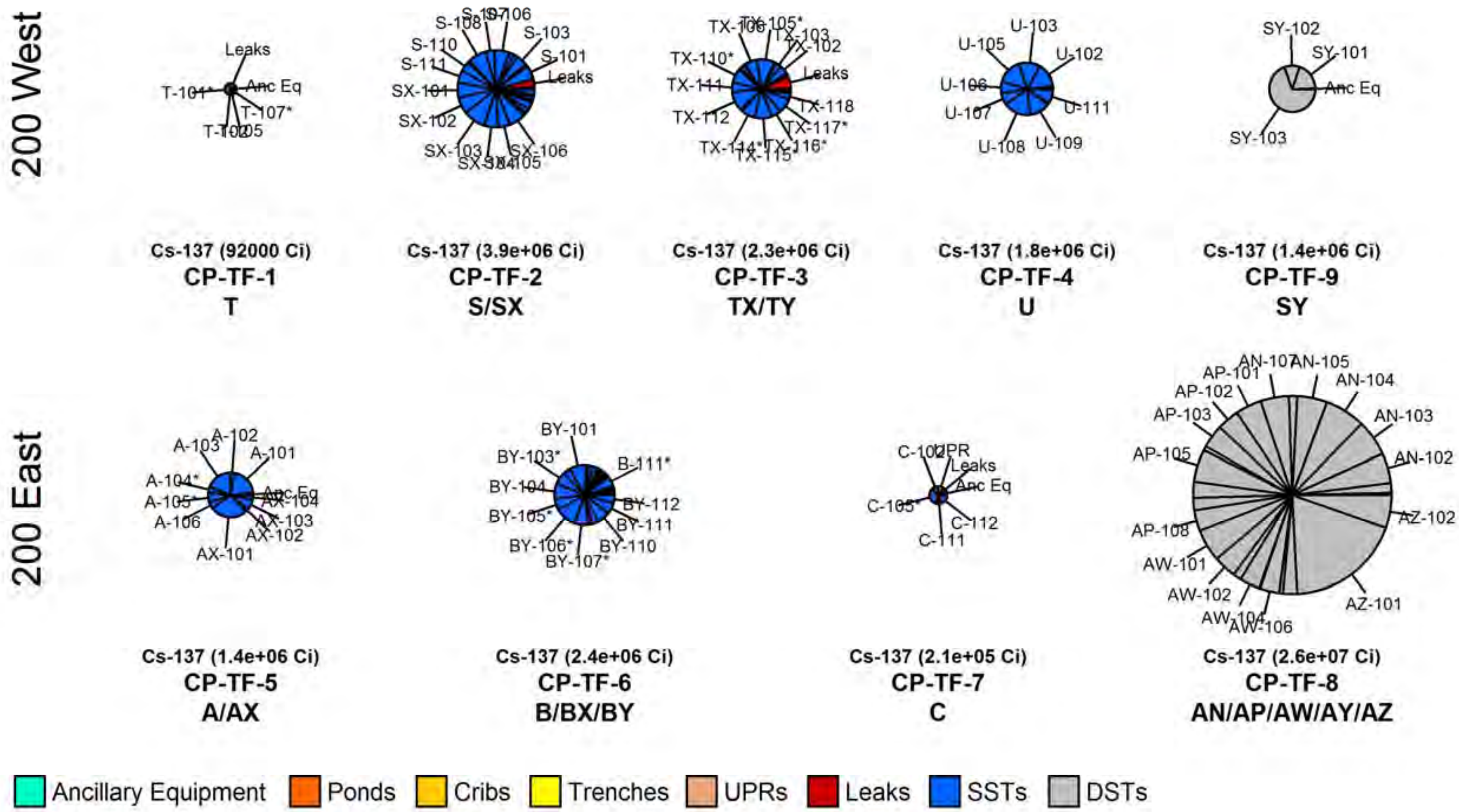


Figure 3-12. Cesium-137: Inventory distribution between waste within tanks and existing environmental contamination from past disposal practices (i.e., discharges to cribs and trenches), leaks, and unplanned releases (UPRs). The relative amount of inventory within each EU is scaled by relative area for each pie. Asterisk (*) indicates an assumed leaker tank.

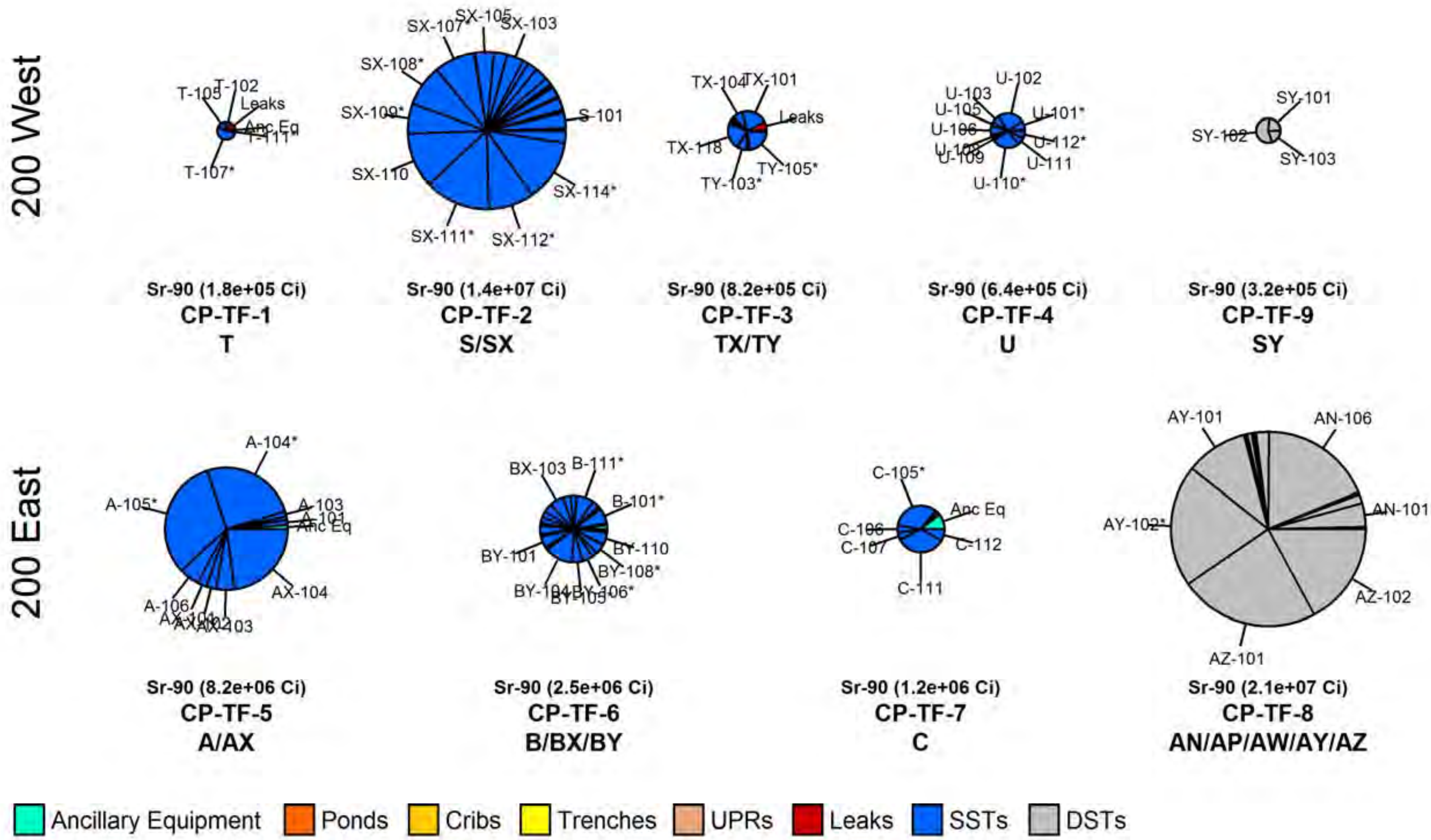


Figure 3-13. Strontium-90: Inventory distribution between waste within tanks and existing environmental contamination from past disposal practices (i.e., discharges to cribs and trenches), leaks, and UPRs. The relative amount of inventory within each EU is scaled by relative area for each pie. Asterisk (*) indicates an assumed leaker tank.

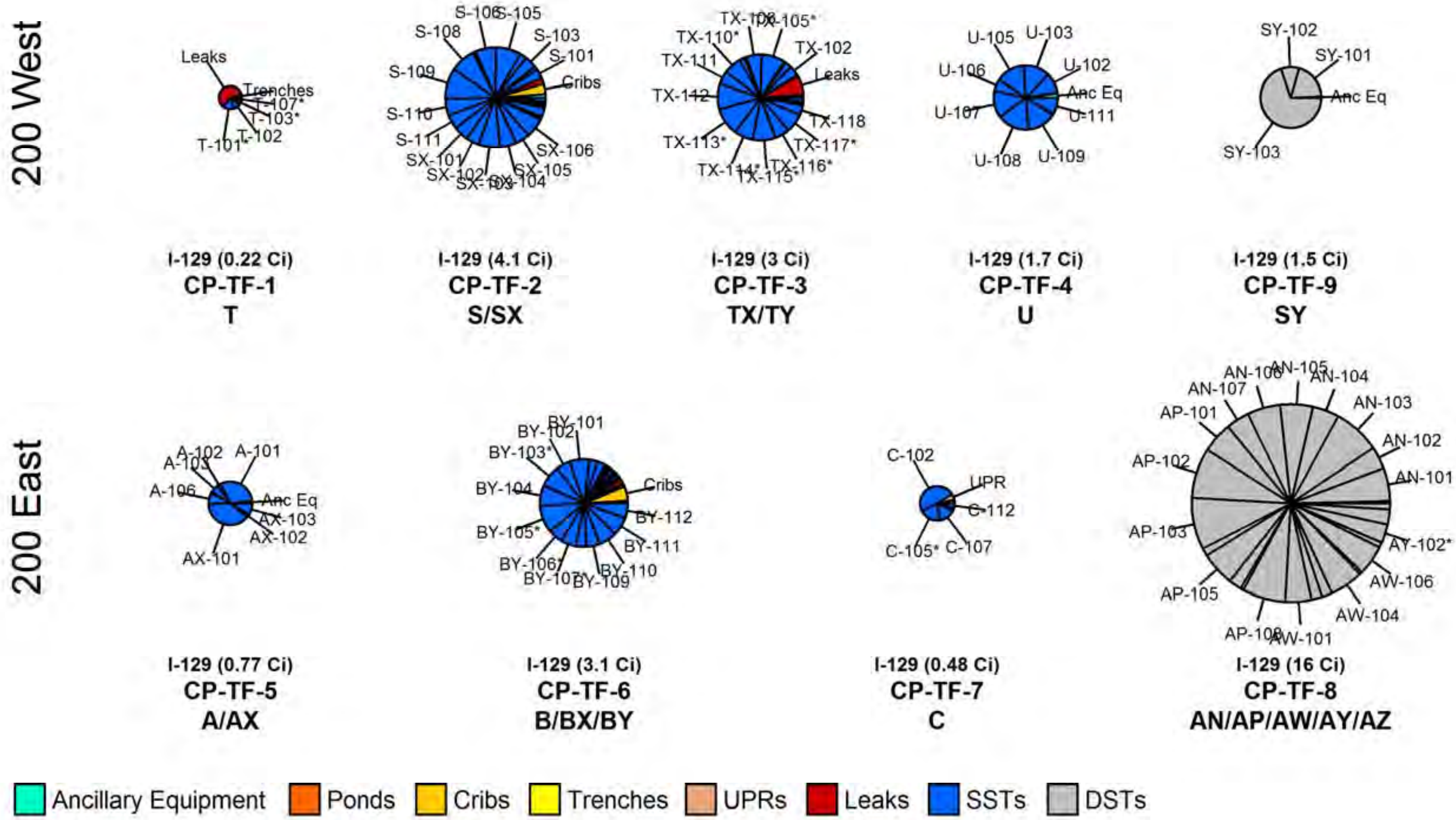


Figure 3-14. Iodine-129: Inventory distribution between waste within tanks and existing environmental contamination from past disposal practices (i.e., discharges to cribs and trenches), leaks, and UPRs. The relative amount of inventory within each EU is scaled by relative area for each pie. Asterisk (*) indicates an assumed leaker tank.

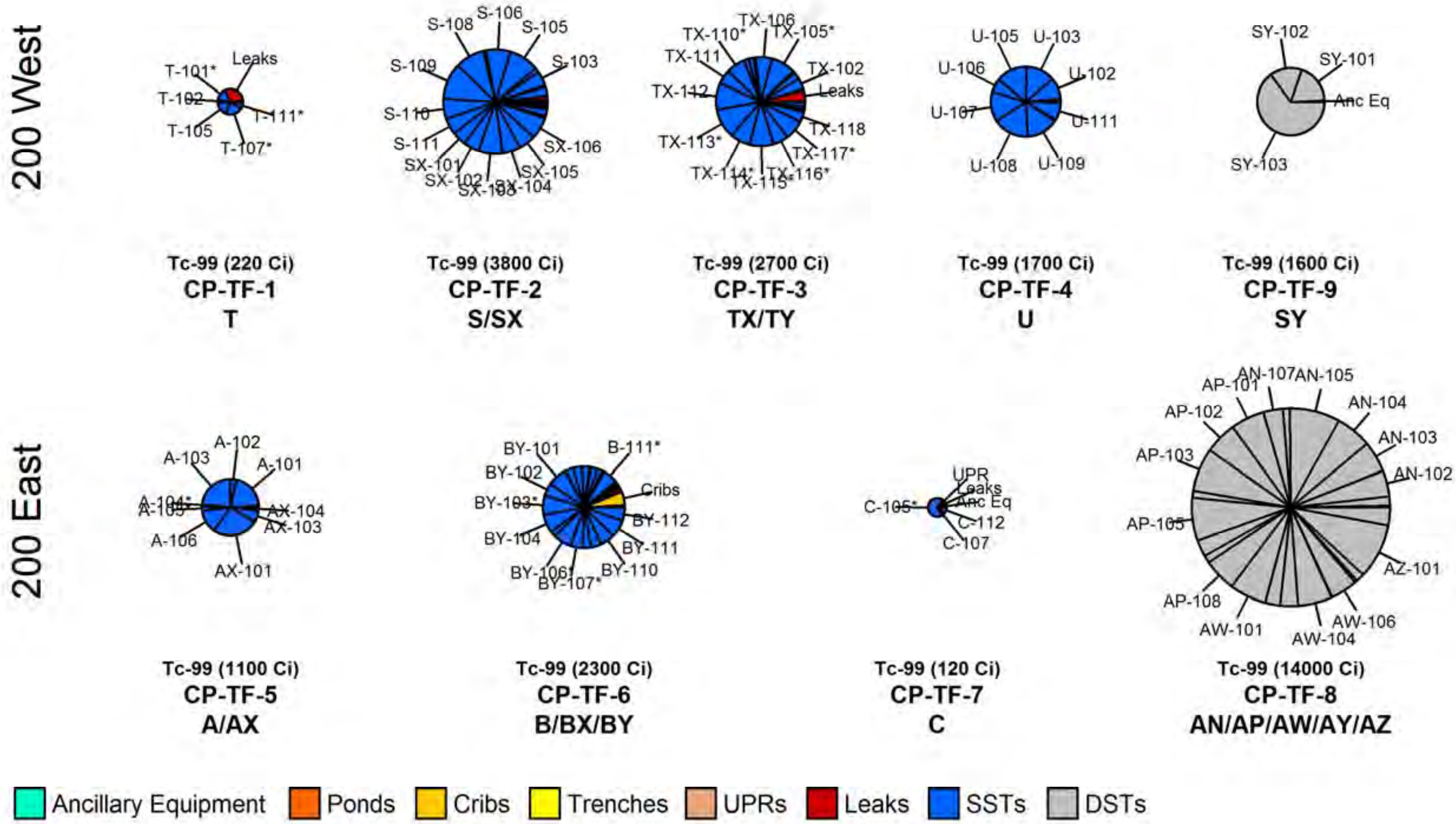


Figure 3-15. Technetium-99: Inventory distribution between waste within tanks and existing environmental contamination from past disposal practices (i.e., discharges to cribs and trenches), leaks, and UPRs. The relative amount of inventory within each EU is scaled by relative area for each pie. Asterisk (*) indicates an assumed leaker tank.

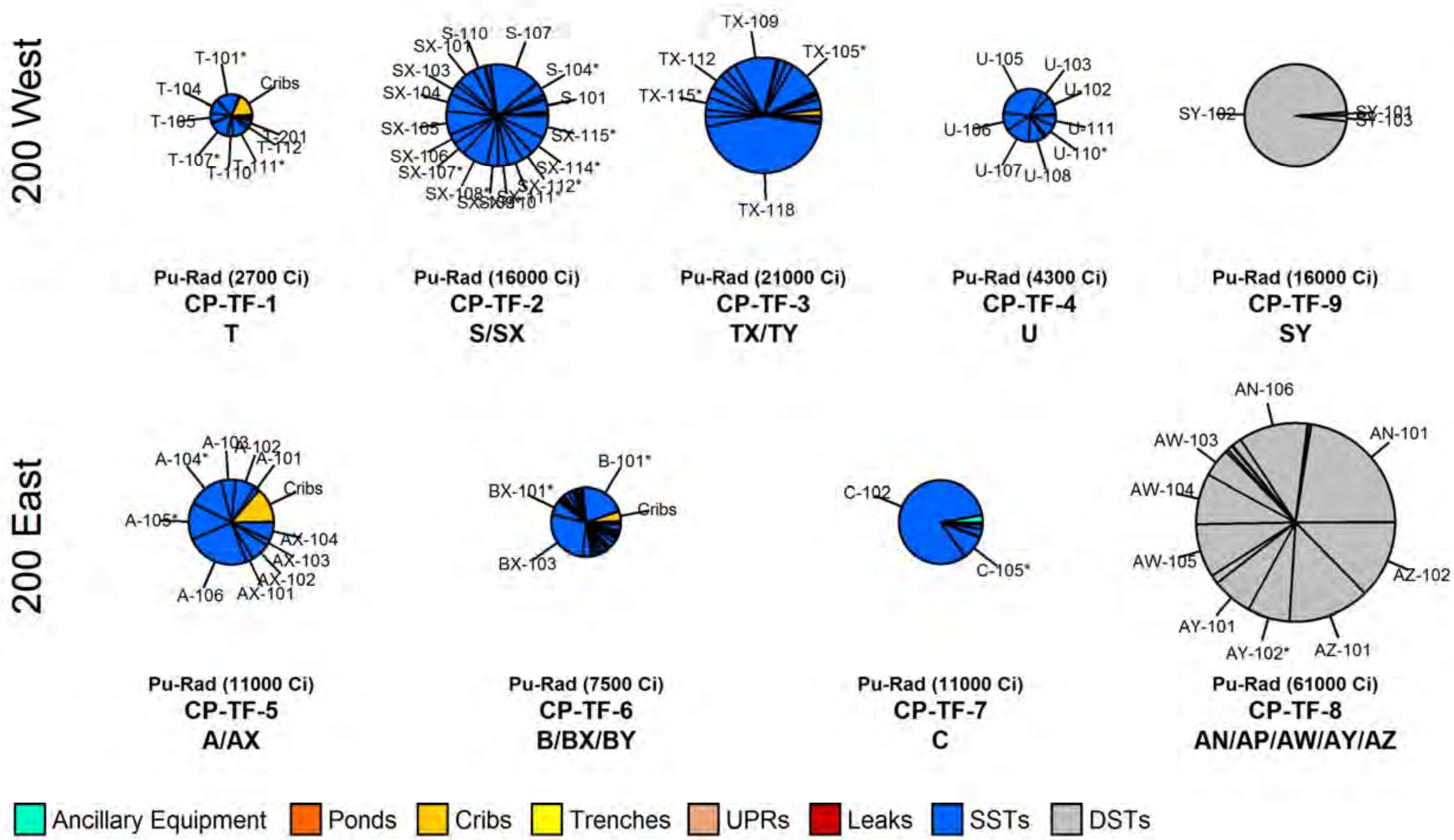


Figure 3-16. Plutonium-Rad (sum of isotopes 238, 239, 240, 241, and 242): Inventory distribution between waste within tanks and existing environmental contamination from past disposal practices (i.e., discharges to cribs and trenches), leaks, and UPRs. The relative amount of inventory within each EU is scaled by relative area for each pie. Asterisk (*) indicates an assumed leaker tank.

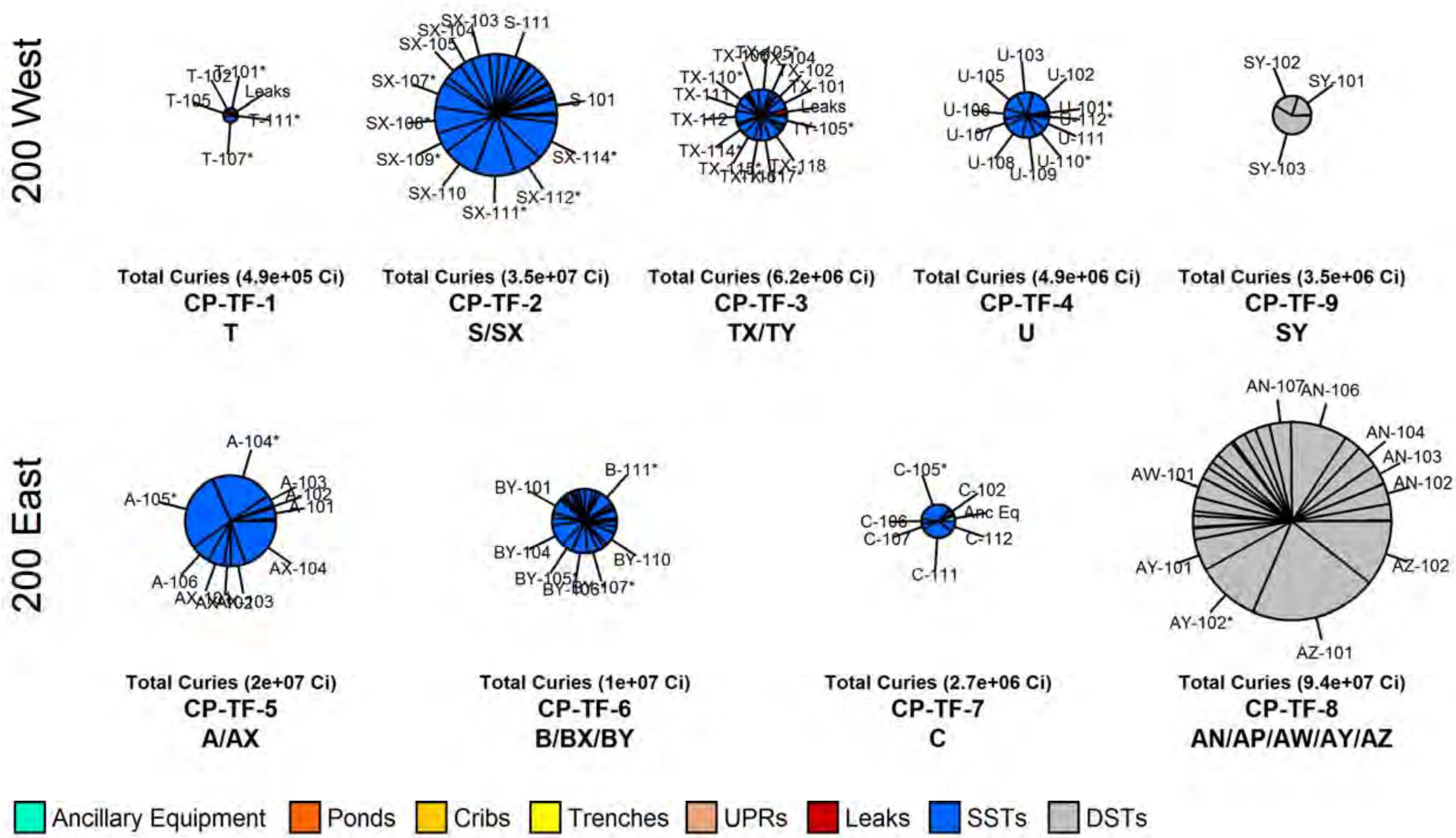


Figure 3-17. Summary of total radionuclide content (Ci) associated with each tank farm: Inventory distribution between waste within tanks and existing environmental contamination from past disposal practices (i.e., discharges to cribs and trenches), leaks, and UPRs. The relative amount of inventory within each EU is scaled by relative area for each pie. Asterisk (*) indicates an assumed leaker tank.

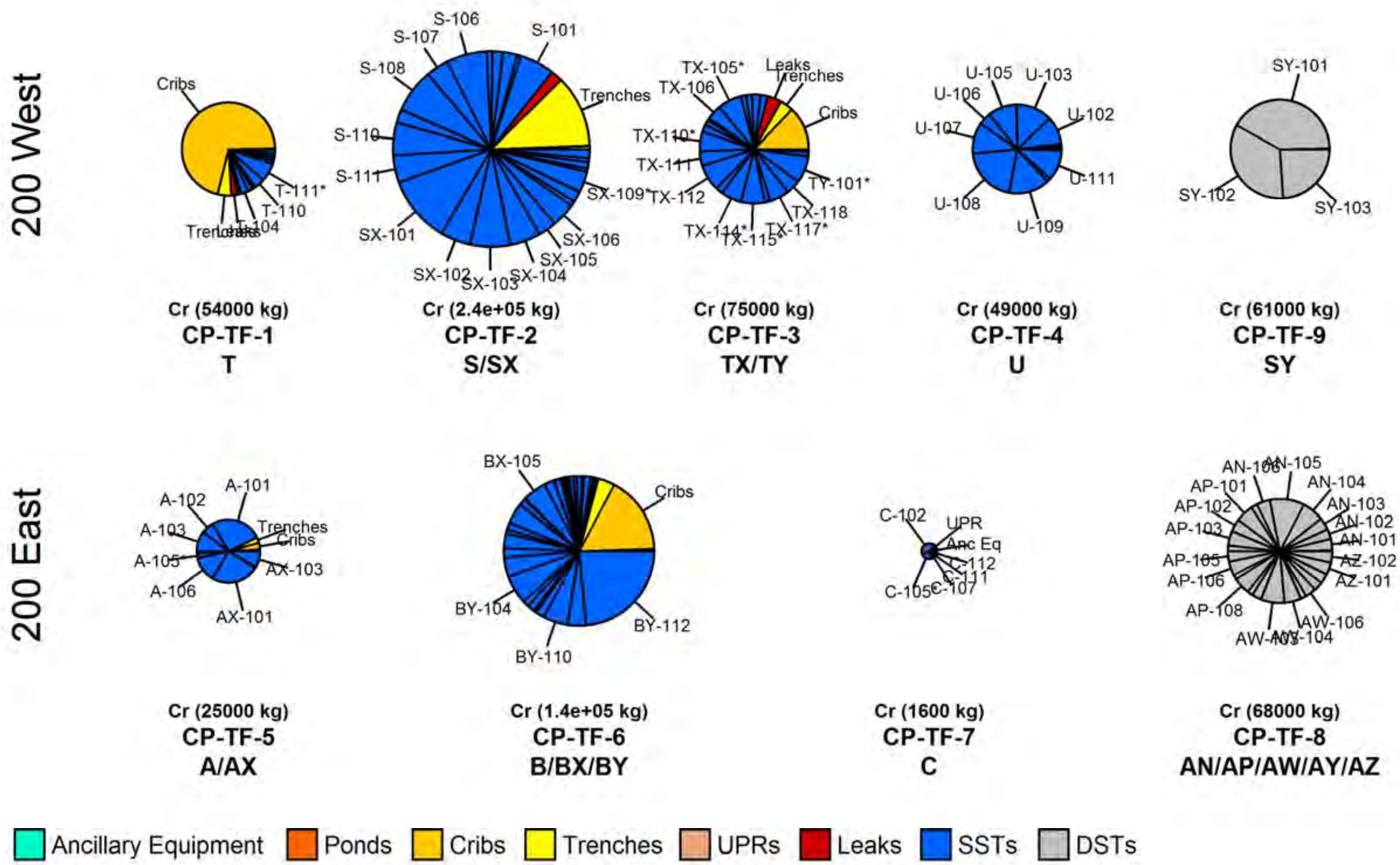


Figure 3-18. Total chromium: Inventory distribution between waste within tanks and existing environmental contamination from past disposal practices (i.e., discharges to cribs and trenches), leaks, and UPRs. The relative amount of inventory within each EU is scaled by relative area for each pie. Asterisk (*) indicates an assumed leaker tank.

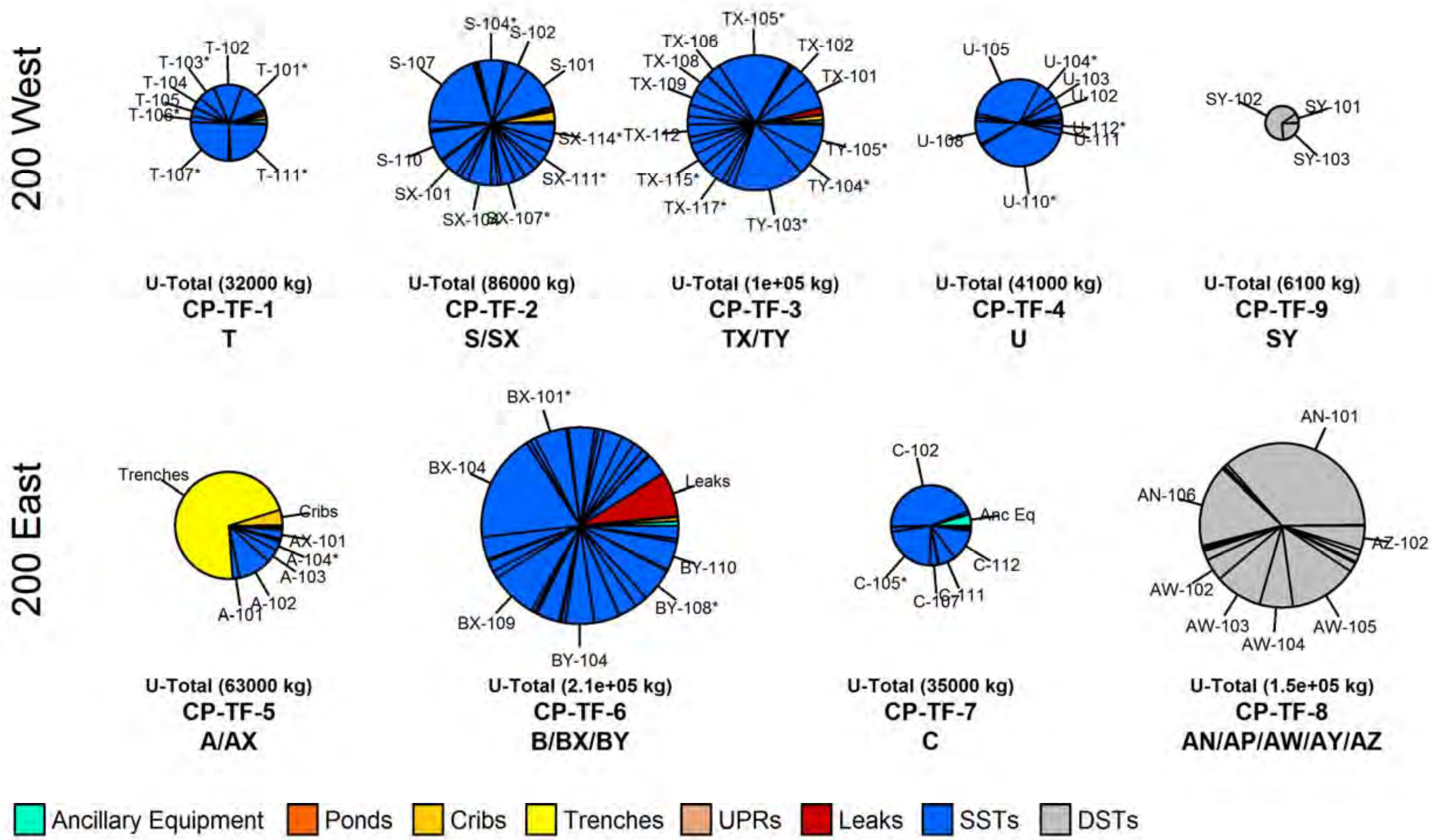


Figure 3-19. Total uranium: Inventory distribution between waste within tanks and existing environmental contamination from past disposal practices (i.e., discharges to cribs and trenches), leaks, and UPRs. The relative amount of inventory within each EU is scaled by relative area for each pie. Asterisk (*) indicates an assumed leaker tank.

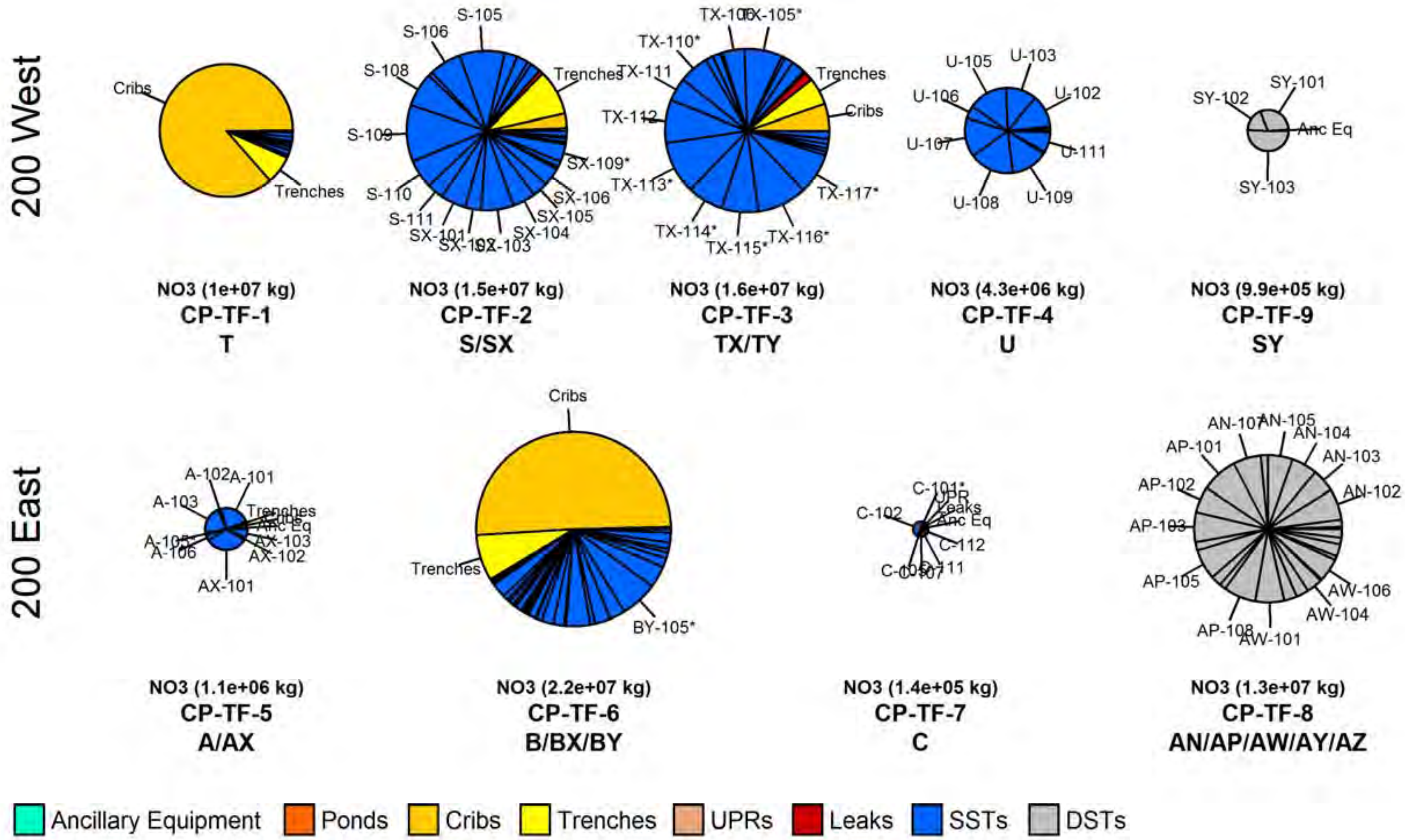


Figure 3-20. Nitrate: Inventory distribution between waste within tanks and existing environmental contamination from past disposal practices (i.e., discharges to cribs and trenches), leaks, and UPRs. The relative amount of inventory within each EU is scaled by relative area for each pie. Asterisk (*) indicates an assumed leaker tank.

PRIMARY NUCLEAR SAFETY AND HUMAN HEALTH RISKS

Major Event Scenarios with the Potential for Significant Human Health and Environmental Impacts

The potential accidents evaluated in the tank farms DSA include flammable gas accident leading to fire/explosion; nuclear criticality resulting in a localized high-energy event; waste transfer leak or air blow accident leading to a spill, leak, or aerosolized spray; release from a contaminated facility; excessive load resulting in partial or total tank (dome) failure; mixing of incompatible materials resulting in unwanted chemical reactions; tank bump leading thermally induced release; and filter failure leading to unfiltered releases of contaminants (RPP-13033).

There are four accidents designated as *Anticipated*[52] for Hanford waste tanks ***if no controls are in place*** **(i.e., unmitigated)**:

- *Flammable gas accidents* – This accident involves flammable gas deflagrations in waste storage vessels/containers (including SSTs) where the bounding event is a flammable gas deflagration from the steady-state generation and accumulation or a gas release event in a DST/SST.
- *Waste transfer leaks* – This accident involves a wide spectrum of waste leaks where the bounding event is a fine spray leak using a high head waste transfer pump.
- *Releases from a contaminated facility* – This accident involves various release mechanisms (i.e., flammable gas deflagrations, fires, load handling accidents, or compressed gas system failures) in contaminated facilities.
- *Air blow accidents* – This accident involves a waste release from a contaminated hose-in-hose transfer line (HIHTL) primary hose assembly and connected waste transfer piping system pressurized by compressed air where the bounding event is a small crack leak below the waste surface.

A nuclear criticality accident is considered *Beyond Extremely Unlikely* (i.e., a frequency of less than once in a million years) (RPP-13033). The flammable gas accident (specifically a detonation in a DST/SST) and waste transfer leaks (specifically a fine spray when using a high head pump) was selected as the bounding accident for evaluation in the tank farms DSA.

Separate evaluations are carried out for radiological doses and toxicological effects (i.e., chemical effects) as part of DOE safety analyses. Of the four anticipated accidents listed above, only the waste transfer leak is considered to have the potential for an onsite radiological total effective dose (consequence) >100 rem. None of the design basis accidents[53] is considered to have the potential for an off-site dose greater than the 25 rem standard that would require safety class engineered systems (i.e., safety class structures, systems, or components) or other technical safety requirements. For onsite toxicological consequences, both the waste transfer leak and air blow accidents are considered less than Protective Action Criteria[54] 3 (life-threatening health effects), and accidents are considered to have

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[52] An anticipated event has frequency greater than once in 100 operating years (RPP-13033). External and natural events are not treated separately since they lead to the same accident types.

[53] A design basis accident is an "accident explicitly considered as part of the facility design for a new facility (or major modifications) for the purpose of establishing functional and performance requirements for safety class and/or safety significant controls" (DOE-STD-3009-2014). There are design basis accidents considered other than the four listed (RPP-13033).

[54] Protective Action Criteria may be used "to evaluate the severity of the event, to identify potential outcomes, and to decide what protective actions should be taken" and may be used "to estimate the severity of consequences of an uncontrolled release and to plan for an effective emergency response." There are benchmark values (i.e., PAC-

offsite toxicological consequences (in contrast to radiological consequences) of less than Protective Action Criteria 2 (irreversible or other serious health effects that could impair the ability to take protective action).

Qualitatively, only the air blow accident (of the four accidents listed above) was judged not to represent a significant impact to a facility worker (i.e., result in "prompt death, serious injury, or significant radiological or chemical exposure to the facility worker") (RPP-13033).

Other representative accidents are considered to have consequences that are less than onsite worker guidelines, and thus do not pose significant facility worker hazards. However, defense-in-depth features are in place at Hanford Site to mitigate the potential for the following additional accident scenarios (RPP-13033):

- SST failure may be caused by excessive concentrated loads or excessive uniform loads, excessive vacuum, load drops, or seismic events and failures of other tanks; dome loading requirements are selected as the defense-in-depth protection feature.
- SST failure could result from chemical reactions resulting from mixing incompatible materials; the verification of paperwork to ensure that the correct chemical is being delivered has been selected as a defense-in-depth feature.
- Contaminated soils may be released (from a crib, ditch, pond) from unplanned excavations or drilling into contaminated soils or ruptures of underground pressurized lines in contaminated soils; environmental air permitting requirements and the excavation permitting process are selected as defense-in-depth features.
- A thermally induced upset (e.g., steam bump in an SST liner gap) could cause a failure in an SST.

There are other representative accidents (e.g., aboveground tank or structure failure, transportation-related waste sample handling accidents, filtration failures, organic solvent fires) that are considered to have consequences less than the guidelines for an onsite worker, do not pose significant facility worker hazards, and have no defense-in-depth features.

The air blow accident and most other accidents evaluated in the tank farms DSA pertain to the active cleanup period (until 2064) evaluated in this Risk Review Project. After closure, the preferred alternative for the SST farms as stated in the Tri-Party Agreement (Ecology, EPA, and DOE 1998) is to have 99% of the waste retrieved (although this may not be practically achievable). Each tank will be filled with grout and covered with an engineered cap that would mitigate potential initiating events, such as fire and natural events that degrade barriers and increase infiltration of water. The manner in which the DSTs will be closed after tank wastes are treated is still to be determined.

Hanford Tank Farm Vapor Exposures

Among the hazards related to the Hanford tank farms are facility worker reports of exposure to vapors from the tanks. Short-term, intermittent vapor exposure has led to respiratory irritation symptoms. Several dozen workers reported upper respiratory symptoms requiring medical evaluation during calendar year 2013; exposures have been attributed to vapors from the tanks. Such events have

1, -2, and -3) for a set of evaluated chemicals. Each successive benchmark represents an increasingly severe effect involving a higher exposure level: (1) mild, transient health effects, (2) irreversible or other serious health effects that could impair the ability to take protective action, and (3) life-threatening health effects. http://orise.orau.gov/emi/scapa/chem-pacs-teels/.

occurred for more than a decade (NIOSH 2004), although the specific offending chemical(s) and sources have not been identified.

An independent review of Washington River Protection Solutions (WRPS) Tank Farm Chemical Vapors Strategy (jointly requested by WRPS and Hanford Challenge, a non-profit group) found that a proposed periodic sampling strategy should be expanded to strengthen the exposure assessment process, the WRPS job hazard analysis should be expanded, and Hanford Site industrial hygienists should expand their capabilities to make sound technical judgements and perform qualitative exposure assessments (especially when quantitative data are not available) (Hanford Concerns Council 2010).

In 2014, the Hanford Tank Vapor Assessment Team (TVAT) from Savannah River National Laboratory concluded that current, available information suggested a causal link between tank vapor releases and the adverse health effects experienced by Hanford tank farm workers (SRNL 2014). Further, an industrial hygiene program emphasizing full-shift exposure measurements and compliance with standard occupational exposure limits cannot adequately characterize the complex, episodic nature of likely tank vapor releases. The team made several recommendations, which DOE and the contractor are implementing, including increased use of personal respiratory protection, improved personal sampling and vapor monitoring, and further tank vapor characterization.

Mitigation of Flammable Gas Accidents

Flammable gas accidents are a concern because of two potential conditions that may result in the accumulation of hydrogen gas in the vapor space of a tank:

- Long-term loss of ventilation that could occur when a regional scale event reduces power to ventilation and other active control systems and passive ventilation is reduced or lost (e.g., from ash fall or other ventilation plugging events)
- Accumulation of gas through entrainment within the settled solids in the tank, followed by a sudden rapid gas coalescence and release event that exceeds the dilution rate to below the LFL by ventilation systems.[55]

Even in the event of flammable gas accumulation as described above, an ignition source still would be necessary for a flammable gas accident to occur.

The following engineered systems are in place to mitigate the potential for flammable gas accidents in the tank farms (RPP-13033, p. T3.3.2.4.1-4):

- *DST primary tank ventilation systems* to maintain the concentration of flammable gases below the LFL in the DST headspace for steady-state releases and induced gas release events due to water or chemical additions and waste transfers into DSTs.
- *Waste transfer primary piping systems* to confine the waste to protect the facility worker from flammable gas accidents in a DST annulus due to a misrouting of materials.

The following flammable gas operational controls for the Hanford tank farms are defined (RPP-13033, p. T3.3.2.4.1-5&6):[56]

[55] The flammability range of a gas is the range (often provided in volumetric terms) in which the gas and air are in the right proportions to burn when ignited. Below the LFL, there is not enough fuel to burn (http://energy.gov/eere/fuelcells/glossary#l).
[56] There are additional controls related to double-contained receiver tanks (DCRTs); inactive/miscellaneous tanks/facilities and waste intruding equipment; and waste packaging that are external to the waste tanks.

- *DST primary tank ventilation systems* for all DSTs ensure the DST primary tank ventilation systems are operable and operating to prevent flammable gas hazards from steady-state releases and slow, continuing induced gas releases following water additions, chemical additions, and waste transfers into DSTs.
- *SST steady-state flammable gas control* for all SSTs, except those in the 241-AX and 241-SX tank farms, protect the facility worker from a flammable gas deflagration caused by steady-state flammable gas releases in an SST by monitoring the flammable gas concentration, verifying passive ventilation for 241-B-203 and 241-B-204, and reducing the flammable gas concentration or eliminating potential ignition sources before the flammable gas concentration exceeds the LFL.
- *DST-induced gas release event flammable gas controls* for all DSTs protect the facility worker from a flammable gas deflagration in a DST due to an operations-induced gas release event by requiring evaluations of waste transfers from DSTs and water additions, chemical additions, and waste transfers into DSTs to determine restrictions or required controls to prevent an induced gas release event flammable gas deflagration.[57]
- *DST-induced gas release event flammable gas control* for all DSTs (when required) ensure the DST primary tank ventilation systems are operable and operating to prevent flammable gas hazards from induced gas release events during water additions, chemical additions, and waste transfers into DSTs.
- *DST annulus flammable gas control* for all DSTs protects the facility worker from a flammable gas deflagration in a DST annulus caused by steady-state flammable gas releases from waste in the DST annulus by monitoring the DST annulus waste level and controlling the flammable gas concentration or eliminating potential ignition sources if a significant quantity of waste is detected in the DST annulus.

The key elements evaluated relative to flammable gas accidents in the Hanford tank farms are (RPP-13033, p. T3.3.2.4.1-7):

- *DST and SST time to LFL* to protect assumptions used to develop surveillance frequencies and action completion times in the limiting conditions of operation for DST primary tank ventilation systems and safety administrative controls for SST steady-state flammable gas control and DST annulus flammable gas control.
- *Ignition controls* to be consistent with the National Fire Protection Association requirements for eliminating potential flammable gas ignition sources; to evaluate activities, equipment, and materials to determine the applicability of and compliance with ignition source control requirements; and to be an important contributor to defense-in-depth by applying ignition controls for the spontaneous gas release event hazard in DSTs 241-AN-103, 241-AN-104, 241-AN-105, 241-AW-101, and 241-SY-103.

[57] In 2012, the Defense Nuclear Facilities Safety Board submitted Recommendation 2012-2, *Hanford Tank Farms Flammable Gas Safety Strategy*, which identified the need to reduce risk posed by flammable gas events at the Hanford tank farms. DOE responded with an implementation plan including a revision to the DSA to include a new control that measures ventilation flow through each DST periodically, supplementing the existing flammable gas monitoring control. This DSA revision also placed requirements on operability of the in-service and standby primary ventilation trains. DOE is working toward installing safety-significant instrumentation for real-time monitoring of the ventilation exhaust flow from each DST.

- *Waste characteristics controls* to protect assumptions used to develop controls for flammable gas deflagrations due to gas release events by preventing the formation of waste gel in DSTs and SSTs.
- *Emergency preparedness requirements* to reduce the risk from seismic-induced flammable gas accidents in DSTs.

The potential for flammable gas-related accidents in the Hanford tank farms is indicated by hydrogen generation rates (HGRs) and times to reach LFLs. Both are provided for each tank in each tank waste and farms EU summary section (Appendices E.1 through E.10). A summary showing tanks with times to reach 25% of the LFL[58] under the zero ventilation scenario (i.e., most restrictive) of less than 6 months[59] is provided in Figure 3-21. The time it would take for a tank to reach 25% of the LFL was selected as a safety indicator by the Risk Review Project because a range of site or regional initiating events potentially could result in temporary or extended loss of ventilation controls (e.g., prolonged loss of power, severe seismic event, high ash fall from volcanic eruption) and indicate the needed response time in an event. Most of the tanks shown are DSTs in the 200 East Area. Under the potential accident scenario of loss of ventilation, current tank waste inventories reveal that three tanks would reach 25% of the LFL in less than 14 days, 13 tanks would reach 25% of the LFL in less than 30 days, and 27 tanks would reach 25% of the LFL in less than 180 days.

The Risk Review Project considered variables that would increase the time to reach the 25% LFL in the tanks, thereby reducing the risk of a flammable gas accident. Removal of Cs-137 was considered because it is very water soluble and potentially could be removed from tanks by the LAW Pretreatment System (LAWPS) currently under design to enable startup of LAW vitrification prior to startup of the entire set Waste Treatment Project facilities (e.g., prior to startup of the WTP HLW Vitrification Facility and Pretreatment Facility). The current design basis for LAWPS is to return separated Cs-137 to the tank farms. Modifications could allow for separation without return to the tank farms if a viable disposition pathway is identified. This analysis also can provide insights into which tanks to consider for Cs-137 return when necessary.

Figure 3-22 depicts the contribution of Cs-137 to the hydrogen generation rate (HGR), which, in conjunction with the amount of waste in the tank, and the volume of the tank vapor space, is a primary variable for the time to reach 25% LFL for an individual tank. The contribution of Cs-137 to the HGR varies by tank from less than 1% to 46% for the tanks with less than 180 days to reach 25% of the LFL under unventilated conditions. Figure 3-23 depicts the resulting impact of Cs-137 removal from the tanks that have less than 180 days to reach 25% of the LFL. The total number of tanks with less than 180 days remains at 27, but the number of tanks with less than 14 days is reduced from 3 to 2, and the number of tanks with less than 30 days is reduced from 13 to 9. Removal of Cs-137 also eliminates a significant source of penetrating radiation (gamma radiation) associated with tank wastes.

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[58] NFPA Standard 69 (2008) requires that fuel concentration only reach 25% of the LFL value, which has been the long-standing practice in the United States.
[59] Typical response times of 14 and 30 days also are shown in Figure 3-21 for reference only.

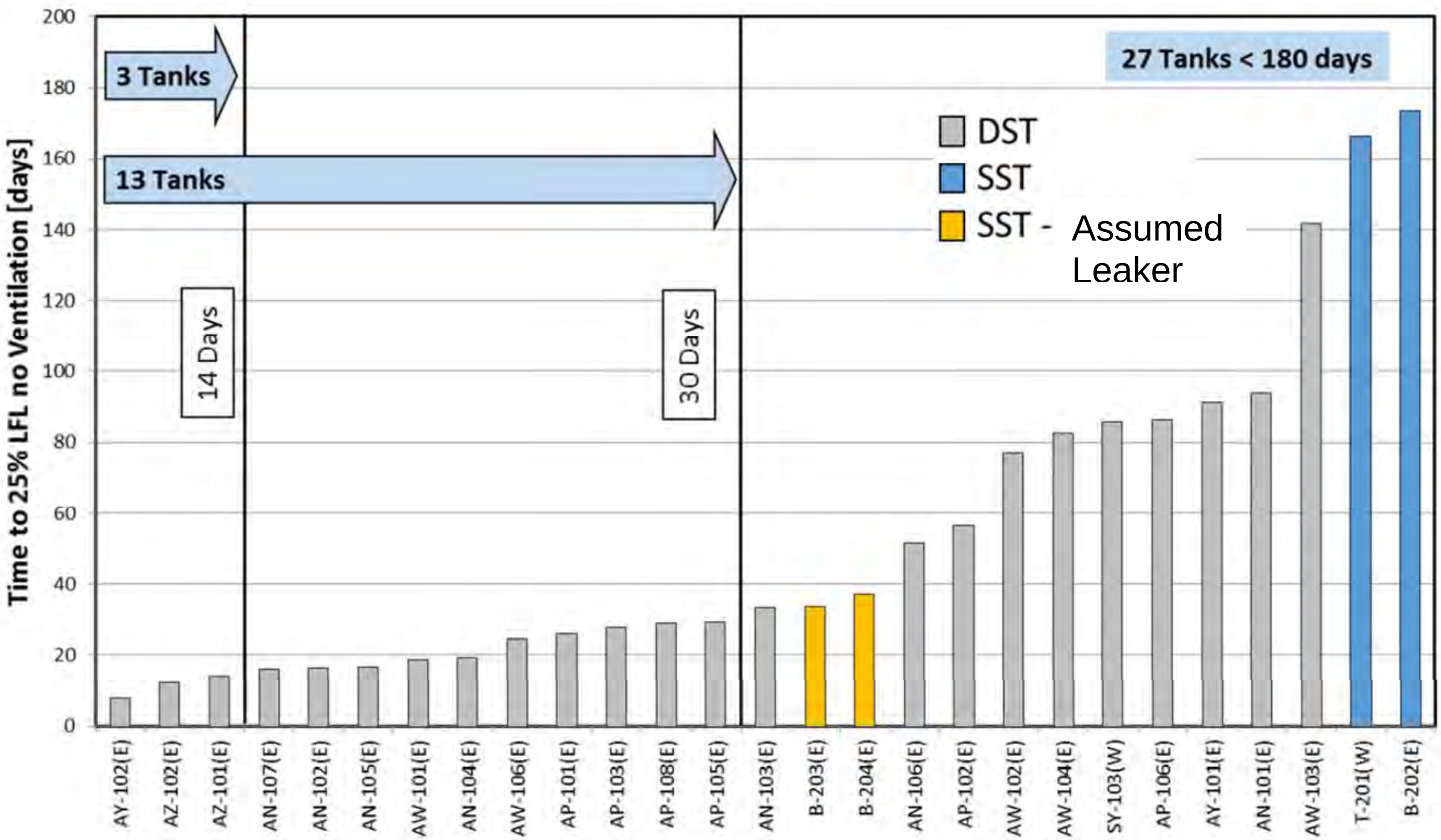

Figure 3-21. Current conditions: Time to 25% LFL for tanks with less than 6 months assuming loss of controls leads to no ventilation (after RPP-5926, Rev. 15). The location (E = 200 East and W = 200 West) is provided after each tank name.

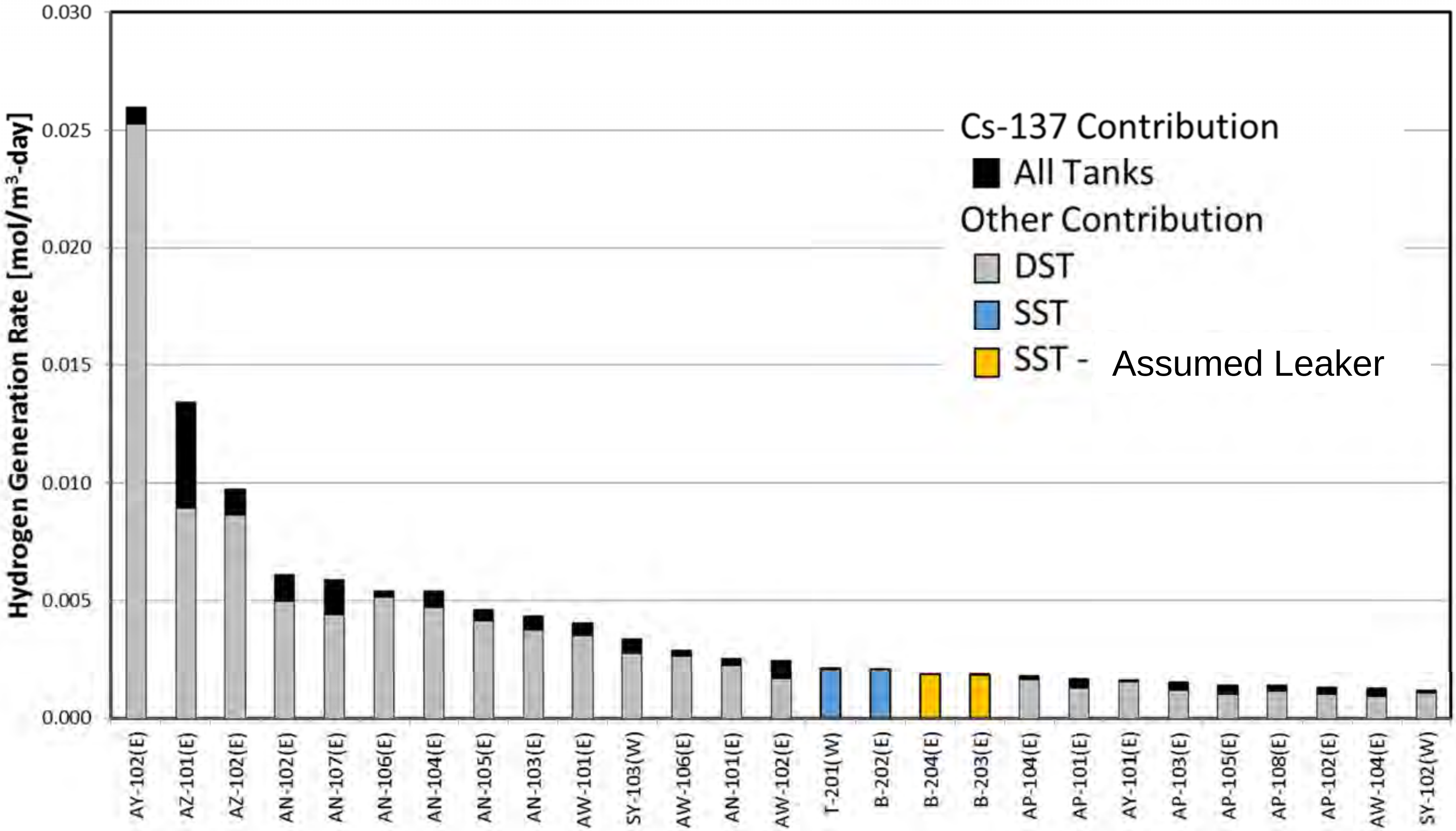

Figure 3-22. Cesium-137 contribution to the HGR for tanks having less than 6 months to 25% of the LFL rate under unventilated conditions (Kirch 2015).

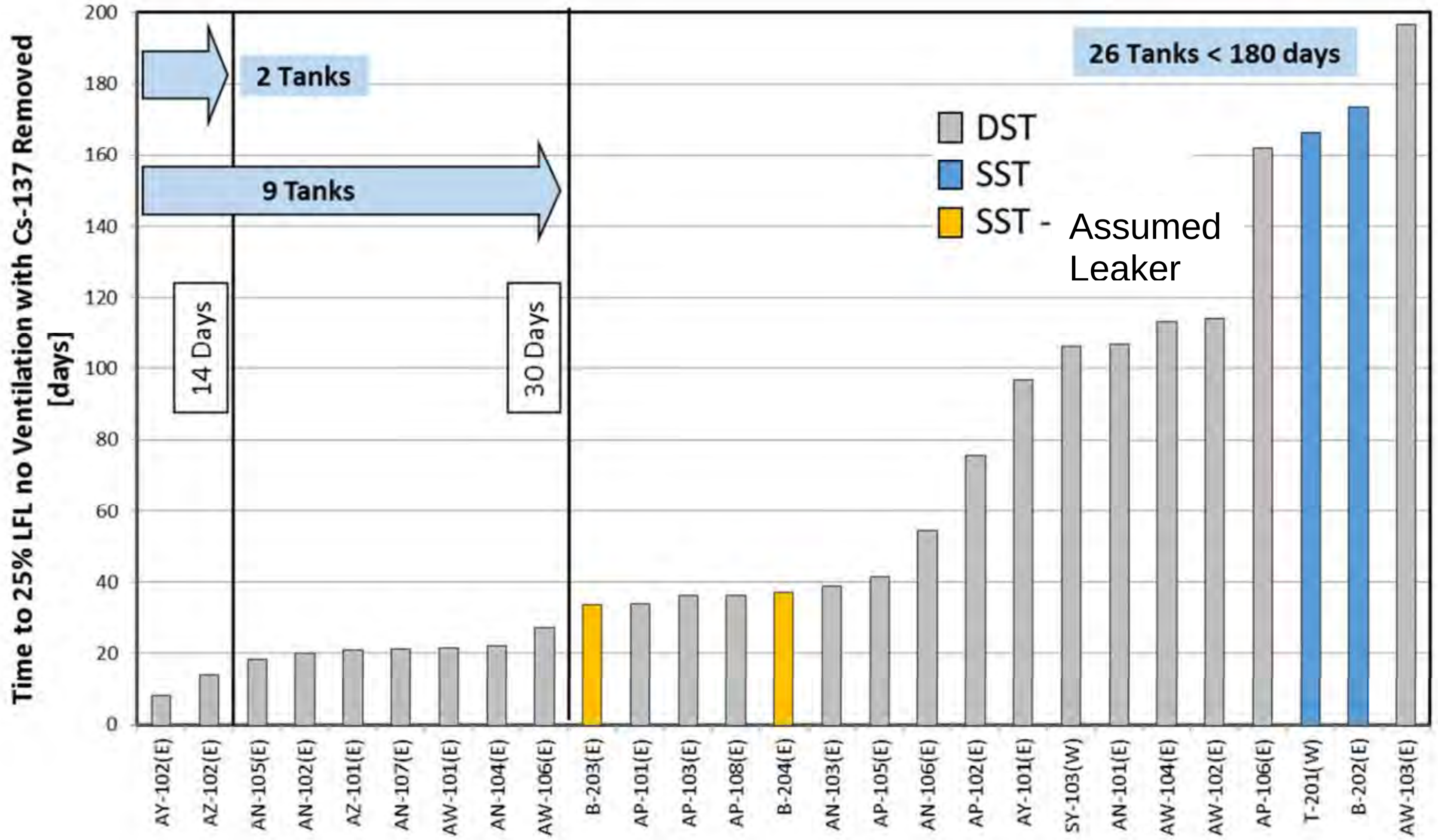

Figure 3-23. Impact of cesium-137 removal: Time to 25% LFL for tanks with less than 6 months assuming removal of Cs-137 and loss of controls leads to no ventilation (based on Kirch 2015 after RPP-5926, Rev. 15). The location (E = 200 East and W = 200 West) is provided after each tank name.

Mitigation of Waste Transfer Leak Accidents and Release from a Contaminated Facility

The following engineered systems are in place to mitigate waste transfer leak accidents and release from contaminated facilities (RPP-13033, p. T3.3.2.4.3-2):

- *Waste transfer primary piping systems* confine waste to decrease the frequency of a fine spray leak, which also protects the facility worker from wetting spray/jet/stream leaks into a normally occupied area and from flammable gas deflagrations in a waste transfer-associated structure due to a waste transfer leak.
- *Hose-in-hose transfer line systems (HIHTL)* confine waste, thus decreasing the frequency of a fine spray leak and protecting the facility worker from wetting spray/jet/stream leaks into a normally occupied area and from flammable gas deflagrations in a waste transfer-associated structure due to a waste transfer leak. This is also an important contributor to defense-in-depth by providing secondary confinement of leaks in the hose-in-hose transfer line primary hose assemblies.
- *Isolation valves for double valve isolation* limit the leakage of waste (through valve leakage), decreasing the consequences of a fine spray leak due to a misrouting and thus protecting the facility worker from wetting spray/jet/stream leaks into a normally occupied area and from flammable gas deflagrations in a waste transfer-associated structure (or other facility) due to a misrouting.

The following additional operational controls are in place to mitigate the potential for waste transfer leaks and releases from contaminated facilities for the Hanford tank farms (RPP-13033, p. T3.3.2.4.1-5-7):

- *Double valve isolation* is required to ensure that safety-significant isolation valves for double-valve isolation are in the closed or block flow position when used to physically disconnect waste transfer primary piping systems, HIHTL primary hose assemblies, and interfacing water systems. This limits waste leakage into the physically disconnected systems, thus decreasing the consequences of a fine spray leak due to a misroute and protecting the facility worker from a wetting spray/jet/stream leak and from a flammable gas deflagration in a waste transfer-associated structure (or other facility) due to a misrouting.
- *Waste transfer-associated structure cover installation and door closure* is an important contributor to defense-in-depth that provides secondary confinement of leaks into waste transfer-associated structures.

Mitigation of Air Blow Accidents

The following engineered systems are used to mitigate the potential for air blow accidents (RPP-13033, p. T3.3.2.4.5-2):

- *Compressed air system pressure relieving devices* limit compressed air system pressure.
- *Waste transfer primary piping systems* provide confinement of waste.

External and Natural Events

No specific engineered systems or operational controls related to external or natural events were identified in the tank farms DSA. The external events evaluated in the DSA include aircraft crash, vehicle accident, and range fire. The external event frequencies range from *Beyond Extremely Unlikely* for accidents like commercial or military aircraft impacting a tank or facility to *anticipated* for range fires.

The natural events evaluated in the DSA include lightning, high winds, earthquakes, volcanic eruptions/ashfall, severe dust storms, heavy snow, hail storms, and floods. For natural events, frequencies range from *not credible* for floods to *anticipated* for extreme temperatures, high winds, hail storms, and dust storms. Natural flooding was determined to be not a credible hazard because of the relative elevations of the tanks and the potential maximum sources of flooding; the physical location of the tanks precludes any potential for impact. The consequences, which relate to the operating accidents described above, would not be increased specifically because the initiating event was an external or natural event. Thus, additional engineered systems and controls were not considered necessary. The only unique aspect of natural events is the possibility that these events cause multiple failures both within a tank farm and also across the Hanford site; however, it was considered unreasonable to expect all releases to be at their highest estimated releases for individual accidents (RPP-13033, p. 3.3.2.4.7-3) in the event of multiple failures. The consequences that relate to the operating accidents described above (e.g., waste transfer leaks, air blow events) would not be increased as a result of external or natural initiating events.

THREATS TO GROUNDWATER

Impact Pathways and Timeframes

The estimated inventories for the vadose zone, groundwater, and treatment amounts associated with the Tank Waste and Farm EUs are found in Appendix E.1 through E.10. These values are used to estimate the inventory remaining in the vadose zone using the process described in Chapter 6 of the methodology report (CRESP 2015). These estimates necessarily have high uncertainties. Recharge travel times for water through the vadose zone have been estimated (Figure 3-24), and while rapid during active site operations with high discharge rates, they are relatively slow, with 50 to 75 years expected for recharge rates of 100 and 50 mm/yr, which correspond with gravel cover or disturbed soil conditions. Lower infiltration rates associated with vegetated cover or engineered covers (less than 3.5 mm/yr) are estimated to result in vadose zone travel times of several hundred years. The focus here is on the Group A and B contaminants in the vadose zone due to their mobility and persistence and thus their potential threats to groundwater. To summarize:

- *Tc-99, I-129* (Figure 3-14 and Figure 3-15) – The vadose zone inventory is dominated by past leaks in the EU CP-TF-1 (T tank farm and associated legacy waste sites, 200 West) and the EU CP-TF-3 (TX-TY tank farms and associated legacy waste sites, 200 West), along with legacy disposal activities in the EU CP-TF-6 (B-BX-BY tank farms and associated legacy waste sites, 200 East).
- *Sr-90* (Figure 3-13) – The vadose zone inventory is dominated by past leaks in the EU CP-TF-1 (T tank farm and associated legacy waste sites, 200 West) and the EU CP-TF-3 (TX-TY tank farms and associated legacy waste sites, 200 West). Thus, the majority of the Sr-90 originally discharged into the vadose zone would have to travel through much of the vadose zone to impact groundwater. The Tank Farm Closure and Waste Management (TC&WM) EIS groundwater transport analysis (DOE/EIS-0391 2012, Appendix O) indicates that Sr-90 is not expected to reach the boundary (T Barrier) closest to the T and TX-TY tank farm EUs.[60]

[60] The 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). The T Barrier is the closest to the T and TX-TY Tank Farm EUs. Despite including sources other than those for the T and TX-TY Tank Farm EUs, the analysis in the

- Furthermore, the average time for water to travel through the vadose zone to groundwater is 64 years, with a range estimated from 50 to greater than 100 years (Figure 3-24) for the 200 West Area (DOE/EIS-0391 2012, Table N-52); thus, the resulting average travel time for Sr-90 to move through the vadose zone to groundwater is more than 300 years (or 10+ half-lives), accounting for retardation by sediment adsorption.[61] It would likely require more time to reach groundwater in a sufficient amount to exceed the drinking water standard over an appreciable area. Thus, a Sr-90 plume is not expected to reach groundwater in significant quantities in the next 150 years due to retardation or after 150 years due to radioactive decay (+99.99% reduction in Sr-90 inventory).
- *Chromium* (Figure 3-18) – The vadose zone inventory is dominated by past discharges to cribs and trenches (for the CP-TF-1, CP-TF-3, and CP-TF-6 TF EUs).
- *Uranium* (Figure 3-19) – The vadose zone inventory is divided among discharges to trenches and cribs (predominantly EU CP-TF-5, but also EUs CP-TF-2, CP-TF-3) and leaks (predominantly EU CP-TF-6). Thus, at least part of the uranium originally discharged into the vadose may have been driven deeper into the vadose zone (with high volume discharges) and may have less of the vadose zone to travel until potentially impacting groundwater. There is an existing uranium plume in the groundwater underlying CP-TF-5 (A-AX tank farms); however, this plume is associated with PUREX and not tank farm operations.

TC&WM EIS was considered reasonable to assess rate of movement of contaminants to groundwater through the vadose zone.

[61] The minimum K_d for Sr-90 for WMAs T and TX-TY is 0.6 mL/g (PNNL-17154, p. 3.87), which translates to a retardation factor of ~6.

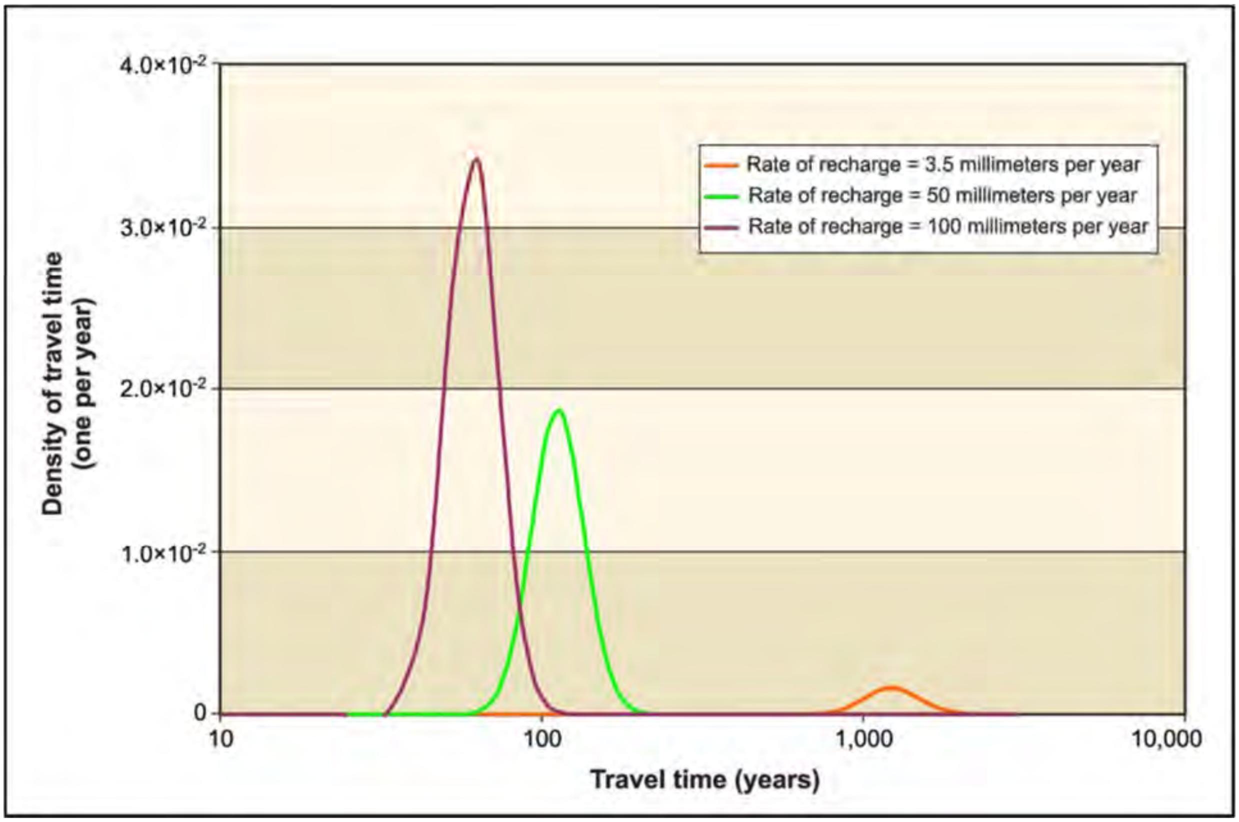

Figure 3-24. Distribution of travel time in the vadose zone for the 200 West Area (DOE/EIS-0391 2012, Fig. N-159, Appendix N).

Estimated Groundwater Threat Metric

The GTM, which represents the maximum volume of water that could be contaminated from a source at the reference threshold (e.g., water quality standard), is used in conjunction with consideration of the time estimated for specific contaminants to reach the groundwater as the primary basis to evaluate the potential for existing contamination in the vadose zone to contaminate groundwater. Similarly, the GTM is used to estimate the potential extent of groundwater contamination if releases from individual tanks occurred. The GTM is defined as the volume of groundwater that could potentially be contaminated by the inventory of a primary contaminant from a source (groundwater plume, vadose zone contamination, tank, etc.) if it was found in the saturated zone at the WQS (e.g., drinking water standard) and in equilibrium with the soil. The GTM accounts only for (1) source inventory, (2) partitioning with the surrounding subsurface, and (3) the WQS. The GTM reflects a snapshot in time (assuming no loss by decay/degradation or dispersion, etc.) and does not account for differences in contaminant mobility or bulk groundwater flow. Refer to the methodology report, Chapter 6, for a more complete discussion of the GTM (CRESP 2015).

The GTM is summarized for each tank in Figure 3-25. For evaluating groundwater threats from tank wastes, the GTM is presented using the maximum GTM value obtained from I-129 and Tc-99 for each tank, existing environmental contamination (from legacy sources), and each EU. The focus is placed on I-129 and Tc-99 because the TC&WM EIS (DOE/EIS-0391 2012) identified these as the risk-driving primary contaminants in the tank wastes that potentially threaten groundwater and the Columbia River.[62] The chart in Figure 3-25 and those like it show the relative fractions of the GTM (or other metrics) for individual tanks and legacy sources across the tank farm EUs; the sizes of the diagrams are also scaled to be relative to the total GTM in the tank farm EU.

Figure 3-25 indicates that the threat to groundwater posed by the tank wastes is very unevenly distributed between tank farms and among tanks within each tank farm EU. The greatest GTM, 15,000 Mm^3, is associated with the 200 East DSTs (CP-TF-8). The next greatest grouping of GTM is associated with EUs CP-TF-2 (S-SX, 200 West, 4200 Mm^3), CP-TF-3 (TX-TY, 200 West, 3000 Mm^3) and CP-TF-6 (B-BX-BY, 200 East, 2700 Mm^3), which are essentially indistinguishable given uncertainties in the tank waste inventory estimates associated with I-129 and Tc-99. The lowest grouping of GTM is associated with EUs CP-TF-1 (T, 200 West, 250 Mm^3) and CP-TF-7 (C, 200 East, 270 Mm^3), noting that the C tank farm has undergone partial waste retrieval and waste retrieval currently is ongoing.

Figure 3-26 illustrates the uneven distribution of GTM among individual tanks within a tank waste and farm EU. For the A-AX tank farm EU, the GTM is dominated by tanks A-101, A-103, A-106 and AX-101 (4 of 10 tanks). For the T tank farm EU, the GTM is dominated by tanks T-101, T-105, T-107, and T-111, three of which are assumed leakers (4 of 14 tanks). Also note that for the T tank farm EU, the GTM associated with past leaks is greater than the GTM associated with any individual tank and dwarfs the GTM associated with all but the 4 tanks with the greatest GTMs. For the T tank farm EU, reducing 99% of the tank inventory in all tanks would reduce the overall GTM for that tank farm EU by only 67.2%, while a 99% reduction for tanks T-101, T-105, T-107, and T-111, along with a 90% reduction of the tank inventory for the remaining 12 tanks, would reduce the overall GTM by 67.6%.

Figure 3-27 compares the GTM for waste in all tanks within each EU to the GTM for the existing environmental contamination in the vadose zone from legacy discharges and leaks. These results indicate that reducing the GTM remaining in the tanks after waste retrieval to levels commensurate with the surrounding vadose zone GTM should be considered, especially in the context where residual inventories in the tanks after retrieval would be grouted in place and would therefore have significantly less leaching potential to impact groundwater than inventories in the vadose zone. Waste retrievals that result in reduction of the GTM contained in the tanks within each tank farm EU by 90% would meet this criteria (tank end-states less than the GTM in the vadose zone) for all SST tank farms except for U and A-AX tank farms. Overall, the GTM in the vadose zone is approximately 3% of the GTM in the SSTs for both 200 East and 200 West tank farms.

Figure 3-28 presents the GTM for all DSTs and SSTs. The waste inventory in 19 tanks (18 DSTs and 1 SST) accounts for 50% of all of the GTM within tanks, while 68 of 177 tanks (26 DSTs and 42 SSTs, including 10 assumed SST leakers) account for 90% of the total GTM within tanks (Table 3-13). All DSTs and SST in the group that accounts for 90% of the total GTM have greater than 100 Mm^3.

If the focus is solely on SSTs, then 90% of the total GTM within SSTs is contained in 58 tanks (Figure 3-29). All of these SSTs have a GTM greater than 78 Mm^3, with 52 of the 58 SSTs having a GTM greater than 100 Mm^3.

[62] Cr(VI) also is identified as having significant potential to threaten groundwater and the Columbia River, but the potential threat from Cr(VI) is from existing environmental contamination (legacy discharges), not from chromium currently in the tanks. Chromium in the tank wastes is primarily precipitated in solids as Cr(III) and is not reported based on fractional speciation between Cr(III) and Cr(VI).

If the focus is on SSTs that are assumed leakers (Figure 3-30), 10 are in the group of tanks that comprises 90% of the total GTM (DSTs and SSTs), and each of these 10 tanks has a GTM greater than 100 Mm^3 (i.e., 7 in the TX tank farm, 2 in the BY tank farm, 1 in the B tank farm). Thirty-six SSTs that are assumed leakers have a GTM greater than 10 Mm^3.

Table 3-12. Groundwater threat metric by tank waste and farm EU, existing contamination within the vadose zone and within tanks.

		GTM (Mm^3)		
Tank Waste and Farms EUs	**200 West SSTs**	**Vadose Zone**	**Within Tanks**	**(GTM Vadose Zone)/ (GTM within Tanks)**
CP-TF-1	T	73	170	43%
CP-TF-2	S-SX	83	4,093	2%
CP-TF-3	TX-TY	124	2,910	4%
CP-TF-4	U	3.1	1,847	0.2%
	Sum:	282	9,020	
	200 East SSTs			
CP-TF-5	A-AX	1.5	1,224	0.1%
CP-TF-6	B-BX-BY	118	2,495	5%
CP-TF-7	C	12	238	5%
	Sum:	132	3,957	

a. The groundwater threat metric (GTM) represents the maximum volume of water that could be contaminated from a source at the reference threshold (e.g., water quality standard).

Table 3-13. 26 of 28 DSTs and 42 of 149 SSTs account for 90% of the total DST+SST GTM based on maximum of I-129 and Tc-99 GTM by tank. Asterisk (*) indicates an assumed leaker tank.

200 East (35 of 91 tanks)		200 West (33 of 86 tanks)	
CP-TF-5 4 Tanks	A-101, A-103, A-106, AX-101	CP-TF-1 0 Tanks	
CP-TF-6 8 Tanks	B-111*, BY-101, BY-103*, BY-104, BY-106*, BY-110, BY-111, BY-112	CP-TF-2 13 Tanks	S-103, S-105, S-106, S-108, S-109, S-110, S-111, SX-101, SX-102, SX-103, SX-104, SX-105, SX-106
CP-TF-7 0 Tanks		CP-TF-3 10 Tanks	TX-105*, TX-106, TX-110*, TX-111, TX-112, TX-113*, TX-114*, TX-115*, TX-116*, TX-117*
CP-TF-8 23 Tanks (DSTs)	AN-101, AN-102, AN-103, AN-104, AN-105, AN-106, AN-107, AP-101, AP-102, AP-103, AP-104, AP-105, AP-106, AP-107, AP-108, AW-101, AW-102, AW-103, AW-104, AW-106, AY-102*, AZ-101, AZ-102	CP-TF-4 7 Tanks	U-102, U-103, U-105, U-107, U-108, U-109, U-111
		CP-TF-9 3 Tanks (DSTs)	SY-101, SY-102, SY-103

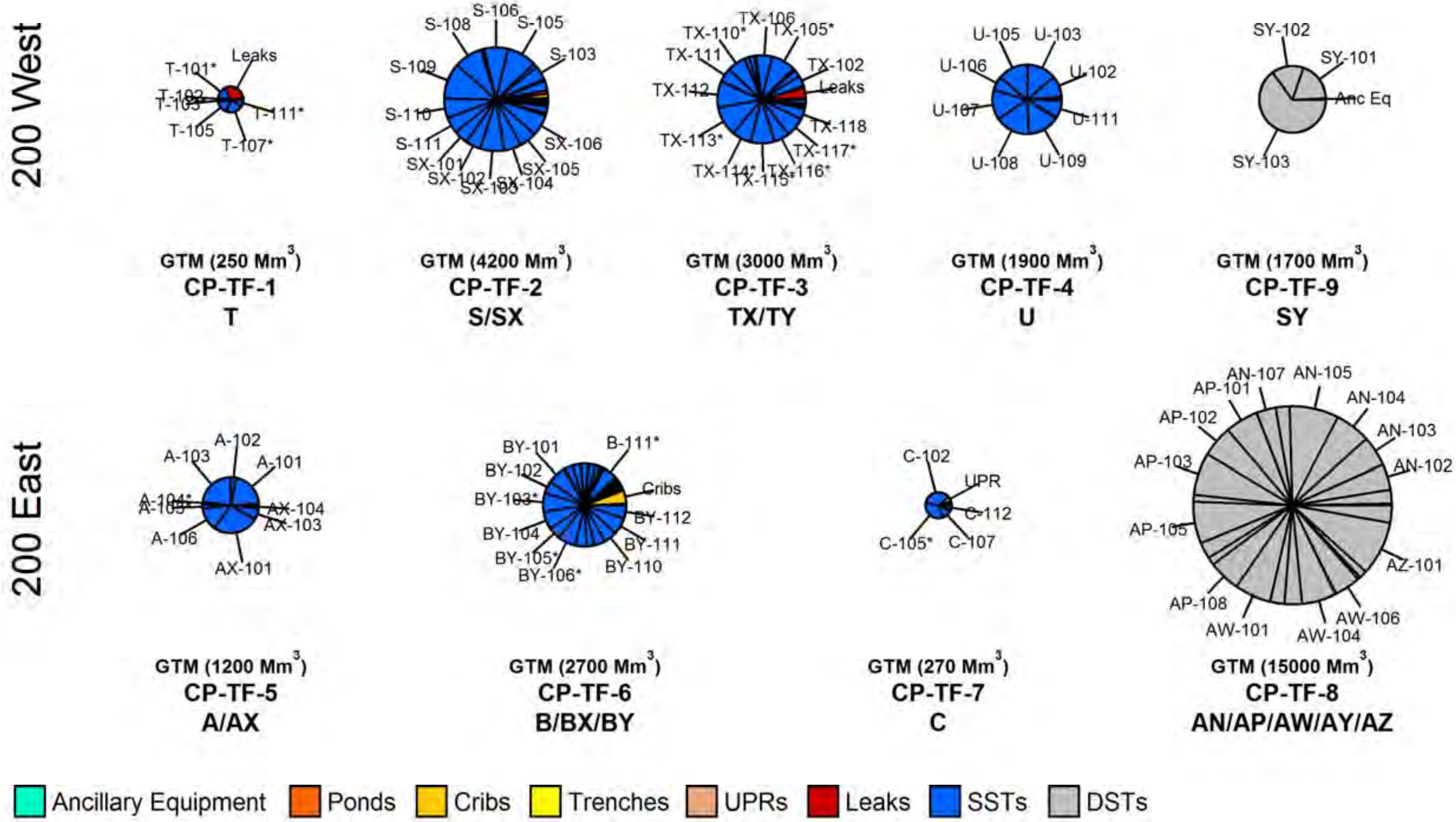

Figure 3-25. Groundwater threat metric based on the maximum GTM between I-129 and Tc-99. The GTM distribution between waste within tanks and existing environmental contamination from past disposal practices (i.e., discharges to cribs and trenches), leaks, and UPRs. The relative GTM within each EU is scaled by relative area for each pie. Asterisk (*) indicates an assumed leaker tank.

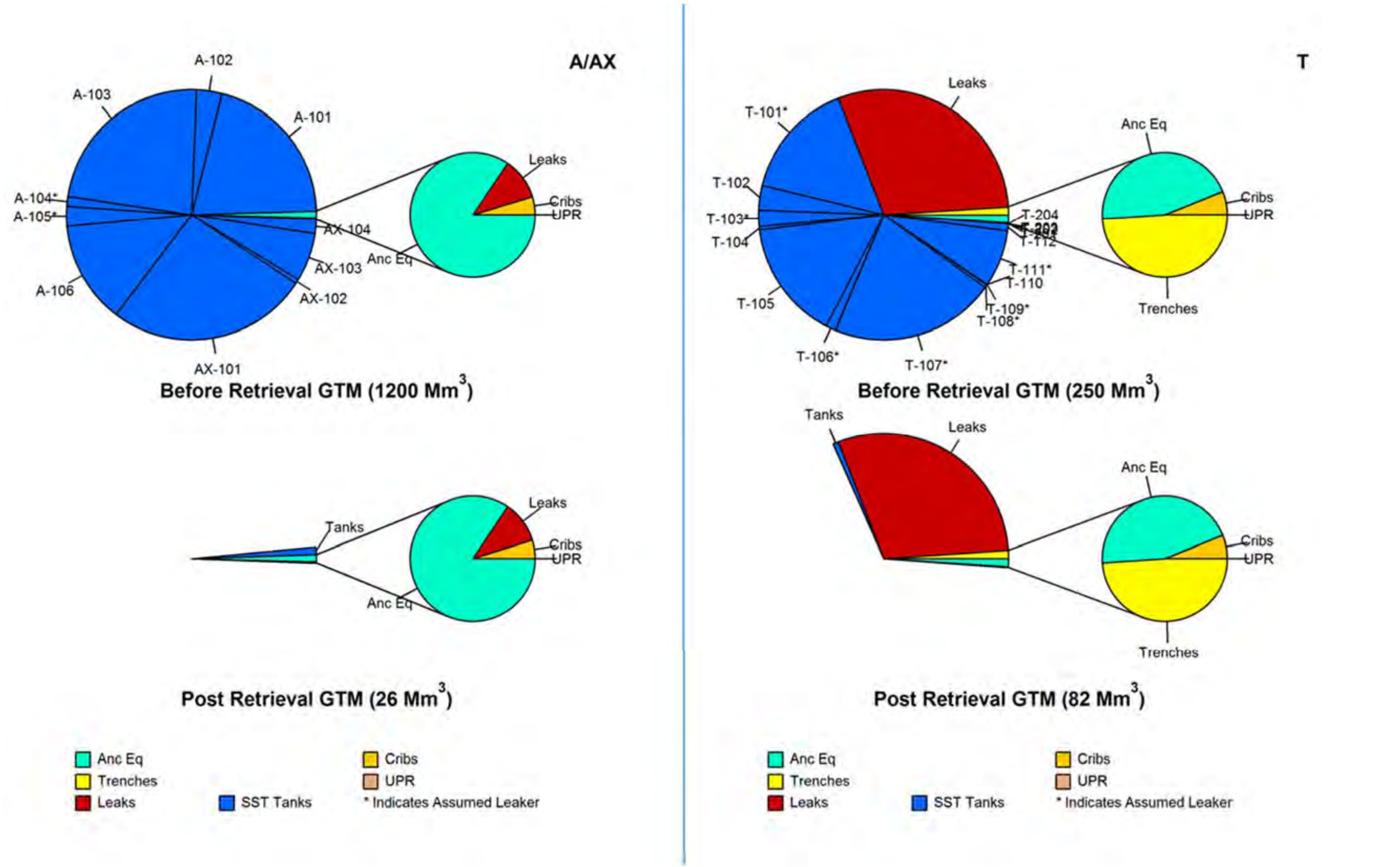

Figure 3-26. Distribution of the GTM based on the maximum GTM of I-129 and Tc-99 among individual tanks and existing environmental contamination for two tank waste and farm EUs (CP-TF-5, A/AX, 200 East; CP-TF-1, T, 200 West). Asterisk (*) indicates an assumed leaker tank.

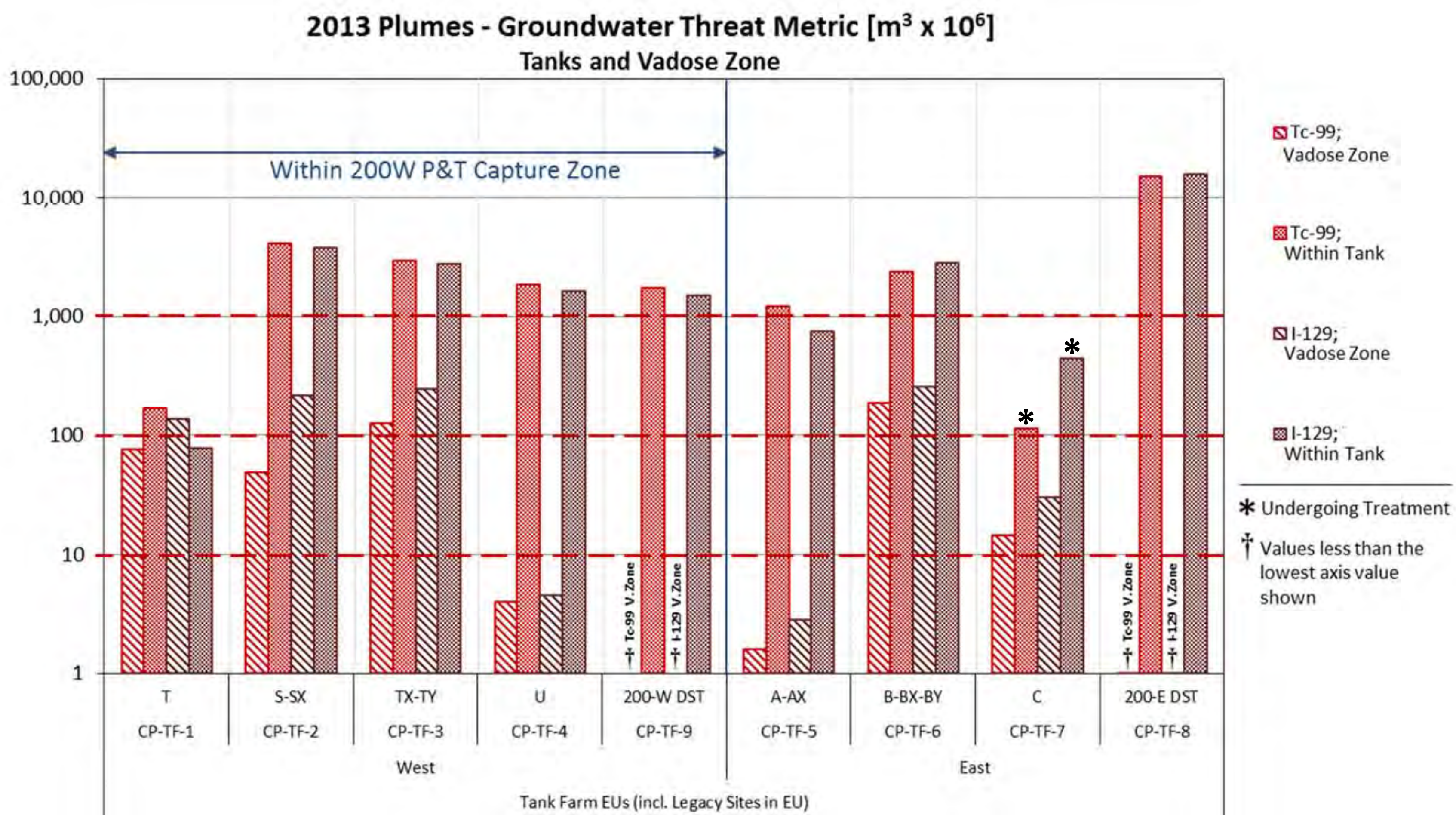

Figure 3-27. Comparison of the GTM (Mm³) from existing contamination in the vadose zone to the GTM associated with the inventories in each tank waste and farm EU.

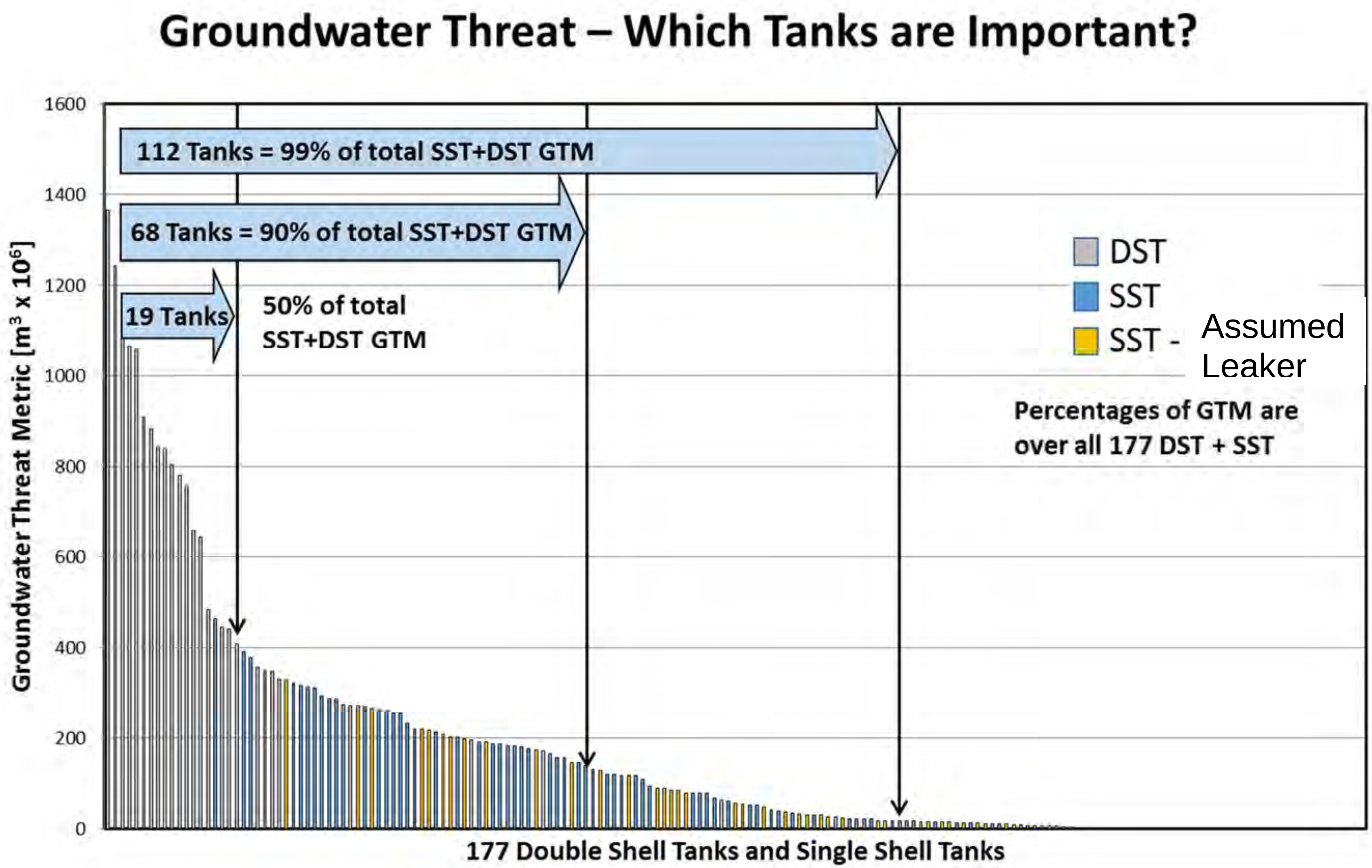

Figure 3-28. Groundwater threat: Which tanks are important? Comparison of GTM within DSTs and SSTs by tank.

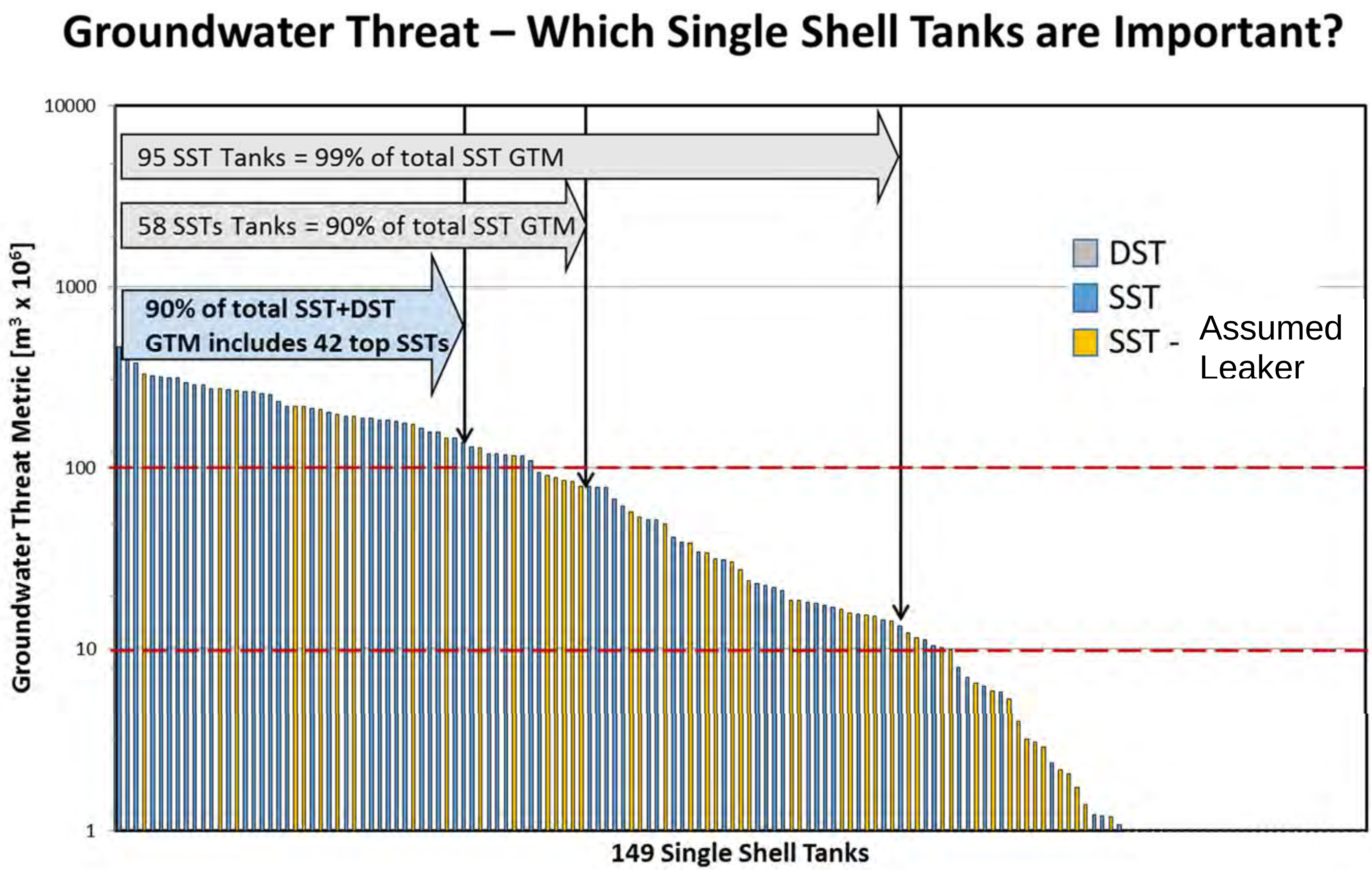

Figure 3-29. Groundwater threat: Which single-shell tanks are important? Comparison of GTM within SSTs by tank.

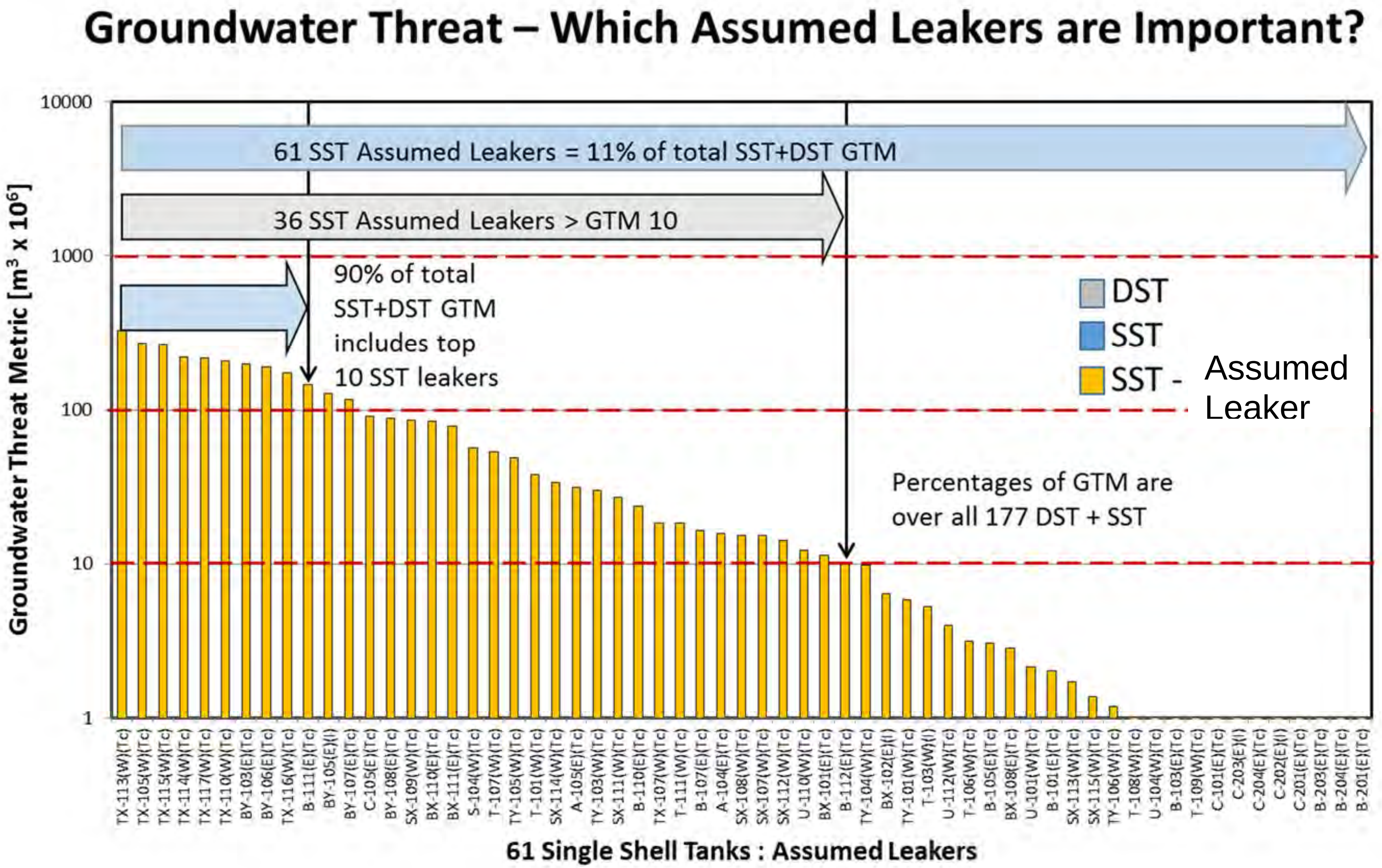

Figure 3-30. Groundwater threat: Which assumed leakers are important? Comparison of GTM for SST assumed leakers by tank.

THREATS TO THE COLUMBIA RIVER

200 West Tank Farm EUs

Current impacts from the tank farm EUs to the benthic, riparian, and free-flowing ecology associated with the Columbia River are rated as *Not Discernible* (ND) for the 200 West tank waste and farms EUs. The groundwater plumes in the 200 West Area (CP-GW-2) resulting from releases related to the 200 West tank farm EUs are managed using the 200-UP-1 and 200-ZP-1 CERCLA groundwater OUs (DOE/RL-2014-32, Rev. 0). The ND rating is based on the information in the 2013 Hanford Annual Groundwater Report (DOE/RL-2014-32, Rev. 0) and PHOENIX (http://phoenix.pnnl.gov/), which indicates that even though contaminants associated with the 200 West tank farm EUs (including Tc-99, I-129, and chromium) are in the saturated zone (as reflected in the 200-ZP-1 and 200-UP-1 OUs), no plumes from the these OUs (and thus the 200 West tank farm EUs) are currently intersecting the Columbia River at concentrations exceeding the WQS.

Because the 200 West tank farm EU plumes originate from 200 West (CP-GW-2 EU), it is unlikely that a plume would reach the Columbia River in the next 150 years (see Figure 3-31) at a concentration that exceeds thresholds since the *water* travel time is greater than 50 years (and likely significantly more) from 200 West to 200 East and approximately 10 to 30 years from 200 East to the Columbia River (Gephart 2003; PNNL-6415 Rev. 18). It is likely that significantly more time would be required to reach the river in sufficient quantity to exceed the WQS or appropriate aquatic screening values.[63]

An ecological screening analysis was performed in the TC&WM EIS (DOE/EIS-0391 2012, Appendix P) to evaluate potential long-term impacts of radioactive and chemical contaminants (*from sources in addition to those in the 200-West Tank Farm EUs under a No Action Alternative*[64]) discharged with groundwater on aquatic and riparian receptors at the Columbia River. The screening results 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-STD-1153-2002) (DOE/EIS-0391 2012, Appendix P, p. P-52), indicating adverse effects from radionuclides should not be expected, which would lead to an *ND* rating for radionuclides for benthic, riparian, and free-flowing receptors (for Current, Active Cleanup, and Near-term, Post Cleanup periods). Compared with the DOE technical standard, recent European Union work has estimated a no observed adverse effects level (NOAEL) at 0.024 rad/d (10 µGy/h) (Anderson et al. 2009) and a LOAEL at 0.24 rad/d (100 µGy/h) (Real et al. 2004) for nonhuman biota.[65]

The screening ecological evaluation in the TC&WM EIS (Appendix P, DOE/EIS-0391 2012) for potential impacts of chemical contaminants discharged with groundwater to the near-river ecology (benthic and riparian) indicates that chromium and nitrate would have predicted hazard quotients exceeding one for aquatic and riparian receptors over the EIS evaluation period (10,000 years). Furthermore, the results of the screening evaluation at the near-shore region under the No Action Alternative (DOE/EIS-0391 2012, Appendix O) that were used to support the screening ecological evaluation indicate that the nitrate peak

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[63] Based on current and expected subsurface conditions, the only path currently considered from 200 West to the Columbia River is that from 200 West to 200 East to the Columbia River (Chapter 6, methodology report).

[64] The results were not provided for specific tank farms so the aggregated screening analysis in the TC&WM EIS (DOE/EIS-0391 2012) was used as an indicator of contaminant travel from the Central Plateau to the Columbia River for the purposes of this Review.

[65] For aquatic biota, the maximum Hazard Index (HI), which is the sum the external and internal radiation doses from exposure to all radioactive COPCs divided by the toxicity reference value (TRV) or 1 rad-per-day, is 2.81×10^{-4} (DOE/EIS-0391 2012, Appendix P, p. P-49) or a total dose of 2.81×10^{-4} rad/d, which is significantly less than the European Union NOAEL of 0.024 rad/d.

concentration (and discharge) occurred in the past and that future concentrations are anticipated not exceed either the drinking water standard or AWQC in the future. Furthermore, the potential impact of increased nitrate levels may depend on other factors (e.g., phosphorus) and are highly uncertain.

The EIS results of the screening evaluation at the near-shore region under the No Action Alternative (DOE/EIS-0391 2012, Appendix O) indicate that the chromium concentration was predicted to exceed the drinking water standard for total chromium (100 µg/L) and the EIS benchmark threshold (as well as the AWQC of 10 µg/L) for hexavalent chromium within the next decade.[66] However, the predicted concentrations are likely overestimated since all discharge is assumed to occur in a 40-m near-shore region. Furthermore, well measurements indicate that chromium movement towards the Columbia River is significantly slower than that predicted in the TC&WM EIS, and that the plume would be unlikely to reach the river in either the Active Cleanup or Near-term, Post Cleanup periods. Because of the long travel times expected from 200-West, the ratings for all evaluation periods is ND.

As described in Chapter 6 of the methodology report (CRESP 2015), the large dilution effect of the Columbia River on the contamination from the seeps and groundwater upwellings results in long-term ratings of *ND* for the free-flowing ecology.

Finally, the No Action Alternative evaluation in the TC&WM EIS (DOE/EIS-0391 2012) suggests that remedial actions (e.g., surface barrier emplacement that would decrease recharge near the tank farms) do not significantly affect the long-term peak concentrations in the near-shore area (benthic and riparian receptors) of the Columbia River. This is not due to an ineffective barrier but instead likely due to large amounts of contaminants already in the subsurface and possible impacts from sources outside the 200-West Tank Waste and Farms EUs. Thus, the ratings are not changed based on the remedial actions (landfill closure or surface barrier emplacement) assumed in the TC&WM EIS.

[66] The benchmark value used for chromium (hexavalent) in the TC&WM EIS was the sensitive-species-test-effect concentration, defined as the concentration that affects 20% of a test population (EC_{20}), despite the fact that the less toxic trivalent form of chromium is more like to be present in oxygenated, aquatic environs (DOE/EIS-0391 2012, Appendix P, pp. P-52 to P-53).

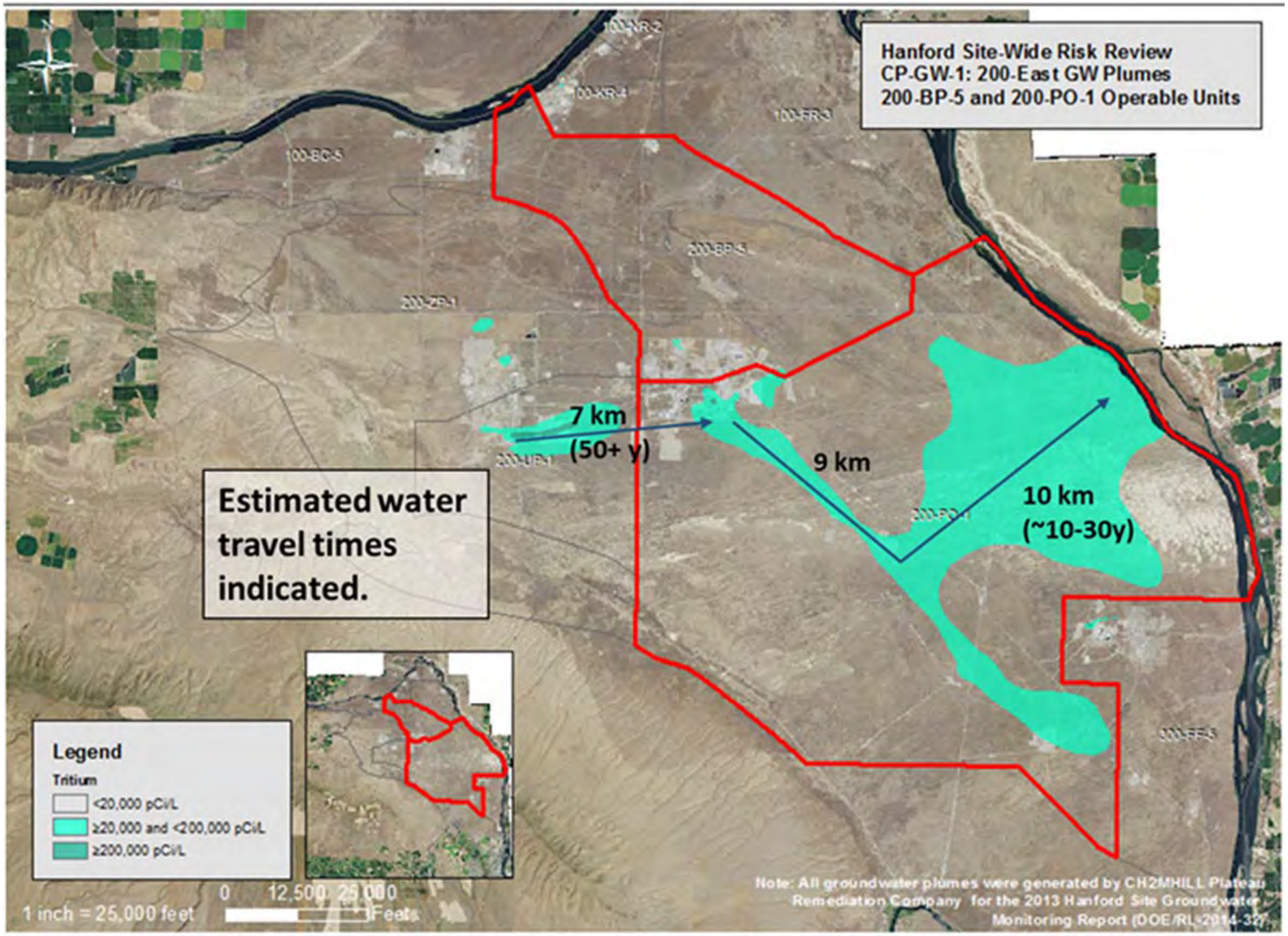

Figure 3-31. Estimating pathways and travel times of groundwater from the 200 Areas to the Columbia River based on past tritium plume movement.

200 East Area Tank Farm EUs

The groundwater plumes in the 200 East Area (CP-GW-1) resulting from releases related to the 200 East tank farm EUs are managed using the 200-BP-5 and 200-PO-1 CERCLA groundwater OUs (DOE/RL-2014-32, Rev. 0). Only the tritium (H-3) plume from the 200-PO-1 OU currently intersects the Columbia River at concentrations exceeding the appropriate WQS; however, this plume is from past PUREX-related operations and is not related to 200 East Tank Farm EUs. The Risk Review Project rating for tritium for all evaluation periods is *ND*.

Because current 200-PO-1 OU plumes originate from 200 East, it is possible that a current plume might reach the Columbia River in the next 150 years since the *water* travel time is relatively fast (approximately 10 to 30 yr) from 200 East to the Columbia River (Gephart 2003; PNNL-6415 Rev. 18). In addition, a plume has reached the Columbia River from 200 East. Following the framework process (Figure 2-11), the ratio, R1, of the predicted peak concentration (Table O-8, Appendix O, DOE/EIS-0391 2012, p. O-59) to the BCG for each radioactive contaminant associated with the 200-East Tank Farm EUs with a current plume (including I-129 and Tc-99) is far less than 1, again indicating low risk. These results agree with those from the TC&WM EIS ecological screening evaluation (Appendix P, DOE/EIS-0391 2012). For 200-East Tank Farm EU chemical contaminants with existing plumes (nitrate and TCE), the predicted peak concentration (Table O-8, Appendix O, DOE/EIS-0391 2012, p. O-59) is less than the standard indicating no adverse risk and an ND rating.

The alternatives (No Action versus Landfill Closure) evaluation in the TC&WM EIS (DOE/EIS-0391 2012, Appendix O) suggests that planned remedial actions (namely surface barrier emplacement that would decrease recharge in the areas near the tank farms) would have little moderating impact on nearshore contaminant concentrations. This is likely due to the large amounts of contaminants already in the subsurface from the 200-East and other sources considered and not due to an ineffective barrier. Thus, the ratings would not be modified based on projected changes in recharge.

Results of the Threat Evaluation to the Benthic Zone and Riparian Zone Ecology

An ecological screening analysis was performed in the TC&WM EIS (DOE/EIS-0391 2012, Appendix P) to evaluate potential long-term impacts of radioactive and chemical contaminants (*from all sources under a No Action Alternative*) discharged with groundwater on aquatic and riparian receptors located in the near-shore region of the Columbia River. The screening results 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-STD-1153-2002 (DOE/EIS-0391 2012, Appendix P, p. P-52), indicating there should be no expected adverse effects from radionuclides. The Risk Review Project ratings for radionuclides during the active cleanup and near-term post-cleanup evaluation periods are thus *ND*. This rating is consistent with the indication of no adverse impacts from radionuclides for both benthic and riparian receptors made under the TC&WM EIS evaluation period, which was a 10,000-year period (DOE/EIS-0391 2012).

The screening evaluation in the TC&WM EIS (DOE/EIS-0391 2012) of potential impacts of chemical contaminants discharged with groundwater to the near-river ecology (benthic and riparian) indicates that nitrate would have expected hazard quotients exceeding 1 (implying moderate risk) for aquatic and riparian receptors over the 10,000-year evaluation period in the TC&WM EIS. However, the nitrate peak concentration (and discharge) occurred in the past and that future concentrations would not exceed either the drinking water standard or AWQC in the future. Furthermore, the potential impact of increased nitrate levels may depend on other factors (e.g., phosphorus) and be highly uncertain. Thus an ND rating is ascribed to nitrate for the Current, Active Cleanup, and Near-term, Post-Cleanup periods.

The EIS results of the screening evaluation at the near-shore region under the No Action Alternative (DOE/EIS-0391 2012, Appendix O) indicate that, although not a current plume from the 200 East Area, the chromium concentration is predicted to exceed thresholds for chromium (48 or 100 µg/L) and the EIS benchmark threshold[67] (as well as the AWQC of 10 µg/L) for hexavalent chromium. The predicted concentrations are likely overestimated since all discharge is assumed to occur within a 40 m, near-shore region. Using the framework outlined in Chapter 6 of the methodology report (CRESP 2015), the peak predicted concentrations would correspond to ratings of *Medium* and *High* for the benthic and riparian ecology, respectively, for the active cleanup and near-term post-cleanup evaluation periods. However, well data suggest that the chromium is moving much slower than predicted in the TC&WM EIS, and it is unlikely that a chromium plume would reach the Columbia River from the 200-East Tank Farm EU sources in the next 50 or 150 years. Thus a rating of ND is ascribed for the benthic and riparian zones for the Current and Active Cleanup periods, and a corresponding rating of Low is ascribed for the Near-term, Post-Cleanup period.

The TC&WM EIS Alternative 2B (*Tank Closure Alternative 2B: Expanded WTP Vitrification; Landfill Closure*) (DOE/EIS-0391 2012) gives an idea of the impact on chromium in the near-shore region if surface barriers are emplaced (i.e., landfill closure). The maximum predicted chromium concentration (over the 10,000-year EIS evaluation period) for the landfill closure alternatives is 228 µg /L (DOE/EIS-0391 2012, Appendix O, p. O-67 for cribs and trenches) versus a value of 232 µg/L for the No Action Alternative. Thus, the rating would not change based on surface barrier installation and changes in recharge rates. This is likely because there is already significant contamination in the groundwater as well as possible impacts from sources outside the 200-East Tank and Waste Farm EUs that were considered in the screening analysis.

Threats to the Columbia River Free-flowing Ecology

The threat determination approach for evaluating the free-flowing river ecology is similar to that described above for benthic receptors (Chapter 6 of the methodology report (CRESP 2015)). However, because the Columbia River has a large dilution effect on contamination from the seeps and groundwater upwellings,[68] the differences from EU to EU are not distinguishable and groundwater contaminant discharges from Hanford Site have a very remote potential to achieve surface water concentrations above relevant water quality standard thresholds.[69]

RISK RATINGS

Table 3-14 summarizes the Risk Review Project ratings for the tank waste and farms EUs. Additional supporting information is provided in Appendix E.1 through Appendix E.10.

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[67] The benchmark value used for chromium (hexavalent) in the TC&WM EIS was the sensitive-species-test-effect concentration that affects 20% of a test population (EC_{20}), even though the less-toxic trivalent form of chromium is more likely to be present in oxygenated, aquatic environs (DOE/EIS-0391 2012, Appendix P, pp. P-52 to P-53).

[68] Groundwater is a potential pathway for contaminants to enter the Columbia River. Groundwater flows into the river from springs above the water line and through areas of upwelling in the riverbed. Hydrologists estimate that groundwater currently flows from the Hanford unconfined aquifer to the Columbia River at a rate of ~ 0.000012 cubic meters per second (Section 4.1 of PNNL-13674). For comparison, the average flow of the Columbia River is ~3400 cubic meters per second (DOE/RL-2014-32, Rev. 0). This represents a dilution effect of more than eight orders of magnitude (a dilution factor of greater than 100 million).

[69] Bioaccumulation and biomagnification of some contaminants in aquatic biota may be possible; however, these effects typically are considered in the development of surface water quality standards, and insufficient information exists at the Hanford Site to consider these effects in the screening process for the Risk Review Project.

Risks and Potential Impacts during the Active Cleanup Period

Groundwater: The ratings for potential impacts or threats to groundwater as a protected resource are described in the appropriate section for each tank farm EU and summarized in

Table 3-15. The Overall High ratings for most 200 West and 200 East Tank and Waste Farms EUs are typically driven by chromium (total and hexavalent) with the exceptions of the A-AX tank farm EU (200-East) where uranium drives risk, the C Tank Farm EU (200-East) where I-129 has a Medium rating, and the U tank farm EU (200-West) that has an overall *Low* rating. The TX-TY tank farm EU (200-West) also includes carbon tetrachloride and Tc-99, and the B-BX-BY Tank Farm EU (200-East) includes Tc-99 and I-129.

Columbia River: The ratings for potential impacts or threats to the Columbia River are described in the appropriate section for each tank farm EU and summarized Table 3-16. The ratings for radionuclides are all *ND*. The Overall Low ratings (benthic and riparian zone) for the 200 East Tank Farm EUs in the Near-Term, Post-Cleanup evaluation period are related to total and hexavalent chromium from Central Plateau sources, including sources other than those for the specific tank farm EUs.

Near-Term Post-Cleanup Risks and Potential Impacts

The EIS preferred HLW tank closure alternative includes 99% retrieval of waste from the SSTs for staging in DSTs and treatment elsewhere onsite, operations and necessary maintenance, waste transfers and associated operations, and upgrades to existing tanks or construction of waste receipt facilities (DOE/EIS-0391 2012, Chapter 2, p. 2-321). SST closure operations include filling the tanks and ancillary equipment with grout to immobilize residual waste contaminants. Disposal of contaminated equipment and soil would occur on site. Decisions on the extent of soil removal and/or treatment are planned to be made on a tank farm or WMA basis through the RCRA closure permitting process. The tanks would be stabilized with grout, and an engineered modified RCRA Subtitle C barrier put in place followed by post-closure care.

Thus, workers and the public would be isolated from the residual contamination in the tanks by the tank structure, grout and soil cover. Tank waste contamination already in the vadose and saturated zones would experience reduced infiltrating water (the primary driver for the release and transport of contaminants) because of the surface barrier.

Continued monitoring could disturb the ecological resources in the T tank farm EU and buffer lands. Remediation may improve habitat through revegetation (and increased monitoring may increase exotic species and change species composition).

Indirect effects to a historic trail may be permanent (cultural resources). Capping could cause permanent indirect effects to the viewshed of a traditional cultural place due to presence of contamination.

Risk Review Rating Symbols: Risk review ratings for each receptor are tabulated in summary tables using a combination of text summaries and symbolism. Specific symbology was developed for the Risk Review Project and is defined on page xxviii and repeated here for convenience. Symbols used in the rating tables indicate the highest rating when a rating range is present, although the accompanying text indicates the risk rating range, where applicable, to reflect uncertainty. Symbols within each entry in rating tables are a combination of a risk rating symbol and additional symbols used to indicate 1) the presence of engineered barriers to prevent release to the environment or further dispersion of radionuclides and chemicals, 2) when treatment, waste retrieval or remediation is in progress, and 3) if interim stabilization has occurred (only for single-shell tanks). Examples of resulting combined symbols are on page xxix.

Symbol	**Meaning**
○	ND Rating
◔	Low Rating
◑	Medium Rating
◕	High Rating
●	Very High Rating
	Barrier Symbols
◯	One engineered barrier, Intact (barriers include tanks, covers, liners, buildings, etc.)
◌	One engineered barrier, barrier compromised (e.g., leaking tank)
◎	Two engineered barriers, both barriers intact
	Two engineered barriers, inner barrier compromised and outer barrier intact
	Two engineered barriers, inner barrier intact and outer barrier compromised
	Two engineered barriers, both barriers compromised.
	Treatment, Remediation and Waste Treatment Symbols
[ ]	Treatment, remediation or waste retrieval in progress
ǂ	Interim stabilized (single shell tank, stabilization through removal of pumpable liquid)

Table 3-14. Impact rating summary for human health (unmitigated basis with mitigated basis provided in parentheses (e.g., "High (Low)").

		Evaluation Period	
		Active Cleanup (to 2064)	
Population or Resource		**Current Condition:** Maintenance & Monitoring (M&M)	**From Cleanup Actions:** Retrieval & Closure
Human Health	Facility Worker	***M&M***: Low-High[a] (Low-High)[a] ***Soil***: ND-High (ND-Low)	***Preferred method***: High (Low) ***Alternative***: High (Low)
	Co-located Person	***M&M***: Low-Medium (Low) ***Soil***: ND (ND)	***Preferred method***: Low-Medium (Low) ***Alternative***: Low-Medium (Low)
	Public	***M&M***: Low (Low) ***Soil***: ND (ND)	***Preferred method***: Low (Low) ***Alternative***: Low (Low)
Environmental	Groundwater	SST Farm EUs[c] 200 W Overall: Low to High 200 E Overall: Medium to High DST Farm EUs[c] Not Discernible	SST Farm EUs[c] 200 W Overall: Low to High 200 E Overall: Medium to High DST Farm EUs[c] Not Discernible
	Columbia River	DST & 200 W SST Tank Farm EUs[d] **Overall**: Not Discernible 200 East SST Farm EUs[d] **Overall**: Not Discernible	DST & 200 W SST Tank Farm EUs[d] **Overall**: Not Discernible 200 East SST Farm EUs[d] **Overall**: Not Discernible
	Ecological Resources[b]	Refer to specific tank farm EU	Refer to specific tank farm EU
Social	Cultural Resources[b]	Refer to specific tank farm EU	Refer to specific tank farm EU

a. ***Industrial safety*** consequences range from Low to High (based on the evaluation scale used) for both mitigated (with controls) and unmitigated (without controls). ***Radiological and toxicological*** consequences to facility workers are High (unmitigated) and Low (mitigated).
b. 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.
c. Refer to

Table 3-15 for details. The Overall High ratings for the 200 West SST farm EUs are driven by chromium (total and hexavalent) for most EUs with the TX-TY tank farm EU also including carbon tetrachloride and Tc-99. The U tank farm EU has a Low rating. The Overall Medium and High ratings for the 200 East SST farms result from I-129 (C), total and hexavalent chromium (A-AX), and I-129, Tc-99, and total and hexavalent chromium (B-BX-BY). The large amounts of Sr-90 would translate to High or

Population or Resource	Evaluation Period Active Cleanup (to 2064) **Current Condition:** Maintenance & Monitoring (M&M)	 **From Cleanup Actions:** Retrieval & Closure

Very High in many of these EUs; however, the relative immobility of Sr-90 in the Hanford subsurface results in *Low* ratings. This is also true for uranium for the A-AX Tank Farm EU.

d. Refer to Table 3-16 for details. The ratings with respect to radionuclides and chemicals are all *ND* consisted with the results of the TC&WM EIS screening analysis.

Table 3-15. Summary of groundwater threat ratings for current vadose zone contaminant inventories in the Hanford tank farm evaluation units.[a]

EU Name	EU	Risk Driver	Current	Risk Driver	Active Cleanup	Risk Driver	Near-Term Post-Cleanup
T Tank Farm	CP-TF-1	Cr[a]	High	Cr[a]	High	Cr[a]	High
S-SX Tank Farms	CP-TF-2	Cr[a]	High	Cr[a]	High	Cr[a]	High
TX-TY Tank Farms	CP-TF-3	Tc-99, CCl4, Cr[a]	High	Tc-99, CCl4, Cr[a]	High	Tc-99, CCl4, Cr[a]	High
U Tank Farm	CP-TF-4	Various[b]	Low	Various[b]	Low	Various[b]	Low
A-AX Tank Farms	CP-TF-5	Cr[a]	Medium	Cr[a]	Medium	Cr[a]	Medium
B-BX-BY Tank Farms	CP-TF-6	I-129, Tc-99, Cr[a]	High	I-129, Tc-99, Cr[a]	High	I-129, Tc-99, Cr[a]	High
C Tank Farms	CP-TF-7	I-129	Medium	I-129	Medium	I-129	Medium
200 East (DSTs)	CP-TF-8	Various[b]	Low		Low		Low
200 West (DSTs)	CP-TF-9		ND		ND		ND

a. Cr represents both total and hexavalent chromium
b. The various non-zero inventory PCs are C-14, I-129, Sr-90, Tc-99, Cr[a], U-Total

Table 3-16. Summary of Columbia River threat ratings for contaminants currently in the vadose zone at the Hanford tank farm evaluation units.

	EU Name	EU	Current	Active Cleanup	Near-Term Post-Cleanup
200 W	T, S-SX, TX-TY, and U Tank Farms	CP-TF-1 CP-TF-2 CP-TF-3 CP-TF-4	Benthic – ND (all)	Benthic – ND (all)	Benthic – ND (all)
			Riparian – ND (all)	Riparian – ND (all)	Riparian – ND (all)
			Overall: ND	Overall: ND	Overall: ND
200 E	A-AX, B-BX-BY, and C Tank Farms	CP-TF-5 CP-TF-6 CP-TF-7	Benthic –	Benthic –	Benthic –
			ND (radionuclides)	ND (radionuclides)	ND (radionuclides)
			ND (chemicals)	ND (chemicals)	Low (chemicals[a])
			Riparian –	Riparian –	Riparian –
			ND (radionuclides)	ND (radionuclides)	ND (radionuclides)
			ND (chemicals)	ND (chemicals)	Low (chemicals[a])
			Overall: ND	Overall: ND	Overall: Low
200 East (DSTs)		CP-TF-8	Benthic – ND (all)	Benthic – ND (all)	Benthic – ND (all)
			Riparian – ND (all)	Riparian – ND (all)	Riparian – ND (all)
			Overall: ND	Overall: ND	Overall: ND
200 West (DSTs)		CP-TF-9	Benthic – ND (all)	Benthic – ND (all)	Benthic – ND (all)
			Riparian – ND (all)	Riparian – ND (all)	Riparian – ND (all)
			Overall: ND	Overall: ND	Overall: ND

a. The threat to the Columbia River related to chemicals is driven by hexavalent chromium in the vadose zone (where none is measured in groundwater above thresholds). Also, chromium is from Central Plateau sources in addition to those for the specific tank farm EU.

IMPLICATIONS FOR SEQUENCING TANK WASTE PROCESSING

Taken together, the information above suggests the following:

- Hydrogen gas generation[70] poses a threat to nuclear safety and human health through loss of safety systems from a major external event.
- Tc-99 and I-129, both being persistent and highly mobile in the subsurface, pose threats to groundwater through leakage from tanks.
- As a first-order analysis, groundwater threats can be substantially reduced by removing water soluble constituents (Tc-99 and I-129) from a selected set of tanks.[71] Similarly, nuclear safety threats also can be reduced for several tanks by removing water soluble Cs-137. This is consistent with the priority given by the Tri-Party agencies to treat LAW at WTP as early as possible if Cs-137, Tc-99, and I-129 separated from the waste are not returned to the tanks. However, the risk to groundwater profile will neither be reduced significantly nor increased if Tc-99 and I-129 are returned to the tanks during LAWPS treatment. The nuclear safety risk profile will be reduced if separated Cs-137 is not returned to the tanks or to tanks with low HGR, and may remain the same or be increased or reduced depending on the time to hydrogen flammability thresholds for the tank(s) accepting returned Cs-137.
- The sequencing of SST retrieval should focus on assumed leakers with significant GTM, and if it is assumed that retrievals are to be staged by tank farm, the initial focus should be on the BY tank farm in 200 East and the TX tank farm in 200 West.
- Processing LAW from the 200 East DSTs would substantially reduce the overall GTM.
- If a target of 95 % reduction in GTM across all SSTs is selected and in-tank grouting of the residual waste inventory is completed, the threat of groundwater contamination from SSTs would be reduced to substantially less than the GTM from existing environmental contamination in the vadose zone in both the 200 West and 200 East Areas from leaks and legacy disposal activities near the SST farms. Waste retrievals that result in reduction by 90% of the GTM contained in the tanks collectively across all tanks within each tank farm EU would meet the criteria of tank end-states being less than the GTM in the vadose zone for all SST tank farms except for U and A-AX tank farms.
- If selective waste retrieval targets of 99% or the limits of multiple technologies are applied to the group of 26 DSTs and 42 SSTs that comprise 90% of the total GTM in all tanks, the result would be a residual GTM of 1% of the initial inventory. Waste retrieval targets of 90% of the GTM or the limits a single technology (if greater than 90% retrieval) would result in a residual GTM of less than an additional 1% of the current GTM, and with a cumulative result that is indistinguishable from a target of 99% across all tanks, considering the inventory uncertainties. Similarly selective retrieval targets can be used if the target reduction was 90% of the GTM across individual tank farms. Selective waste retrieval targets as discussed above may allow for

[70] Hydrogen generation rate is primarily related to Cs-137 and Sr-90 content of the waste.

[71] For hydrogen generation,200 East DSTs, and SSTs B-202, B-203, B-204, and T-201 have times to 25% of the LFL of less than 6 months under unventilated conditions; for groundwater threat, greater than 70% of the GTM is from 200 East DSTs, SY-101 and SY-103 (200 West DSTs) and SSTs AX-101, S-105, S-106, S-108, S-109, SX-106, TX-105,* TX-113,* TX-115,* U-109, U-105 (* indicates assumed SST leaker).

significant acceleration of tank waste retrievals and much more rapid reduction in groundwater threats from tank wastes than currently planned. Selective retrieval targets can be accomplished for individual tanks within each tank farm, allowing for different amounts of retrieval while completing waste retrievals at an entire tank farm. Further evaluation of this concept is warranted. A tank farm waste retrieval and processing system plan evaluation of this approach is suggested.

3.3. GROUNDWATER EVALUATION UNITS AND THE COLUMBIA RIVER

The process developed as a general framework for binning EUs using the evaluation metrics has been applied to the Risk Review Project groundwater EUs considering three distinct potential impacts: (1) groundwater as a protected resource, (2) groundwater as a pathway to impact the Columbia River, and (3) impact to groundwater from potential future sources (e.g., tank leaks) and current vadose zone contamination to groundwater and the Columbia River.

The focus on the evaluation metrics allows for differentiation of the potential groundwater-related risks from the EUs. This process is not concerned directly with highly uncertain point estimates of risks and impacts often used for other analyses (e.g., performance assessments or baseline risk assessments). The uncertainties associated with the analyses related to EUs become more tractable when evaluation metrics are considered in relative, rather than absolute terms. A detailed description of the methodology used for rating risks to groundwater and the Columbia River is provided in the methodology report (CRESP 2015). Detailed results for each groundwater EU are provided in Appendices G.1 through G.6.

The evaluation metrics for risks to groundwater *as a protected resource* from current groundwater plumes and near surface or vadose zone sources are:

1. The estimated time interval until groundwater would be *impacted* over the three evaluation periods by a primary contaminant if the specific contaminant source is not currently causing a groundwater plume. Groundwater is considered *impacted* when a primary contaminant concentration exceeds a threshold value (e.g., a drinking water standard or maximum contaminant level).
2. The estimated amount of groundwater (e.g., areal extent) currently *impacted* by the primary contaminants with existing plumes.
3. The *GTM*, defined as the volume of groundwater that could potentially be contaminated by the inventory of a primary contaminant from a source (be it groundwater plume, vadose zone contamination, tank, etc.) if it was found in the saturated zone at the WQS (e.g., drinking water standard) and in equilibrium with the soil. The GTM accounts only for (1) source inventory, (2) partitioning with the surrounding subsurface and (3) the WQS. The GTM reflects a snapshot in time (assuming no loss by decay/degradation or dispersion, etc.) and does not account for differences in mobility or bulk groundwater flow.

The selected evaluation metrics for risks to the Columbia River from near-surface, vadose zone, and groundwater contamination sources are:

1. The estimated time interval until the Columbia River is *impacted* over the three evaluation periods. The Columbia River is considered *impacted* when a primary contaminant concentration exceeds a benthic or free-flowing threshold value.

2. The ratio (R1) of the maximum primary contaminant concentration within the plume to the reference threshold screening value (e.g., BCG for radionuclides or AWQC for chemicals).
3. The ratio (R2) of the upper 95th percentile UCL on the log-mean plume concentration to the reference threshold screening value.
4. For benthic impacts, the length of river shoreline estimated to be impacted by the plume above a reference threshold.
5. For riparian zone impacts, the area of the riparian zone estimated to be impacted by the plume above a reference threshold.

The screening thresholds used in the Risk Review Project are provided in Table 3-17. The primary contaminant groups used in this Risk Review Project are described in Section 2.3 and Table 2-6, which categorizes them according to mobility and persistence in the Hanford Site environment. When considering groundwater as a protected resource, the drinking water standard is used as the screening threshold, except for Cr(VI), where a drinking water standard is not available, and a screening threshold of 48 µg/L is used. When considering impacts to the Columbia River, a combination of the AWQC and the BCG are used, whichever is value is more stringent and therefore more conservative. However, for total uranium, the natural background groundwater concentration of uranium at 12.9 µg/L is used, which is greater than the Tier II screening concentration value (SCV) reported.

Table 3-17. Thresholds considered in the Risk Review Project for the Group A and B primary contaminants. The primary thresholds used in the analysis are indicated in the red boxes.

PC	Grp	WQS[a]	DWS	DOE DCS[b]	BCG[c]	AWQC[d]/SCV[e]
Tc-99	A	900 pCi/L	900 pCi/L	44000 pCi/L	667000 pCi/L	---
I-129	A	1 pCi/L	1 pCi/L	330 pCi/L	38500 pCi/L	---
C-14	A	2000 pCi/L	2000 pCi/L	62000 pCi/L	609 pCi/L	---
Cr-VI	A	10-48 ug/L[f]	---	---	---	10 ug/L[f]
CCl_4	A	3.4 ug/L[g]	5 ug/L	---	---	9.8 ug/L
Sr-90	B	8 pCi/L	8 pCi/L	1100 pCi/L	279 pCi/L	7 ug/L (Sr)
U(tot)	B	30 ug/L	30 ug/L	750 pCi/L (U-238)	224 pCi/L (U-238)	12.9 ug/L[h]
Cr(tot)	B	48 ug/L[f]	100 ug/L[f]	---	---	55 ug/L
CN	B	200 ug/L	200 ug/L	---	---	5.2 ug/L
TCE	B	4[g]-5 ug/L	5 ug/L	---	---	47 ug/L

Human Health ⟷ Benthic/ Riparian

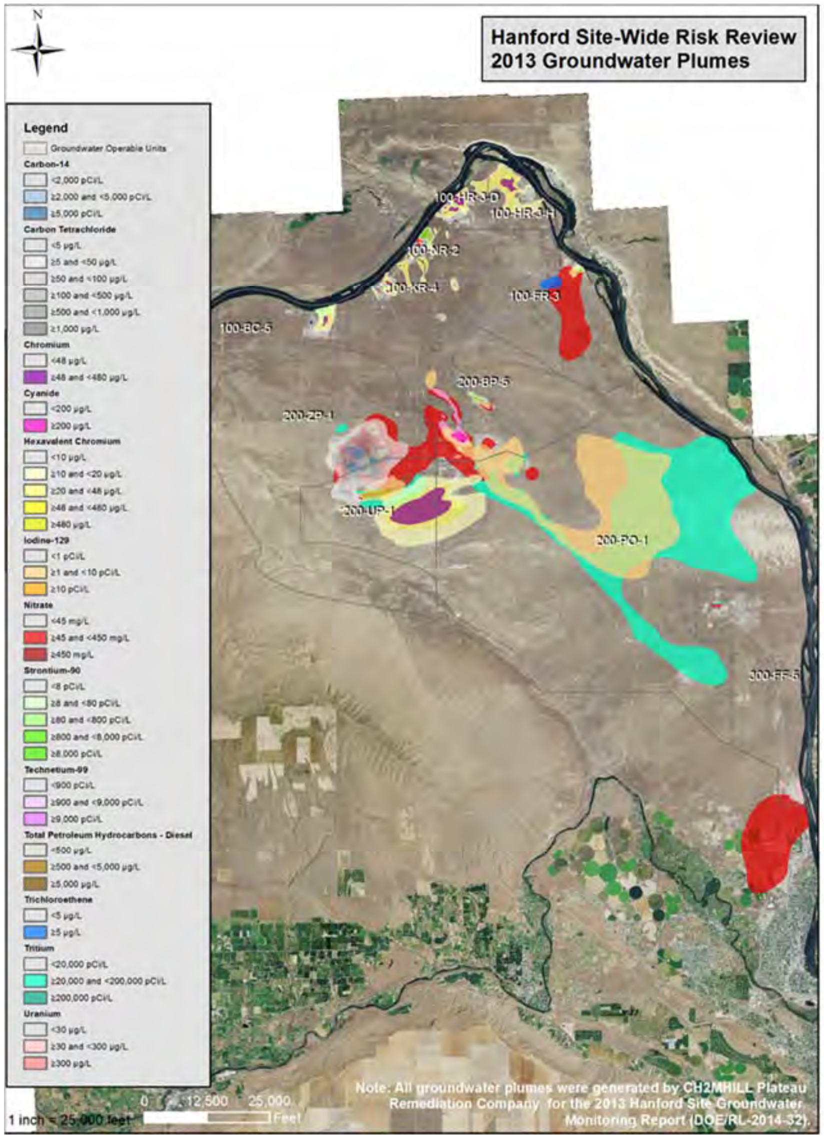
a. Water Quality Standard (WQS) from 2013 Annual GW Report (DOE/RL-2014-32, Rev. 0). Some values vary by Operable Unit.
b. DOE Derived Concentration Standard (Ingested Water DCS from Table 5 in DOE-STD-1196-2011).
c. Biota Concentration Guide (BCG) from RESRAD-BIOTA v1.5 (consistent with DOE Technical Standard DOE-STD-1153-2002).
d. Ambient Water Quality Criterion (AWQC) (Table 6-1 in DOE/RL-2010-117, Rev. 0).
e. Tier II Screening Concentration Value (SVC) (http://rais.ornl.gov/documents/tm96r2.pdf) when AQWC not provided.
f. Different values tabulated for different GW Operable Units. 10 ug/L is the surface water standard for Cr-VI. 20 ug/L is the groundwater cleanup target for Cr-VI identified for interim remedial action. 48 ug/L is the MTCA groundwater cleanup standard. 100 ug/L is the drinking water standard for total chromium.
g. Risk-based cleanup value from the record of decision as reported in the 2013 Annual GW Report (DOE/RL-2014-32, Rev. 0).
h. Uranium (total) screening values were 0.5 ug/L (DOE/RL-2007-21 2012) and 5 ug/L (DOE/RL-2010-117, Rev. 0, 2010). Background uranium levels of 0.5-12.8 µg/L were detected near the 300-F Area with a value of 12.9 µg/L selected (Peterson et al, 2008, p. 6.9). No effect levels span 3-900 µg/L reflecting considerable uncertainty (DOE/RL-2010-117, Rev. 0, 2010).

GROUNDWATER CONTAMINANT PLUMES ASSOCIATED WITH EACH EVALUATION UNIT

Figure 3-32 provides an overview of all primary groundwater contaminant plumes present within the Hanford Site, which are further grouped into three groundwater EUs along the River Corridor and two groundwater EUs in the Central Plateau.[72] Figure 3-33 focuses on the Central Plateau groundwater plumes and Figure 3-34 provides a simplified version of the Central Plateau groundwater plumes (excluding nitrate and tritium) in the 200 East Area (EU CP-GW-1) and 200 West Area (EU CP-GW-2) that includes only the Group A primary contaminants (high mobility and high persistence; Tc-99, I-129, C-14, Cr(VI) and carbon tetrachloride) and Group B primary contaminants (high mobility with medium persistence, i.e., cyanide, TCE, and PCE, and medium mobility with high or medium persistence, i.e., U(total), Cr(total), and Sr-90).

An overview of the River Corridor groundwater contaminant plumes is provided in Figure 3-35 through Figure 3-37. Figure 3-35 is enlarged to show the intersection of the existing groundwater plume with the riparian zone (magenta cross hatch area) and also provides the primary contaminant groupings, plume areas, and AWQS.

[72] 2013 groundwater monitoring data (DOE/RL-2014-32, Rev. 0. 2014) is used for evaluation as the most recent published data set available at the time of preparation of this report.



Hanford Plumes

River Corridor

EU: RC-GW-1 **OU:** 300-FF-5 (uranium)
EU: RC-GW-2 **OU:**100-NR-2 (strontium-90)
EU: RC-GW-3 **OUs:** 100-BC-5, 100-HR-3 (D/H), 100-FR-3, 100-KR-4 (chromium, strontium-90, others)

Central Plateau

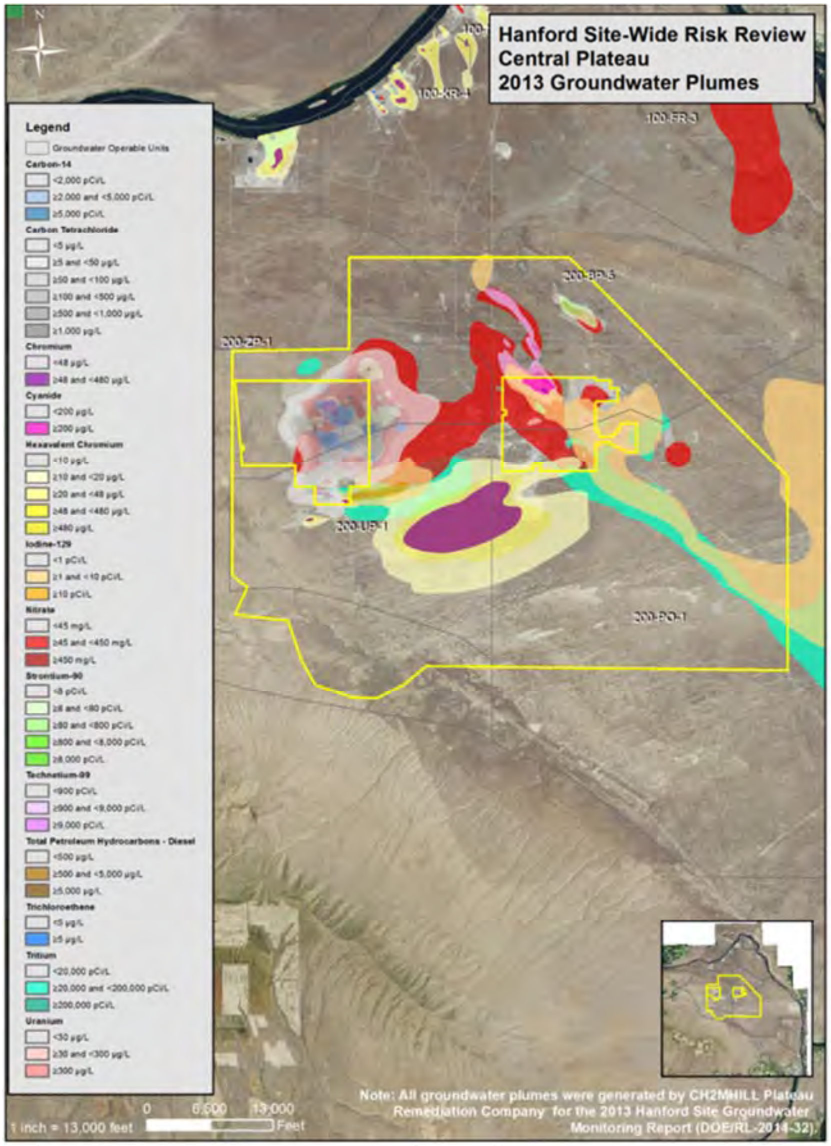
200 East Groundwater –

EU: CP-GW-1 **OUs:** 200-BP-5, 200-PO-1 (iodine-129, tritium)

200 West Groundwater –

EU: CP-GW-2 **OUs:** 200-UP-1, 200-ZP-1 (carbon tetrachloride, technetium-99)

Figure 3-32. Groundwater plumes at the Hanford Site based on 2013 groundwater monitoring data (DOE/RL-2014-32, Rev. 0. 2014) and listing of EU and corresponding regulatory operable unit designations.



EU: CP-GW-1 (200 East GW OUs)

PC	PC Grp	WQS	200-BP-1 Area (km²)	200-PO-1 Area (km²)
H-3	C	2E4 pCi/L	0.2	83.4
I-129	A	1 pCi/L	4.5	52.1
NO_3	C	45 mg/L	7.9	3.71
Tc-99	A	900 pCi/L	2.4	0.03
Sr-90	B	8 pCi/L	0.6	0.01
U (tot)	B	30 µg/L	0.5	0.02
CN	B	200 µg/L	0.4	---

EU: CP-GW-2 (200 West GW OUs)

PC	PC Grp	WQS	200-ZP-1 Area (km²)	200-UP-1 Area (km²)
CCl_4	A	3.4 µg/L	13.3	
NO_3	C	45 mg/L	9.77	5.80
H-3	C	2E4 pCi/L	0.08	5.50
Cr-VI	A	48 µg/L	0.22	3.85
I-129	A	1 pCi/L	0.10	3.10
TCE	B	5 µg/L	1.16	---
U (tot)	B	30 µg/L	---	0.34
Tc-99	A	900 pCi/L	0.07	0.29

Figure 3-33. Central Plateau groundwater plumes (200 E, 200 W, and Central Plateau indicated by yellow outlines), plume areas, primary contaminant (PC) groups, and applicable WQS based on 2013 monitoring data (DOE/RL-2014-32, Rev. 0. 2014).

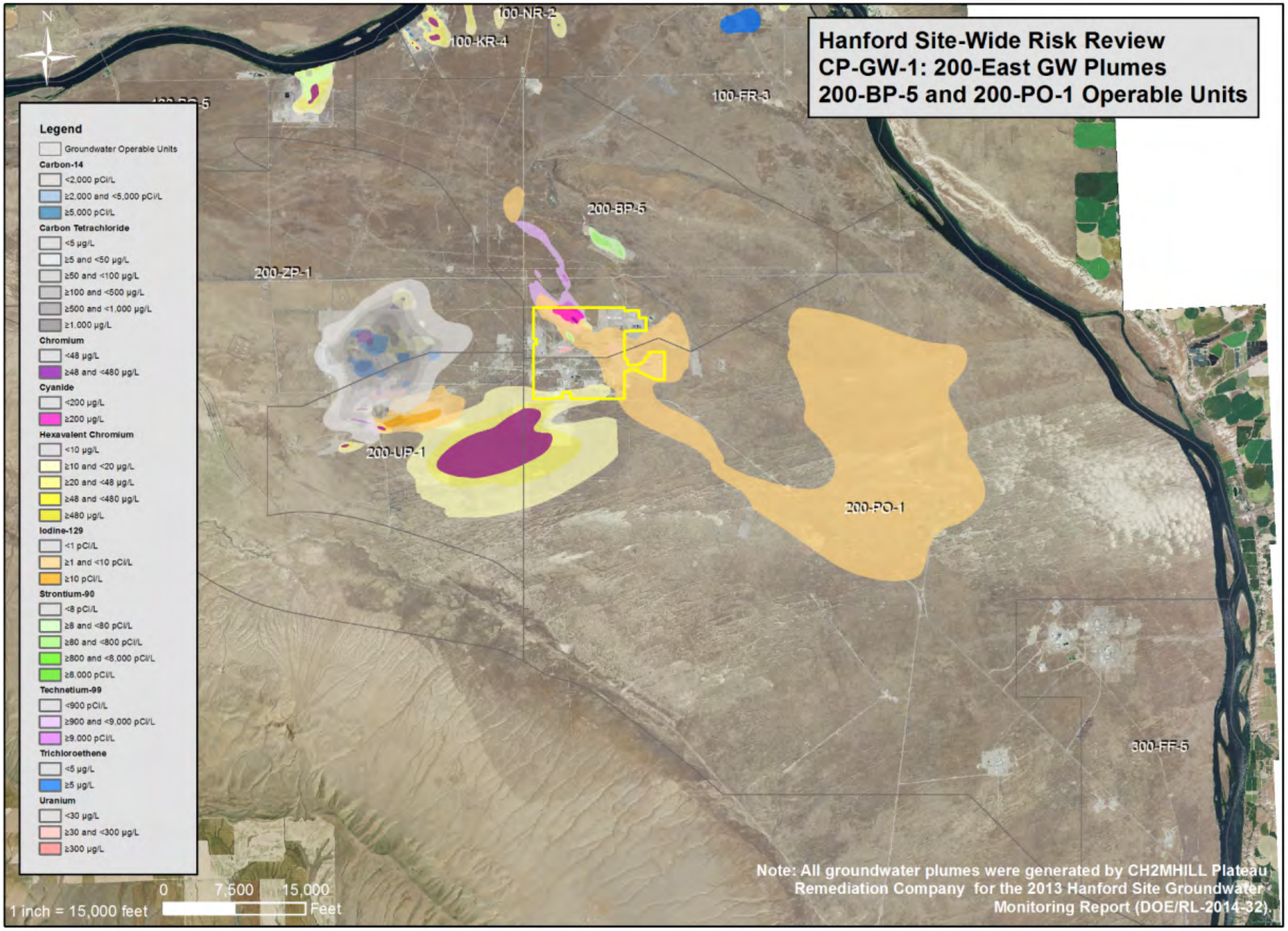
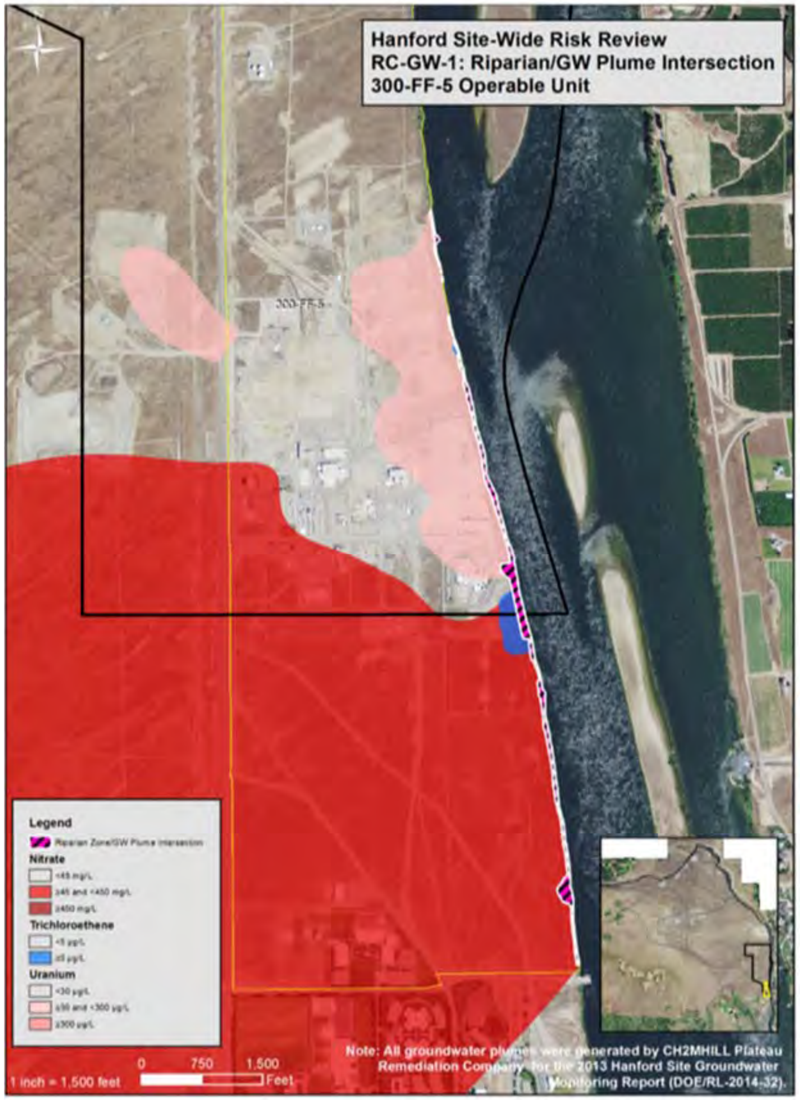


Figure 3-34. 200 East Area groundwater plumes (EU: CP-GW-1) and 200 West Area groundwater plumes (EU: CP-GW-2) based on 2013 groundwater monitoring data, excluding tritium and nitrate. 200 East Area is indicated by the yellow outline.



Columbia River Corridor Plumes

PC	Grp	WQS	RC-GW-1 300-FF-5 Area (km^2)	RC-GW-2 100-NR-2 Area (km^2)
Cr-VI	A	10 µg/L	0.22	0.73
Sr-90	B	8 pCi/L	---	0.61
U (tot)	B	30 µg/L	0.5	---
H-3	C	2E4 pCi/L	0.13	0.003
NO_3	C	45 mg/L	0.1	0.49

PC	Grp	WQS	RC-GW-3 100-BC-5 Area (km^2)	RC-GW-3 100-HR-3 Area (km^2)
Cr-VI	A	48 µg/L	1.6	7.3
Sr-90	B	8 pCi/L	0.6	0.03
NO_3	C	45 mg/L	---	0.06

PC	Grp	WQS	RC-GW-3 100-FR-3 Area (km^2)	RC-GW-3 100-KR-4 Area (km^2)
NO_3	C	45 mg/L	9.3	0.03
Cr-VI	A	48 µg/L	0.34	2.1
TCE	B	5 µg/L	0.81	0.01
Sr-90	B	8 pCi/L	0.16	0.05
C-14	A	2000 pCi/L	---	0.03
H-3	C	2E4 pCi/L	---	0.02

Figure 3-35. 300 Area groundwater plume map (EU: RC-GW-1) indicating intersection with the riparian zone along with Columbia River plume areas, PC groups, and applicable WQS (DOE/RL-2014-32, Rev. 0. 2014). Contaminant plumes in top left not shown to allow enlargement to indicate riparian zone.

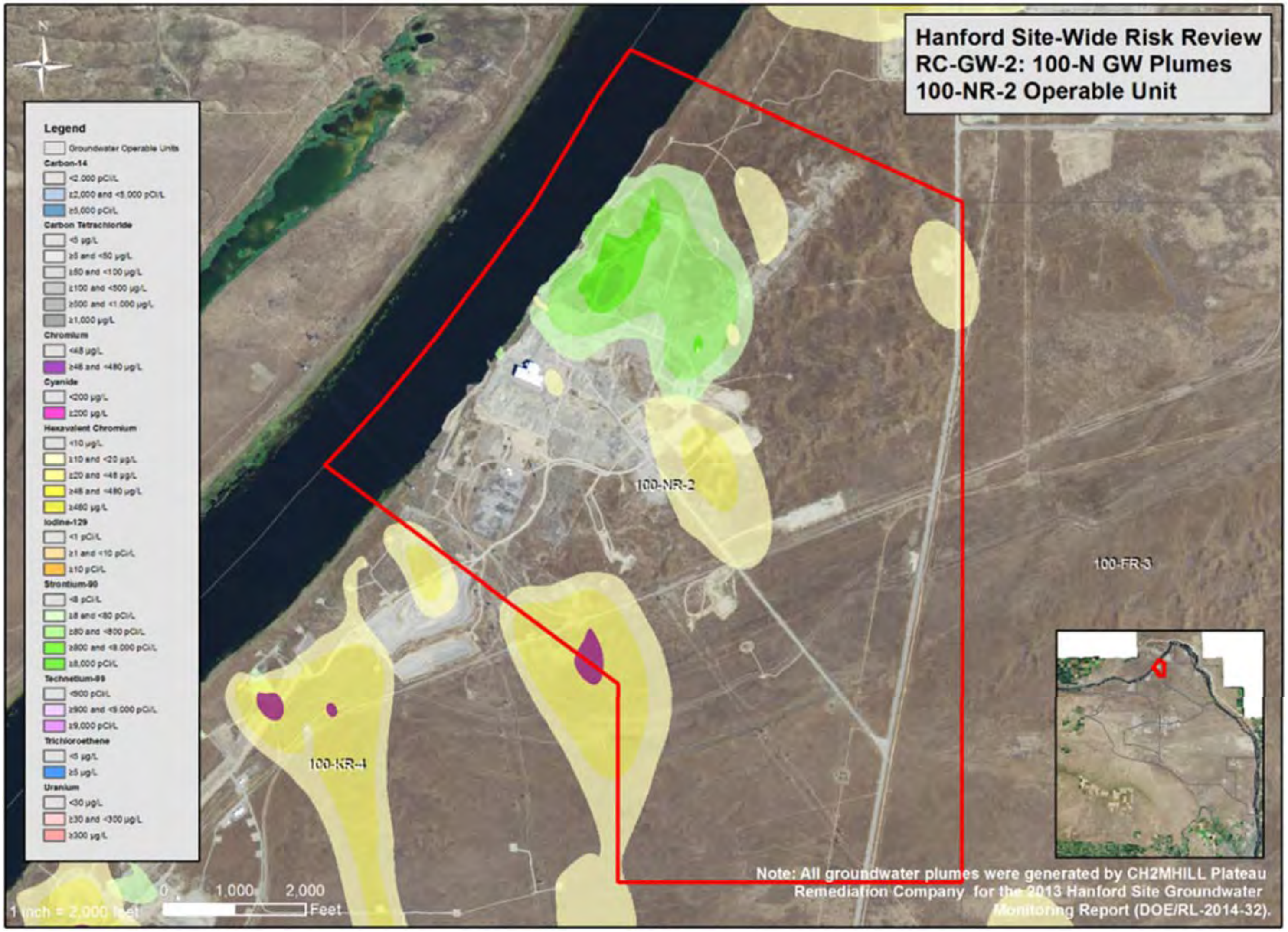


Figure 3-36. 100-N Area River Corridor groundwater plumes (EU: RC-GW-2, based on 2013 monitoring data; riparian zone not indicated).

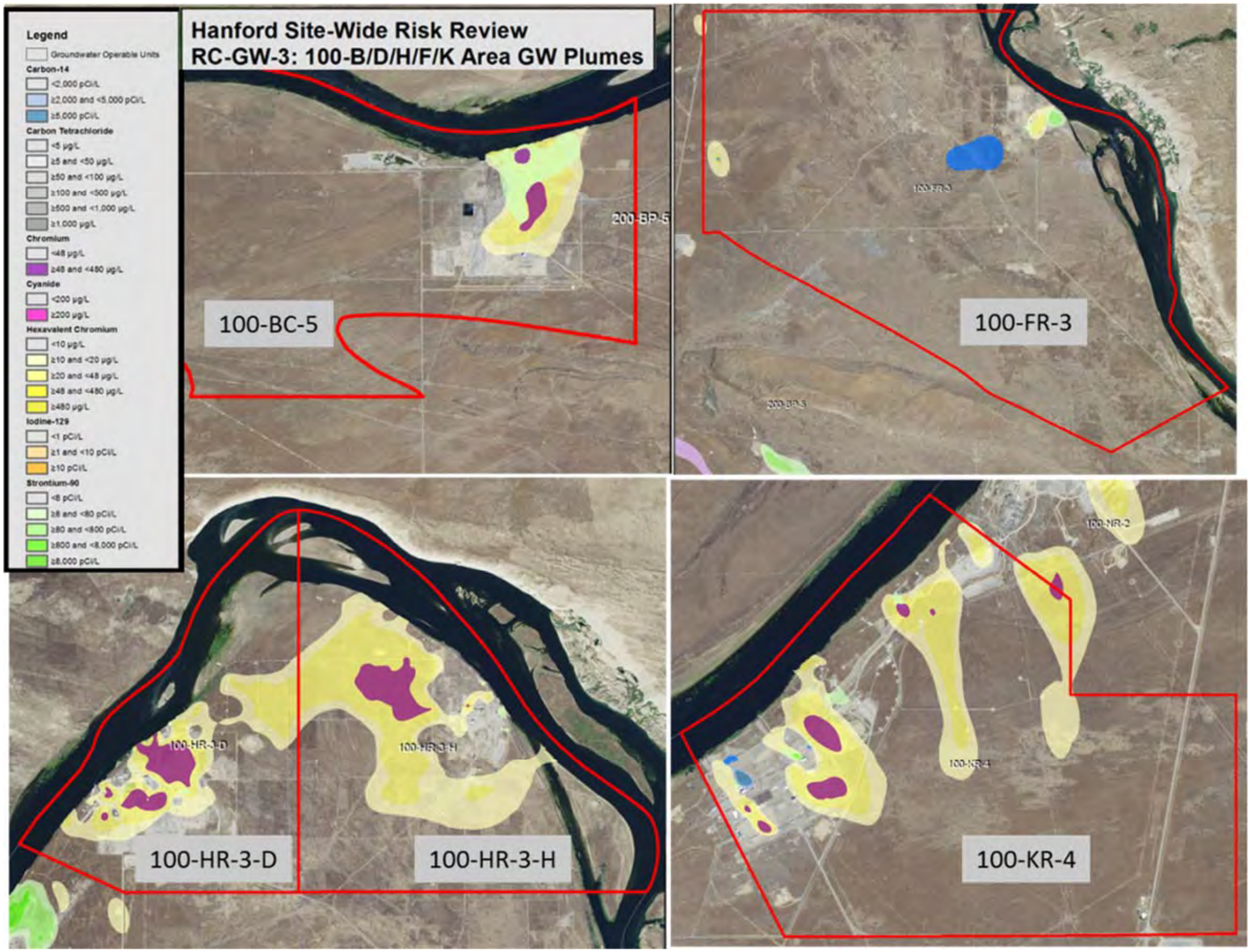


Figure 3-37. 100-B/D/H/F/K Area groundwater plumes (DOE/RL-2014-32, Rev. 0. 2014) (EU: RC-GW-3, based on 2013 monitoring data; riparian zone not indicated).

Threats to Groundwater as a Protected Resource

The scale used to rate threats to groundwater as a protected resource is focused on the amount of groundwater that is currently or could become contaminated above the screening threshold (see Table 3-17). Table 3-18 provides the rating scale used for Group A and Group B primary contaminants, which is based on the GTM. For Group C contaminants, the area of the groundwater plume above the screening threshold is used to rate each plume,[73] where Group C contaminant plume areas of less than 0.1 km^2 are rated as *Low* and plume areas of greater than 0.1 km^2 are rated as *Medium*.[74]

Table 3-18. Groundwater threat metric rating table for Group A and B primary contaminants.

GTM (millions of m^3)	Rating
GTM ≤ 10	Low
10 < GTM ≤ 100	Medium
100 < GTM ≤ 1,000	High
GTM > 1,000	Very High

Currently Contaminated Groundwater

Figure 3-38 compares the results of calculating the GTM for each Group A and Group B contaminant in the River Corridor and Central Plateau groundwater plumes. Contaminant plumes currently undergoing treatment are indicated with an asterisk.

When considering contaminant impacts to groundwater as a protected resource, all contaminant plumes along the River Corridor are rated as *Low*, except the strontium-90 plume in EU RC-GW-2 (OU 100-NR-2), which is rated as *Medium* and is undergoing treatment using an in situ reactive barrier. For groundwater contaminant plumes in the Central Plateau, the highest GTM value (rated *Very High*) is associated with carbon tetrachloride plume in EU CP-GW-2 (200 West, OU 200-ZP-1), which is being treated with along with other contaminants through the 200 West Area pump-and-treat system. The next highest GTM value (rated *Very High*) is for the I-129 plume, which is very large (>53 km^2) and may be too dispersed for effective treatment (Figure 3-34). The next highest rated plumes (rated *High*) are Tc-99, I-129, and Sr-90 plumes in EU CP-GW-1 (200 East, OU 200-BP-5) and are not currently undergoing treatment.

Threats to Groundwater from Contaminants in the Vadose Zone

Figure 3-39 compares the results of the GTM applied to contaminants currently present in the vadose zone for the Central Plateau with the GTM for contaminants in the saturated zone (i.e., groundwater contaminant plumes). Results are not provided for the vadose zone in the River Corridor because prior extensive excavation and remediation prevents meaningful estimates of remaining vadose zone contaminant inventories. The highest vadose zone GTM value (rated *Very High*) is associated with carbon tetrachloride in EU CP-LS-2, which is currently being treated in the 200-West pump-and-treat system.[75] Strontium-90 is the cause of five GTM values greater than 1000 and four additional GTM

[73] Group C includes tritium, which has a relatively short radioactive decay half-life (12.3 years), and nitrate, which is readily biodegraded. Additional information is provided in the methodology report (CRESP 2015).

[74] Group D contaminants have very low mobility in the vadose zone and groundwater. Additional information is provided in the methodology report (CRESP 2015).

[75] Carbon tetrachloride was treated using soil vapor extraction (SVE) in the 200-PW-1 OU overlying the 200-ZP-1 groundwater OU. Over 80,000 kg of carbon tetrachloride was removed. The SVE system did not operate in 2013.

values greater than 100. However, the relatively low mobility of strontium-90 in the vadose zone, coupled with its relatively short half-life for natural radioactive decay indicates a low potential for substantial groundwater contamination resulting from these vadose zone sources under current recharge rates. Several of the vadose zone contaminant sources with GTM values greater than 100 (rated *High*) are located in the 200 East Area, either associated with the BC Cribs and Trenches (EU CP-LS-1) or the legacy sites at the A-AX and B-BX-BY tank waste and farms EUs (EUs CP-TF-5 and CP-TF-6) and currently are not undergoing treatment (except for perched water with uranium in EU CP-TF-6). Many of the GTM values greater than 100 in the 200 West Area are associated with legacy sites within tank waste and farms EUs (CP-TF-1 (T), CP-TF-2 (S, SX), CP-TF-3 (TX-TY)) and are within the current or planned capture zones of the 200 West pump-and-treat system. These results suggest that if groundwater cleanup and quality is a priority, then focus on the 200 East Area is warranted.

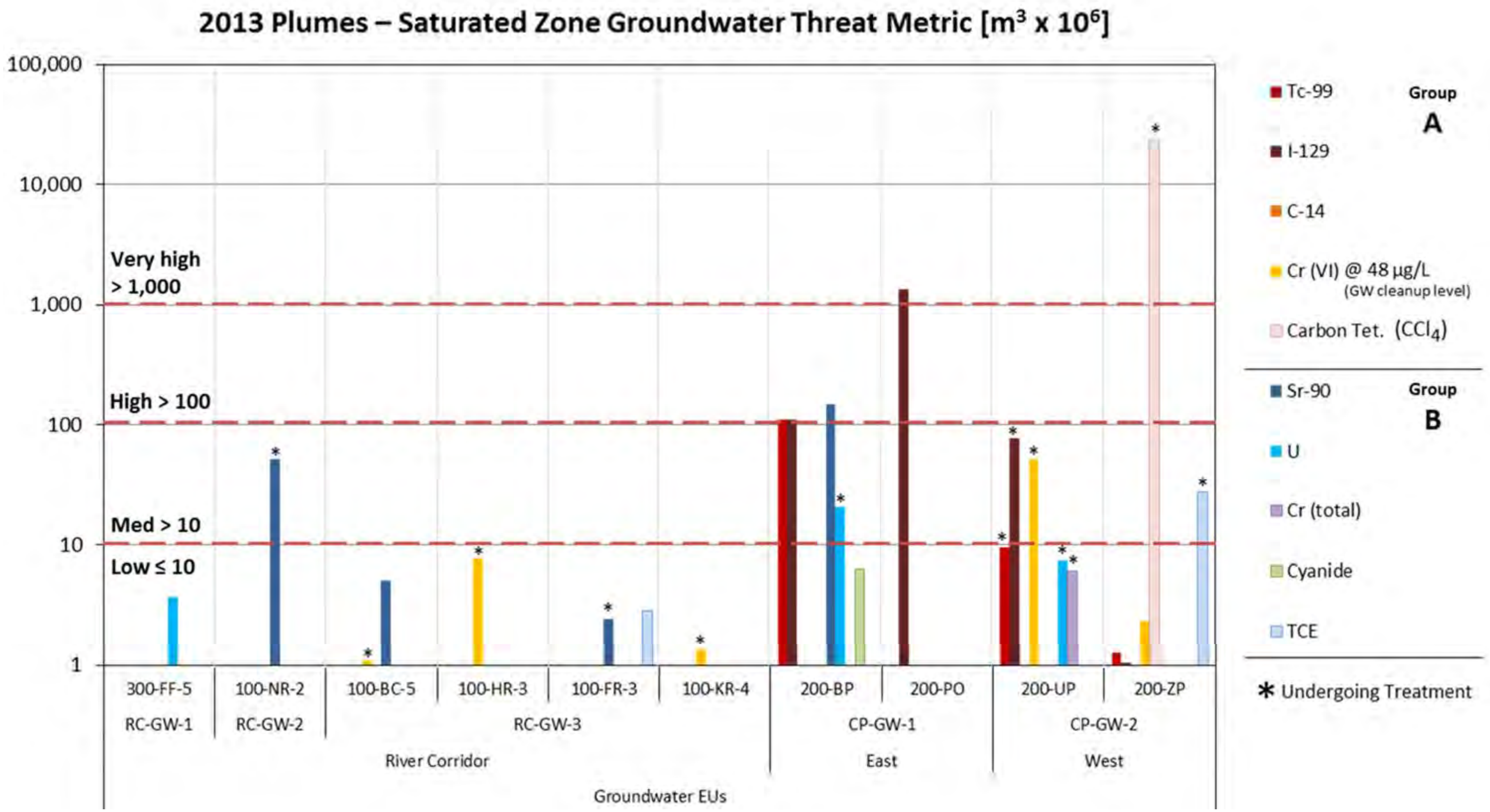


Figure 3-38. Rating groundwater contaminant plumes as a threat to *groundwater as a protected resource* based on the groundwater threat metric. Groundwater threat metric in millions of cubic meters.

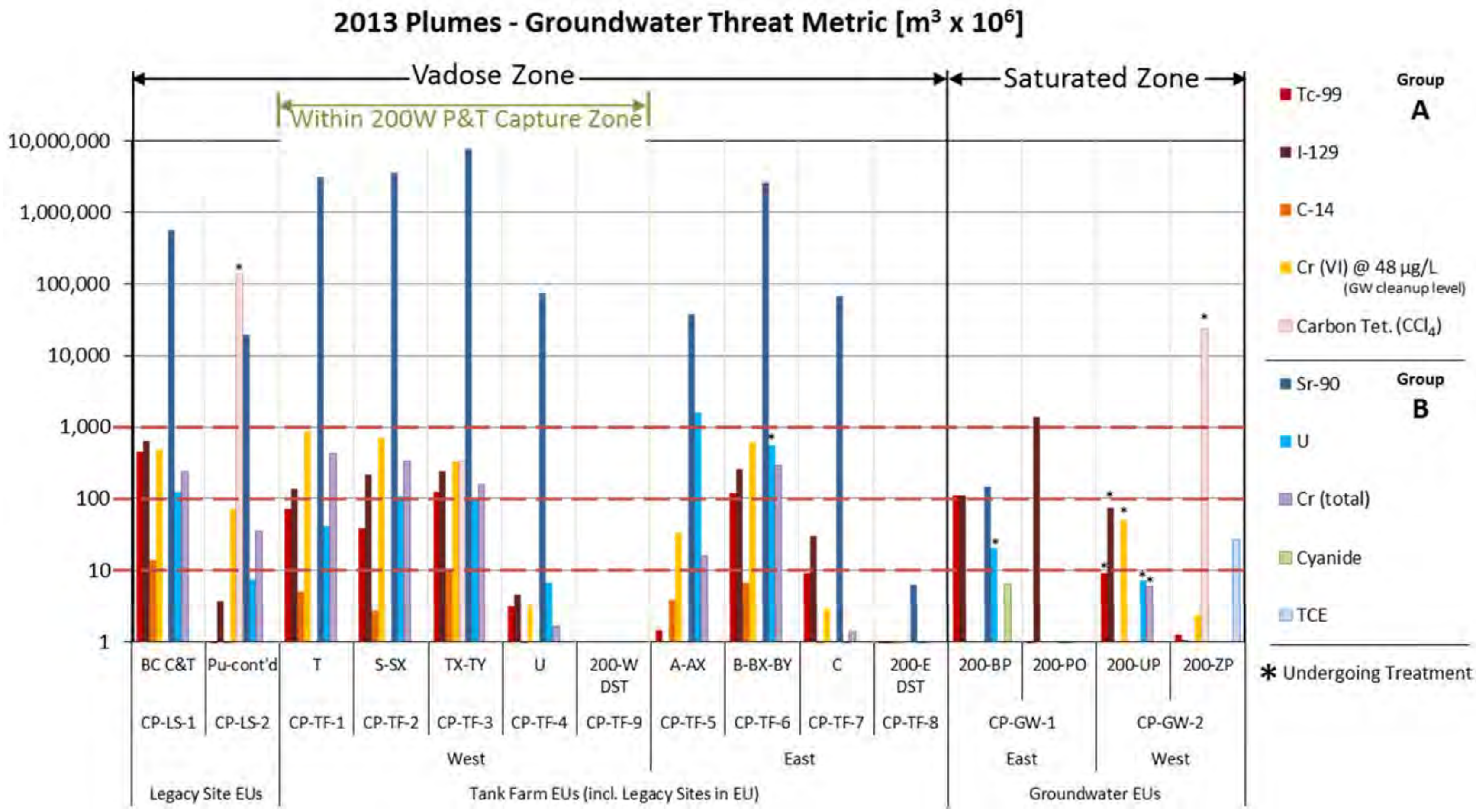


Figure 3-39. Rating vadose zone contaminant inventories as a threat to *groundwater as a protected resource* based on the groundwater threat metric. Groundwater threat metric in millions of cubic meters.

Groundwater Contamination Mitigation Efforts in the Central Plateau

A number of groundwater (GW) interim remedial actions have been conducted in the 200 West Area as part of the 200-UP-1 and 200-ZP-1 OUs. Figure 3-38 and Figure 3-39 indicate where remediation efforts have been undertaken by an asterisk (*) associated with vertical bar representing each contaminant source. In the 200-UP-1 OU, these actions include (EPA 2012):

- *216-U-1 Crib and 216-U-2 Crib Groundwater Interim Remedial Action (1985)*: An interim remedial action was designed to pump-and-treat (P&T) groundwater below these cribs. Pumping started in June 1985 and continued until November 1985. The system removed 687 kg of uranium via ion exchange treatment.
- *200-UP-1 Groundwater OU Interim Remedial Action (1997, amended in 2009 & 2010)*: A pilot-scale treatability test consisting of a P&T system was constructed adjacent to the 216-U-17 Crib. Phase I operations commenced September 1995 and continued until February 1997. The test demonstrated that the ion exchange resin and granular activated carbon were effective at removing Tc-99, uranium, and carbon tetrachloride from groundwater. Based on the success of the pilot system, and interim groundwater extraction and treatment system was implemented. Cleanup started in 1997 and met its remedial action objective of reducing highest concentrations to below 10 times the cleanup level of 48 µg/L for uranium and 10 times the maximum contaminant level of 900 pCi/L for Tc-99. This system removed 220.5 kg of uranium, 127 g (2.17 Curies) of Tc-99, 41 kg of carbon tetrachloride, and 49,000 kg of nitrate (see also DOE/RL-2014-32, Rev. 0, p. UP-2). The system was shut down in 2012.
- *WMA S-SX Groundwater Extraction System*: A groundwater extraction system for Tc-99 was constructed in 2011 and started operation in August 2012. The design consists of a three-well extraction system, aboveground pipelines, and a transfer building to pump extracted groundwater to the 200 West Groundwater Treatment Facility for treatment and reinjection. As of the 2013, the system has removed 60.8 g (1.03 Ci) of Tc-99, 17.9 kg of chromium, 9,560 kg of nitrate, and 121 kg of carbon tetrachloride since startup (DOE/RL-2014-32, Rev. 0, p. UP-34).
- The final ROD for the 200-UP-1 OU will be pursued when future groundwater impacts are adequately understood and potential technologies to treat I-129 are evaluated (EPA 2012).

In addition to the actions above, the following actions have been or are being taken to address groundwater contamination in the 200-ZP-1 OU:

- *200-ZP-1 OU Interim Remedial Action (1995)*: In 1996, a pump-and-treat system was started to reduce the mass of carbon tetrachloride (as well as secondary contaminants TCE and chloroform) in the groundwater primarily from waste sites south and east of the Plutonium Finishing Facility (DOE/RL-2012-03, Rev. 0). This action was completed and the interim P&T system was deactivated in May 2012 (with startup of the 200 West Area P&T facility). From 1996 through 2012, the system removed 13,911 kg of carbon tetrachloride, 14.5 kg of chromium, 84,693 kg of nitrate, 81.7 g (1.3 Ci) of Tc-99, and 0.73 kg of TCE (DOE/RL-2014-32, Rev. 0, p. ZP-25).
- *200-ZP-1 Record of Decision (2008)*: The 200-ZP-1 ROD was issued in 2008 and selected P&T, MNA, and Institutional Controls (ICs) to remediate contaminated groundwater including impacting the direction of groundwater flow and further reducing the levels of carbon tetrachloride present and migrating towards the 200-UP-1 OU. The P&T system was started in 2012 and removed 3,580 kg of carbon tetrachloride, 91.24 kg of chromium, 0.000242 µCi of

I-129, 243,905 kg of nitrate, 98.03 g (1.5 Ci) of Tc-99, and 15.49 kg of TCE, and 1.08 kg of U[76] by 2013 (DOE/RL-2014-32, Rev. 0, p. ZP-25).

- *200-PW-1 Interim Record of Decision (1992)*: Soil vapor extraction was implemented as an interim action in 1992 to remove carbon tetrachloride from the vadose zone in 200-PW-1 overlying the 200-ZP-1 groundwater (DOE/RL-2014-32, Rev. 0). The system has removed 80,107 kg of carbon tetrachloride to date; however, the mass removed each year has been decreasing (DOE/RL-2014-32, Rev. 0, p. ZP-28). The system did not operate in 2013.

The 200-BP and 200-PO OUs, both within the 200 East Area, 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 the impact to groundwater prior to determining the path forward for remedial action. For 200-BP-5, the following actions are being conducted:

- Ongoing perched water treatability test (200-DV-1) at WMA B-BX-BY to remove uranium. By 2013, approximately 691,000 L of perched water containing approximately 373 Kg of nitrate, 0.022 Ci of Tc-99, and 31.9 kg of uranium was extracted (DOE/RL-2013-22, Rev. 0; DOE/RL-2014-32, Rev. 0, page BP-8).
- WMA C Tank Waste Retrieval. Tank wastes are currently being retrieved from WMA C. Waste retrieval has been completed in nine of the 16 tanks, has been completed to various limits of technology in four tanks, and retrievals are in progress in the remaining three tanks (Weyns 2015).
- The final action ROD for the 200-BP-5 OU is scheduled for 2016 (DOE/RL-2014-32, Rev. 0, p. BP-3).

Groundwater-Related Threats to the Columbia River

The assessment of threats from primary contaminants to the Columbia River is based on consideration of the benthic and riparian zones. Impacts to benthic and riparian zones were considered more sensitive evaluation bases than free-stream concentrations because of the very high dilution of groundwater discharges within the Columbia River. The basic concept employed is that the threat or risk is a function of three factors: i) contaminant characteristics, ii) how much greater the contaminant concentration is with respect to the relevant screening threshold (i.e., informed by ecotoxicity), and iii) how large of an area (either river reach or riparian zone) is impacted.

Threats to the Columbia River Benthic Ecology from Contaminants

The first step in the threat determination process for impacts to the Columbia River (Figure 2-11) was to determine if the plume is in contact with the Columbia River at concentrations exceeding the WQS based on the 2013 Hanford Annual Groundwater Report (DOE/RL-2014-32, Rev. 0) and the aquifer tube data from PHOENIX (http://phoenix.pnnl.gov/). If the plume is not in contact with the Columbia River, then available information (EISs, baseline risk assessments, records of decision, etc.) is used to determine if a plume can be expected to intersect the Columbia River in the next 150 years. If not, then available modeling results are used to describe potential long-term impacts (1050 years or longer, if appropriate).

[76] Uranium is not a contaminant of concern for the 200-ZP-1 OU; it is included to track 200-UP-1 groundwater treated.

If the plume either is in contact with the Columbia River or expected to intersect the River in 150 years, then the threat to the Columbia River is evaluated using the multi-step process illustrated in Figure 2-11.

First the ratio (R1) of the maximum concentration to the appropriate benthic screening value is computed using the screening values provided in Table 3-17:

- For radionuclides, the BCG consistent with DOE-STD-1153-2002 is used.
- For chemicals, the AWQC is used (the Tier II screening risk values are used when the AWQC is unavailable). The only exception is (total) uranium where the AWQC (5 µg/L) from the Columbia River Component Risk Assessment (DOE/RL-2010-117, Rev. 0, 2010) is less than most measured background concentrations (e.g., ranging from 0.5 - 12.8 µg/L in the 300 Area) (PNNL-17034, p. 6.9). A value (12.9 µg/L) was selected for total uranium to identify those areas contaminated by the Hanford Site.[77]

The rating process for ***benthic threats*** under current conditions (Figure 2-11) proceeds as follows:

- If the ratio R1 ≤ 1 (i.e., the maximum concentration is less than the screening threshold), then the rating for benthic threats is *ND*. Results for calculation of the ratio R1 are provided in Figure 3-40. Note that total uranium, and TCE in EU RC-GW-1 (OU 300-FF-5), chromium in EU RC-GW-2 (OU 100-NR-2) and EU RC-GW-3 (OUs 100-BC-5, 100-HR-3, 100-FR-3 and 100-KR-4) as well as carbon-14 and strontium-90 in EU RC-GW-3 (OU 100-KR-4) have R1 values that exceed 1, and therefore proceed to the next steps.
- If the primary contaminant is in Group C (Table 2-6), then the rating for benthic impacts is *Low*.
- If the primary contaminant is in Group A or B (Table 2-6), then the rating is *Low* if the ratio R1 ≤ 5.
- If the ratio R1 > 5, then rating is *Low* if the plume is not currently intersecting the Columbia River (using aquifer tube data or contours exceeding the threshold). If the plume is currently intersecting the River, then the ratio R2 of the log-mean 95% upper confidence limit (UCL) estimate to the screening value (BCG or AWQC) is computed. Results of the calculated ratio R2 are presented for the River Corridor groundwater EUs in Figure 3-41.
- If the ratio R2 ≤ 1 (i.e., the mean concentration is less than the screening threshold), then the rating is *Low* if the ratio R1 ≤ 5.
- If the ratio R2 > 1, then the matrix represented in Table 2-8 is used to determine the rating based on the ratio R2 and the Shoreline Impact provided in the 2013 Hanford Annual Groundwater Report (DOE/RL-2014-32, Rev. 0). The relative lengths of shoreline impact for each plume is presented in Figure 3-42.

Results of the above assessment process for the River Corridor EUs is presented in Figure 3-43. The results for the uranium plume in the 300 F Area are reflected by a range from ND to High because of the large uncertainty associated with the uranium no observed effects level (NOEL).

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[77] The selected value of 12.9 µg/L represents between the 90th and 95th percentile for site-wide background uranium concentration (DOE/RL-96-61, 1997). Note that there is a large uncertainty relative to the No Effects level for total uranium. As stated in the Columbia River Component Risk Assessment, "Effect levels span nearly three orders of magnitude (3 µg/L to 900 µg/L), reflecting considerable uncertainty in selection of a no-effect concentration. The value selected is a probable no effect concentration and is the 5th percentile of the toxicity data set." (DOE/RL-2010-117, Rev. 0, p. 6.2)

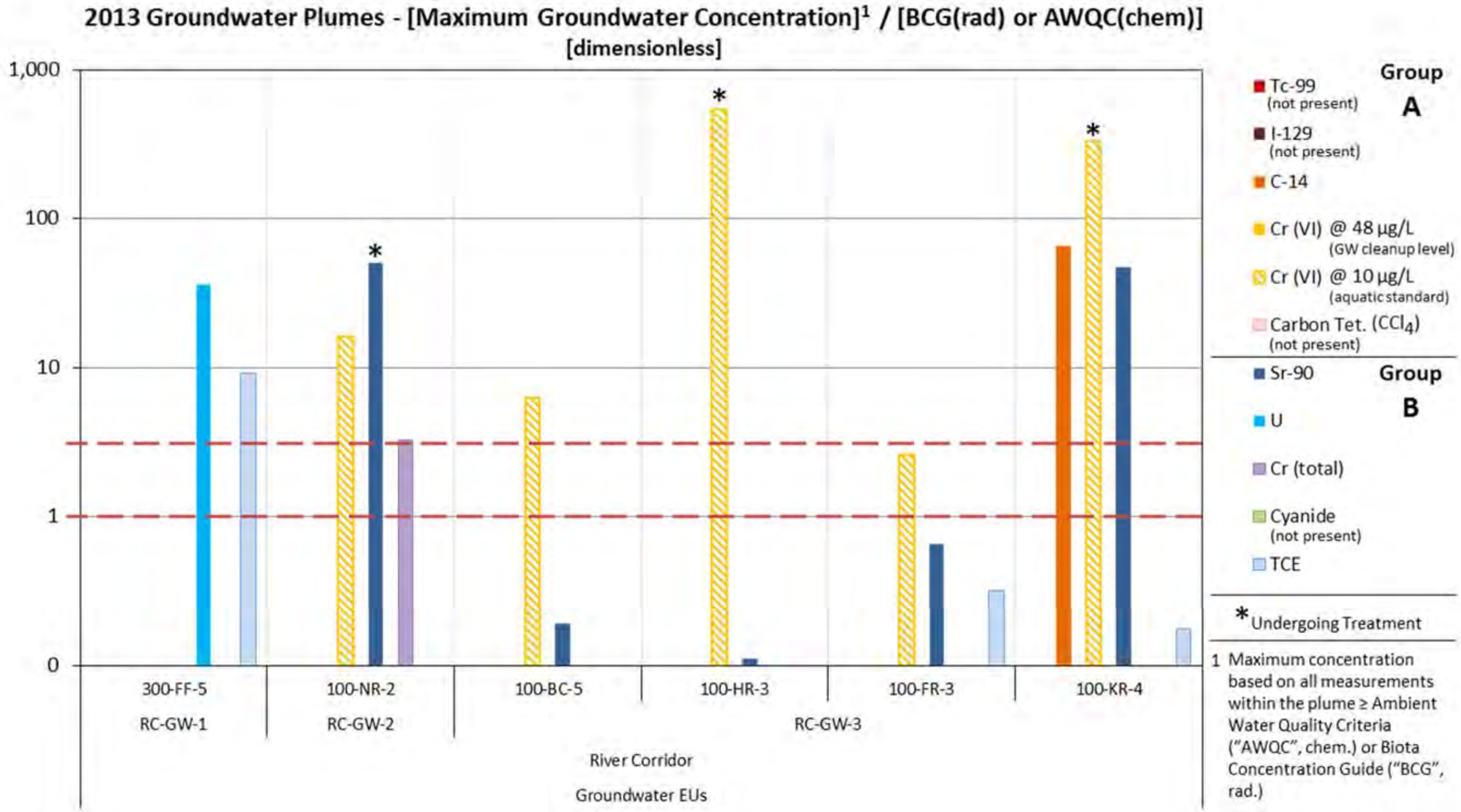


Figure 3-40. Calculated values of the ratio R1 for the River Corridor EUs using the 2013 groundwater monitoring data.

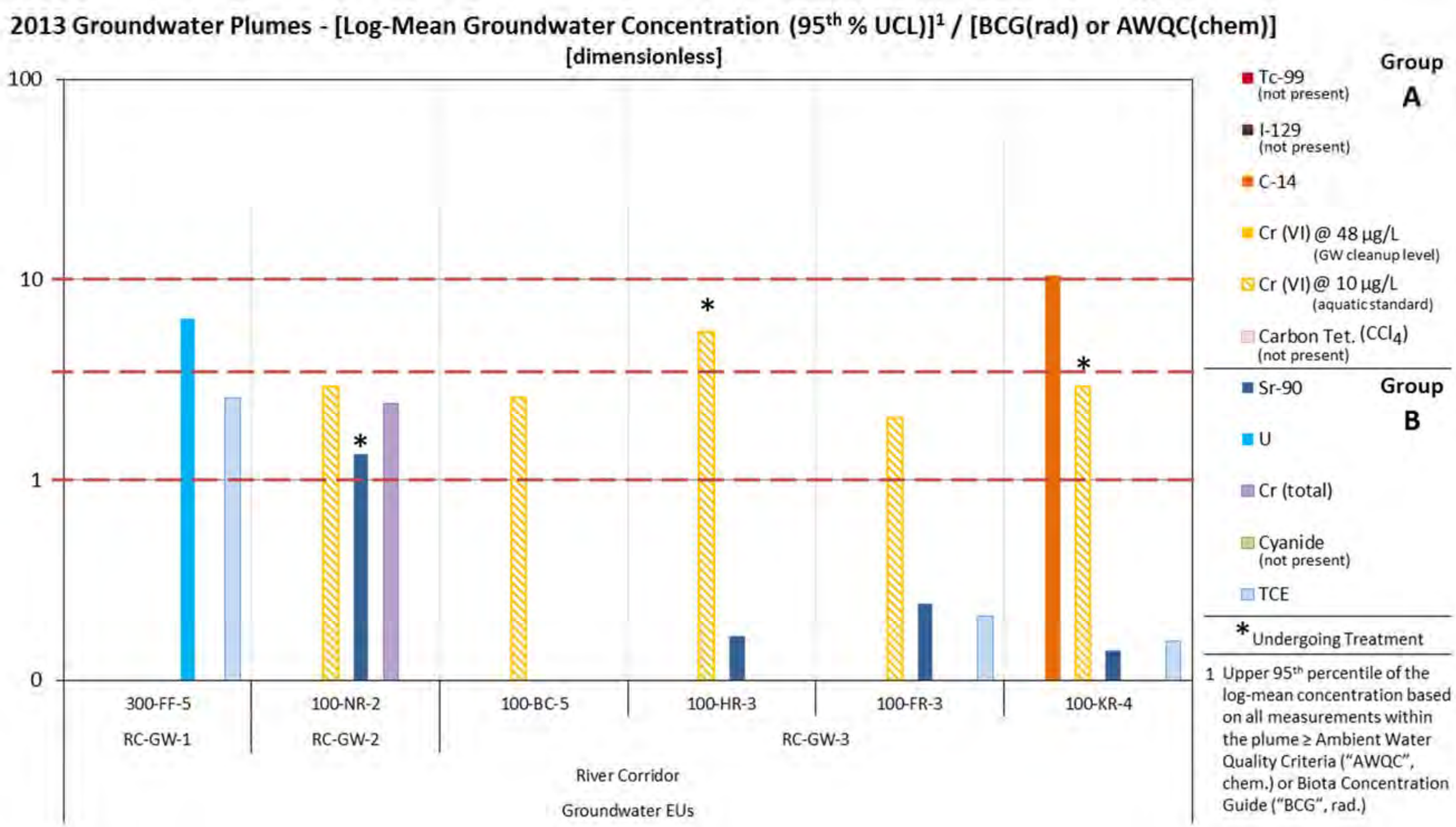


Figure 3-41. Calculated values of the ratio R2 for the River Corridor EUs using the 2013 groundwater monitoring data.

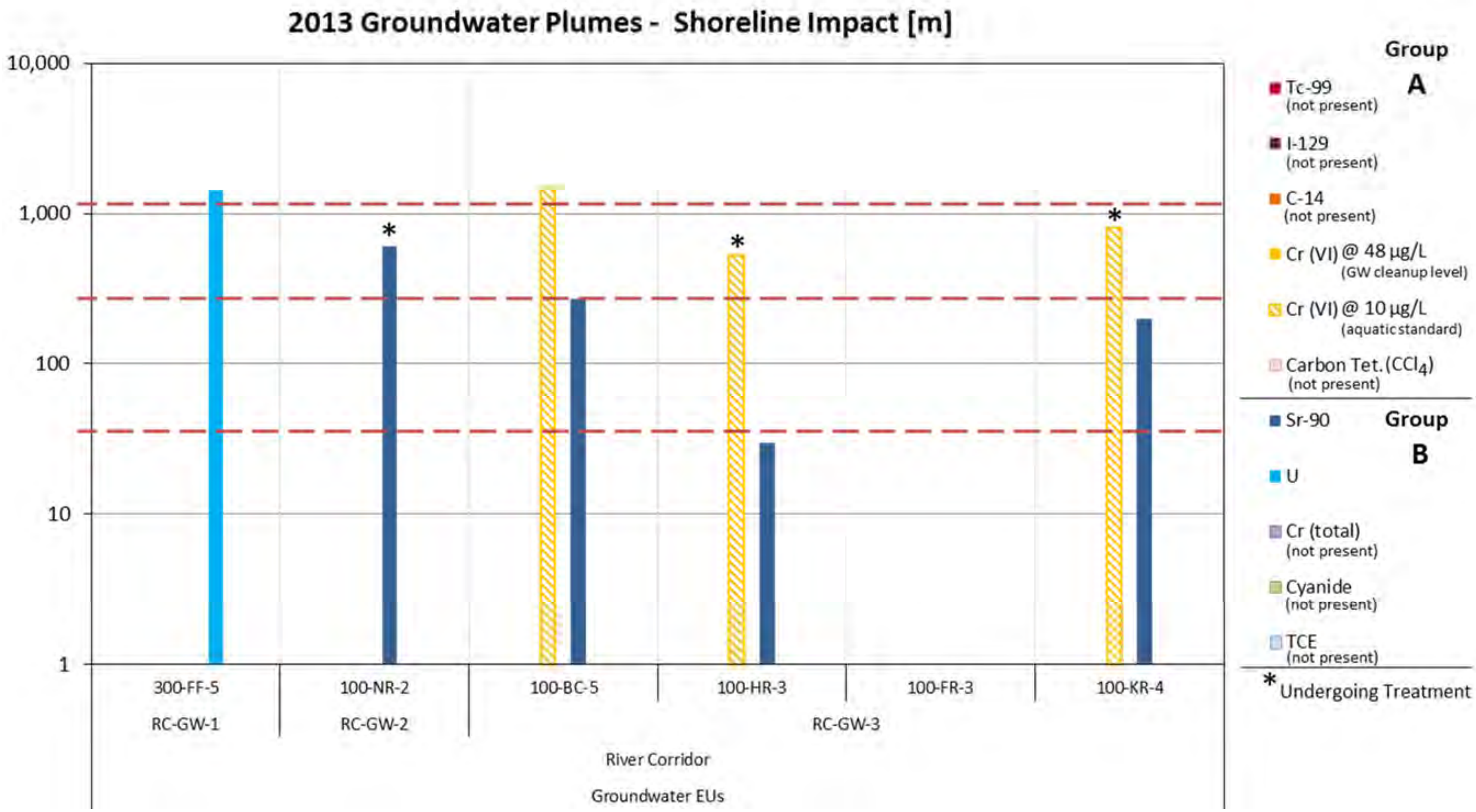


Figure 3-42. Estimated extent of shoreline impact (i.e., river reach) by the groundwater plumes in the River Corridor based on 2013 groundwater monitoring data.

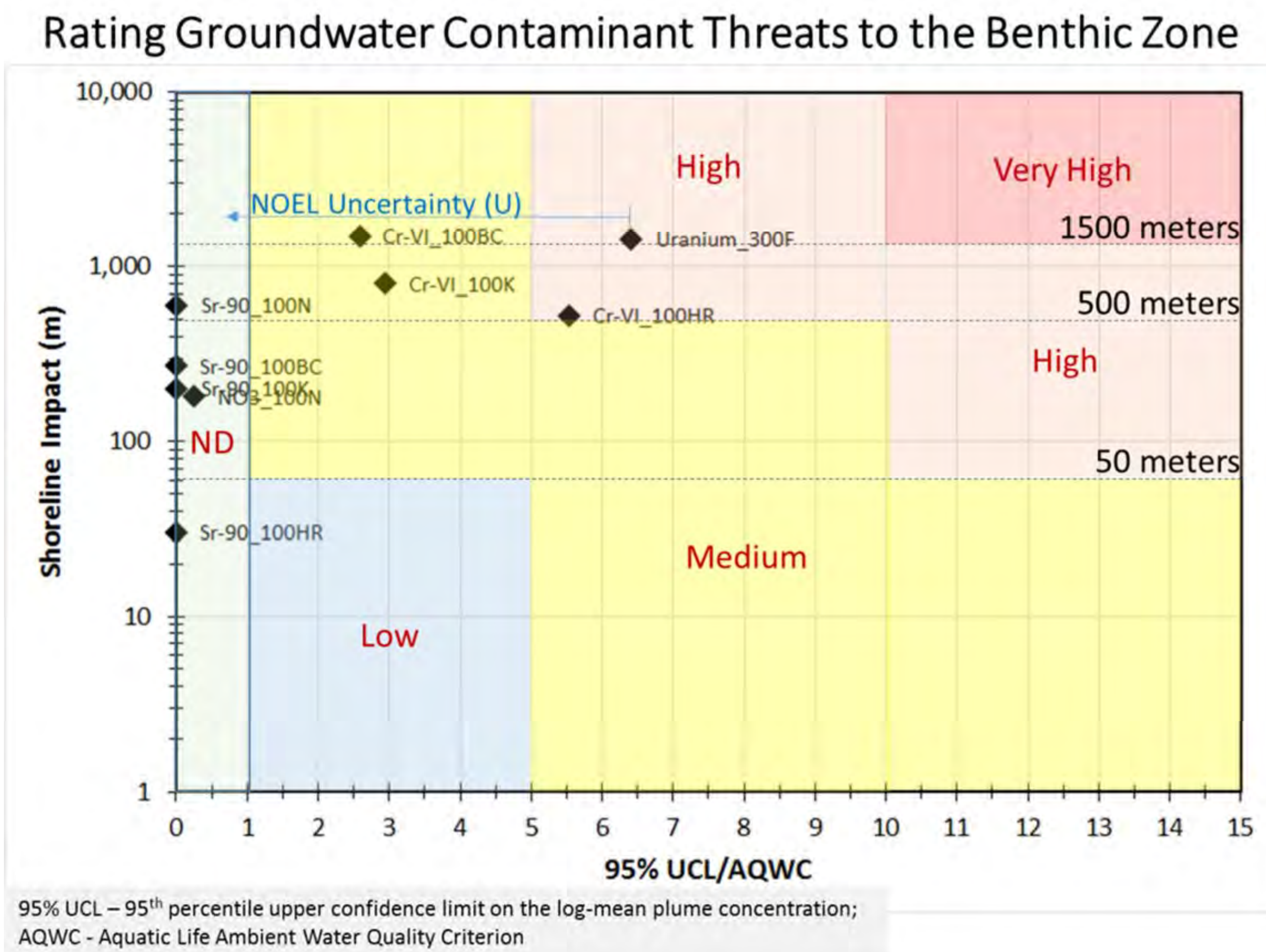


Figure 3-43. Risk Review Project ratings for groundwater contaminant threats to the benthic zone for River Corridor EUs.

Threats to the Columbia River Riparian Zone Ecology from Contaminants

The rating process for the riparian zone (Figure 2-11) proceeds along the same lines as the rating process for benthic receptors with the exception that if the ratio R2 exceeds unity, then the final step in the threat assessment process is

- If the ratio R2 > 1, then the matrix represented in Table 2-7 is used to determine the rating based on the ratio R2 and the Riparian Zone impact area.[78] The riparian zone area impacted by each of the River Corridor groundwater plumes was estimated based on habitat definition along the river and the intersection with the groundwater plumes greater than the screening threshold (Figure 3-44).

Results of the rating process for each River Corridor groundwater plume are presented in Figure 3-45.

[78] The intersection area between the groundwater plume and the riparian zone was provided by PNNL based on the 2013 Hanford Site Groundwater Monitoring Report (DOE/RL-2014-32, Rev. 0).

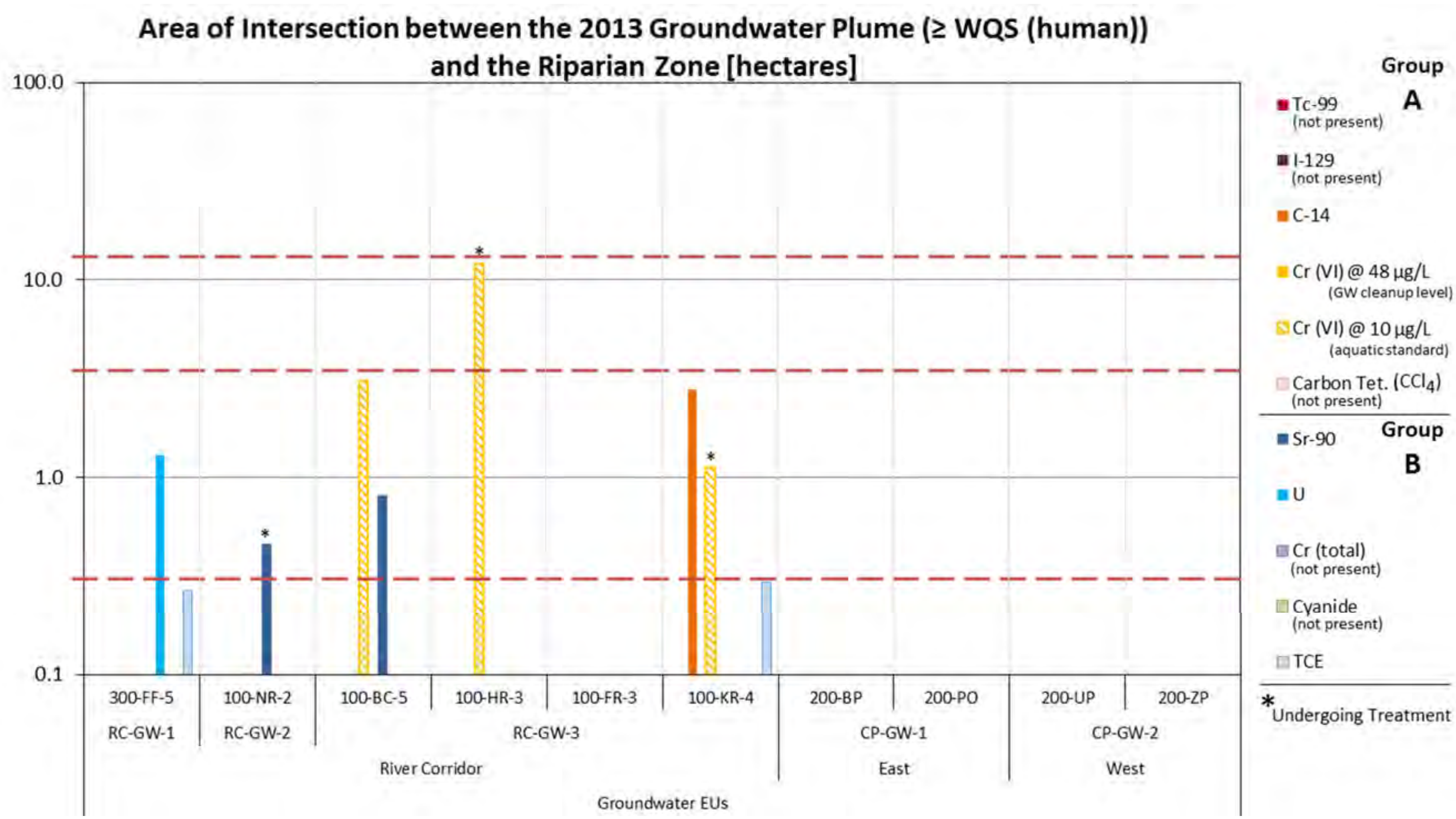
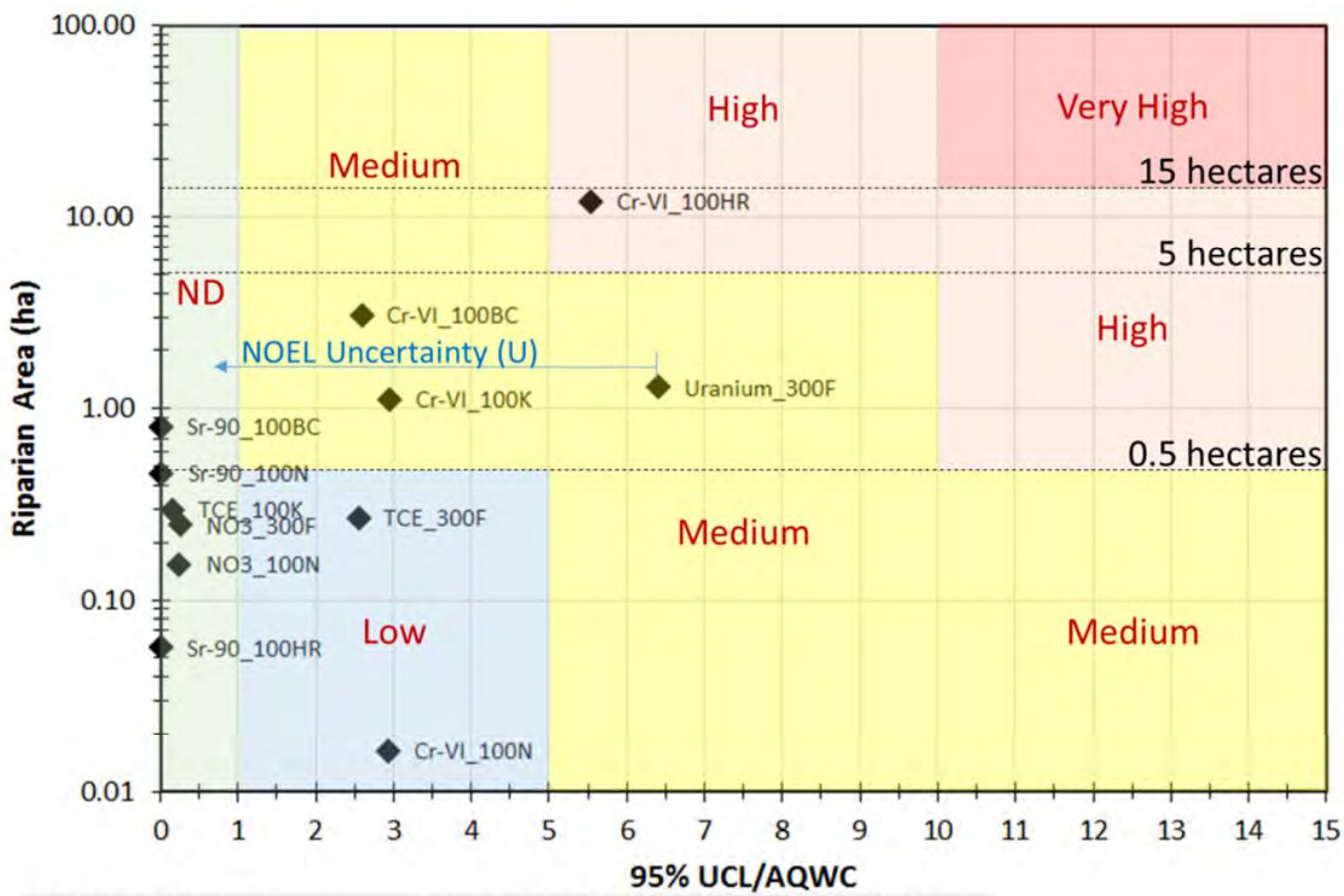


Figure 3-44. Area of intersection between the 2013 groundwater plumes along the River Corridor and the riparian zone.



95% UCL – 95th percentile upper confidence limit on the log-mean plume concentration;
AQWC - Aquatic Life Ambient Water Quality Criterion

Figure 3-45. Risk Review Project ratings for groundwater contaminant threats to the riparian zone for River Corridor EUs.

Threats to the Columbia River Free-flowing Ecology

The threat determination process for the free-flowing river ecology was evaluated in a manner similar to that described above for benthic receptors (Figure 2-11). However, because of the Columbia River's large dilution effect of on the contamination from the seeps and groundwater upwellings,[79] the differences from EU to EU were not found distinguishing and the potential for groundwater contaminant discharges from Hanford to achieve concentrations above relevant thresholds is very remote. If additional information becomes available (e.g., based on concentration measurements or bioaccumulation in certain areas of the Hanford Reach) that would lead to significant differentiation among EUs based on potential free-flowing river impacts, then the framework will be revised for the Hanford Risk Review Project final report.

SUMMARY OF RISK RATINGS

A summary of all groundwater EU risk ratings is provided in Chapter 4.3 (see Table 4-5).

3.4. DEACTIVATION, DECOMMISIONING, DECONTAMINATION, AND DEMOLITION OF FACILITIES (D4) EVALUATION UNITS

The Hanford Site contains seven major surplus facilities that are currently or will be undergoing one or more of deactivation, decommissioning, decontamination, and demolition (D4) phases. Final disposition will be burial of the demolition debris at ERDF or WIPP for plutonium/TRU contaminants, or the placement of an engineered barrier over the partially demolished structure along with maintenance of institutional controls, post-closure monitoring and caretaking. In addition, the K-Reactor ancillary buildings are currently undergoing D4, and the two reactor core buildings will be cocooned for interim safe storage until these two reactors and the other reactors along the Columbia River undergo final demolition and burial at ERDF.

An evaluation has been completed on the current condition and proposed D4 actions on three of the seven major D4 facilities, Building 324, PUREX, and the K Reactors, and the findings are compared below.

Figure 3-46 is a map of the Hanford Site showing the location of each D4 facility, with green stars identifying the three EUs included in this report and red stars identifying the EUs remaining to be evaluated as part of the final report. The K Reactors are identified with both colored stars, with the green star noting the current interim safe storage evaluation included in this report and the red star noting the final disposition in about 50 years to be evaluated as part of the final report.

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[79] "Groundwater is a potential pathway for contaminants to enter the Columbia River. Groundwater flows into the river from springs located above the water line and through areas of upwelling in the river bed. Hydrologists estimate that groundwater currently flows from the Hanford unconfined aquifer to the Columbia River at a rate of ~ 0.000012 cubic meters per second (Section 4.1 of PNNL-13674). For comparison, the average flow of the Columbia River is ~3,400 cubic meters per second (DOE/RL-2014-32, Rev. 0)." This represents a dilution effect of more than eight orders of magnitude (a dilution factor of greater than 100 million).

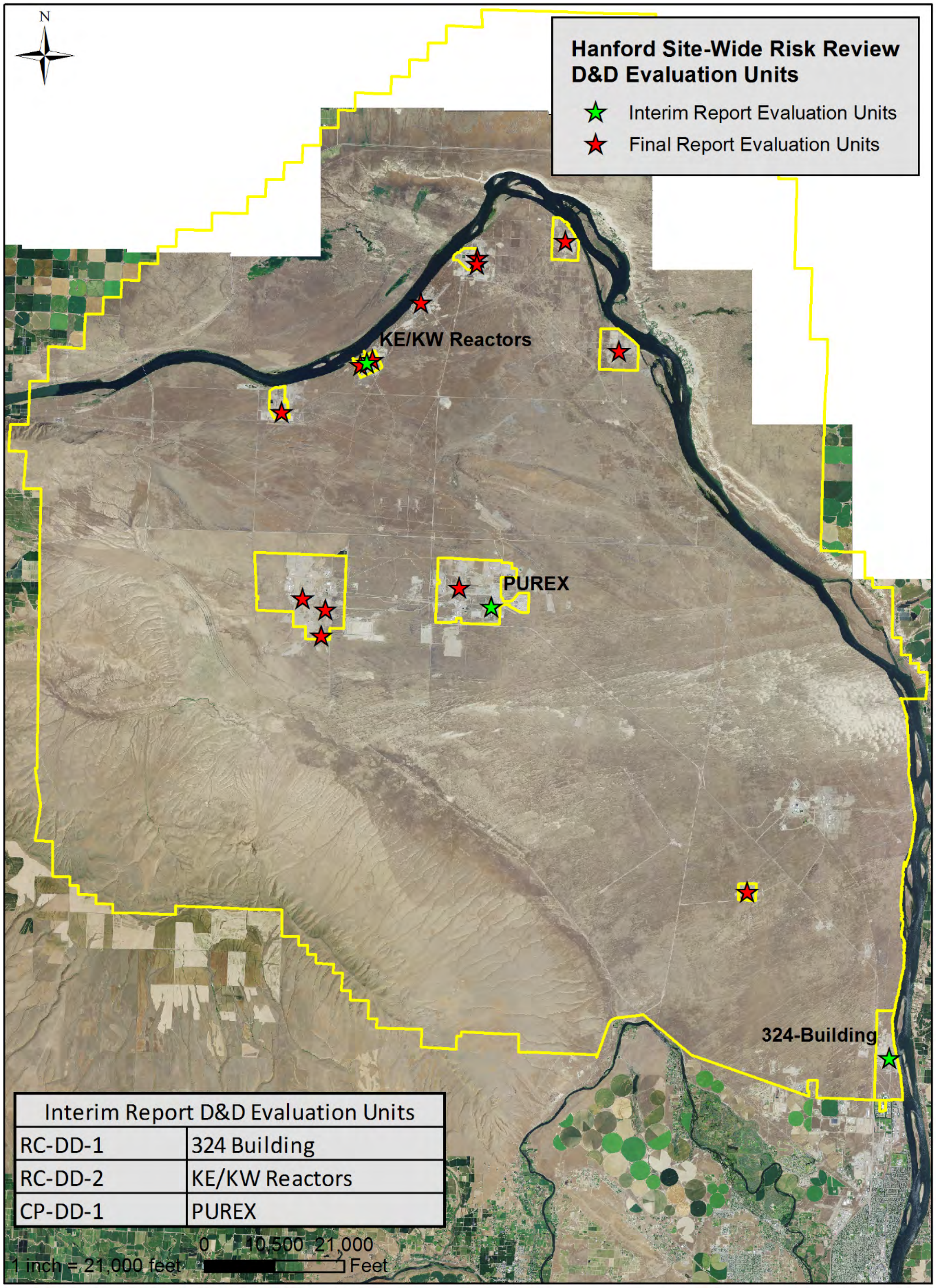

Figure 3-46. Map of D4 evaluation unit locations.

Description of D4 Evaluation Units

The following are short overview summaries of the Hanford D4 group of evaluation units:

- Building 324 (RC-DD-1)
- K-East, K-West Reactors (RC-DD-2)
- Plutonium-Uranium Extraction Facility (PUREX) (CP-DD-1)

Building 324 (RC-DD-1)

The 324 Chemical and Materials Engineering Laboratory (Figure 3-47), a Hazard Category 2 nonreactor nuclear facility, was constructed in 1965 as a dual-purpose facility that contained both radiochemical and radiometallurgical hot cells and laboratories. Located approximately 1000 ft from the Columbia River, the facility was operated by PNNL until 1996, although it continued limited operations in the 324 Building until October 1998, when it was transferred to B&W Hanford Company.

Figure 3-47. Aerial view of Building 324.

In 2009, a breach in the B-Cell liner was discovered during grout removal in the trench and sump. Investigations determined that a spill of approximately 510 L of a highly radioactive waste stream (approximately 1.3 million curies) containing Cs-137 and Sr-90 occurred in the B-Cell in October 1986. High radiation levels at the failed liner locations led to concerns that contamination had spread to the soil beneath the cell. In 2010, eight closed casings (geoprobes) were installed beneath B-Cell, which indicated contamination up to 8900 rad/hr in the soil. Modeling by PNNL estimated that the contamination had migrated to as much as 13 ft below B-Cell due to continuing amounts of water seeping through the hole until it was plugged up in 1992. In October 2014, nine new geoprobes were inserted by Washington Closure Hanford (WCH) below the floor that enabled the measurement of exposure rates along the length of the housing. These exposure rates were then converted to activity rates (curies) at 1 ft increments. The modeling[80] of this data indicates a contaminant plume, extending down to the cobble layer 4 ft below the B-Cell footings that spread out horizontally with increasing depth, that contains an estimated 224,100 Ci of activity. A maximum reading of 11,700 rad/hr was recorded by one of the probes. The more recent analysis indicates that the contamination has migrated down less than initial estimated but also horizontally to outside the boundaries of the building foundation.

[80] Washington Closure Hanford 2011, *Characterization of the Soil Contamination Under 324 B-Cell*, Calculation Sheet Project 618-10FR, Job No. 14655, Calc. No. 0300X-CA-N0140, Rev. 2, February 18, 2015.

Current Status: AREVA was awarded a $19 million contract in January 2014 to design, construct, and operate a pilot project designed as “proof of concept” for the remote retrieval of these highly contaminated soils through the floor of B-Cell. They are constructing a full-scale mockup of B-Cell and associated hot cells, and expect to have tested and documented the proposed removal process by September 2015. This might be delayed by the new and different data developed on the location of the soils that will need to be remediated. Building 324 currently is being maintained in a safe surveillance and maintenance mode pending completion and evaluation of the AREVA pilot project results and decision to proceed with soil remediation.

Contaminants: A recent analysis[81] indicates that an estimated 23,000 Ci of Sr-90 and 42,000 Ci of Cs-137 are primarily located in the building’s A- and B-Cells and the High-Level Vault and Low-Level Vault tanks. Modeling of data from 9 probes inserted under the B-Cell in 2014 estimated a contaminate plume of 155,700 Ci of Cs-137 and 68,420 curies of Sr-90 extending down to the cobble layer 4 ft below the B-Cell footings that has spread out horizontally with increasing depth. Two hydraulic hammer unit penetrometers that were inserted at an angle into the cobble layer showed that the level of contamination below the cobble layer is negligible compared to the level of contamination immediately below B-Cell. There has been no indication of Cs-137 or Sr-90 migration from the soils underlying the building to the groundwater or the Columbia River. An important consideration with respect to prevention of Cs-137 and Sr-90 migration is prevention of water infiltration into the contaminated soils. Pending remediation of the soils, the greatest risk of water infiltration is from a leak or pipe rupture of the water supply main that runs close to the building. However, the very large quantities of Cs-137 and Sr-90 in the soil directly underlying the 324 building will remain a large near-surface hazard well past the 150 year evaluation period, and will require interim measures to prevent accidental water intrusion (through a water main break or building decay) and either long-term immobilization (e.g., grout and capping) or removal.

Final Cleanup and Disposition: One of the biggest challenges facing DOE is how to safely remove or contain the highly radioactive soils beneath the building’s B-Cell. The current plan is to extract the soil up through the B-Cell floor, mix with grout and transfer to the C and D hot cells. The outer shell of Building 324 would be demolished, and the hot cells would be cut into monoliths and transported to ERDF for disposal. This process involves technical uncertainty that WCH is seeking to resolve through a $19 million contract with AREVA to design, construct, and operate a pilot project designed as “proof of concept” for the remote retrieval of these highly contaminated soils. An earlier estimate was for the soil mitigation work to be completed sometime around the fall of 2016, followed by demolition of the building and removal and transport of the hot cells by about mid-2020. Results of the AREVA study will not be available before September 2015, although this might be delayed by the release in February 2015 of new and different data on the location of the soils that will need to be remediated.

An alternative evaluated by WCH (Washington Closure Hanford 2014, Washington Closure Hanford 2011) was deemed safer and more feasible than the above method. However, DOE believes that this method is inconsistent with the RTD requirements of the *Interim Action Record of Decision for the 300-FF-2 Operable Unit, Hanford Site* (EPA 2001) and CERCLA documentation for the 300 Area. It involves stabilizing the contamination in place by injecting a grout or polymer into and/or under the waste matrix to stabilize and prevent its migration to groundwater, and leaving the contamination in situ with an engineered cap over the site. If the proposed remote retrieval prove technically infeasible, approaches

[81] Washington Closure Hanford 2014, *324 Building Basis for Interim Operation*, River Corridor Closure Contract: WCH-140 Rev. 7, May 2014

that allow for immobilization and in situ decay of the soil contaminants (Cs-137, Sr-90) warrant further consideration.

Primary Risks: Building 324 is currently maintained in a safe surveillance and maintenance mode with minimal worker activities. The primary future risks to facility workers, co-located workers, and the public are associated with the significant radiological residual contaminates in the B hot cell and other hot cells. Any one of several worker-related accidents during future stabilization and deactivation activities could release high radiological doses to each because of the short distances from the building to offsite and public areas. The soils beneath the B-Cell represent the highest risk to workers and possibly co-located persons, but only if they are excavated and contaminants are released into the environment. The public, in the form of users of water from the Columbia River, are at risk only if the soil contaminants reach groundwater through a large infusion of water to the surface, such as the rupture of the aging high-pressure fire suppression water line system located above the contaminant area.

K-East, K-West Reactors (RC-DD-2)

The K Reactors were two (K-West, K-East) (Figure 3-48) third-generation-design plutonium production reactors. Construction of K-West began in 1952, with the initial startup of the reactor occurring on January 4, 1955. The final shutdown of the reactor occurred on February 1, 1970. Construction of K-East began in 1953, with the initial startup of the reactor occurring on April 17, 1955. The final shutdown of the reactor occurred on January 28, 1971. During final shutdown of the reactor buildings, extensive procedures were performed to safely shut down the entire facility and contain contamination within the reactor block.

Figure 3-48. Aerial view of K-East, K-West reactors

Current Status and Interim Cleanup: The K-East Reactor building achieved Cold and Dark status (electrical and mechanical systems air-gapped to eliminate potential external energy sources) in February 2010. The K-West Reactor building is currently managed as less than a Hazard Category 3 for authorized surveillance and maintenance activities. D&D of buildings and structures ancillary to the reactor core building will begin when the contaminated sludge is removed from the K-West fuel basin. The K-West fuel storage basin and sludge treatment project is addressed as a separate EU, as is the cleanup of the waste sites at the K-West area.

Pending funds availability, work will proceed to put both reactor buildings into interim safe storage until approximately the year 2068, followed by deferred demolition of the buildings and transporting the reactor cores to ERDF for disposition. Interim safe storage consists of demolishing part of the reactor building, constructing a safe storage enclosure (SSE) around the reactor block ("cocooning" the reactor building), and providing long-term monitoring. The SSE will be a structurally independent building supported on a newly poured concrete foundation.

Although DOE is currently following a remediation path of temporarily cocooning the two reactor buildings as selected in the 1993 NEPA ROD[82] and applied to the other Hanford surplus reactors, it has broadened its decommissioning approach by retaining the immediate one-piece removal alternative that was deemed equally favorable based solely on the evaluation of environmental impacts. An EIS supplemental analysis (DOE/EIS-0119F-SA-01) prepared in July 2010 addresses a proposed action to pursue accelerated dismantlement, removal, and disposal of all eight surplus reactor facilities on the Hanford Site, with an initial focus on the K-East Reactor as a demonstration of capabilities to accelerate the dismantlement, removal, and disposal of the remaining seven surplus production reactors. In April 2011, DOE advised the Hanford Advisory Board that it was no longer pursuing this option and was proceeding with construction of SSEs for both reactor buildings.

The existing soil grading exposes the exterior of the K-East Reactor building to a depth of approximately 16 to 21 ft below grade on three sides. The floor of the basin excavation pit on the north side is covered with approximately 2 ft of clean overburden for radiation shielding and to reduce contamination levels when backfill is resumed. A delay may require temporary filling of these areas to retain structural stability of the exposed building. Long delays in constructing the SSEs over each of the K-East and K-West Reactor buildings could cause the building envelope to lose integrity such that precipitation and animals can infiltrate. There is also the potential for building decay and spread of hazardous materials such as contamination that could complicate further cleanup.

Contaminants: The reactor blocks each contain approximately 18,000 Ci of radionuclides, with the primary contaminants within the reactor building based on curies being H-3, C-14, Ni-63, Co-60, Cl-36 and Cs-137. The block is located near the center of the building, and consists of a graphite moderator stack (41 ft wide by 41 ft high by 33.5 ft deep) encased in a cast iron thermal shield (10 in. thick) and a biological shield consisting of high-density aggregate concrete (45 to 83 in. thick). The entire block rests on a massive concrete foundation. The reactor block, including the foundation, weighs approximately 12,100 tons. A cast iron thermal shield surrounding the graphite stack isolates the biological (radiation) shield from the core (Figure 3-49).

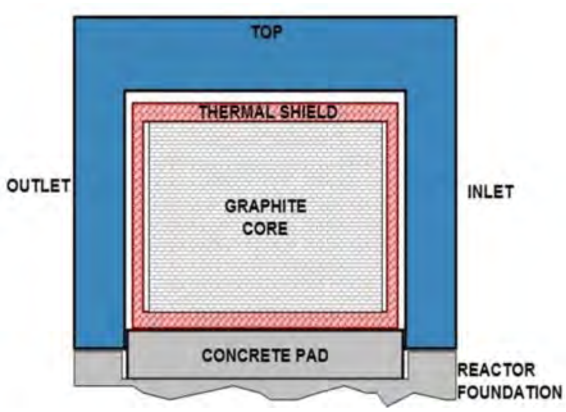

Figure 3-49. Schematic reactor cross-section.

In addition, about 187 tons of lead (in 1993[83]) exists in surface coatings (i.e., lead-based paint), plumbing, and as radiological shielding (e.g., lead shot, brick, sheet, and cast-lead forms) inside some of the 100-K Area facilities. About 926 yd^3 (in 1993) of asbestos-containing material is located in and around the facilities and may exist as vessel or piping insulation, floor tiles, transite wall coverings or panels, sheetrock, electrical wire insulation, and ducting. PCBs are identified as potential contaminants in the 100-K Area facilities and PCB-contaminated waste will likely be generated.

In addition, there is a fixed radionuclide contamination area on the lower part of the north exterior wall of the K-East Reactor building of

[82] 58 FR 48509

[83] Referenced in: Bechtel Hanford, Inc., *Surplus Reactor Auditable Safety Analysis, BHI-01172, Rev. 3.,* for U.S. Department of Energy, Richland Operations Office. August 19, 2004

approximately 864 ft^2 that was caused by openings between the chute feeding the fuel basin and the reactor building. It has been covered with Polymeric Barrier System fixative.

Hexavalent chromium is the primary groundwater contaminant underlying the 100-K Area (100-KR-3 and 100-KR-4 OUs), and the potential exists for high concentrations of chromium in the soils underlying the reactor building and related facilities.

Final Cleanup and Disposition: In or about 2068, DOE has proposed to demolish the two SSEs and the remaining reactor shell around the reactor block, followed by a one-piece removal of the reactor block that would be transported to ERDF for permanent disposal. The reactor block includes the graphite core, the thermal and biological shields, and the concrete base. The site would be backfilled, graded, revegetated, and released for other DOE use. This process is expected to take about 3 years for each reactor.

Interim safe storage of the two reactor buildings is expected to last until approximately 2068. The reactor block, including the thermal and biological shields, is of robust construction and has shown little degradation after 50 years. However, as noted above, long delays in constructing the SSEs over each of the K-East and K-West Reactor buildings could cause the building envelope to lose integrity such that precipitation and animals can infiltrate. Once constructed, the SSE will protect the reactor block from the elements, it is reasonable to expect that the reactor will remain structurally sound for the duration of interim safe storage. It is therefore highly unlikely that the co-located person or public would be at more than a Low risk of radiological exposure throughout this period.

Primary Risks: The K Reactors represent an ND to Low risk to a facility worker, co-located person, or the public because the primary contaminants are decaying inside a reactor core that can withstand a design basis seismic event.

PUREX (CP-DD-1)

The PUREX Plant complex (Figure 3-50) is a nuclear fuel processing facility that was constructed between 1953 and 1955 and was operated until 1990 to chemically separate plutonium, uranium, and neptunium from Hanford Site nuclear reactor fuel elements. Plutonium was recovered as an acidic solution of plutonium nitrate or was converted to plutonium oxide in N-cell. Nearly 70% of Hanford's uranium was reprocessed through PUREX. The original plant was a concrete rectangle 1005 ft long, 104 ft high (with approximately 40 ft below grade), and 61.5 ft wide.

The PUREX Plant incorporated a unique feature for disposing of large pieces of radioactive solid waste, such as failed or worn equipment. A 500 ft rail extension running southward was built onto the single-track rail tunnel that was used to bring irradiated slugs to the east end of the PUREX building. The tunnel's rectangular walls and ceiling are primarily constructed of 12 in. by 14 in. creosoted timbers arranged side by side with the 12 in. face exposed. Between June 1960 and January 1965, eight railcars with radioactive equipment were pushed into the tunnel by a remote controlled electric engine. In 1964, a 1700 ft tunnel was constructed to provide storage space for 40 railcars after the first tunnel had become full and was sealed. Its semicircular walls are supported by internal steel I-beams attached to externally constructed 3-foot-thick reinforced concrete arches, with a bituminous coated steel liner on the interior. It currently contains 28 railcars of radioactively contaminated equipment.

Figure 3-50. Aerial view of PUREX.

Between 1995 and 1997 the PUREX Plant was brought to a safe, low-cost, low-maintenance deactivation status. As part of the deactivation, the water-fillable doors of both tunnels and the outer PUREX railroad tunnel door were sealed. The current scope of work includes surveillance and maintenance that maintains confinement of hazardous wastes and protects the worker. This work scope includes pre-approved activities for surveillance of the facility, preventative maintenance of selected equipment, and incidental storage of necessary supplies and equipment.

Contaminants: The radioactive material inventory remaining at the end of deactivation in 1995 through 1997 was primarily in the form of contaminated equipment and surfaces, dust, and debris, with some remaining plutonium and oxide dust stabilized in gloveboxes (total of about 29,000 Ci). Various pieces of dangerous debris and equipment containing or contaminated with dangerous/mixed waste stored on the PUREX Canyon Deck were removed and placed in PUREX Storage Tunnel #2. In total, it contains more than 400,000 Ci of Cs-137 and Sr-90, as well as about 7200 Ci of total Pu. The PUREX Building and two tunnels are classified as nuclear Hazard Category 2 facilities (potential for significant onsite consequences). Other hazardous materials that remain are a relatively minor risk, as there are no substantial volatile, caustic, or reactive materials remaining.

Final Cleanup and Disposition: Final D&D of the PUREX building is expected to be similar to the "Close in Place-Partially Demolished Structure" alternative chosen for the 221-U Plant. There are several D&D options for the rail cars and equipment in the two tunnels, including injecting grout and close in-place or removal, treatment, and onsite or offsite disposal. The Tri-Party Agreement requires DOE to submit a change package by September 30, 2015 to establish a schedule for submittal of the remedial investigation/feasibility study work plans for PUREX and other 200 Area canyon facilities.

Primary Risks: The primary risks at PUREX are largely linked to a seismic or other natural phenomenon event that would cause structural failure of the 202-A Building or tunnels and would release much of the dispersible radiological contaminants. An additional primary risk is a fire in Tunnel #1 that would result in a similar release.

COMPARISON OF INVENTORIES AND PHYSICAL/CHEMICAL STATES OF WASTES AND CONTAMINANTS, BARRIERS

There are significant differences in the primary radiological inventories currently present at these three D4 EUs, as well as the long-term integrity of current barriers to release or allow dispersion of the contaminants (Table 3-19) and the potential unmitigated radiological dose impact to the co-located person and the public (Table 3-20). The K Reactors (excluding consideration of the K-West Basins) are Hazard Category 3 facilities. The radiologic inventory in each reactor is less than about 18,000 Ci, much of which is tritium that has a half-life of 12.3 years (7010 Ci), and the contaminants are located within a concrete and steel reinforced reactor block (Figure 3-50) that is sufficient to withstand a design basis seismic event.

Table 3-19. Summary of major radiological primary contaminant inventories, form, and barriers to release.

	Primary Contaminants (Ci)					
Evaluation Unit	**Cs^{137}**	**Sr^{90}**	**Pu (total)**	**Am^{241}**	**Form**	**Containment/ Barriers**
BUILDING 324 (RC-DD-1):[a]						
Building	42,000	23,000	NP	NP	Fixed and dispersible	Concrete walled A- and B-Cells and room containing High-Level Vault and Low-Level Vault tanks.
Soils	460,000	200,000	NP	NP	Mobile	Plume located between B-Cell footings and cobble layer 4 ft below[84]
K REACTORS (RC-DD-2):						
Reactors	35	12	7.4	<1	Fixed and dispersible	Concrete and cast iron reactor block
Building Exterior	0.75	0.34	0.033	0.033		
PUREX (CP-DD-1):[b]						
202-A Building	11,000	8,900	8,100	1,200	Fixed and dispersible	Concrete walled canyon
Tunnel #1	10,000	8,200	2,500	440	Fixed and dispersible	Wood tunnel walls covered by 8 ft of soil
Tunnel #2	330,000	170,000	7,200	330	Fixed and dispersible	Concrete/metal tunnel walls covered by 8 ft of soil
Soils	1.1	1.2	0.034	0.0037		

a. The Building 324 EU source sites also contain 1000 kg of chromium and 10,000 kg of total uranium.
b. The PUREX EU source sites also contain 3300 kg of total uranium, 47,000 kg of nitrate, 42 Ci of tritium, and minor quantities of other PCs.

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[84] Washington Closure Hanford 2011, *Characterization of the Soil Contamination Under 324 B-Cell*, Calculation Sheet Project 618-10FR, Job No. 14655, Calc. No. 0300X-CA-N0140, Rev. 2, February 18, 2015.

Table 3-20. Unmitigated radiological dose (rem) impacts to co-located person and public.

	PUREX and Tunnels		Building 324		K Reactors	
Accident/Event Scenario	**Co-located Person**	**Public**	**Co-located Person**	**Public**	**Co-located Person**	**Public**
Seismic (0.2g)	250	0.170	11	3	Reactor blocks are stable and inventory would not be released	
Partial building collapse	25	<0.02	NA	NA	NA	NA
Crane Drop - Tunnel #2	14	<0.01	NA	NA	NA	NA
Waste Handling Accidents	4	<0.01	268	79	NA	NA
Fires	14-70	<0.05	4	1	External fire K-East: low consequences	
Explosions	NA	NA	24	7	NA	NA

Table 3-21. Unmitigated dose impacts to co-located person and public.

	PUREX and Tunnels		Building 324		K Reactors	
Accident/Event Scenario	**Co-located Person**	**Public**	**Co-located Person**	**Public**	**Co-located Person**	**Public**
Seismic (0.2g)	High	Low	Medium	Medium	Reactor blocks are stable and inventory would not be released	
Partial building collapse	Medium	ND	NA	NA	NA	NA
Crane Drop - Tunnel #2	Medium	ND	NA	NA	NA	NA
Waste Handling Accidents	Low	ND	High	High	NA	NA
Fires	Med-High	ND	Low	Low	External fire K-East: low consequences	
Explosions	NA	NA	Medium	High	NA	NA

CONSIDERATIONS FOR TIMING OF THE CLEANUP ACTIONS

A delay in initiating and completing D4 activities would have different potential impacts on the co-located person and public/MOI at each of these three D4 sites. With the K Reactors, physical maintenance of the building structures will become a priority if there is long delay in constructing the safe storage enclosures (holes in roof, etc.). The timing of construction of the K-East SSE is partially linked to the desire to work on the K-West Reactor building around the same time to make efficient use of personnel and other resources; however, a long-term delay could cause residual contaminants in exposed soils to migrate toward groundwater. D4 and waste site cleanup work on K-West cannot begin until the sludge is removed from the K-West used fuel basin and the fuel basins demolished, which is a separate project.

Delays in completing the proposed "Close in Place-Partially Demolish Structure" type D4 action on the PUREX 202-A canyon building and some type of grout in place and more permanent sealing of the two tunnels will leave the potential for the several natural phenomena hazard events and accidents mentioned earlier to occur, with resulting large aerial releases of contaminants. The timber walls and ceiling of Tunnel #1 will also continue to weaken and possibly collapse causing a similar release of contaminants.

There is not a short-term threat of the Cs-137 and Sr-90 contaminants beneath Building 324's B-Cell migrating to groundwater levels based on current extent of radionuclide migration (over 30 years), but that could change if a driving force such as a large source of water (e.g., from a water main break) pushes the contamination lower. Conversely, there are potential benefits to near-term measures that prevent infiltration to the soils (e.g., covers or in situ grouting) and allow time for an order of magnitude decrease in radiation levels due to natural decay (ca. 90 years) or allowing natural attenuation to achieve long-term environmental safety. Many of the exposure risks from waste handling accidents inside the building will be alleviated by completion of the stabilization, deactivation, decontamination, decommissioning of equipment and systems work.

COMPARATIVE SUMMARY

Although DOE and its contractors employ active and passive safety class and safety significant systems and controls to mitigate the potential adverse impacts of virtually all but some natural phenomena events, identifying differences between the three D4 EUs requires consideration of the unlikely but possible failure of one or more of these controls and thus the unmitigated radiological dose exposures to onsite and offsite persons as represented by a hypothetical individual located 100 m from the EU boundary (co-located person) and another individual located at Hanford Site controlled access boundary (public or MOI). As revealed by the comparison of these three D4 sites, human health risks are driven by the following factors:

- Quantity (in Ci) of the contaminant
- Form of the contaminant (fixed, dispersible, mobile)
- Integrity of its containment (concrete canyon or reactor walls, tunnel, soils)
- Whether cleanup work is going on that could cause accidents
- For the public or MOI, the distance between the initiating event and the Hanford boundary

As noted earlier, the K Reactors represent the lowest risk among the three EUs. The amount of radiological contaminants is smaller and contained in the most stable structure, and no work is going on that would cause an accident that might release the contaminants.

The PUREX 202-A canyon building and two adjacent tunnels contain the largest quantities of radiological contaminants that could be dispersed in the air, but the current surveillance and maintenance work offers little or no opportunity for an accident that might release them into the air. A seismic-caused collapse of the building and tunnels or a fire in Tunnel #1 represent high exposure risks to humans near the facilities, but the 8.5 mile distance to the closest Hanford boundary significantly reduces exposure risks to the public/MOI.

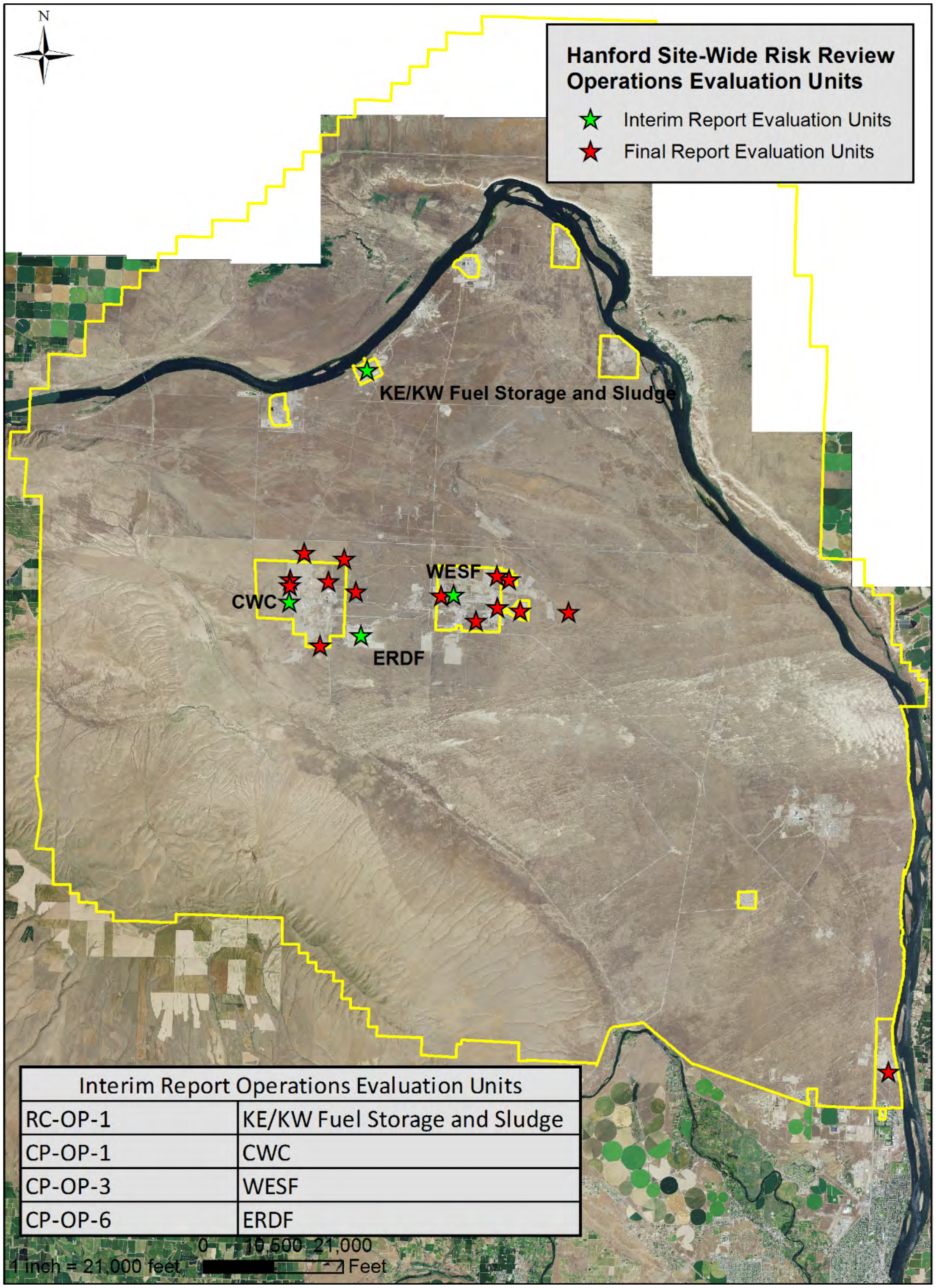
Building 324 represents the highest risk to human exposure among these three EUs. This is largely because the stabilization, deactivation, decontamination, decommissioning of equipment and systems work inside the building could cause accidents that release large amounts of radiological contaminants that adversely impact facility workers and co-located persons, as well as the public/MOI because of the relatively short distance between the building and the Columbia River Hanford Site boundary. In addition, although the building's foundation and structure is effectively containing a significant amount of Cs-137 and Sr-90 located in soils below the B-Cell by preventing any large infusion of rain, snow melt, or other water from reaching the contaminants, a worker-related fire inside the building could cause a fire protection water line on the building exterior to rupture and sufficient influx of water to the soil to cause the contaminants to migrate toward groundwater.

3.5. OPERATING FACILITY EVALUATION UNITS

The Hanford Site contains many facilities that are currently in active operations. These facilities are spread across the site and include many facilities to aid in the site cleanup, including both storage and treatment operations. Other types of onsite operating facilities are used to conduct research and testing for DOE programs.

An evaluation has been completed on the current condition and proposed actions of four of these facilities: the WESF, the ERDF, the K-West Basin Sludge Project, and the CWC. A summary of the findings from the review of these four facilities follows.

Figure 3-51 is a map of the Hanford Site showing the location of each of these facilities, with green stars identifying the three EUs included in this report and red stars identifying the EUs remaining to be evaluated as part of the final report.



Interim Report Operations Evaluation Units	
RC-OP-1	KE/KW Fuel Storage and Sludge
CP-OP-1	CWC
CP-OP-3	WESF
CP-OP-6	ERDF

Figure 3-51. Map of operating facilities with Hanford.

Description of Operating facilities

The following are short overview summaries of the Hanford operating facility group of EU:

- WESF (CP-OP-3)
- ERDF (CP-OP-6)
- K-West Basin Sludge (RC-OP-1)
- CWC (CP-OP-1)

Waste Encapsulation and Storage Facility

The WESF (Figure 3-52) was designed and constructed to process, encapsulate, and store Sr-90 and Cs-137 separated from wastes generated during the chemical processing of used fuel on the Hanford Site. Hanford produced 1577 cesium capsules and 640 strontium capsules for a total of 2217 capsules. However, during the years since their production some capsules have been removed from WESF and sent elsewhere for a range of purposes under a range of conditions. The capsules that have been returned are in storage currently (1959 total capsules). A total of 187 capsules were not returned to WESF and were deconstructed and placed into glass logs, and the remaining 71 capsules were destructively examined.

Figure 3-52. Waste Encapsulation Storage Facility.

The construction of WESF lasted from 1971 to 1973. Cesium processing was shut down in October 1983 and strontium processing was shut down in January 1985. Final overall process shutdown was accomplished in September 1985.

Current Status: Current WESF operations consist of essentially one task: safely storing cesium and strontium capsules within a series of interconnected pools within the WESF building. The current scope of the WESF mission is limited to facility maintenance activities: inspection, decontamination, and movement of capsules; and storage and surveillance of capsules.

Contaminants: Table 3-22 provides the currently estimated primary radiological contaminates at WESF (in curies). The majority of radioactive material (cesium chloride and strontium fluoride) at WESF is confined in doubly encapsulated stainless steel capsules. WESF currently stores 1335 cesium capsules, 23 of which are single-contained Type W overpack capsules, and 601 strontium capsules in pool cells located in the 225-B building. The radioactivity level contained within the Cs capsules is approximately 68 MCi (34 MCi of Cs-137 and 34 MCi of Ba-137m). The radioactivity level contained within the Sr capsules is approximately 30 MCi (15 MCi of Sr-90 and 15 MCi of Y-90). Contamination within the hot cells and connecting ventilation is approximately 300 kCi. The hot cells A through F (G is clean) contain around 55 kCi of Cs and 43 kCi of Sr. The connecting ventilation and ductwork to the hot cells contain around 2,800 Ci of Cs and 107,500 Ci of Sr.

Table 3-22. WESF (CP-OP-3) radionuclide inventory.

Radionuclides	Group	Cs/Sr Capsules, Ci	Hot Cells, Ducts, Ci
Americium-241	D	NP	NP
Carbon-14	A	NP	NP
Chlorine-36	A	NP	NP
Cobalt-60	C	NP	NP
Cesium-137	D	34,000,000	57,000
Europium-152	D	NP	NP
Europium-154	D	NP	NP
Tritium	C	NP	NP
Iodine-129	A	NP	NP
Nickel-59	D	NP	NP
Nickel-63	D	NP	NP
Plutonium-Total Rad[(a)]	D	NP	NP
Strontium-90	B	15,000,000	150,000
Technetium-99	A	NP	NP
Uranium- Total Rad[(b)]	B	NP	NP

a. Sum of plutonium isotopes 238, 239, 240, 241, and 242
b. Sum of uranium isotopes 232, 233, 234, 235, 236, and 238

Primary Risks: The primary current risk is that the safe containment of the cesium chloride and strontium fluoride within the capsules could be compromised under design basis accident and beyond design basis accident conditions if the pool cells were to lose water. The second most potentially significant event that could impact human health is a hydrogen explosion in hot cell G and the connecting K3 duct that releases contamination from the hot cells and connecting contaminated ventilation ducts, thereby releasing contaminants that become airborne and also cause external gamma radiation doses.

Final Cleanup and Disposition: Future plans are divided into two phases. The first phase is to upgrade the ventilation system and stabilize the hot cell contaminants. The long-term, tentative plan is to remove the Cs and Sr capsules from the pools by packaging the capsules into dry storage overpacks and storing them on the Hanford Site. This movement into dry storage will allow the adjacent building (B-Plant) to proceed with D&D plans tied to a TPA milestone.

Environmental Restoration and Disposal Facility (CP-OP-6)

Figure 3-53. Aerial view of ERDF.

The ERDF (Figure 3-53) is composite-lined waste disposal facility located on the Central Plateau area of the Hanford Site between the 200 West and 200 East Areas.[85] ERDF was constructed to permanently dispose of all wastes generated by remediation of Hanford Site past-practice and CERCLA waste sites in an environmentally protective manner. Waste disposal at ERDF predominantly consists of high-volume slightly contaminated soils and debris delivered by truck from remediation sites that are spreading in ERDF cells and compacted to minimize void space and limit future waste volume subsidence. However, other demolition wastes are also placed in ERDF, and when necessary, wastes are grouted to fill void spaces that could lead to compression and settlement over the long term.

ERDF is lined with a state-of-the-art double composite barrier system that has been shown to transmit virtually no leakage. The final cover proposed for ERDF also employs a composite barrier and an overlying water balance cover that will result in de minimis percolation. This high level of containment is complemented by a thick vadose zone (geologic zone above the water table) that is 80 to 100 m thick and provides the greatest possible distance to the water table compared to other Hanford waste sites. In addition, because ERDF is located in the middle of the Central Plateau, ERDF has largest distance practical for contaminant migration to the Columbia River from the Hanford Site.

Current Status: ERDF was constructed in a modular fashion so that additional disposal space can be built as needed. The first eight disposal cells were built in pairs located at the west end of the site. Each cell is approximately 152 m by 152 m at the bottom, approximately 21 m deep, and has a 3:1 (horizontal to vertical ratio) side slope that extends 64 m horizontally from the base of the cells. The latest cell construction toward the east (supercells 9 and 10) combines the cell pairings into larger cells, approximately the same size as each two-cell pair. Cells 1 through 4 have been filled, cells 5 through 8 are nearly filled, and supercells 9 and 10 are receiving waste. As of July 2013, approximately 13.6 million metric tons of waste has been disposed at ERDF since the facility started operations in July 1996 (an average of 800,000 metric tons per year).

Contaminants: Table 3-23 includes the currently estimated primary radiological contaminants at ERDF (in curies) and total uranium (in kg).

[85] ERDF is constructed to RCRA sub-title C design standards but is permitted under CERCLA as a corrective action management unit.

Table 3-23. ERDF (CP-OP-6) radionuclide inventory (2014) and projected at closure.

Radionuclides	Group	Curies (Ci) - 2014	Curies (Ci) – at closure
Americium-241	D	540	
Carbon-14	A	1,900	< 45,000
Chlorine-36	A	NP	< 300
Cobalt-60	C	5400	< 30,000
Cesium-137	D	15,000	< 2,000,000
Europium-152	D	4,800	
Europium-154	D	1,400	
Tritium	C	7,800	< 160,000
Iodine-129	A	0.019	
Nickel-59	D	190	
Nickel-63	D	15,000	< 110,000
Plutonium-Total Rad[(a)]	D	5,500	
Strontium-90	B	11,000	< 1,200,000
Technetium-99	A	21	< 860
Uranium- Total	B	200,000 kg	< 870,000 kg

a. Sum of plutonium isotopes 238, 239, 240, 241, and 242

Primary Risks: The primary risks at ERDF are associated with radiation exposure through worker contact with waste of much higher activity than expected when unloading trucks and placing waste in the disposal cell, and physical accidents associated with trucks and machinery within or entering/exiting the ERDF area.

Final Cleanup and Disposition: ERDF is intended for permanent disposal and isolation of wastes. No cleanup approaches are needed after the facility is filled and the final cover is installed. The only “clean up” activity is installation of the final cover.

K-West Basin Sludge (RC-OP-1)

Figure 3-54. K-West Basin sludge.

The K-East and K-West Basins (Figure 3-54) were constructed in the early 1950s to support K-Reactor operations. After irradiation, fuel was pushed from the horizontal fuel channels in the reactors into the discharge chutes and then sorted, canned, and queued underwater in the basins. This allowed for decay of radionuclides with short half-lives prior to reprocessing the fuel at either the 202-S REDOX or the 202-A PUREX facilities for plutonium and uranium recovery. The basins originally had a 20-year design life and were deactivated when the K-West and K-East Reactors were shut down. The K-West Basin was reactivated later as supplemental storage for irradiated N Reactor fuel. The basin superstructures are not sealed from the environment, which allowed sand, dirt, and organic material (weeds, bugs, etc.) to be deposited in the basins.

Current Status and Interim Cleanup: The present condition of the K-West Basin Sludge Project is safe storage of K-West and K-East sludge in engineered containers in the K-West Basin. Typical operations in the basin include the operation of the water treatment system; management of fuel fragments; retrieval, storage, movement and containerization of sludge; sorting and removal of debris (e.g., dust and sand); removal and disposition of equipment no longer in use; handling and interim storage of waste; and the construction of the K-West Basin Annex, which will house the Engineered Container Removal and Transfer System (ECRTS), the next phase of the K-West Basin Sludge Project.

Contaminants: The sludge in the K-West Basin is classified as remote handled TRU. This waste consists primarily of sludge retrieved from the K-East Basin and contains aluminum cladding shards, oxidized fuel, and metal fuel particles as well as windblown sand and environmental debris, spalled concrete from the basin walls, iron and aluminum corrosion products, and ion exchange resin beads. Sludge retrieved from the K-West Basin floor and the pit sludge stream prior to the retrieval and packaging of spent nuclear fuel for its removal, iron and aluminum corrosion products, flexible graphite [GrafoilTM1], limited amounts of uranium oxides, and uranium fuel particles.

Primary Risks: The primary or highest risks to workers and co-located persons at the K Basins during the current phase are (1) deflagration of accumulated hydrogen that has been generated through radiolysis and fuel corrosion accumulating in the headspace of the annular filter vessel while the Integrated Water Treatment System is out of service for an extended period (a leak allows air to enter, and a deflagration results); (2) industrial accidents that might cause a fire. The hazardous operations study for the ECRTS phase identified 13 events that are anticipated and have High consequences, including uncontrolled releases from initiating events.

Final Cleanup and Disposition: Cleanup of the K-West Basin Sludge Project involves closing several facilities: K-West Basin, K Basin Modified Annex, T Plant, and the future sludge treatment system facility.

In terms of the K-West Basin, the removal sludge is integral to the D&D process. When the sludge has been removed from the K-West Basin, the K-East and K-West Basins will continue with D&D procedures including the K Basin Modified Annex.

At the conclusion of the ECRTS activities, the sludge will be stored in T Plant in the sludge transportation and storage containers. These will eventually be removed from T Plant for Phase 2 of sludge processing, from which point the treated and packaged sludge will be stored and eventually shipped to WIPP. The emptied remaining sludge transportation and storage containers will be disposed of at a location TBD.

Central Waste Complex (CP-OP-1)

Current Status and Interim Cleanup: The CWC (Figure 3-55) provides storage, inspection (as required), limited processing, and staging for waste containers that are awaiting waste processing operations or disposal at other waste management facilities. The CWC receives waste from both onsite and offsite generators. Four types of waste are processed or stored at the CWC: low-level radioactive waste; mixed, low-level radioactive waste, TRU waste; and TRU mixed waste. The CWC can receive, as necessary, unvented containers from retrieval operations for staging prior to venting (for example, at T Plant).

Personnel receive and inspect waste packages at the Waste Receiving and Staging Area. In accordance with all applicable procedures, transport offloading operations are performed using handtrucks, forklifts, or cranes operated by qualified personnel. Packages are transferred from the offloading area to the appropriate CWC storage building or other storage area. Alternatively, waste packages may be received, inspected, and unloaded at the specific CWC building or storage area where the waste would be stored. Typical stored waste packages include 208-liter (55-gallon) drums; 322-liter (85-gallon) overpacks; and fiberglass-reinforced plywood, plywood, or metal boxes. Atypical packages include, but are not limited to, radioisotopic thermoelectric generators, vault tank filter assemblies, blanked-off gloveboxes, overpacks, and pipe overpacks in 208-liter (55-gallon) drums.

Figure 3-55. Central Waste Complex.

Contaminants: In the Master Documented Safety Analysis for Solid Waste Operations Complex (HNF-14741), the bounding drum and array analysis assumptions of the DOE-STD-3009-2014 and SARAH (HNF-8739) are used. In that bounding drum, the radionuclides are assumed to be Pu-238, Pu-239 (more than 80% by activity), Pu-240, Pu-241, and Pu-242, along with the Pu decay product Am-241. Debris from D&D and operational wastes, notably from PNNL and tank farms, WRAP, Low Level Burial Grounds, and T Plant also contain fission products (Cs-137, Sr-90). However, majority of presently stored waste is classified as remote handled or contact handled TRU. The waste also contains some RCRA-classified dangerous waste as well as pyrophoric materials including sodium.

Primary Risks: The primary hazards at the CWC are radiological and chemical hazards to the workers, both remediation and co-located, as well as the environment, including near-surface soils and groundwater. Several waste containers at the facility have been determined to have leaks or have the potential to develop leaks in the near future. Leaking waste containers are the primary source of the hazards described above. Along with potential leaks, there is an exposure pathway for some radiation to workers performing daily activities around the waste. Accident scenarios with High consequences to co-located workers had an unlikely frequency. These included two fire scenarios (small inside fire, small outside fire) and a seismic building collapse (design basis seismic event).

Final Cleanup and Disposition: Addendum H of the RCRA Permit for the CWC outlines closure activities as follows: (1) remove waste inventory, (2) decontaminate structural surfaces and equipment, (3) analyze decontamination waste to determine proper methods of treatment/disposal, and (4) dispose of decontamination waste based on results of waste analysis. The cleanup phase is expected to take 180 days. The DSA states that D&D and cleanup activities have yet to be planned. Future uses would await post-D&D condition assessment; however, CWC is located on the Central Plateau, an area presently scheduled for continued federal custody.

COMPARISON OF RADIOLOGICAL INVENTORIES, CONTAINMENT, AND POTENTIAL IMPACTS

Table 3-24 summarizes the radiological inventories associated with each operating facility EU. Table 3-25 compares the estimated unmitigated doses to a co-located person from postulated event scenarios.

Table 3-24. Radiological inventories, form, and barriers to release for operating facility EUs.

Operating Facility EU Name (Barrier Type) [Contaminant: Fixed (F), Dispersible (D), Mobile(M)]	Cs-137 [Ci]	Sr-90 [Ci]	Tc-99 [Ci]	H-3 [Ci]	Pu (total) [Ci]	U (total) [Ci]	Sum of all other radio-nuclides [Ci]	Isotope Names
KW Sludge Treatment Project (b) [F and D]	13,000	17,000	9		15,000	17		
Central Waste Complex (e) [F and D]					53,000			
WESF (Cs/Sr capsules) (b) [F and D]	34,000,000	15,000,000					49,000,000	Ba-137m, Y-90
WESF (Hot Cells, Ducts) (b) [F and D]	57,000	150,000						
ERDF (CY2014) (d) [F]	15,000	11,000	21	7,800	5,500	200,000 kg	15,000	C-14, Co-60, Ni-63
ERDF (Closure) (d) [F]	<2,000,000	<1,200,000	<860	<160,000		<870,000 kg	<190,000	C-14, Co-60, Ni-63

Notes: If there is a blank cell, then values are not available. Barrier type indicated by letter within parentheses after operating facility EU name: (a) None, (b) Bldg. & Engr. System, (c) Soil Cover & Veg., (d) Liner, (e) Packaging, (f) Packaging post-2004, (g) Tank Constr. (Single Shell Tank), (h) Tank Constr. (Double Shell Tank), (i) Remedial Process in Place.

Table 3-25. Unmitigated radiological dose (rem) impacts to co-located person and public.

Accident/Event Scenario	CWC		K Basins Sludge		WESF[(a)]		ERDF	
	Co-located Person	Public	Co-located Person	Public	Co-located Person	Public	Co-located Person	Public
Seismic (0.2g)	285	0.75	NA	NA	21	0.006	NA	NA
Loss of Water	NA	NA	0.0044	0.0002	277	0.21	NA	NA
Water Release (Spray)	NA	NA	0.68	0.033	3.1	0.0028	NA	NA
Waste Handling Accidents	53.5	0.05	13.4	1.23	NA	NA	<1	NA
Fires	770	0.73	5.7	0.28	7.8	0.006	NA	NA
Explosions	NA	NA	3.2	0.15	102	0.031	NA	NA

a. The beyond design basis event earthquake is not evaluated in the DSA, but a separate analysis was performed, titled *WESF Beyond Design Basis Accident Conditions and Plans* (CHPRC-02047, Rev. 0). The unmitigated doses were estimated to be 380 rem for the co-located person (380 rem) and 0.24 rem for a member of the public. Note that the design basis earthquake cannot cause the loss of pool cell water by itself; a combination of operational (human-caused) errors and conditions is required that is, in effect, a ***beyond*** design basis event. The difference is that the design basis earthquake only releases material from the hot cells and connecting ventilation system and the beyond design basis event earthquake releases material from the capsules stored in the pool cells at WESF.

Table 3-26. Unmitigated radiological risk rating impacts to co-located person and public.

Accident/Event Scenario	CWC		K Basins Sludge		WESF		ERDF	
	Co-located Person	Public	Co-located Person	Public	Co-located Person	Public	Co-located Person	Public
Seismic (0.2g)	High	Low	NA	NA	Medium	ND	NA	NA
Loss of Water	NA	NA	ND	ND	High	Low	NA	NA
Water Release (Spray)	NA	NA	Low	ND	Low	ND	NA	NA
Waste Handling Accidents	High	ND	Medium	Medium	NA	NA	Low	NA
Fires	High	Low	Medium	Low	Medium	ND	NA	NA
Explosions	NA	NA	Low	Low	High	ND	NA	NA

Dependence on other Facilities and Considerations for Timing of the Cleanup Actions

The K-West Basin Sludge Treatment Project has direct ties to several other facilities and processes, including the D&D of the K-West Reactor facility, and an interim period of operations at T Plant. The project also involves a future facility to treat the sludge, the location of which has yet to be determined.

The K-West Basin Sludge Treatment Project is multi-phase, and delay would have different impacts, depending on when it occurred. These will be addressed in chronological order:

1. *Delay in removing the sludge from the K-West Basin* – The sludge stored in engineered containers at the K-West Basin is the last significant quantity of nuclear material in the K Area. Transportation of this material out of the K Area to T Plant is on the critical path to enable completion of environmental restoration activities on the K Area.
2. *Delay in design and construction of the Phase 2 Sludge Treatment System* – T Plant is intended to be only an interim stop for the sludge material from K Basins. CH2M Hill Plateau Remediation Company (CHPRC) has completed alternatives analysis and recommended a warm water oxidation system to stabilize the remaining uranium in the sludge (along with some limited development of backup/enhancement technologies). The DOE Richland Operations Office has approved this path forward and CHPRC has developed a preliminary technology development plan to mature the technologies to support design of the Phase 2 treatment system. Delays in design and construction of the Phase 2 treatment system, or the technology development program to support it, would result in the sludge being stored for longer than currently planned in T Plant. Such a delay could make retrieval of the sludge for processing problematic. (Note: The aging properties of the sludge materials while in storage at T Plant is a line of inquiry in the technology development planning.)

The CWC has ties to WRAP, the Low Level Burial Grounds, and T Plant. For the CWC there are two foreseeable delays: (1) overall delays that that result in the risks and hazards of the operating facility continuing as they are, without moving into a cleanup phase; (2) problems with WIPP or other long-term storage that would require the CWC to remain available to store TRU for an extended period, which would result in the continuation of operating risks and hazards.

WESF is a multi-phase project and delay would have different impacts, depending on when it occurred. These impacts are addressed below:

4. *Delay in completion of the WESF Stabilization and Ventilation Modification Project* – This will result in a longer period in which (1) a substantial (~300,000 Ci) source term is available for potential dispersion during a beyond design basis event, and (2) the ventilation system at WESF is not in compliance with requirement for confinement ventilation systems, thus increasing the potential for an inadequately filtered release from WESF.
5. *Delay in removal of the Cs and Sr capsules* - The Waste Management EIS mentions two potential options for addressing the HLW present in the capsules at WESF: (1) designing and building a facility that would be an adjunct to the WTP, which would allow the capsules to be opened, prepared, and fed to the HLW vitrification melter; and (2) more recently, due to the age of WESF and schedule challenges at WTP, the retrieval of the capsules from the storage pool in WESF and placement in dry cask storage, similar to commercial spent nuclear fuel, to await disposition in a geologic repository. Both options require the design and construction of new facilities. Delay in either option results in extended storage of the capsules in the 40-year-old WESF.
6. *Continued need to perform surveillance and maintenance on WESF systems and Cs and Sr capsules*. – The timeliness of moving capsules out of WESF does impact the progress of the D&D timeline of B Plant and milestone TPA M-092-05 (Ecology, EPA, and DOE 1998).

ERDF provides the end-state from other projects on site, and the activities at ERDF can scale up or down depending on the level of activity at the projects that supply waste. ERDF will continue to operate until all other projects at Hanford are complete, and then will undergo final closure as the last active construction-related project at Hanford.

Clarification of Stages for Each Facility

The Sludge Treatment Project consists of three phases, two of which are discussed in this report: (1) storage and transfer of sludge from K-West Basin to T Plant and (2) treatment of sludge and shipment for disposal. Each phase has several stages. Phase 1 stages include (1) storage of sludge in K-West Basin, (2) the Engineered Container Removal and Transfer System (ECRTS); and (3) storage of sludge in T Plant. Phase 2 stages include sludge treatment. A third phase, processing of knock out pot material, has been completed and will not be discussed in this review.

The CWC does not have several operational phases; however, the D&D processes and ultimate disposition of the land will involve processes that are yet to be determined.

Future plans for WESF are divided into two phases. The first phase is to upgrade the ventilation system and stabilize the hot cell contaminants. The long-term, tentative plan is to remove the Cs and Sr capsules from the pools by packaging the capsules into dry storage overpacks and storing them on the Hanford Site. This movement into dry storage will allow the adjacent building (B Plant) to proceed with D&D plans that are tied to a Tri-Party Agreement milestone.

ERDF has three stages: filling, final closure, and long-term surveillance. ERDF is currently in the filling stage. During filling, additional cells are constructed to support disposal at the Hanford Site. Ten cells currently exist, with expansion possible for two more cells. However, given the available space surrounding ERDF, much more expansion beyond 12 cells could be provided. New cells are added as existing cells are filled and demand exists for more disposal volume. Once filling is complete, the final closure stage will be undertaken, followed by long-term surveillance.

Comparative Summary

Although DOE and its contractors employ active and passive safety class and safety significant systems and controls to mitigate the potential adverse impacts of virtually all but some natural phenomena events, identifying differences between the four operating facilities EUs requires consideration of the unlikely but possible failure of one or more of these controls and thus the unmitigated radiological dose exposures to onsite and offsite persons as represented by a hypothetical individual located 100 m from the EU boundary (co-located person) and another individual located at Hanford Site controlled access boundary (public or MOI). As revealed by the comparison of these four operating facility sites, human health risks are driven by the following factors:

- Quantity (in Ci) of the contaminant
- Form of the contaminant (fixed, dispersible, mobile)
- Whether cleanup work is going on that could cause accidents
- For the public or MOI, the distance between the initiating event and the Hanford boundary

The WESF operating facility contains the highest level of radioactivity contained within capsules but it is beyond extremely unlikely that an initiating event would cause a release from the capsules. The integrity of the capsules is tested regularly and the structural analysis of the pool cell concrete has estimated that even with a very conservative estimate of 50% concrete strength degradation, the pool cell structure would still survive a design basis earthquake.

By far, the highest unmitigated dose to the co-located person (770 rem) is associated with a fire in the CWC. The second highest unmitigated dose to the co-located person (285 rem) is associated with the design basis event for the CWC. The third highest unmitigated dose to the co-located person (277 rem) is associated with the loss of all pool cell water resulting from a combination of external events and human response failures at WESF.

The highest unmitigated dose to a member of the public (1.23 rem) is associated with a waste handling accident at the K Basins Sludge facility. The second highest unmitigated dose to a member of the public (0.75 rem) is associated with a design basis earthquake affecting the CWC. A fire at the CWC would result with the third highest unmitigated dose to the member of the public (0.73 rem). Interestingly, WESF unmitigated doses to the hypothetical member of the public at Hanford's site boundary are much lower for other operating facility EUs.

The only potential hazard to the co-located person or the public at the ERDF site is associated with a waste handling accident (radiological or non-radiological, although the former is dominant). Such accidents are considered as anticipated but unlikely and would have a Low consequence to the co-located person 100 m from the ERDF boundary.

CHAPTER 4. RESULTS FROM REVIEW FOR EACH RECEPTOR CATEGORY

4.1. INVENTORIES

Figure 4-1 through Figure 4-4 summarize the inventories of selected radionuclides and chemical contaminants for comparison across EUs. On a total curie basis, Cs-137 and Sr-90 dominate the total inventory of radionuclides across all EUs evaluated. The largest inventories of Cs-139 and Sr-90 are in the WESF capsules, 200 East DSTs, and the S-SX and A-AX tank waste and farm EUs (Figure 4-1). The sum of all other radionuclides for WESF (representing decay products) are of the same order of magnitude as the inventory in the Cs-137 and Sr-90 capsules. However, the inventory of all radionuclides in the Energy Northwest Columbia Generating Station, which are present in current and used fuel (including fission products), is much greater than the Hanford inventories examined. The Cs-137 and Sr-90 inventory in the soils underlying Building 324 is the dominant contributor to the overall Building 324 EU and PUREX Tunnel #2 is the dominant contributor to the overall PUREX EU.

Pu (total) is primarily in the CWC (packaged wastes), tank wastes, PUREX (distributed between the 202-A Building and the tunnels) and the Pu-contaminated waste sites EUs (Figure 4-2). U (total) is primarily associated with the tank waste and farms EUs, with smaller amounts present in PUREX and anticipated to be in ERDF at the time of closure (based on permit specifications).

Tc-99 and I-129 are primarily associated with the tank waste and farms EUs and legacy disposal practices at BC Cribs and Trenches, and also are anticipated to be in ERDF at the time of closure (Figure 4-3).

For chemical contaminants (Figure 4-4), substantial inventories of total chromium are associated with the tank waste and farm EUs, BC Cribs and Trenches, and similar inventories associated with the subsurface at 200 East and 200 West Areas. Carbon tetrachloride is primarily associated with legacy disposal practices that originated in the Pu-contaminated waste sites but then migrated in the groundwater in the 200 West Area. Significant quantities of TCE are only present in one of the River Corridor EUs.

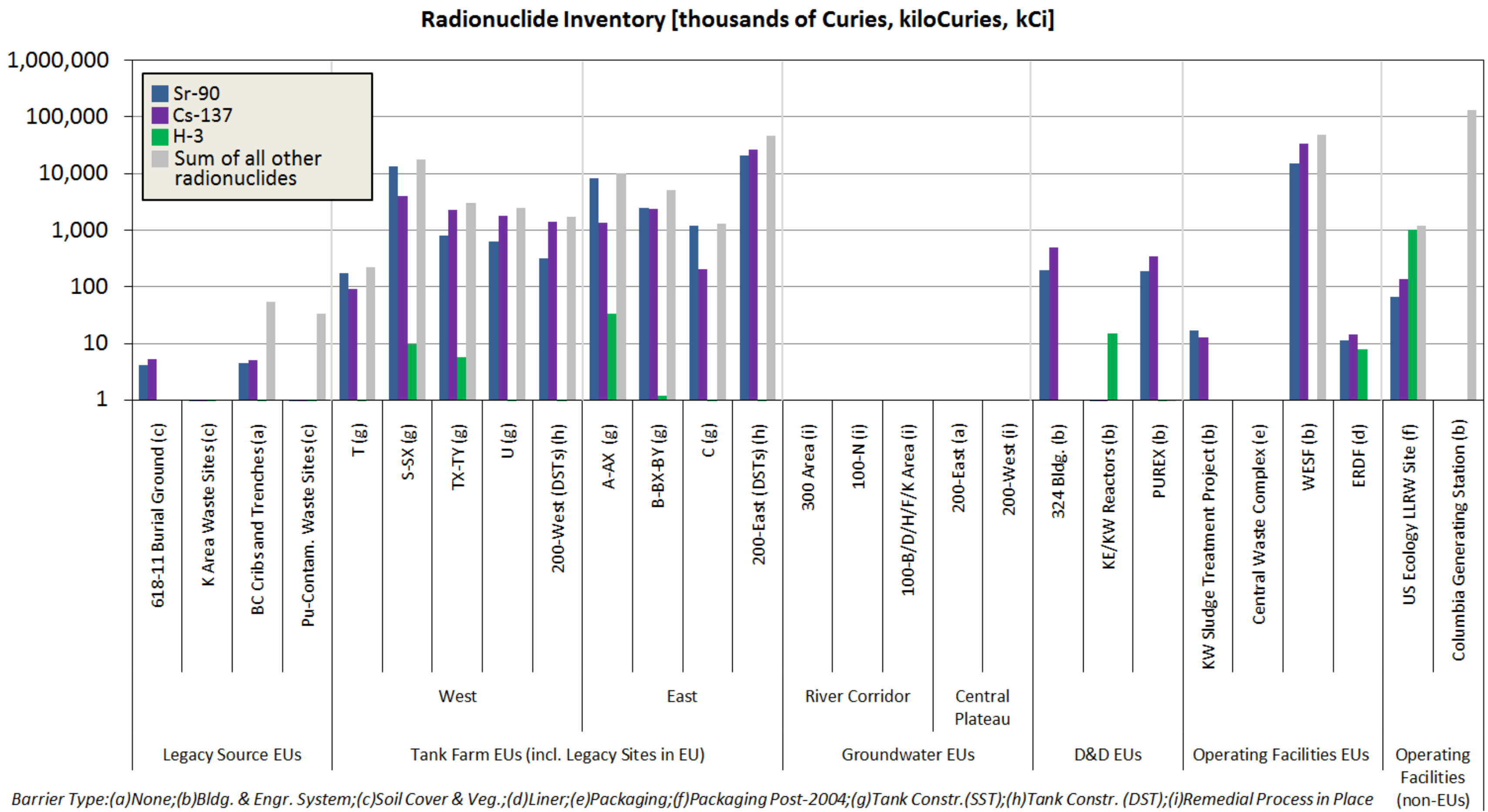


Figure 4-1. Radionuclide inventories – Sr-90, Cs-137, tritium (H-3): Comparison of inventories for each EU.

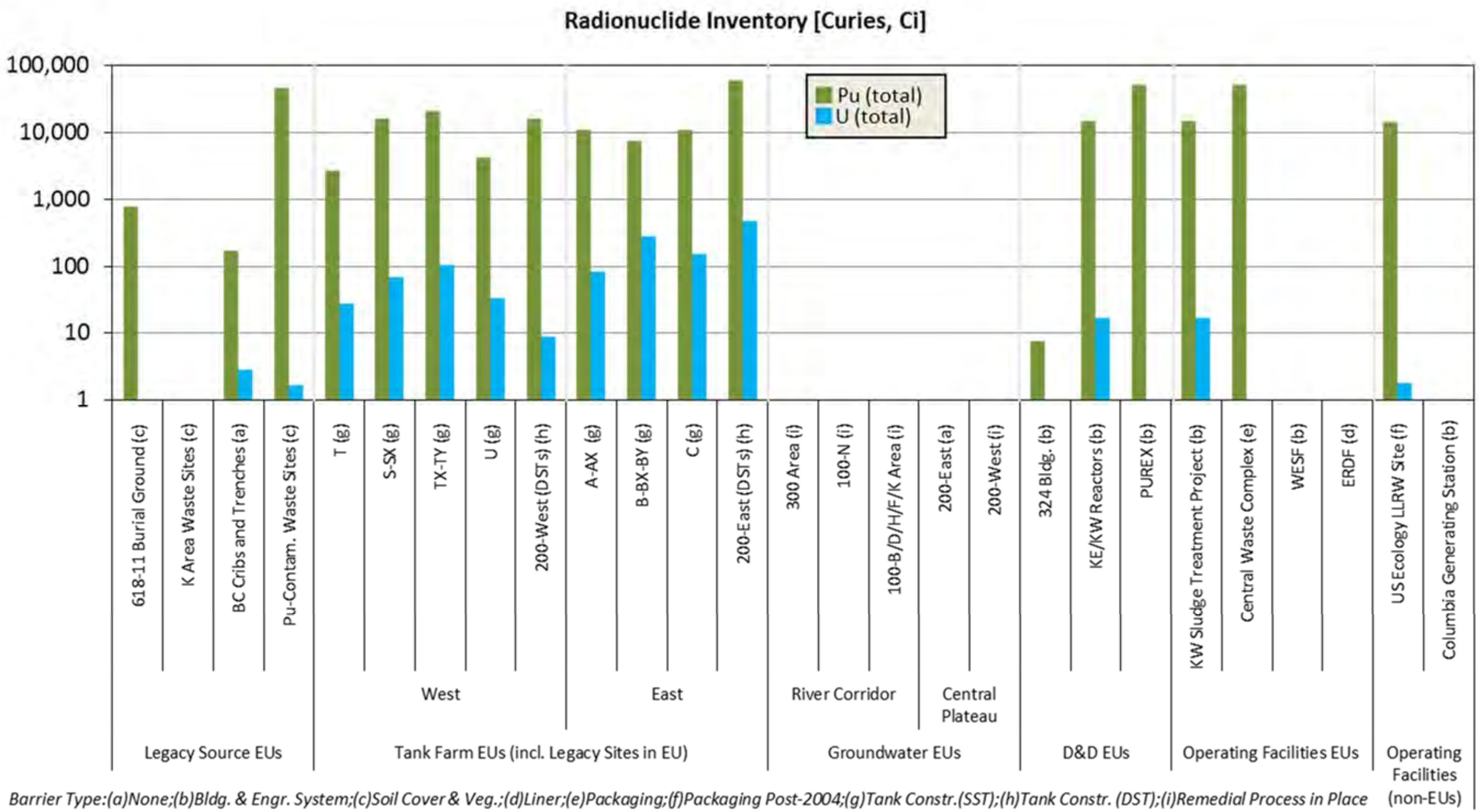


Figure 4-2. Radionuclide inventories – Pu (total) and U (total): Comparison of inventories for each EU.

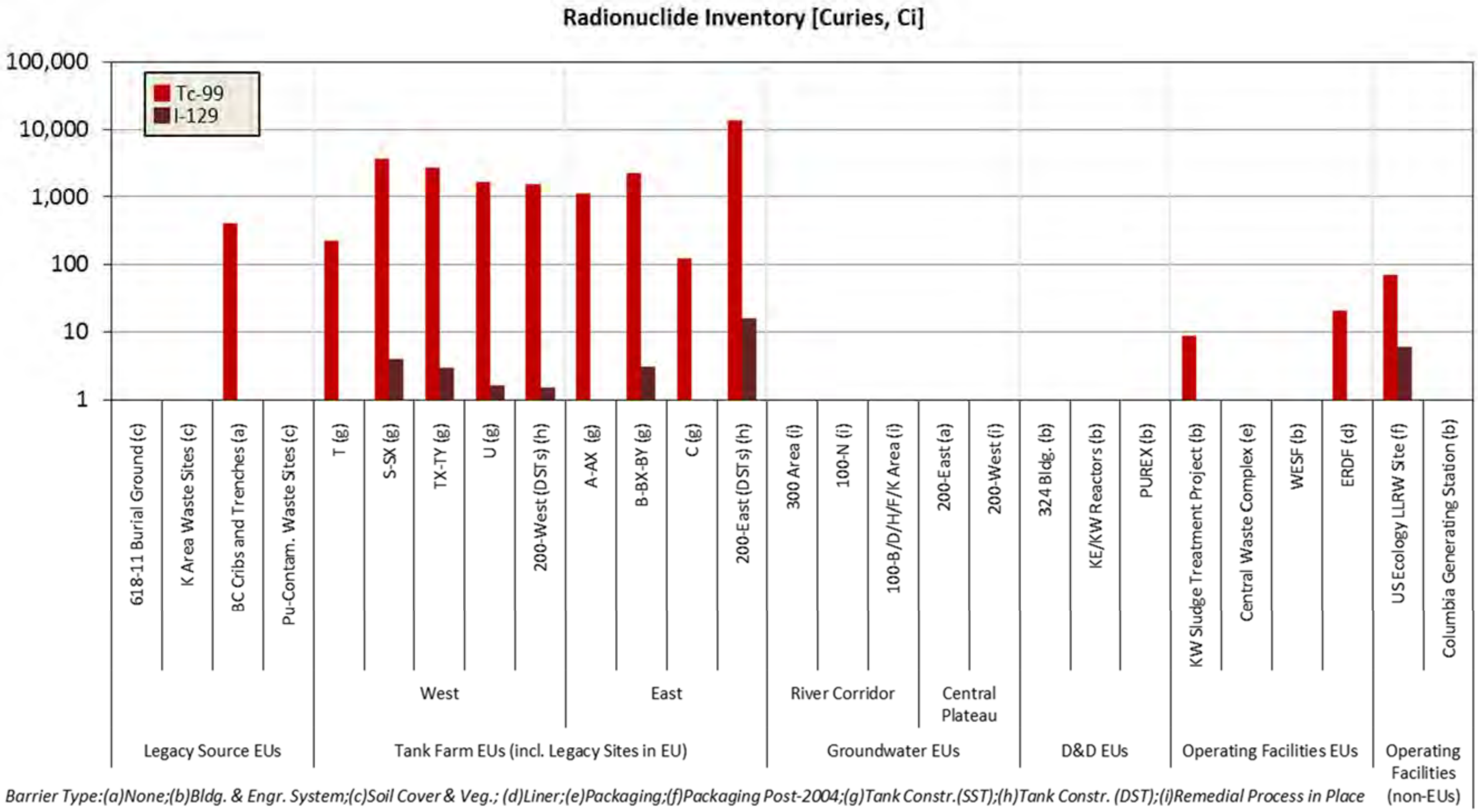


Figure 4-3. Radionuclide inventories – Tc-99 and I-129: Comparison of inventories for each EU.

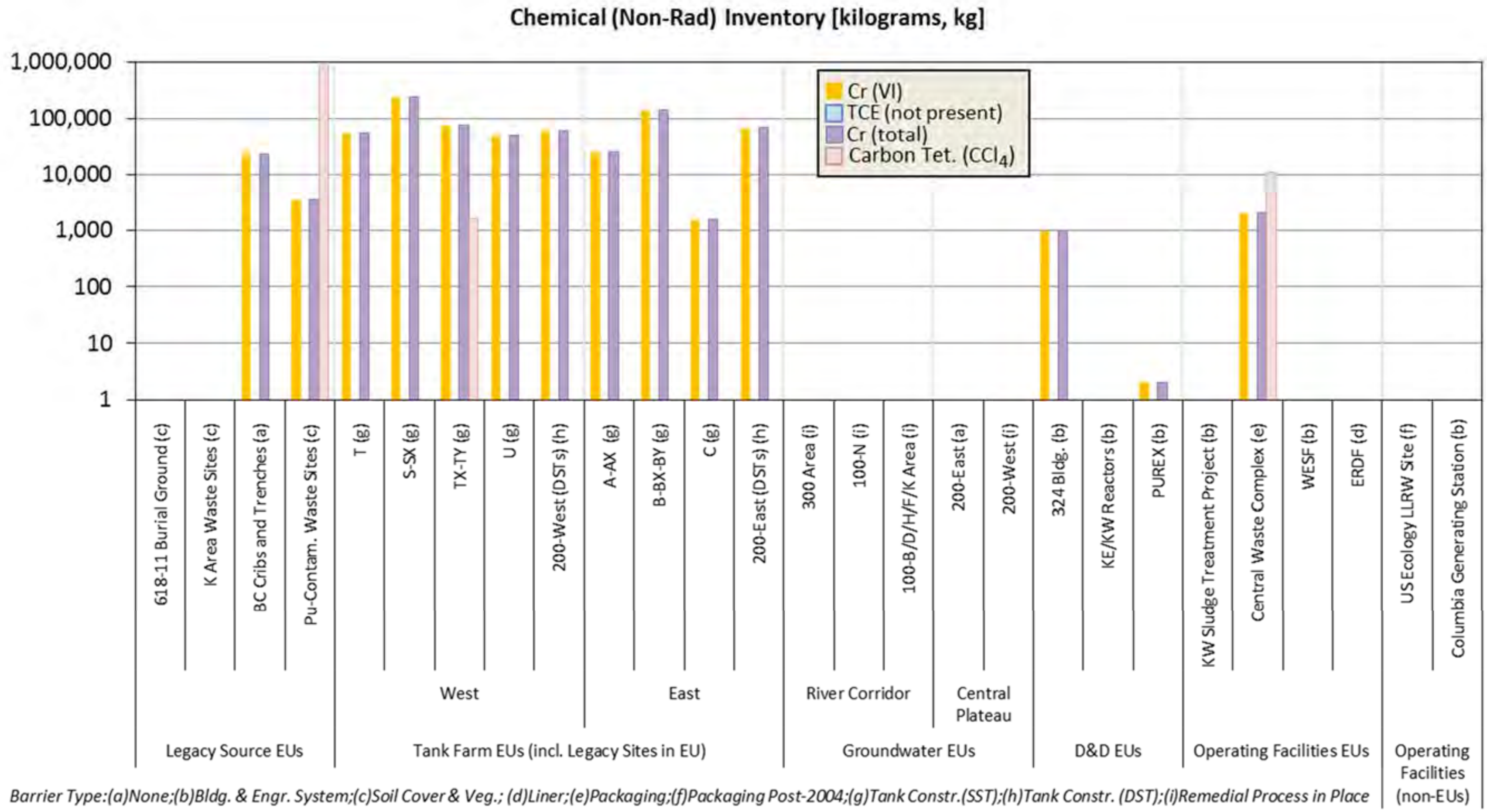


Figure 4-4. Chemical inventories – Cr(VI), Cr(total), TCE, and carbon tetrachloride: Comparison of inventories for each EU.

4.2. HUMAN HEALTH (MITIGATED AND UNMITIGATED)

Figure 4-5 compares estimated unmitigated doses to the co-located person for the highest dose scenarios associated with each EU. Significant potential doses from operational accidents are associated with the 324 Building, the CWC, WESF ducts, PUREX, and 618-11 Burial Grounds. Estimated doses from natural phenomenon and external events are as a consequence of a severe seismic, fire, or loss of active controls (e.g., ventilation or cooling water) associated with an extended period of loss of power. Further discussion of each of these scenarios can be found in the related appendices that provide the Evaluation Template for each facility.

Table 4-1 through Table 4-9 provide the summary ratings for each EU with respect to human health. Ratings for facility workers are first by Type 1 (acute threats from sudden events or nuclear safety accident scenarios), Type 2 (acute threats from sudden events or nuclear safety accident scenarios), and Type 3 (threats from industrial accidents (heat stress, physical trauma, etc.)) events and accidents that threaten worker safety. Review of these ratings clearly indicates worker safety threats are predominantly from the cleanup activities, although some worker safety threats are present from maintenance and monitoring activities both before and after cleanup. Furthermore, nuclear safety event scenarios are the most important differentiator between ratings of specific EUs, followed by the type of EU (e.g., legacy sites vs. D4 EUs).

For threats to public health, operational accidents at the legacy waste site 618-11 and the D4 EU Building 324 are the only cases where the Risk Review Project ratings are higher than low.

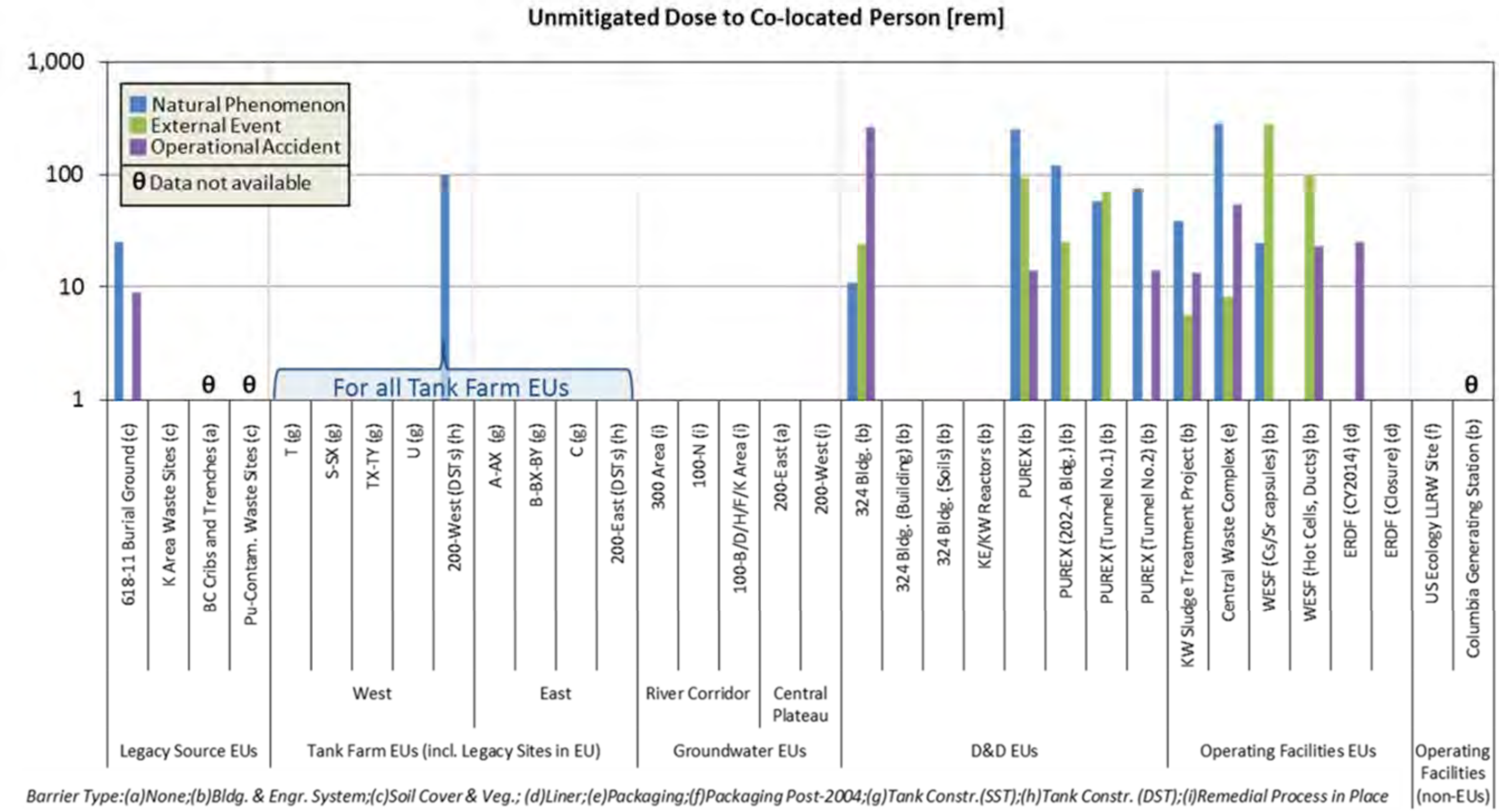


Figure 4-5. Unmitigated dose to co-located person (rem): Comparison of event types and dose estimates for each EU.

Table 4-1. Summary of Risk Review Project ratings: facility worker Type 1, 2, and 3 worker safety events and accidents. (See symbology legend p. xxv)

EU Name	EU #	Type 1 - Acute threats from sudden events or nuclear safety accident scenarios	Type 2 - Subacute or chronic threats from occupational exposures to chemicals or radiation	Type 3 - Threats from industrial accidents (heat stress, physical trauma, etc.)
Legacy Sites				
618-11 Burial Grounds	RC-LS-1	Low to Med	ND to Low	Low
K –Area Waste Sites	RC-LS-2	Low	ND to Low	Low
BC Cribs and Trenches	CP-LS-1	Med	ND to Low	Low to Med
Pu-Contaminated Waste Sites	CP-LS-2	Low to Med	ND to Low	Low to Med
Tank Farms				
T Tank Farm	CP-TF-1	High	Low to Med	Low to Med
S-SX Tank Farms	CP-TF-2	High	Low to Med	Low to Med
TX-TY Tank Farms	CP-TF-3	High	Low to Med	Low to Med
U Tank Farm	CP-TF-4	High	Low to Med	Low to Med
A-AX Tank Farms	CP-TF-5	High	Low to Med	Low to Med
B-BX-BY Tank Farms	CP-TF-6	High	Low to Med	Low to Med
C Tank Farms	CP-TF-7	High	Low to Med	Low to Med
200 East (DSTs)	CP-TF-8	High	Low to Med	Low to Med
200 West (DSTs)	CP-TF-9	High	Low to Med	Low to Med
Groundwater				
300 Area GW Plumes	RC-GW-1	ND to Low	ND to Low	Low
100-N GW Plumes	RC-GW-2	ND to Low	ND to Low	Low
00-B/D/H/F/K Area GW Plumes	RC-GW-3	ND	ND to Low	Low
200 East Groundwater	CP-GW-1	ND to Low	ND to Low	Low
200 West Groundwater	CP-GW-2	ND to Low	ND to Low	Low
D&D				
324 Building	RC-DD-1	Med to High	ND to Low	Low to Med
KE/KW Reactors	RC-DD-1	ND to Low	ND	Med to High
PUREX	CP-DD-1	Med to High	Low to Med	Low to Med
Operating Facilities				

EU Name	EU #	Type 1 - Acute threats from sudden events or nuclear safety accident scenarios	Type 2 - Subacute or chronic threats from occupational exposures to chemicals or radiation	Type 3 - Threats from industrial accidents (heat stress, physical trauma, etc.)
KW Basin Sludge	RC-OP-1	Med to High	ND to Low	Low to Med
CWC	CP-OP-1	Med to High	ND to Low	ND to Low
WESF	CP-OP-3	Med to High	ND to Low	Low to Med
ERDF	CP-OP-6	Low to Med	Low to Med	Low to Med

Table 4-2. Summary of Risk Review Project ratings: human health: facility worker. (See symbology legend p. xxv)

EU Name	EU #	Current	Active Cleanup	Near-Term Post-Cleanup
Legacy Sites				
618-11 Burial Grounds	RC-LS-1	ND	Med[a]	Low
K-Area Waste Sites	RC-LS-2	Low	Low	ND to Low
BC Cribs and Trenches	CP-LS-1	Low	Low to High[b]	Low
Pu-Contaminated Waste Sites	CP-LS-2	ND to Low	Low to Med[c]	ND to Low
Tank Farms				
T Tank Farm	CP-TF-1	Low to High	High	Low
S-SX Tank Farms	CP-TF-2	Low to High	High	Low
TX-TY Tank Farms	CP-TF-3	Low to High	High	Low
U Tank Farm	CP-TF-4	Low to High	High	Low
A-AX Tank Farms	CP-TF-5	Low to High	High	Low
B-BX-BY Tank Farms	CP-TF-6	Low to High	High	Low
C Tank Farms	CP-TF-7	Low to High	High	Low
200 East (DSTs)	CP-TF-8	Low to High	High	Low
200 West (DSTs)	CP-TF-9	Low to High	High	Low
Groundwater				
300 Area Groundwater Plumes	RC-GW-1	Low	Low	Low
100-N GW Plumes	RC-GW-2	Low	Low	Low
00-B/D/H/F/K Area Groundwater Plumes	RC-GW-3	Low to Med	Low to Med	Low
200 East Groundwater	CP-GW-1	Low to Med	Low to Med	Low
200 West Groundwater	CP-GW-2	Low to Med	Low to Med	Low
D&D				
324 Building	RC-DD-1	High[d]	High[d]	ND
KE/KW Reactors	RC-DD-1	Low	Low	ND to Low
PUREX	CP-DD-1	High[e]	High[e]	ND to Low
Operating Facilities				
KW Basin Sludge	RC-OP-1	Med	High[f]	NA[g]
CWC	CP-OP-1	High[h]	NA[i]	NA[9]

EU Name	EU #	Current	Active Cleanup	Near-Term Post-Cleanup
WESF	CP-OP-3	High[j]	High[j]	IS[k]
ERDF	CP-OP-6	Med[l]	Med[l]	ND

a. 618-11 Burial - Medium for sampling pit accident
b. BC Cribs - High for significant action associated with removal treatment and disposal
c. Pu-Contaminated - Medium for removal of heavily Pu contaminated soils
d. Building 324 - High for waste handling accident, Hydrogen deflagration, and seismic events
e. PUREX - High for seismic caused collapse of Building 202-A and fire in Tunnel #1
f. K-West Basin Sludge - High in phase 2 (ECRTS) under multiple scenarios
g. K-West Basin - D&D to be done with K-West Reactor
h. CWC - High for fire scenarios and seismic event
i. D&D of facility not yet planned
j. WESF - High for loss of pool cell water, hydrogen explosion in hot cell G or K3 duct, hydrogen explosion in ion exchange module (WIXM) and design basis seismic event
k. WESF - Insufficient information
l. ERDF - Medium for contact with waste of much higher activity than expected

Table 4-3. Summary of Risk Review Project ratings: human health: co-located person. (See symbology legend p. xxv)

EU Name	EU #	Current	Active Cleanup	Near-Term Post-Cleanup
Legacy Sites				
618-11 Burial Grounds	RC-LS-1	ND	Med[a]	ND
K –Area Waste Sites	RC-LS-2	Low	Low	ND
BC Cribs and Trenches	CP-LS-1	ND to Low	Low to Med[b]	Low
Pu-Contaminated Waste Sites	CP-LS-2	ND to Low	Low	ND
Tank Farms				
T Tank Farm	CP-TF-1	Low to Med	Low to Med	Low
S-SX Tank Farms	CP-TF-2	Low to Med	Low to Med	Low
TX-TY Tank Farms	CP-TF-3	Low to Med	Low to Med	Low
U Tank Farm	CP-TF-4	Low to Med	Low to Med	Low
A-AX Tank Farms	CP-TF-5	Low to Med	Low to Med	Low
B-BX-BY Tank Farms	CP-TF-6	Low to Med	Low to Med	Low
C Tank Farms	CP-TF-7	Low to Med	Low to Med	Low
200 East (DSTs)	CP-TF-8	Low to Med	Low to Med	Low
200 West (DSTs)	CP-TF-9	Low to Med	Low to Med	Low
Groundwater				
300 Area GW Plumes	RC-GW-1	Low	Low	Low
100-N GW Plumes	RC-GW-2	Low	Low	ND
00-B/D/H/F/K Area GW Plumes	RC-GW-3	Low to Med	Low to Med	ND to Low
200 East Groundwater	CP-GW-1	Low to Med	Low to Med	ND to Low
200 West Groundwater	CP-GW-2	Low to Med	Low to Med	ND
D&D				
324 Building	RC-DD-1	High[c]	High[c]	ND
KE/KW Reactors	RC-DD-1	Low	Low	ND
PUREX	CP-DD-1	High[d]	Med[d]	ND

Operating Facilities				
KW Basin Sludge	RC-OP-1	Med	High[e]	NA[f]
CWC	CP-OP-1	High[g]	NA[h]	NA[h]
WESF	CP-OP-3	High[i]	Med[j]	IS[k]
ERDF	CP-OP-6	Low[l]	Low[l]	ND

a. 618-11 Burial - Medium for Sampling Pit accident
b. BC Cribs - High for significant action associated with removal treatment and disposal
c. Building 324 - High for waste handling accident
d. PUREX - High for seismic caused collapse of Building 202-A and fire in Tunnel #1
e. KW Basin Sludge - High in phase 2 (ECRTS) under multiple scenarios
f. KW Basin - D&D to be done with K-West Reactor
g. CWC - High for fire scenarios and seismic event
h. D&D of facility not yet planned
i. WESF - High for loss of pool cell water and hydrogen explosion in hot cell G or K3 duct
j. WESF - Medium for design basis seismic event, crane drop through roof and hydrogen explosion K3 filter
k. WESF - Insufficient information
l. ERDF - Medium for contact with waste of much higher activity than expected

Table 4-4. Summary of Risk Review Project ratings: human health: public. (See symbology legend p. xxv)

EU Name	EU #	Current	Active Cleanup	Near-term Post-cleanup
Legacy Sites				
618-11 Burial Grounds	RC-LS-1	ND	Med	ND
K-Area Waste Sites	RC-LS-2	Low	Low	ND
BC Cribs and Trenches	CP-LS-1	ND	ND to Low	ND
Pu-Contaminated Waste Sites	CP-LS-2	ND	ND	ND
Tank Farms				
T Tank Farm	CP-TF-1	Low	Low	ND
S-SX Tank Farms	CP-TF-2	Low	Low	ND
TX-TY Tank Farms	CP-TF-3	Low	Low	ND
U Tank Farm	CP-TF-4	Low	Low	ND
A-AX Tank Farms	CP-TF-5	Low	Low	ND
B-BX-BY Tank Farms	CP-TF-6	Low	Low	ND
C Tank Farms	CP-TF-7	Low	Low	ND
200 East (DSTs)	CP-TF-8	Low	Low	ND
200 West (DSTs)	CP-TF-9	Low	Low	ND
Groundwater				
300 Area GW Plumes	RC-GW-1	ND	ND	ND
100-N GW Plumes	RC-GW-2	ND	ND	ND
00-B/D/H/F/K Area GW Plumes	RC-GW-3	ND to Low	ND to Low	ND
200 East Groundwater	CP-GW-1	ND to Low	ND to Low	ND
200 West Groundwater	CP-GW-2	ND to Low	ND to Low	ND
D&D				
324 Building	RC-DD-1	High[(a)]	High[(b)]	ND
KE/KW Reactors	RC-DD-1	Low	Low	ND-Low
PUREX	CP-DD-1	ND to Low	ND to Low	ND-Low

Operating Facilities				
KW Basin Sludge	RC-OP-1	Low	Low	NA[c]
CWC	CP-OP-1	Low	NA[d]	NA[d]
WESF	CP-OP-3	Low	Low	IS[e]
ERDF	CP-OP-6	ND to Low	ND to Low	ND

a. 618-11 – Med for sampling and retrieval accident, including impacts at Energy Northwest Columbia Generating Station
b. Building 324 - High for waste handling accident
c. K-West Basin - D&D to be done with K-West Reactor
d. D&D of facility not yet planned
e. WESF - Insufficient information

4.3. GROUNDWATER AND COLUMBIA RIVER

Many of the EUs being considered involve discharges of contaminants into the environment that either have resulted in current groundwater contamination or may in the future impact groundwater. In addition, groundwater may serve as a contaminant transport pathway for threats to the Columbia River. Table 4-5 through Table 4-7 provide the Risk Review Project ratings related to current and potential future groundwater contamination. Threats to groundwater evaluated are:

1. Groundwater currently contaminated and the potential for increased extent of contaminated groundwater from the spread of contaminants already in groundwater (Table 4-5)
2. The potential for existing environmental contamination in the near surface or vadose zone to increase the extent of contaminated groundwater (Table 4-6)
3. The potential for contaminants currently in engineered facilities (i.e., tank wastes) to increase the extent of contaminated groundwater.

The primary focus was on Group A and Group B primary contaminants because of their persistence and mobility.

Threats considered to the Columbia River from discharges of contaminated groundwater through springs and upwellings are (Table 4-7):

1. Threats to the riparian zone ecology
2. Threats to the Columbia River benthic zone ecology
3. Threats to the free stream ecology

Current threats to human health from groundwater are non-discernible because contaminated groundwater is not currently being used. The most sensitive receptors are (1) groundwater (as a protected resource) because of the large volumes of groundwater currently contaminated above resource protection thresholds, and (2) the riparian zone as part of the rating of threats to the Columbia River because of elevated contaminant concentrations in an area of sensitive ecosystems. Most of the groundwater EUs with elevated Risk Review Project ratings (in the River Corridor and the Central Plateau) are currently being treated, with the notable exception of groundwater and vadose contamination in the 200 East Area. The current state of groundwater contamination in the River Corridor suggests that current active treatment actions (e.g., groundwater pump and treat) should be evaluated for optimization and consideration of appropriate end-points.

Table 4-5. Summary of Risk Review Project ratings: threats to groundwater as a resource from existing groundwater contamination. (See symbology legend p. xxv)

EU Name	EU #	Risk Driver	Current	Active Cleanup	Near-Term Post-Cleanup
Groundwater					
300 Area GW Plumes	RC-GW-1	U-Total	Low	ND	ND
100-N GW Plumes	RC-GW-2	Sr-90	Medium	Medium	Medium
100-B/D/H/F/K Area GW Plumes	RC-GW-3	Cr-VI	Medium	Medium	Medium
200 East Groundwater	CP-GW-1	I-129	Very High	Very High	Very High
200 West Groundwater	CP-GW-2		Very High (CCl4)	Very High (CCL4)	High (I-129)

Table 4-6. Summary of Risk Review Project ratings threats to groundwater from contaminants currently in the vadose zone (includes current vadose zone inventory in Tank Farm and Waste EUs but not inventory within the tanks themselves). (See symbology legend p. xxv)

EU Name	EU	Risk Driver	Current	Risk Driver	Active Cleanup	Risk Driver	Near-term Post-cleanup
Legacy Site EUs							
618-11 Burial Grounds	RC-LS-1	Sr-90	Low	Sr-90	Low	Sr-90	ND
K–Area Waste Sites	RC-LS-2	C-14	Medium	C-14	Medium	C-14	Medium
BC Cribs and Trenches	CP-LS-1	I-129, Tc-99, Cr[(a)]	High	I-129, Tc-99, Cr[(a)]	High	I-129, Tc-99, Cr[(a)]	High
Pu-Contam-inated Waste Sites	CP-LS-2	CCl4	Very High	CCl4	Very High	CCl4	Very High
Tank Waste and Farms							
T Tank Farm	CP-TF-1	Cr[(a)]	High ǂ	Cr[(a)]	High ǂ	Cr[(a)]	High
S-SX Tank Farms	CP-TF-2	Cr[(a)]	High ǂ	Cr[(a)]	High ǂ	Cr[(a)]	High
TX-TY Tank Farms	CP-TF-3	Tc-99, CCl4, Cr[(a)]	High ǂ	Tc-99, CCl4, Cr[(a)]	High ǂ	Tc-99, CCl4, Cr[(a)]	High
U Tank Farm	CP-TF-4	Various[(b)]	Low ǂ	Various[(b)]	Low ǂ	Various[(b)]	Low

EU Name	EU	Risk Driver	Current	Risk Driver	Active Cleanup	Risk Driver	Near-term Post-cleanup
A-AX Tank Farms	CP-TF-5	Cr(a)	Medium ‡	Cr(a)	Medium [ ]‡	Cr(a)	Medium
B-BX-BY Tank Farms	CP-TF-6	I-129, Tc-99, Cr(a)	High ‡	I-129, Tc-99, Cr(a)	High [ ]‡	I-129, Tc-99, Cr(a)	High
C Tank Farms	CP-TF-7	I-129	Medium [ ]‡	I-129	Medium [ ]‡	I-129	Medium
200 East (DSTs)	CP-TF-8	Various(b)	Low	Various(b)	Low [ ]	Various(b)	Low
200 West (DSTs)	CP-TF-9		ND		ND [ ]		ND
D4							
324 Building	RC-DD-1	Sr-90	Low	Sr-90	Low [ ]		ND
KE/KW Reactors	RC-DD-2		ND		ND [ ]		ND
PUREX	CP-DD-1	Various(c)	Low	Various(c)	Low [ ]	Various(c)	Low
Operating Facilities							
KW Basin Sludge	RC-OP-1		ND		ND		ND
CWC	CP-OP-1		ND		ND		ND
WESF	CP-OP-3		ND		ND		ND
ERDF	CP-OP-6		ND		ND		Low

a. Cr represents both total and hexavalent chromium
b. The various non-zero inventory PCs are C-14, I-129, Sr-90, Tc-99, Cr(a), U-Total
c. The various non-zero inventory PCs are C-14, I-129, Tc-99, Cr(a)
d. 618-11 – Med for sampling and retrieval accident, including impacts at Energy Northwest Columbia Generating Station
e. Building 324 - High for waste handling accident
f. K-West Basin - D&D to be done with K-West Reactor
g. D&D of facility not yet planned
h. WESF - Insufficient information

Table 4-7. Summary of Risk Review Project ratings: threats to the Columbia River through groundwater contaminant transport. (See symbology legend p. xxv)

EU Name	EU	Receptor	Current	Active Cleanup	Near-Term Post-Cleanup
Groundwater (from existing groundwater contamination)					
300 Area GW Plumes	RC-GW-1	Benthic (all)	High[a]	ND	ND
		Riparian (all)	Medium	ND	ND
		Free-flowing (all)	ND	ND	ND
100-N GW Plumes	RC-GW-2	Benthic (all)	Medium (Sr-90)	Medium (Sr-90)	Medium (Sr-90)
		Riparian (all)	Low (Sr-90, Cr-VI)	Low (Sr-90, Cr-VI)	Low (Sr-90, Cr-VI)
		Free-flowing (all)	ND	ND	ND
100-B/D/H/F/K Area GW Plumes	RC-GW-3	Benthic (all)	High (Cr-VI)	Medium (Cr-VI)	Medium (Cr-VI)
		Riparian (all)	High (Cr-VI)	Medium (Cr-VI)	Medium (Cr-VI)
		Free-flowing (all)	ND	ND	ND
200 East Groundwater	CP-GW-1	Benthic (all)	ND	ND	ND
		Riparian (all)	ND	ND	ND
		Free-flowing (all)	ND	ND	ND
200 West Groundwater	CP-GW-2	Benthic (all)	ND	ND	ND
		Riparian (all)	ND	ND	ND
		Free-flowing (all)	ND	ND	ND
Legacy Site EUs					
618-11 Burial Grounds	RC-LS-1	Benthic (all)	ND	ND	ND
		Riparian (all)	ND	ND	ND
		Free-flowing (all)	ND	ND	ND
K–Area Waste Sites	RC-LS-2	Benthic (all)	ND	Low (C-14)	Low (C-14)
		Riparian (all)	ND	Low (C-14)	Low (C-14)
		Free-flowing (all)	ND	Low (C-14)	Low (C-14)
BC Cribs and Trenches	CP-LS-1	Benthic –			
		(radionuclides)	ND	ND	ND
		(chemicals)	ND	ND	ND

EU Name	EU	Receptor	Current		Active Cleanup		Near-Term Post-Cleanup	
		Riparian –						
		(radionuclides)	ND	○	ND	[○]	ND	◎
		(chemicals)	ND	○	ND	[○]	ND	◎
		Free-flowing (all)	ND	○	ND	[○]	ND	◎
Pu-Cont'd Sites	CP-LS-2	Benthic (all)	ND	○	ND	[○]	ND	◎
		Riparian (all)	ND	○	ND	[○]	ND	◎
		Free-flowing (all)	ND	○	ND	[○]	ND	◎
Tank Waste and Farms								
200-West SSTs								
T Tank Farm	CP-TF-1	Benthic (all)	ND	○ǂ	ND	○ǂ	ND	◎
		Riparian (all)	ND	○ǂ	ND	○ǂ	ND	◎
		Free-flowing (all)	ND	○ǂ	ND	○ǂ	ND	◎
S-SX Tank Farms TX-TY Tank Farms U Tank Farm	CP-TF-2 CP-TF-3 CP-TF-4	Benthic (all)	ND	◌ǂ	ND	[◌]ǂ	ND	◎
		Riparian (all)	ND	◌ǂ	ND	[◌]ǂ	ND	◎
		Free-flowing (all)	ND	◌ǂ	ND	[◌]ǂ	ND	◎
200-East SSTs								
A-AX Tank Farms B-BX-BY Tank Farms	CP-TF-5 CP-TF-6	Benthic –						
		(radionuclides)	ND	◌ǂ	ND	[◌]ǂ	ND	◎
		(chemicals[b])	ND	◌ǂ	ND	[◌]ǂ	Low	◔
		Riparian –						
		(radionuclides)	ND	◌ǂ	ND	[◌]ǂ	ND	◎
		(chemicals)	ND	◌ǂ	ND	[◌]ǂ	ND	◎
		Free-flowing (all)	ND	◌ǂ	ND	[◌]ǂ	ND	◎
C Tank Farms	CP-TF-7	Benthic –						
		(radionuclides)	ND	[◌]ǂ	ND	[◌]ǂ	ND	◎
		(chemicals)	ND	[◌]ǂ	ND	[◌]ǂ	ND	◎
		Riparian –						
		(radionuclides)	ND	[◌]ǂ	ND	[◌]ǂ	ND	◎
		(chemicals)	ND	[◌]ǂ	ND	[◌]ǂ	ND	◎
		Free-flowing (all)	ND	[◌]ǂ	ND	[◌]ǂ	ND	◎
	CP-TF-8	Benthic (all)	ND	⊚	ND	[⊚]	ND	⊚

EU Name	EU	Receptor	Current		Active Cleanup		Near-Term Post-Cleanup	
200 East DSTs		Riparian (all)	ND	◎	ND	[◎]	ND	◎
		Free-flowing (all)	ND	◎	ND	[◎]	ND	◎
200 West DSTs	CP-TF-9	Benthic (all)	ND	◎	ND	[◎]	ND	◎
		Riparian (all)	ND	◎	ND	[◎]	ND	◎
		Free-flowing (all)	ND	◎	ND	[◎]	ND	◎
D4								
324 Building	RC-DD-1	Benthic (all)	ND	◎	ND	[◎]	ND	◎
		Riparian (all)	ND	◎	ND	[◎]	ND	◎
		Free-flowing (all)	ND	◎	ND	[◎]	ND	◎
KE/KW Reactors	RC-DD-2	Benthic (all)	ND	◎	ND	[◎]	ND	○
		Riparian (all)	ND	◎	ND	[◎]	ND	○
		Free-flowing (all)	ND	◎	ND	[◎]	ND	○
PUREX	CP-DD-1	Benthic (all)	ND	◎	ND	[◎]	ND	◎
		Riparian (all)	ND	◎	ND	[◎]	ND	◎
		Free-flowing (all)	ND	◎	ND	[◎]	ND	◎
Operating Facilities								
KW Basin Sludge	RC-OP-1	Benthic (all)	ND	◎	ND	◎	ND	○
		Riparian (all)	ND	◎	ND	◎	ND	○
		Free-flowing (all)	ND	◎	ND	◎	ND	○
CWC	CP-OP-1	Benthic (all)	ND	◎	ND	◎	ND	◎
		Riparian (all)	ND	◎	ND	◎	ND	◎
		Free-flowing (all)	ND	◎	ND	◎	ND	◎
WESF	CP-OP-3	Benthic (all)	ND	◎	ND	◎	ND	◎
		Riparian (all)	ND	◎	ND	◎	ND	◎
		Free-flowing (all)	ND	◎	ND	◎	ND	◎
ERDF	CP-OP-6	Benthic (all)	ND	◎	ND	◎	ND	◎
		Riparian (all)	ND	◎	ND	◎	ND	◎
		Free-flowing (all)	ND	◎	ND	◎	ND	◎

4.4. ECOLOGICAL RESOURCES

Plants and animals belong to communities and ecosystems, which in turn are part of larger geographical units or ecoregions. The value of ecological resources depends not only on resources at a specific site, but on their relationship to adjacent areas, the region, and the greater ecoregion, as well as to human communities. For this Risk Review Project, ecological resources at Hanford were evaluated relative to three landscape scales: (1) the Columbia Basin Ecoregion, (2) Hanford-wide, and (3) site-specific with respect to EUs and their buffer.

In general, the habitats most at risk are those that currently are in short supply both at Hanford Site and in the Columbia Basin Ecoregion, as well as those habitats that have been declining most rapidly on site or in the ecoregion. Bluebunch Wheatgrass is a unique habitat that increased on Hanford over the last centuries, but decreased markedly in the ecoregion (see Chapter 7 of the methodology report (CRESP 2015)). Big Sagebrush steppe is also of concern because Hanford has a significant component of this habitat in the ecoregion, and it has decreased both at Hanford and in the ecoregion (although it is still the dominant and largest habitat on the Hanford Site). Sagebrush is a priority habitat in the State of Washington.

On the Hanford Site, Big Sagebrush habitats are considered at risk even though they are common, partly because large areas of sagebrush can be destroyed by fire, reducing its availability for decades. Further, the value of a habitat type increases with the size of the patch; many small, separate sagebrush patches are of less value than single patch that has similar amount of sagebrush. Large patches have less edge to interior and are less likely to be invaded by non-native, noxious species. Aquatic habitats embedded within the terrestrial environment at the Hanford Site are critical because they are so limited in space, and act as habitat islands for many species. That is, some species are limited to these regions, and the dry steppe habitat that surrounds them serves as a barrier to movement. Sensitive and irreplaceable habitats on the Hanford Site include cliffs, lithosols, dune fields, ephemeral streams and vernal ponds, and fall Chinook salmon and steelhead spawning areas (DOE/RL-96-32 2013, Chapter 7 of the methodology report (CRESP 2015)).

The most highly valued habitats on the Hanford Site are in the riparian zone along the Columbia River (DOE/RL-96-32 2013, Chapter 7 of the methodology report (CRESP 2015)). The riparian zone (1) is in short supply and occurs only in a narrow band along the Columbia River; (2) is the interface zone between land and water, and biota living there have adapted to that narrow habitat band; (3) is a zone of relatively high species diversity; (4) has plants that can withstand inundation by flood waters, and dry out during low water; (5) is vulnerable to stressors from both the land and Columbia River; (6) is vulnerable to disturbance because of the vertical gradient sloping down to the Columbia River; (7) provides the exposure pathway from land to the Columbia River to physical, biological, and chemical/radiological contamination stressors; and (8) is the region most used by humans for thousands of years because of its proximity to the Columbia River. Thus, the resources in the riparian zone are critical and highly valued (Level 5 resources, DOE/RL-96-32 2013, Chapter 7 of the methodology report (CRESP 2015)) by the State of Washington.

There are three federally endangered/threatened species, and four Washington State endangered (threatened) species on the Hanford Site (reviewed in Chapter 7 of the methodology report (CRESP 2015)). The federally endangered fish are spring chinook salmon (spring run), and threatened fish are steelhead and bull trout. Although bull trout have been reported on the Hanford Reach, their natural habitat is mountain streams. Although many species are being monitored or are of special concern, few are actually listed as endangered or threatened by the U.S. Fish and Wildlife Service or Washington State at any one time.

The most critical component of determining risk to ecological resources is the evaluation of the EUs and their buffer areas (defined as 1X the greatest diameter of the EU, Chapter 7 of the methodology report (CRESP 2015)). Twenty-five EUs were evaluated. The ecological evaluation of EUs and their buffer involved using GIS-based data, previous resource level designations (DOE/RL-96-32 2013), field data collected in 2014 and 2015 (Appendix J), a table of disposition options (Appendix B), and a risk rating for each EU (see Chapter 7 of the methodology report (CRESP 2015)).

There were five levels of ecological resources (DOE/RL-96-32, 2013), described briefly below (see Chapter 7 of the methodology report (CRESP 2015) for a full description).

Levels of Ecological Resources (DOE/RL-96-32, 2013)

Level 5 =	Irreplaceable habitat or federal threatened and endangered species (including proposed species, and species that are new to science or unique to Washington state).
Level 4 =	Essential habitat for important species.
Level 3 =	Important habitat.
Level 2 =	Habitat with high potential for restoration (ecologically, not legally)
Level 1 =	Industrial or developed.
Level 0 =	Non-native plants and animals.

Three caveats: (1) many of these resources have not been evaluated for a decade or more (and so may have changed), (2) no invasive species inventory has been completed, and (3) while much of the site was evaluated for resource level, not all sites were evaluated; thus, evaluations are valid where given. If a site is blank on the resource map, it may not indicate lack of a value, but rather that it was not surveyed. This is another reason for the field evaluations (see below).

The Risk Review Project uses the following five risk ratings. Full definitions and explanations can be found in Chapter 7 of the methodology report (CRESP 2015).

ND =	Not discernible from the surrounding conditions; not additional risk
Low =	Little risk to disrupt or impact level 3-5 ecological resources.
Medium =	Potential to disrupt or impair level 3-5 ecological resources, but the remedial action is not expected to disrupt communities permanently.
High =	Likely to disrupt and impair level 3-5 ecological resources of high value or resources that have restoration potential, and can cause permanent disruption.
Very High =	Very high probability of impairing (or destroying) ecological resources of high value (levels 3-5) that have typical (and healthy) shrub-steppe species, low percent of exotic species, and may have federally listed species. The remediation likely results in permanent destruction or degradation of habitat.

The lowest risk ratings are self-explanatory, but High and Very High require some comment. High is applied when there are high-level resources (Levels 3 to 5) that can be disrupted permanently. Very High is reserved for EUs where there is high probability of impairing or destroying resources of very high value. This is especially true of Level 5 resources. For example, all of the riparian zone along the Columbia River was designated as Level 5 resources because the riparian zone is limited and was rated the highest value resource on the Hanford Site (DOE/RL-96-32, 2013). Thus, if there is currently, or could be as a result of remediation, degradation to the riparian zone along the Columbia River, the rating would be Very High.

The risk ratings for the 25 EUs, along with brief comments, can be found in Table 4-10. Below is a summary table for each EU (Table 4-8).

Table 4-8. Summary of risk ratings for ecological resources. (See symbology legend p. xxv)

EU Name	EU #	Current	Active Cleanup	Near-Term Post-Cleanup
Legacy Site EUs				
618-11 Burial Grounds	RC-LS-1	ND	Low to Med	Low
K-Area Waste Sites	RC-LS-2	ND to Low	ND to Med	Low to Med
BC Cribs and Trenches	CP-LS-1	ND to Low	Low to Med	ND to Low
Pu-Contaminated Waste Sites	CP-LS-2	ND to Low	Low to Med	Low
Tank Waste and Farms				
T Tank Farm	CP-TF-1	ND to Low ǂ	Low to Med ǂ	ND to Low
S-SX Tank Farms	CP-TF-2	ND to Low ǂ	Low to Med ǂ	ND to Low
TX-TY Tank Farms	CP-TF-3	ND to Low ǂ	Low to Med ǂ	ND to Low
U Tank Farm	CP-TF-4	ND to Low ǂ	Low to Med ǂ	ND to Low
A-AX Tank Farms	CP-TF-5	ND to Low ǂ	Low to Med ǂ	ND to Low
B-BX-BY Tank Farms	CP-TF-6	ND to Low ǂ	Low to Med ǂ	ND to Low
C Tank Farms	CP-TF-7	ND ǂ	ND to Med ǂ	ND to Low
200 East (DSTs)	CP-TF-8	ND	ND to Med	ND to Low
200 West (DSTs)	CP-TF-9	ND	ND to Med	ND to Low
Groundwater				
300 Area GW Plumes	RC-GW-1	Low to Med	Very High	Low to Med
100-N GW Plumes	RC-GW-2	Low to Med	Very High	Low to Med
00-B/D/H/F/K Area GW Plumes	RC-GW-3	Low to Very High	Very High	Low to Med
200 East Groundwater	CP-GW-1	Low	Very High	Low
200 West Groundwater	CP-GW-2	ND to Low	ND to Low	ND to Low
D4				
324 Building	RC-DD-1	ND	ND	ND to Low
KE/KW Reactors	RC-DD-2	ND	ND	ND to Low
PUREX	CP-DD-1	ND to Low	Low to Med	ND to Low
Operating Facilities				

EU Name	EU #	Current	Active Cleanup	Near-Term Post-Cleanup
KW Basin Sludge	RC-OP-1	ND	ND	ND to Low
CWC	CP-OP-1	ND	ND to Low	ND to Low
WESF	CP-OP-3	ND	ND	ND
ERDF	CP-OP-6	Low to Med	ND to High	ND to Low

A compilation of the risk ratings follows (Table 4-9). The number of EUs in each category is summed in each source category by evaluation period (current, active cleanup, near-term post cleanup). Ratings given are the highest for that period; if the rating is ND to Medium, it is categorized in the Medium risk rating category. Variations in the ratings are due to potential differences in remediation options.

Table 4-9. Summary of risk ratings for ecological resources on EUs as a function of source type.

EUs	ND	Low	Medium	High	Very High
Current					
Legacy Sites	1	3			
Tank Farms	3	6			
Groundwater		2	2		1
D&D	2	1			
Operating Facilities	3		1		
Totals (%)	9 (36%)	12 (48%)	3 (12%)		1 (4%)
Active Cleanup					
Legacy Sites			4		
Tank Farms			9		
Groundwater		1			4
D&D		2	1		
Operating Facilities	2	1		1	
Totals (%)	2 (8%)	4 (16%)	14 (56%)	1 (4%)	4 (16%)
Near-Term Post-Cleanup					
Legacy Sites		3	1		
Tank Farms		9			
Groundwater		2	3		
D&D		3			
Operating Facilities	1	3			
Totals (%)	1 (4 %)	20 (80%)	4 (16%)		

Several observations are clear from the data (tables above and Table 4-10 at end of this section):

1. Risk to ecological receptors is highest during cleanup, intermediate before cleanup, and lowest after.
2. The greatest risk before cleanup (current condition) is for the groundwater EUs, largely because of risk to the riparian zone and the Columbia River.
3. The highest risk to ecological receptors during remediation is for the groundwater EUs, followed by the tank farms and legacy sites.
4. After remediation (near-term post-cleanup), the greatest risk to ecological receptors is for the groundwater sites.
5. Variability in cleanup options is expressed as variation in the risk ratings. The percent of EUs with a range of risk ratings (e.g. ND to Medium, ND to Low) was 56% currently, 68 % during active clean-up, and 80% in the near-term post-cleanup. Since the table reflects the highest range given, the risk may be lower (depending upon cleanup method selected during active clean-up, and restoration after active clean up).
6. For some EUs, the risk rating is higher in the near-term post cleanup period because during clean up, many sites will undergo restoration. This is the effect of creating higher resource level than existed there before. In other words, DOE has improved the habitat, allowing there to be a higher risk to those new resources than existed when the site had no ecological resources.

A summary of the ratings for each of the EUs is given in Table 4-10.

Summary of Risk Rating for Ecological Resources

Overall, the risks to ecological resources range from ND to Very High currently, partly due to the high value resources in the riparian zone that are vulnerable to both contamination and physical disruption. Ecological resources are most vulnerable during active cleanup, when the risk is Medium to High for 76 % of the EUs. After active cleanup, only 16 % have a Medium risk, and are mainly the groundwater sites because of revegetation in areas surrounded by Level 3 and 4 resources, and the continued potential for disruption and disturbance (especially in the riparian zone).

The change in risk for the 25 EUs is illustrated in Figure 4-6. It summarizes the ratings for the three evaluation periods. It is critical to note the hatched part of each bar. This indicates the EUs that had a ND rating before cleanup (e.g., current condition) and a higher risk rating after cleanup. The reason for this change is that currently there are NO resources on the site (e.g., it is gravel or entirely buildings), but during cleanup restoration of native vegetation to the site will occur. This vegetation (not currently present) could then be at risk if the site is exposed to continued monitoring or other activities during the near-term post cleanup period. It is thus an indication of additional habitat created by DOE during the cleanup phase.

At the other end, the high risks currently or during cleanup are all reduced in the near-term post cleanup period. Thus, risk to ecological resources is highest during cleanup, and decreases after cleanup. And, DOE will have created new ecological resources on some EUs due to restoration during cleanup.

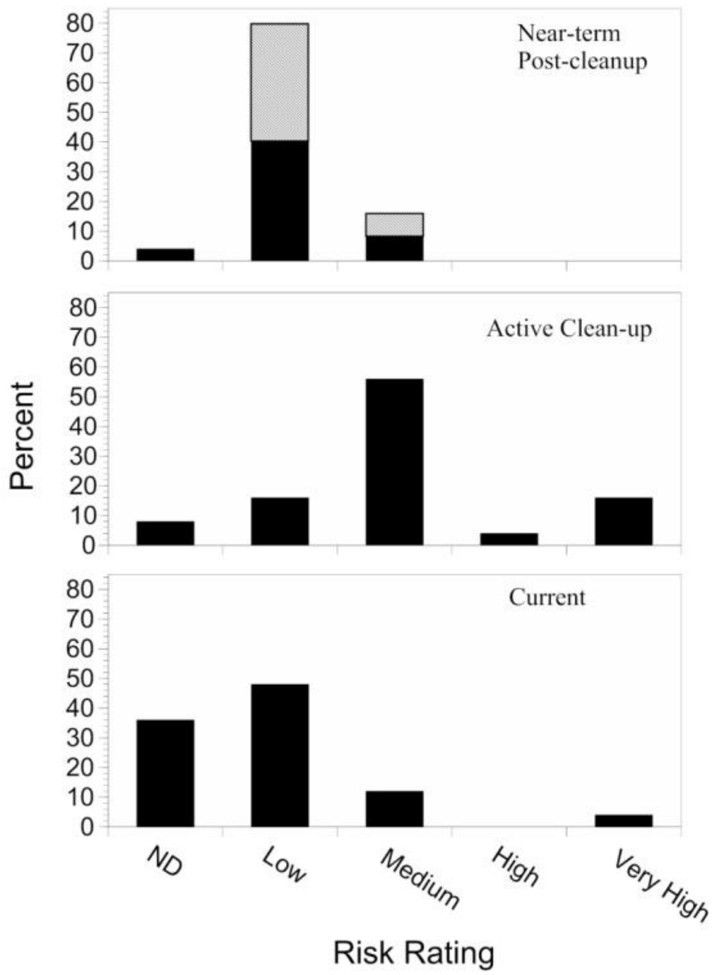


Figure 4-6. Summary of risk to ecological resources during the different evaluation periods (current, active cleanup, near-term post-cleanup).

The ratings for the different evaluation periods are shown in Table 4-10 for all the EUs completed so far, along with a brief explanation of the ratings. Full explanations can be found in the individual EU templates.

Table 4-10. Risk and potential impacts ratings for ecological summary.

Active cleanup refers to the period of 50 years or until 2064; near-term post-cleanup is from 2064 to 2164. High-level or high-quality resources are resource levels 3 to 5.

EU Name	EU ID	Evaluation Period	Potential Risk or Impact Rating	Comments
618-11 Burial Grounds	RC-LS-1	Current	ND	ND because currently there is no disturbance to site, although 10% of EU consists of Level 3 resources and over half of buffer area consists of Level 4 resources
		Active Cleanup	Low to Medium	Low in EU because only about 10% consists of Level 3 resources (none higher), but Low to Medium in buffer zone because 65% consists of Level 3 and 4 resources. Disturbance could result during soil removal.
		Near-Term Post-Cleanup	Low to Medium	Revegetation in EU will potentially place additional Level 3 and 4 resources at risk because of disturbance, especially from invasive species and change of species composition. Similar effects in buffer zone.
K Areas Waste Sites	RC-LS-2	Current	ND to Low	Most of the EU is non-vegetated, but risk is Low (rather than ND) because part of the EU falls in an eagle roosting area, which is a species of concern, and 8% consists of Level 4 resources.
		Active Cleanup	ND to Medium	ND to Low in EU because of eagle roosting, but Low to Medium in buffer because of high percent of Level 3 and 4 resources (78% consists of Level 3 and 4 resources), and it is close to the riparian habitat (all of which is Level 5 habitat). Removal of dirt will result in disturbance and disruption.
		Near-Term Post-Cleanup	Low to Medium	Revegetation 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. Similar effects in buffer zone.
BC Cribs And Trenches	CP-LS-1	Current	ND to Low	ND to Low in EU because nearly 30% is Level 3 and 4 resources, along with the buffer area. There is the potential for disturbance and invasion of exotic species in both EU and buffer area.
		Active Cleanup	Low to Medium	Depending on remediation option, could result in disturbance and disruption to Level 3 and 4 resources (30% of EU and 77% of buffer), including increases in exotic species and changes in species composition of native species.

EU Name	EU ID	Evaluation Period	Potential Risk or Impact Rating	Comments
		Near-Term Post-Cleanup	ND to Medium	Depending on remediation options, it could be ND, but it may be Medium in both EU and buffer areas because of high percent of Level 3 and 4 resources, uncertainty about remediation options, disturbance, and potential for invasion by exotic species, changes in species composition of native species.
Plutonium Cont. Waste Sites	CP-LS-2	Current	ND to LOW	ND to Low in the EU due to low resource value (only 5% Level 3 resources), but Low in buffer area because there is a small finger with 3% Level 3 vegetation, which could be disturbed by traffic.
		Active Cleanup	Low to Medium	The risk depends on the importance of some of the Level 3 habitat in buffer area (5% of EU). The range of remediation options being considered results in both activity and potential of disruptive activity, changing species composition of vegetation in EU and buffer.
		Near-Term Post-Cleanup	Low to Medium	There are two waste sites with contamination in place, which will have continued monitoring, which leads to disturbance, and the potential for exotic species to invade and disrupt native habitat.
T Tank Farm	CP-TF-1	Current	ND to Low	Little habitat in EU (>1% Level 3 resources), but over 10% in buffer area consists of Level 3 resources. Effect ND in EU, but may be up to Low in buffer due to truck disturbance.
		Active Cleanup	Low to Medium	Effects to resources are due to increased disturbance and potential for contaminant release, increases in exotic species, and potential loss of some nesting habitat in buffer area, run over lizards and other wildlife during cleanup.
		Near-Term Post-Cleanup	ND to Low	Continued monitoring could result in some disturbance to EU, and buffer lands. Remediation may improve habitat through revegetation (and increased monitoring may lead to increases in exotic species, and changes in species composition).
S-SX Tank Farms	CP-TF-2	Current	ND to Low	Little habitat in EU (Level 2 only), but over 10% in buffer consists of Level 3 resources. ND in buffer, unless there are trucks in the buffer, then it is Low
		Active Cleanup	Low to Medium	Effects due to increased disturbance and potential for contaminant release, increases in exotic species, and could lose some nesting habitat, run over lizards and other wildlife during cleanup.

EU Name	EU ID	Evaluation Period	Potential Risk or Impact Rating	Comments
		Near-Term Post-Cleanup	ND to Low	Continued monitoring could result in some disturbance to EU and buffer lands. Remediation may improve habitat (and increased monitoring may lead to increases in exotic species, changes in species composition).
TX-TY Tank Farms	CP-TF-3	Current	ND to Low	Some Level 3 resources in EU (4%) and in buffer area (9%). People and trucks are present, which could lead to increases in exotic species and changes in species diversity in Level 3 resource areas of EU and buffer.
		Active Cleanup	Low to Medium	Potential for continual disturbance levels with increasing number of trucks, which may cause changes in abundance and diversity in Level 3 resources in EU and buffer.
		Near-Term Post-Cleanup	ND to Low	It will be capped, which results in less frequent monitoring, but monitoring activities can cause some disruption and disturbance to EU and buffer areas. Remediation may improve habitat through revegetation (and increased monitoring may lead to increases in exotic species, and changes in species composition).
U TANK FARM	CP-TF-4	Current	ND to Low	Some Level 3 resources in EU (16%) and in buffer area (18%). People and trucks are present, which could lead to increases in exotic species and changes in species diversity in Level 3 resource areas of EU and buffer.
		Active Cleanup	Low to Medium	Potential for continual disturbance levels with increasing number of trucks, results may cause changes in abundance and diversity in Level 3 resource areas.
		Near-Term Post-Cleanup	ND to Low	It will be capped, which results in less frequent monitoring, but monitoring activities can cause some disruption and disturbance to EU and buffer resources. Remediation may improve habitat through revegetation.
A-AX Tank Farms	CP-TF-5	Current	ND to Low	High-quality habitat (22% Level 3) in EU, and 27% Level 3 and 4 in buffer suggests potential for disturbance even though truck traffic is low. Trucks can bring in seeds of exotic species, changing species composition. There is some nice sagebrush habitat on EU.

EU Name	EU ID	Evaluation Period	Potential Risk or Impact Rating	Comments
		Active Cleanup	Low to Medium	Remediation may result in some destruction of Level 3 habitat in EU (with sagebrush habitat); intense activity will result in loss of resources to EU and potentially buffer area (with 27% Level 3 and 4 resources).
		Near-Term Post-Cleanup	ND to Low	If capped and monitored, there could be some disturbance to EU and buffer habitat, but revegetation may increase resource value.
B-BX-BY Tank Farms	CP-TF-6	Current	ND to Low	Little habitat in EU, but over 10% in buffer consists of Level 3 resources. ND in buffer, unless there are trucks in the buffer, then it is Low. Habitat is fragmented, which increases disturbance and increases exotic species and potentially changes in species composition of vegetation.
		Active Cleanup	Low to Medium	Effects due to increased disturbance and potential for contaminant release, increases in exotic species, and could lose some nesting habitat, trucks could run over lizards and other wildlife during cleanup.
		Near-Term Post-Cleanup	ND to Low	Continued monitoring could result in some disturbance to EU and buffer lands. Remediation may improve habitat (and increased monitoring may lead to increases in exotic species or changes in vegetation species composition).
C Tank Farm	CP-TF-7	Current	ND	No resources on site, but about 15% Level 3 resources on buffer. If no trucks, ND effects.
		Active Cleanup	ND to Medium	No resources on EU, but about 15% Level 3 resources on buffer area. Remediation could result in truck disturbance, increases in exotic species, and changes in species composition in buffer.
		Near-Term Post-Cleanup	ND to Low	Likely monitoring of caps, with potential for disruption due to monitoring. Revegetation could result in higher quality habitat on EU.
200 East DSTs	CP-TF-8	Current	ND	No resources on site, but about 5% Level 3 resources on buffer. Assuming no trucks in buffer, it is ND.
		Active Cleanup	ND to Medium	No resources on EU, but about 5% Level 3 resources on buffer. Remediation could result in truck disturbance, increases in exotic species, changes in species composition in buffer, and contamination of sensitive species.

EU Name	EU ID	Evaluation Period	Potential Risk or Impact Rating	Comments
		Near-Term Post-Cleanup	ND to Low	Likely monitoring of caps, with potential for disruption due to monitoring. Revegetation could result in higher quality habitat on EU, but there could be some residual contamination to sensitive resources.
200 West DSTs	CP-TF-9	Current	ND	No resources on site, but about 15% Level 3 resources on buffer. Assuming no trucks in buffer, it is ND.
		Active Cleanup	ND to Medium	No resources on EU, but about 7% Level 3 resources on buffer. Remediation could result in truck disturbance, increases in exotic species, changes in species composition in buffer, and contamination of sensitive species.
		Near-Term Post-Cleanup	ND to Low	Likely monitoring of caps, little disturbance, but potential for disruption due to monitoring, and some contamination of receptors. Revegetation could result in higher quality habitat on EU.
300 Area GW Plumes	RC-GW-1	Current	Low to Moderate	There are areas where groundwater plumes intersect the riparian vegetation. Monitoring shows concentrations of uranium exceeding aquatic water criteria in groundwater near shoreline. Potential for contaminant uptake by terrestrial vegetation. Sensitive animals and bird species use region and may be at risk.
		Active Cleanup	Very High	Remediation activities in the shoreline will need to be monitored to evaluate resources and seasonal use of shoreline.
		Near-Term Post-Cleanup	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. Revegetation 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.
100 N Area Groundwater Plumes	RC-GW-2	Current	Low to Moderate	There are areas where groundwater plumes intersect the riparian vegetation. Potential for contaminant uptake by terrestrial vegetation. Sensitive animals and bird species use region and may be at risk.

EU Name	EU ID	Evaluation Period	Potential Risk or Impact Rating	Comments
		Active Cleanup	Very High	Remediation activities in the shoreline will need to be monitored to evaluate resources and seasonal use of shoreline.
		Near-Term Post-Cleanup	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. Revegetation 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.
100 B/D/H/F/K Areas Groundwater Plumes	RC-GW-3	Current	Low to Very High	There are areas where groundwater plumes intersect the riparian vegetation. Monitoring shows concentrations of chromium 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.
		Active Cleanup	Very High	Remediation activities in the shoreline will need to be monitored to evaluate resources and seasonal use of shoreline.
		Near-Term Post-Cleanup	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. Revegetation 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.
200 East Groundwater Plumes	CP-GW-1	Current	Low	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.
		Active Cleanup	Very High	Remediation activities in the shoreline will need to be monitored to evaluate resources and seasonal use of shoreline.

EU Name	EU ID	Evaluation Period	Potential Risk or Impact Rating	Comments
		Near-Term Post-Cleanup	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. Revegetation 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.
200 West Groundwater Plumes	CP-GW-2	Current	ND to Low	Groundwater wells on Central Plateau are in sensitive ecological areas. There is the potential for disturbance and invasion of exotic species in EU. Ecological resources at locations of new wells are evaluated prior to activities to assess potential impacts.
		Active Cleanup	ND to Low	Remediation could degrade habitats, disturb wildlife and affect animal behavior, and introduce exotic plant species.
		Near-Term Post-Cleanup	ND to 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. Revegetation 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.
324 Building	RC-DD-1	Current	ND	Currently no ecological resources on EU or buffer area.
		Active Cleanup	ND	No ecological resources on EU or buffer area during active cleanup.
		Near-Term Post-Cleanup	ND to Low	Any risk depends on the quality and quantity of revegetation following remediation. Could be a risk from invasion of exotic species.
KE/KW Reactors	RC-DD-2	Current	ND	Currently no ecological resources on EU, and only 1 acre of Level 3 on buffer area.
		Active Cleanup	ND	No ecological resources on EU, and few on buffer.
		Near-Term Post-Cleanup	ND to Low	Any risk depends on the quality and quantity of revegetation following remediation. Could be a risk from invasion of exotic species.

EU Name	EU ID	Evaluation Period	Potential Risk or Impact Rating	Comments
PUREX	CP-DD-1	Current	ND to Low	Generally ND on EU because there are few ecological resources (5% Level 3 resources), Low because of possible contamination to ecological receptors on buffer area (31% Level 3 and 4 resources)
		Active Cleanup	Low to Medium	Few high-level resources in EU (5% Level 3 resources), but Low to Medium in buffer area because of high value resources (nearly a third of area has Level 3 and 4 resources).
		Near-Term Post-Cleanup	ND to Low	Remote chance of penetration of roots into contaminated site, allowing exposure to residual contamination.
KW Basin Sludge	RC-OP-1	Current	ND	Currently no ecological resources on EU, and only 1 acre of Level 3 on buffer area.
		Active Cleanup	ND	No ecological resources on EU, and few on buffer.
		Near-Term Post-Cleanup	ND to Low	Any risk depends on the quality and quantity of revegetation following remediation. Could be a risk from invasion of exotic species.
CWC	CP-OP-1	Current	ND	Little high quality resources on EU or on buffer.
		Active Cleanup	ND to Low	Little high quality resources on EU or on buffer, but remediation options unknown. Remediation options could result in contamination of the few resources on site (only 2% Level 3 resources in EU).
		Near-Term Post-Cleanup	ND to Low	Remediation options unknown, thus whether area with be revegetated is unknown. If revegetated, risk could be Low (rather than ND) due to presence of higher quality resources (e.g. Level 3 or 4) created by revegetation.
WESF	CP-OP-3	Current	ND	No resources on EU or buffer, mainly Level 2 or below.
		Active Cleanup	ND	No resources on EU or buffer to be disturbed during active cleanup.
		Near-Term Post-Cleanup	ND	Few ecological resources now, and likely none in the future. If there is revegetation, then continued activity and monitoring could result in minor disturbance in EU.

EU Name	EU ID	Evaluation Period	Potential Risk or Impact Rating	Comments
ERDF	CP-OP-6	Current	Low to Medium	Levels of frequent disturbance can result in increases in invasive species, particularly to high quality habitat in buffer (80% consists of Level 3-5 resources). ERDF is one of only two EUs in interim progress report with Level 5 resources (about 9% of buffer is Level 5 resources, 0 in EU)
		Active Cleanup	ND to High	Because of high quality of resources in buffer area (7% Level 3 resources in EU, 80% Level 3-5 in buffer), the potential for disturbance is Medium, which could disrupt native communities in buffer, and result in increases in exotic species. Continued dust suppression changes available water levels, which could affect native species diversity and abundance
		Near-Term Post-Cleanup	ND to Low	Because of low level of monitoring expected in the near-term post-cleanup period, effect may be ND, but risk will depend upon disturbance, which may adversely affect the 80% Level 3-5 resources in buffer area.

4.5. CULTURAL RESOURCES

An overall risk rating has not been completed for cultural resources because federal law requires that a review of cultural resources be completed in advance of any project or activity (16 U.S.C. 470 et. seq.). This means an evaluation must be completed by DOE regardless of any rating that may be provided under the Risk Review Project. While a rating has not been made, evaluations, nonetheless, have been completed. The objective was to determine whether a resource is or has been present within the unit being evaluated based on a thorough review of DOE and Washington State cultural resources records. The review was conducted by professional archaeologists. Afterward, a written report was prepared on the results of the literature review for each EU (Appendix K).

If the information gathered from the literature review established the presence of cultural resources, the impacts for the periods evaluated (current operations, during active cleanup, and during near-term post-cleanup) are considered known as shown in the table below. If the review revealed an uncertainty, the impacts are considered unknown. Finally, if the review established no presence of cultural resources, the impacts are considered none. Consideration was also given to the anticipated remediation option for that EU.

The analysis described above was made for all three cultural resources landscapes identified at the Hanford Site (Native American, Pre-Hanford Era, and Manhattan Project/Cold War Era), and for each landscape the same analysis was made to determine the direct and indirect impacts to cultural resources during the evaluation periods. As noted in this interim progress report and in Chapter 8 of the methodology document (CRESP 2015), direct effects or impacts are derived from regulatory requirements prescribed under the National Historic Preservation Act and relate to physical destruction (all or part) or alteration such as diminished integrity (16 U.S.C. 470 et.seq.,36 CFR 800 (2004)). Indirect effects or impacts under the regulations include, but are not limited to, the introduction of visual, atmospheric, or audible elements that diminish the cultural resource's significant, historic features. Direct and indirect impacts were determined based on the literature review and what is known about the remediation option for that EU (Evaluation Unit Disposition Table, Appendix B).

Table 4-11 summarizes the results for the 25 EUs evaluated using the cultural resources methodology (Chapter 8, methodology report (CRESP 2015)) and which are described in the Evaluation Templates completed for this interim progress report. Brief comments from the literature review also are included. For more information regarding a specific EU, refer to the completed template for that EU as well as the EU's literature review (Appendix K).

It should be noted that the assignation of known or unknown regarding direct impacts to cultural resources within the Native American and Pre-Hanford Era landscapes remains the same for current operations and near-term post-cleanup evaluation periods. Indirect effects could change from current operations to near-term post-cleanup depending, for example, on whether the view shed of a traditional cultural place considered and recognized as culturally important to living communities, including Native Americans, may be affected during active cleanup. Additionally, in those EUs where the remediation option is deactivation and demolition, the assignation provided assumes that deactivation and demolition will have been completed when the near-term post-cleanup period begins or in 2064. So, for the Manhattan Project/Cold War Era landscape, the assignation is "none" for the near-term post-cleanup evaluation period.

Table 4-11. Compilation of evaluations for cultural resources for EUs contained in the interim progress report.

EU Name	EU ID	Evaluation Period	Potential RISK OR IMPACT	Comments
618-11 Burial Grounds	RC-LS-1	Current	Native American: Direct: Unknown Indirect: Known Historic Pre-Hanford: Direct: Unknown Indirect: Known Manhattan/Cold War: Direct: Known Indirect: Unknown	There are no known recorded cultural resources located within or near this EU.
		Active Cleanup	Native American: Direct: Unknown Indirect: Known Historic Pre-Hanford: Direct: Unknown Indirect: Unknown Manhattan/Cold War: Direct: Known Indirect: Unknown	There are no known recorded cultural resources located within or near this EU. Surface and subsurface investigations may be necessary prior to ground disturbance.

EU Name	EU ID	Evaluation Period	Potential RISK OR IMPACT	Comments
		Near-Term Post-Cleanup	Native American: Direct: Unknown Indirect: Known Historic Pre-Hanford: Direct: Unknown Indirect: Unknown Manhattan/Cold War: Direct: None Indirect: None	No expectations for impacts to known cultural resources.
K Areas Waste Sites	RC-LS-2	Current	Native American: Direct: Known Indirect: Known Historic Pre-Hanford: Direct: Known Indirect: Known Manhattan/Cold War: Direct: Known Indirect: Known	Manhattan Project/Cold War significant resources have already been mitigated. Area within the EU is heavily disturbed, but the entire area is extremely culturally sensitive based on prehistoric, ethno-historic, and historic land use in the area. Traditional cultural places are known to be located in the vicinity as well as National Register eligible archaeological sites associated with all three landscapes.
		Active Cleanup	Native American: Direct: Known Indirect: Known Historic Pre-Hanford: Direct: Known Indirect: Known Manhattan/Cold War: Direct: Known Indirect: Known	Due to high cultural sensitivity of area, consultation may need to occur. Archaeological investigations or monitoring may also need to occur. Direct and indirect effects are likely to archaeological sites and traditional cultural places.
		Near-Term Post-Cleanup	Native American: Direct: Known Indirect: Known Historic Pre-Hanford: Direct: Known Indirect: Known Manhattan/Cold War: Direct: None Indirect: None	Permanent direct and indirect effects are possible due to high sensitivity of area.
BC Cribs And Trenches	CP-LS-1	Current	Native American: Direct: Known Indirect: Known Historic Pre-Hanford: Direct: Unknown Indirect: None Manhattan/Cold War: Direct: Known Indirect: Unknown	There are unevaluated cultural resources located within this EU. Manhattan Project/Cold War significant resources have already been mitigated. Traditional cultural places in view shed.

EU Name	EU ID	Evaluation Period	Potential RISK OR IMPACT	Comments
		Active Cleanup	Native American: Direct: Known Indirect: Known Historic Pre-Hanford: Direct: Unknown Indirect: None Manhattan/Cold War: Direct: Known Indirect: Unknown	There is one unevaluated (for National Register) cultural resource. Traditional cultural places in view shed. Indirect effects are possible from capping.
		Near-Term Post-Cleanup	Native American: Direct: Known Indirect: Known Historic Pre-Hanford: Direct: Unknown Indirect: None Manhattan/Cold War: Direct: None Indirect: None	Permanent indirect effects to view shed are possible from capping. Permanent effects may be possible due to presence of contamination if capping occurs. No other expected cultural resources impacts.
Plutonium Contam-inated Waste Sites	CP-LS-2	Current	Native American: Direct: Known Indirect: Known Historic Pre-Hanford: Direct: Known Indirect: Known Manhattan/Cold War: Direct: Known Indirect: Unknown	Manhattan Project/Cold War significant resources have already been mitigated. Area is very disturbed and there are no known recorded archaeological resources within the EU. There is evidence of ethno-historic and historic land use near the EU.
		Active Cleanup	Native American: Direct: Known Indirect: Known Historic Pre-Hanford: Direct: Known Indirect: Known Manhattan/Cold War: Direct: Known Indirect: Unknown	Due to proximity of historic and ethno-historic land use near this EU, consultation will be necessary. Very small potential for surface or subsurface archaeological material to be present in pockets of undisturbed ground, if any.
		Near-Term Post-Cleanup	Native American: Direct: Known Indirect: Known Historic Pre-Hanford: Direct: Unknown Indirect: Unknown Manhattan/Cold War: Direct: None Indirect: None	No expectations for impacts to known cultural resources.

EU Name	EU ID	Evaluation Period	Potential RISK OR IMPACT	Comments
T Tank Farm	CP-TF-1	Current	Native American: Direct: Unknown Indirect: Known Historic Pre-Hanford: Direct: None Indirect: Unknown Manhattan/Cold War: Direct: Known Indirect: Known	Historical evidence of National Register eligible historic trail through the EU, however, extensive disturbance in area indicates low likelihood of remaining archaeological resources. Manhattan Project/Cold War significant resources have already been mitigated. Area is very disturbed and there is no evidence of archaeological sites being recorded within the EU. There is evidence of ethno historic and historic land use within the EU that has been destroyed by the tank farms.
		Active Cleanup	Native American: Direct: Unknown Indirect: Known Historic Pre-Hanford: Direct: None Indirect: Unknown Manhattan/Cold War: Direct: Known Indirect: Known	Due to presence of historic and ethno-historic land use within this EU, consultation will be necessary. Little to no potential for intact surface or subsurface archaeological material to be present due to heavy disturbance throughout EU.
		Near-Term Post-Cleanup	Native American: Direct: Unknown Indirect: Known Historic Pre-Hanford: Direct: None Indirect: Unknown Manhattan/Cold War: Direct: None Indirect: None	Indirect effects to trail may be permanent. Permanent indirect effects to view shed are possible from capping. Permanent effects may be possible due to presence of contamination if capping occurs.
S-SX Tank Farms	CP-TF-2	Current	Native American: Direct: Unknown Indirect: Known Historic Pre-Hanford: Direct: Known Indirect: Unknown Manhattan/Cold War: Direct: Known Indirect: Unknown	Manhattan Project/Cold War significant resources have already been mitigated. Area is very disturbed and there are no known recorded archaeological resources within the EU. There is evidence of ethno-historic and historic land use.

EU Name	EU ID	Evaluation Period	Potential RISK OR IMPACT	Comments
		Active Cleanup	Native American: Direct: Unknown Indirect: Known Historic Pre-Hanford: Direct: Known Indirect: Unknown Manhattan/Cold War: Direct: Known Indirect: Unknown	Because area has not been investigated on the surface or subsurface, archaeological investigations may need to occur within pockets of undisturbed land if any prior to remediation. Potential for intact archaeological material to be present is very low.
		Near-Term Post-Cleanup	Native American: Direct: Unknown Indirect: Known Historic Pre-Hanford: Direct: Known Indirect: Unknown Manhattan/Cold War: Direct: None Indirect: None	Permanent indirect effects to view shed are possible from capping. Permanent effects may be possible due to presence of contamination if capping occurs. No other expected cultural resources impacts.
TX-TY Tank Farms	CP-TF-3	Current	Native American: Direct: Known Indirect: Known Historic Pre-Hanford: Direct: Known Indirect: Known Manhattan/Cold War: Direct: Known Indirect: Unknown	Manhattan Project/Cold War significant resources have already been mitigated. Area is very disturbed and there are no known recorded archaeological resources within the EU. Traditional cultural places are visible from EU.
		Active Cleanup	Native American: Direct: Known Indirect: Known Historic Pre-Hanford: Direct: Known Indirect: Known Manhattan/Cold War: Direct: Known Indirect: Unknown	Because area has not been investigated on the surface or subsurface, archaeological investigations may need to occur within pockets of undisturbed land if any prior to remediation. Potential for intact archaeological material to be present is very low.
		Near-Term Post-Cleanup	Native American: Direct: Known Indirect: Known Historic Pre-Hanford: Direct: Known Indirect: Known Manhattan/Cold War: Direct: None Indirect: None	Permanent indirect effects to view shed are possible from capping. Permanent effects may be possible due to presence of contamination if capping occurs. No other expected cultural resources impacts.

EU Name	EU ID	Evaluation Period	Potential RISK OR IMPACT	Comments
U Tank Farms	CP-TF-4	Current	Native American: Direct: Unknown Indirect: Known Historic Pre-Hanford: Direct: Unknown Indirect: Unknown Manhattan/Cold War: Direct: Known Indirect: Unknown	Manhattan Project/Cold War significant resources have already been mitigated. Area is very disturbed and there are no known recorded archaeological resources within the EU. Traditional cultural places are visible from EU.
		Active Cleanup	Native American: Direct: Unknown Indirect: Known Historic Pre-Hanford: Direct: Unknown Indirect: Unknown Manhattan/Cold War: Direct: Known Indirect: Unknown	Because area has not been investigated on the surface or subsurface, archaeological investigations may need to occur within pockets of undisturbed land if any prior to remediation. Potential for intact archaeological material to be present is very low.
		Near-Term Post-Cleanup	Native American: Direct: Unknown Indirect: Known Historic Pre-Hanford: Direct: Unknown Indirect: Unknown Manhattan/Cold War: Direct: None Indirect: None	Permanent indirect effects to view shed are possible from capping. Permanent effects may be possible due to presence of contamination if capping occurs. No other expected cultural resources impacts.
A-AX Tank Farms	CP-TF-5	Current	Native American: Direct: Unknown Indirect: Known Historic Pre-Hanford: Direct: Unknown Indirect: Unknown Manhattan/Cold War: Direct: Known Indirect: Known	Manhattan Project/Cold War significant resources have already been mitigated. Area is very disturbed and there are no known recorded archaeological resources within the EU. Traditional cultural places are visible from EU.
		Active Cleanup	Native American: Direct: Unknown Indirect: Known Historic Pre-Hanford: Direct: Unknown Indirect: Unknown Manhattan/Cold War: Direct: Known Indirect: Known	Because area has not been investigated on the surface or subsurface, archaeological investigations may need to occur within pockets of undisturbed land if any prior to remediation. Potential for intact archaeological material to be present is very low.

EU Name	EU ID	Evaluation Period	Potential RISK OR IMPACT	Comments
		Near-Term Post-Cleanup	Native American: Direct: Unknown Indirect: Known Historic Pre-Hanford: Direct: Unknown Indirect: Unknown Manhattan/Cold War: Direct: None Indirect: None	Permanent indirect effects to view shed are possible from capping. Permanent effects may be possible due to presence of contamination if capping occurs. No other expected cultural resources impacts.
B-BX-BY Tank Farms	CP-TF-6	Current	Native American: Direct: Unknown Indirect: Known Historic Pre-Hanford: Direct: Known Indirect: Unknown Manhattan/Cold War: Direct: Known Indirect: Known	Manhattan Project/Cold War significant resources have already been mitigated. Area is very disturbed and there are no known recorded archaeological resources within the EU. EU has not been investigated for archaeological resources (surface or subsurface). Traditional cultural places are visible from EU.
		Active Cleanup	Native American: Direct: Unknown Indirect: Known Historic Pre-Hanford: Direct: Known Indirect: Unknown Manhattan/Cold War: Direct: Known Indirect: Known	Because area has not been investigated on the surface or subsurface, archaeological investigations may need to occur within pockets of undisturbed land if any prior to remediation. Potential for intact archaeological material to be present is very low.
		Near-Term Post-Cleanup	Native American: Direct: Unknown Indirect: Known Historic Pre-Hanford: Direct: Known Indirect: Unknown Manhattan/Cold War: Direct: None Indirect: None	Permanent indirect effects to view shed are possible from capping. Permanent effects may be possible due to presence of contamination if capping occurs. No other expected cultural resources impacts.
C Tank Farm	CP-TF-7	Current	Native American: Direct: Known Indirect: Known Historic Pre-Hanford: Direct: Known Indirect: Unknown Manhattan/Cold War: Direct: Known Indirect: Known	Manhattan Project/Cold War significant resources have already been mitigated. Area is very disturbed and there are no known recorded archaeological resources within the EU. Traditional cultural places are visible from EU.

EU Name	EU ID	Evaluation Period	Potential RISK OR IMPACT	Comments
		Active Cleanup	Native American: Direct: Known Indirect: Known Historic Pre-Hanford: Direct: Known Indirect: Unknown Manhattan/Cold War: Direct: Known Indirect: Known	Because area has not been investigated on the surface or subsurface, archaeological investigations may need to occur within pockets of undisturbed land if any prior to remediation. Potential for intact archaeological material to be present is very low.
		Near-Term Post-Cleanup	Native American: Direct: Known Indirect: Known Historic Pre-Hanford: Direct: Known Indirect: Unknown Manhattan/Cold War: Direct: None Indirect: None	Permanent indirect effects to view shed are possible from capping. Permanent effects may be possible due to presence of contamination if capping occurs. No other expected cultural resources impacts.
200 East DSTs	CP-TF-8	Current	Native American: Direct: Unknown Indirect: Known Historic Pre-Hanford: Direct: Unknown Indirect: Unknown Manhattan/Cold War: Direct: Known Indirect: Known	Manhattan Project/Cold War significant resources have already been mitigated. Area is very disturbed and there are no known recorded archaeological resources within the EU. Traditional cultural places are visible from EU.
		Active Cleanup	Native American: Direct: Unknown Indirect: Known Historic Pre-Hanford: Direct: Unknown Indirect: Unknown Manhattan/Cold War: Direct: Known Indirect: Known	Because area has not been investigated on the surface or subsurface, archaeological investigations may need to occur within pockets of undisturbed land if any prior to remediation. Potential for intact archaeological material to be present is very low.
		Near-Term Post-Cleanup	Native American: Direct: Unknown Indirect: Known Historic Pre-Hanford: Direct: Unknown Indirect: Unknown Manhattan/Cold War: Direct: None Indirect: None	Permanent indirect effects to view shed are possible from capping. Permanent effects may be possible due to presence of contamination if capping occurs. No other expected cultural resources impacts.

EU Name	EU ID	Evaluation Period	Potential RISK OR IMPACT	Comments
200 West DSTs	CP-TF-9	Current	Native American: Direct: Unknown Indirect: Known Historic Pre-Hanford: Direct: Unknown Indirect: Unknown Manhattan/Cold War: Direct: Known Indirect: Known	Manhattan Project/Cold War significant resources have already been mitigated. Area is very disturbed and there are no known recorded archaeological resources within the EU. Traditional cultural places are visible from EU.
		Active Cleanup	Native American: Direct: Unknown Indirect: Known Historic Pre-Hanford: Direct: Unknown Indirect: Unknown Manhattan/Cold War: Direct: Known Indirect: Known	Because area has not been investigated on the surface or subsurface, archaeological investigations may need to occur within pockets of undisturbed land if any prior to remediation. Potential for intact archaeological material to be present is very low.
		Near-Term Post-Cleanup	Native American: Direct: Unknown Indirect: Known Historic Pre-Hanford: Direct: Unknown Indirect: Unknown Manhattan/Cold War: Direct: None Indirect: None	Permanent indirect effects to view shed are possible from capping. Permanent effects may be possible due to presence of contamination if capping occurs. No other expected cultural resources impacts.
300 Area Ground-water Plumes	RC-GW-1	Current	Native American: Direct: Known Indirect: Known Historic Pre-Hanford: Direct: Known Indirect: Known Manhattan/Cold War: Direct: Known Indirect: Known	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 three landscapes.

EU Name	EU ID	Evaluation Period	Potential RISK OR IMPACT	Comments
		Active Cleanup	Native American: Direct: Known Indirect: Known Historic Pre-Hanford: Direct: Known Indirect: Known Manhattan/Cold War: Direct: Known Indirect: Known	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 three landscapes.
		Near-Term Post-Cleanup	Native American: Direct: Known Indirect: Known Historic Pre-Hanford: Direct: Known Indirect: Known Manhattan/Cold War: Direct: Unknown Indirect: Unknown	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.
100-N Ground-water Plumes	RC-GW-2	Current	Native American: Direct: Known Indirect: Known Historic Pre-Hanford: Direct: Known Indirect: Known Manhattan/Cold War: Direct: Known Indirect: Known	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 three landscapes.
		Active Cleanup	Native American: Direct: Known Indirect: Known Historic Pre-Hanford: Direct: Known Indirect: Known Manhattan/Cold War: Direct: Known Indirect: Known	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 three landscapes.

EU Name	EU ID	Evaluation Period	Potential RISK OR IMPACT	Comments
		Near-Term Post-Cleanup	Native American: Direct: Known Indirect: Known Historic Pre-Hanford: Direct: Known Indirect: Known Manhattan/Cold War: Direct: Unknown Indirect: Unknown	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.
100-B/D/H/F/K	RC-GW-3	Current	Native American: Direct: Known Indirect: Known Historic Pre-Hanford: Direct: Known Indirect: Known Manhattan/Cold War: Direct: Known Indirect: Known	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 three landscapes.
		Active Cleanup	Native American: Direct: Known Indirect: Known Historic Pre-Hanford: Direct: Known Indirect: Known Manhattan/Cold War: Direct: Known Indirect: Known	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 three landscapes.
		Near-Term Post-Cleanup	Native American: Direct: Known Indirect: Known Historic Pre-Hanford: Direct: Known Indirect: Known Manhattan/Cold War: Direct: Unknown Indirect: Unknown	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.

EU Name	EU ID	Evaluation Period	Potential RISK OR IMPACT	Comments
200 East Area	CP-GW-1	Current	Native American: Direct: Known Indirect: Known Historic Pre-Hanford: Direct: Known Indirect: Known Manhattan/Cold War: Direct: Known Indirect: Known	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 three landscapes.
		Active Cleanup	Native American: Direct: Known Indirect: Known Historic Pre-Hanford: Direct: Known Indirect: Known Manhattan/Cold War: Direct: Known Indirect: Known	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 three landscapes.
		Near-Term Post-Cleanup	Native American: Direct: Known Indirect: Known Historic Pre-Hanford: Direct: Known Indirect: Known Manhattan/Cold War: Direct: Unknown Indirect: Unknown	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.
200 West Area	CP-GW-2	Current	Native American: Direct: Unknown Indirect: Unknown Historic Pre-Hanford: Direct: Unknown Indirect: Unknown Manhattan/Cold War: Direct: Unknown Indirect: Unknown	Groundwater plumes are not intercepting riparian areas; along river; vehicle traffic with monitoring and remediation wells could introduce exotic species that disrupt native communities, including biota of cultural importance.

EU Name	EU ID	Evaluation Period	Potential RISK OR IMPACT	Comments
		Active Cleanup	Native American: Direct: Unknown Indirect: Unknown Historic Pre-Hanford: Direct: Unknown Indirect: Unknown Manhattan/Cold War: Direct: Unknown Indirect: Unknown	Groundwater plumes are not intercepting riparian areas; along river; vehicle traffic with monitoring and remediation wells could introduce exotic species that disrupt native communities, including biota of cultural importance.
		Near-Term Post-Cleanup	Native American: Direct: Unknown Indirect: Unknown Historic Pre-Hanford: Direct: Unknown Indirect: Unknown Manhattan/Cold War: Direct: Unknown Indirect: Unknown	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.
324 Building	RC-DD-1	Current	Native American: Direct: Known Indirect: Unknown Historic Pre-Hanford: Direct: Known Indirect: Unknown Manhattan/Cold War: Direct: Known Indirect: None	Very disturbed, but close to important resources (close proximity to river), Manhattan era significant facility has already been mitigated. There are no known recorded archaeological sites or traditional cultural places located within the 324 Building EU; there are five archaeological sites located within 500 m of the 324 Building EU.
		Active Cleanup	Native American: Direct: Known Indirect: Unknown Historic Pre-Hanford: Direct: Known Indirect: Unknown Manhattan/Cold War: Direct: Known Indirect: None	Very disturbed, but close to important resources (close to river).
		Near-Term Post-Cleanup	Native American: Direct: Unknown Indirect: Known Historic Pre-Hanford: Direct: Known Indirect: None Manhattan/Cold War: Direct: None Indirect: None	No expectations for impacts to known cultural resources.

EU Name	EU ID	Evaluation Period	Potential RISK OR IMPACT	Comments
KE/KW Reactors	RC-DD-2	Current	Native American: Direct: Known Indirect: Known Historic Pre-Hanford: Direct: Known Indirect: Known Manhattan/Cold War: Direct: Known Indirect: Known	Manhattan Project/Cold War significant resources have already been mitigated. Area within the EU is heavily disturbed, but the entire area is extremely culturally sensitive based on prehistoric, ethno-historic, and historic land use in the area. Traditional cultural places are known to be located in the vicinity as well as National Register eligible archaeological sites associated with all three landscapes.
		Active Cleanup	Native American: Direct: Known Indirect: Known Historic Pre-Hanford: Direct: Known Indirect: Known Manhattan/Cold War: Direct: Known Indirect: Known	Due to highly sensitive cultural resources in vicinity of the EU, consultation is needed. Archaeological investigations or monitoring may also need to occur. Direct and indirect effects are likely to archaeological sites and traditional cultural places in vicinity of EU.
		Near-Term Post-Cleanup	Native American: Direct: Known Indirect: Known Historic Pre-Hanford: Direct: Known Indirect: Known Manhattan/Cold War: Direct: None Indirect: None	Permanent direct and indirect effects are possible due to high sensitivity of area.
PUREX	CP-DD-1	Current	Native American: Direct: Unknown Indirect: Known Historic Pre-Hanford: Direct: Unknown Indirect: None Manhattan/Cold War: Direct: Known Indirect: None	Manhattan Project/Cold War significant resources have already been mitigated. Area is heavily disturbed and even thought the entire area has not been inventoried for archaeological resources, it has very low potential to contact intact archaeological resources on the surface or subsurface. Traditional cultural places are visible from EU.

EU Name	EU ID	Evaluation Period	Potential RISK OR IMPACT	Comments
		Active Cleanup	Native American: Direct: Unknown Indirect: Known Historic Pre-Hanford: Direct: Unknown Indirect: None Manhattan/Cold War: Direct: Known Indirect: None	Area has not been investigated either on the surface or subsurface, archaeological investigations may need to occur within pockets of undisturbed land if any prior to remediation. Potential for intact archaeological material to be present is very low.
		Near-Term Post-Cleanup	Native American: Direct: Unknown Indirect: Known Historic Pre-Hanford: Direct: None Indirect: None Manhattan/Cold War: Direct: None Indirect: None	Permanent indirect effects to view shed are possible from capping. No other expected cultural resources impacts.
K Basin Sludge	RC-OP-1	Current	Native American: Direct: Known Indirect: Known Historic Pre-Hanford: Direct: Known Indirect: Known Manhattan/Cold War: Direct: Known Indirect: Known	Manhattan Project/Cold War significant resources have already been mitigated. Area within the EU is heavily disturbed, but the entire area is extremely culturally sensitive based on prehistoric, ethno-historic, and historic land use in the area. Traditional cultural places are known to be located in the vicinity as well as National Register eligible archaeological sites associated with all three landscapes.
		Active Cleanup	Native American: Direct: Known Indirect: Known Historic Pre-Hanford: Direct: Known Indirect: Known Manhattan/Cold War: Direct: Known Indirect: Known	Due to highly sensitive cultural resources in vicinity of the EU, consultation is needed. Archaeological investigations or monitoring may also need to occur. Direct and indirect effects are likely to archaeological sites and traditional cultural places in vicinity of EU.
		Near-Term Post-Cleanup	Native American: Direct: Known Indirect: Known Historic Pre-Hanford: Direct: Known Indirect: Known Manhattan/Cold War: Direct: None Indirect: None	Permanent direct and indirect effects are possible due to high sensitivity of area.

EU Name	EU ID	Evaluation Period	Potential RISK OR IMPACT	Comments
CWC	CP-OP-1	Current	Native American: Direct: Known Indirect: Known Historic Pre-Hanford: Direct: Known Indirect: Known Manhattan/Cold War: Direct: None Indirect: None	National Register eligible historic trail runs through the EU. Two National Register ineligible sites/isolates are located within the EU. Potential for additional resources within pockets of undisturbed soil if it exists based on presence of Native American and Historic era resources within 500 m of EU. Traditional cultural places are visible from the EU.
		Active Cleanup	Native American: Direct: Known Indirect: Known Historic Pre-Hanford: Direct: Known Indirect: Known Manhattan/Cold War: Direct: None Indirect: None	Both direct and indirect effects are likely on National Register eligible trail. Other sites have been determined ineligible. Potential for additional archaeological resources where pockets of undisturbed soils exist.
		Near-Term Post-Cleanup	Native American: Direct: Known Indirect: Known Historic Pre-Hanford: Direct: Known Indirect: Known Manhattan/Cold War: Direct: None Indirect: None	Long-term protection measures may be in place to resolve adverse effects to National Register eligible trail. Permanent effects possible due to presence of contamination.
WESF	CP-OP-3	Current	Native American: Direct: Unknown Indirect: Unknown Historic Pre-Hanford: Direct: Unknown Indirect: Unknown Manhattan/Cold War: Direct: Known Indirect: Known	This EU is located within a Manhattan Project/Cold War significant resource that has already been mitigated. There are no archaeological resources known to be located within this EU. Traditional cultural places are visible from this EU.
		Active Cleanup	Native American: Direct: Unknown Indirect: Unknown Historic Pre-Hanford: Direct: Unknown Indirect: Unknown Manhattan/Cold War: Direct: Known Indirect: Known	Because no ground disturbance will occur, there should be no impact to archaeological resources.

EU Name	EU ID	Evaluation Period	Potential RISK OR IMPACT	Comments
		Near-Term Post-Cleanup	Native American: Direct: Unknown Indirect: Unknown Historic Pre-Hanford: Direct: Unknown Indirect: Unknown Manhattan/Cold War: Direct: None Indirect: None	No expectations for impacts to known cultural resources.
ERDF	CP-OP-6	Current	Native American: Direct: Unknown Indirect: Known Historic Pre-Hanford: Direct: Known Indirect: Unknown Manhattan/Cold War: Direct: Known Indirect: Known	A few National Register ineligible archaeological sites and isolated finds were recorded before construction of ERDF within this EU. None are likely present due to construction of ERDF and were addressed under the National Historic Preservation Act, Section 106 Review completed prior to ERDF construction. A Manhattan Project/Cold War eligible site is recorded within 500 m of ERDF as well as several other archaeological sites associated with various landscapes. Traditional cultural places are visible from this EU.
		Active Cleanup	Native American: Direct: Unknown Indirect: Known Historic Pre-Hanford: Direct: Known Indirect: Unknown Manhattan/Cold War: Direct: Known Indirect: Known	All of the EU has been inventoried for archaeological resources on the surface. Because there are pockets of land where no disturbance has occurred, the potential for subsurface archaeological material to be present in these areas is moderate. Indirect effects to the Manhattan Project/Cold War eligible archaeological site are possible.
		Near-Term Post-Cleanup	Native American: Direct: Unknown Indirect: Known Historic Pre-Hanford: Direct: Known Indirect: Unknown Manhattan/Cold War: Direct: None Indirect: None	Permanent indirect effects to view shed are possible from capping. Permanent effects may be possible due to presence of contamination if capping occurs. No other expected cultural resources impacts.

CHAPTER 5. PROVIDING CONTEXT, SUMMARY DISCUSSION, AND INTERIM OBSERVATIONS

5.1. CONTEXT FOR THE RISK REVIEW PROJECT RESULTS

In January 2014, the Department of Energy (DOE) asked the Consortium for Risk Evaluation with Stakeholder Participation (CRESP) to conduct an independent Hanford Site-wide evaluation of human health, nuclear safety, environmental and cultural resource risks (hereinafter referred to as the "Risk Review Project") associated with existing hazards, environmental contamination and remaining cleanup activities. The overarching goal of the Risk Review Project is to carry out a screening process for risks and impacts to human health and resources[86]. The results of the Risk Review Project are intended to provide the DOE, regulators, Tribal Nations and the public with a more comprehensive understanding of the remaining cleanup at the Hanford Site to help inform (1) decisions on sequencing of future cleanup activities, and (2) selection, planning and execution of specific cleanup actions, including which areas at the Hanford Site should be addressed earlier for additional characterization, analysis, and remediation[87]. DOE, the State of Washington, and EPA recognize that the Risk Review Project results, including evaluations of hazards and risks, are only one of many inputs and considerations to prioritization of future cleanup activities at Hanford.

Cleanup at the Hanford Site is a costly, long-term, and technically challenging mission that began in 1989. Approximately 25% of the overall Hanford Site cleanup has been completed to-date. Extensive nuclear waste inventories in tanks and other forms; heavily contaminated formerly used nuclear materials processing facilities; as well as near-surface, vadose zone, and groundwater contamination are major parts of the remaining cleanup effort. It is anticipated that more than $100 billion will be expended on cleanup during the next 50 years. Yet, while earlier studies have evaluated portions of the Hanford Site and some receptors, a comprehensive, site-wide review of the risks to human health and resources from contamination, waste management, and cleanup activities has never occurred. Thus, periodic reviews should be conducted that consider risks to human health, water resources, ecological resources, and cultural resources for the remaining cleanup. These types of reviews are essential for sequencing and planning future cleanup actions that ultimately span multiple generations.

The Risk Review Project focuses on anticipated cleanup work remaining to be completed as of October 2015. This interim progress report presents both the results of the first set of 25 EUs of approximately 60 EUs to be assessed as part of the Risk Review Project. Evaluations included here represent all nine of the EUs for tank waste and farms, and all five of the EUs for groundwater plumes, but only 3 of 9 major facilities for decommissioning and final disposition, 4 of 22 legacy source sites (former near-surface disposal areas), and 4 of 17 operating facilities supporting the cleanup mission.

The Risk Review Project is not intended to substitute for or preempt any requirement imposed under applicable federal or state laws or treaties. As important, the Risk Review Project is not intended to make or replace any decisions made under the Tri-Party Agreement and/or 2010 Consent Order, or amendments. Furthermore, the Risk Review Project is neither a CERCLA risk assessment nor a Natural

[86] In this Risk Review Project, human health and resources evaluated include groundwater and the Columbia River, facility workers, co-located people, the public, and ecological and cultural resources. Collectively, humans and these resources also are referred to as "receptors".

[87] Additionally, while earlier studies have evaluated portions of the Hanford Site, there has never been a comprehensive, site-wide review of the risks to human health and resources from contamination, waste management, and cleanup activities.

Resources Damage Assessment evaluation. The Risk Review Project is not intended to interpret treaty rights that exist between the United States and Native American Tribes.

5.2. SUMMARY OF KEY ASSUMPTIONS AND RESULTS

The Risk Review Project is relying primarily on previously obtained primary data, safety analyses, risk analyses, environmental impact assessments, remedial investigations, and similar information sources. Tens of thousands of pages of information and even more data have been reviewed and integrated to form the basis for this report. The methodology used reflects input from state and federal regulatory agencies, Tribal Nations, non-governmental agencies, the public, and independent experts (CRESP 2015). Still, important uncertainties and data gaps remain that require assumptions to carry out the project. The major general assumptions that have been used to guide the Risk Review Project are as follows:

1. The existing data and uncertainties regarding radionuclide and contaminant inventories, physical-chemical forms, and distribution of existing environmental contamination, as well as future events, allow for rough order of magnitude differentiation across EUs between radionuclide and chemical hazards (e.g., contained in engineered systems), existing environmental contamination, and potential impacts and risks to receptors.
2. Three evaluation periods have been selected, with assumed time frames to facilitate the Project's evaluation: active cleanup (50 years or until 2064), including during the current status and during cleanup actions, and recognizing that all cleanup may not be completed within this period; near-term post-cleanup (100 years post-cleanup or 2064 to 2164); and, long-term post-cleanup (1000 years post-cleanup or 2164 to 3064, although impacts projected to occur beyond this time frame are also noted when indicated from prior studies).
3. Screening thresholds for groundwater and the Columbia River have been selected based on existing risk-informed regulatory criteria that reflect water quality associated with designated highest beneficial uses (e.g., drinking water quality for groundwater, and ecological protection for the Columbia River).
4. Institutional controls are assumed to be effective for the duration of federal control of designated land areas and the EUs contained therein. Furthermore, institutional controls are assumed only to be effective for 100 years after the transfer of land areas from federal to non-federal control. Some areas of the Hanford Site are currently planned to be under federal control for very long periods (e.g., greater than 300 years for permitted disposal areas in the Central Plateau). Periods of planned federal control may change over time in response to changes in public policy or other decisions. Changes in assumptions of institutional controls may necessitate changes in the end-states of an EU (i.e., changes in final barriers or physical-chemical forms or amounts of remaining contaminants) and cannot be predicted. Failure of barriers or institutional controls may result in higher exposure, which may in the future require additional cleanup of residual contamination.

The current risks that are in the highest risk rating group are at specific EUs from (1) loss of nuclear safety controls from major natural hazards (e.g., from seismic events, volcanic ashfall, or wildfire) or other external events (e.g., prolonged loss of power or water), or operational accidents (including facility fires) that can effect human health and a broad range of receptors, and (2) contamination of groundwater from further spread of existing groundwater contamination, migration of contaminants from legacy surface disposal sites and the vadose zone, or unplanned release of contaminants from engineered facilities (e.g., waste tanks). Current significant threats to the Columbia River from contaminants in the River Corridor are being treated, and significant threats from groundwater contaminants to the Columbia River from the Central Plateau are either being treated or would not be realized for a long time and only if they are not treated during the active cleanup period.

The highest rated risks during cleanup are (1) to workers, co-located people, and controlled access groups from operational accidents, and (2) to ecological and cultural resources from physical disruption or introduction of invasive species, either because of insufficient planning, selected cleanup methods, or lack of a prior knowledge.

The major risks remaining after cleanup are from potential failure of institutional or engineered controls, which may affect human health, water resources, and ecological resources. In addition, ***safety of consumptive practices*** (such as those associated with some Tribal Nation cultural practices and some recreational activities) cannot be assured without both risk assessment and appropriate biomonitoring.

5.3. INTERIM OBSERVATIONS

Prioritization and sequencing of cleanup activities should consider risks from nuclear, chemical, and physical hazards and existing environmental contamination, as well as a range of other factors, including regulatory requirements, funding and personnel, project continuity, and stakeholder input. The following interim observations should be regarded as preliminary because there are approximately 35 EUs remaining to be evaluated. The final report will contain the results of all evaluations of these units as well as final observations. Interim observations fall into one of four categories: (1) general; (2) sequencing of cleanup; (3) planning for and activities associated with cleanup; and (4) key information gaps.

GENERAL OBSERVATIONS

1. At the Hanford Site, current hazard and risk conditions reflect the inventory, site access controls that are in place, and cleanup actions already completed. These controls and completed actions have greatly reduced threats to human health and ecological resources, as well as addressing some of the groundwater contamination. When considering future cleanup, different hazard and risk considerations are important for specific aspects of the cleanup:
    a. **To inform sequencing of cleanup activities –** *nuclear, chemical, and physical safety* (i.e., hazards, initiating events and accident scenarios) *and the threats to groundwater* and the Columbia River *are the primary risk considerations*.
    b. **To inform selection, planning and execution of specific cleanup actions –** potential *risks and impacts to worker safety, ecological resources, and cultural resources are the primary risk considerations*.
    c. **To inform cleanup criteria** (i.e., cleanup levels to meet regulatory standards) **–** *future land use, protection of water resources, land ownership and control, durability of institutional and engineered controls, and legal/regulatory requirements are the primary considerations that influence future human health risk estimates*. Risks to human health should be considered in combination with risks to environmental and ecological resources for establishing cleanup criteria. The establishment of end-state cleanup criteria is not the focus of the Risk Review Project.

2. Currently, members of the public, whether located at the official Hanford Site boundary or at the controlled access boundary (river and highways), usually have Low to ND risks, even if postulated radioactive contaminant releases are realized.

3. Timing of cleanup of a specific EU **may reduce** worker risk (e.g., by radioactive decay) **or may increase worker risk** (e.g., by facility deterioration, insufficient trained workforce availability, repetitive or chronic exposures due to maintenance, potential for complacency).
    a. Worker risk varies with respect to the nature of hazards, complexity, duration of project, technical approaches, and controls or mitigation measures in-place to ensure worker health and safety.
    b. DOE and its contractors have accident rates approximately two-thirds less than comparable non-DOE work. Ongoing vigilance is needed to maintain this excellent record.
4. The ecological resources on the Hanford Site are very important to the Columbia River Basin Ecoregion, where the shrub-steppe habitat has decreased at a far greater rate region-wide than on the Hanford Site. Stewardship by the DOE has helped protect these resources.
5. The historical and cultural significance of the Hanford Site to Tribal Nations stretches over 10,000 years. The Hanford Site also is considered to have important historical significance to western settlement, which began in the early 1800s and only ended at the site to make way for the Manhattan Project. Finally, the site played a major role during the Manhattan Project Era and after World War II during the Cold War Era. DOE's stewardship helps assure that the site's historical and cultural significance will continue to be recognized.

INFORMING CLEANUP SEQUENCING

1. **Address parts of specific evaluation units earlier.** For several EUs, specific activities, hazards or risk characteristics warrant being addressed before the EU as a whole.
2. **Highest priority group based on evaluation of potential risks to human health and the environment.** For the facilities and activities evaluated under the Risk Review Project to date, the major cleanup activities that are in the highest priority group based on evaluation of potential risks to human health and the environment are as follows (*not in any specific order*):
    a. **Reduction of threats posed by tank wastes.** (Appendix E) Hydrogen gas generation[88] poses a threat to nuclear safety and human health through hydrogen flammability events that may result in atmospheric or subsurface release of waste or contaminants from containment (worker risk from tank vapors are discussed below). Tc-99 and I-129, both being persistent and highly mobile in the subsurface, pose threats to groundwater through potential leakage from tanks[89]. Risks posed by hydrogen gas generation can be somewhat reduced through removal of water soluble Cs-137. Groundwater threats can be substantially reduced by removal of water-soluble constituents from a selected set of tanks.[90] This interim observation is consistent with the priority given by the agencies to

[88] Hydrogen generation rate is primarily related to Cs-137 and Sr-90 content of the waste.
[89] The threat to groundwater from tank leakage has been mitigated in the near-term through interim stabilization of single shell tanks (SSTs) by removal of pumpable liquids.
[90] For hydrogen generation – 200 East DSTs, 200 West DST SY-103 and single shell tanks East B-202, B-203, B-204, and West T-201 have times to 25% of the lower flammability limit of less than 6 months under unventilated conditions. Cs-137 removal would most significantly increase time to 25 percent of the lower flammability limit for tanks AZ-101, AN-102, AN-107, AP-101, AP-103 and AP-105. For groundwater threat, greater than 70% of the GTM is from – 200 East DSTs, SY-101 and SY-103 (200 West DSTs) and single shell tanks, AX-101, S-105, S-106, S-108, S-109, SX-106, TX-105*, TX-113*, TX-115*, U-109, U-105 (* indicates assumed SST leaker).

treat LAW at WTP as early as possible if Cs-137, Tc-99 and I-129 separated from the waste are not returned to the tanks. However, the risk profile will not be reduced significantly nor increased if Cs-137, Tc-99 and I-129 are returned to the tanks during LAW treatment.

b. **Reduction or elimination of risks associated with external events and natural phenomena (severe seismic events, fires, loss of power for long duration).** Facilities affected are WESF (cesium and strontium capsules), CWC, and PUREX waste storage tunnels.

    i. **For WESF** (Appendix H.4)**:**

    The primary scenario that causes release of radionuclides from capsules stored in the WESF pool cells is an accident that results in the loss of all water from the pools cells, which provides cooling and radiation shielding. The design basis seismic event alone cannot cause the loss of all pool cell water by itself: release of significant quantities of radionuclides can only be caused if multiple root causes occur (some in sequence, some in parallel) that include man-made errors, natural events, and external events. The storage pool structures have been exposed to high radiation fields for an extended period of time. An initial assessment completed indicates that the storage pools currently are safe, although the long-term integrity of the structures is uncertain.[91] DOE proposes to over-pack and then transfer cesium and strontium capsules to onsite dry storage.[92]

    ii. **For Central Waste Complex** (Appendix H.3)**:**

    Estimated unmitigated doses from incident scenarios to the co-located person exposed to the worst design basis event at the Central Waste Complex is from a large fire involving more than eight drums or 82.5 Ci (dose equivalent) of material with 770 rem. The risk may increase because the Central Waste Complex continues to receive wastes, but currently is unable to ship wastes to off-site disposal, due to WIPP being closed and also because budgets have been insufficient to support repackaging wastes into standard containers. Localized accumulation of material at risk without a disposition pathway can increase overall risk. Consideration also should include reductions in the amount of material at risk for similar facilities that require interaction with other offsite facilities that may not be available.

    iii. **For PUREX** (Appendix F.4):

        1. A design basis seismic event could lead to a total structural failure of the 202-A building and both tunnels, causing an estimated unmitigated combined 250 rem dose to the co-located person.

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[91] A separate DOE-initiated review of the condition of the WESF concrete structure and the reliability of the initial DOE estimate is in progress.

[92] The capsules may experience significantly higher temperatures in dry storage than in pool storage. The elevated temperatures, combined with the variable and uncertain chemical composition of some capsules, could raise concerns about the integrity of the capsules over time as storage is likely for at least decades (see Appendix H.4). This concern would be part of the safety analysis associated with the dry storage design process.

2. The wood ceiling and wall structure of Tunnel #1 are vulnerable to fire or collapse in about 30 years[93] due to ongoing degradation occurring from continued exposure to the gamma radiation from equipment being stored. These events could release a large fraction of the 21,200 Ci radiological inventory to the environment.[94]

c. **Dependence on active controls (e.g., reliance on power, cooling water, active ventilation) to maintain safety for additional facilities with large inventories of radionuclides.** These conditions are (1) air handling ducts at WESF, and (2) sludge at K-Basins (sludge treatment project; Appendix H.2).

i. During the design basis event earthquake, contaminants from WESF's hot cell and ventilation system are the hazard sources that produce doses to the co-located person [Co-located person: 21 rem].

ii. Current safe storage relies on maintaining the K-Basin sludge submerged under water to reduce radiation exposure to workers and prevent fires of reactive metal fragments. Safe processing of K-Basin sludge also requires keeping it wet during retrieval, transfer, interim storage, and processing to prevent pyrophoric constituents from igniting.

3. **Cleanup actions that could cause substantial human health risks**. The following cleanup activities themselves could cause substantial risks to human health and therefore warrant consideration of interim actions, and different cleanup approaches and timing (recognizing that mitigation measures would be both necessary and implemented before and during remedial actions):

a. **Retrieval, treatment, and disposal of contaminated soils underlying Building 324 and disposal of the building after grouting the contaminated soils in the building** (Appendix F.2)**.** Currently, no migration of soil contamination to groundwater has been indicated, suggesting that required cleanup is not urgent. In addition, the excavation and transfer of the soils through the B-Cell floor may not be technically feasible and/or may present challenging risk scenarios. As a result, approaches that allow for immobilization and in situ decay of the soil contaminants (Cs-137, Sr-90) warrant further consideration.

b. **Retrieval, treatment, and disposal of materials from 618-11 within caissons, vertical pipe units, and burial grounds** (Appendix D.2) because of the characteristics of wastes (high activity, pyrophoric, poorly characterized) to be retrieved. The possible event of a fire and/or release from 618-11, jeopardizes continued operations and worker safety at the Columbia Northwest Generating Station because of the proximity of the two facilities. The current cover over the buried wastes, but not present over the caissons and vertical pipe units, is effective in limiting water infiltration to the wastes where the cover is present. These conditions warrant consideration of instituting interim mitigation measures and delaying waste retrieval until closure of the generating station.

4. **Groundwater Threats** (Appendix G). Many of the threats and current impacts to groundwater are being interdicted and/or treated. The greatest threats and impacts to groundwater that are not currently being addressed are from:

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[93] The time estimate of 30 years has large uncertainty, and can be shorter or longer.

[94] The document safety analysis for this facility provides a detailed analysis of potential upset events (see Appendix F.4).

a. **Groundwater plumes not currently being actively addressed.** Tc-99 and I-129 are already in groundwater in 200 East Area (200-BP-5; EU CP-GW-1). The 200-BP-5 I-129 plume extends to the southeast (200-PO-1; EU CP-GW-1) but may be too dispersed for effective remediation other than natural attenuation.

b. **Vadose zone threats to groundwater not currently being addressed.** Tc-99, I-129 and Cr(VI) are in the vadose zone associated with BC Cribs and Trenches (EU CP-LS-1; Appendix D.4) and the legacy sites associated with B-BX-BY tank farms (EU CP-TF-6; Appendix E.7), both located in the 200 East Area. Sr-90 results in a very high rating in B-BX-BY because of the large inventory but also is relatively immobile and will naturally decay. Infiltration control (e.g., capping) and other approaches, may reduce the flux of these contaminants from the vadose zone into groundwater. Uranium currently is being extracted from perched water in B-Complex.

c. **324 Building, where relatively modest interim actions could reduce threat.** The largest risk for migration of Cs-137 and Sr-90 from the soils until cleanup can be completed (through a combination of D4, soil treatment and/or removal and natural attenuation) is from breakage of a main water pipe and infiltration of precipitation and run off in close vicinity of the building. Building 324 is currently being maintained in a safe surveillance and maintenance mode pending completion and evaluation of a pilot project and assurances that resources are available to complete a multi-year soil remediation and D4 activities. Current risks from potential water infiltration and resultant contaminant migration may be mitigated through water supply modifications, infiltration controls, and additional groundwater monitoring[95].

d. **618-11 waste site, where relatively modest interim actions could reduce threat**. At 618-11, the potential for release of additional contaminants to groundwater can be mitigated by providing a cover that prevents infiltration but maintains gas venting over the caissons and vertical pipe units (currently gravel covered area).

5. **Operating facilities have a time dependent risk, which create additional challenges.** Unplanned changes in inventory can occur over time, with delays in planned processing resulting in increased risk. The hazard and risk profiles change as funding is available to implement identified plans. For example, with processing delays along with, waste storage conditions may deteriorate or additional waste may accumulate. In addition, operating facilities rely on interfaces with existing facilities (e.g., WIPP, T Plant, off-site processing and disposition facilities) and planned facilities (e.g., dry capsule storage for cesium and strontium capsules, Phase 2 K-Basin Sludge Processing). Outages or delays in availability of interfacing facilities may result in processing disruptions.

PLANNING FOR, AND ACTIVITIES ASSOCIATED WITH, CLEANUP

1. Selective retrieval targets of 99% or the limits of multiple technologies applied to the group of 26 DSTs and 42 SSTs that comprise 90% of the total GTM within all tanks, would result in a residual GTM of 1% of the initial inventory. Waste retrieval targets of 90% of the GTM or the limits a single technology (if greater than 90%) would result in a residual of less than an additional 1% of the current GTM, and with a cumulative result that is indistinguishable from a target of 99% across all tanks, considering the inventory uncertainties. Selective waste retrieval

[95] While groundwater monitoring does not prevent infiltration or contaminant migration, it does mitigate risks by providing early warning of a change in the subsurface contaminant spatial distribution.

targets as indicated may allow for significant acceleration of tank waste retrievals and much more rapid reduction in groundwater threats from tank wastes than currently planned. Recognizing that waste retrievals are most efficiently carried out on tank farm by tank farm basis, selective extents of retrieval focusing on tanks with large inventories of contaminants that threaten groundwater, can be accomplished for individual tanks within each tank farm, allowing for different extents of retrieval while completing retrievals at an entire tank farm. Retrieval targets also should consider the extent of retrieval for specific contaminants that threaten groundwater rather than solely on volumetric-based retrieval targets. Further evaluation of this concept is warranted. A tank farm waste retrieval and processing system plan evaluation of this approach is suggested.

   a. A target of 90 % reduction in GTM across all SSTs and considering in-tank grouting of residual waste inventory would reduce the threat of groundwater contamination from SSTs to substantially less the GTM from the existing environmental contamination in the vadose zone in the 200 West and 200 East Areas from leaks and legacy disposal activities in the proximity of the SST farms.

2. During the active cleanup period, worker risks from chronic, sub-acute and acute exposures to hazards, and industrial type accidents are the major human health considerations.
   a. Prior to active cleanup, surveillance and maintenance, chronic radiation exposures and chemical exposures such as to poorly characterized vapors at tank farms, constitute the greatest worker risks.
   b. During cleanup action, worker risks can be high at legacy waste disposal sites that are not, or cannot be, fully characterized. D&D workers may encounter asbestos, radiation, and chemical hazards (including PCBs, lead, beryllium).
3. For almost all cases, the potential for adverse impacts to ecological resources from contaminants has already been mitigated either by removal actions or by the presence of engineered barriers (e.g., cover materials, buildings or engineered structures). Uptake of contaminants from groundwater in the riparian zone and groundwater discharge to the benthic zone, of the Columbia River remain the most important pathways for contaminants to impact ecological resources. An additional potential future pathway includes through irrigation and plant uptake associated with use of contaminated groundwater.
4. Physical disruption and invasive species are the primary mechanisms of adverse impacts on ecological resources at the Hanford Site. Patch size and interdiction of patches is an important aspect of ecological value, and should be considered during cleanup. Decreasing the footprint of cleanup activities on the EU and buffer are one of the most important mechanisms of reducing risk to ecological resources. Planning for remediation requires careful consideration of how the activities will disrupt eco-receptors and ecosystems on the EU, and surrounding areas (including vehicular traffic, people, roads, traffic routes, lay-down areas), reducing effects where possible, and specifically avoiding high quality ecological resource areas on or off the EU. Allowing non-native species to invade an EU or the surrounding buffer can disrupt and damage high quality native resources and is preventable. If high quality resources on the EU and buffer are disturbed, it may not be possible to restore them. Thus protection of ecological resources during remediation is the best option and is superior to trying to repair damaged resources

5. Ecological restoration[96] is an important step in remediation, and must be carried out with native species, processes and structure, and monitoring to assess efficacy is critical to determining how to do restoration for future cleanup activities. The value of ecological resources at any given EU depends upon the resources there and in the surrounding buffer, the historical presence of resources of high value, the remediation and restoration history on the EU and buffer, and chance/weather/fires. These factors affect the ecological restoration potential during remediation.
6. The Manhattan Project/Cold War era built environment is well understood as extensive inventories have been completed to document the historical importance of the era's buildings and structures and which of those buildings and structures will remain after remediation has ended.
7. Physical exposure and disruption during remediation are the primary mechanisms for adverse impacts on cultural resources from activities associated with cleanup of specific EUs. Planning for remediation, particularly at the earliest stages, should include (a) how remediation activities, such as road traffic and heavy equipment through the cleanup area could impact potential cultural resources that are, or could be present within and adjacent to, the area undergoing cleanup and (b) the mitigation measures that could avoid or limit the impact. Limiting the footprint of activities associated with remediation can decrease the chance that a cultural resource will be exposed or adversely impacted during cleanup. Additionally, limiting the footprint decreases the chance that indirect impacts, such as the visibility of a site that Native Americans consider to be important to their culture, will occur.
8. Remediation of the 100-K Area waste sites (EU RC-LS-2) currently is a "work in progress" where soil cover and vegetation have been removed in some areas, and active dust suppression is required, so there is increased potential for dispersal and/or transport to groundwater of contaminants remaining in the waste sites. Remediation and re-vegetation of the site will reduce infiltration and transport of residual vadose zone contamination to groundwater. Re-vegetation needs to consider topography and native plants.

KEY INFORMATION GAPS

1. There is a need for regular updating of assumptions within the DSA regarding where the maximum exposed individual (public) is located, as the use of the Hanford Site evolves.
2. Contaminant inventories at many of the EUs are highly uncertain. Further characterization of contaminated or potentially contaminated areas needs to be carried out to the extent necessary to make informed cleanup decisions and assure that residual risks to human health, water resources and ecological resources are below acceptable thresholds.
3. Additional risk analyses will be needed to evaluate risks to human health as part of planning for new controlled access activities. Current analyses do not provide sufficient resolution to understand potential safety risks to a broader range of people present between 100 m from facility or activity boundaries to the Hanford Site security boundaries. Additional mitigation measures, such as biomonitoring, also may be necessary for controlled access that includes gathering or consumptive activities such as Tribal cultural activities.

[96] In this report, the term "restoration" does not refer to Natural Resource Damage Assessment considerations. Instead, as used here, ecological restoration refers to a process that includes such activities as environmental assessment, vegetation assessment, geographical and contour considerations, re-vegetation, and monitoring, among other processes.

4. The condition of infrastructure and the impacts of infrastructure challenges on the waste management and long-term cleanup efforts, and resulting risks, are subjects of current evaluation and planning by DOE.
5. For many existing groundwater plumes and for many areas of contamination in the vadose zone, the vertical distribution of primary contaminants is highly uncertain because of limited characterization data.
6. For most EUs and areas on the Hanford Site, there has not been a recent evaluation or inventory of the ecological resource level (e.g., habitats). Planning and sequencing to reduce risk to eco-receptors depends on avoiding and protecting high quality resources (especially large patches, or smaller patches close to large patches).
7. For most EUs and areas on the Hanford Site, there has not been any survey of the nature and extent of invasive species, especially on large patches of high quality resources (Levels 3-5 resources, including habitat for important species and threatened or endangered species). There should also be monitoring in the years following cleanup to determine the extent of non-native species invasions to determine efficacy of measures to prevent invasion.
8. The majority of the Hanford Site has not been surveyed for cultural resources related to the Native American and Pre-Hanford Eras. There likely are cultural resources present from those eras, particularly those that are not directly visible. Cultural resources reviews are carried out on a case-by-case basis when cleanup actions, or other activities may disrupt specific land areas or land transfers are being considered.
9. Existing cultural resources records oftentimes are not compiled or organized in ways that would be helpful during planning for cleanup at a particular location. Cultural resources reviews would benefit from a more streamlined process that provides information in a more timely fashion and with sufficient detail for planning and sequencing of remediation actions while still protecting the cultural resources.

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APPENDIX A

HANFORD SITE-WIDE RISK REVIEW PROJECT DIRECTION MEMORANDUM

Department of Energy
Washington, DC 20585
January 16, 2014

MEMORANDUM FOR DAVID G. HUIZENGA
SENIOR ADVISOR
FOR ENVIRONMENTAL MANAGEMENT

DAVID S. KOSSON
PRINCIPAL INVESTIGATOR, CONSORTIUM FOR RISK
EVALUATION WITH STAKEHOLDER PARTICIPATION

FROM: DAVID M. KLAUS
DEPUTY UNDER SECRETARY
FOR MANAGEMENT AND PERFORMANCE

SUBJECT: Hanford Site-Wide Risk Review Project

The purpose of this memo is to request the conduct of a Hanford site-wide evaluation of human health, nuclear safety, environmental and cultural resource risks (Risk Review Project). The goal of the Risk Review Project is to identify and characterize potential risks and impacts to the public, workers, and the environment at the Hanford Site and to inform the efficient use of Department of Energy (DOE) Environmental Management (EM) resources. The project shall be independently led by the Consortium for Risk Evaluation with Stakeholder Participation (CRESP) and shall involve the active cooperation and participation of senior management at DOE-EM, DOE-Office of River Protection (ORP) and DOE-Richland (RL) as well as by U.S. Environmental Protection Agency (EPA) and the State of Washington Departments of Ecology and Health as participants in a Core Team to be established as part of the execution of the project. Additionally, the Pacific Northwest National Laboratory will provide assistance in a supporting role to CRESP during the Project.

The purpose of the Risk Review Project is to review existing information and to develop a summary level catalogue of risks and impacts to the environment and to rate or bin those risks and impacts according to the magnitude of potential risks to the members of the public, workers, and to the environment. The Risk Review Project should take into consideration: current and potential future impacts to human health (public and workers), land and river ecology, nuclear safety, natural resources, and cultural resources. This effort is to focus on risks associated with cleanup work that is currently on-going and remaining at the Hanford Site, and therefore recommendations should be prospective in nature. On-going and future cleanup work to be considered includes tank waste treatment and tank closure; soils, vadose zone and groundwater remediation; facility decommissioning; on-site near-surface disposal; and on-site risks from transuranic and high level wastes projected for off-site disposition for which formal regulatory completion of the remedy or corrective action has not been achieved. The review should place Hanford environmental and nuclear safety hazards and risks in context with currently designated future uses of the Hanford site and nearby land uses and activities that have a potential to impact risks, natural resources, and cultural resources. Additional context should be provided on impacts to on-site and nearby economic resources.

The participation of EPA Region 10 and EPA Headquarters and Washington Department of Ecology (Ecology) and Washington Department of Health (Health) is an important component of the Risk Review Project. Toward that end, please ensure that EPA, Ecology and Health are provided the opportunity to have representation on the Core Team, which will be established to oversee the development of risk characterization metrics and templates for determining risk ratings, the analysis and integration of rating results and to develop conclusions and recommendations regarding the risks and impacts evaluated. Additionally, please consult with appropriate tribal nations and give other stakeholders and agencies an opportunity to provide input during the execution of the Risk Review Project.

To help ensure efficient completion of the Project, I am directing the following:

1. EM, ORP, and RL will make the necessary staff and resources available to assist CRESP in conducting the review in a timely manner. This includes active senior management participation on the Core Team; and
2. EM, ORP, and RL will provide CRESP with all appropriate written reports, investigations, reviews, maps, charts, surveys, summaries or other communications or documents and access to electronic databases that CRESP may request as needed for the Risk Review Project. Documentation and electronic data may include mapping or other geographic information system data and overlays.

CRESP is responsible for scheduling meetings and/or teleconferences as needed, with cooperation from RL, ORP and EM. CRESP is to carry out the Risk Review Project based on the following schedule:

1. Within 2 months, initiate Core Team meetings to be held in Richland, WA;
2. Within 9 months, provide for review a set of approximately half of the draft summaries and specific evaluations to be completed and an interim progress report; and
3. Within 18 months, provide a draft final report.

A more detailed schedule is to be developed and updated quarterly. Quarterly progress summaries are to be provided by CRESP as well as progress briefings, as requested.

APPENDIX B

EVALUATION UNIT DISPOSITION TABLE

Appendix B: Evaluation Unit Disposition Table
(Interim Report EUs only)

Evaluation Unit (EU) ID*	Description & Comments	Operable Unit Cross Walk	Reference	Existing Cleanup Decisions
RC-LS-1 (Interim)	618-11 Burial Ground	300-FF-2	DOE/RL-2013-02 Table A-1 ROD (Final, 2013)	Record of Decision (ROD) for 300-FF-2 and 300-FF-5, and ROD Amendment for 300-FF-1 The major components of the selected remedy for the 300-FF-2 Operable Unit (OU) are: - Remove, treat, and dispose (RTD) at waste sites - Temporary surface barriers and pipeline void filling - Enhanced attenuation of uranium using sequestration in the vadose zone, periodically rewetted zone (PRZ), and top of the aquifer - Institutional controls (ICs)
RC-LS-2 (Interim)	K Area Waste Sites: legacy waste sites within the fence at 100-K, where remediation is post-2015	100-KR-1	DOE/RL-2013-02 Table A-1	ROD (Interim Action): Interim Action ROD for the 100-BC-1, 100-BC-2, 100-DR-1, 100-DR-2, 100-FR-1, 100-FR-2, 100-HR-1, 100-HR-2, 100-KR-1, 100-KR-2, 100-IU-2, 100-IU-6, and 200-CW-3 OUs: (EPA/ROD/R10-99/039) *Remove Treat Dispose for 46 sites; disposal of debris from B, D, H, and K Reactors to the Environmental Restoration Disposal Facility (ERDF); provides decision framework for leaving waste in place, generally below 15-ft depth.*
		100-KR-2	DOE/RL-2013-02 Table A-1	ROD (Interim Action): Interim Action ROD for the 100-BC-1, 100-BC-2, 100-DR-1, 100-DR-2, 100-FR-1, 100-FR-2, 100-HR-1, 100-HR-2, 100-KR-1, 100-KR-2, 100-IU-2, 100-IU-6, and 200-CW-3 OUs: (EPA/ROD/R10-99/039) *Remove Treat Dispose for 46 sites; disposal of debris from B, D, H, and K Reactors to ERDF; provides decision framework for leaving waste in place, generally below 15-ft depth.*
			DOE/RL-2013-02 Table A-1	Declaration of the ROD for the 100-BC-1, 100-BC-2, 100-DR-1, 100-DR-2, 100-FR-2, 100-HR-2, and 100-KR-2 OUs (EPA/ROD/R10-00/121) Remove contaminated soil, structures, and debris; treat as needed; dispose at ERDF; backfill and revegetate.

Appendix B: Evaluation Unit Disposition Table
(Interim Report EUs only)

Evaluation Unit (EU) ID*	Description & Comments	Operable Unit Cross Walk	Reference	Existing Cleanup Decisions
CP-LS-1 (Interim)	BC Cribs and Trenches: cribs, trenches and tank located to the south of the 200 East Area	200-BC-1 (Note: Utilized 200 WA-1)	DOE/RL-2010-49, DRAFT A	These sites are covered under DOE/RL-2000-38, 200-TW-1 Scavenged Waste Group OU and 200-TW-2 Tank Waste Group OU Remedial Investigation/Feasibility Study (RI/FS) Work Plan, but are included in this work plan for consistency in information collection and storage. These sites will also be covered in the 200 WA-1 FS.
			DOE/RL-2013-02 (Table B-3 CP-15)	**CP-15 – Remediate Remaining 200 West Inner Area Contaminated Soil Sites (200 WA-1 OU)** Cleanup Decision Summary and Relevant Decision Documents Several action memoranda are in place to remove contaminated soil, structures, and debris from 200 West Inner Area soil sites with disposal at ERDF. <u>Range of Alternatives</u> - RTD approximately half of waste sites and cap remainder - RTD all waste sites; backfill and revegetate - Cap and maintain under long-term storage (LTS) with monitoring and appropriate institutional controls If residual contamination remains after cleanup actions are completed, cleanup work will transition to LTS, including institutional controls and 5-year reviews of remedy effectiveness.
CP-LS-2 (Interim)	Plutonium-contaminated cribs and trenches associated with Plutonium Finishing Plant in central part of 200 West Area	200-PW-1,3,6 200-CW-5	DOE/RL-2013-02 (Table A-1) Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) Final ROD	ROD, Superfund Site 200-CW-5 and 200-PW-1, 200-PW-3 and 200-PW-6 OUs (EPA 2011c): - RTD of soil and debris to specified depths or specified cleanup levels for plutonium-contaminated soils and subsurface structures and debris - Soil vapor extraction at three 200-PW-1 waste sites will continue until vadose zone cleanup levels are met - Soil covers will be used to provide coverage to a depth of at least 15 ft over cesium-contaminated soils. Removal of sludge followed by tank stabilization for two tanks - No action for two waste sites - ICs and long-term monitoring for waste sites where contamination is left in place and an unrestricted land use is precluded

Appendix B: Evaluation Unit Disposition Table
(Interim Report EUs only)

Evaluation Unit (EU) ID*	Description & Comments	Operable Unit Cross Walk	Reference	Existing Cleanup Decisions
CP-TF-1 (Interim)	T tank farm, ancillary structures, associated liquid waste sites, and soils contamination	200-DV-1, WMA T, 200 WA-1	DOE/RL-2013-02 (Table B-3 TW-1)	**TW-1 Tank Waste – Tank Retrieval and Single-Shell Tank Farm Closure** Tank Closure and Waste Management Environmental Impact Statement ROD (78 FR 75913, December 13, 2013) sets the following requirements for tank retrieval and closure: • 99% retrieval of waste by volume from the single-shell tanks (SSTs) • Leak detection monitoring and routine maintenance • New and existing storage facilities • Operations and necessary maintenance, waste transfers and associated operations, and upgrades to existing tanks or construction of waste receipt facilities • SST closure operations include filling the tanks and ancillary equipment with grout to immobilize the residual waste • Disposal of contaminated equipment and soil would occur on site • Decisions on the extent of soil removal or treatment would be made on a tank farm or waste management area basis through the Resource Conservation and Recovery Act (RCRA) closure permitting process • The tanks would be stabilized, and an engineered modified RCRA Subtitle C barrier put in place followed by post-closure care Existing decisions for tank retrieval are also present within the Tri-Party Agreement (TPA) and the Consent Decree (State of Washington v. DOE, No. 08-5085-FVS (E.D. Wa.): • TPA milestone M-45-00 states, “Closure will follow retrieval of as much tank waste as technically possible, with tank waste residues not to exceed 360 cubic feet in each of the 100 series tanks, 30 cubic feet in each of the 200 series tanks, or the limit of waste retrieval technology, whichever is less.” A procedure for gaining an exemption from this requirement is outlined in Appendix H of the TPA. • The Consent Decree defines retrieval requirements for 10 tanks in C farm and 9 additional tanks. Up to three retrieval technologies may be required to their “limits of technology” in an effort to obtain the waste residue goal of 360 cubic feet of waste or less. Provisions are provided to determine the “practicability” of continued use of a retrieval technology including matters “such as risk reduction, facilitating tank closures, costs, the potential for exacerbating leaks, worker safety, and the overall impact on the tank waste retrieval mission.”

Appendix B: Evaluation Unit Disposition Table
(Interim Report EUs only)

Evaluation Unit (EU) ID*	Description & Comments	Operable Unit Cross Walk	Reference	Existing Cleanup Decisions
CP-TF-2 (Interim)	S-SX tank farms, ancillary structures, associated liquid waste sites, and soils contamination; includes 242-S Evaporator	WMA S/SX, 200-DV-1, 200 WA-1		Same as CP-TF-1
CP-TF-3 (Interim)	TX-TY tank farms, ancillary structures, associated liquid waste sites, and soils contamination; includes 242-T Evaporator	WMA TX/TY, 200-DV-1, 200 WA-1		Same as CP-TF-1
CP-TF-4 (Interim)	U tank farm, ancillary structures, associated liquid waste sites, and soils contamination	WMA U, 200 WA-1		Same as CP-TF-1

Appendix B: Evaluation Unit Disposition Table
(Interim Report EUs only)

Evaluation Unit (EU) ID*	Description & Comments	Operable Unit Cross Walk	Reference	Existing Cleanup Decisions
CP-TF-5 (Interim)	A-AX tank farms, ancillary structures, associated liquid waste sites, and soils contamination	WMA A/AX, 200 EA-1, 200-PW-3		Same as CP-TF-1
CP-TF-6 (Interim)	B-BX-BY tank farms, ancillary structures, associated liquid waste sites, and soils contamination	WMA B/BX/BY, 200-DV-1, 200 EA-1		Same as CP-TF-1
CP-TF-7 (Interim)	C tank farm, ancillary structures, associated liquid waste sites, and soils contamination	WMA C		Same as CP-TF-1
CP-TF-8 (Interim)	200 East Area DSTs: AN, AP, AW, AY, AZ tank farms, ancillary structures, associated liquid waste sites, and soils contamination	Not Applicable	DOE/RL-2013-02 (Table B-3 TW-4)	**TW-4 Tank Waste – Double-Shell Tank (DST) Closure** Cleanup Decision Summary and Relevant Decision Documents No cleanup decisions have been made. Decisions have been deferred to future decision-making processes. Range of Alternatives - Retrieve DST wastes consistent with RCRA; achieve designated retrieval objectives or limits of technology; remediate structures and soil and install cover/cap to meet closure performance standards; maintain post-closure care and monitoring consistent with RCRA Permit - Close under RCRA

Appendix B: Evaluation Unit Disposition Table
(Interim Report EUs only)

Evaluation Unit (EU) ID*	Description & Comments	Operable Unit Cross Walk	Reference	Existing Cleanup Decisions
CP-TF-9 (Interim)	200 West Area DSTs: SY tank farm, ancillary structures, associated liquid waste sites, and soils contamination	WMA S/SX	DOE/RL-2013-02 (Table B-3 TW-4)	**TW-4 Tank Waste – Double-Shell Tank Closure** Cleanup Decision Summary and Relevant Decision Documents No cleanup decisions have been made. Decisions have been deferred to future decision-making processes. Range of Alternatives - Retrieve DST wastes consistent with RCRA; achieve designated retrieval objectives or limits of technology; remediate structures and soil and install cover/cap to meet closure performance standards; maintain post-closure care and monitoring consistent with RCRA Permit - Close under RCRA
RC-GW-1 (Interim)	300 Area uranium and associated contaminant plumes	300-FF-5	DOE/RL-2013-02 Table A-1 ROD (Final, 2013)	ROD for 300-FF-2 and 300-FF-5, and ROD Amendment for 300-FF-1 The major components of the selected remedy for the 300-FF-2 OU are: - Remove, Treat and Dispose (RTD) at waste sites - Temporary surface barriers and pipeline void filling - Enhanced attenuation of uranium using sequestration in the vadose zone, Periodically Rewetted Zone (PRZ) and top of the aquifer - Institutional Controls (ICs)
RC-GW-2 (Interim)	100-N strontium and associated contaminant plumes	100-NR-2	DOE/RL-2013-02 (Table A-1) CERCLA Interim Action ROD	Interim Remedial Action ROD for the 100-NR-1 and 100-NR-2 OUs (EPA/ROD/R10-99/112) - ICs for shoreline site; in situ and RTD with ex situ bioremediation for petroleum sites - RTD for remainder of sites in 100-NR-1 - Maintain ERA pump-and-treat (P&T) for 100-NR-2 Deploys the apatite sequestration technology for remediating strontium-90 in the 100-NR-2 OU by extending existing apatite permeable reactive barrier.

Appendix B: Evaluation Unit Disposition Table
(Interim Report EUs only)

Evaluation Unit (EU) ID*	Description & Comments	Operable Unit Cross Walk	Reference	Existing Cleanup Decisions
			DOE/RL-2013-02 (Table B-2 RC-4.3)	**RC-4.3 – Restore 100-NR-2 Groundwater OU to Beneficial Use** An action memorandum, interim ROD, and Explanation of Significant Differences (ESD) are in place to clean up strontium-90 in the groundwater using P&T and physical barriers. An in situ apatite barrier and phytoremediation treatability tests are being evaluated for use in the cleanup of strontium-90 in groundwater. <u>Range of Plausible Alternatives</u> - Resume operation of existing P&T system; operate and expand system as necessary until cleanup objectives are achieved; transition to surveillance and maintenance for post-treatment groundwater monitoring - Construct an impermeable barrier along the shoreline to redirect groundwater flow and increase travel times for radioactive decay to achieve cleanup objectives - Expand the apatite permeable reactive barrier to promote sequestration of strontium-90 - Incorporate phytotechnology - Use sequestration and immobilization technologies for inner portion of strontium-90 plume - Allow monitored natural attenuation to proceed under LTS with institutional controls - If residual contamination remains after cleanup actions are completed, cleanup work will transition to LTS, including institutional controls and 5-year reviews of remedy effectiveness

Appendix B: Evaluation Unit Disposition Table
(Interim Report EUs only)

Evaluation Unit (EU) ID*	Description & Comments	Operable Unit Cross Walk	Reference	Existing Cleanup Decisions
RC-GW-3 (Interim)	100-B/D/H/F/K Area chromium and associated contaminant plumes, includes pump and treat (P&T) systems	100-BC-5	DOE/RL-2013-02 (Table B-2 RC-4.1)	**RC-4.1 – Restore 100-BC-5 Groundwater OU to Beneficial Use** No cleanup decisions have been made for this OU. Groundwater monitoring and reporting continue to track groundwater contamination in this OU. <u>Range of Plausible Alternatives</u> - Install P&T system in 100-BC-5; transition to surveillance and maintenance for post-treatment groundwater monitoring - Incorporate bioremediation for chromium - Allow monitored natural attenuation to proceed under LTS with institutional controls - If residual contamination remains after cleanup actions are completed, cleanup work will transition to LTS, including institutional controls and 5-year reviews of remedy effectiveness.
		100-KR-4	DOE/RL-2013-02 Table A-1 CERCLA Interim Action ROD	Declaration of the ROD for the 100-HR-3 and 100-KR-4 OUs: - Remove hexavalent chromium from groundwater; 30 extraction wells; ion exchange treatment; reinject treated effluent - Implement in situ redox manipulation barrier for second chromium plume - Monitor - Institute ICs
			DOE/RL-2013-02 (Table B-2 RC-4.2)	**RC-4.2 – Restore 100-KR-4 Groundwater OU to Beneficial Use** An interim ROD is in place to clean up hexavalent chromium in the groundwater using P&T <u>Range of Plausible Alternatives</u> - Expand the P&T system in 100-KR-4; transition to surveillance and maintenance for post-treatment groundwater monitoring - Continue operation of P&T system with incorporation of bioremediation for chromium - Allow monitored natural attenuation to proceed under LTS with institutional controls If residual contamination remains after cleanup actions are completed, cleanup work will transition to LTS, including institutional controls and 5-year reviews of remedy effectiveness.

Appendix B: Evaluation Unit Disposition Table
(Interim Report EUs only)

Evaluation Unit (EU) ID*	Description & Comments	Operable Unit Cross Walk	Reference	Existing Cleanup Decisions
		100-HR-3	DOE/RL-2013-02 Table A-1 CERCLA Interim Action ROD	Declaration of the ROD for the 100-HR-3 and 100-KR-4 OUs: - Remove hexavalent chromium from groundwater; 30 extraction wells; ion exchange treatment; reinject treated effluent - Implement in situ redox manipulation barrier for second chromium plume - Monitor - Institute institutional controls
			DOE/RL-2013-02 (Table B-2 RC-4.4)	**RC-4.4 – Restore 100-HR-3 Groundwater OU to Beneficial Use** An interim ROD, ROD amendment, and ESDs are in place to clean up hexavalent chromium in the groundwater using P&T and an in situ reduction/oxidation ("REDOX") manipulation barrier. Range of Plausible Alternatives - Expand P&T system in 100-HR-3; transition to surveillance and maintenance for post-treatment groundwater monitoring - Maintain and repair in situ redox manipulation barrier - Incorporate bioremediation - Allow monitored natural attenuation to proceed under LTS with institutional controls - If residual contamination remains after cleanup actions are completed, cleanup work will transition to LTS, including institutional controls and 5-year reviews of remedy effectiveness
		100-FR-3	DOE/RL-2013-02 (Table B-2 RC-4.5)	**RC-4.5 – Restore 100-FR-3 Groundwater OU to Beneficial Use** No cleanup decisions have been made for this OU. Range of Plausible Alternatives - Install P&T system in 100-FR-3; transition to surveillance and maintenance for post-treatment groundwater monitoring - Incorporate bioremediation for chromium - Allow monitored natural attenuation to proceed under LTS with institutional controls If residual contamination remains after cleanup actions are completed, cleanup work will transition to LTS, including institutional controls and 5-year reviews of remedy effectiveness.

Appendix B: Evaluation Unit Disposition Table
(Interim Report EUs only)

Evaluation Unit (EU) ID*	Description & Comments	Operable Unit Cross Walk	Reference	Existing Cleanup Decisions
CP-GW-1 (Interim)	Existing groundwater plumes emanating from 200 East Area	200-BP-5, 200-PO-1	DOE/RL-2013-02 (Table B-3 CP-22)	**CP-22 – Restore 200 East Groundwater to Beneficial Use (200-PO-1/200-BP-5 OUs)** Cleanup Decision Summary and Relevant Decision Documents No cleanup decisions have been made for the 200 East groundwater. <u>Range of Alternatives:</u> - 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 - Install P&T system for 200-BP-5 and selective P&T for 200-PO-1 hot spots Note: 400 Area groundwater cleanup actions are included as part of 200-PO-1 OU.
CP-GW-2 (Interim)	Existing groundwater plumes emanating from 200 West Area. Includes P&T systems	200-ZP-1,	DOE/RL-2013-02 Table A-1	ROD (200-ZP-1 Final): - Pump and Treat (P&T) to address carbon tetrachloride, nitrate, chromium, trichloroethylene, iodine-129, technetium-99, and tritium - Monitored natural attenuation - Flow-path control through injection of treated water - Institutional controls
		200-UP-1	DOE/RL-2013-02 Table A-1 ROD (Interim Action): EPA 2012	*ROD for Interim Remedial Action, Hanford 200 Area Superfund Site 200-UP-1 OU* (12-AMRP-0171) AR/PIR Accession Number 0091413 The major components of the selected remedy for the 200-UP-1 OU are: - Groundwater extraction/treatment - Monitored natural attenuation - Iodine-129 hydraulic containment and treatment technology evaluation - Remedy performance monitoring - Institutional controls
RC-DD-1 (Interim)	324 Building and associated soil contamination under the building	324 Building	DOE/RL-2013-02 Table A-2	**Action Memorandum #2 for the 300 Area Facilities** Provides for deactivation, decontamination, decommissioning, and demolition (D4) of the 324 and 327 Buildings and ancillary facilities in the 300 Area with D4 waste going to ERDF. The action memorandum provides a list of the ancillary facilities. In general, slabs and subsurface structures would be removed along with about 1 m of surrounding soil;

Appendix B: Evaluation Unit Disposition Table
(Interim Report EUs only)

Evaluation Unit (EU) ID*	Description & Comments	Operable Unit Cross Walk	Reference	Existing Cleanup Decisions
				however, on a case-by-case basis, the slabs and/or below-grade structures and soils can be deferred to CERCLA actions associated with the 300-FF-2 OU.
			DOE/RL-2013-02 Table C-21 (PBS RL-0041)	The D4 process includes deactivating the facility by removing loose hazardous materials and equipment; decontaminating the facility to allow open-air demolition; and decommissioning the facility by disconnecting utilities and services. The structure is then demolished using techniques such as track hoe, processor, loader, cranes, explosives, cutting equipment, or other methods, and the demolition debris is disposed, generally to ERDF. Following demolition, samples are collected to verify that cleanup criteria are met, and the sites are backfilled and revegetated.
		300-FF-2	DOE/RL-2013-02 Table A-1 CERCLA Interim Action ROD	Declaration of the Interim ROD for the 300-FF-2 OU (EPA/ROD/R10-01/119): - Remove contaminated soil, structures, and debris; treat as needed; dispose at ERDF, Waste Isolation Pilot Plant, or other facility - Backfill and revegetate - Establish Institutional controls - Continued groundwater monitoring EPA 2004b: - Uranium soil cleanup level from 350 to 267 pCi/g based on engineering study to ensure protectiveness of the groundwater and river - Modified land use assumption for eight outlying waste sites from industrial to unrestricted changed cleanup levels for these sites to those consistent with 100 Area cleanup
			DOE/RL-2013-02 Table A-1 ROD (Final)	ROD for 300-FF-2 and 300-FF-5, and ROD Amendment for 300-FF-1 (Hanford Administrative Record Accession Number: 0087180, 2013) The major components of the selected remedy for the 300-FF-2 OU are: - Remove, Treat and Dispose (RTD) at waste sites - Temporary surface barriers and pipeline void filling - Enhanced attenuation of uranium using sequestration in the vadose zone, PRZ, and top of the aquifer - Institutional Controls
RC-DD-2 (Interim)	KE/KW Reactors, basin, ancillary	*105-K Reactor*	DOE/RL-2013-02 Table A-2	**Action Memorandum for the Non-Time-Critical Removal Action for the 105-KE and 105-KW Reactor Facilities and Ancillary Facilities (DOE and EPA 2007)**

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(Interim Report EUs only)

Evaluation Unit (EU) ID*	Description & Comments	Operable Unit Cross Walk	Reference	Existing Cleanup Decisions
	buildings, and associated soil contamination			Identifies interim safe storage (ISS) for 105-KE and 105-KW Reactor cores, deactivation (decontamination) and decommissioning (D&D) of reactor components up to the cores and for remaining buildings and structures in 100-K Area. Subsurface structures will be removed 3 ft bgs; substructures and soil beneath facilities that exceed cleanup levels will be evaluated through source OU cleanup activities that are considered final for the ancillary facilities and demolished portions of the reactors. Further decisions are expected on reactor cores in ISS.
		100 K Basins	DOE/RL-2013-02 Table A-1 CERCLA Interim Action ROD	Declaration of the ROD for the 100-KR-2 OU, (EPA/ROD/R10-99/059) - Remove spent nuclear fuel from basins - Remove sludge from basins, including sludge treatment prior to interim storage - Treat and remove water from the basins - Remove debris from the basins, including grouting in place - Deactivate and remove basins - Institute Institutional controls
			DOE/RL-2013-02 (Table B-2 RC-2)	**RC-2 – Disposition 100 Area K West Basin** An interim ROD, ROD amendment, and action memorandum are in place for the removal, treatment, and interim onsite storage of spent nuclear fuel and sludge from the K Basins. **Range of Plausible Alternatives** - Remove, treat, and transfer sludge for interim storage at T Plant - Transfer fuel scrap for interim storage at Canister Storage Building - D4 K West Basin and ancillary structures - Remediate below-grade portions consistent with 100 Area contaminated soil sites* * May require removing K Reactors to access below-grade contaminated soils. K East Basin was demolished in 2009.
		100-KR-1 (include 100 K ancillary bldgs and legacy sites)	DOE/RL-2013-02 Table A-1	ROD (Interim Action): Interim Action ROD for the 100-BC-1, 100-BC-2, 100-DR-1, 100-DR-2, 100-FR-1, 100-FR-2, 100-HR-1, 100-HR-2, 100-KR-1, 100-KR-2, 100-IU-2, 100-IU-6, and 200-CW-3 OUs: (EPA/ROD/R10-99/039) *Remove Treat Dispose for 46 sites; disposal of debris from B, D, H, and K Reactors to ERDF; provides decision framework for leaving waste in place, generally below 15-ft depth.*

Appendix B: Evaluation Unit Disposition Table
(Interim Report EUs only)

Evaluation Unit (EU) ID*	Description & Comments	Operable Unit Cross Walk	Reference	Existing Cleanup Decisions
		100-KR-2 (include 100 K ancillary bldgs and legacy sites)	DOE/RL-2013-02 Table A-1	ROD (Interim Action): Interim Action ROD for the 100-BC-1, 100-BC-2, 100-DR-1, 100-DR-2, 100-FR-1, 100-FR-2, 100-HR-1, 100-HR-2, 100-KR-1, 100-KR-2, 100-IU-2, 100-IU-6, and 200-CW-3 OUs: (EPA/ROD/R10-99/039) *Remove Treat Dispose for 46 sites; disposal of debris from B, D, H, and K reactors to ERDF; provides decision framework for leaving waste in place, generally below 15-ft depth.*
			DOE/RL-2013-02 Table A-1	Declaration of the ROD for the 100-BC-1, 100-BC-2, 100-DR-1, 100-DR-2, 100-FR-2, 100-HR-2 and the 100-KR-2 OUs (EPA/ROD/R10-00/121) Remove contaminated soil, structures, and debris; treat as needed; dispose at ERDF; backfill and revegetate.
		100 K ancillary bldgs	DOE/RL-2013-02 Table A-2	**Action Memorandum for the Non-Time-Critical Removal Action for the 100-K Area Ancillary Facilities (DOE and EPA 2005b)** Provides for D4 of 27 buildings/structures in northern part of 100-K Area with D4 waste going to ERDF. In general, slabs and subsurface structures would be removed with about 1 m of surrounding soil; however, on a case-by-case basis, the slabs, below-grade structures and soils can be deferred to CERCLA actions associated with 100-KR-1 and 100-KR-2 source OUs.
			DOE/RL-2013-02 Table A-2	**Action Memorandum for the Non-Time-Critical Removal Action for the 105-KE and 105-KW Reactor Facilities and Ancillary Facilities (DOE and EPA 2007)** Identifies ISS for 105-KE and 105-KW Reactor cores, D&D of reactor components up to the cores **and for remaining buildings and structures in 100-K Area**. Subsurface structures will be removed 3 ft bgs; substructures and soil beneath facilities that exceed cleanup levels will be evaluated through source OU cleanup activities that are considered final for the ancillary facilities and demolished portions of the reactors. Further decisions are expected on reactor cores in ISS.
CP-DD-1 (Interim)	PUREX Canyon, tunnels, ancillary buildings, structures, and associated near-surface	200-CP-1 - Canyon	DOE/RL-2013-02 (Table B-3 CP-5)	**CP-5 – Disposition PUREX Canyon Building/Associated Waste Sites (200-CP-1 OU)** Several action memoranda are in place to remove contaminated soil, structures, and debris from waste sites with disposal at ERDF. Future cleanup decisions for remaining buildings and waste sites will be included in decision documents (e.g., action memoranda, RODs). Range of Alternatives:

Evaluation Unit (EU) ID*	Description & Comments	Operable Unit Cross Walk	Reference	Existing Cleanup Decisions
	contaminated soils			- Remove all contents and D4 PUREX Canyon Building including below-grade foundation; remove all contaminated materials, associated waste sites and contaminated soils to achieve remedial action objectives; dispose all wastes and debris at approved facility - Condition contents to place in spaces below canyon deck level; stabilize and fill voids; remove contaminated wastes and soils from associated waste sites and dispose at approved facility; partially demolish building to canyon deck level; place engineered barrier over demolished structure; maintain institutional controls and perform post-closure monitoring and caretaking - Condition contents, retrieve associated waste site contaminated soils and debris, and place in PUREX Canyon for entombment; (option to allow other wastes) stabilize and fill voids; surround with clean fill and place an engineered barrier over the canyon building; maintain institutional controls and perform post-closure monitoring and caretaking
		200-CP-1 - Tunnel	DOE/RL-2013-02 (Table B-3 CP-6)	**CP-6 – Disposition PUREX Storage Tunnels (200-CP-1 OU)** Cleanup Decision Summary and Relevant Decision Documents No cleanup decisions have been made for the PUREX Storage Tunnels. Range of Alternatives: - Maintain safe storage, perform hazardous waste facility closure consistent with RCRA Permit, remediate radionuclides consistent with CERCLA, and conduct post-closure monitoring - Stabilize waste and prepare tunnels for in-place disposal, install barrier, perform post-closure care, and transition to LTS - Remove and dispose waste and contaminated equipment from tunnels, evaluate tunnels for residual contamination, and remediate tunnels consistent with 200 East Inner Area contaminated soil sites
		200-MG-1	DOE/RL-2013-02 (Table B-3 CP-5)	DOE/RL-2009-48; DOE/RL-2009-86 Action memoranda to remove contaminated soil, structures, and debris from waste sites with disposal at ERDF.
		200-MG-2	DOE/RL-2013-02 (Table B-3 CP-5)	DOE/RL-2009-37

Appendix B: Evaluation Unit Disposition Table
(Interim Report EUs only)

Evaluation Unit (EU) ID*	Description & Comments	Operable Unit Cross Walk	Reference	Existing Cleanup Decisions
				Action memoranda to remove contaminated soil, structures, and debris from waste sites with disposal at ERDF.

Appendix B: Evaluation Unit Disposition Table
(Interim Report EUs only)

Evaluation Unit (EU) ID*	Description & Comments	Operable Unit Cross Walk	Reference	Existing Cleanup Decisions
RC-OP-1 (Interim)	KE/KW fuel storage and sludge	105-K Reactor	DOE/RL-2013-02 Table A-2	**Action Memorandum for the Non-Time-Critical Removal Action for the 105-KE and 105-KW Reactor Facilities and Ancillary Facilities (DOE and EPA 2007)** Identifies ISS for 105-KE and 105-KW Reactor cores, D&D of reactor components up to the cores and for remaining buildings and structures in 100-K Area. Subsurface structures will be removed 3 ft bgs; substructures and soil beneath facilities that exceed cleanup levels will be evaluated through source OU cleanup activities that are considered final for the ancillary facilities and demolished portions of the reactors. Further decisions are expected on reactor cores in ISS.
		100 K Basins	DOE/RL-2013-02 Table A-1 CERCLA Interim Action ROD	Declaration of the ROD for the 100-KR-2 OU, (EPA/ROD/R10-99/059) - Remove spent nuclear fuel from basins - Remove sludge from basins, including sludge treatment prior to interim storage - Treat and remove water from the basins - Remove debris from the basins, including grouting in place - Deactivate and removal of the basins - Institute ICs
			DOE/RL-2013-02 (Table B-2 RC-2)	**RC-2 – Disposition 100 Area K West Basin** An interim ROD, ROD amendment, and action memorandum are in place for the removal, treatment, and interim onsite storage of spent nuclear fuel and sludge from the K Basins. <u>Range of Plausible Alternatives</u> - Remove, treat, and transfer sludge for interim storage at T Plant - Transfer fuel scrap for interim storage at Canister Storage Building - D4 K West Basin and ancillary structures - Remediate below-grade portions consistent with 100 Area contaminated soil sites* * May require removing K Reactors to access below-grade contaminated soils. K East Basin was demolished in 2009.

Appendix B: Evaluation Unit Disposition Table
(Interim Report EUs only)

Evaluation Unit (EU) ID*	Description & Comments	Operable Unit Cross Walk	Reference	Existing Cleanup Decisions
		100-KR-2 (include 100 K ancillary bldgs and legacy sites)	DOE/RL-2013-02 Table A-1	ROD (Interim Action): Interim Action ROD for the 100-BC-1, 100-BC-2, 100-DR-1, 100-DR-2, 100-FR-1, 100-FR-2, 100-HR-1, 100-HR-2, 100-KR-1, 100-KR-2, 100-IU-2, 100-IU-6, and 200-CW-3 OUs: (EPA/ROD/R10-99/039) *Remove Treat Dispose for 46 sites; disposal of debris from B, D, H, and K Reactors to ERDF; provides decision framework for leaving waste in place, generally below 15-ft depth.*
			DOE/RL-2013-02 Table A-1	Declaration of the ROD for the 100-BC-1, 100-BC-2, 100-DR-1, 100-DR-2, 100-FR-2, 100-HR-2, and 100-KR-2 OUs (EPA/ROD/R10-00/121) Remove contaminated soil, structures, and debris; treat as needed; dispose at ERDF; backfill and revegetate.
CP-OP-1 (Interim)	Central Waste Complex (CWC) operations, closure, and D&D		DOE/RL-2013-02 (Table B-3 CP-12)	**CP-12– Disposition Remaining Waste Treatment, Storage and Disposal Facilities*** No cleanup decisions have been made for the remaining waste treatment, storage and disposal facilities. Range of Plausible Alternatives - Closure of facilities will be according to approved operating plans and closure plans (e.g., RCRA Closure Plans); consequently, cleanup actions will be determined and accomplished in accordance with applicable regulatory and permit/license requirements. **No other alternatives are being considered.** *Includes Liquid Effluent Retention Facility/Effluent Treatment Facility, Waste Encapsulation and Storage Facility (WESF), Waste Receiving and Processing Facility, 222-S Lab, Interim Disposal Facility, and Inert Waste Landfill/Pit 9. (Note: CWC not specifically mentioned but would fall into this category.)

Appendix B: Evaluation Unit Disposition Table
(Interim Report EUs only)

Evaluation Unit (EU) ID*	Description & Comments	Operable Unit Cross Walk	Reference	Existing Cleanup Decisions
CP-OP-3 (Interim)	Waste Encapsulation and Storage Facility (WESF): Evaluate for the storage and removal of Cs/Sr capsules; D&D included with B Plant Evaluation Unit	Not Applicable	DOE/RL-2013-02 (Table B-3 CP-9)	**CP-9 – Disposition Cesium/Strontium Capsules** No cleanup decisions have been made for final disposition of the cesium/strontium capsules. Decisions have been deferred to future decision-making processes. Range of Plausible Alternatives - Package and transport capsules from WESF to dry storage; store capsules pending final disposition; direct disposal of capsules at a geologic repository - Incorporate capsules into immobilized high-level waste glass at Waste Treatment and Immobilization Plant Store capsules at Hanford for 300 years (approximately 10 half-lives); after natural decay, direct dispose of capsules as mixed low-level radioactive waste.
CP-OP-6 (Interim)	Environmental Restoration Disposal Facility (ERDF)) operations and closure	Not Applicable	DOE/RL-2013-02 (Table A-1) Final ROD	Declaration of the ROD for the ERDF (EPA/ROD/R10- 95/100) - Landfill construction in accordance with RCRA - Capped at completion
			DOE/RL-2013-02 (Table B-6)	Central Plateau–Manage ERDF - ERDF was approved according to a CERCLA Final ROD and closure and post-closure care are part of the operating documentation. Alternatives need not be analyzed, unless future decisions are made that modify the current final ERDF decisions.

APPENDIX C

A SUMMARY OF SITE INFRASTRUCTURE AND SERVICES ON THE HANFORD SITE

The U.S. Department of Energy (DOE) maintains a number of infrastructure elements and services throughout the Hanford Site, including but not limited to roads and transportation services, electrical and water services, facility maintenance, emergency response (fire and patrol) services, network and software engineering, cyber security and records management, and environmental compliance and clean energy solutions.[1] Hanford Site missions, including decommissioning, legacy site remediation, groundwater remediation, tank farm remediation and Waste Treatment and Immobilization Plant (WTP) operations, will continue to rely on Hanford's infrastructure systems for at least the next 40 to 60 years.

These systems are spread throughout each evaluation unit, but are generally not directly included in the risk analysis methodology, as they are assumed to be ever present throughout all evaluation periods, representing the same relative risks, and same relative costs to maintain. However, it is recognized that some infrastructure changes will take place as old systems are taken out of service, the Hanford Site is downsized, and new infrastructure is needed.[2]

Background

Much of the Hanford Site's infrastructure has its roots in the Manhattan Project. Railroads, utilities, roads, and buildings were constructed during the 1940s as part of the wartime effort. Over the years, varying levels of programmatic activity and a lack of dedicated funding for maintenance and upgrades allowed many infrastructure systems to deteriorate. In the 1980s, a $92 million program was undertaken to restore deteriorated systems and replace technologically obsolete equipment with newer state of the art systems (DOE 1990). Some of the main targets of this program included the rail system, transportation system/equipment, building maintenance and roofing, electrical distribution system, road system, and telecommunications system.

Many Hanford Site infrastructure systems are operating outside the original design purposes (with outdated technology and lack of vendors) and well beyond their original design life, experiencing failures (e.g., water line leaks) and straining operational budgets. Today, the Hanford Site infrastructure is managed, in part, through the Infrastructure and Services Alignment Plan, ISAP (Mathes 2014). The ISAP works in conjunction with baseline operations and maintenance of the infrastructure to ensure that reliable, on time, and cost effective services are provided at the required capacities for the Hanford stakeholders (Mathes 2014). Examples of key projects included in the 2014 ISAP are:

- 200 East Area electrical distribution system capacity upgrades to support waste feed and delivery needs
- Fire station relocation and consolidation projects to align with the shrinking cleanup footprint and needs of the River Protection Project
- Export water system piping upgrades to improve reliability of water delivery to critical Central Plateau facilities
- Roadway refurbishment of primary access roads to the Central Plateau facilities, including Route 4S, 1st Street, and Akron Avenue
- Electrical power pole replacement for improved reliability of power delivery to Central Plateau facilities, including tank farms, Waste Encapsulation and Storage Facility, Central Waste Complex, Effluent Treatment Facility, and Canister Storage Building

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[1] Mission Support Alliance. Accessed at http://www.hanford.gov/page.cfm/MSA on January 26, 2015.
[2] 2014 Limited Update of the Hanford Ten-Year Site Plan. 14-AMMS-0017_Attachment_HQ_FINAL_Deliverable_R0_(2)2.docx received in an email forwarded by Wayne Johnson to George Last on January 22, 2015, from Mark Triplett, originally from Dickie Ortiz, on September 26, 2014.

Hanford's 60-year-old infrastructure needs to last at least another 60 years. Mission Support Alliance, LLC, (MSA) provides site services and maintains critical infrastructure for DOE and Hanford Site cleanup contractors. Future challenges will be to modernize water lines/pipes and facilities, upgrade electrical power system for capacity and reliability, right-size the transportation system by focusing resources on arterial and core roads that will serve the Central Plateau, and integrate information technology (IT) infrastructure for more accessibility and mobilization of work on the site (Armijo 2014).

Infrastructure Elements

The Hanford Site infrastructure can be divided into several distinct systems (modified from DOE 1990 and Mathes 2014). Offsite, an extensive network of highways, rail lines, navigable river routes, and electric power grids serve the area for transportation of raw materials and finished products, and support major industrial development in the region.[3]

Electrical System

Electrical transmission and distribution services not only service the Hanford Site, but also other businesses and communities beyond the site boundary with 200,000 MWh of electricity per year.[4] The core system has a peak demand of 39 MW with various components owned and/or managed by a number of entities, including DOE-Richland Operations Office (DOE-RL), Bonneville Power Administration, and the City of Richland. These systems include substations and miles of transmission lines, power poles, and street/security light poles.

Water System

The Hanford Site water system consists of numerous buildings, pumps, valve houses, reservoirs, wells, and distribution piping that deliver water to all areas of the site (Figure C-1). The largest of these, the export water system, extracts water from the Columbia River near the 100 B and 100 D Areas and transports it via underground pipelines to points within the 100, 200, and 600 Areas (DOE 1990).

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[3] Hanford Site Assets and Attributes. U.S. Department of Energy. Accessed at http://energy.gov/ari/downloads/hanford-ari-overview on January 22, 2015.
[4] Hanford Site Assets and Attributes. U.S. Department of Energy. Accessed at http://energy.gov/ari/downloads/hanford-ari-overview on January 22, 2015.

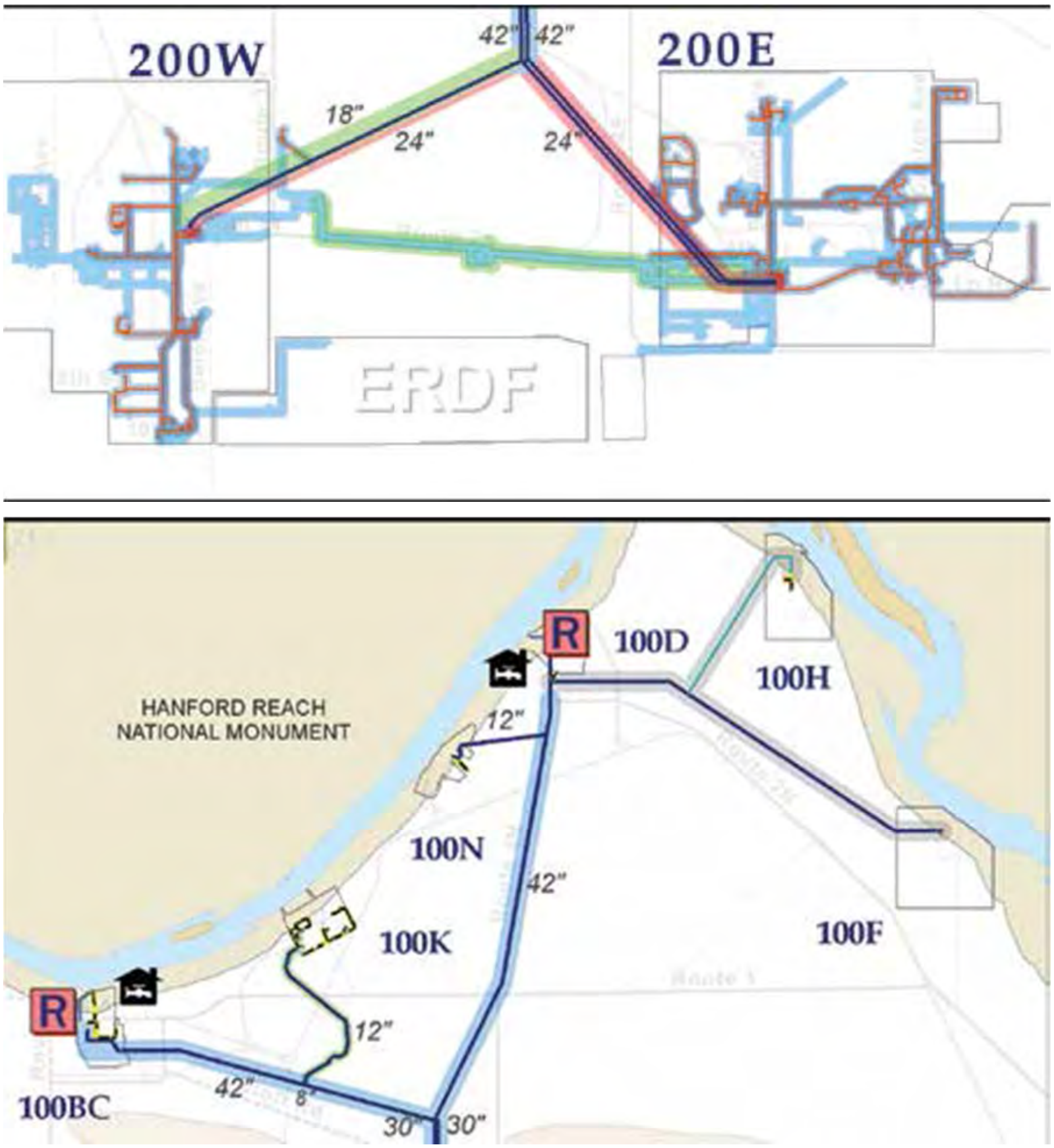

Figure C-1. Major components of Hanford's Export, Raw, and Potable Water Supply System (from Mathes 2014).

Sanitary Sewer System

Sanitary sewer systems service over 4000 workers and consist of many pipelines, 60 drain fields, 18 holding tanks, and miscellaneous lagoons (Mathes 2014). In addition, the Hanford Site contractors employ a large number of portable toilets.

Natural Gas Pipeline

A natural gas pipeline has been proposed to service the WTP. Construction is expected to be completed by June 2015 (Mathes 2014).

Information Technology Systems and Business Services

In 2013, the Hanford Site upgraded its core data center switches and routers along with a majority of the distribution layer switches all supporting the Hanford Federal Cloud (Eckman et al. 2013). This provides Hanford with a more reliable and resilient network architecture to support bandwidth-intense applications, such as video teleconferencing. Some of the key services include Core Network (backbone, firewall, load balancers); Voicemail; Voice over IP (VoIP); Emergency Notification; Virtual desktops; and, numerous production applications and data. IT systems manage more than 6.5 million electronic records, and include more than 500 miles of secure wireless transmission (Armijo 2014).

IT support includes 7 WiMAX microwave links, 369 miles of WiMAX coverage, support to 10,000 desktop computers, and 12,000 telephone lines.[5] These systems include a number of telecommunications buildings that are underutilized because legacy systems are still in place (Mathes 2014). Other elements of the IT systems include radio towers and emergency notification sirens (Mathes 2014).

Business Services provided at the Hanford Site include Publications and Information/Word Processing, Graphics Services, Mail Services, Reproduction Services, Photography/Audiovisual Services, Records Management (DOE 1990), and Library services (e.g., Administrative Record and Public Information Repository). Records Management systems include various records storage areas (e.g. the DOE-RL Public Reading Room). Other related systems include sample archive facilities (e.g. geotechnical library), and electronic database management systems (e.g., the Hanford Environmental Information System and the Hanford Geographic Information System).

Fire and Emergency Response Systems

Fire and emergency response systems include three fire stations (note that the 400 fire station has already been closed), two of which (100 Area and 300 Area) are planned for closure, while the existing 200 Area fire station is planned for upgrades, and a new fire station planned to support WTP operations (Mathes 2014). These facilities also include a number of fire engines and ambulances, and the Radio Fire Alert and Reporting system (which has been noted as obsolete, with replacement parts no longer manufactured) (Mathes 2014).

Safeguards and Security

Safeguards functions are responsible for controlling inventories and records of special nuclear materials at the site (DOE 1990; Mathes 2014). Security functions refer mainly to the operations of the Hanford Patrol, including information and physical security systems (DOE 1990; Mathes 2014). The Hanford Patrol provides round-the-clock security for the Hanford Site to prevent unauthorized access, acts of sabotage, and theft or loss of classified matter and government property. The highly trained staff includes officers, including a special response team and canine handlers. Physical security systems include three main barricade/guard house facilities and miles of security fencing. Specialized equipment and training facilities includes patrol cars, four-wheel drive vehicles, vans, trucks, etc. The patrol training academy includes general facilities, a live fire shoot house, and a firing range complex.

Transportation

MSA is responsible for maintaining 1200 vehicles, 1500 heavy-duty vehicles, 25 mobile cranes, and 630 fuel-efficient vehicles (Armijo 2014).

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[5] Hanford Site Assets and Attributes. U.S. Department of Energy. Accessed at http://energy.gov/ari/downloads/hanford-ari-overview on January 22, 2015.

Rail

In 1990, the Hanford Site railroad system consisted of 127 miles of trackage and 139 pieces of HO-coded rolling stock and longer support equipment. The system was constructed during World War II for the Manhattan Project using predominately salvaged-rail of at least nine different weights (DOE 1990). In 1999, the railway system was taken over by the newly established Tri-City Railroad (TCRY), which is a Class III common carrier railroad.[6] The TCRY operates and maintains the railroad line owned by the Port of Benton, rarely operating on the Hanford Site. In 2010, 30 miles of the Hanford Site railroad track were removed miles from rail spurs that ran to the nine plutonium production reactors along the Columbia River and to the 300 Area.[7]

Roads

Hanford maintains a road system composed of 377 miles of paved roads (Figure C-2) and 122 miles of unpaved roads that is safe, compliant, and reliable for personnel and movement of materials and products.[8] Average daily traffic is estimated at 5700 vehicles per day (Mathes 2014).

[6] Tri-City Railroad Company. Accessed at www.tcry.com on January 23, 2015.
[7] Cary, A. 2010. Old Hanford railroad tracks safe to be reused. In *Tri-City Herald*, November 10, 2010. Accessed at http://seattletimes.com/html/localnews/2013394996_apwahanfordrailrecycling1stldwritethru.html on January 27, 2015.
[8] Hanford Site Assets and Attributes. U.S. Department of Energy. Accessed at http://energy.gov/ari/downloads/hanford-ari-overview on January 22, 2015.

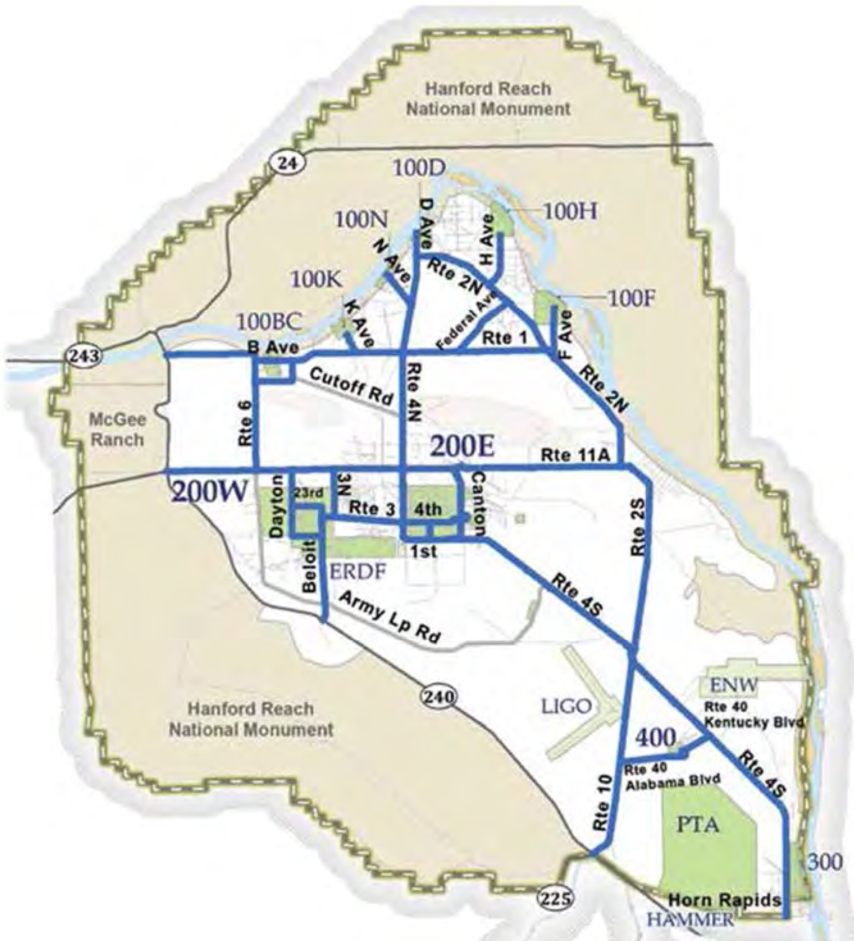

Figure C-2. Major roads on the Hanford Site (from Mathes 2014).

Medical Services

Basic occupational health care services are provided to the site by the Occupational Medical Services Contractor.[9] This includes:

- Providing occupational medical services to approximately 8000 employees working for Hanford Site contractors, DOE offices, or others working at the Hanford Site.
- Operating and maintain services at two clinical facilities, one in the 200 West Area, and one in Richland.[10]
- Providing support to epidemiological studies of current and former Hanford Site workers, the Chronic Beryllium Disease Prevention Program, and Energy Employees Occupational Injury Compensation Program Act.
- Maintaining and protecting the medical records of current and former Hanford workers.

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[9] DOE Awards Hanford Site Occupational Medical Services Contract. Accessed at http://energy.gov/em/articles/doe-awards-hanford-site-occupational-medical-services-contract on January 23, 2014.

[10] HPM Corporation (HPMC). Accessed at http://www.hanford.gov/page.cfm/HPMCHanford on January 23, 2014.

Laundry Services

Laundry services in support of DOE-RL, the DOE Office of River Protection, and Hanford Site contractors include both regulated (i.e., radiological protective clothing) and non-regulated laundry services, as well as decontamination services for government-owned protective clothing, non-regulated items, and respirator face pieces.[11]

Laboratory and Test Facilities

Laboratory and test facilities that have supported Hanford Site missions include research and development laboratories (e.g., 325 Building), Standards Laboratory, Hanford Environmental Management Laboratories (e.g. 318 building, Meteorological Station), Personnel Dosimetry Laboratory, and Environmental Health Sciences Laboratory (DOE 1990). These laboratories and test facilities continue to change in response to Hanford Site mission needs.

Personnel Dosimetry Laboratory (including the whole body counter)

These services include the operation of the whole-body counting facilities located in the 747A Building, in downtown Richland.

Meteorological and Air Monitoring Stations

The Meteorological Station (formerly known as the Atmospheric Physics Laboratory) provides meteorological and climatological services. The facility includes the 622R Building and associated meteorology towers to monitor weather patterns on the Hanford Site.

Weather data is provided to the DOE and its Hanford Site contractors 24 hours per day, 365 days per year. It is a fully functional National Weather Service station providing meteorological support in the following areas: emergency response, general weather forecasts, severe weather forecasts, special wind forecasts, climatological data (monthly and annual summaries), and other specialized forecast and climatological services as requested (DOE 1990). Over 30 instrumented towers are strategically placed around the Hanford Site and the surrounding region (Figure C-3).

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[11] UNITECH SERVICES GROUP, Regulated and Non-Regulated Laundry Services. Accessed at http://www.hanford.gov/files.cfm/Contracts_UniTech_Contract_Original_Part_I_Section_C.pdf on January 23, 2015.

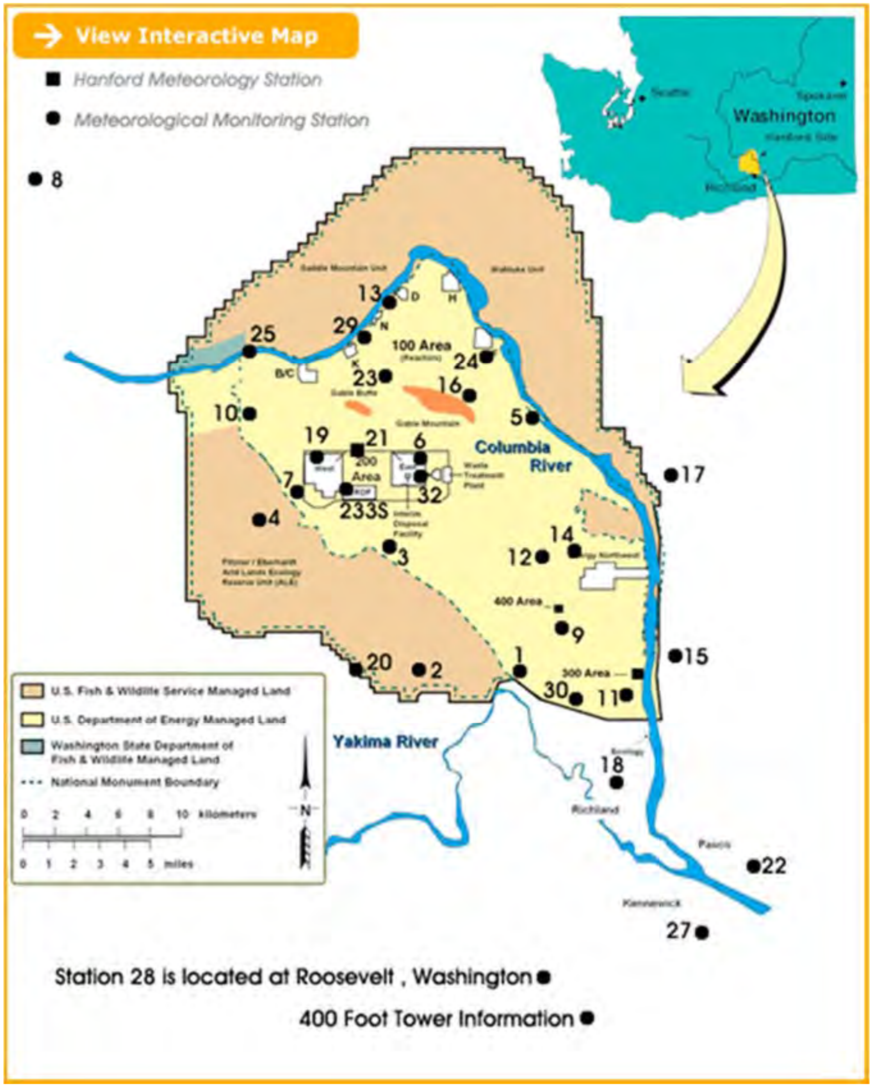

Figure C-3. Hanford Meteorological Monitoring Stations.

<u>Monitoring Wells</u>

DOE operates an extensive groundwater monitoring program on the Hanford Site, collecting thousands of samples from hundreds of groundwater wells each year (CH2M Hill 2014). Hundreds of vadose zone monitoring wells and past characterization boreholes are also present throughout the Hanford Site. While the numbers and locations of wells will continue to change in response to mission needs, many of these wells will be needed throughout the life of the Hanford Site.

<u>Lysimeter and other Field Test Facilities</u>

The Hanford Site contains a number of long-term field test facilities to support the Hanford Site mission. These include lysimeter/recharge testing facilities, surface barrier test facilities, and other site characterization and testing facilities, including but not limited to:

- The Grass Site
- 200E Lysimeter (in active)
- 300N Lysimeter

- Field Lysimeter Test Facility (near Meteorological Station)
- Solid Waste Landfill
- Cold Test Facility (near HAMMER)
- Mock Tank Facility (200 East)
- Above Ground Spent Fuel Storage Test Site (Inactive, 200 West)
- Sisson and Lu Field Test Site (200 East)

Seismic Monitoring Network

The Hanford Site seismic monitoring network provides an uninterrupted collection of high-quality raw seismic data in and around the Hanford Site and consists of two types of equipment; seismometers and strong motion accelerometers (Figure C-4).[12]

[12] Seismic Monitoring. Accessed at http://www.hanford.gov/page.cfm/SeismicMonitoring on January 26, 2015.

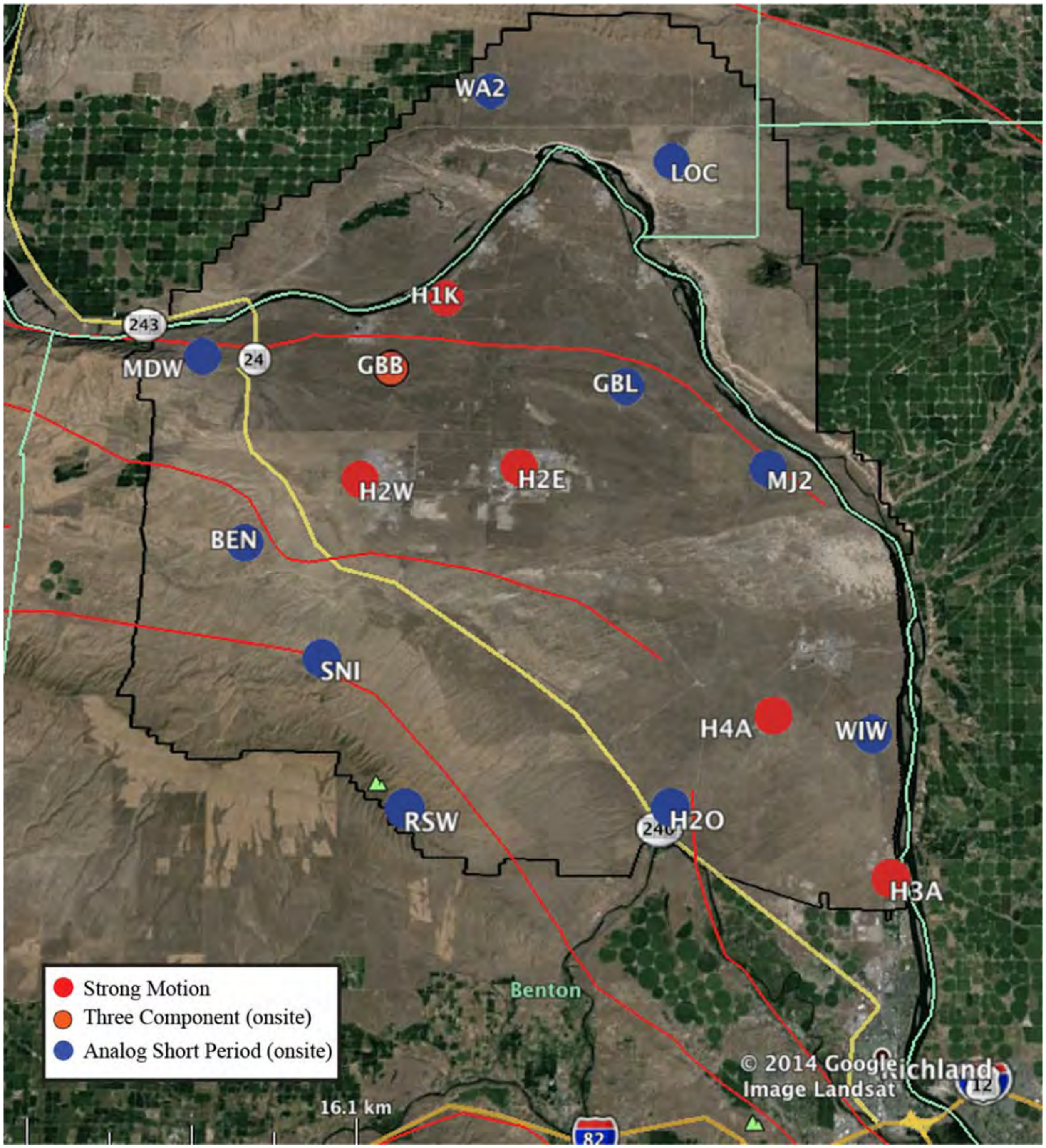

Figure C-4. Existing Hanford seismograph stations (after Integrated Science Solutions, Inc. 2014)

General Purpose Buildings

The Hanford Site has 592,000 ft^2 of warehouse storage and 122 buildings throughout the Hanford Site, with approximately 3.4 million gross square feet.[13]

Training Facilities - HAMMER

The Volpentest HAMMER Federal Training Center provides the training opportunities and facilities that support the Hanford Site missions and the Hanford workforce. The 88-acre facility includes realistic training props for hands-on training, and new technology deployment, plus 20 classrooms with state-of-the-art computers, projectors, and screens.[14]

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[13] Hanford Site Assets and Attributes. U.S. Department of Energy. Accessed at http://energy.gov/ari/downloads/hanford-ari-overview on January 22, 2015.
[14] Volpentest Hammer Federal Training Center. Accessed at http://www.hammertraining.com on January 23, 2014.

APPENDIX D.1

OVERVIEW OF GROUNDWATER EVALUATION UNITS AND THE RATING PROCESS

Table of Contents D.1-

List of Tables

List of Figures

CHAPTER 1. Overview of Groundwater Evaluation Units and the Rating Process

The process developed as a general framework for binning EUs using the evaluation metrics has been applied to the Risk Review Project groundwater EUs considering three distinct potential impacts: 1) groundwater as a protected resource, 2) groundwater as a pathway to impact the Columbia River, and 3) impact from potential future sources (e.g., tank leaks) and current vadose zone contamination to groundwater and the Columbia River. The focus on the evaluation metrics allows for differentiation between potential groundwater-related risks from the EUs. This process does not concern itself directly with highly uncertain point estimates of risks and impacts often used for other analyses (e.g., performance or baseline risk assessments). The uncertainties associated with the analyses related to EUs become more tractable when evaluation metrics are considered in relative rather than absolute terms. A detailed description of the methodology used for rating risks to groundwater and the Columbia River is provided in the Methodology Report (CRESP 2015). Detailed results for each groundwater EU are provided in Appendices D.2 through D.6.

The evaluation metrics for risks to groundwater from current groundwater plumes and near surface or vadose zone sources are:

1. The estimated time interval until groundwater would be *impacted* by a primary contaminant where a current plume does not exist over the three evaluation periods. Groundwater is considered *impacted* when a primary contaminant concentration exceeds a threshold value, e.g., a drinking water standard or maximum contaminant level.
2. The estimated amount of groundwater (e.g., areal extent) currently *impacted* by the primary contaminants with existing plumes.
3. The *groundwater threat metric (GTM)*, defined as the volume of groundwater that could potentially be contaminated by the inventory of a primary contaminant from a source (be it groundwater plume, vadose zone contamination, tank, etc.) if it was found in the saturated zone at the WQS (e.g., drinking water standard) and in equilibrium with the soil. The GTM accounts only for 1) source inventory, 2) partitioning with the surrounding subsurface and 3) the WQS. The GTM reflects a snapshot in time (assuming no loss by decay/degradation or dispersion, etc.) and does not account for differences in contaminant mobility or bulk groundwater flow.

The selected evaluation metrics for risks to the Columbia River from near surface, vadose zone, and groundwater contamination sources are:

1. The estimated time interval until the Columbia River is *impacted* over the three evaluation periods. The Columbia River is considered *impacted* when a primary contaminant concentration exceeds a benthic or free-flowing threshold value.
2. The ratio (R1) of the maximum primary contaminant concentration within the plume to the reference threshold screening value (e.g., Biota Concentration Guide for radionuclides or Ambient Water Quality Criterion for chemicals).
3. The ratio (R2) of the upper 95th percentile upper confidence limit on the log-mean plume concentrations to the reference threshold screening value.
4. For benthic impacts, the length of river shoreline estimated to be impacted by the plume above a reference threshold.
5. For riparian zone impacts, the area of the riparian zone estimated to be impacted by the plume above a reference threshold.

The primary contaminant groups used in this Risk Review Project are described in Table D.1-1, which categorizes them according to their mobility and persistence in the Hanford Site environment. The categorization was done on a relative basis among the primary contaminants. Mobility relates to the relative ability of the primary contaminant to be transported in the subsurface environment (as represented by the contaminant transport retardation factor, R) and is mainly a function of the contaminant's chemistry and sorption with the Hanford subsurface geology. For the radioactive contaminants, the persistence category is based on the radionuclide's half-life. The persistence category of the organic and inorganic contaminants is based on their chemical degradation and biodegradation potential. Chromium, being non-degrading and not radioactive, is classified as having a high persistence in the subsurface. For the purposes of this Risk Review Project, the primary contaminants were divided into four groups based on their persistence and mobility. Group A includes technetium-99, iodine-129, carbon-14, chlorine-26, hexavalent chromium, and carbon tetrachloride. Group B contains strontium-90, trichloroethylene (TCE), uranium, total chromium, and cyanide. Group C contains tritium, nitrate, and TPH-diesel. Group D contains cesium-137 and plutonium. The groups are ranked relative to each other with Group A being the highest (highly mobile and highly persistent) and Group D being the lowest (low mobility and highly persistent) for the purpose of this Risk Review Project.

Table D.1-1. Primary Contaminant Groups used in this Risk Review Project.

		Mobility*		
		Low (R>500)	Medium (5<R<500)	High (R<5)
Persistence	Low		TPH-diesel	^3H_2O, NO_3
	Medium	Cs-137, Am-241	Sr-90	Cyanide, TCE
	High	Pu, Eu, Ni (all isotopes)	$U^{(total)}$, $Cr^{(total)}$	Tc-99, I-129, C-14, Cl-36, Cr^{6+}, Carbon Tetrachloride

Group A Primary Contaminants (red)
Group B Primary Contaminants (orange)
Group C Primary Contaminants (green)
Group D Primary Contaminants (blue)

* Assume most mobile form of contaminant
R = retardation factor

The screening thresholds used in the Risk Review Project are provided in Table D.1-2. When considering groundwater as a protected resource, the drinking water standard is used as the screening threshold, except for Cr(VI), where a drinking water standard is not available, and a screening threshold of 48 µg/L is used. When considering impacts to the Columbia River, a combination of the ambient water quality criterion (AWQC) and the biota concentration guide (BCG) are used, whichever is value is more stringent. However, for total uranium, the natural background groundwater concentration of uranium at 12.9 µg/L is used, which was greater than the Tier II screening concentration value (SCV) reported.

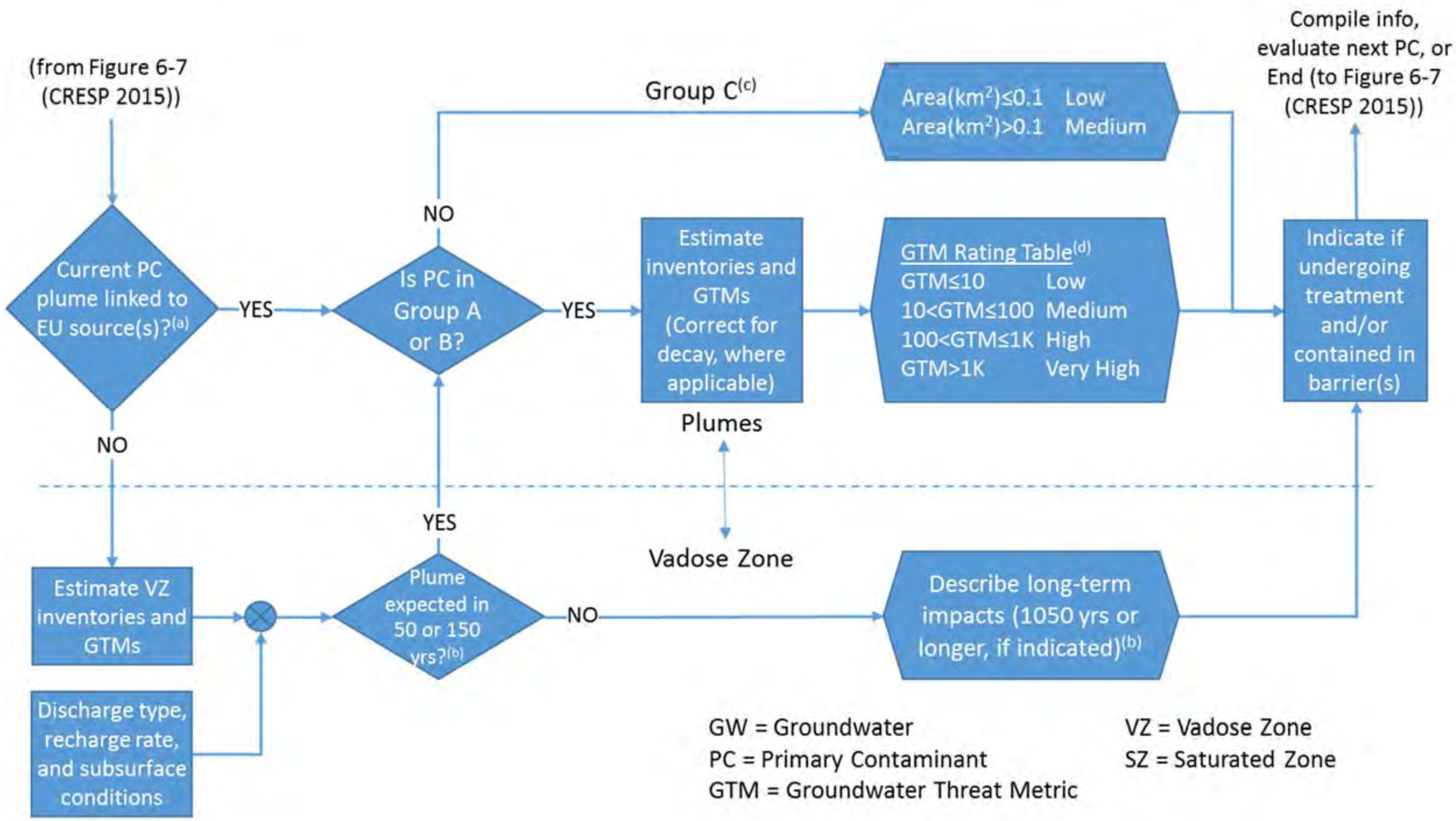
Table D.1-2. Thresholds Considered in the Risk Review Project for the Group A and B Primary Contaminants. The primary thresholds used in the analysis are indicated in the red boxes.

PC	Grp	WQS[a]	DWS	DOE DCS[b]	BCG[c]	AWQC[d]/SCV[e]
Tc-99	A	900 pCi/L	900 pCi/L	44000 pCi/L	667000 pCi/L	---
I-129	A	1 pCi/L	1 pCi/L	330 pCi/L	38500 pCi/L	---
C-14	A	2000 pCi/L	2000 pCi/L	62000 pCi/L	609 pCi/L	---
Cr-VI	A	10-48 ug/L[f]	---	---	---	10 ug/L[f]
CCl_4	A	3.4 ug/L[g]	5 ug/L	---	---	9.8 ug/L
Sr-90	B	8 pCi/L	8 pCi/L	1100 pCi/L	279 pCi/L	7 ug/L (Sr)
U(tot)	B	30 ug/L	30 ug/L	750 pCi/L (U-238)	224 pCi/L (U-238)	12.9 ug/L[h]
Cr(tot)	B	48 ug/L[f]	100 ug/L[f]	---	---	55 ug/L
CN	B	200 ug/L	200 ug/L	---	---	5.2 ug/L
TCE	B	4[g]-5 ug/L	5 ug/L	---	---	47 ug/L

Human Health ⟷ Benthic/Riparian

a. Water Quality Standard (WQS) from 2013 Annual GW Report (DOE/RL-2014-32, Rev. 0). Some values vary by Operable Unit.
b. DOE Derived Concentration Standard (Ingested Water DCS from Table 5 in DOE-STD-1196-2011).
c. Biota Concentration Guide (BCG) from RESRAD-BIOTA v1.5 (consistent with DOE Technical Standard DOE-STD-1153-2002).
d. Ambient Water Quality Criterion (AWQC) (Table 6-1 in DOE/RL-2010-117, Rev. 0).
e. Tier II Screening Concentration Value (SVC) (http://rais.ornl.gov/documents/tm96r2.pdf) when AQWC not provided.
f. Different values tabulated for different GW Operable Units. 10 ug/L is the surface water standard for Cr-VI. 20 ug/L is the groundwater cleanup target for Cr-VI identified for interim remedial action. 48 ug/L is the MTCA groundwater cleanup standard. 100 ug/L is the drinking water standard for total chromium.
g. Risk-based cleanup value from the record of decision as reported in the 2013 Annual GW Report (DOE/RL-2014-32, Rev. 0).
h. Uranium (total) screening values were 0.5 ug/L (DOE/RL-2007-21 2012) and 5 ug/L (DOE/RL-2010-117, Rev. 0, 2010). Background uranium levels of 0.5-12.8 µg/L were detected near the 300-F Area with a value of 12.9 µg/L selected (Peterson et al, 2008, p. 6.9). No effect levels span 3-900 µg/L reflecting considerable uncertainty (DOE/RL-2010-117, Rev. 0, 2010).

General flow diagrams are provided that summarize the rating process used for evaluating 1) groundwater as a protected resource (Figure D.1-1), 2) groundwater as a pathway to impact the Columbia River (Figure D.1-2), and 3) impact from current vadose zone contamination (Figure D.1-3). Additional background information and more detailed discussion of the rating methodology is provided in the Methodology Report (CRESP 2015).



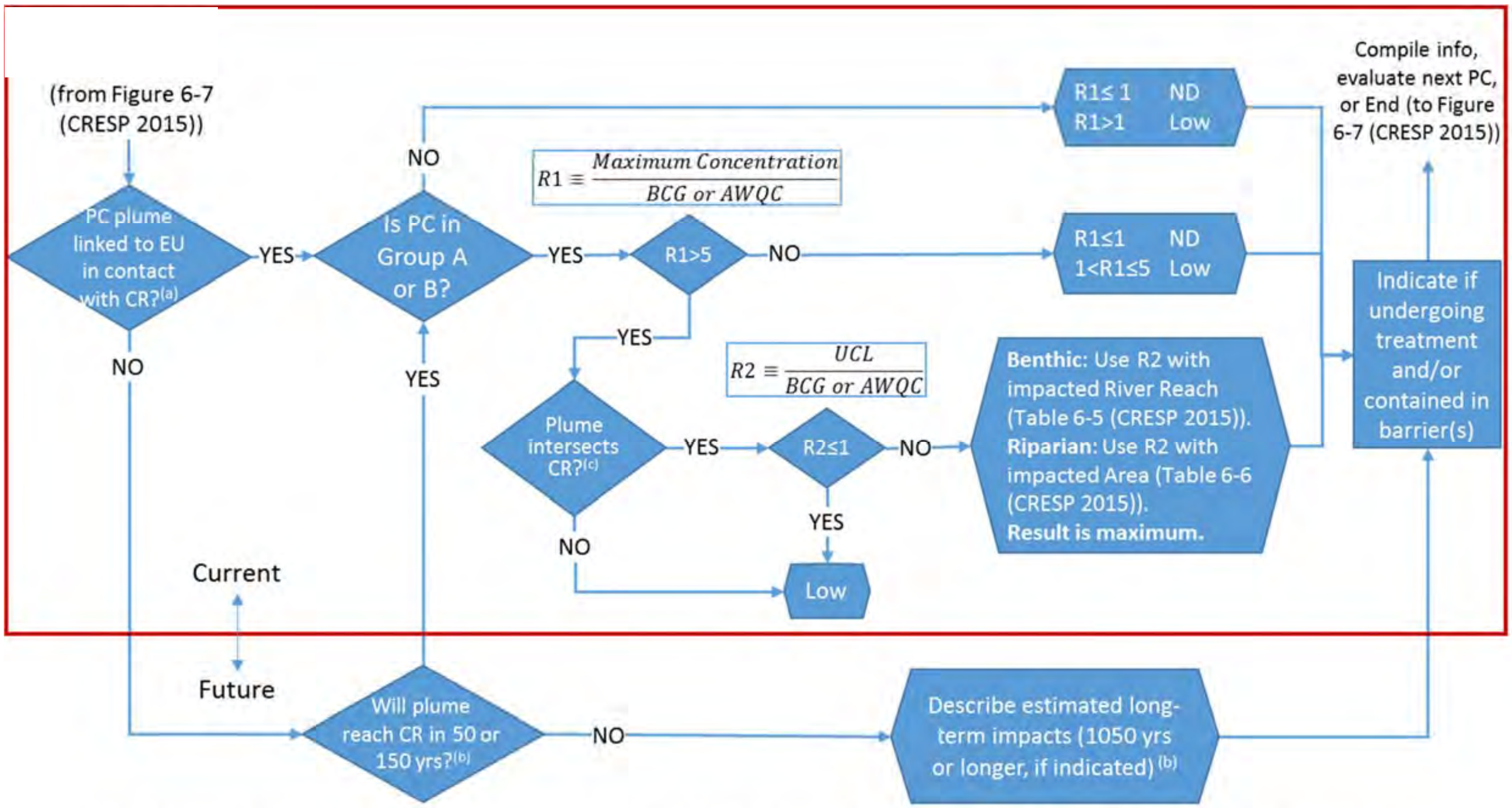
a. Based on plume area above a threshold (e.g., Water Quality Standard (WQS) from 2013 Annual GW Monitoring Report (DOE/RL-2014-32 Rev. 0)). Note plume areas and corresponding estimated plume volumes are (highly) positively correlated.

b. Use available information (e.g., environmental impact statements, risk assessments) to evaluate.

c. Note, no Group D contaminants have been identified as groundwater threats.

d. GTM Rating Table for Group A and B PCs (Table 6-3 (CRESP 2015)).

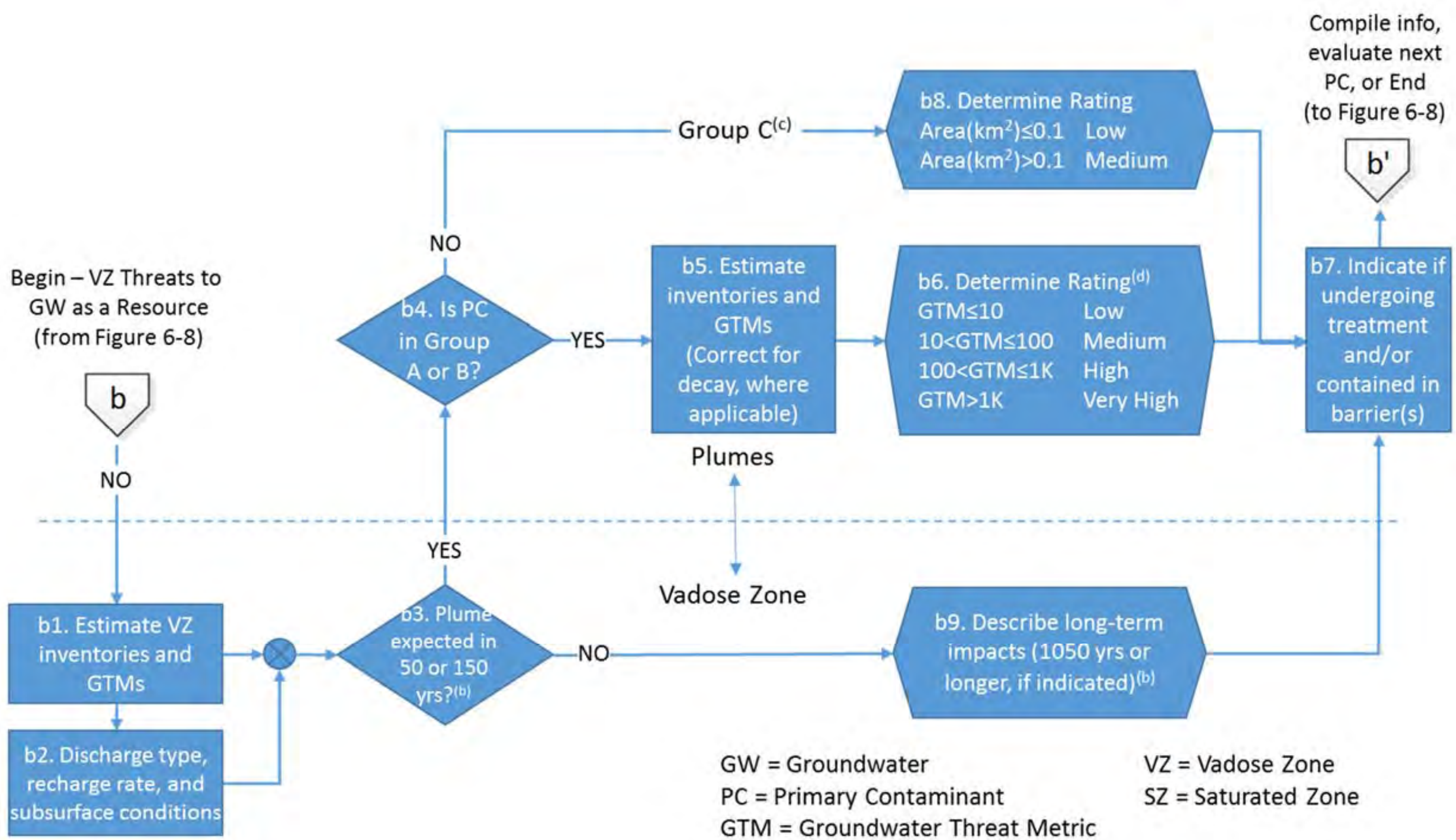
Figure D.1-1. Framework steps for characterizing an evaluation unit for threats to Groundwater as a Protected Resource (CRESP 2015).



PC = Primary Contaminant
GTM = Groundwater Threat Metric
UCL = Upper 95% confidence limit (log-mean)
VZ = Vadose Zone
CR = Columbia River
AWQC = Ambient Water Quality Criterion (chemicals)
BCG = Biota Concentration Guide (radionuclides)
ND = Not discernible

a. Based on plume area above a threshold (e.g., Water Quality Standard (WQS) from 2013 Annual GW Monitoring Report (DOE/RL-2014-32 Rev. 0)). Note plume areas and corresponding estimated plume volumes are (highly) positively correlated.
b. Use available information (e.g., environmental impact statements, risk assessments) to evaluate.
c. Based on either aquifer tube data or contours exceeding the threshold (e.g., from PHOENIX at http://phoenix.pnnl.gov/).

Figure D.1-2. Framework steps for characterizing an evaluation unit for threats to the Columbia River (where steps in red box are for current impacts and those below are for potential future impacts to the River) (CRESP 2015).



a. Based on plume area above a threshold (e.g., Water Quality Standard (WQS) from 2013 Annual GW Monitoring Report (DOE/RL-2014-32 Rev. 0)). Note plume areas and corresponding estimated plume volumes are (highly) positively correlated.

b. Use available information (e.g., environmental impact statements, risk assessments) to evaluate.

c. Note, no Group D contaminants have been identified as groundwater threats.

d. GTM Rating Table for Group A and B PCs (Table 6-3).

Figure D.1-3. Framework steps for characterizing an evaluation unit for Vadose Zone threats to Groundwater as a Protected Resource (CRESP 2015).

1.1. GROUNDWATER CONTAMINANT PLUMES ASSOCIATED WITH EACH EVALUATION UNIT

Figure D.1-4 provides an overview of all the primary groundwater contaminant plumes present within the Hanford Site, which are further grouped into three groundwater EUs along the River Corridor and two groundwater EUs in the Central Plateau. Figure D.1-5 focuses on the Central Plateau groundwater plumes and Figure D.1-6 provides a simplified version of the Central Plateau groundwater plumes (excluding nitrate and tritium) in the 200 East Area (EU CP-GW-1) and 200 West Area (EU CP-GW-2) that includes only the Group A primary contaminants (high mobility and high persistence including Tc-99, I-129, C-14, Cr(VI) and carbon tetrachloride) and Group B primary contaminants (high mobility with medium persistence, including cyanide and TCE; and medium mobility with high or medium persistence, including U(total), Cr(total) and Sr-90).

An overview of the River Corridor groundwater contaminant plumes are provided in Figure D.1-7, Figure D.1-8 and Figure D.1-9. Figure D.1-7 is enlarged to show an example of the intersection of the existing groundwater plume with the riparian zone (magenta cross hatch area) and also provides the primary contaminant groupings, plume areas, and applicable water quality standards (AWS).

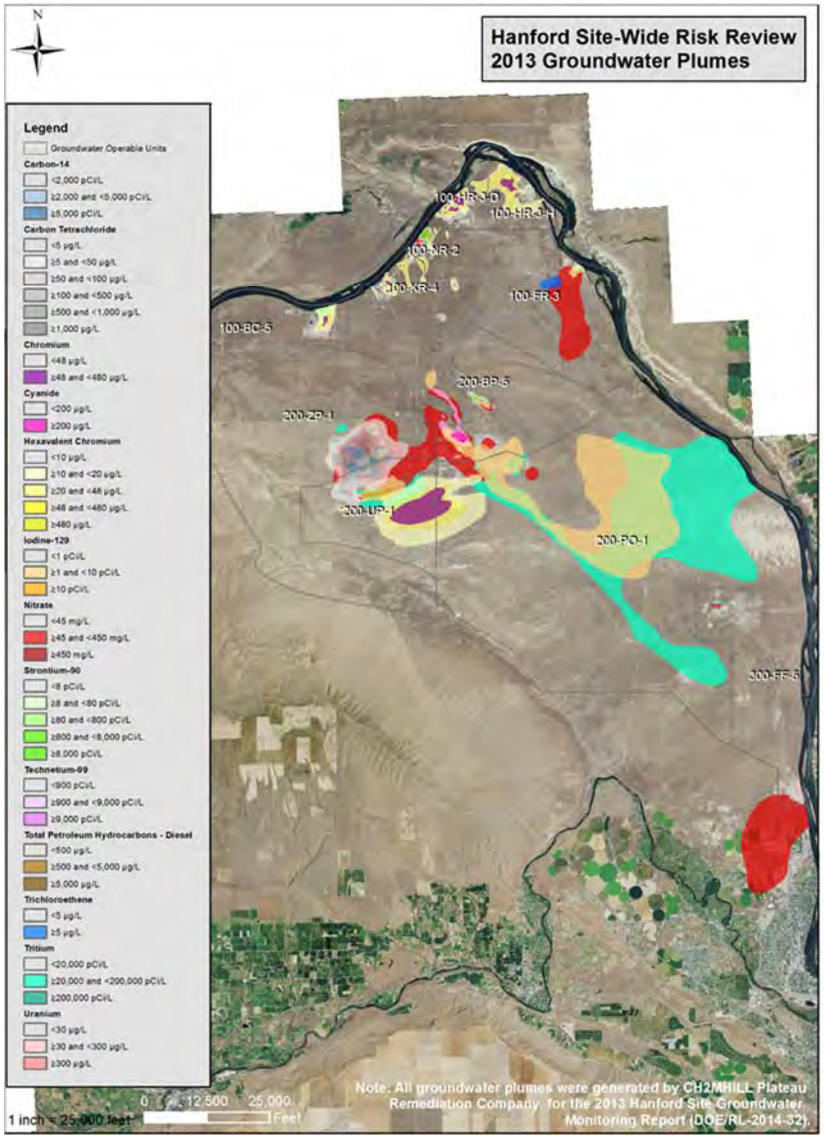
1.2. REFERENCES

CRESP 2015. *Methodology for the Hanford Site-Wide Risk Review Project*, The Consortium for Risk Evaluation with Stakeholder Participation III (CRESP), Vanderbilt University, Nashville, TN. Available at: www.cresp.org/hanford.

DOE/RL-2007-21 2007, *River Corridor Baseline Risk Assessment Volume II: Human Health Risk Assessment, Part 1*. U.S. Department of Energy, Richland Operations Office, Richland, WA.

DOE/RL-2010-117, Rev. 0, *Columbia River Component Risk Assessment, Volume I: Screening-Level Ecological Risk Assessment*, DOE/RL-2010-117, U.S. Department of Energy, Richland Operations Office, Richland, Washington (2012).

DOE/RL-2014-32 Rev. 0 2014, *Hanford Site Groundwater Monitoring Report for 2013*, U.S. Department of Energy, Richland Operations Office, Richland, WA. Available at: http://www.hanford.gov/c.cfm/sgrp/GWRep13/start.htm.



Hanford Plumes

River Corridor

EU: RC-GW-1 **OU:** 300-FF-5 (uranium)
EU: RC-GW-2 **OU:**100-NR-2 (strontium-90)
EU: RC-GW-3 **OUs:** 100-BC-5, 100-HR-3 (D/H), 100-FR-3, 100-KR-4 (chromium, strontium-90, others)

Central Plateau

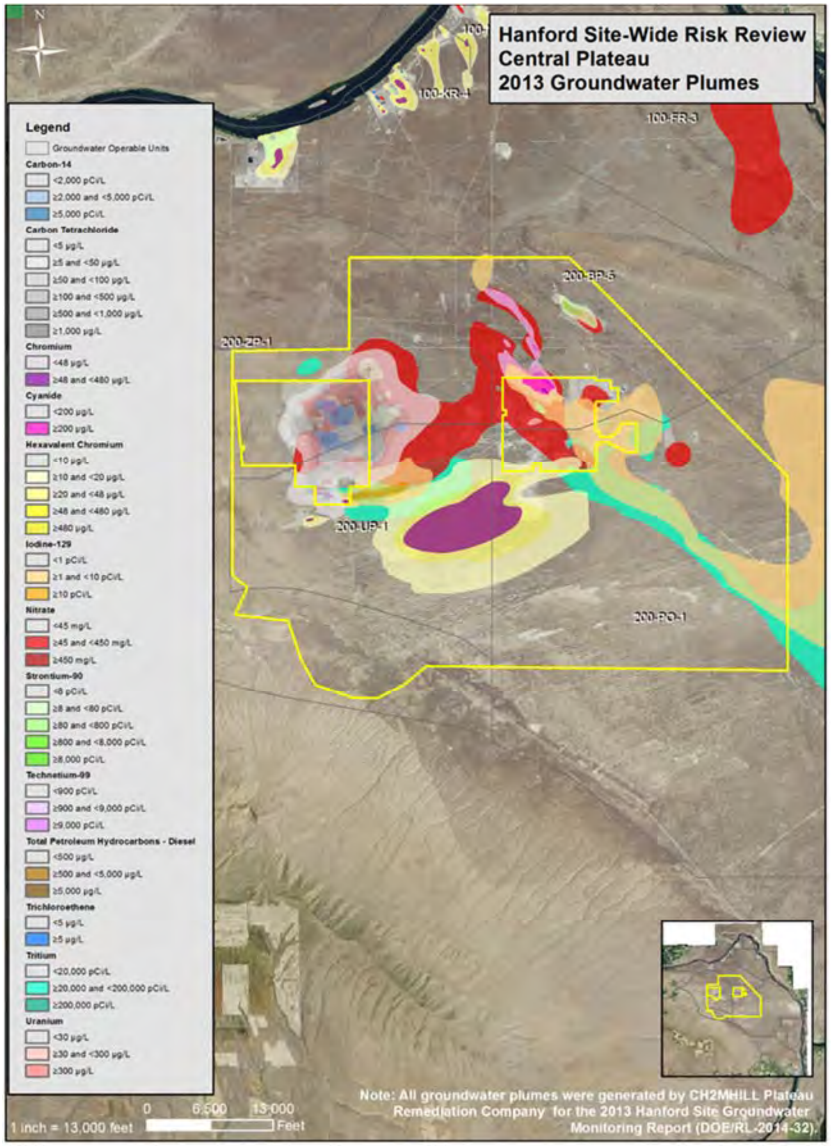
200 East Groundwater –

EU: CP-GW-1 **OUs:** 200-BP-5, 200-PO-1 (iodine-129, tritium)

200 West Groundwater –

EU: CP-GW-2 **OUs:** 200-UP-1, 200-ZP-1 (carbon tetrachloride, technetium-99)

Figure D.1-4. Groundwater plumes at the Hanford Site based on 2013 groundwater monitoring data and listing of Evaluation Unit (EU) and corresponding regulatory operable unit (OU) designations.



EU: CP-GW-1 (200 East GW OUs)

PC	PC Grp	WQS	200-BP-1 Area (km²)	200-PO-1 Area (km²)
H-3	C	2E4 pCi/L	0.2	83.4
I-129	A	1 pCi/L	4.5	52.1
NO_3	C	45 mg/L	7.9	3.71
Tc-99	A	900 pCi/L	2.4	0.03
Sr-90	B	8 pCi/L	0.6	0.01
U (tot)	B	30 µg/L	0.5	0.02
CN	B	200 µg/L	0.4	---

EU: CP-GW-2 (200 West GW OUs)

PC	PC Grp	WQS	200-ZP-1 Area (km²)	200-UP-1 Area (km²)
CCl_4	A	3.4 µg/L	13.3	
NO_3	C	45 mg/L	9.77	5.80
H-3	C	2E4 pCi/L	0.08	5.50
Cr-VI	A	48 µg/L	0.22	3.85
I-129	A	1 pCi/L	0.10	3.10
TCE	B	5 µg/L	1.16	---
U (tot)	B	30 µg/L	---	0.34
Tc-99	A	900 pCi/L	0.07	0.29

Figure D.1-5. Central Plateau groundwater plumes (200 E, 200 W and Central Plateau indicated by yellow outlines), plume areas, PC groups and applicable WQS.

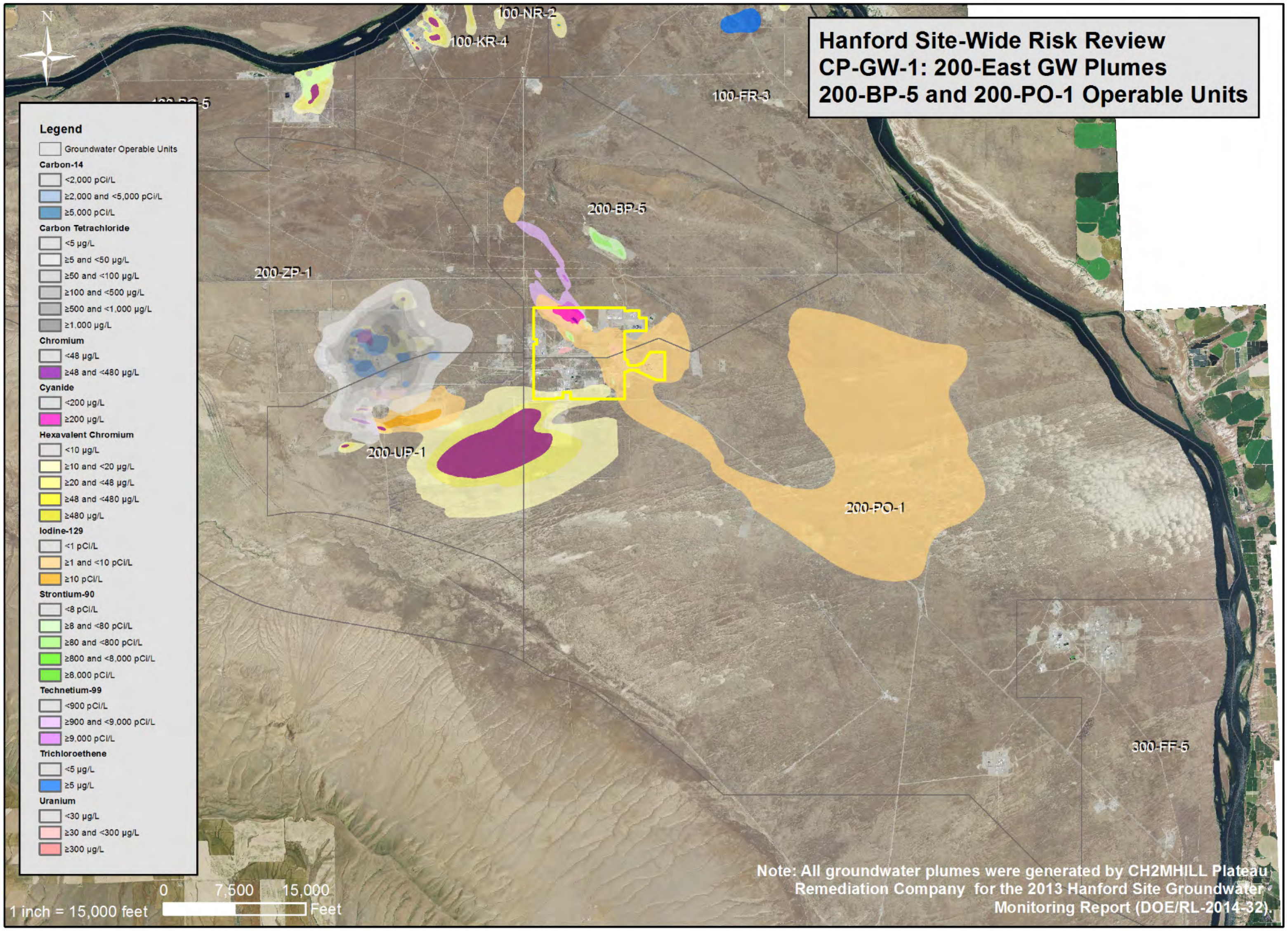
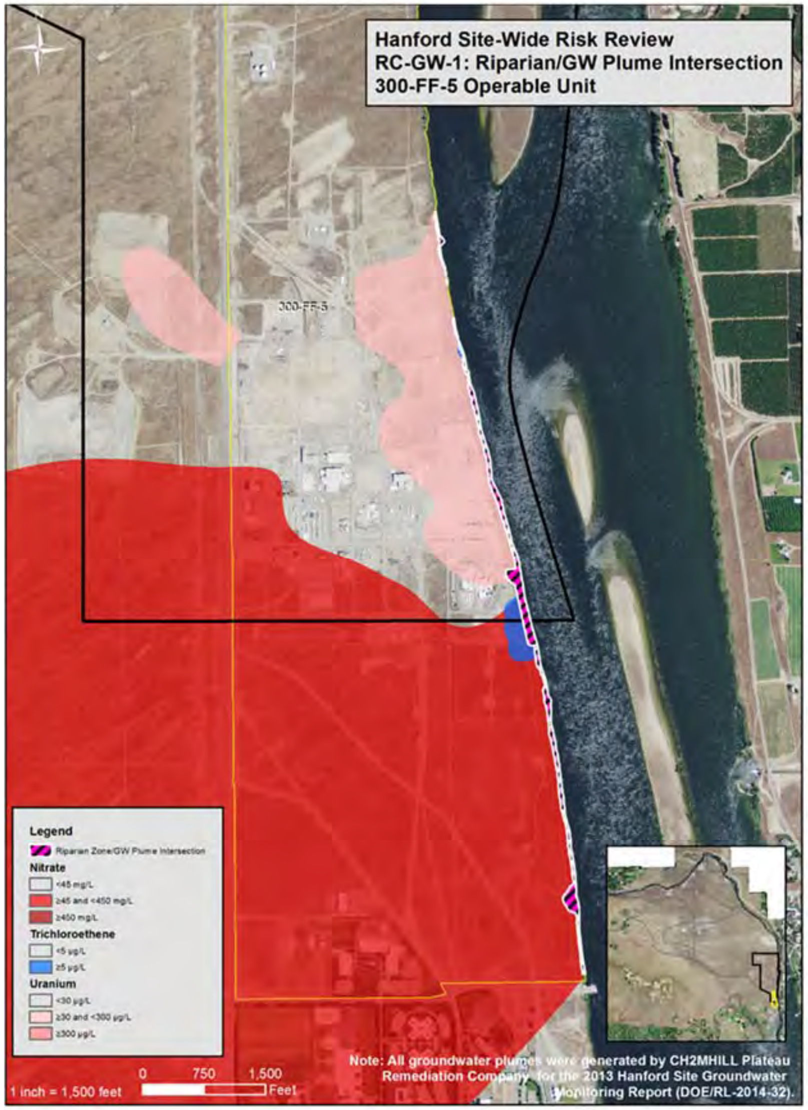


Figure D.1-6. 200 East Area groundwater plumes (EU: CP-GW-1) and 200 West Area groundwater plumes (EU: CP-GW-2) based on 2013 groundwater monitoring data, excluding tritium and nitrate. 200 East Area is indicated by the yellow outline.



Columbia River Corridor Plumes

PC	Grp	WQS	RC-GW-1 300-FF-5 Area (km²)	RC-GW-2 100-NR-2 Area (km²)
Cr-VI	A	10 µg/L	0.22	0.73
Sr-90	B	8 pCi/L	---	0.61
U (tot)	B	30 µg/L	0.5	---
H-3	C	2E4 pCi/L	0.13	0.003
NO_3	C	45 mg/L	0.1	0.49

PC	Grp	WQS	RC-GW-3 100-BC-5 Area (km²)	RC-GW-3 100-HR-3 Area (km²)
Cr-VI	A	48 µg/L	1.6	7.3
Sr-90	B	8 pCi/L	0.6	0.03
NO_3	C	45 mg/L	---	0.06

PC	Grp	WQS	RC-GW-3 100-FR-3 Area (km²)	RC-GW-3 100-KR-4 Area (km²)
NO_3	C	45 mg/L	9.3	0.03
Cr-VI	A	48 µg/L	0.34	2.1
TCE	B	5 µg/L	0.81	0.01
Sr-90	B	8 pCi/L	0.16	0.05
C-14	A	2000 pCi/L	---	0.03
H-3	C	2E4 pCi/L	---	0.02

Figure D.1-7. 300 Area groundwater plume map (EU: RC-GW-1) indicating intersection with the riparian zone along with Columbia River plume areas, PC groups and applicable WQS. Contaminant plumes in top left not shown to allow enlargement to indicate riparian zone.

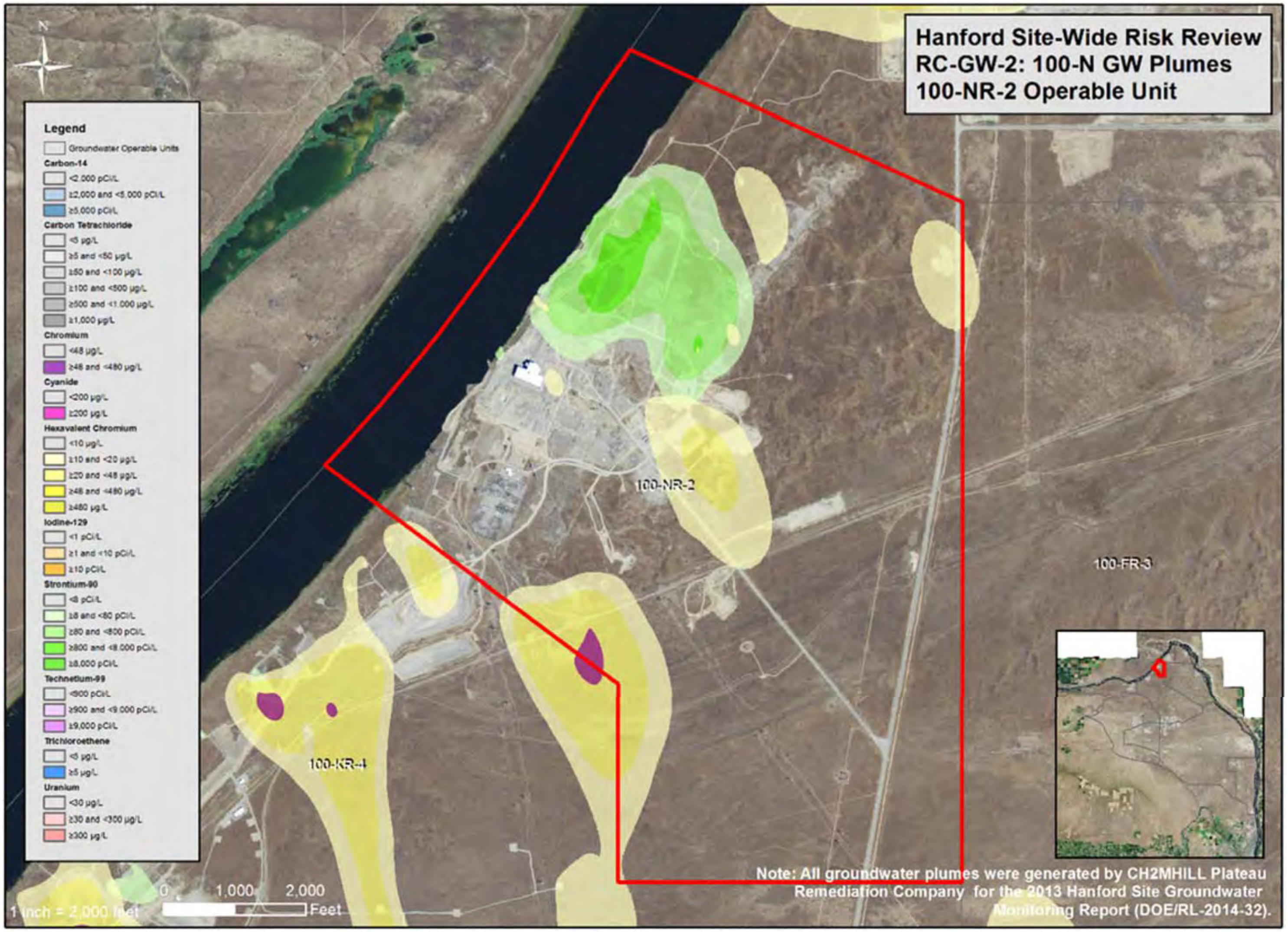


Figure D.1-8. 100-N Area River Corridor groundwater plumes (EU: RC-GW-2, based on 2013 monitoring data; riparian zone not indicated).

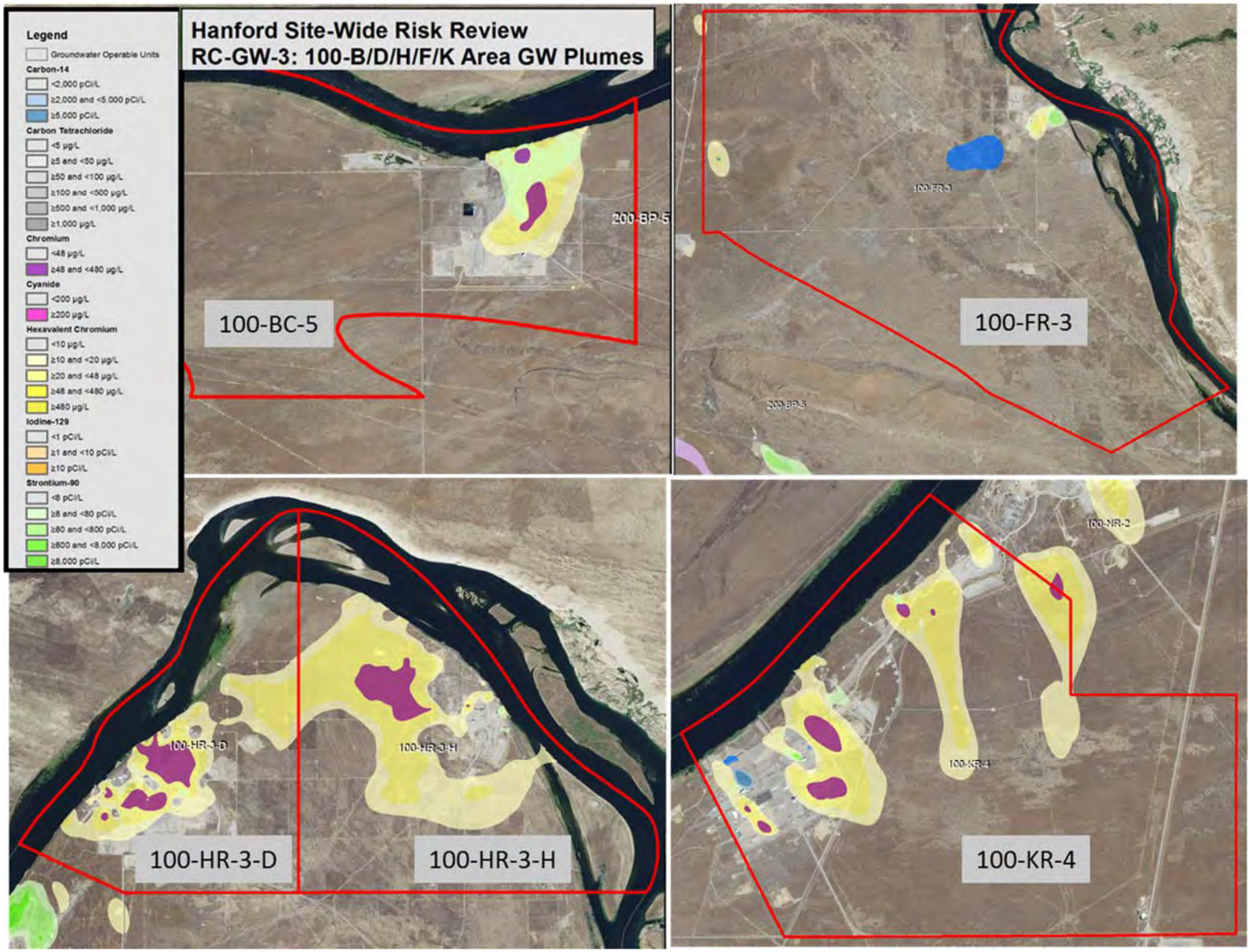


Figure D.1-9. 100-B/D/H/F/K Area groundwater plumes (EU: RC-GW-3, based on 2013 monitoring data; riparian zone not indicated)

APPENDIX D.2

300-FF-5 (RC-GW-1, RIVER CORRIDOR)
EVALUATION UNIT SUMMARY TEMPLATE

Table of Contents

List of Tables -

List of Figures

PART I. EXECUTIVE SUMMARY

EU Location

300 Industrial Area

Related EUs

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

Primary Contaminants, Contaminated Media and Wastes:

The primary contaminants of concern in the 300 Industrial Area include uranium (primarily U^{238}), nitrate, tritium, *cis*-1,2-Dichloroethene (DCE), and trichloroethene (TCE). Contaminated media include a vadose zone comprised of sand and gravel of the Hanford formation portion of the Ringold Formation units B, C, and/or E. An unconfined aquifer also possesses contaminants within the sand and gravel from the Ringold and Hanford formations. This unconfined aquifer is highly transmissive due to the open framework gravelly sediment, resulting in high flow velocities. The base of the aquifer consists of one of a number of fine-grained layers of the Ringold Formation. In addition, numerous distinct layers of sand and gravel that typically contain water and act as local confined aquifers. Basalt confined aquifers are also present. (DOE/RL-2014-32, Rev. 0)

Brief Narrative Description:

The 300 FF Area is composed of a 0.52-square mile 300 Area Industrial Complex and 1 square mile of surrounding areas used for solid and liquid waste disposal (618-10 Burial Ground/316-4 Crib, and 618-11 Burial Ground). Former operations included fabrication of nuclear fuel assemblies from 1943–1987, and research in irradiated fuel processing during the 1950s and 1960s. Groundwater contamination originated primarily from historical routine disposal of liquid effluent associated with fabrication of nuclear fuel assemblies and research involving the processing of irradiated fuel. Disposal areas and plumes of contaminated groundwater cover approximately 1.6 square miles. Principal liquid waste disposal facilities (trenches) have been out of service for decades and most have been remediated by removing contaminated soil. Contamination remaining in the underlying vadose zone and aquifer is residual. The final record of decision was signed in 2013 and remedial action of groundwater includes enhanced attenuation of uranium using sequestration by phosphate application. Monitored natural attenuation (MNA) is the remedy of choice for other contaminants of concern. (DOE/RL-2014-32, Rev. 0)

Summary Tables of Risks and Potential Impacts to Receptors

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

Human Health: A Facility Worker is deemed to be an individual located anywhere within the physical boundaries of the 300 FF area; a Co-located Person (CP) is an individual located 100 meters from the physical boundaries of the 300 FF areas; and Public is an individual located at the closest point on the Hanford Site boundary not subject to DOE access control. The nuclear-related risks to humans are based on unmitigated (unprotected or controlled conditions) dose exposures expressed in a range of from

Non-Discernable (ND) to Medium. The estimated mitigated exposure that takes engineered and administrative controls and protections into consideration, is shown in parenthesis.

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 Non-Discernable (ND) to Medium.

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

Cultural Resources: No risk ratings are provided for Cultural Resources. The Table 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.

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

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

a. For both Ecological and Cultural Resources see Appendices J and K respectively for a complete description of Ecological Field Assessments and literature review for Cultural Resources.

b. Organics (including trichloroethene (TCE) and *cis*-1,2-dichloroethene (DCE)) are locally present in deeper sediments; however, plume extents and shoreline impacts cannot be determined from current data (DOE/RL-2014-32, Rev. 0). These omissions represent data gaps for the analysis of potential groundwater and Columbia River impacts related to 300-FF.

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

SUPPORT FOR RISK AND IMPACT RATINGS FOR EACH POPULATION OR RESOURCE

Human Health

__Current__

Human health risk from exposure to groundwater was evaluated through risk calculations and comparison to federal and state drinking water or cleanup standards. The approach assumes that the groundwater is used as a tap water source for a 30 year period. Potential routes of exposure include ingestion, dermal contact, and inhalation of volatiles during household activities. Groundwater concentrations were also compared to existing federal and state drinking water or cleanup standards. Current remediation activities for the 300-FF-5 groundwater OU involve sampling and monitoring for tritium, TCE, DCE, and enhanced attenuation with monitoring for uranium. Institutional controls (ICs) are also being used to control access to residual contaminants in soil and groundwater. As such, impacts from potential remediation approaches will vary slightly, depending on the activity. (EPA et al., 2013)

Risks and Potential Impacts from Selected or Potential Cleanup Approaches

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

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

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

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

ENVIRONMENTAL – GROUNDWATER

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

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

Current
The groundwater plumes (uranium, tritium, nitrate, TCE, and DCE) associated with 300-FF-5 are described in Part V. As shown in Table D.2-3 in Part VI, the saturated zone (SZ) groundwater threat metric (GTM) values for the Group A and B primary contaminants translate to *Low* (uranium) to *Medium* (tritium and nitrate) ratings for the RC-GW-1 EU. Thus the overall rating for groundwater impacts from current plumes is *Medium*. The only Group A or B contaminant evaluated is total uranium (*Low* rating) because a plume extent cannot be determined for TCE from current data (DOE/RL-2014-32, Rev. 0).

Risks and Potential Impacts from Selected or Potential Cleanup Approaches
Selected remediation Alternative 3a uses a MNA and monitoring for nitrate, tritium, TCE, and DCE in groundwater, and enhanced attenuation with monitoring for uranium and monitoring for gross alpha in groundwater. ICs are also being used to control access to residual contaminants in soil and groundwater as long as they exceed the CULs. As such, impacts from the selected remediation approach will vary little from current conditions (i.e., during active remediation until cleanup levels are reduced below WQSs. Once below WQS (the dissolved uranium concentration is predicted to take approximately 28 years (starting in 2012) to drop below the WQS of 30 µg/L, while the tritium concentrations would decline to below the WQS by 2031 under all remediation alternatives (EPA et al., 2013))[1], the overall rating for groundwater impacts will be assessed *Not Discernible (ND)*.

ENVIRONMENTAL – COLUMBIA RIVER

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

The rating threat evaluation to the benthic ecology for uranium (total) is *high* due to the high maximum groundwater concentration to BCG ratio and impacted shoreline. Benthic ratings were not able to be determined for TCE due to data and modeling constraints, *identifying a significant data need for the 300-FF-5 groundwater OU.*

The rating threat evaluation to the riparian ecology for uranium (total) is *medium* due to the high Ratio and the moderate riparian impact area of 1.30 hectares. The rating *Ratio* for TCE is 9.15, and a riparian impact area of 0.27 hectares, garnering a rating of *low*.

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

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

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

Environmental – Ecological Resources:

Current

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

Risks and Potential Impacts from Selected or Potential Cleanup Approaches

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

NEAR-TERM POST-CLEANUP

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

Social – Cultural Resources

Current

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

Risks and Potential Impacts from Selected or Potential Cleanup Approaches

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

Considerations for timing of the cleanup actions

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

Near-Term, Post-Cleanup Risks and Potential Impacts

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

PART II. ADMINISTRATIVE INFORMATION

OU AND/OR TSDF DESIGNATION(S)

300-FF-5

COMMON NAME(S) FOR EU

RC-GW-1 in 300-FF-5

KEY WORDS

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

REGULATORY STATUS

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

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

Applicable Consent Decree or TPA milestones: There is one TPA milestone for the 300-FF-5 Groundwater OU: M-016-110-T05. DOE will have a remedy in place designed to meet Federal Drinking Water Standards for uranium throughout the groundwater plume in the 300-FF-5 Operable Unit unless otherwise specified in a CERCLA decision document. Date: 12/31/2015.

RISK REVIEW EVALUATION INFORMATION

Completed: Revised 21 August 2015

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

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

PART III. SUMMARY DESCRIPTION

CURRENT LAND USE

DOE Hanford industrial site area

DESIGNATED FUTURE LAND USE

Industrial (300 Area Final ROD)

PRIMARY EU SOURCE COMPONENTS

Legacy Source Sites

Not Applicable

High-Level Waste Tanks and Ancillary Equipment

Not Applicable.

Groundwater Plumes

Three geographic regions comprise 300-FF: the 300 Area Industrial Complex, and the 618-11 Burial Ground. The contaminants of concern include uranium, TCE, and DCE in the 300 Area Industrial Complex, and tritium and nitrate in the 618-11 Burial Ground. From the Hanford Site Groundwater Monitoring Report for 2013 (DOE/RL-2014-32, Rev. 0):

- Uranium (total) concentrations remain above the cleanup level (30 µg/L) in groundwater in the 300 Area Industrial Complex, with varying concentrations depending on changes in water table elevation as influenced by stages of the Columbia River. Large volumes of liquid waste containing uranium were discharged to the former South Process Pond (316-1) (1943 to 1975), North Process Pond (316-2) (1948 to 1975), and 300-Area Process Trenches (316-5) (1975 to 1987). Contaminated soil was removed from the 300 Area Process Trenches in 1991; additional excavation of contaminated soil occurred at this site and at other major liquid waste disposal sites in the 300-Area Industrial Complex from 1997 through 2000. A second area of uranium contamination appears downgradient from the 618-7 Burial Ground, and is apparently resulting from infiltration of dust control water and soil fixatives used during remediation activities. The contamination is migrating toward the Columbia River where it is merging with the uranium plume in the 300 Area Industrial Complex.
  - Maximum concentrations: 462 µg/L (399-1-55) versus a Cleanup Level of 30 µg/L.
  - Areal extent of the plume: 0.5 km^2.
  - Shoreline impact: 1430 m.
- Trichloroethene (TCE) concentrations did not exceed the cleanup level (4 µg/L) in any 300-FF monitoring wells in 2013. TCE was detected at concentrations above the cleanup level at some aquifer tubes that are screened proximal to, or within, a finer-grained interval of Ringold Unit E sediment. TCE was used in degreasing operations associated with the fuels fabrication process and was discharged to the South Process Pond (316-1) and North Process Pond (316-2).
  - Maximum concentrations: 430 µg/L (AT-3-3-D) versus a Cleanup Level of 4 µg/L.

    - Areal extent of the plume: Undefined[2].
    - Shoreline impact: Undefined[2].
- *cis*-1,2-dichloroethene, which is a degradation product of TCE and tetrachloroethene (PCE), also continues to exceed permit limits in 2013.
    - Maximum concentrations: 220 µg/L (399-1-16B) versus a Cleanup Level of 16 µg/L.
    - Areal extent of the plume: Undefined[2].
    - Shoreline impact: Undefined[2].
- A high concentration tritium plume originates from irradiated material associated with the 618-11 Burial Ground (i.e., tritium gas released from buried radiological solid wastes in a series of caissons located along the north side of the burial ground). Concentrations at a well adjacent to the burial ground have decreased from a peak value of 8,140,000 pCi/L in January 2000 to a level concentration of 900,000 from 2007 to 2013, and the plume has maintained its basic shape since its discovery in 1999.
    - Maximum concentrations: $1x10^6$ pCi/L (699-13-3A) versus a Cleanup Level of $2x10^4$ pCi/L.
    - Areal extent of the plume: 0.13 km^2. [3]
    - Shoreline impact: None[3]
- Nitrate concentrations near the 618-11 Burial Ground continue to exceed the cleanup level of 45 mg/L. Concentrations of nitrate above 45 mg/L are also are present in groundwater beneath part of the 300 Area Industrial Complex, from agricultural and industrial activities not associated with the Hanford Site.
    - Maximum concentrations: 122,000 µg/L (399-1-62) versus a Cleanup Level of 45,000 µg/L.
    - Areal extent of the plume: 0.19 km^2. [3]
    - Shoreline impact: None[3]

Operating Facilities

Not Applicable

LOCATION AND LAYOUT MAPS

A series of maps are used to illustrate the location of the components within the RC-GW-1 EU relative to the Hanford Site. Figure D.2-1 shows the relationship among the various Evaluation Units studied in the Interim Report and the Hanford Site. Figure D.2-2 illustrates the extent of groundwater contamination in the River Corridor. Figure D.2-3 shows a detailed view of the groundwater plumes in and near the 300-FF-5 Operable Unit (OU) and RC-GW-1 EU.

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[2] Organics are locally present in deeper sediments, and the plume extent cannot be determined from current data (DOE/RL-2014-32, Rev. 0). This lack of plume definition for TCE and *cis*-1,2-dichloroethene represents a data gap for the analysis of potential groundwater impacts related to 300-FF.
[3] Excludes plume associated with 200-PO Operable Unit and off-site sources of nitrate (DOE/RL-2014-32, Rev. 0).

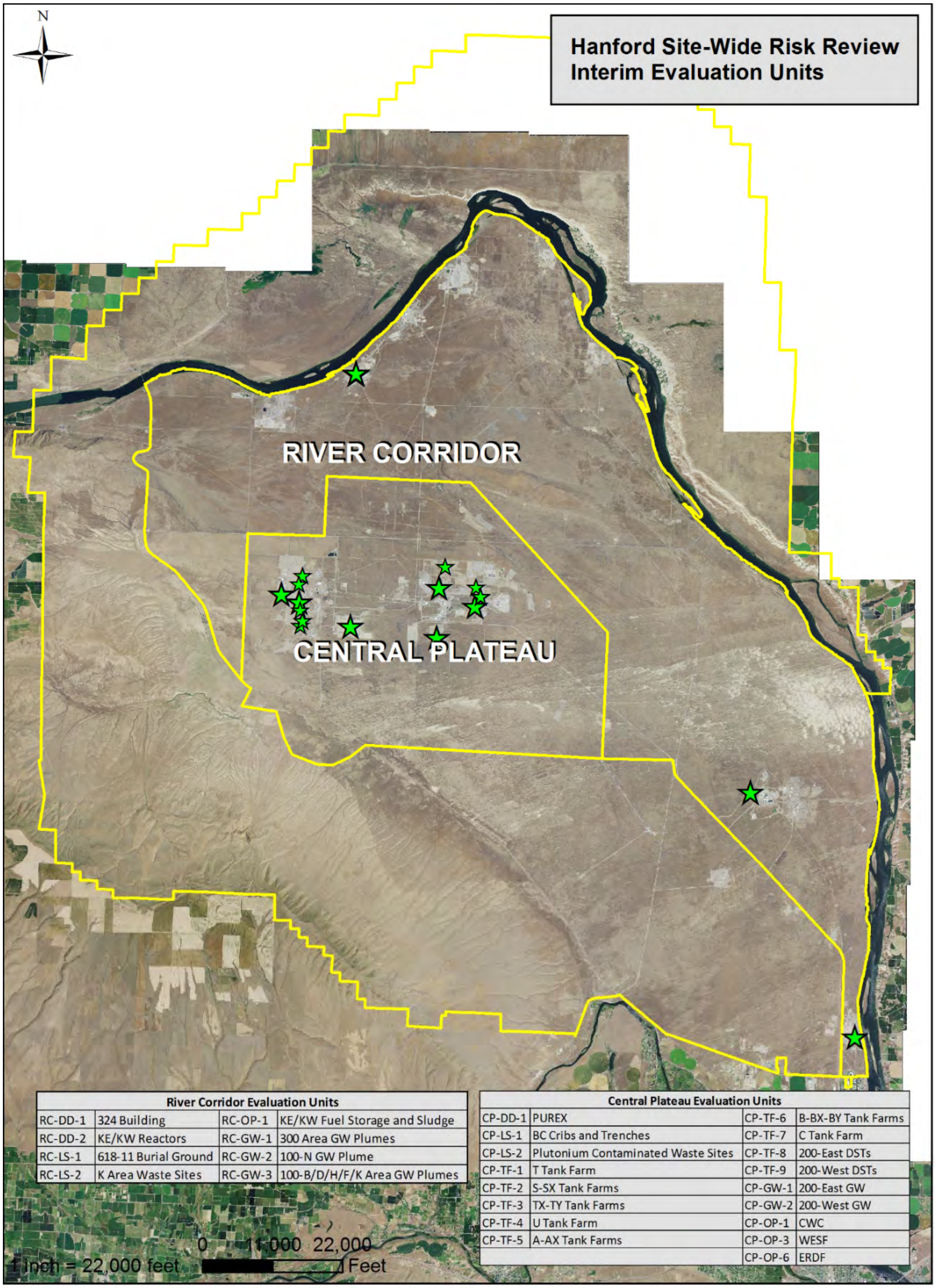

Figure D.2-1. Location of the Evaluation Units in Relation to the Hanford Site.

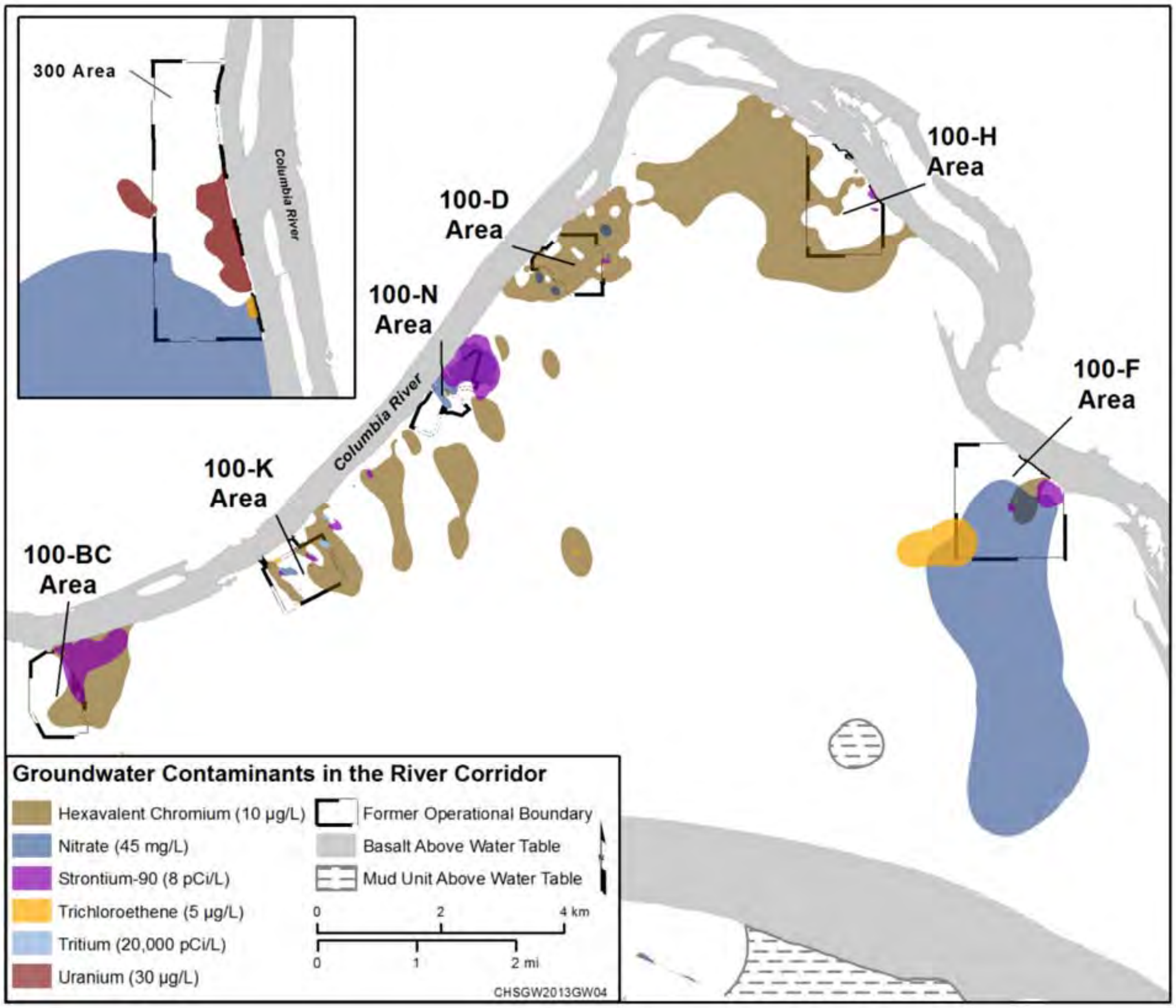

Figure D.2-2. Groundwater Contamination in the River Corridor in 2013 (DOE/RL-2014-32, Rev. 0)

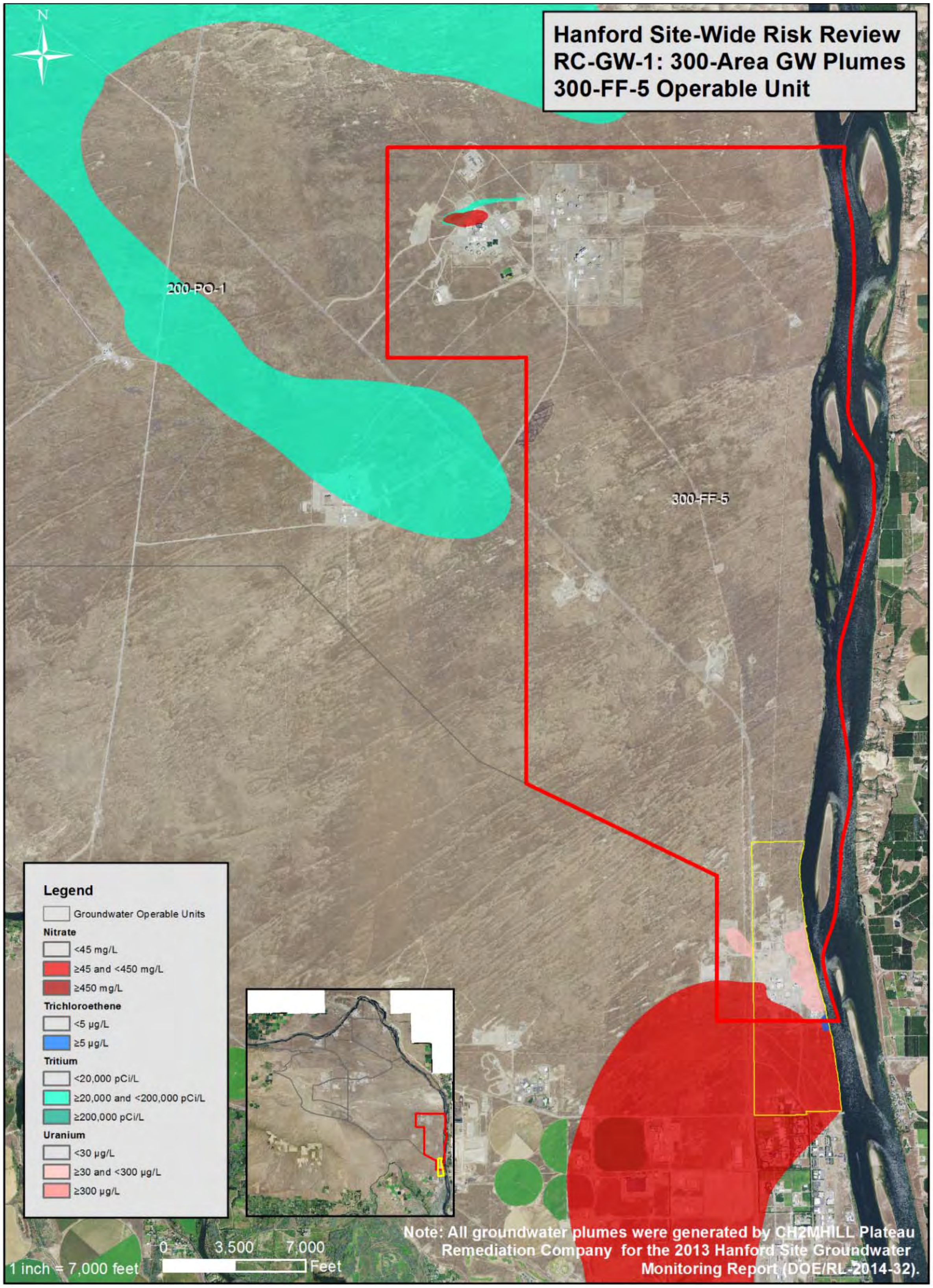

Figure D.2-3. Groundwater Plumes near the 300-FF-5 Operable Unit in 2013

PART IV. UNIT DESCRIPTION AND HISTORY

EU Former/Current Use(s)

The groundwater contamination in 300-FF largely originated from the past routine disposal of liquid effluent from the fabrication of nuclear fuel assemblies and research involving the processing of irradiated fuel (DOE/RL-2014-32, Rev. 0). Primary liquid waste disposal facilities have been out of service for decades, and most have been remediated by removing contaminated soil leaving residual contamination in the underlying vadose zone and aquifer.

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

Legacy Source Sites

Not Applicable

High-Level Waste Tanks

Not Applicable

Groundwater Plumes

Please see groundwater plume description in Part III above.

D&D of Inactive Facilities

Not Applicable

Operating Facilities

Not Applicable

Ecological Resources Setting

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

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

Table D.2-2 and indicate the extent of biological resources that could potentially be affected by the groundwater plumes. For the groundwater evaluation units, there are approximately 109.5 acres of riparian habitat along the river shoreline that where contaminated groundwater could affect the ecological resources.

Table D.2-2. Areal Extent (Acres) of Riparian Zone Intersected by 2013 Groundwater Plumes Within Each Groundwater Operable Unit

Evaluation Unit		*RC-GW-3*	*RC-GW-3*	*RC-GW-2*	*RC-GW-3*	*CP-GW-1*	*RC-GW-1*	
Groundwater OU	**Reference Value**	*100-BC-5*	*100-KR-4*	*100-NR-2*	*100-HR-3*	*200-PO-1*	*300-FF-5*	**Total Area**
COPC								
Carbon-14	2,000 pCi/L[a]	-	-	-	-	-	-	-
Cyanide	200 µg/L[a]	-	-	-	-	-	-	-
Chromium	10 µg/L[b]	7.61	2.78	0.04	29.9	-	-	40.32
Carbon Tetrachloride	5 µg/L[a]	-	-	-	-	-	-	-
Iodine-129	1 pCi/L[a]	-	-	-	-	-	-	-
Nitrate	45 mg/L[a]	-	-	0.38	-	-	0.61	0.99
Strontium-90	8 pCi/L[a]	2	-	1.14	0.14	-	-	3.28
Technetium-99	900 pCi/L[a]	-	-	-	-	-	-	-
Trichloroethylene	5 µg/L[a]	-	0.73	-	-	-	0.66	1.39
TPH-D	200 µg/L[c]	-	-	0.1	-	-	-	0.1
Tritium	20,000 pCi/L[a]	-	-	0.11	-	52.84	-	52.94
Uranium	30 µg/L[a]	-	-	-	-	-	3.21	3.21
Total Extent of Plumes[d]	-	7.61	3.55	1.54	30.51	52.84	4.2	100.25
Total Riparian Area[e]	-	491.52	78.04	11.38	792.84	357.37	208.42	2660.78

a. EPA and/or DOH Drinking Water Standard

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

c. EPA and/or DOH Secondary Drinking Water Standard for Total Dissolved Solids. Secondary drinking water standards are not associated with health effects, but associated with taste, odor, staining, or other aesthetic qualities.

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

e. The Total Riparian Area is the based on the areal extent of mapped riparian vegetation along the Benton County shoreline of the Hanford Site. The total riparian area listed (2660.78 ac) includes riparian area within 100-FR-3 (721.2 ac), which is part of the Hanford Reach but is not listed in other parts of the table because there is no plume intersection with the riparian zone.

Cultural Resources Setting

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

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

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

PART V. WASTE AND CONTAMINATION INVENTORY

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

CONTAMINATION WITHIN PRIMARY EU SOURCE COMPONENTS

Legacy Source Sites

Not Applicable

High Level Waste Tanks and Ancillary Equipment

Not Applicable

Vadose Zone Contamination

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

Groundwater Plumes

The estimated inventory for the saturated zone contamination is provided in Table D.2-3 where the process is outlined in Chapter 6 of the Methodology Report (CRESP 2015). For the groundwater plumes described in the 300-FF-5 OU (DOE/RL-2014-32, Rev. 0), inventories are estimated as follows:[4]

- Uranium – The maximum measured concentration in 2013 was 462 µg/L, the upper 95% confidence limit (UCL) on the log-transformed groundwater and aquifer tube (AT) data from PHOENIX (http://phoenix.pnnl.gov/) was 82.6 µg/L, and the 95% UCL for the 2013 AT data was 76.5 µg/L. The areal extent of the plume is 0.5 km^2. The plume pore volume is estimated to be 1.35E+06 m^3, the plume inventory (pore water) is estimated to be 112 kg, and the plume inventory (sediment) is estimated to be 912 kg (K_d of approximately 0.8 mL/g).
- Tritium – The maximum measured concentration in 2013 was 1.00E+06 pCi/L, the upper 95% confidence limit (UCL) on the log-transformed groundwater and aquifer tube (AT) data from

[4] As indicated in Table D.2-3, plume depths are not known for the 300-FF primary contaminants. As indicated in the Methodology Report (CRESP 2015), in this case, the minimum of the value from the Hanford 200-UP-1 OU Interim ROD (EPA 2012) or the unconfined aquifer thickness is used. The unconfined aquifer thickness used (~25 m) is the combination of Hanford Unit (~5 m) (DOE/RL-2014-32, Rev. 0) and Ringold Unit E (~20 m) (Last 2006, pp. 4.5-4.6). However, TCE and DCE do not have plume areas and thus no volumes of threats are computed for these contaminants; these omissions represent data gaps in the analysis of threats to groundwater. Furthermore, use of the depths from the Hanford 200-UP-1 OU Interim ROD (EPA 2012) likely results in very large uncertainties in the pore volume and related estimates.

PHOENIX (http://phoenix.pnnl.gov/) was 4.26E+05 pCi/L. The plume inventory (pore water) is estimated to be 249 kg.

- Nitrate – The maximum measured concentration in 2013 was 122 mg/L, the upper 95% confidence limit (UCL) on the log-transformed groundwater and aquifer tube (AT) data from PHOENIX (http://phoenix.pnnl.gov/) was 84.9 mg/L. The plume pore volume is estimated to be 1.35×10^6 m^3, and the plume inventory (pore water) is estimated to be 6.97E+04 kg.
- TCE and DCE – No plume inventories were estimated since no plume areal extent was provided due to fate and transport modeling limitations.

As illustrated in Table D.2-3, the maximum of the saturated zone (SZ) GTM values for the Group A and B primary contaminants (where uranium is evaluated and TCE could not be due to data limitations) are 3.72 Mm^3 for the RC-GW-1 EU translating to *Low* rating. The plume areas for the Group C contaminants (tritium and nitrate) translate to *Medium* ratings.

It is unlikely that additional PCs might contaminant the groundwater in the 300-FF-5 OU in the future. Remediation activities including MNA, monitoring, enhanced attenuation, and ICs should not increase contaminant migration into groundwater. Scenarios where this is possible, albeit unlikely, include increased infiltration of water into the subsurface due to a broken water pipe or other significant water addition event such as could occur for dust suppression. Neither of which is associated with any planned remediation activities or ICs.

Columbia River

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

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

<u>Results of the Threat Evaluation to the Benthic Ecology</u>

The rating threat evaluation to the benthic ecology is summarized in Table D.2-4. Here, the rating *Ratio* (R1) for uranium (total) is 35.8, and a shoreline impact of 1420 m, garnering a threat evaluation rating of

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

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

High. Benthic ratings were not able to be determined for TCE due to data and modeling constraints, *identifying a significant data need for the 300-FF-5 groundwater OU.*

Results of the Threat Evaluation to the Riparian Zone Ecology

The rating threat evaluation to the riparian ecology is also summarized in Table D.2-4. Here, the rating *Ratio* (R1) for uranium (total) is again 35.8, and a riparian impact area of 1.30 hectares, garnering a rating of *Medium*. The rating *Ratio* for TCE is 9.15, and a riparian impact area of 0.27 hectares, garnering a rating of *Low*. The rating *Ratios* for nitrate and tritium are less than one, garnering ratings of *Not Discernible*.

Threats to the Columbia River Free-flowing Ecology

The threat determination process for the free-flowing River ecology was evaluated in a manner similar to that described above for benthic receptors (Chapter 6, Methodology Report (CRESP 2015)). However, because of the large dilution effect of the Columbia River on the contamination from the seeps and groundwater upwellings[7], the differences from EU to EU were not found distinguishing and the potential for groundwater contaminant discharges from Hanford to achieve concentrations above relevant thresholds is very remote.

Facilities for D&D

Not Applicable

Operating Facilities

Not Applicable

[7] "Groundwater is a potential pathway for contaminants to enter the Columbia River. Groundwater flows into the river from springs located above the water line and through areas of upwelling in the river bed. Hydrologists estimate that groundwater currently flows from the Hanford unconfined aquifer to the Columbia River at a rate of ~ 0.000012 cubic meters per second (Section 4.1 of PNNL-13674). For comparison, the average flow of the Columbia River is ~3,400 cubic meters per second (DOE/RL-2014-32, Rev. 0)." This represents a dilution effect of more than eight orders of magnitude (a dilution factor of greater than 100 million).

Table D.2-3. Summary of the Evaluation of Current Threats to Groundwater as a Protected Resource from Saturated Zone (SZ) Contamination associated with RC-GW-1 (300-FF-5).

OU	PC	Grp	WQS[a]	Area (km²)[b]	Thick-ness (m)[c]	Pore Vol. (Mm³)	Max GW Conc	95th % GW UCL	Porosity[d]	K_d (mL/g)[d]	ρ (kg/L)[d]	R	SZ Total M^{SZ} (kg or Ci)	SZ GTM (Mm³)	SZ Rating[e]
300-FF-5	U	B	30 µg/L	0.5	15	1.35E+00	462 µg/L	82.6 µg/L	0.18	0.8	1.84	9.18E+00	1.12E+02	3.72E+00	Low
	H-3	C	20000 pCi/L	0.13	25	5.85E-01	1.00E+06 pCi/L	426000 pCi/L	0.18	0	1.84	1.00E+00	2.49E+02	---	Medium
	NO3	C	45 mg/L	0.19	24	8.21E-01	122 mg/L	84.9 mg/L	0.18	0	1.84	1.00E+00	6.97E+04	---	Medium
	TCE	B	4 µg/L	Undefined	25	---	430 µg/L	120 µg/L	0.18	0	1.84	1.00E+00	---	---	---
	DCE	---	16 µg/L	Undefined	25	---	220 µg/L	---	0.18	0	1.84	1.00E+00	---	---	---

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

b. Plume area (DOE/RL-2014-32, Rev. 0). Organics (TCE and DCE) are locally present in deeper sediments, and the plume extent cannot be determined from current data (DOE/RL-2014-32, Rev. 0). This lack of plume definition for TCE and *cis*-1,2-dichloroethene (DCE) represents a data gap for the analysis of potential groundwater impacts related to 300-FF.

c. As described in Chapter 6 of the Methodology Report (CRESP 2015), for those areas outside of the 200-UP-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. The unconfined aquifer thickness used (~25 m) is the combination of Hanford Unit (~5 m) (DOE/RL-2014-32, Rev. 0) and Ringold Unit E (~20 m) (Last 2006, pp. 4.5-4.6). However, the TCE and DCE do not have plume areas and thus no volumes of threats are computed for these contaminants; these omissions represent data gaps in the analysis of threats to groundwater.

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

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

Table D.2-4. Summary of the Evaluation of Groundwater as Pathway to the Columbia River associated with RC-GW-1 (300-FF-5).

OU	PC	Grp	WQS[a]	BCG or AWQC[b]	Max GW Conc	95th % GW UCL	$R1, \frac{\text{Max GW Conc}}{\text{BCG or AWQC}}$	$R2, \frac{\text{95th \% GW UCL}}{\text{BCG or AWQC}}$	Shoreline Impact (m)[c]	Riparian Area (ha)[d]	Benthic rating[e]	Riparian rating[e]	Overall rating[e]
300-FF-5	U	B	30 µg/L	12.9 µg/L	462 µg/L	82.6 µg/L	3.58E+01	6.40E+00	1.43E+03	1.30E+00	High	Medium	High
	H-3	C	20000 pCi/L	2.65E+08 pCi/L	1.00E+06 pCi/L	426000 pCi/L	3.77E-03	1.61E-03	None	---	---	---	ND
	NO3	C	45 mg/L	7100 mg/L	122 mg/L	84.9 mg/L	3.58E-01	2.49E-01	None	2.47E-01	---	---	ND
	TCE	B	4 µg/L	47 µg/L	430 µg/L	120 µg/L	9.15E+00	2.56E+00	Undefined	2.67E-01	---	Low	Low
	DCE	---	16 µg/L	590 µg/L	220 µg/L	---	3.73E-01	---	Undefined	---	---	---	---

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

b. Biota Concentration Guide (BCG) from RESRAD-BIOTA v1.5 (consistent with DOE Technical Standard DOE-STD-1153-2002) for radionuclides. For chemicals, either the Ambient Water Quality Criterion (AWQC) (Table 6-1 in DOE/RL-2010-117, Rev. 0) or Tier II Screening Concentration Value (SVC) (http://rais.ornl.gov/documents/tm96r2.pdf) is used when AQWC not available. The exception is (total) uranium where a value (12.9 µg/L) was selected for total uranium to identify those areas contaminated by the Hanford Site.

c. Shoreline impact from 2013 Hanford Site Groundwater Monitoring Report (DOE/RL-2014-32, Rev. 0). Excludes tritium and nitrate in plumes associated with the 200-PO groundwater interest area (Appendix G.1). The shoreline rating for TCE and DCE are undefined because these organics are locally present in deeper sediments.

d. The intersection area between the groundwater plume and the riparian zone was provided by PNNL based on the 2013 Hanford Site Groundwater Monitoring Report (DOE/RL-2014-32, Rev. 0).

e. Benthic and riparian zone ratings based on Figure 6-11 in the Methodology Report (CRESP 2015). The Group C ratings (for nitrate and tritium) are ND because R1 ≤ 1. The free-flowing ratings are all ND. The overall rating is the maximum rating.

PART VI. POTENTIAL RISK/IMPACT PATHWAYS AND EVENTS

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

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

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

As the river water height goes up and down on a seasonal cycle, so too does the groundwater level throughout the 300 Area Industrial Complex that abuts the river. Rising groundwater saturates what usually is the deep layer of the vadose zone. In some years, the river water height is much higher and remains high for much longer than in most years, and resulting elevated groundwater saturates deep vadose zone layers that may not have been wet for years. This fluctuating groundwater elevation creates the PRZ (**Figure D.1-4**).

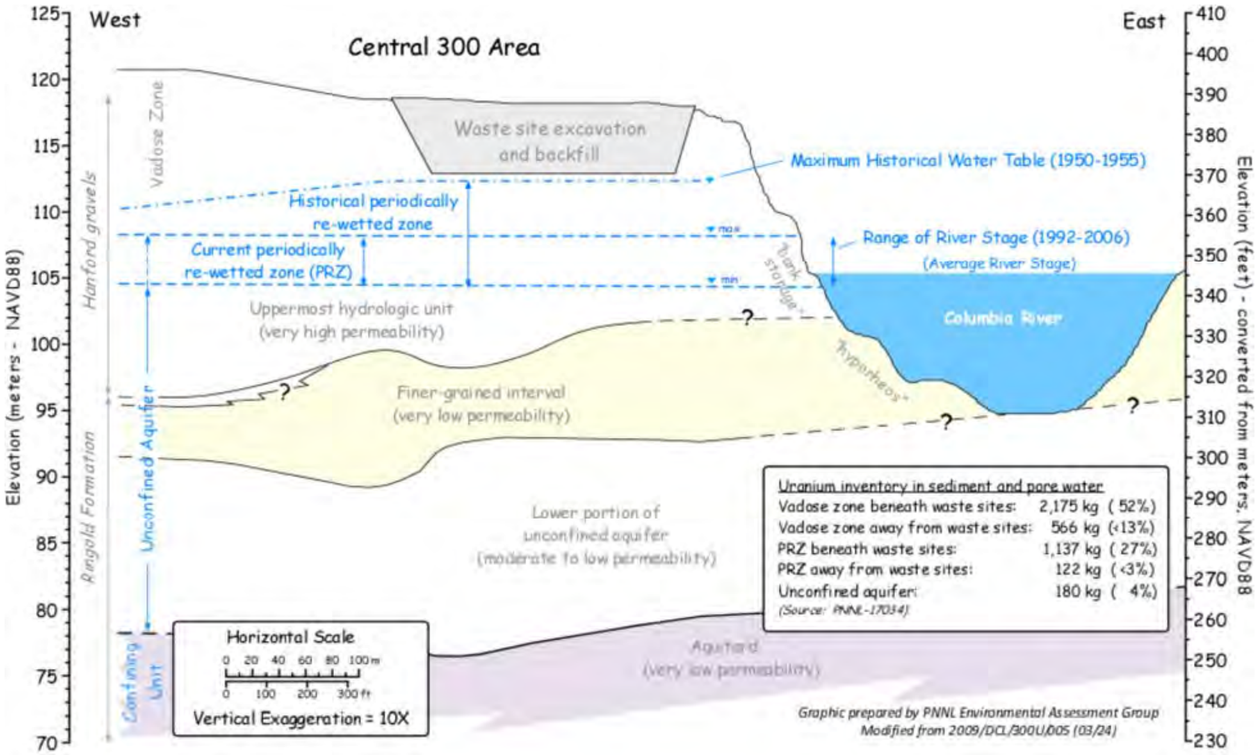

Figure D.2-4. Principal Subsurface Features with PRZ and Uranium Inventory Estimates (after EPA et al., 2013).

The unconfined aquifer occurs in the highly permeable gravel-dominated Hanford formation and in the underlying, less permeable sands and gravels of the Ringold Formation (Figure D.1-5). The Ringold Formation lower mud unit is a confining layer, the aquitard at the base of the unconfined aquifer, and is characterized by very low permeability fine-grained sediment. This hydrologic unit prevents further downward movement of groundwater contamination to the deeper aquifers. The thickness of the unconfined aquifer along the Columbia River shoreline is about 25 m (80 ft). Groundwater in the unconfined aquifer discharges to the Columbia River via upwelling through the riverbed and riverbank springs and seeps. The flux from the Hanford Site aquifer is very low, compared to the flow of the river. Because the river stage regularly fluctuates up and down, flow beneath the shoreline is back and forth, with river water intruding into the unconfined aquifer and mixing with groundwater at times. When the river stage drops quickly to a low elevation, riverbank seeps appear.

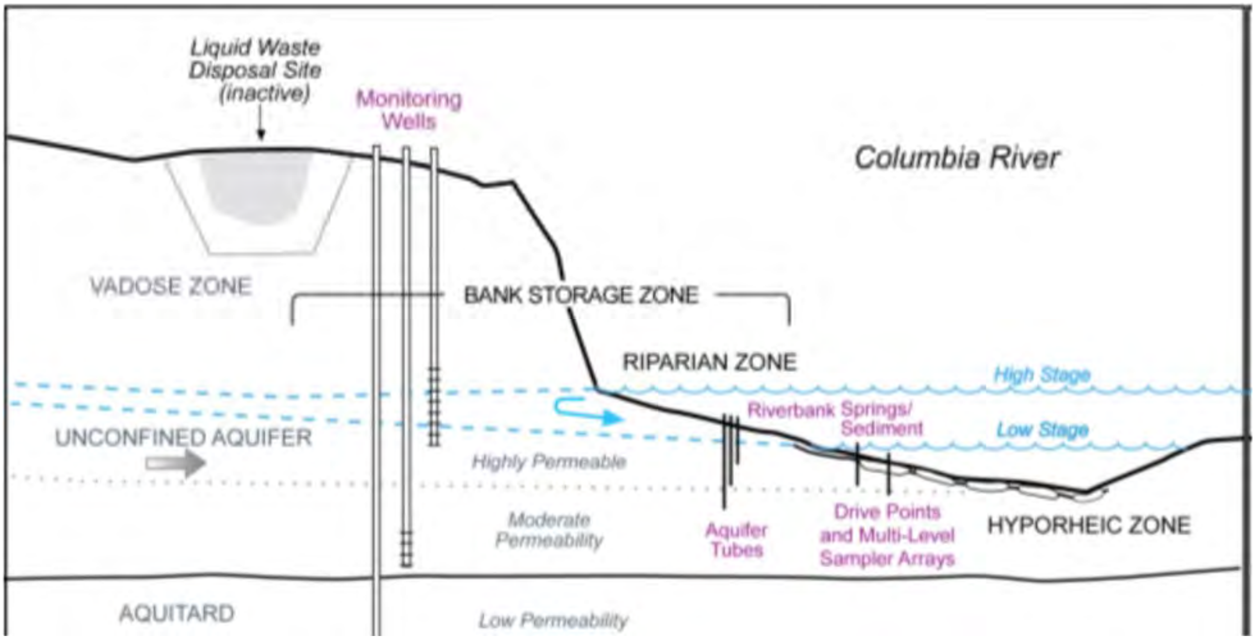

Figure D.2-5. Conceptual Site Model of River and Groundwater Mixing Zone (after EPA et al., 2013).

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

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

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

POPULATIONS AND RESOURCES CURRENTLY AT RISK OR POTENTIALLY IMPACTED

Facility Worker

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

Co-Located Person (CP)

Workers are not directly exposed to the contaminated groundwaters because they are located below grade beneath a clean soil cover.

Public

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

Groundwater

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

Current

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

Based on a GTM (units of 1E6 m^3 or Mm^3) of 3.72 Mm^3 for uranium, the threat rating was evaluated as *low*. Unfortunately, no GTM rating was able to be determined for TCE or DCE due to the inability to adequately define the plumes by current data (DOE/RL-2014-32, Rev. 0), although these organics were determined to be locally present in deeper sediments. For tritium and nitrate, the contaminant plume areas were 0.13 km^2 and 0.19 km^2, respectively, reflecting a *Medium* groundwater threat.

Risks and Potential Impacts from Selected or Potential Cleanup Approaches

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

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

Columbia River

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

The rating threat evaluation to the benthic ecology for uranium (total) is *High* due to the high maximum groundwater concentration to BCG ratio and impacted shoreline. Benthic ratings were not able to be determined for TCE due to data and modeling constraints, *identifying a significant data need for the 300-FF-5 groundwater OU.*

The rating threat evaluation to the riparian ecology for uranium (total) is *Medium* due to the high Ratio and the moderate riparian impact area of 1.30 hectares. The rating *Ratio* for TCE is 9.15, and a riparian impact area of 0.27 hectares, garnering a rating of *Low*.

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

Ecological Resources

For the four groundwater evaluation units with plumes that are estimated to intersect the Columbia River, there are approximately 100.25 acres of riparian habitat and resources along the river shoreline that could potentially be affected.

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

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

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

Cultural Resources

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

CLEANUP APPROACHES AND END-STATE CONCEPTUAL MODEL

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

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

These remedial action objectives provide four remedy components:

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

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

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

- Groundwater monitoring would be conducted for uranium from waste sites in 300-FF-1 and 300-FF-2 with uranium contamination above CULs deeper than 4.6 m (15 ft) bgs (former liquid waste sites 316-1, 316-2, 316-3 and 316-5 and former solid waste sites 618-2 and 618-3) and 618-1 because of the large waste disposal inventory and the proximity of 618-1 to higher uranium groundwater concentrations.

- The enhanced attenuation of residual uranium in the deep vadose zone and periodically rewetted zone (PRZ) will occur in an approximately 1 hectare (3 acre) area that is the highest contributing area to the persistent uranium groundwater contamination. This treatment area is in the vicinity of former waste sites 316-5 and 316-2, where the highest uranium contamination consistently occurs in groundwater.
- This alternative will apply phosphate to the highest uranium concentration areas of the vadose zone and PRZ using a combination of surface infiltration, PRZ injection and groundwater injection techniques. Prior to phosphate application in the vadose zone and PRZ, phosphate will be injected into the upper portion of the groundwater below and to the east and south of the vadose zone and PRZ treatment area. This is done to sequester uranium potentially mobilized by the surface infiltration and PRZ injection. During implementation, tests will be conducted on post treatment vadose zone core samples to refine the groundwater model, and groundwater monitoring will be conducted to assess changes in uranium concentrations and the lateral spread of phosphate.
- The use of sequestration as an enhancement to immobilize the deep residual uranium that is providing the highest uranium concentrations to the groundwater is expected to accelerate the natural attenuation of uranium contamination in the vadose zone, PRZ and aquifer.
- Uranium sequestration in alternative 3a is estimated to take approximately four years to complete. This time period is based on one year to complete the RD/RAWP and three years to implement the enhanced attenuation. This alternative addresses the deep uranium contamination contributing to the persistent groundwater contamination.
- Contaminant fate and transport modeling was performed to simulate and predict the movement of uranium, tritium, TCE, and DCE. The model predictions for uranium indicate a long-term declining trend in the dissolved uranium concentrations in groundwater for uranium transported from vadose zone sediments, with seasonal increases and decreases in concentrations as the water table rises and falls with river stage fluctuations. With no remedial actions, the dissolved uranium concentration is predicted to take approximately 28 years (starting in 2012) to drop below the drinking water standard (DWS) of 30 µg/L. The estimates of the time for the uranium concentration to decline below the DWS for each remedial alternative were based on the longer time of either the 90th percentile, or the 95 percent upper confidence limit on the mean of the uranium concentration in the most contaminated monitoring well. These fate and transport simulations assume that the current hydrologic and chemical conditions remain unchanged. This two-dimensional model was developed specifically for this evaluation, incorporating data collected since the original modeling was performed that supported the 1996 ROD, and includes more physically-based treatment of uranium sorption and desorption processes based on information about uranium transport in this environment learned from research at DOE's Integrated Field Research Center test site located in the former South Process Pond (316-1).
- Natural attenuation of nitrate and tritium from the 618-11 Burial Ground will occur through a combination of dispersion during transport and natural radiological decay for tritium. Computer modeling predicts that the tritium concentrations will decrease to below the CUL by 2031. The waste within the 618-11 Burial Ground that released the nitrate and tritium will be removed by RTD. MNA is used for the TCE and DCE in groundwater from the 300 Area Industrial Complex. Natural attenuation will occur primarily through physical attenuation (diffusion and dispersion) and biodegradation. MNA includes monitoring to ensure the effectiveness of natural attenuation to meet CULs.

- Groundwater monitoring, including as required as a component of MNA, will be integrated into the sampling and analysis portion of the RD/RAWP. Sampling will be sufficient to document changes in contaminant plumes for all groundwater contaminants of concern (COCs). As part of monitoring the lateral extent of plumes, groundwater will be monitored in the near vicinity of the Columbia River throughout the 300 Area Industrial Complex and both north and south of that area to ensure lateral extent of the plumes are defined. Because several of the 300-FF-5 groundwater COCs are also contaminants in 200-PO-1 that move through the 300 Area, monitoring of 300-FF-5 COC plumes will include lateral extent sufficient to distinguish contamination that is part of 300-FF-5 verses 200-PO-1. Monitoring will continue until COCs have attained the CULs and are expected to continue to meet CULs and EPA approves termination of the monitoring. Considered in the evaluation will be processes that can affect concentrations such as river fluctuations, waste site activities and land use activities. Groundwater monitoring will be performed to evaluate the effectiveness of the selected 300-FF-5 remedy to achieve CULs. The monitoring will be for groundwater COCs (uranium, gross alpha, nitrate, TCE and DCE at the 300 Area Industrial Complex; uranium and gross alpha down gradient from the 618-7 Burial Ground; and tritium and nitrate down gradient from the 618-11 Burial Ground).
- Note that there is significant uncertainty in the estimated time to achieve the uranium CUL in slected remediation Alternative 3a due to complex interactions of the contamination in the vadose zone, PRZ, and groundwater with the dynamic groundwater levels controlled by seasonal changes in the elevation of the river water. Further, the model predictions do not include uranium mobilized from the vadose zone and PRZ during remedial activities (either through sequestration or RTD), which can influence the time necessary to achieve the CUL. This remediation alternative minimizes these impacts by providing partial treatment of the groundwater to sequester uranium mobilized through the application of phosphate to the overlying vadose zone and PRZ. The estimated time to achieve the uranium CUL is also influenced by when the phosphate application can occur. Phosphate application will be performed when groundwater velocities are slow (i.e., rising and high river stage) and the groundwater conditions are favorable, so the limited window of opportunity for these favorable conditions may delay the schedule if the favorable conditions are missed. Although Alternative 3a is estimated to achieve the uranium CUL in 22 to 28 years, this timeframe is uncertain due to the factors described above. (EPA et al., 2013)

Contaminant Inventory Remaining at the Conclusion of Planned Active Cleanup Period

Current and anticipated water use in the 300 Area Industrial Complex derives from municipal water from the city of Richland. There are no current plans to start using 300-FF-5 groundwater as drinking water when drinking water standards (DWSs) are met. The expected timeframes to attain the WQSs in 300-FF-5 groundwater range from 22-28 years for uranium, and 18 years for tritium. An expected timeframe for nitrate concentrations to achieve the DWS has not been determined since the nitrate originates from off-site sources and is not part of 300-FF-5. Similarly, the timeframe for organics TCE and DCE degradation to DWSs could not be estimated due to insufficient data on the contaminant plumes. (EPA et al., 2013)

Risks and Potential Impacts Associated with Cleanup

Ecological Resources

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

Cultural Resources

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

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

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

Workers (directly involved)

Please see above.

Co-located Person (CP)

Please see above.

Public

Please see above.

Groundwater

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

Columbia River

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

Ecological Resources

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

Cultural Resources

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

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

Additional Risks and Potential Impacts if Cleanup is Delayed

Please see above.

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

Please see above.

Populations and Resources at Risk or Potentially Impacted After Cleanup Actions (from residual contaminant inventory or long-term activities)

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

Population or Resource		Risk/Impact Rating	Comments
Human	Facility Worker	Low	Only workers at risk or impacted would be working on the active remediation activities, to include monitoring and sampling.
	Co-located Person	Low	Workers are not directly exposed to the contaminated groundwaters because they are located below grade beneath a clean soil cover.
	Public	Not Discernible	The contamination remains underground, except where the contaminated groundwater intersects the Columbia River.
Environmental	Groundwater	Not Discernible	Based on a GTM (units of 1E6 m^3 or Mm^3) of 3.72 Mm^3 for uranium, the original threat rating was evaluated as *Low*. No GTM rating was able to be determined for TCE or DCE due to the inability to adequately define the plumes by current data (DOE/RL-2014-32, Rev. 0), although these organics were determined to be locally present in deeper sediments (i*ndicating a significant data need for the 300-FF-5 groundwater OU*). For tritium and nitrate, the contaminant plume areas translated to *Medium* ratings. However, modeling (EPA et al., 2013) suggests that concentrations will fall below drinking water standards before the beginning of the Active Cleanup (and thus the near-term, post-Cleanup period) resulting in *Not Discernible* ratings.
	Columbia River	Not Discernible	The current benthic ecology rating for total uranium (Group B) is *High* due to the high maximum groundwater concentration to BCG ratio and impacted shoreline. Benthic ratings were not able to be determined for TCE due to data and modeling constraints, *identifying a significant data need for the 300-FF-5 groundwater OU.*

			The current rating to the riparian ecology for total uranium (Group B) is *Medium* due to the high Ratio and the moderate riparian impact area of 1.30 hectares. The rating *Ratio* for TCE is 9.15, and a riparian impact area of 0.27 hectares, garnering a rating of *low*. However, modeling (EPA et al., 2013) suggests that concentrations will fall below drinking water standards (and thus corresponding riparian and benthic thresholds) before the beginning of the Active Cleanup (and thus the near-term, post-Cleanup period) resulting in *Not Discernible* ratings. The large dilution effect of the Columbia River results in a rating of *Not Discernible* for the free-flowing ecology for all evaluation periods.
	Ecological Resources*	Low	Contamination remaining in areas for monitored natural attenuation may still result in uptake in biota, but is not likely to cause an effect to the biota. Continued long-term monitoring activities may disrupt riparian and terrestrial habitats. Re-vegetation in EU will result in additional level 3 resources, and potentially creation of level 4 resources potentially at risk because of disturbance, especially from invasive species.
Social	Cultural Resources*	**Native American:** Direct: Known Indirect: Known **Historic Pre-Hanford:** Direct: Known Indirect: Known **Manhattan/Cold War**: Direct: Unknown Indirect: Unknown	Permanent direct and indirect effects are possible due to high sensitivity of area.

*For both Ecological and Cultural Resources see Appendices J and K respectively for a complete description of Ecological Field Assessments and literature review for Cultural Resources.

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

The National Contingency Plan (NCP) (40 CFR 300) establishes an expectation to "return useable ground waters to their beneficial uses wherever practicable, within a timeframe that is reasonable given the particular circumstances of the site" ("Remedial Investigation/Feasibility Study and Selection of Remedy" [40 CFR 300.430(a)(1)(iii)(F)]). Washington state regulations contain a similar expectation. Given the nature of the groundwater in 300-FF-5, potential beneficial groundwater uses include drinking water, irrigation, and industrial uses. Drinking water use includes other domestic uses such as bathing and cooking. (EPA et al., 2013)

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

PART VII. SUPPLEMENTAL INFORMATION AND CONSIDERATIONS

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

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APPENDIX D.3

100-N GROUNDWATER
(RC-GW-2, RIVER CORRIDOR)
EVALUATION UNIT SUMMARY TEMPLATE

Table of Contents

List of Tables

List of Figures

PART I. EXECUTIVE SUMMARY

EU LOCATION

100 Industrial Area

RELATED EUS

Other Groundwater Projects

PRIMARY CONTAMINANTS, CONTAMINATED MEDIA AND WASTES

The primary contaminants of the 100-NR OU includes strontium-90 (Sr-90), nitrate (NO3), diesel as total petroleum hydrocarbon (TPH-diesel), hexavalent chromium (Cr-VI), and tritium (H-3). Contaminated media includes a vadose zone comprised of sand and gravel of the Hanford formation portion of the Ringold Formation unit E. An unconfined aquifer also possesses contaminants within the sand and gravel from the Ringold and Hanford formations. This unconfined aquifer is highly transmissive due to the open framework gravelly sediment, resulting in high flow velocities. The Ringold upper mud unit (RUM) forms the base of the unconfined aquifer. (DOE/RL-2014-32, Rev. 0)

BRIEF NARRATIVE DESCRIPTION:

The 100-NR groundwater area is adjacent to the Columbia River and encompasses the 100-N Area. Groundwater contamination in 100-NR is primarily associated with wastes produced by the N reactor (a dual-purpose reactor that produced plutonium for defense and steam for electrical power generation) and associated processes. Strontium-90 and TPH-diesel are being remediated under a Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (CERCLA) interim action (EPA/ROD/R10-99/112 as amended). Under this interim ROD, a permeable reactive barrier is in place along the shoreline to reduce the amount of strontium-90 migrating from groundwater into the Columbia River. A draft Remedial Investigation (RI)/Feasibility Study (FS) report was submitted by U.S. DOE to the lead regulatory agency in 2013 for review. Final cleanup decisions are expected in 2015. (DOE/RL-2014-32, Rev. 0)

SUMMARY TABLES OF RISKS AND POTENTIAL IMPACTS TO RECEPTORS

Table D.3-1 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 100-NR-2 area; a Co-located Person (CP) is an individual located 100 meters from the physical boundaries of the BC Cribs and Trenches 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 Non-Discernable (ND) to Very High. The estimated mitigated exposure that takes engineered and administrative controls and protections into consideration, is shown in parenthesis.

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 Non-Discernable (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: No risk ratings are provided for Cultural Resources. The Table 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.

Table D.3-1 Risk Rating Summary (for Human Health, unmitigated nuclear safety basis indicated, mitigated basis indicated in parenthesis (e.g., "Very High" (Low)).

Population or Resource		Evaluation Time Period — Active Cleanup (to 2064): Current Condition:	Evaluation Time Period — Active Cleanup (to 2064): From Cleanup Actions:
Human Health	Facility Worker	Low (Low)	Low (Low)
	Co-located Person	Low (Low)	Low (Low)
	Public	Not Discernable (Not Discernable)	Not Discernable (Not Discernable)
Environmental	Groundwater (No Vadose Zone)	A&B: Medium (Sr-90) All: Medium (Sr-90, NO3)	A&B: Medium (Sr-90)[b] All: Medium (Sr-90, NO3)[b]
	Columbia River (No Vadose Zone)	A&B: Medium (Sr-90, benthic) All: Medium (Sr-90, benthic)	A&B: Medium (Sr-90, benthic)[b] All: Medium (Sr-90, benthic)[b]
	Ecological Resources[a]	Low to Moderate	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.

b. The final remedy has not been selected and thus the times needed to reach cleanup levels are not known. After cleanup levels are achieved, then these ratings would be *Not Discernible*.

SUPPORT FOR RISK AND IMPACT RATINGS FOR EACH POPULATION OR RESOURCE

Human Health

Current

Human health risk from exposure to groundwater was evaluated through risk calculations and comparison to federal and state drinking water or cleanup standards. The approach assumes that the groundwater is used as a tap water source for a 30 year period. Potential routes of exposure include ingestion, dermal contact, and inhalation of volatiles during household activities. Groundwater concentrations were also compared to existing federal and state drinking water or cleanup standards. Current interim remediation activities for the 100-NR-2 groundwater OU involve (i) Sampling and monitoring for strontium-90, nitrate, total petroleum hydrocarbon-diesel (TPH-D), hexavalent chromium (CR-VI), total chromium (Cr), and tritium; (ii) Pump and treat for removal of strontium-90 contaminated groundwater; (iii) Use of an apatite barrier to retard and/or cease the migration of strontium-90 contaminated groundwater into the Columbia River; (iv) Remove/dispose for radioactive, inorganic, burn pit, and surface solid groups to a depth of 4.6 m; (v) Remove/ex-situ bioremediation/dispose for TPH-D with near-surface contamination to a depth of 4.6 m or the bottom of the engineering structure, whichever is deeper; (vi) In-situ bioremediation for TPH-D with deep contamination below 4.6m; and (vii) Institutional controls (ICs). As such, impacts from potential remediation approaches will vary depending on the activity (U.S. DOE, 2000).

Risks and Potential Impacts from Selected or Potential Cleanup Approaches

The range of cleanup activities for the 100-NR-2 groundwater OU is significant. As such, impacts from potential remediation approaches will vary depending on the activity: RTD, monitoring/sampling, pump and treat, in-situ bioremediation, and IC. The threat to the Facility Worker is thus described as low to medium risk (Low for monitoring, sampling, and IC; Medium for RTD, in-situ bioremediation, and appetite barrier).

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

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

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

Environmental – Groundwater

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

Current

The groundwater plumes (strontium-90, nitrate, TPH-D, CR-VI, total chromium (Cr), and tritium) associated with 100-NR-2 are described in Part V. As shown in Table D.3-3 in Part VI, the saturated zone (SZ) groundwater threat metric (GTM) values for the Group A and B primary contaminants translate to Low to Medium ratings for the RC-GW-2 EU. Thus the overall rating for groundwater impacts from current plumes is Medium.

Risks and Potential Impacts from Selected or Potential Cleanup Approaches

Selected interim remediation activities involve a number of remedial approaches, each with ICs. As such, impacts from the selected remediation approach will vary little from the current conditions risk assessment during active remediation until cleanup levels are reduced below WQSs. Once below WQS, the overall rating for groundwater impacts would be assessed *Not Discernable (ND)*.

Environmental – Columbia River

Current

Plumes associated with the RC-GW-2 EU currently intersect the Columbia River, which translate to *Not Discernable* to *Medium* ratings for all evaluation periods.

The rating threat evaluation to the benthic ecology for strontium-90, a Group B PC, is *Medium* due to the high maximum groundwater concentration to BCG ratio (50.2) and relatively moderate length of impacted shoreline (600 m). Benthic threat ratings for Cr-VI, a Group B PC, is *Low* due to the moderate maximum groundwater concentration to BCG ratio (15.9) and current lack of impacted shoreline.

The rating threat evaluation to the riparian ecology for strontium-90 is *Low* due to the high Ratio, but relatively low riparian impact area of 0.46 hectares. The rating *Ratio* for Cr-VI is 15.9, and a riparian impact area of 0.02 hectares, garnering a rating of *Low*. The rating *Ratio* for nitrate, a Group C PC, is 0.49, and a riparian impact area of 0.15 hectares, garnering a rating of *Not Discernable*.

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

Risks and Potential Impacts from Selected or Potential Cleanup Approaches

Use of (i) sampling and monitoring; (ii) pump and treat (iii) Use of an apatite barrier for strontium-90; (iv) remove/dispose for radioactive, inorganic, burn pit, and surface solid groups to a depth of 4.6 m; (v) remove/ex-situ bioremediation/dispose for TPH-D; (vi) in-situ bioremediation for TPH-D with deep contamination; and (vii) institutional controls (ICs) suggests that the selected remediation approaches will vary significantly, but that the current conditions risk assessment for groundwater during active remediation is likely to remain unchanged from current conditions until cleanup levels are reduced below WQSs (U.S. DOE, 2000). Once below WQS, the overall rating for groundwater impacts will be assessed *Not Discernable (ND)*. Further, because the selected remediation activities may result in hazardous substances remaining on-site above levels that allow for unlimited use, a review will be conducted to ensure that the remedies continue to provide adequate protection of human health and the environment within five years after the commencement of the interim remedial actions (U.S. DOE 2000).

Ecological Resources

Current

There are areas where groundwater plumes intersect the riparian vegetation. Potential for contaminant uptake by terrestrial vegetation. Sensitive animals and bird species use region and may be at risk.

<u>Risks and Potential Impacts from Selected or Potential Cleanup Approaches</u>
Remediation activities in the shoreline will need to be monitored to evaluate resources and seasonal use of shoreline.

Cultural Resources

<u>Current</u>
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.

<u>Risks and Potential Impacts from Selected or Potential Cleanup Approaches</u>
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

Near-Term, Post-Cleanup Risks and Potential Impacts

Permanent direct and indirect effects are possible due to the high sensitivity of area.

PART II. ADMINISTRATIVE INFORMATION

OU AND/OR TSDF DESIGNATION(S)

100-NR-2

COMMON NAME(S) FOR EU

RC-GW-2 in 100-NR-2

KEY WORDS

100 Area, RC-GW-2, 100-NR-2, Soils, Sediments, River Corridor

REGULATORY STATUS

Regulatory basis

Contaminants strontium-90 and TPH-diesel are being remediated under a CERCLA interim action (EPA/ROD/R10-99/112 as amended). Groundwater is being monitored at four waste sites to meet requirements of RCRA and WAC-173-303.

Applicable regulatory documentation

- Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (CERCLA) interim action (EPA/ROD/R10-99/112 as amended).
- Resource Conservation and Recovery Act of 1976 (RCRA).

- Chapter WAC-173-303 Dangerous Waste Regulations, State of Washington Department of Ecology, 30 June 2009.

Applicable Consent Decree or TPA milestones:

There is one TPA milestone for the 100-NR-2 Groundwater OU: M-016-110-T03. DOE shall take actions necessary to contain the Strontium-90 groundwater plume at the 100-NR-2 Operable Unit such that the default ambient water quality standard (8 pCi/L) for strontium-90 is achieved in the hyporheic zone and river water column. Date: 12/31/2016.

RISK REVIEW EVALUATION INFORMATION

Completed: Revised 21 August 2015

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

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

PART III. SUMMARY DESCRIPTION

CURRENT LAND USE

DOE Hanford industrial site area.

DESIGNATED FUTURE LAND USE

The Record of Decision: Hanford Comprehensive Land-Use Plan Environmental Impact Statement (HCP EIS) (CLUP ROD) identifies the 100-NR-2 OU within the geographic area of the Columbia River Corridor. The remediation and restoration efforts in the Columbia River Corridor are expected to return the lands to undeveloped, natural conditions over the next 75 years, although restrictions on certain activities may continue to be required to prevent the mobilization of contaminants, the most likely example of which is the restriction of activities that discharge water to the soil or involve excavating below 4.6 m. (U.S. DOE 2003)

PRIMARY EU SOURCE COMPONENTS

Legacy Source Sites

Not Applicable.

High-Level Waste Tanks and Ancillary Equipment

Not Applicable.

Groundwater Plumes

The 100-N Area is located adjacent to the Columbia River. The contaminants of concern include strontium-90, nitrate, TPH-D, Cr-VI, chromium (total), and tritium. Specific groundwater plume details are extracted from the Hanford Site Groundwater Monitoring Report for 2013 (DOE/RL-2014-32, Rev. 0).

- The primary source of the strontium-90 contamination in 100-NR was liquid waste disposal to the 116-N-1 and 116-N-3 waste sites. The size and shape of the strontium-90 plume changes very little from year to year, except near the apatite permeable reactive barrier. The plume extends from beneath the 116-N-1 and 116-N-3 waste sites to the Columbia River at concentrations exceeding the drinking water standard (DWS) (8 pCi/L). The highest concentration portion of the strontium-90 groundwater plume (i.e., the area with concentrations exceeding 800 pCi/L) primarily underlies the 116- N-1 Trench and the 116-N-3 Crib. The highest concentration is found beneath, and inferred downgradient of, 116-N-1. The lateral distribution of the groundwater plume with concentrations between 8 and 800 pCi/L is found peripheral to the highest concentration in a distribution consistent with historical radial flow away from the two trenches and elongated toward the river.
  - Maximum concentrations: 14,000 pCi/L versus a Cleanup Level of 8 pCi/L.
  - Areal extent of the plume: 0.61 km^2.
  - Shoreline impact: 600 m.
  - Riparian area: 0.46 hectares.
- Tritium concentrations were elevated in 2013 at an aquifer tube cluster; likely due to existing soil contamination that was mobilized by the application of water for dust suppression during nearby field remedial activities in 2012 and 2013. These aquifer tubes are located close to the engineered fill in vicinity of an outfall, which suggests that outfall construction created a preferential pathway in the fill for migration of contaminated groundwater to the river. Tritium

concentrations exceeded the DWS (20,000 pCi/L) in well 199-N-186 in 2013 (the maximum value was 41,000 pCi/L) and have been detected above the DWS since the well was installed in 2011. The 116-N-1 Crib was a source of tritium contamination in 100-NR groundwater. With the exception of this localized tritium hotspot beneath the 116-N-1 Crib, tritium results for 100-NR wells were all below the DWS in 2013.

  - Maximum concentrations: 120,000 pCi/L versus a Cleanup Level of 20,000 pCi/L.
  - Areal extent of the plume: 0.003 km^2.
  - Shoreline impact: undefined.
  - Riparian area: 0.04 hectares.

- Nitrate exceeds 45 mg/L in groundwater beneath the 116-N-1 and 116-N-3 waste sites and the 100-N Reactor area to the southwest. The highest concentration detected in 2013 was 168 mg/L in well 199-N-186 in the 116-N-1 crib. The 116-N-1 and 116-N-3 waste sites are implicated as the primary source of nitrate based on the persistent groundwater plume beneath them. Nitrate concentrations were relatively low during disposal operations at the 116-N-1 and 116-N-3 sites. The highest nitrate concentrations were detected following remediation activities at these two sites from 2000 to 2006, which included excavation, application of dust suppression water and soil fixatives, and backfill. Increases in nitrate concentrations in 2013 may be due to delayed drainage from the deep vadose zone caused by additional surface water applied during waste site remediation several years ago.
  - Maximum concentrations: 168 mg/L versus a Cleanup Level of 45 mg/L.
  - Areal extent of the plume: 0.49 km^2.
  - Shoreline impact: 180 m.
  - Riparian area: 0.15 hectares.
- The primary source of the TPH-diesel groundwater contamination is a 1966 diesel fuel spill. A small, relatively narrow groundwater plume extends downgradient from the spill location to the river. The highest groundwater concentration in 2013 was 9,450 µg/L, which is a substantial decrease from the 2011 and 2010 maximum concentrations of 48,000 and 420,000 µg/L, respectively, but an increase from the 2012 maximum concentration of 4,620 µg/L. The overall plume reduction in concentration in 2012 and 2013 is attributed primarily to the bioventing pilot test conducted by Washington Closure Hanford in 2010 and 2011 for remediation of diesel in the deep vadose zone at UPR-100-N-17. Some natural biodegradation of diesel occurs in groundwater, as shown by the anomalously low nitrate groundwater concentrations in this area. In 2013, the two aquifer tubes near the intersection of the groundwater plume and the Columbia River showed detections of TPH-diesel.
  - Maximum concentrations: 9.45 mg/L versus a Cleanup Level of 0.5 mg/L.
  - Areal extent of the plume: 0.02 km^2.
  - Shoreline impact: 55 m.
  - Riparian area: 0.04 hectares.
- Sodium dichromate was used in N Reactor operations only from 1964 to 1972, and in lesser amounts than in the other 100 Area reactors because of the design of the N Reactor cooling system and the use of corrosion-resistant metals in the fuel and facility. Although chromium was present in the effluent discharged to the 116-N-1 waste site, it was never detected in samples of the effluent. Given the mobility and nonsorbing nature of chromium in solution, the high continuous discharge rates and high temperatures while chromium was being delivered to the 116-N-1 waste site, and the fact that liquid discharges to 116-N-1 continued for another 10 years after use of sodium dichromate had ceased, the mobile portion of chromium was

thoroughly flushed from the subsurface and into the Columbia River by the end of the N Reactor's operational period.

- Maximum concentrations:
  - Cr-VI: 159 µg/L versus a Cleanup Level of 10 µg/L.
  - Chromium (total): 177 µg/L versus a Cleanup Level of 100 µg/L.
- Areal extent of the plume:
  - Cr-VI: 0.73 km^2.
  - Chromium (total): unknown.
- Shoreline impact:
  - Cr-VI: none.
  - Chromium (total): none.
- Riparian area:
  - Cr-VI: 0.02 hectares.
  - Chromium (total): unknown.

Operating Facilities

Not Applicable

LOCATION AND LAYOUT MAPS

A series of maps are used to illustrate the location of the components within the RC-GW-2 EU relative to the Hanford Site. Figure D.3-1 shows the relationship among the various Evaluation Units studied in the Interim Report and the Hanford Site. Figure D.3-2 illustrates the extent of groundwater contamination in the River Corridor. Figure D.3-3 shows a detailed view of the groundwater plumes in and near the 100-NR-2 Operable Unit (OU) and RC-GW-1 EU.

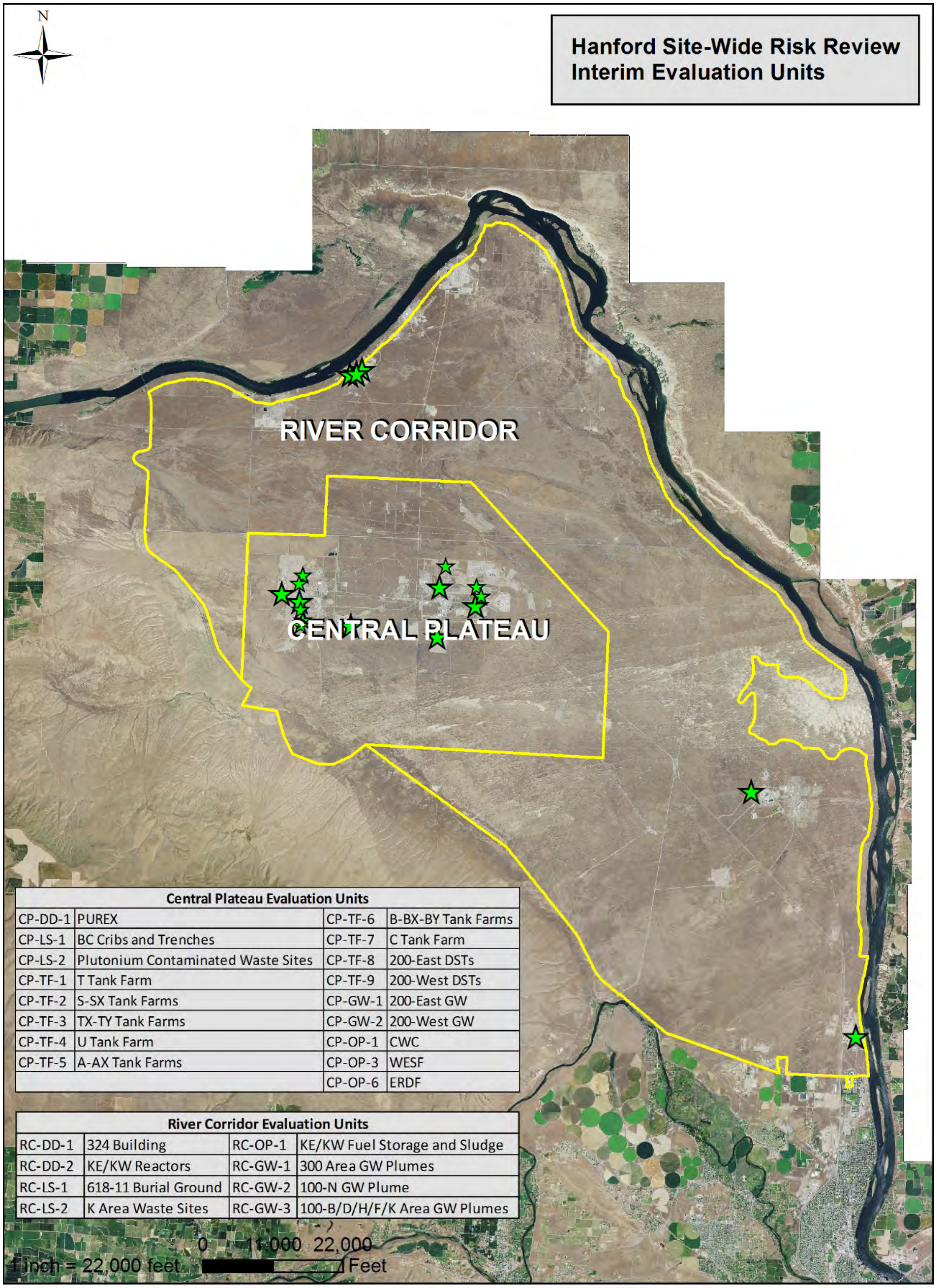

Figure D.3-1. Location of the Evaluation Units in Relation to the Hanford Site.

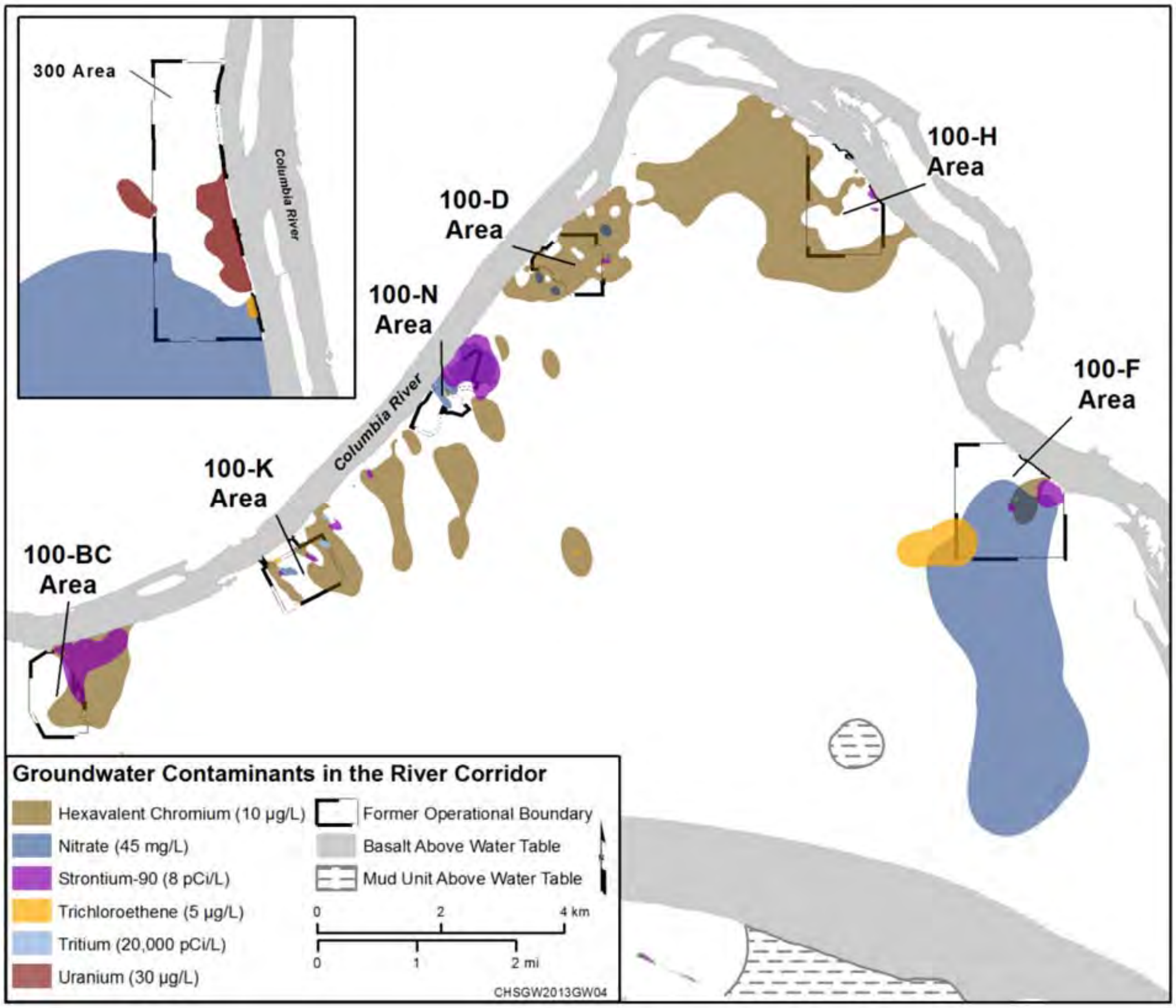

Figure D.3-2. Groundwater Contamination in the River Corridor in 2013 (DOE/RL-2014-32, Rev. 0)

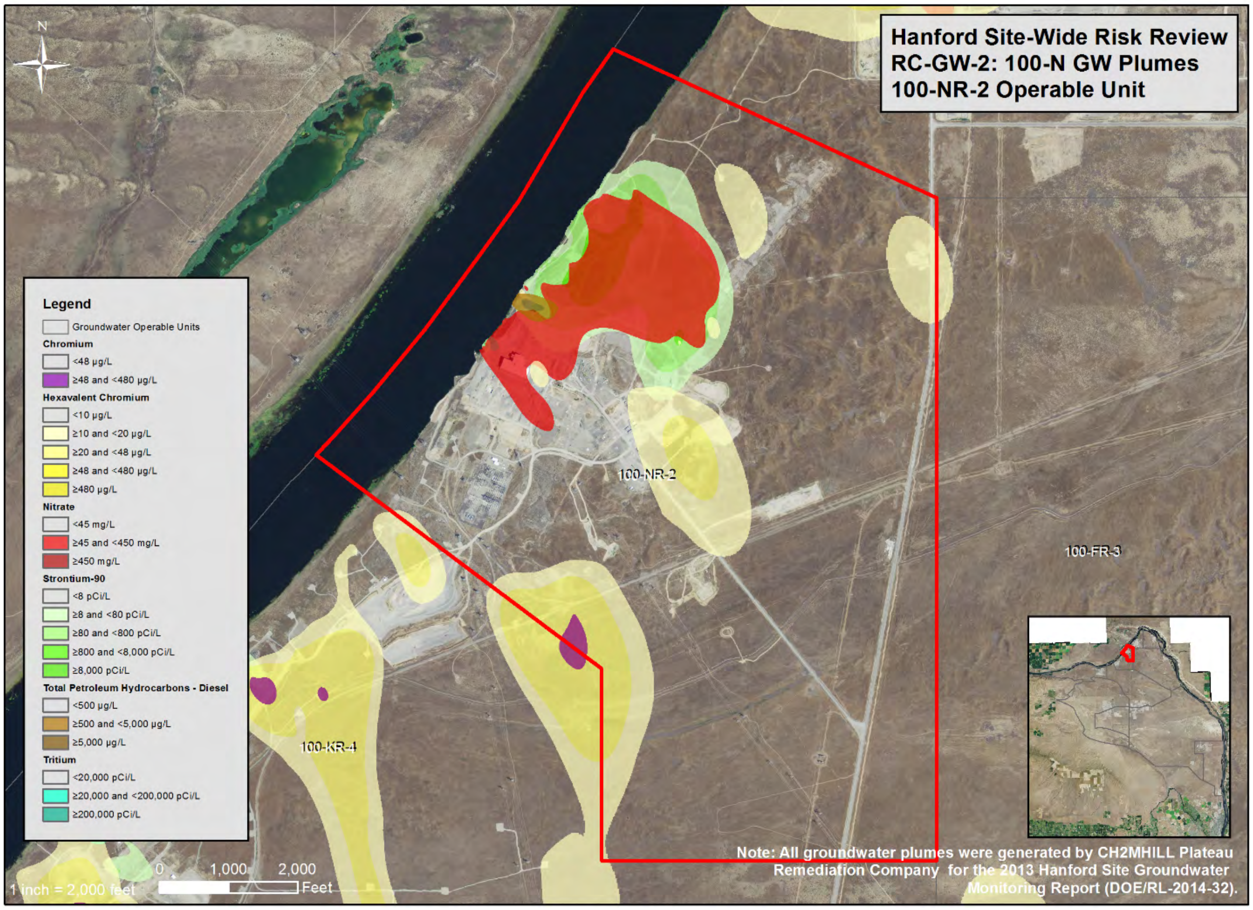

Figure D.3-3. Groundwater Plumes near the 100-NR-2 Operable Unit in 2013

PART IV. UNIT DESCRIPTION AND HISTORY

EU Former/Current Use(s)

The 100-N Area includes two Operable Units (OUs). The 100-NR-1 OU encompasses approximately 405 hectares (1,000 acres), while the 100-NR-2 OU includes contaminated groundwater beneath and in proximity to the 100-NR-1 OU. A separate interim action ROD, *Interim Remedial Action Record of Decision for the 100- NR-1 Operable Unit of the Hanford 100-N Area, Hanford Site*, addresses all contaminated soil, structures, and pipelines associated with the 116-N-1 and 116-N-3 liquid waste disposal facilities (LWDFs). Cooling water from 100-N Area reactor operations was initially discharged to two LWDFs. When Strontium-90 was detected at the shoreline in 1985, the cooling water was diverted to the a third LWDF, which was located farther inland (DOE/RL-95-111, *Corrective Measures Study for the 100-NR-1 and 100-NR-2 Operable Units*). The discharges to the LWDFs contained radioactive waste products, as well as corrosive liquids, metals-laden wastes, and other laboratory chemicals as identified in the RCRA Part A permit (DOE/RL-88-21, 2004, *Hanford Facility Dangerous Waste Part A Permit Application*, Rev. 37). While the reactor was in operation, large volumes (3,785 L [1,000 gal.] per minute) of cooling water were discharged (DOE/RL-95-111) to the soil through the 116-N-1 LWDF (between 1963 and 1983) and the 116 N-3 LWDF (between 1983 and 1991). The liquids percolated through the soil column where they were subsequently transported by groundwater toward the

Columbia River. The LWDFs are known to be the primary source of Strontium-90 contamination present in the 100-NR-2 OU. (U.S. EPA SEP 2010). Current use of the site is as an active remediation site.

Legacy Source Sites

Not Applicable

High-Level Waste Tanks

Not Applicable

Groundwater Plumes

Please See Above

D&D of Inactive Facilities

Not Applicable

Operating Facilities

Not Applicable

Ecological Resources Setting

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

For purposes of this assessment, areas were delineated where the mapped riparian zone along the river shoreline intersects the estimated contours for the groundwater plumes. Riparian areas along the river shoreline are considered priority habitats that are classified as level 4 biological resources. The delineated area and acreage for the intersection of the riparian zone for separate contaminant plumes within each groundwater evaluation unit are provided in Table D.3-2 and indicate the extent of biological resources that could potentially be affected by the groundwater plumes. For the groundwater evaluation units, there are approximately 109.5 acres of riparian habitat along the river shoreline that where contaminated groundwater could affect the ecological resources.

Table D.3-2. Areal Extent (Acres) of Riparian Zone Intersected by 2013 Groundwater Plumes Within Each Groundwater Operable Unit.

Evaluation Unit		*RC-GW-3*	*RC-GW-3*	*RC-GW-2*	*RC-GW-3*	*CP-GW-1*	*RC-GW-1*	
Groundwater Operable Unit / **COPC**	**Reference Value**	*100-BC-5*	*100-KR-4*	*100-NR-2*	*100-HR-3*	*200-PO-1*	*300-FF-5*	**Total Area**
Carbon-14	2,000 pCi/L[a]	-	-	-	-	-	-	-
Cyanide	200 µg/L[a]	-	-	-	-	-	-	-
Chromium	10 µg/L[b]	7.61	2.78	0.04	29.9	-	-	40.32
Carbon Tetrachloride	5 µg/L[a]	-	-	-	-	-	-	-
Iodine-129	1 pCi/L[a]	-	-	-	-	-	-	-
Nitrate	45 mg/L[a]	-	-	0.38	-	-	0.61	0.99
Strontium-90	8 pCi/L[a]	2	-	1.14	0.14	-	-	3.28
Technetium-99	900 pCi/L[a]	-	-	-	-	-	-	-
Trichloroethylene	5 µg/L[a]	-	0.73	-	-	-	0.66	1.39
TPH-D	200 µg/L[c]	-	-	0.1	-	-	-	0.1
Tritium	20,000 pCi/L[a]	-	-	0.11	-	52.84	-	52.94
Uranium	30 µg/L[a]	-	-	-	-	-	3.21	3.21
Total Extent of Plumes[d]	-	7.61	3.55	1.54	30.51	52.84	4.2	100.25
Total Riparian Area[e]	-	491.52	78.04	11.38	792.84	357.37	208.42	2660.78

a. EPA and/or DOH Drinking Water Standard

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

c. EPA and/or DOH Secondary Drinking Water Standard for Total Dissolved Solids. Secondary drinking water standards are not associated with health effects, but associated with taste, odor, staining, or other aesthetic qualities.

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

e. The Total Riparian Area is the based on the areal extent of mapped riparian vegetation along the Benton County shoreline of the Hanford Site. The total riparian area listed (2660.78 ac) includes riparian area within 100-FR-3 (721.2 ac), which is part of the Hanford Reach but is not listed in other parts of the table because there is no plume intersection with the riparian zone.

CULTURAL RESOURCES SETTING

The potential for cultural resources in the area of the groundwater plumes is high and likely to affect the Native American, Historic Pre-Hanford, and Manhattan Project/Cold War landscapes. As discussed in RC-LS-2, K Area Waste Sites EU, there are documented cultural resources along the shoreline for all the landscapes. A literature review of the setting for the groundwater EUs has not been completed. Current remedial actions for groundwater plumes have included evaluation of Section 106 of the National Historic Preservation Act. Future activities will also include Section 106 evaluations.

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

PART V. WASTE AND CONTAMINATION INVENTORY

The method described in Chapter 6 of the Methodology Report (CRESP 2015) was used to approximate saturated zone inventories for the 100-NR-2 primary contaminants.

CONTAMINATION WITHIN PRIMARY EU SOURCE COMPONENTS

Legacy Source Sites

Not Applicable.

High Level Waste Tanks and Ancillary Equipment

Not Applicable.

Vadose Zone Contamination

Please see related EUs for specific details on the vadose zone contamination and potential impacts.

Groundwater Plumes

The estimated inventory for the saturated zone contamination is provided in Table D.3-3 where the process is outlined in Chapter 6 of the Methodology Report (CRESP 2015). For the groundwater plumes described in the 100-NR-2 groundwater OU (DOE/RL-2014-32, Rev. 0), inventories are estimated as follows: [1]

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[1] As indicated in Table D.3-3, plume depths are not known for the 100-NR-2 OU primary contaminants. As indicated in the Methodology Report (CRESP 2015), in this case, the minimum of the value from the Hanford 200-UP-1 OU Interim ROD (EPA 2012) or the unconfined aquifer thickness is used. The unconfined aquifer thickness used (~10 m) is Ringold Unit E (DOE/RL-2014-32, Rev. 0; Last 2006, pp. 4.5-4.6). Furthermore, use of the unconfined aquifer thickness likely results in very large uncertainties in the pore volume and related estimates.

- Strontium-90 – The maximum measured concentration in 2013 was 14,000 pCi/L, the 95% upper confidence limit (UCL) for the 2013 aquifer tube (AT) data from PHOENIX (http://phoenix.pnnl.gov/) was 377 pCi/L. The areal extent of the plume is 0.61 km^2. The plume pore volume is estimated to be 1.10×10^6 m^3, the plume inventory (pore water) is estimated to be 0.414 kg.
- TPH-Diesel – The maximum measured concentration in 2013 was 9.45 mg/L, the 95% UCL on the log-transformed groundwater and AT data from PHOENIX was not available. The plume pore volume is estimated to be 2.88×10^4 m^3, and the plume inventory (pore water) was also not available.
- Nitrate – The maximum measured concentration in 2013 was 168 mg/L, the 95% UCL on the log-transformed groundwater and aquifer tube (AT) data from PHOENIX (http://phoenix.pnnl.gov/) was 81.9 mg/L. The plume pore volume is estimated to be 0.82×10^6 m^3, and the plume inventory (pore water) is estimated to be 7.22×10^4 kg.
- Cr-VI – The maximum measured concentration in 2013 was 159 µg/L, the 95% UCL on the log-transformed groundwater and AT data from PHOENIX was 29.1 µg/L. The plume pore volume is estimated to be 1.32×10^6 m^3, and the plume inventory (pore water) is estimated to be 38.4 kg.
- Tritium – The maximum measured concentration in 2013 was 1.20×10^5 pCi/L, the 95% UCL on the log-transformed groundwater and AT data from PHOENIX was 6.34×10^4 pCi/L. The plume inventory (pore water) is estimated to be 0.34 kg.

As illustrated in Table D.3-3, the saturated zone (SZ) GTM values for the Group A and B primary contaminants are 3.84 for Mm^3 and 51.7 Mm^3 for Cr-VI (*Low* rating) and strontium-90 (*Medium* rating), respectively. The plume areas for the Group C contaminants (TPH-diesel, tritium, and nitrate) translate to *Low*, *Medium*, and *Low* ratings, respectively.

It is unlikely that additional PCs might contaminant the groundwater in the 100-NR-2 OU in the future. Remediation activities should not increase contaminant migration into groundwater. Scenarios where this is possible, albeit unlikely, include increased infiltration of water into the subsurface due to a broken water pipe or other significant water addition event such as could occur for dust suppression. Neither of which is associated with any planned remediation activities or ICs.

Columbia River

Contaminant plumes of strontium-90, TPH-diesel, nitrate, chromium (total and CR-VI), and tritium all are in contact or close proximity of the Columbia River, and thus have already or are expected to migrate to the Columbia River within 10 years or less. As such, the evaluation in Chapter 6 of the Methodology Report (CRESP 2015) based on *current impacts* to benthic and riparian ecology will be used as a function of the ratio (*Ratio*) of the maximum groundwater concentration to the biota concentration guide (BCG) or ambient water quality criterion (AWQC). For radionuclides, the BCG consistent with DOE Technical Standard DOE-STD-1153-2002[2] is used. For chemical PCs, the AWQC from the Columbia River Component Risk Assessment (CRCRA) (DOE/RL-2010-117, Rev. 0) Volume I: Screening Level Ecological Risk Assessment are used (where the Tier II Screening Risk Values are used when the AWQC is unavailable, which is also consistent with the CRCRA).

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

As illustrated in Table D.3-4, the overall evaluation of groundwater as a pathway to the Columbia River is assessed as *Medium* for strontium-90 (Group B), *Low* for Cr-VI (Group A), and *Not Discernable* for nitrate and tritium (Group C).

Results of the Threat Evaluation to the Benthic Ecology

The rating threat evaluation to the benthic ecology (Table D.3-4) for Cr-VI, (Group A) is *Low* due to the moderate maximum groundwater concentration to BCG ratio (15.9) and current lack of impacted shoreline. Benthic threat ratings for strontium-90 (Group B) is *Medium* due to the high maximum groundwater concentration to BCG ratio (50.2) and relatively moderate length of impacted shoreline (600 m).

Results of the Threat Evaluation to the Riparian Zone Ecology

The rating threat evaluation to the riparian ecology (Table D.3-4) for strontium-90 (Group B) is *Low* due to the high Ratio, but relatively low riparian impact area of 0.46 hectares. The rating *Ratio* for Cr-VI is 15.9, and a riparian impact area of 0.02 hectares, garnering a rating of *Low*. The rating *Ratio* for nitrate (Group C) is 0.49, and a riparian impact area of 0.15 hectares, garnering a rating of *Not Discernable*.

Threats to the Columbia River Free-flowing Ecology

The threat determination process for the free-flowing River ecology was evaluated in a manner similar to that described above for benthic receptors (Chapter 6, Methodology Report). However, because of the large dilution effect of the Columbia River on the contamination from the seeps and groundwater upwellings[3], the differences from EU to EU were not found distinguishing and the potential for groundwater contaminant discharges from Hanford to achieve concentrations above relevant thresholds is very remote.

Facilities for D&D

Not Applicable.

Operating Facilities

Not Applicable.

[3] "Groundwater is a potential pathway for contaminants to enter the Columbia River. Groundwater flows into the river from springs located above the water line and through areas of upwelling in the river bed. Hydrologists estimate that groundwater currently flows from the Hanford unconfined aquifer to the Columbia River at a rate of ~ 0.000012 cubic meters per second (Section 4.1 of PNNL-13674). For comparison, the average flow of the Columbia River is ~3,400 cubic meters per second (DOE/RL-2014-32, Rev. 0)." This represents a dilution effect of more than eight orders of magnitude (a dilution factor of greater than 100 million).

Table D.3-3. Summary of the Evaluation of Threats to Groundwater as a Protected Resource from Saturated Zone (SZ) Contamination associated with RC-GW-2 (100-NR-2).

OU	PC	Grp	WQS[a]	Area (km^2)[b]	Thick-ness (m)[c]	Pore Vol. (Mm^3)	Max GW Conc	95th % GW UCL	Porosity[d]	K_d (mL/g)[d]	ρ (kg/L)[d]	R	SZ Total M^{SZ} (kg or Ci)	SZ GTM (Mm^3)	SZ Rating[e]
100-NR-2	Sr-90	B	8 pCi/L	0.61	10	1.10E+00	14000 pCi/L	377 pCi/L	0.18	22	1.84	2.26E+02	4.14E-01	5.17E+01	Medium*
	TPH-D	C	0.5 mg/L	0.016	10	2.88E-02	9.45 mg/L	---	0.18	0	1.84	1.00E+00	---	---	Low*
	NO3	C	45 mg/L	0.49	10	8.82E-01	168 mg/L	81.9 mg/L	0.18	0	1.84	1.00E+00	7.22E+04	---	Medium
	Cr	B	100 µg/L	---	10	---	177 µg/L	133 µg/L	0.18	0	1.84	1.00E+00	---	---	---
	Cr-VI	A	10 µg/L	0.73	10	1.32E+00	159 µg/L	29.1µg/L	0.18	0	1.84	1.00E+00	3.84E+01	3.84E+00	Low
	H-3	C	20000 pCi/L	0.003	10	5.40E-03	120000 pCi/L	63400 pCi/L	0.18	0	1.84	1.00E+00	3.42E-01	---	Low

a. The Water Quality Standard (WQS) is typically the drinking water standard (DWS). The exceptions are TPH-diesel (TPH-D) where the cleanup value (0.5 mg/L or 500 µg/L from WAC 173-340-720(3)(b) Table 720-1) is used and hexavalent chromium (Cr-VI) where the surface water standard is used.

b. Plume area (DOE/RL-2014-32, 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. The unconfined aquifer thickness used (~10 m) is Ringold Unit E (DOE/RL-2014-32, Rev. 0; Last 2006, pp. 4.5-4.6). Furthermore, use of the unconfined aquifer thickness likely results in very large uncertainties in the pore volume and related estimates.

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

e. Groundwater Threat Metric rating based on Table 6-3, Methodology Report. After pump-and-treat (Interim Action) was found to be insufficient, an apatite permeable reactive barrier was installed (2006-2011) to enhance attenuation of Sr-90 in groundwater moving toward the Columbia River. TPH-diesel free product is being removed from groundwater in one well (199-N-18), and Washington Closure Hanford conducted a bioventing pilot test (2010-2011) for remediation of diesel in the deep vadose zone (DOE/RL-2014-32, Rev. 0).

Table D.3-4. Summary of the Evaluation of Groundwater as Pathway to the Columbia River associated with RC-GW-2 (100-NR-2)

OU	PC	Grp	WQS[a]	BCG or AWQC[b]	Max GW Conc	95th % GW UCL	Max GW Conc / BCG or WQS	95th % GW UCL / BCG or WQS	Shoreline Impact (m)[c]	Riparian Area (ha)[d]	Benthic rating[e]	Riparian rating[e]	Overall rating[e]
100-NR-2	Sr-90	B	8 pCi/L	279 pCi/L	14000 pCi/L	377 pCi/L	5.02E+01	1.35E+00	6.00E+02	4.61E-01	Medium	Low	Medium
	TPH-D	C	0.5 mg/L	Undefined	9.45 mg/L	---	---	---	5.50E+01	4.05E-02	---	---	---
	NO3	C	45 mg/L	7100 mg/L	168 mg/L	81.9 mg/L	4.93E-01	2.40E-01	1.80E+02	1.54E-01	---	---	ND
	Cr	B	100 µg/L	55 µg/L	177 µg/L	133 µg/L	3.22E+00	2.42E+00	0.00E+00	---	---	---	---
	Cr-VI	A	10 µg/L	10 µg/L	159 µg/L	29.1µg/L	1.59E+01	2.92E+00	0.00E+00	1.62E-02	Low	Low	Low
	H-3	C	20000 pCi/L	2.65E+08 pCi/L	120000 pCi/L	63400 pCi/L	4.53E-04	2.39E-04	N/C	4.45E-02	---	---	ND

a. The Water Quality Standard (WQS) is typically the drinking water standard (DWS). The exceptions are TPH-diesel (TPH-D) where the cleanup value (0.5 mg/L or 500 µg/L from WAC 173-340-720(3)(b) Table 720-1) is used and hexavalent chromium (Cr-VI) where the surface water standard is used.

b. Biota Concentration Guide (BCG) from RESRAD-BIOTA v1.5 (consistent with DOE Technical Standard DOE-STD-1153-2002) for radionuclides. For chemicals, either the Ambient Water Quality Criterion (AWQC) (Table 6-1 in DOE/RL-2010-117, Rev. 0) or Tier II Screening Concentration Value (SVC) (http://rais.ornl.gov/documents/tm96r2.pdf) is used when AQWC not available. No threshold is available for TPH-diesel, which constitutes a gap in the analysis of potential threats to the Columbia River.

c. Shoreline impact from 2013 Hanford Site Groundwater Monitoring Report (DOE/RL-2014-32, Rev. 0). Excludes tritium and nitrate in plumes associated with the 200-PO groundwater interest area (Appendix G.1).

d. The intersection area between the groundwater plume and the riparian zone was provided by PNNL based on the 2013 Hanford Site Groundwater Monitoring Report (DOE/RL-2014-32, Rev. 0).

e. Benthic and riparian zone ratings based on Figure 6-11 in the Methodology Report (CRESP 2015). The Group C ratings (for nitrate and tritium) are ND because R1 ≤ 1. The free-flowing ratings are all ND. The overall rating is the maximum rating.

PART VI. POTENTIAL RISK/IMPACT PATHWAYS AND EVENTS

CURRENT CONCEPTUAL MODEL

The vadose zone in 100-NR is 0 to 23 meters thick and is composed of gravels and sands of the Hanford formation and upper Ringold Formation unit E (Table D.3-4). The unconfined aquifer is approximately 6.5 to 14 meters thick. When the Columbia River stage is high, the water table can rise into the Hanford formation in wells near the shoreline. The Ringold upper mud unit (RUM) forms the base of the unconfined aquifer. Groundwater in 100-NR generally flows northwest toward the Columbia River. The magnitude of the change in groundwater hydraulic head across 100-NR in March 2013 was about 2 meters. Groundwater flow was influenced in 2013 by groundwater extraction and injection for the KX Pump and Treat (P&T) remediation system located in the southwest portion of 100-NR. A small groundwater mound approximately 1 meter high surrounding KX injection wells 199-K-159, 199-K-160, and 199-K-164 creates local radial flow. In 2013, the high river stage lasted from late March through late August. Water levels in well 199-N-146 near the river rose approximately 2.5 meters between mid-March and mid-April. Water levels in well 199-N-2, 170 meters inland from the river, rose approximately 1.5 meters with a lag time of a few days. Changing river stage influences groundwater elevations over 1 kilometer inland from the river. (DOE/RL-2014-32, Rev. 0)

Fluctuations in river stage, caused by dam operations, and seasonal variations have the same general impact on flow direction, hydraulic gradients, and groundwater levels throughout the 100-N Area. Contamination associated with 100·NR-I waste sites ranges from surface contamination, such as at the 128·N-I Burn Pit or the 100-N-47 Military Site, to very deep contamination, probably reaching groundwater (18 to 23 m) for most of the 100-N Area). Approximate depth to groundwater near the 116-N-1 Crib is 19 m and near the 116-N-3 Crib it is 22 m. (U.S. DOE 2000)

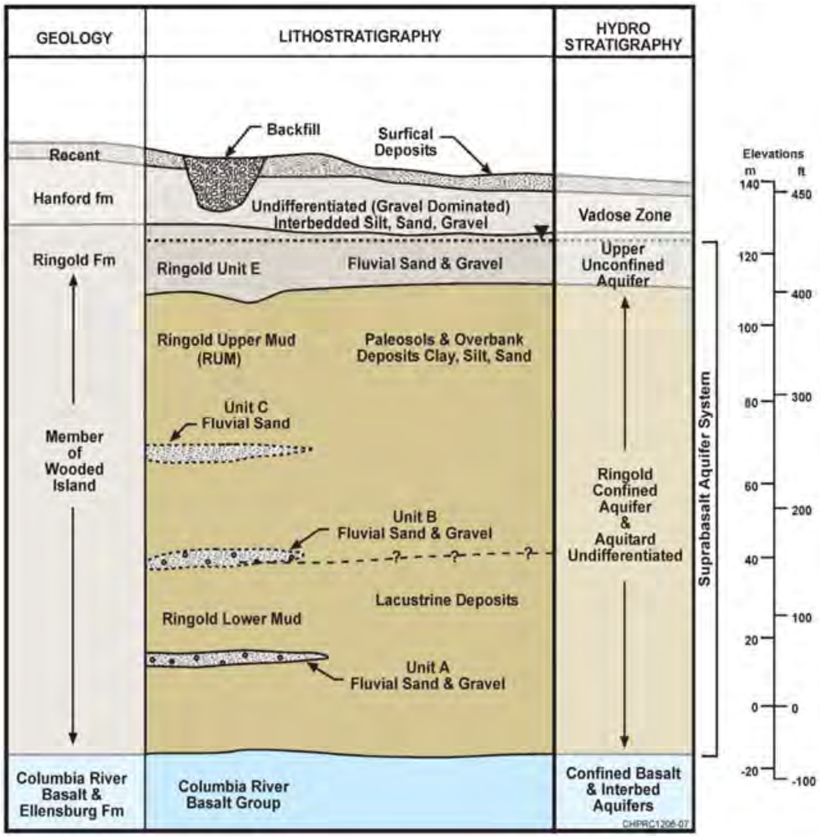

Figure D.3-4. 100-NR Area Geology Profile (after EPA et al., 2013).

POPULATIONS AND RESOURCES CURRENTLY AT RISK OR POTENTIALLY IMPACTED

Facility Worker

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

Co-Located Person (CP)

Workers typically are not directly exposed to the contaminated groundwaters because they are located below grade beneath soil covers.

Public

The contamination remains underground, except where there is active RTD remediation activities and where the contaminated groundwater intersects the Columbia River.

Groundwater

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

<u>**Current**</u>
For strontium-90, TPH-diesel, nitrate, Cr-VI, chromium (total), and tritium, the measured maximum groundwater concentrations currently exceed the water quality standard (WQS) in each instance. Further, contaminants are grouped based on their relative mobility and persistence, with Group A possessing both high mobility and high persistence (e.g., Cr-VI), followed by Group B (e.g., Chromium

(total), Strontium-90), Group C (e.g., tritium, nitrate, TPH-diesel), and Group D (e.g., Cs-137). From Table D.3-3, Cr-VI is categorized as a Group A primary contaminant (PC); strontium-90 and chromium (total) are categorized as Group B PCs; while tritium and nitrate are categorized as Group C PCs. For Group A and Group B PCs, the groundwater threat metric (GTM) is used to evaluate the groundwater threat and represents the maximum volume of water that could be contaminated by the inventory of a primary contaminant from a source if it was found in the saturated zone at the WQS and in equilibrium with the soil/sediment. Note that the GTM accounts only for (i) source inventory; (ii) partitioning with the surrounding subsurface; and (iii) the WQS. The GTM reflects a snapshot in time (assuming no loss by decay/degradation or dispersion, etc.) and does not account for differences in contaminant mobility or bulk groundwater flow. For Group C PCs, the threat is evaluated in terms of contaminant plume area.

Based on a GTM (units of 1E6 m^3 or Mm^3) of 51.7 Mm^3 for strontium-90, the threat rating was evaluated as *Medium*. For Cr-VI, the threat rating was evaluated as *Low* due to the low GTM of 3.84 Mm^3 and plume area of 0.73 km^2. For tritium, TPH-diesel, and nitrate, the contaminant plume areas were 0.003 km^2, 0.016 km^2, and 0.49 km^2, respectively, reflecting *Low*, *Low*, and *Medium* groundwater ratings, respectively.

<u>Risks and Potential Impacts from Selected or Potential Cleanup Approaches</u>
Interim actions are being conducted for strontium-90 and TPH-diesel contamination in 100-NR-2, including constructing a permeable reactive barrier to sequester strontium-90 and removal of petroleum hydrocarbons (free product) if observed in a monitoring well (DOE/RL-2014-32, Rev. 0). The final Record of Decision is anticipated in 2015. Thus the time required to reach selected cleanup levels will be dependent upon the final remedy selection (and is thus unknown)[4]. As such, impacts from the selected remediation approach are assumed to vary little from the current conditions during active remediation until cleanup levels are reduced below cleanup levels. Once below WQS, the overall rating for groundwater impacts would be assessed *Not Discernable (ND)*.

Columbia River

As described in Part V (Table D.3-4), plumes associated with the RC-GW-2 EU currently intersect the Columbia River, which translate to *Not Discernable* to *Medium* ratings.

The rating threat evaluation to the benthic ecology for Cr-VI (Group A) is *Low* due to the moderate maximum groundwater concentration to AWQC ratio (15.9) and current lack of impacted shoreline. Benthic threat ratings for strontium-90 (Group B) is *Medium* due to the high maximum groundwater concentration to BCG ratio (50.2) and relatively moderate length of impacted shoreline (600 m)[5]. No AWQC or SVC exists for TPH-diesel so no threat rating was evaluated (representing an analysis gap); however, if the cleanup level were to be used, then the TPH-diesel (Group C) would have a *Low* rating.

The rating threat evaluation to the riparian ecology for strontium-90 is *Low* due to the high Ratio, but relatively low riparian impact area of 0.46 hectares[6]. The rating *Ratio* for Cr-VI is 15.9, and a riparian

[4] The treatability test using an apatite barrier has been effective in reducing strontium-90 concentrations in performance monitoring wells (DOE/RL-2014-32, Rev. 0).

[5] For reasons given in the previous section, the benthic rating for strontium-90 will be maintained as *Medium* for the Active Cleanup period and modified to *Low* for the Near-term, Post-Cleanup period.

[6] Because the riparian rating for strontium-90 is already *Low*, it will not be modified for the Active or Near-term, Post-Cleanup periods.

impact area of 0.02 hectares, garnering a rating of *Low*. The rating *Ratio* for nitrate, a Group C PC, is 0.49, and a riparian impact area of 0.15 hectares, garnering a rating of *Not Discernable*.

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

Ecological Resources

For the four groundwater evaluation units with plumes that are estimated to intersect the Columbia River, there are approximately 100.25 acres of riparian habitat and resources along the river shoreline that could potentially be affected.

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

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

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

Cultural Resources

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

Cleanup Approaches and End-State Conceptual Model

The Interim Record of Decision (ROD) (U.S. DOE, 2000) for the 100-NR-2 OU was signed on 29 September 1999. The Selected interim remedial actions are intended to ensure that contaminants present at these waste sites will not adversely impact existing groundwater quality beneath the sites or beneficial uses of the Columbia River. The future land use for the 100-NR Area has not been determined; however, the selected remedial actions are intended to not preclude any future land use (other than for the Columbia River shoreline site): Remedial action objectives and cleanup standards will be re-evaluated if future land use and groundwater use determinations are inconsistent with the selected remedy (U.S. DOE, 2000). Specific ICs and remedial actions follow below as provided by the Interim ROD (U.S. DOE 2000).

Institutional Controls

- U.S. DOE will continue to use a badging program and control access to the sites associated with this ROD for the duration of the interim action. Visitors (i.e., persons not employed on the Hanford Site who are granted access for discussions on project related matters, employment interviews, or tours) entering any of the sites associated with this ROD are required to be escorted at all times.
- DOE will utilize the on-site excavation permit process to control well dril1ing and excavation of soil within the 100 Area OUs to prohibit any drilling or excavation except as approved by Ecology.
- DOE will maintain existing signs prohibiting public access to the shoreline site. .
- DOE will provide notification to Ecology upon discovery of any trespass incidents.
- Trespass incidents will be reported to the County Sheriff's Office for investigation and evaluation for possible prosecution.
- DOE will take the necessary precautions to add access restriction language to any land transfer, sale, or lease of property that the U.S. Government considers appropriate while institutional controls arc compu1sory, and Ecology will have to approve any access restrictions prior to transfer, sale, or lease.
- Until final remedy selection, DOE shall not delete or terminate any institutional control requirement established in this ROD unless Ecology has provided written concurrence on the deletion or termination.
- DOE will evaluate the implementation and effectiveness of ICs on an annual basis. DOE shall submit a report to Ecology by 31 July of each year summarizing the results of the evaluation for the preceding calendar year. At a minimum, the report shall contain an evaluation of whether or not the OU IC requirements continue to be me, a description of any deficiencies discovered, and what measures have been taken to correct problems.

Remove/Dispose for Radioactive, Inorganic, Burn Pit, and Surface Solid Groups

- Remove contaminated soil, structures, debris, and pipelines to a depth of 4.6 m below surrounding grade or to the bottom of the engineering structure, whichever is deeper.
- Treat these wastes as required to meet ERDF compliance criteria.
- Dispose of soil, structures, debris, and pipelines at ERDF.
- Backfill excavated areas with clean material, grade, and re-vegetate the areas.
- Maintain ICs as described above for this group.

Remove/Ex-Situ Bioremediation/Dispose for Petroleum Waste Group with Near-Surface Contamination

- Remove contaminated media (soil debris) down to a depth of 4.6 m below surrounding grade or the bottom of the engineering structure, whichever is deeper. The depth of removal may be adjusted if field conditions warrant and Ecology approves.
- Remove contaminated media (soil/debris) below 4.6 m as necessary if field conditions warrant and Ecology approves.
- Ex-Situ bioremediate contaminated media within the 100-N boundary.
- Dispose of residual contaminated media, if required, to an Ecology approved facility.

- Collect and dispose of leachate to the Effluent Treatment Facility (ETF) or as approved by Ecology.
- Backfill excavated areas with clean material, grade, and re-vegetate the areas.
- Maintain ICs as described above for this group.

In-Situ Bioremediation for Petroleum Waste Group with Deep Contamination

- In-Situ bioremediation of contaminated media below 4.6 m of surrounding grade, bottom of' engineering structure, or at the stopping point of *Ex Situ* bioremediation, whichever is greater.
- Install necessary injection wells and infrastructure.
- Maintain groundwater monitoring wells to monitor bioremediation and impacts to groundwater.
- Grade and re-vegetate the areas.
- Maintain ICs as described above for this group until remediation is complete.

CONTAMINANT INVENTORY REMAINING AT THE CONCLUSION OF PLANNED ACTIVE CLEANUP PERIOD

The Interim Action ROD provides a decision framework to evaluate leaving contamination in place at a limited number of sites, specifically where contamination is located at depths greater than 4.6 m. The decision to leave contamination wastes in place at such sites will be a site-specific determination made during remedial design and remedial action activities that will balance the extent of remediation with protection of human health and the environment, disturbance of ecological and cultural resources, worker health and safety, remediation costs, operation and maintenance costs, and radioactive decay of short-lived radionuclides (half lives less than 30.2 years). The application of the balancing factors criteria and the process for determining the extent of remediation at deep sites will be made by the U.S. EPA and Ecology. Any decision to leave waste in place will occur after the public has been asked to comment on the proposal to leave waste in place. (U.S. DOE, 2000)

Current and anticipated water use in the 100-N Area derives from municipal water from the city of Richland. There are no current plans to start using 100-NR-2 groundwater as drinking water when drinking water standards (DWSs) are met. The expected timeframes to attain the WQSs in 100-NR-2 groundwater are dependent upon final remedial actions (U.S. DOE, 2000).

RISKS AND POTENTIAL IMPACTS ASSOCIATED WITH CLEANUP

Ecological Resources

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

Cultural Resources

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

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

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

Workers (directly involved)

Please see above.

Co-located Person (CP)

Please see above.

Public

Please see above.

Groundwater

Please see above. As described in Part V, the final remedy has not been selected and future conditions are assumed to vary little from current conditions (until cleanup levels are achieved). Ratings for the primary contaminants would be *Not Discernible* when cleanup levels are achieved.

Columbia River

Please see above. As described in Part V, the final remedy has not been selected and future conditions are assumed to vary little from current conditions (until cleanup levels are achieved). Ratings for the primary contaminants would be *Not Discernible* when cleanup levels are achieved.

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.

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Additional Risks and Potential Impacts if Cleanup is Delayed

Please see above.

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

Please see above.

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

Table D.3-5. Populations and Resources at Risk or Potential Impacted After Cleanup Actions.

Population or Resource		Risk/Impact Rating	Comments
Human	Facility Worker	Low	Only workers at risk or impacted would be working on the active remediation activities, to include monitoring and sampling.
	Co-located Person	Not Discernable	Workers are not directly exposed to the contaminated groundwaters because they are located below grade beneath a soil cover. Further, strontium-90 is expected to be below AWQS after cleanup actions.
	Public	Not Discernable	The contamination remains underground, except where the contaminated groundwater intersects the Columbia River.
Environmental	Groundwater	Group A&B: Medium (Sr-90) All: Medium (Sr-90, NO3)	Based on a GTM (units of 1E6 m^3 or Mm^3) of 51.7 Mm^3 for Sr-90, the threat rating was evaluated as *Medium*. For Cr-VI, the threat rating was evaluated as *Low* due to the low GTM of 3.84 Mm^3. For tritium and nitrate, plume areas were 0.003 km^2 and 0.49 km^2, respectively, reflecting *Low* and *Medium* ratings, respectively. Conditions assumed to vary little from current until cleanup levels are achieved.
	Columbia River	A&B: Medium (Sr-90, benthic) All: Medium (Sr-90, benthic)	The rating threat evaluation to the benthic ecology for Cr-VI (Group A) is *Low* due to the moderate maximum groundwater concentration to AWQC ratio (15.9) and current lack of impacted shoreline. Benthic threat ratings for Sr-90 (Group B) is *Medium* due to the high maximum groundwater concentration to BCG ratio (50.2) and relatively moderate length of impacted shoreline (600 m). Conditions assumed to vary little from current until cleanup levels are achieved. The rating threat evaluation to the riparian ecology for strontium-90 is *Low*

			due to the high Ratio, but relatively low riparian impact area of 0.46 hectares. The rating *Ratio* for Cr-VI is 15.9, and a riparian impact area of 0.02 hectares, garnering a rating of *Low*. The ratings for nitrate and TPH-diesel (Group C) are *Not Discernable*. These are not altered. Conditions assumed to vary little from current until cleanup levels are achieved. The large dilution effect of the Columbia River results in a rating of *Not Discernable* for the free-flowing ecology for all evaluation periods.
	Ecological Resources*	Low	Contamination remaining in areas for monitored natural attenuation may still result in uptake in biota, but is not likely to cause an effect to the biota. Continued long-term monitoring activities may disrupt riparian and terrestrial habitats. Re-vegetation in EU will result in additional level 3 resources, and potentially creation of level 4 resources potentially at risk because of disturbance, especially from invasive species.
Social	Cultural Resources*	**Native American:** Direct: Known Indirect: Known **Historic Pre-Hanford:** Direct: Known Indirect: Known **Manhattan/Cold War**: Direct: Unknown Indirect: Unknown	Permanent direct and indirect effects are possible due to high sensitivity of area.

*For both Ecological and Cultural Resources see Appendices J and K respectively for a complete description of Ecological Field Assessments and literature review for Cultural Resources.

Long-Term, Post-Cleanup Status – Inventories and Risks and Potential Impact Pathways

The National Contingency Plan (NCP) (40 CFR 300) establishes an expectation to "return useable ground waters to their beneficial uses wherever practicable, within a timeframe that is reasonable given the particular circumstances of the site" ("Remedial Investigation/Feasibility Study and Selection of Remedy" [40 CFR 300.430(a)(1)(iii)(F)]). Washington state regulations contain a similar expectation. Given the nature of the groundwater in 100-NR-2, potential beneficial groundwater uses include drinking water, irrigation, and industrial uses. Drinking water use includes other domestic uses such as bathing and cooking. (EPA et al., 2013)

PART VII. SUPPLEMENTAL INFORMATION AND CONSIDERATIONS

The 100-NR Area needs to remain under DOE control to maintain institutional control for all remediation activities until all soil and groundwater contaminants reach CULs, to include areas outside 100-NR which have the potential to also contaminant groundwater in this area.

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APPENDIX D.4

100-B/D/H/F/K AREA GROUNDWATER
(RC-GW-3, RIVER CORRIDOR)
EVALUATION UNIT SUMMARY TEMPLATE

Table of Contents

List of Tables

List of Figures

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PART I. EXECUTIVE SUMMARY

EU LOCATION

100 Industrial Area

RELATED EU

Other Groundwater Projects

PRIMARY CONTAMINANTS, CONTAMINATED MEDIA AND WASTES

The RC-GW-3 Evaluation Unit is related to four Hanford groundwater interest areas: 100-BC (including the 100-BC-5 Groundwater Operable Unit (OU)), 100-FR (including the 100-FR-3 OU), 100-HR (including the 100-HR-3 OU), and 100-KR (including the 100-KR-4 OU). In this review, the focus will be on the groundwater operable units because the data tend to be collected based on these areas. The primary contaminants (i.e., those with areas of concentration exceeding drinking water standards) for the 100-BC-5 OU are hexavalent chromium, Sr-90, and tritium (H-3) (DOE/RL-2014-32, Rev. 0, p. BC-2). The 100-BC vadose zone is comprised of Hanford formation sand and gravel where the water table is at a depth of 18-24 meters. The upper portion of the unconfined aquifer beneath most of 100-BC is in the highly permeable sediments of the Hanford formation and lower portion is within the Ringold unit E sands and gravels (DOE/RL-2014-32, Rev. 0, p. BC-1).

The primary contaminants for the 100-FR-3 OU are nitrate, hexavalent chromium, Sr-90, and trichloroethene (TCE) (DOE/RL-2014-32, Rev. 0, p. FR-1). The 100-FR vadose zone and the unconfined aquifer (from 1-8 m thick) are composed of Hanford formation sand and gravel where the bottom of the aquifer is the Ringold upper mud unit (RUM) (DOE/RL-2014-32, Rev. 0, p. FR-4).

The primary contaminants for the 100-HR-3 OU are hexavalent chromium, nitrate, Sr-90, and tritium (H-3) (DOE/RL-2014-32, Rev. 0, p. HR-1). In 100-HR vadose zone thickness (and depth to groundwater) ranges from 0 to 27 meters where the thickness of the unconfined aquifer (present in the Ringold Formation unit E sands and gravels in 100-D and in the Hanford formation gravels in 100-H) mimics the topography of the Ringold Formation upper mud unit (RUM) (DOE/RL-2014-32, Rev. 0, p. HR-3).

The primary contaminants for the 100-KR-4 OU are hexavalent chromium, tritium (H-3), nitrate, Sr-90, C-14, and trichloroethene (TCE) (DOE/RL-2014-32, Rev. 0, p. KR-2). In 100-KR the unconfined aquifer ranges from 5-32 meters and is primarily present in the Ringold Formation unit E sand and gravel and is overlain by the gravels and interbedded sand and silt of the Hanford formation. Contaminant concentrations are highest within the upper part of the aquifer although mobile contaminants (including hexavalent chromium) have been detected over the entire aquifer thickness.

BRIEF NARRATIVE DESCRIPTION:

The CP-GW-1 EU is related to four Hanford interest areas: 100-BC, 100-FR, 100-HR, and 100-KR; however, we will focus on the corresponding CERCLA Groundwater Operable Units (OUs), 100-BC-5, 100-FR-3, 100-HR-3, and 100-KR-4 for this discussion.

The 100-BC interest area includes the 100-BC-5 GW OU and surrounding areas contaminated mainly by wastes from the B and C Reactors and related operations. Nearly all of the waste sites in 100-BC are either classified as not requiring remedial action or have been remediated (DOE/RL-2014-32, Rev. 0, p. BC-1). The last remedial action in the area included a very large soil excavation down to the water table

(~24 m), backfilling with native soil and revegetation. DOE monitors groundwater to meet Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (CERCLA) and Atomic Energy Act of 1954 (AEA) requirements.

The 100-FR interest area includes the 100-FR-3 OU and surrounding areas contaminated mainly by wastes from the F Reactor and related operations and biological experiments. Waste site remediation under an interim Record of Decision (ROD) has been completed. A final ROD was expected in 2014. DOE monitors groundwater to meet Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (CERCLA) and Atomic Energy Act of 1954 (AEA) requirements.

The 100-HR interest area includes the 100-HR-3 OU and surrounding areas contaminated by waste releases from operation of the D, DR, and H Reactors and related support facilities. By the end of 2013, more than 75% of the waste sites had been addressed (closed, interim closed, no action, etc.). DOE monitors groundwater to meet Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (CERCLA) requirements.

The 100-KR groundwater interest area includes the 100-KR-4 operable unit (OU) where groundwater was contaminated by waste releases associated KE and KW Reactor operations and associated support facilities. At the end of 2013, ~60 percent of the waste sites were addressed (closed, interim closed, no action, etc.), with ~37 percent having undergone active remediation to remove secondary sources of contamination that could migrate to groundwater and reduce the risk of direct exposure at the surface. DOE monitors groundwater to meet Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (CERCLA) and Atomic Energy Act of 1954 (AEA) requirements.

Summary Tables of Risks and Potential Impacts to Receptors

Table D.4-1 provides a summary of nuclear and industrial safety related risks to humans and impacts to important physical Hanford site resources.

Human Health: A Facility Worker is deemed to be an individual located anywhere within the physical boundaries of the 300 FF area; a Co-located Person (CP) is an individual located 100 meters from the physical boundaries of the BC Cribs and Trenches 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 Non-Discernable (ND) to Very High. The estimated mitigated exposure that takes engineered and administrative controls and protections into consideration, is shown in parenthesis.

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 Non-Discernable (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: No risk ratings are provided for Cultural Resources. The Table 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.

Table D.4-1. Risk Rating Summary (for Human Health, unmitigated nuclear safety basis indicated, mitigated basis indicated in parenthesis (e.g., "Very High" (Low)).

Population or Resource		Evaluation Time Period Active Cleanup (to 2064) Current Condition:	 From Cleanup Actions:
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)*: *Not Discernible (ND) to Low*** (ND)
Environmental	Groundwater	100-BC-5 OU: Medium (Cr-VI) 100-HR-3 OU: Medium (Cr-VI)[b] 100-FR-3 OU: Medium (NO3) 100-KR-4 OU: Medium (Cr-VI)[b] Overall: Medium (Cr-VI, NO3)	100-BC-5 OU: Medium (Cr-VI) 100-HR-3 OU: Medium (Cr-VI)[b] 100-FR-3 OU: Medium (NO3) 100-KR-4 OU: Medium (Cr-VI)[b] Overall: Medium (Cr-VI, NO3)
	Columbia River	Benthic/Riparian: 100-BC-5: Medium (Cr-VI) 100-HR-3: High (Cr-VI)[b] 100-FR-3: Low (Cr-VI) 100-KR-4: Medium (Cr-VI)[b] Free-flowing: All OUs: Not Discernible **Overall**: High (Cr-VI)[b]	Benthic/Riparian: 100-BC-5: Medium (Cr-VI) 100-HR-3: Medium (Cr-VI)[b] 100-FR-3: Low (Cr-VI, Sr-90) 100-KR-4: Medium (Cr-VI)[b] Free-flowing: All OUs: Not Discernible **Overall**: Medium (Cr-VI)[b]
	Ecological Resources[a]	Low to Very High	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.

b. Groundwater contaminants are being treated (Cr-VI in 100-HR using In Situ Redox Manipulation (ISRM) and P&T and Cr-VI in 100-KR using P&T) although other contaminants are likely being extracted (e.g., Cr-VI in 100-BC).

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 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.

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

Remediation alternatives have been selected for each RC-GW-3 OU as interim actions as part of an integrated strategy to achieve cleanup standards along the river corridor. The range of alternatives 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. Worker risks are thus rated as *Low to Medium*.

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.4-2, the saturated zone (SZ) GTM values translate to:

- 100-BC-5: Group A and B primary contaminants range from *Low* for Sr-90 to *Medium* for hexavalent chromium. There is no calculated tritium (Group C) plume areas and thus no rating.

- 100-HR-3: Group A and B primary contaminants range from *Low* for Sr-90 to *Medium* for hexavalent chromium. The nitrate plume areas (Group C) translates to *Low* based on the current plume area. There is no calculated tritium (Group C) plume areas and thus no rating.
- 100-FR-3: Group A and B primary contaminants are *Low* for hexavalent chromium, Sr-90, and TCE. The nitrate plume areas (Group C) translate to *Medium* ratings.
- 100-KR-4: Group A and B primary contaminants are *Low* for Sr-90, C-14, and TCE to *Medium* for hexavalent chromium. The tritium and nitrate plume areas (Group C) translate to *Low* ratings.

Thus the overall rating for the RC-GW-3 EU threat to groundwater would be *Medium* related to hexavalent chromium (100-BC-5, 100-HR-3, and 100-KR-4) and nitrate (Group C) in the 100-FR-3 OU.

Columbia River: Based on the information in the 2013 Hanford Annual Groundwater Report (DOE/RL-2014-32, Rev. 0) summarized in Table D.4-3, seven plumes from these four OUs are currently intersecting the Columbia River at concentrations exceeding the WQS. The ratings obtained from using the process shown in Chapter 6 (Figure 6-10) range from *Not Discernible* for TCE (100-KR-4) to *Low* for Cr-VI (100-FR-3), Sr-90 (100-KR-4), and C-14 (100-KR-4) to *Medium* for Cr-VI (100-BC-5 and 100-100-KR-4) to *High* for Cr-VI (100-HR-3). The ratings for the other contaminants would be *Not Discernible*. Thus *current* impacts from these OUs to the Columbia River benthic and riparian zone ecology would be rated as *High* related to hexavalent chromium in 100-HR-3, which is currently being treated using P&T and ISRM.

Ecological Resources: There are areas where groundwater plumes intersect the riparian vegetation. Monitoring shows concentrations of chromium 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: As described in Part V, some constituents may be significantly impacted by cleanup operations or radioactive decay. To summarize, the modified results (from those for Current Conditions) for the River Corridor are:

- Hexavalent chromium (Group A) – For 100-HR-3 it is assumed that the P&T and ISRM systems would continue to be effective resulting in *Medium* and *Low* ratings for Active and Near-term, Post-Cleanup periods, respectively (to account for inventory and treatment uncertainties and because the final ROD has yet to be signed). For 100-KR-4 it is assumed that the P&T system would continue to be effective resulting in *Medium* and *Low* ratings for Active and Near-term, Post-Cleanup periods, respectively (again to account for inventory and treatment uncertainties and because the final ROD has yet to be signed).
- Sr-90 (Group B) – The maximum concentrations for OUs other than 100-KR-4 would result in *Low* ratings in the Near-term, Post-Cleanup period.

Columbia River: For those contaminants currently in contact with the River, the following changes would be made to ratings (as described in Part V):

- 100-HR-3: Hexavalent chromium is expected to reach the cleanup level (10 µg/L) during the Active Cleanup period (DOE/RL-2011-111, Draft A) using the P&T and ISRM systems resulting in a *Medium* rating and a corresponding *Low* rating for the Near-term, Post-Cleanup period to account for uncertainties in inventory and treatment.
- 100-KR-4: Hexavalent chromium is expected to reach the cleanup level (10 µg/L) over much of 100-KR during the Active Cleanup period (DOE/RL-2010-97, Draft A) resulting in a *Medium* rating

and a corresponding *Low* rating for the Near-term, Post-Cleanup period again to account for uncertainties in inventory and treatment.

As described in Part V because most of the plumes are unlikely to contact the Columbia River over the next 150 years (unless hydrologic conditions change significantly), the ratings (primarily *Not Discernible* or *Low*) for most of the contaminants not currently in contact with the Columbia River will not be modified. However, for Sr-90 (100-FR-3) even though the plume moves very slowly, there is a chance that it could reach the River in the Active Cleanup period (*Low* rating) but decay would likely result in no plume (all things being equal) for an *Not Discernible* rating during the Near-term, Post-Cleanup period.

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

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

The CP-GW-1 EU CERCLA Groundwater Operable Units (OUs), 100-BC-5, 100-FR-3, 100-HR-3, and 100-KR-4, have each undergone extensive characterization, assessment, and remediation. As such, active remediation actions are ongoing in each OU as part of an integrated strategy for achieving final cleanup in the River Corridor (WCH-71 Rev. 0).

Near-Term, Post-Cleanup Risks and Potential Impacts

Groundwater: Please see Part V for a discussion of the impact of cleanup, recharge, and decay on groundwater and Columbia River ratings in the Near-term, Post-Cleanup period. For potential impacts to groundwater, the ratings for the four 100 Area OUs tend to be either *ND* to *Low* to reflect presumed treatment effectiveness. The exception is hexavalent chromium in 100-BC-5 (with a *Medium* rating) indicating no final remedial actions selected and inventories that might translate to appreciable plumes in this evaluation period.

Columbia River: For the ratings related to threats to the Columbia River, only the hexavalent chromium in 100-BC-5 has a rating (*Medium*) in this period indicating that monitoring and treatment are needed.

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

PART II. ADMINISTRATIVE INFORMATION

OU AND/OR TSDF DESIGNATION(S)

100-BC-5, 100-HR-3, 100-FR-3, and 100-KR-4

Common name(s) for EU

RC-GW-3 in 100 Area (100-BC-5, 100-HR-3, 100-FR-3, and 100-KR-4)

Key Words

100 Areas, RC-GW-3, 100-BC-5, 100-HR-3, 100-FR-3, and 100-KR-4, River Corridor

Regulatory Status

Regulatory basis

100-BC: Nearly all of the waste sites in 100-BC interest area (and 100-BC-5 OU) are either classified as not requiring remedial action or have been remediated (DOE/RL-2014-32, Rev. 0, p. BC-1). The last remedial action in the area included a very large soil excavation down to the water table (~24 m) and then backfilling the excavated area with native soil and revegetation. DOE monitors groundwater to meet Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (CERCLA) and Atomic Energy Act of 1954 (AEA) requirements.

100-FR: Waste site remediation under previous interim Records of Decision (ROD) has been completed (DOE/RL-2014-32, Rev. 0, p. BC-1). A final ROD was issued in 2014 that includes the 100-FR-3 OU (EPA 2014). DOE monitors groundwater to meet Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (CERCLA) and Atomic Energy Act of 1954 (AEA) requirements.

100-HR: By the end of 2013, more than 75% of the waste sites in 100-HR interest area (that includes the 100-HR-3 OU) had been addressed (closed, interim closed, no action, etc.). DOE monitors groundwater to meet Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (CERCLA) requirements.

100-KR: At the end of 2013, ~60 percent of the 100-KR interest area waste sites (that include the 100-KR-4 OU) were addressed (closed, interim closed, no action, etc.) with ~37 percent having undergone active remediation to remove secondary sources of contamination that could migrate to groundwater and reduce the risk of direct exposure at the surface. DOE monitors groundwater to meet Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (CERCLA) and Atomic Energy Act of 1954 (AEA) requirements.

Applicable regulatory documentation

100-BC-5: interim action record of decision (ROD) (EPA/ROD/R10-95/126; EPA/ROD/R10-99/039; EPA/ROD/R10-00/121) and RI/FS (DOE/RL-2010-96)

100-HR-3: remedial investigation/feasibility study (RI/FS) (DOE/RL-2010-95 Draft A), RI/FS work plan addendum (DOE/RL-2008-46-ADD1) and sampling and analysis plan (SAP) (DOE/RL-2009-40). Changes to the SAP were documented in Tri-Party Agreement Change Notices (TPA-CN-460), interim remedial action ROD (EPA/ROD/R10-96/134), which was amended in 2000 (EPA/AMD/R10-00/122).

100-FR-3: A CERCLA Remedial Investigation (RI)/Feasibility Study (FS) report (DOE/RL-2010-98), was finalized in 2014 and public review of the proposed plan took place between June 9 and August 11, 2014. A final record of decision (ROD) was issued in 2014 (EPA 2014). Groundwater sampling and analysis plan (SAP) (DOE/RL-2003-49, as modified by TPA-CN-241).

100-KR-4: A remedial investigation (RI)/feasibility study (FS) for the K Reactor Area source and groundwater OUs (DOE/RL-2010-97 Draft A) and Proposed Plan (DOE/RL-2011-82 Draft A).

Applicable Consent Decree or TPA milestones

100-BC

M-015-78 by 02/28/2016 *Lead Agency: EPA*

Milestone: Complete two years of groundwater and aquifer tube sampling at the 100-BC expanded monitoring network in accordance with the revised 100-BC-1, 100-BC-2, and 100-BC-5 RI/FS Work Plan.

M-015-79 by 12/15/2016 *Lead Agency: EPA*

Milestone: Submit CERCLA Remedial Investigation/Feasibility Study Report and Proposed Plan for the 100-BC-1 and 100-BC-2 source operable units and the 100 BC-5 groundwater operable unit.

100-HR

M-016-161 by 03/31/2016 *Lead Agency: Ecology*

Milestone: Complete interim response actions for the following 100-D and 100-H Area waste sites: 100-D-14, 100-D-56, 100-D-62, 100-D-63, 100-D-65, 100-D-66, 100-D-71, 100-D-73, 100-D-75:2, 100-D-76, 100-D-78, 100-D-80, 100-D-81, 100-D-96, 100-D-101, 100-D-102, 116-DR-3, 118-D6:4, 1607-D1, 1607-D2, 100-H-37, 100-H-43, 100-H-48, 100-H-52, 100-H-57.

M-016-159 by 03/31/2015 *Lead Agency: Ecology*

Milestone: Complete 100-D and 100-H Area interim response actions for the following waste sites: 100-D-30, 100-D-31, 100-D-50 (except 100-D-50:2), 100-D-69, 100-D-72, 100-D-77, 100-D-83, 100-D-84, 100-D-85, 100-D-86, 100-D-97, 100-D-98:2, 100-D-99, 100-D-100, 100-D-103, 100-D-104, 100-D-105, 100-D-106, 100-H-28, 100-H-38, 100-H-42, 100-H-44, 100-H-46, 100-H-49, 100-H-51, 100-H-53, 100-H-56, 100-H-59, and 600-385, including revegetation of 100-D and 100H wastes sites.

Complete the decommissioning of the in-situ redox manipulation pond (147-D), a surface impoundment constructed as part of the 100-HR-3 Operable Unit interim remedial action.

100-FR

Not Applicable

100-KR

Not Applicable

RISK REVIEW EVALUATION INFORMATION

Completed: Revised 23 August 2015

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

Currently the land use in the 100 Areas is for industrial purposes and includes maintenance shops, water supply systems, and environmental cleanup (EPA/ROD/R10-00/121).

DESIGNATED FUTURE LAND USE

(WCH-8, Rev. 0)

Final Hanford Comprehensive Land-Use Plan Environmental Impact Statement (HCP EIS) (DOE 1999) and associated NEPA land-use ROD issued (64 Federal Register 61615) with multi-use theme of industrial-exclusive, industrial, research and development, high-intensity recreation, low-intensity recreation, conservation (mining), and preservation land uses.

Interim action ROD for 100 Area burial grounds issued (EPA 2000) acknowledging the HCP EIS and concluding that "unrestricted use" assumption was not inconsistent with identified land uses.

Three land uses were developed by the Hanford Future Site Uses Working Group (FSUWG) for the 100 Areas in the river corridor, consisting of the following:

- "Unrestricted" Use. This included removal and disposal of contaminated soil and structures (including reactors) and remediation of groundwater to "unrestricted" status.
- Limited Recreation, Commercial, and Wildlife Use. This included cleanup of groundwater and areas designated for commercial and recreational activities to "unrestricted" use (reactors to remain in place), but allowing areas to be managed for wildlife habitat to be remediated to "restricted" status.
- "Unrestricted" Use/B Reactor Remains in Place. This is similar to the unrestricted use except that B Reactor would remain in place and be remediated to "restricted" status.

The DOE selected land uses for the 100 Area include recreation, conservation, and preservation (EPA/ROD/R10-00/121).

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)[1] in the 100-BC-5, 100-HR-3, 100-FR-5, and 100-KR-4 Operable Units (OUs).

In 100-BC-5 OU contaminants of concern associated with waste produced by the reactors and related processes are hexavalent chromium, Sr-90, and tritium (H-3) (DOE/RL-2010-96); however, previous assessments have not resulted in interim remedial measures. Approximately 92% of waste sites have been addressed (with status of closed, interim closed, no action, not accepted, or rejected). The final Record of Decision is expected in 2017. To summarize:

- Hexavalent chromium sources included cribs near reactor buildings, trenches and retention basins near the River, and pipelines from the reactor buildings to the near-river facilities; other

[1] 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 are collectively denoted water quality standards (WQS) for the purpose of this Review.

sources included 100-C-7 and 100-C-7:1 and the 100-B-27 sodium dichromate spill site. The hexavalent chromium plume area has varied in size over the years (Figure D.4-1).

- Maximum concentration: 62 µg/L (199-B4-8) versus a "Model Toxics Control Act—Cleanup" (WAC 173-340) Method B groundwater cleanup level for hexavalent chromium of 48 µg/L and a surface water standard of 10 µg/L[2]
- Areal extent of the plume: 0.2 km^2 (48 µg/L) and 1.6 km^2 (10 µg/L)
- Shoreline impact: 0 m (48 µg/L) and 1,500 m (10 µg/L)
- Riparian zone intersected: 0 ha (48 µg/L) and 3.1 ha (10 µg/L)

- Sr-90 sources were liquid effluent discharges to cribs near the reactors and to cribs, trenches and retention basins. The Sr-90 plume area has increased slightly over the past few years (Figure D.4-1).
  - Maximum concentration: 53 pCi/L (199-B3-46) versus a WQS of 8 pCi/L
  - Areal extent of the plume: 0.60 km^2
  - Shoreline impact: 270 m
  - Riparian zone intersected: 0.81 ha
- Tritium was in effluent discharged to former cribs near the B Reactor and the Columbia River as well as the former 118-B-1 Burial Ground. These waste sites have been remediated resulting in a zero plume area in 2013 (Figure D.4-1).
  - Maximum concentration: 19,000 pCi/L (199-B8-9) versus a WQS of 20,000 pCi/L
  - Areal extent of the plume: 0 km^2
  - Shoreline impact: 0 m
  - Riparian zone intersected: 0 ha

[2] The "Model Toxics Control Act—Cleanup" (WAC 173-340) Method B groundwater cleanup level for hexavalent chromium of 48 µg/L was also listed for the 100-BC interest area (and is used for the Central Plateau EUs); however, the surface water standard was selected for River Corridor EUs for this Review.

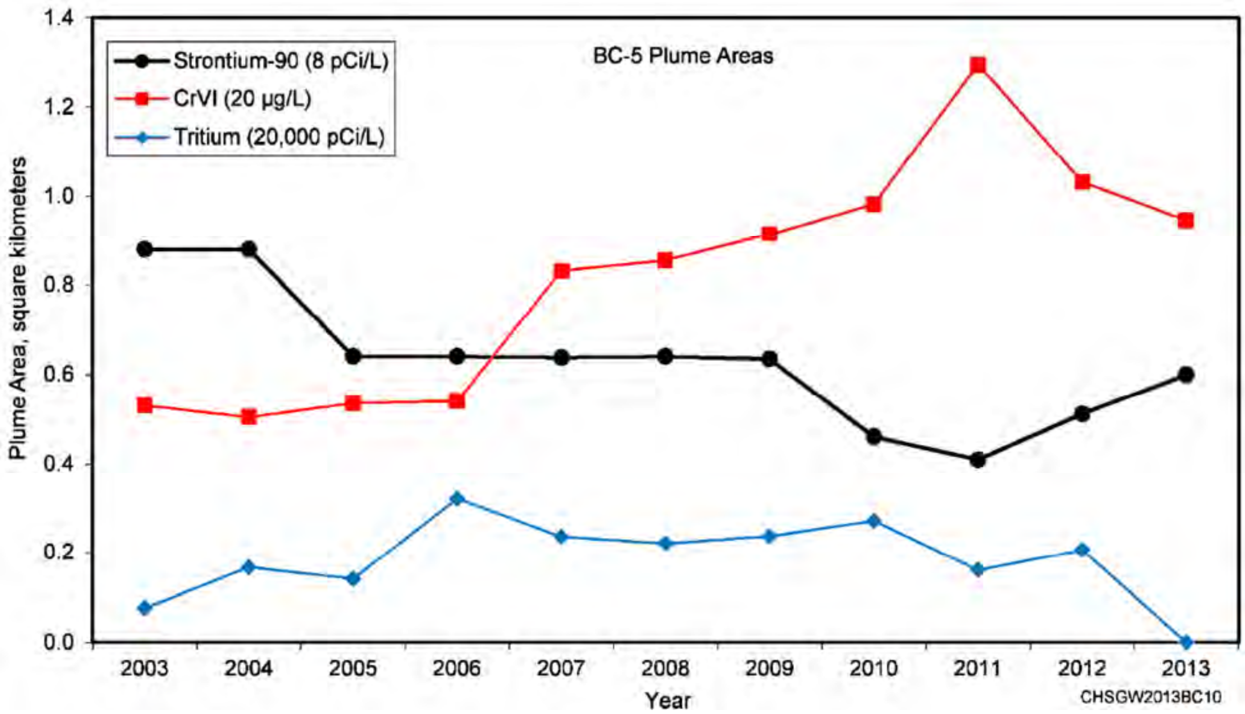

Figure D.4-1. 100-BC Plume Areas (DOE/RL-2014-32, Rev. 0, p. BC-4)

In 100-HR contaminants of concern are from waste releases associated with past operation of the D, DR, and H Reactors and associated support facilities are hexavalent chromium, nitrate, Sr-90, and tritium (H-3). By the end of 2013, 77+% of the waste sites were addressed (closed, interim closed, no action, not accepted, or rejected) where a final ROD is expected in 2015. To summarize:

- Hexavalent chromium contamination resulted from discharges to the 116-DR-1&2 trenches in 1967 creating a plume that extends across the Horn from 100-D to 100-H. Ongoing remedial activities are reducing contaminant levels and have separated the Horn plume. The hexavalent chromium plume area (20 µg/L) has been steadily decreasing since 2010 (Figure D.4-2).
    - Maximum concentration: 5,392 µg/L (P&T sample from 199-D5-104) and 4,690 µg/L (routine sample from 199-D5-10) versus a 20 µg/L groundwater cleanup target identified in ROD for interim remedial action although the surface water standard of 10 µg/L is used in this Review.
    - Areal extent of the plume: 4.0 km^2 (20 µg/L) and 7.3 km^2 (10 µg/L) estimated using Photoshop (as illustrated in Attachment 6-4 in the Methodology Report (CRESP 2015))
    - Shoreline impact: 525 m (20 µg/L) and ≥525 m (10 µg/L); the shoreline impact area was not estimated at the surface water standard but must be greater than or equal to that at the cleanup level
    - Riparian zone intersected: 12.1 ha (20 µg/L) and ≥12.1 ha (10 µg/L); the riparian zone intersection area was not estimated at the surface water standard but must be greater than or equal to that at the cleanup level
- Nitrate plume sources in 100-HR included gas condensate from the reactors, septic systems and sewer lines, former agricultural practices, and waste sites that received nitric acid. Nitrate concentrations exceed the 45 mg/L DWS equivalent in 100-D groundwater but were below that level throughout 100-H in 2013 (and is not found above the DWS equivalent in the Horn). Overall, the combined area of the nitrate plumes continued to decrease (Figure D.4-2).

   - Maximum concentration: 70.4 mg/L (199-D4-20) versus a WQS (equivalent) of 45 mg/L.
   - Areal extent of the plume: 0.06 km^2
   - Shoreline impact: 0 m
   - Riparian zone intersected: 0 ha
- Sr-90 was present in wastes disposed of at both 100-D and 100-H where 2013 concentrations in groundwater exceeded the DWS (8 pCi/L) in both 100-D and 100-H monitoring locations and is elevated in isolated source areas in both 100-H and 100-D. Sr-90 is not present in the Horn. The Sr-90 plume area has decreased the past couple of years (Figure D.4-2).
   - Maximum concentration: 53 pCi/L (199-B3-46) versus a WQS of 8 pCi/L
   - Areal extent of the plume: 0.03 km^2
   - Shoreline impact: 30 m
   - Riparian zone intersected: 0.06 ha
- Tritium in 100-HR was detected in a single well at the standard so no plume area was calculated resulting in a zero plume area in 2013 (Figure D.4-2).
   - Maximum concentration: 20,000 pCi/L (199-D4-20) versus a WQS of 20,000 pCi/L
   - Areal extent of the plume: 0 km^2
   - Shoreline impact: 0 m
   - Riparian zone intersected: 0 ha

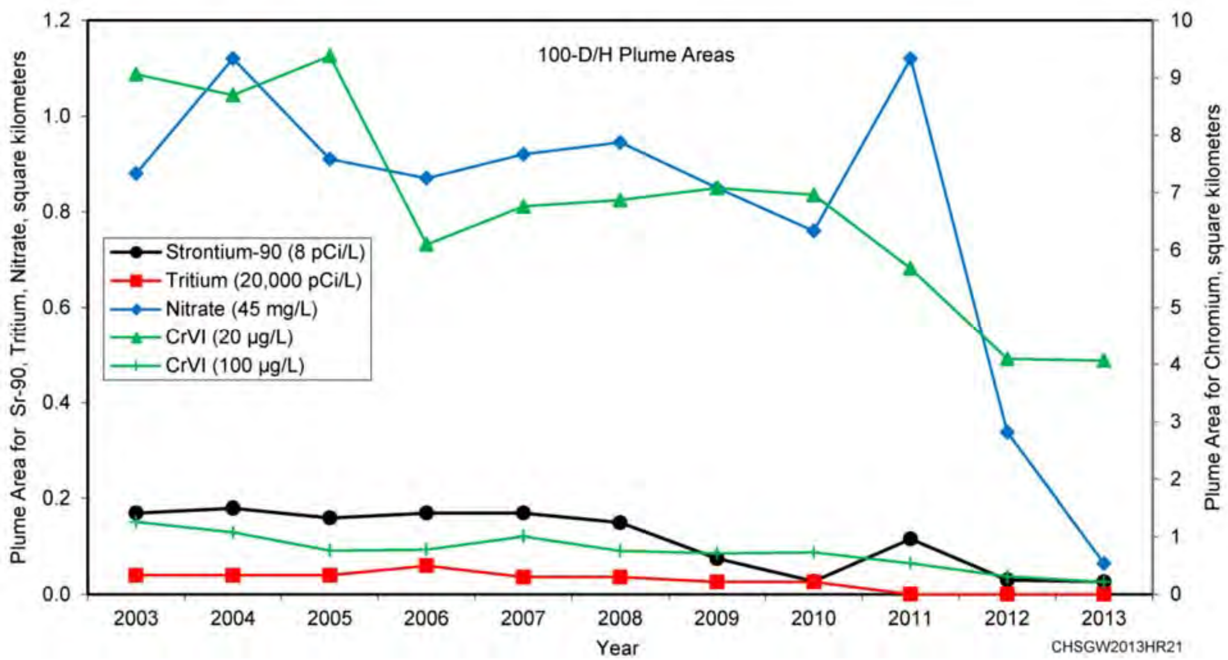

Figure D.4-2. 100-HR Plume Areas (DOE/RL-2014-32, Rev. 0, p. HR-9)

In 100-FR contaminants of concern originated from waste sources related to reactor operations and biological experiments and include nitrate, hexavalent chromium, Sr-90, and trichloroethene (TCE). Remedial actions under an interim action record of decision are complete, and previous assessments have not resulted in any interim remedial measures for groundwater. To summarize:

- Nitrate plume sources in 100-FR included the experimental animal farm various septic tanks and leach fields, which have been remediated, as well as potentially pre-Hanford Site agriculture. Overall, the nitrate plume areas has continued to decrease since 2009 (Figure D.4-3).

  - Maximum concentration: 189 mg/L (199-F5-56) versus a WQS (equivalent) of 45 mg/L
  - Areal extent of the plume: 9.3 km^2
  - Shoreline impact: 0 m
  - Riparian zone intersected: 0 ha
- Hexavalent chromium contamination resulted from facilities near the reactor building, trenches and retention basins near the Columbia River, and pipelines from the reactor building to near-river facilities. These waste sites have been remediated, and concentrations in groundwater are expected to continue to decline with time although the plume area (in this case, 20 µg/L) has remained steady (Figure D.4-3).
  - Maximum concentration: 25.5 µg/L (199-F5-46) versus a "Model Toxics Control Act—Cleanup" (WAC 173-340) Method B groundwater cleanup level for hexavalent chromium of 48 µg/L and a surface water standard of 10 µg/L[3]
  - Areal extent of the plume: 0 km^2 (48 µg/L) and 0.34 km^2 (10 µg/L)
  - Shoreline impact: 0 m (48 µg/L) and 0 m (10 µg/L)
  - Riparian zone intersected: 0 ha (48 µg/L) and 0 ha (10 µg/L)
- Sr-90 sources included the 116-F-14 Retention Basins and 116-F-2 Trench as well as areas near the reactor building and burial grounds. The combined Sr-90 plume area has remained steady over the past decade (Figure D.4-3).
  - Maximum concentration: 180 pCi/L (199-F5-55) versus a WQS of 8 pCi/L
  - Areal extent of the plume: 0.16 km^2
  - Shoreline impact: 0 m
  - Riparian zone intersected: 0 ha
- TCE plume sources in 100-FR included the former 600-127 waste site, which was remediated. The plume area has remained relatively steady since 2008 (Figure D.4-3).
  - Maximum concentration: 15 µg/L (299-F6-1) versus a WQS (equivalent) of 5 µg/L
  - Areal extent of the plume: 0.81 km
  - Shoreline impact: 0 m
  - Riparian zone intersected: 0 ha

[3] The "Model Toxics Control Act—Cleanup" (WAC 173-340) Method B groundwater cleanup level for hexavalent chromium of 48 µg/L was also listed for the 100-BC interest area (and is used for the Central Plateau EUs); however, the surface water standard was selected for River Corridor EUs for this Review.

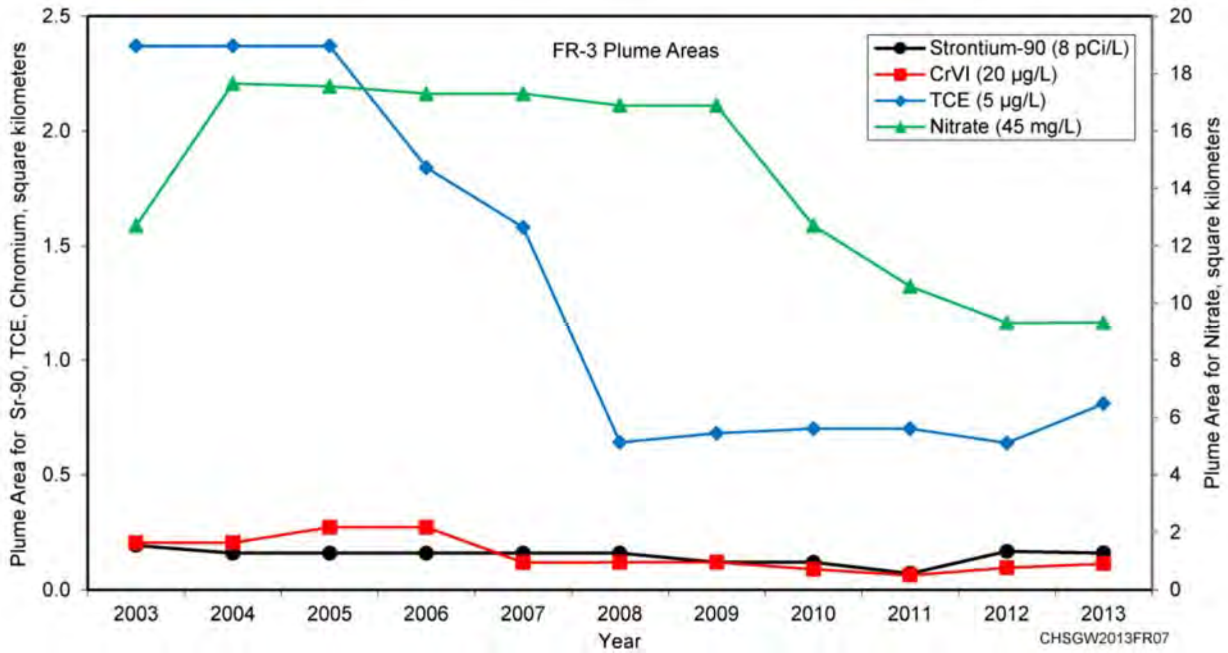

Figure D.4-3. 100-FR Plume Areas (DOE/RL-2014-32, Rev. 0, p. FR-4)

In 100-KR contaminants of concern originated from waste releases associated with past operations of the KE and KW Reactors and associated support facilities and include hexavalent chromium, tritium (H-3), nitrate, Sr-90, C-14, and trichloroethene (TCE). Remedial actions under an interim action record of decision are ~59% complete. To summarize:

- Hexavalent chromium is a mobile contaminant, and its presence resulted from spills, leaks, and limited intentional discharge of concentrated sodium dichromate dihydrate solutions and spent reactor cooling water from retention basin leaks and intentional discharges to the 116-K-1 Crib and 116-K-2 Trench. Plume areas (20 µg/L) have generally decreased since 2005 (Figure D.4-4).
    - Maximum concentration: 3,280 µg/L (199-K-205) versus a 20 µg/L groundwater cleanup target identified in ROD for interim remedial action and a 10 µg/L surface water standard (added for this Review)
    - Areal extent of the plume: 1.05 km^2 (20 µg/L) and 2.12 km^2 (10 µg/L) estimated using Photoshop (as illustrated in Attachment 6-4 in the Methodology Report (CRESP 2015)))
    - Shoreline impact: 800 m (20 µg/L) and ≥800 m (10 µg/L); the shoreline impact area was not estimated at the surface water standard but must be greater than or equal to that at the cleanup level
    - Riparian zone intersected: 1.13 ha (48 µg/L) and >1.13 ha (10 µg/L); the riparian zone intersection area was not estimated at the surface water standard but must be greater than or equal to that at the cleanup level
- Tritium is also a highly mobile contaminant with sources including releases of reactor gas dryer condensate to the 116-KE-1 and 116-KW-1 Cribs, releases of fuel storage basin water to the 116-KE-3 and 116-KW-2 Cribs, and solid waste disposed at the 118-K-1 Burial Ground. The tritium plume areas has been generally decreasing over the past decade (Figure D.4-4).
    - Maximum concentration: 76,000 pCi/L (199-K-202) versus a WQS of 20,000 pCi/L
    - Areal extent of the plume: 0.02 km^2
    - Shoreline impact: 0 m

    - Riparian zone intersected: 0 ha
- Nitrate originated primarily from ammonia in reactor gas dryer condensate discharged to the 116-KE-1 and 116-KW-1 Crib with additional contributions possible from sanitary waste drain fields within the 100-K Area. Overall, the nitrate plume areas have been generally decreasing over the past decade (Figure D.4-4).
    - Maximum concentration: 63.7 mg/L (199-K-34) versus a WQS (equivalent) of 45 mg/L
    - Areal extent of the plume: 0.03 km^2
    - Shoreline impact: 0 m
    - Riparian zone intersected: 0 ha
- Sr-90 was released during fuel failure events resulting in contaminated reactor cooling water that was released to the 116-K-2 Trench under off-normal conditions as well as to the reactor fuel storage basins during discharge of irradiated fuel. The Sr-90 plume area has generally decreased over the past decade (Figure D.4-4).
    - Maximum concentration: 13,200 pCi/L (estimated) versus a WQS of 8 pCi/L
    - Areal extent of the plume: 0.05 km^2
    - Shoreline impact: 200 m
    - Riparian zone intersected: 0 ha
- C-14 in the groundwater primarily originated from historical discharges of reactor gas dryer regeneration condensate to the 116-KE-1 and 116-KW-1 gas condensate cribs. The C-14 plume area has slowly decreased since 2007 (Figure D.4-4).
    - Maximum concentration: 39,500 pCi/L (estimated) versus a WQS of 2,000 pCi/L
    - Areal extent of the plume: 0.03 km^2
    - Shoreline impact: 0 m
    - Riparian zone intersected: 0 ha
- TCE plume sources are not currently known but are likely related to the use of solvents during equipment maintenance activities. The plume area has remained relatively steady over the past decade (Figure D.4-3).
    - Maximum concentration: 8.3 µg/L (199-K-185) versus a WQS (equivalent) of 5 µg/L
    - Areal extent of the plume: 0.01 km^2
    - Shoreline impact: 0 m
    - Riparian zone intersected: 0.3 ha

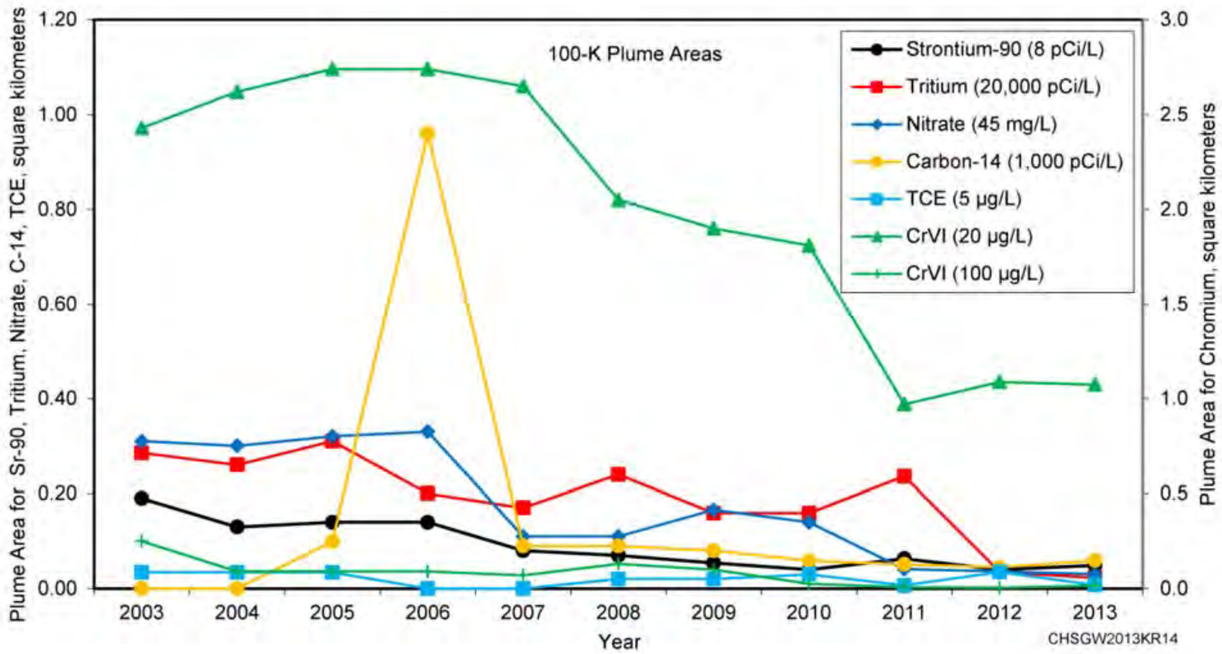

Figure D.4-4. 100-KR Plume Areas (DOE/RL-2014-32, Rev. 0, p. KR-4)

Operating Facilities

Not Applicable

Location and Layout Maps

A series of maps are used to illustrate the location of the components within the RC-GW-3 EU relative to the Hanford Site. Figure D.4-5 shows the relationship among the various Evaluation Units studied in the Interim Report and the Hanford Site. Figure D.4-6 through Figure D.4-9 illustrate the extent of groundwater contamination in the 100-BC-5, 100-HR-3, 100-FR-3, and 100-KR-4 OUs.

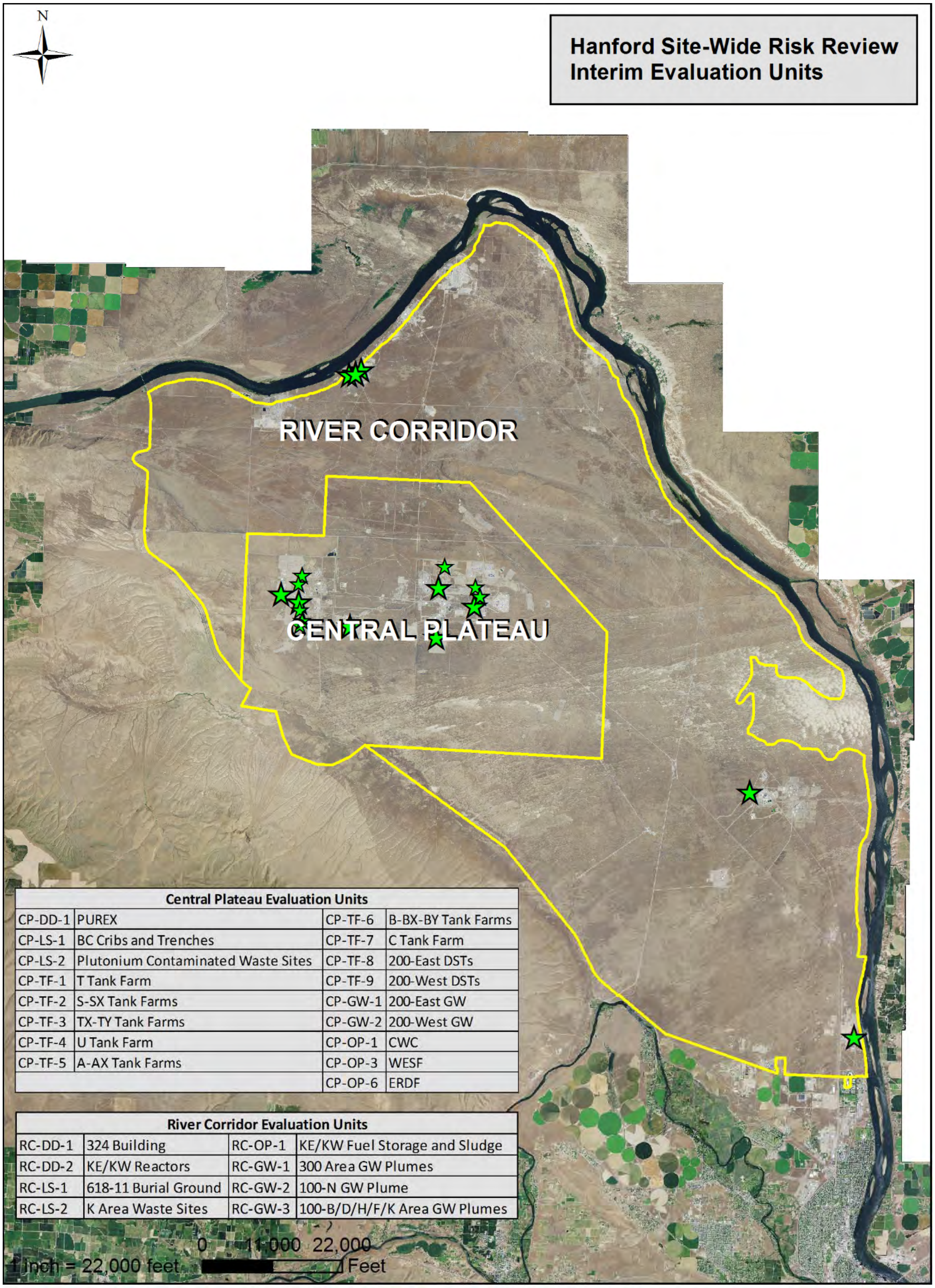

Figure D.4-5. Location of the Evaluation Units in Relation to the Hanford Site.

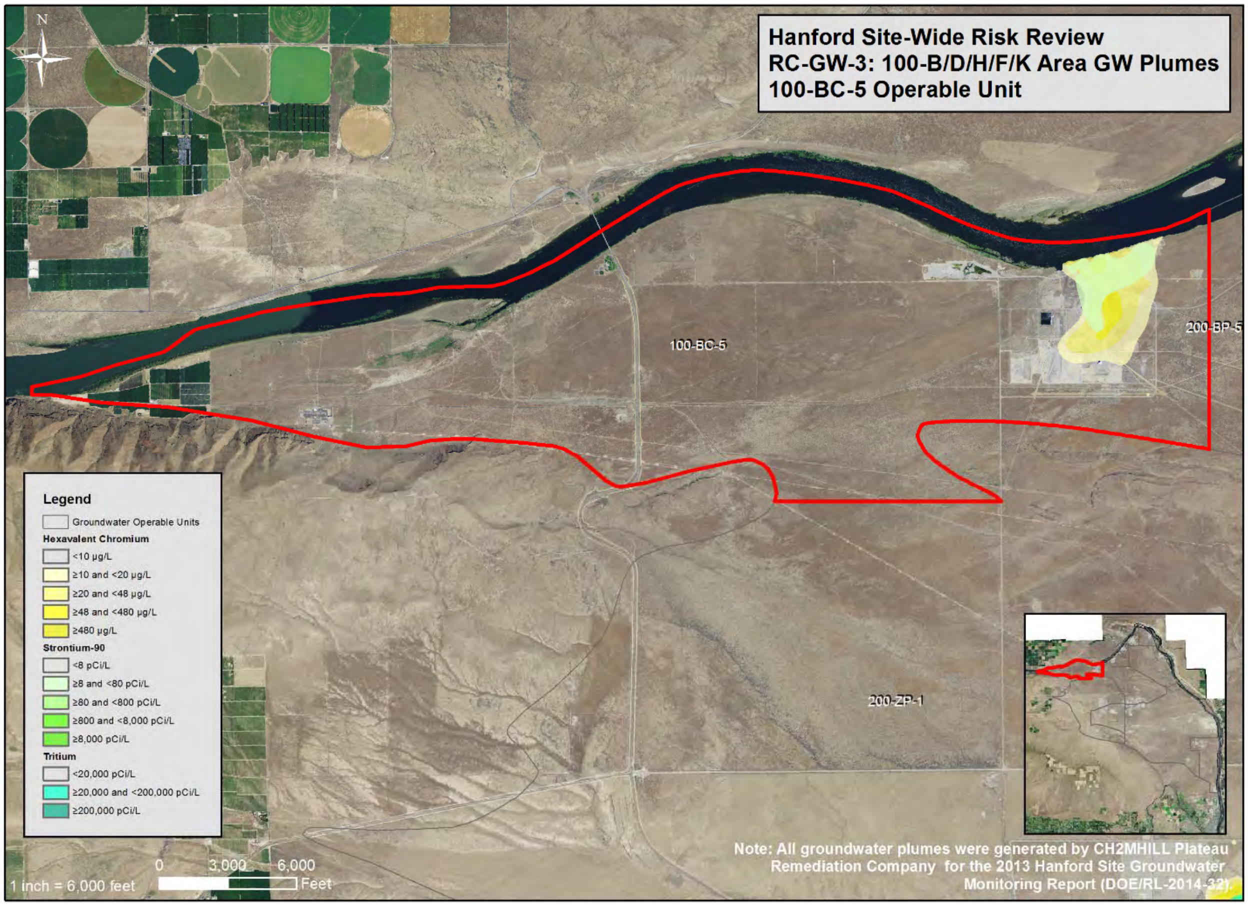

Figure D.4-6. Groundwater Contamination in the 100-BC-5 Operable Unit

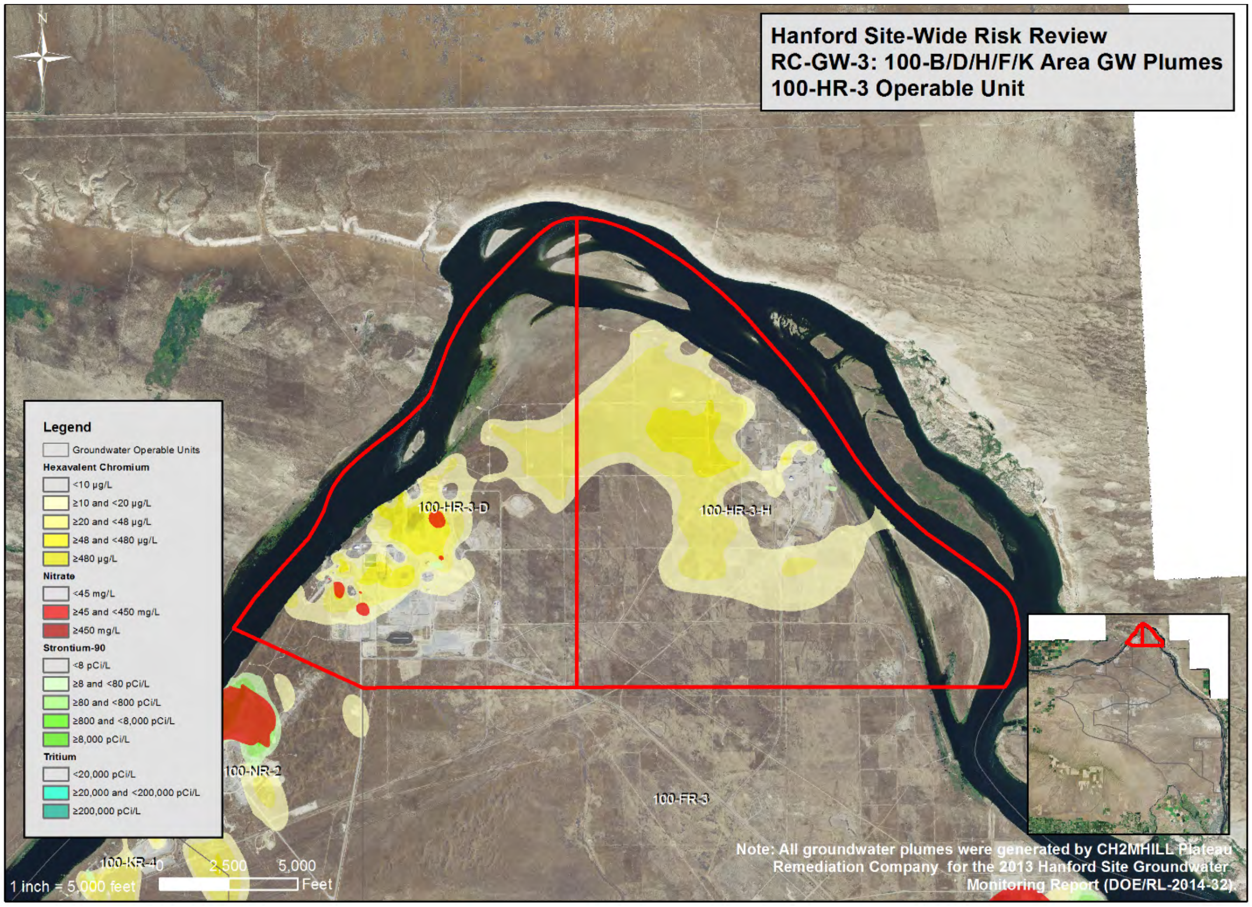

Figure D.4-7. Groundwater Contamination in the 100-HR-3 Operable Unit

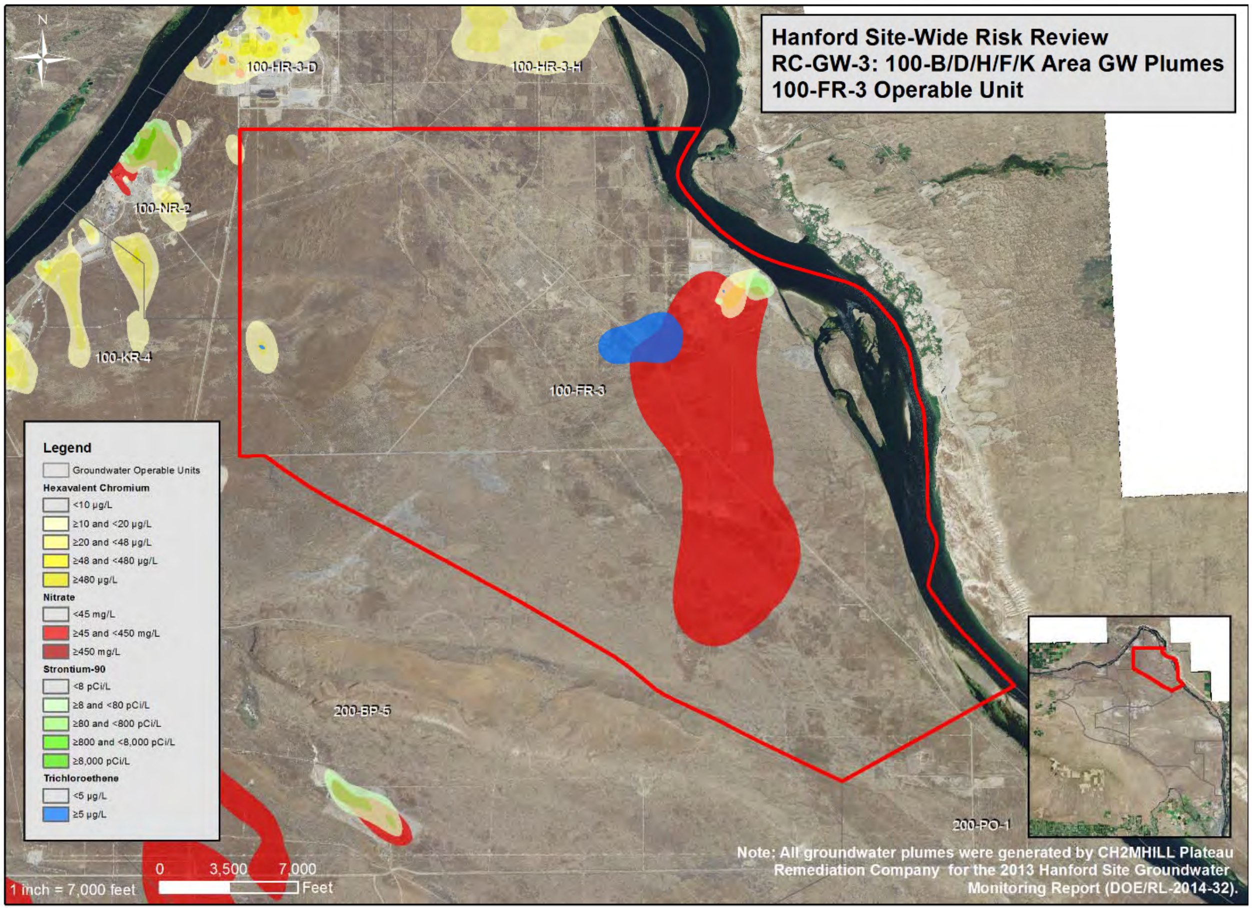

Figure D.4-8. Groundwater Contamination in the 100-FR-3 Operable Unit

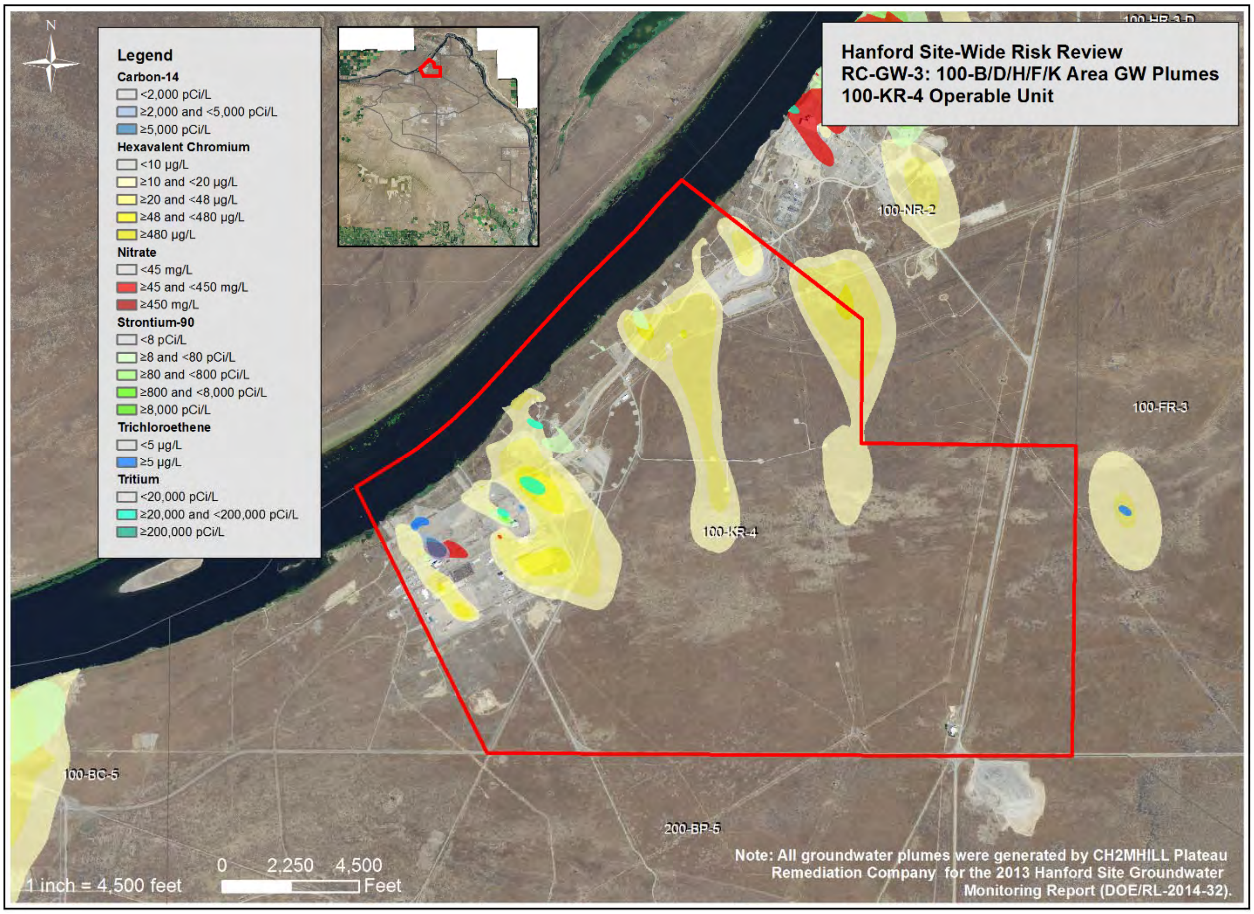

Figure D.4-9. Groundwater Contamination in the 100-KR-4 Operable Unit

PART IV. UNIT DESCRIPTION AND HISTORY

EU Former/Current Use(s)

The RC-GW-3 Evaluation Unit is comprised of four Groundwater Operable Units: 100-BC-5, 100-HR-3, 100-FR-3, and 100-KR-4. Brief descriptions of individual area backgrounds and current uses are provided below.

100-BC Area (after DOE/RL-2014-32, Rev. 0). The 100-BC groundwater interest area includes the 100-BC-5 operable unit (OU) and surrounding region. Two nuclear reactors formerly operated in 100-BC. The B Reactor was the first of its kind, and it operated from 1944 to 1968. Its primary mission was plutonium production for the development of an atomic bomb during World War II. The C Reactor operated from 1952 to 1969. Groundwater contamination in 100-BC is mainly associated with waste produced by the reactors and related processes. The U.S. Department of Energy (DOE) monitors 100-BC groundwater to meet Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (CERCLA) and Atomic Energy Act of 1954 (AEA) requirements. Groundwater contaminants of concern are hexavalent chromium, strontium-90, and tritium (DOE/RL-2010-96). Previous assessments have not resulted in any interim remedial measures for groundwater. Nearly all of the waste sites in 100-BC have been remediated or are classified as not requiring remediation. The last site to undergo remediation under the interim action record of decision (ROD) (EPA/ROD/R10-95/126; EPA/ROD/R10-99/039;

EPA/ROD/R10-00/121) was 100-C-7:1. The excavation to remove contaminated soil from this site was very large, extending to the water table at a depth of approximately 24 meters. Workers backfilled the hole in 2013 and revegetated the surface in 2014. With the completion of this remediation, there are no known remaining sources of significant contamination that could migrate to groundwater.

100-HR (after EPA/ROD/R10-99/039 and DOE/RL-2014-32, Rev. 0). The 105-H Reactor complex was constructed after World War II to produce plutonium for use in military weapons. The H Reactor operated from 1949 to 1965, when it was retired from service. Currently, there are no active facilities, operations, or liquid discharges within the 100-HR-1 source OU. The 100-HR-1 and 100-HR-2 source OUs, located in the 100-H Area, include contaminant sources, and the 100-HR-3 groundwater OU includes contamination present in the underlying groundwater. Groundwater in 100-HR was contaminated by waste releases associated with past operation of the deactivated D, DR, and H Reactors and from associated support facilities. At the end of 2012, approximately 70 percent of the waste sites were classified as closed, interim closed, no action, not accepted, or rejected. Removing contaminants from the vadose zone eliminates secondary sources of contamination that could migrate to groundwater and reduce the risk of direct exposure at the surface.

100-F Area (after DOE/RL-2014-32, Rev. 0). The 100-FR groundwater interest area includes the 100-FR-3 operable unit (OU) and surrounding region. One nuclear reactor operated at 100-FR between 1945 and 1965. Groundwater contamination originated from waste sources related to reactor operations and biological experiments that continued until 1976. The U.S. Department of Energy (DOE) monitors 100-FR groundwater to meet the CERCLA and AEA requirements. Groundwater contaminants of concern are nitrate, trichloroethene, hexavalent chromium, and strontium-90 (DOE/RL-2010-98). Waste site remediation under an interim action record of decision is complete. Previous assessments have not resulted in any interim remedial measures for groundwater. A CERCLA Remedial Investigation (RI)/Feasibility Study (FS) report (DOE/RL-2010-98), was finalized in 2014 and public review of the proposed plan took place between June 9 and August 11, 2014. A final record of decision (ROD) was issued in 2014 (EPA 2014).

100-K Area (after EPA/ROD/R10-99/039 and DOE/RL-2014-32, Rev. 0). The 100-K Area is situated in the north-central part of the Hanford Site along the southern shoreline of the Columbia River, approximately 40 km northwest of the city of Richland, Washington. The 100-KR groundwater interest area includes the 100-KR-4 OU. Groundwater in 100-KR was contaminated by waste releases associated with past operations of the KE and KW Reactors and from associated support facilities. At the end of 2013, approximately 59 percent of the waste sites were classified as closed, interim closed, no action, or not accepted or rejected, with approximately 37 percent having undergone active remediation. Removing contaminants from the vadose zone eliminates secondary sources of contamination that could migrate to groundwater and reduce the risk of direct exposure at the surface. Former waste sites known or suspected to have contributed to observed groundwater contamination at 100-KR include 183-KE and 183-KW Head House tank farms, 116-KE-1 and 116-KW-1 Gas Condensate Cribs, 116-KE-3 and 116-KW-2 Fuel Storage Basin Cribs/Reverse Wells, 116-K-1 Crib, 116-K-2 Trench, and 118-K-1 Burial Ground.

Legacy Source Sites

Not Applicable

High-Level Waste Tanks

Not Applicable

GROUNDWATER PLUMES

Please see groundwater plume description in Part III above.

D&D OF INACTIVE FACILITIES

Not Applicable

OPERATING FACILITIES

Not Applicable

ECOLOGICAL RESOURCES SETTING

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

For purposes of this assessment, areas were delineated where the mapped riparian zone along the river shoreline intersects the estimated contours for the groundwater plumes. Riparian areas along the river shoreline are considered priority habitats that are classified as level 4 biological resources. The delineated area and acreage for the intersection of the riparian zone for separate contaminant plumes within each groundwater evaluation unit are provided in Table 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 109.5 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 was used to approximate saturated zone inventories for the primary contaminants in the 100-BC-5, 100-HR-3, 100-FR-3, and 100-KR-4 Operable Units.

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 EUs.

Groundwater Plumes

The estimated inventory for the saturated zone contamination is provided in Table D.4-2 where the process outlined in Chapter 6 of the Methodology Report (CRESP 2015). For the 100-BC-5, 100-HR-3, 100-FR-3, and 100-KR-4 groundwater plumes (DOE/RL-2014-32, Rev. 0), the following information is provided:

- Maximum measured concentration in 2013 (DOE/RL-2014-32, Rev. 0);
- Upper 95% confidence limit (UCL) on the log-transformed groundwater and aquifer tube (AT) data from PHOENIX (http://phoenix.pnnl.gov/) exceeding the given threshold (e.g., DWS), where the AT can also be used to estimate if the plume is in contact with the Columbia River;
- Plume area in 2013 (exceeding the water quality standard (WQS), often the DWS or risk-based cleanup level) (DOE/RL-2014-32, 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 or the unconfined aquifer thickness is used for the contaminant depth interval[4];
- 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.

As illustrated in Table D.4-2, the saturated zone (SZ) GTM values translate to:

- 100-BC-5: Group A and B primary contaminants range from *Low* for Sr-90 to *Medium* for hexavalent chromium (Cr-VI). There is no calculated tritium (Group C) plume areas and thus no rating.
- 100-HR-3: Group A and B primary contaminants range from *Low* for Sr-90 to *Medium* for hexavalent chromium. The nitrate plume areas (Group C) translates to *Low* based on the current plume area. There is no calculated tritium (Group C) plume areas and thus no rating.

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[4] Plume depths are not known for the 100 Areas primary contaminants. As indicated in the Methodology Report (CRESP 2015), the minimum of the value from the Hanford 200-UP-1 OU Interim ROD (EPA 2012) or the unconfined aquifer thickness is used. The unconfined aquifer thicknesses are: 100-BC: ~30 m, 100-HR: ~10 m, 100-FR: ~10 m and 100-KR: ~30 m (Last 2006). Use of the depths from the Hanford 200-UP-1 OU Interim ROD (EPA 2012) or the unconfined aquifer thickness likely results in very large uncertainties in the pore volume and related estimates.

- 100-FR-3: Group A and B primary contaminants are *Low* for hexavalent chromium, Sr-90, and TCE. The nitrate plume areas (Group C) translates to *Medium*.
- 100-KR-4: Group A and B primary contaminants are *Low* for Sr-90, C-14, and TCE to *Medium* for hexavalent chromium. The tritium and nitrate plume areas (Group C) translates to *Low* ratings.

Thus the overall rating for the RC-GW-3 EU threat to groundwater would be *Medium* related to hexavalent chromium (100-BC-5, 100-HR-3, and 100-KR-4) and nitrate (Group C) in the 100-FR-3 OU where hexavalent chromium is Group A.

Impact of Cleanup, Recharge Rate, and Radioactive Decay on Groundwater Ratings
For some constituents there may be significant impacts from cleanup operations or radioactive decay. However, because of the shallow vadose zone in the River Corridor and proximity to the River, potential impacts of different recharge rates are assumed insignificant. To summarize, the results for the River Corridor impacts include:

- Hexavalent chromium (Group A) – There are current plumes in 100-BC-5, 100-HR-3, and 100-KR-4 that translate to current *Medium* ratings. For 100-BC-5, there is no current treatment (where the final ROD is expected 2017) so the rating is assumed to remain *Medium* for the Active and Near-term, Post-Cleanup periods (since there is no assumed biological "decay"). For 100-HR-3 it is assumed that the P&T and ISRM systems would continue to be effective resulting in *Medium* and *Low* ratings for Active and Near-term, Post-Cleanup periods, respectively (to account for inventory and treatment uncertainties and because the final ROD has yet to be signed). For 100-FR-3, the rating (*Low*) will not be modified because there is not treatment and the final ROD has not been signed. For 100-KR-4 it is assumed that the P&T system would continue to be effective resulting in *Medium* and *Low* ratings for Active and Near-term, Post-Cleanup periods, respectively (again to account for inventory and treatment uncertainties and because the final ROD has yet to be signed).
- Sr-90 (Group B) – There are current plumes in all four OUs that currently translate to *Low* ratings. Maximum measured concentrations range from 31 to 13,200 pCi/L. All other things being equal, these concentrations adjusted for decay after 50 years would still result in non-zero Sr-90 plumes in all areas and thus the ratings for the Active Cleanup period remain *Low* for these OUs. For the 100-KR-4 maximum concentration, the value adjusted for decay over 150 years (Near-term, Post-Cleanup period) would still result in a concentration above the 8 pCi/L limit (all other things being equal) resulting in again a *Low* rating; however, the maximum concentrations for the other areas would result in *Not Discernible* ratings.
- Carbon-14 (Group A), Trichloroethene (TCE) (Group B), Tritium/Nitrate (Group C) – There are current plumes for these contaminants in one or more OUs. However, since there are neither remedial activities selected for these constituents nor will there likely be radioactive or biological decay or other significant impacts, the ratings are assumed to not change for the Active and Near-term, Post-Cleanup periods. Note only the nitrate in 100-FR-3 (rated *Medium*) would thus be rated above *Low*. The proposed groundwater remedial alternative, MNA including the installation of additional monitoring wells, would be used to monitor remedial performance and reduce uncertainties in the extent of nitrate contamination (DOE/RL-2014-32, Rev. 0, p. FR-7).

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.

Benthic and Riparian Zone – Current Impacts

Based on the information in the 2013 Hanford Annual Groundwater Report (DOE/RL-2014-32, Rev. 0) summarized in Table D.4-3, seven plumes from these four OUs are currently intersecting the Columbia River at concentrations exceeding the WQS. The ratings obtained from using the process shown in Chapter 6 (Figure 6-11) range from *Not Discernible* for TCE (100-KR-4) to *Low* for Cr-VI (100-FR-3), Sr-90 (100-KR-4), and C-14 (100-KR-4) to *Medium* for Cr-VI (100-BC-5 and 100-100-KR-4) to *High* for Cr-VI (100-HR-3). The ratings for the other contaminants would be *Not Discernible*. Thus *current* impacts from these OUs to the Columbia River benthic and riparian zone ecology would be rated as *High* related to hexavalent chromium in 100-HR-3, which is currently being treated using P&T and ISRM.

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

For those contaminants currently in contact with the River:

- 100-BC-5: Hexavalent chromium rating (*Medium*) is not modified since there is no selected treatment and the final ROD has not been signed. The Sr-90 rating remains *Not Discernible* since the plume is assumed to continue to decrease due to radioactive decay.
- 100-HR-3: Hexavalent chromium is expected to reach the cleanup level (10 µg/L) during the Active Cleanup period (DOE/RL-2011-111, Draft A) using the P&T and ISRM systems resulting in a *Medium* rating and a corresponding *Low* rating for the Near-term, Post-Cleanup period to account for uncertainties in inventory and treatment. The Sr-90 (100-HR-3) rating will remain *Not Discernible* since the plume is assumed to decrease due to radioactive decay.
- 100-FR-3: No plumes currently in contact with the Columbia River (i.e., no shoreline impact estimates) (DOE/RL-2014-32, Rev. 0).
- 100-KR-4: Hexavalent chromium is expected to reach the cleanup level (10 µg/L) over much of 100-KR during the Active Cleanup period (DOE/RL-2010-97, Draft A) resulting in a *Medium* rating and a corresponding *Low* rating for the Near-term, Post-Cleanup period to account for uncertainties in inventory and treatment. Because of the localized hot spot for Sr-90, the rating is not modified since radioactive decay over the 150-year period appears to not be sufficient (all other things being equal) to lower the concentration below the 8 pCi/L standard. For the TCE, the *Not Discernible* rating is not modified for the Current or Near-term, Post-Cleanup periods.

For those contaminants not currently in contact with the Columbia River, the next step is to estimate if a plume could likely contact the River within the next 50 or 150 years. From inspection of the plumes areas over time (Figure D.4-1 through Figure D.4-4) for the various OUs, it appears as though most of the plumes (i.e., those which are 150+ m from the River) are unlikely to contact the Columbia River over the Active Cleanup period (50 years) or Near-term, Post-Cleanup period (150 years) unless hydrologic conditions change significantly (from those over the past decade). Thus ratings (primarily *ND* or *Low*) will not change for many of these contaminants. For hexavalent chromium (100-FR-3), the current *Low* rating will not be modified for the Active Cleanup and Near-term, Post-Cleanup periods because no final remedial selection has been made. For Sr-90 (100-FR-3) even though the plume moves very slowly, there is a chance that it could reach the River in the Active Cleanup period (thus assigned a *Low* rating to account for uncertainties); however, radioactive decay would result in no plume (all things being equal) for a *Not Discernible* rating during the Near-term, Post-Cleanup period.

Benthic and Riparian Zone – Long-term

From the above analysis, only the hexavalent chromium in 100-BC-5 (no remedial action selected) and C-14 in 100-KR-4 (hot spot) are predicted to have *Medium* ratings. These results indicate the need for both monitoring and remedial action selection for these OUs. The final RODs for the 100-BC-5 and 100-KR-3 OUs are expected in 2017 and after 2015, respectively.

Threats to the Columbia River Free-flowing Ecology

As described in 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[5].

Facilities for D&D

Not Applicable

Operating Facilities

Not Applicable

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[5] "Groundwater is a potential pathway for contaminants to enter the Columbia River. Groundwater flows into the river from springs located above the water line and through areas of upwelling in the river bed. Hydrologists estimate that groundwater currently flows from the Hanford unconfined aquifer to the Columbia River at a rate of ~ 0.000012 cubic meters per second (Section 4.1 of PNNL-13674). For comparison, the average flow of the Columbia River is ~3,400 cubic meters per second (DOE/RL-2014-32, Rev. 0)." This represents a dilution effect of more than eight orders of magnitude (a dilution factor of greater than 100 million). Thus the differences from EU to EU were not found distinguishing and the potential for groundwater contaminant discharges from Hanford to achieve concentrations above relevant thresholds is very remote.

Table D.4-2. Summary of the Evaluation of Threats to Groundwater as a Protected Resource from Saturated Zone (SZ) Contamination associated with the RC-GW-3 Evaluation Unit (100-BC-5, 100-HR-3, 100-FR-3, and 100-KR-4 Operable Units)

OU	PC	Grp	WQS[a]	Area (km^2)[b]	Thick-ness (m)[c]	Pore Vol. (Mm^3)	Max GW Conc	95th % GW UCL	Porosity[d]	K_d (mL/g)[d]	ρ (kg/L)[d]	R	SZ Total M^{SZ} (kg or Ci)	SZ GTM (Mm^3)	SZ Rating[e]
100-BC-5	Cr-VI	A	10 µg/L	1.6	24	6.91E+00	62 µg/L	25.9 µg/L	0.18	0	1.84	1.00E+00	1.79E+02	1.79E+01	Medium
	Sr-90	B	8 pCi/L	0.6	15	1.62E+00	53 pCi/L	25.2 pCi/L	0.18	22	1.84	2.26E+02	4.08E-02	5.10E+00	Low
	H-3	C	20000 pCi/L	---	---	---	19000 pCi/L	---	0.18	0	1.84	1.00E+00	---	---	---
100-HR-3	Cr-VI	A	10 µg/L	7.3	10	1.31E+01	5392 µg/L	55.3 µg/L	0.18	0	1.84	1.00E+00	7.25E+02	7.25E+01	Medium*
	NO3	C	45 mg/L	0.06	10	1.08E-01	70.4 mg/L	54.6 mg/L	0.18	0	1.84	1.00E+00	5.90E+03	---	Low
	Sr-90	B	8 pCi/L	0.03	10	5.40E-02	31 pCi/L	46.5 pCi/L	0.18	22	1.84	2.26E+02	2.51E-03	3.14E-01	Low
	H-3	C	20000 pCi/L	---	---	---	20000 pCi/L	---	0.18	0	1.84	1.00E+00	---	---	---
100-FR-3	NO3	C	45 mg/L	9.3	10	1.67E+01	189 mg/L	115 mg/L	0.18	0	1.84	1.00E+00	1.93E+06	---	Medium
	Cr-VI	A	10 µg/L	0.34	10	6.12E-01	25.5 µg/L	20.3 µg/L	0.18	0	1.84	1.00E+00	1.24E+01	1.24E+00	Low
	Sr-90	B	8 pCi/L	0.16	10	2.88E-01	180 pCi/L	67.5 pCi/L	0.18	22	1.84	2.26E+02	1.94E-02	2.43E+00	Low
	TCE	B	5 µg/L	0.81	10	1.46E+00	15 µg/L	9.78 µg/L	0.18	0	1.84	1.00E+00	1.43E+01	2.85E+00	Low
100-KR-4	Cr-VI	A	10 µg/L	2.1	24	9.15E+00	3280 µg/L	29.4 µg/L	0.18	0	1.84	1.00E+00	2.69E+02	2.69E+01	Medium*
	H-3	C	20000 pCi/L	0.02	30	1.08E-01	76000 pCi/L	41000 pCi/L	0.18	0	1.84	1.00E+00	4.43E+00	---	Low
	NO3	C	45 mg/L	0.03	24	1.30E-01	63.7 mg/L	59.6 mg/L	0.18	0	1.84	1.00E+00	7.72E+03	---	Low
	Sr-90	B	8 pCi/L	0.05	15	1.35E-01	13200 pCi/L	39.3 pCi/L	0.18	22	1.84	2.26E+02	5.31E-03	6.63E-01	Low
	C-14	A	2000 pCi/L	0.03	24	1.30E-01	39500 pCi/L	6380 pCi/L	0.18	0	1.84	1.00E+00	8.27E-01	4.13E-01	Low
	TCE	B	5 µg/L	0.01	30	5.40E-02	8.3 µg/L	7.4 µg/L	0.18	0	1.84	1.00E+00	4.00E-01	7.99E-02	Low

a. The Water Quality Standard (WQS) is typically the drinking water standard (DWS). The exception is hexavalent chromium (Cr-VI) where the surface water standard (10 µg/L) is used for this Review.

b. Plume area (DOE/RL-2014-32, Rev. 0).

c. As indicated in the Methodology Report (CRESP 2015), the minimum of the value from the Hanford 200-UP-1 OU Interim ROD (EPA 2012) or the unconfined aquifer thickness is used. Plume depths are not known for the 100 Areas primary contaminants. The unconfined aquifer thicknesses are 100-BC: ~30 m, 100-HR: ~10 m, 100-FR: ~10 m and 100-KR: ~30 m (Last 2006). Use of depths from the Hanford 200-UP-1 OU Interim ROD (EPA 2012) or the unconfined aquifer thickness likely results in very large uncertainties in the pore volume and related estimates.

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. Groundwater Threat Metric rating based on Table 6-3, Methodology Report (CRESP 2015) for the Group A and B primary contaminants. Groundwater contaminants that are being treated (Cr-VI in 100-HR using In Situ Redox Manipulation (ISRM) and P&T and Cr-VI in 100-KR using P&T) are indicated in the table with an asterisk (*) although other contaminants are likely being extracted (e.g., Cr-VI in 100-BC).

Table D.4-3. Summary of the Evaluation of Groundwater as Pathway to the Columbia River associated with the RC-GW-3 Evaluation Unit (100-BC-5, 100-HR-3, 100-FR-3, and 100-KR-4 Operable Units)

OU	PC	Group	WQS	BCG or AWQC[a]	Max GW Conc	95th % GW UCL	$R1, \frac{\text{Max GW Conc}}{\text{BCG or WQS}}$	$R2, \frac{\text{95th \% GW UCL}}{\text{BCG or WQS}}$	Shoreline Impact (m)[b]	Riparian Area (ha)[c]	Benthic rating	Riparian rating	Overall rating[d]
100-BC-5	Cr-VI	A	10 µg/L	10 µg/L	62 µg/L	25.9 µg/L	6.20E+00 > 5	2.59E+00 > 1	1.50E+03	3.08E+00	Medium	Medium	Medium
	Sr-90	B	8 pCi/L	279 pCi/L	53 pCi/L	25.2 pCi/L	1.90E-01	9.03E-02	2.70E+02	8.09E-01	---	---	ND
	H-3	C	20000 pCi/L	2.65E+08 pCi/L	19000 pCi/L	---	7.17E-05	---	---	---	---	---	ND
100-HR-3	Cr-VI	A	10 µg/L	10 µg/L	5392 µg/L	55.3 µg/L	5.39E+02 > 5	5.53E+00 > 1	5.25E+02	1.21E+01	High	High	High*
	NO3	C	45 mg/L	7100 mg/L	70.4 mg/L	54.6 mg/L	2.07E-01	1.60E-01	---	---	---	---	ND
	Sr-90	B	8 pCi/L	279 pCi/L	31 pCi/L	46.5 pCi/L	1.11E-01	1.67E-01	3.00E+01	5.67E-02	---	---	ND
	H-3	C	20000 pCi/L	2.65E+08 pCi/L	20000 pCi/L	---	7.55E-05	---	---	---	---	---	ND
100-FR-3	NO3	C	45 mg/L	7100 mg/L	189 mg/L	115 mg/L	5.55E-01	3.37E-01	---	---	---	---	ND
	Cr-VI	A	10 µg/L	10 µg/L	25.5 µg/L	20.3 µg/L	2.55E+00	2.03E+00 > 1	---	---	---	---	Low
	Sr-90	B	8 pCi/L	279 pCi/L	180 pCi/L	67.5 pCi/L	6.45E-01	2.42E-01	---	---	---	---	ND
	TCE	B	5 µg/L	47 µg/L	15 µg/L	9.78 µg/L	3.19E-01	2.08E-01	---	---	---	---	ND
100-KR-4	Cr-VI	A	10 µg/L	10 µg/L	3280 µg/L	29.4 µg/L	3.28E+02 > 5	2.94E+00 > 1	8.00E+02	1.13E+00	Medium	Medium	Medium*
	H-3	C	20000 pCi/L	2.65E+08 pCi/L	76000 pCi/L	41000 pCi/L	2.87E-04	1.55E-04	---	---	---	---	ND
	NO3	C	45 mg/L	7100 mg/L	63.7 mg/L	59.6 mg/L	1.87E-01	1.75E-01	---	---	---	---	ND
	Sr-90	B	8 pCi/L	279 pCi/L	13200 pCi/L	39.3 pCi/L	4.73E+01 > 5	1.41E-01	2.00E+02	2.81E-01[e]	---	---	Low
	C-14	A	2000 pCi/L	609 pCi/L	39500 pCi/L	6380 pCi/L	6.49E+01 > 5	1.05E+01 > 1	---	---	---	---	Low
	TCE	B	5 µg/L	47 µg/L	8.3 µg/L	7.4 µg/L	1.77E-01	1.57E-01	2.10E+02[e]	2.95E-01	---	---	ND

a. Biota Concentration Guide (BCG) from RESRAD-BIOTA v1.5 (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-2014-32, Rev. 0)

c. The intersection area between the groundwater plume and the riparian zone was provided by PNNL based on the 2013 Hanford Site Groundwater Monitoring Report (DOE/RL-2014-32, Rev. 0).

d. The groundwater contaminants that are being treated (Cr-VI in 100-HR using In Situ Redox Manipulation (ISRM) and P&T and Cr-VI in 100-KR using P&T) are indicated in the table with an asterisk (*) although other contaminants are likely being extracted (e.g., Cr-VI in 100-BC).

e. Since there was either a Shoreline Impact or Riparian Area estimate made, the corresponding area of impact was estimated using the ratio of 1.13 ha to 800 m from the hexavalent chromium in 100-KR.

PART VI. POTENTIAL RISK/IMPACT PATHWAYS AND EVENTS

Current Conceptual Model

100-BC (from DOE/RL-2013-22, Rev. 0)

The vadose zone in 100-BC is comprised of Hanford formation sand and gravel (Figure D.4-10). The water table is at a depth of approximately 18 to 24 meters. The upper portion of the unconfined aquifer beneath most of 100-BC is in the highly permeable sediments of the Hanford formation. The lower portion of the aquifer, and the entire aquifer near the Columbia River, is within the Ringold unit E sands and gravels. The unconfined aquifer is 32 to 48 meters thick, and the base of the aquifer is a silt/clay-rich unit commonly called the Ringold upper mud unit (RUM) (DOE/RL-2010-96).

The hydraulic gradient is steepest in the north near the Columbia River, where the water table is in Ringold unit E. The gradient is very low in southern 100-BC where the water table is in the highly permeable Hanford formation. In northern 100-BC, flow is primarily to the north during periods of low and moderate river stage. When river stage is very high, river water flows into the aquifer. A reversed gradient was not observed in 2013, similar to observations in the other river corridor areas. In July when the river stage was high, trend surface analysis showed the potential for flow toward the northwest.

The water table is very flat in southern 100-BC. Trend surface analysis of available data in 2013 indicated flow in southern 100-BC was toward the north-northeast in January and July, and northeast in late February. The water table dipped toward the northwest in October 2013 at a very low gradient. The results of the analyses in February and October have greater uncertainty than the others because the difference in water-table elevations was only about 2 cm across a distance of more than 1 km. Tracer tests conducted in the 100-C-7:1 excavation in spring and summer 2012 indicated flow toward the northeast (PNNL-21845). Recent movement of groundwater contaminants in the shallow aquifer also indicates that flow primarily is toward the northeast.

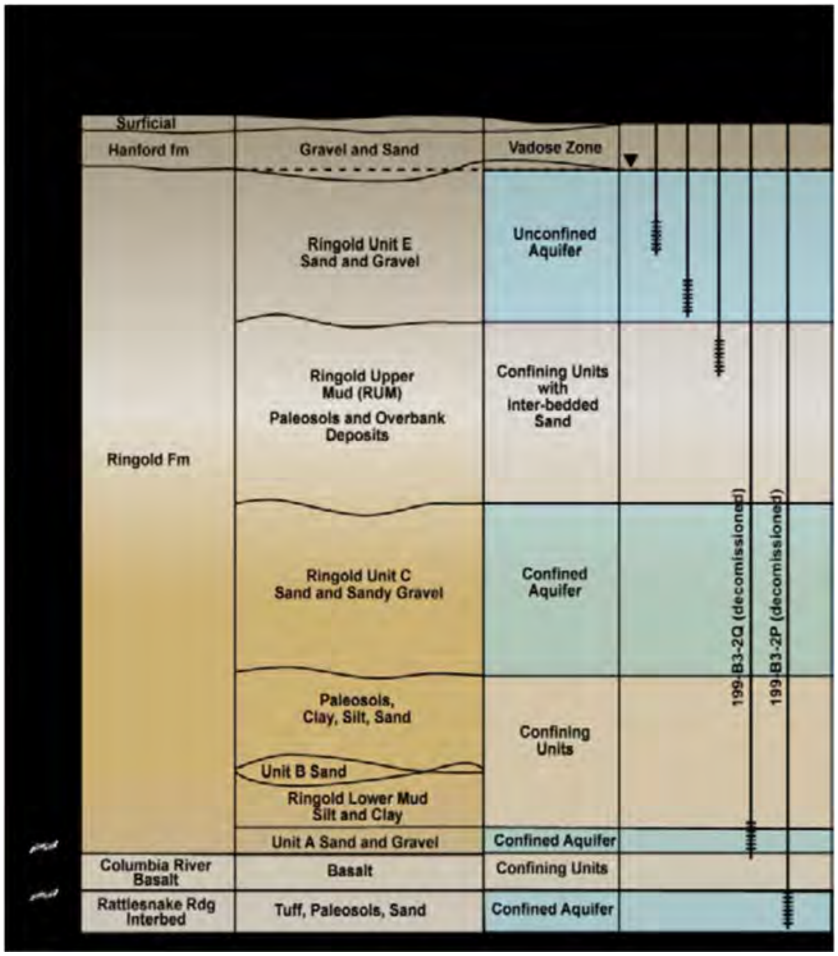

Figure D.4-10. 100-BC Geology (after DOE/RL-2013-22, Rev. 0)

100-FR (from DOE/RL-2013-22, Rev. 0)

The vadose zone and the unconfined aquifer comprise Hanford formation sand and gravel (Figure D.4-11). Ringold Formation unit E is largely absent in this region, limited to isolated remnants. The bottom of the aquifer is the Ringold upper mud unit (RUM). The aquifer ranges from 1 to 8 meters thick. Most of the monitoring wells are screened across all, or nearly all, of the aquifer.

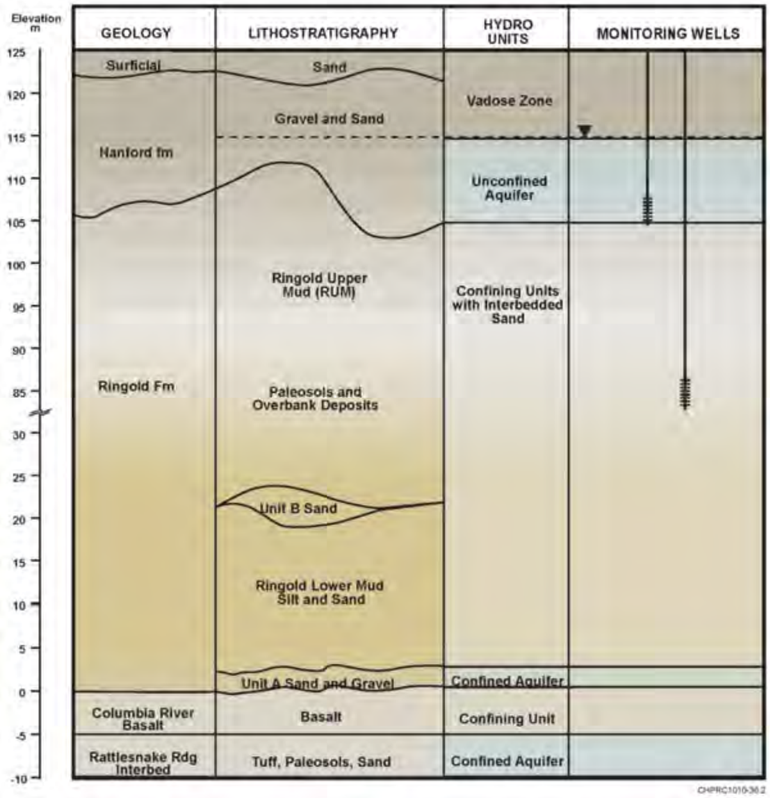

Figure D.4-11. 100-FR Geology (after DOE/RL-2014-32, Rev. 0)

100-HR (from DOE/RL-2013-22, Rev. 0)

Vadose zone thickness, which also represents the depth to groundwater, ranges from 0 to 27 meters, with an average thickness of 20 meters in 100-D and an average thickness of 11.3 meters in 100-H. Thickness of the unconfined aquifer ranges from nearly 0 to 12 meters across the area. Aquifer thickness varies from about 6 to 9 meters beneath 100-D, and from 2 to 5 meters beneath 100-H. The thickness of the unconfined aquifer mimics the topography of the RUM (Hydrogeological Summary Report for 600 Area Between 100-D and 100-H for the 100-HR-3 Groundwater Operable Unit [DOE/RL-2008-42]). The uneven surface of the silt- and clay rich Ringold Formation upper mud unit (RUM) forms the base of the unconfined aquifer.

The unconfined aquifer is primarily present in the Ringold Formation unit E sand and gravels in 100-D and in the Hanford formation gravels in 100-H (Figure D.4.12). Across the Horn, the geology is transitional, changing from predominantly Ringold unit E closer to 100-D to Hanford formation farther east. Pockets of Ringold unit E are found as remnants in various locations. Areas where Ringold unit E is absent form channels across the Horn, resulting in preferential groundwater flow pathways.

Groundwater in 100-HR-3 flows generally to the east-northeast direction, from 100-D across the Horn to 100-H. Flow in 100-H is easterly, generally towards the river. In the southern and central portions of 100-D, groundwater flows to the northwest, towards the Columbia River. The hydraulic gradients are flatter during high river stage when compared to low river conditions. Operation of pump and treat systems at 100-HR-3 has created localized changes in groundwater flow direction and velocity throughout 100-HR-3. These changes are expressed as local depressions and mounds in the water table, affecting the local flow direction and gradient.

Daily and seasonal fluctuations in the river stage also affect groundwater flow in 100-HR-3. As would be expected, longer term changes in the river stage produce more extensive and longer lived changes in the water levels, hydraulic gradient, and flow directions in the unconfined aquifer. The effect of river water migrating into the aquifer can cause lower contaminant concentrations in aquifer tubes and in some near-river wells. Seasonal changes in hexavalent chromium concentrations caused by mixing with river water are most evident at locations within a few meters of the shoreline. Longer-term changes in the river stage produce more extensive and longer-lived changes in the water levels, hydraulic gradient, and flow directions in the unconfined aquifer relative to daily fluctuations.

Contaminants of concern in the 100-HR-3 unconfined aquifer were identified in the RI/FS and include hexavalent chromium, nitrate, strontium-90, and uranium. In the first water bearing unit within the RUM in the 100-H and Horn areas, the contaminant of concern is hexavalent chromium. Other contaminants of interest within 100-HR-3 include technetium-99, sulfate, and tritium. Technetium-99 and uranium have historically been detected in 100-HR-3 groundwater downgradient from their source. Sulfate previously exceeded the 250 mg/L secondary drinking water standard in wells within and downgradient of the In Situ Redox Manipulation (ISRM) barrier in 100-D because of injections of sodium dithionite solution.

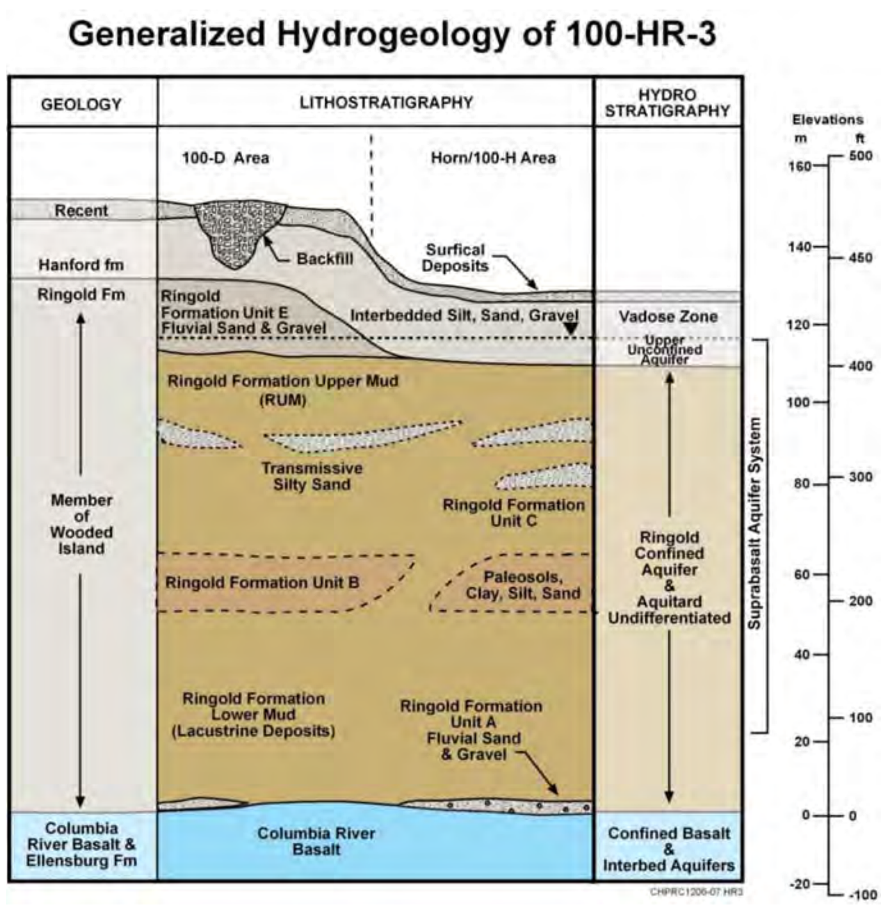

Figure D.4.12. 100-HR Geology (after DOE/RL-2014-32, Rev. 0).

100-KR (from DOE/RL-2014-32, Rev. 0)

The unconfined aquifer in 100-KR ranges from 5.2 to more than 32 meters thick. This aquifer is primarily present in the Ringold Formation unit E sand and gravel (Figure D.4-13). This unit is overlain by the gravels and interbedded sand and silt of the Hanford formation, which comprise the bulk of the vadose zone. The vadose zone ranges from less than 1 meter thick near the Columbia River to 32 meters thick inland. The uneven surface of the silt- and clay-rich Ringold Formation upper mud unit (RUM) forms the bottom of the unconfined aquifer. Contaminant concentrations are generally highest within the uppermost portion of the aquifer near the water table, however, mobile contaminants (e.g., hexavalent chromium) have been detected over the entire aquifer thickness, particularly near source areas.

Groundwater in 100-KR flows generally to the northwest toward the Columbia River, which forms a discharge boundary for the unconfined aquifer. Operation of pump and treat (P&T) systems at 100-KR creates changes in groundwater flow direction and velocity. Larger mounds, such as that produced by the combined discharges from KR4 and KX systems near the middle of the 116-K-2 Trench, create conditions of radial flow away from the mound. This creates local diversion of groundwater flow direction away from the natural patterns. Groundwater further inland of 100-K Area generally flows to the north and northeast toward 100-N and 100-D Areas. The actual flow direction and apparent velocity in this inland area is somewhat uncertain due to sparse groundwater elevation measurements in the area.

Daily and seasonal fluctuations in the river stage also affect groundwater flow in 100-KR. As would be expected, longer term changes in the river stage produce more extensive and longer lived changes in the water levels, hydraulic gradient, and flow directions in the unconfined aquifer. Intrusion of river water into the aquifer during high river stage can lower contaminant concentrations in aquifer tubes and in some near-river wells. Peak high river stage in 2013 was observed at three periods in April, May, and June. Low river stage periods for calendar year 2013 were observed from January 2013 through March and from early August through December 2013. The peak river stage elevation observed in 2013 was about 2 meters lower than the peaks observed in the two years preceding (i.e., 2012 and 2011).

Contaminants of concern (COCs) in the 100-KR unconfined aquifer were identified in the RI/FS and include chromium (total and hexavalent), tritium, nitrate, strontium-90, carbon-14, and trichloroethene (TCE). All elevated anthropogenic chromium at 100-KR is understood to be present as hexavalent chromium and so total chromium and hexavalent chromium are discussed as hexavalent chromium for purposes of this report.

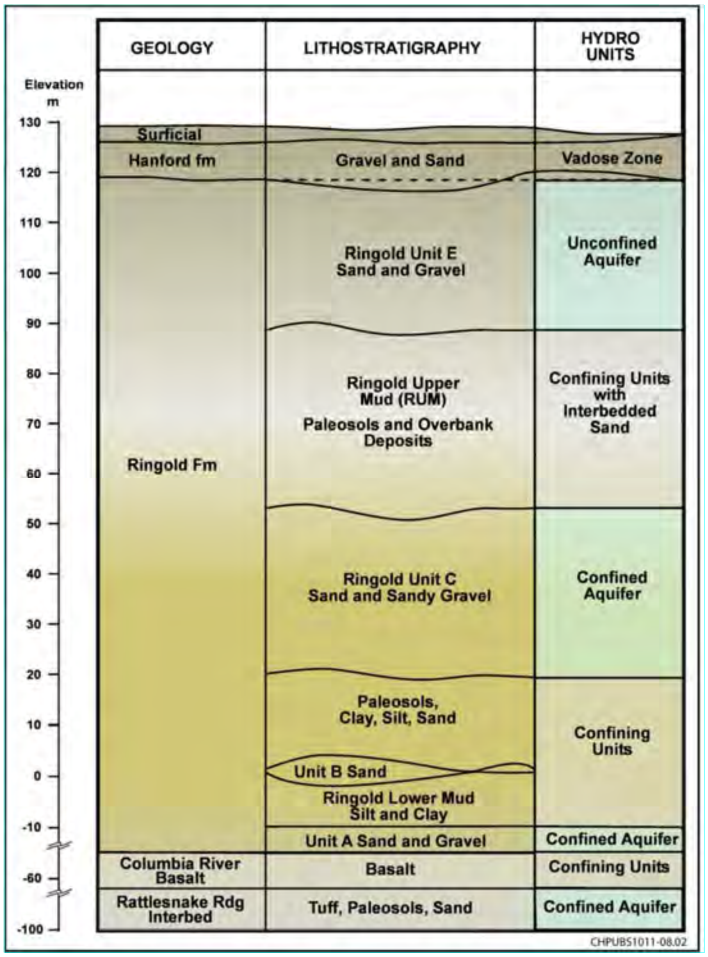

Figure D.4-13. 100-KR Geology (after DOE/RL-2014-32, Rev. 0)

POPULATIONS AND RESOURCES CURRENTLY AT RISK OR POTENTIALLY IMPACTED

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, 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.4-2, the current saturated zone (SZ) GTM values translate to:

- 100-BC-5: Group A and B primary contaminants range from *Low* for Sr-90 to *Medium* for hexavalent chromium (which is not being treated). There is no calculated tritium (Group C) plume areas and thus no rating.
- 100-HR-3: Group A and B primary contaminants range from *Low* for Sr-90 to *Medium* for hexavalent chromium (which is being treated). The nitrate plume areas (Group C) translates to *Low* based on the current plume area. There is no calculated tritium (Group C) plume areas and thus no rating.
- 100-FR-3: Group A and B primary contaminants are *Low* for hexavalent chromium, Sr-90, and TCE. The nitrate plume areas (Group C) translates to *Medium* (which is not being treated).
- 100-KR-4: Group A and B primary contaminants are *Low* for Sr-90, C-14, and TCE to *Medium* for hexavalent chromium (which is being treated). The tritium and nitrate plume areas (Group C) translates to *Low* ratings.

Thus the overall rating for the RC-GW-3 EU threat to groundwater would be *Medium* related to hexavalent chromium (100-BC-5, 100-HR-3, and 100-KR-4) and nitrate (Group C) in the 100-FR-3 OU.

Columbia River

As described in Part V (Table D.4-3), seven plumes from the four OUs currently intersect the Columbia River at concentrations exceeding the WQS. The ratings range from *Not Discernible* for TCE (100-KR-4) to *Low* for Cr-VI (100-FR-3), Sr-90 (100-KR-4), and C-14 (100-KR-4) to *Medium* for Cr-VI (100-BC-5 and 100-100-KR-4) to *High* for Cr-VI (100-HR-3). The ratings for the other contaminants would be *Not Discernible*. Thus current impacts from these OUs to the Columbia River benthic and riparian zone ecology would be rated as *High* related to hexavalent chromium in 100-HR-3, which is currently being treated using P&T and ISRM.

Ecological Resources

For the four groundwater evaluation units with plumes that are estimated to intersect the Columbia River, there are approximately 100.25 acres of riparian habitat and resources along the river shoreline that could potentially be affected.

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

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

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

Cultural Resources

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

CLEANUP APPROACHES AND END-STATE CONCEPTUAL MODEL

Selected or Potential Cleanup Approaches

100-BC-5: (after DOE/RL-90-08 Procedural Draft and DOE/RL-2014-32 Rev. 0). Previous assessments have not resulted in any interim remedial measures for groundwater for 100-BC-5. In 2013, CERCLA activities in 100-BC included routine groundwater monitoring and the beginning of additional remedial investigation (RI) studies. DOE is conducting additional studies in 100-BC between 2013 and 2015 to reduce uncertainties relating to (i) the completion of waste site remediation; (ii) short term changes in groundwater contaminants related to waste site remediation; (iii) modeling results predicting that it will take a long time for the hexavalent chromium plume to attenuate; and (iv) the level of risk associated with variable contaminant concentrations in Columbia River pore water. To address these uncertainties, a change was initiated in TPA Milestone M-015-74 and the RI/Feasibility Study (FS) Work Plan and Sampling Analysis Plan (SAP) were amended. In 2013, workers installed a series of shallow aquifer tubes called hyporheic sampling points (HSP) to monitor Columbia River pore water. The HSPs will be monitored for hexavalent chromium monthly for 2 years to identify seasonal changes and characterize the level of risk to aquatic receptors. Tritium, strontium-90, and additional parameters will be analyzed semiannually. The revised work plan called for installation of between 7 and 10 new groundwater monitoring wells to characterize the geology and vertical distribution of contaminants in areas of uncertainty. The wells were planned in pairs to increase vertical monitoring capability. Drilling began in fall 2013 and eight wells were completed before the end of February 2014. The new wells and older wells will be monitored for two years to evaluate (i) the nature and extent of hexavalent chromium contamination (and co-contaminants), (ii) groundwater model input parameters, and (iii) which natural attenuation processes are occurring. Monitoring frequency is quarterly for the new wells and older wells with rapid changes in chromium concentration, and semiannually or annually for wells with less variability.

100-FR-3: (after ECF-100FR3-11-0116 Revision 3). No final Record of Decision has been signed for 100-FR-3. Remedial alternatives are provided from the RI/FS for Remedial Investigation/Feasibility Study for the 100-FR-3 Operable Unit (ECF-100FR3-11-0116 Revision 3).

- **Alternative 1 – (No Action [as required by the NCP]).** This alternative is required by the NCP ("Remedial Investigation/Feasibility Study and Selection of Remedy" [40 CFR 300.430(e)(6)]). For this alternative, it is assumed that all site remedial activities and interim actions, with the possible exception of backfilling any unsafe open excavations, will be discontinued in December 2012. Operation of the existing DX and HX pump-and-treat systems and any other monitoring would cease.
- **Alternative 2 – Institutional Controls (ICs) and Monitored Natural Attenuation (MNA).** ICs will be used to prevent exposure to contaminated groundwater until natural attenuation processes reduce COC concentrations of the COC plumes as they migrate under ambient aquifer conditions.
- **Alternative 3 –** Pump and Treat (P&T) Optimized with Other Technologies. Installation and operation of a P&T with implementation of in-situ treatment (bioremediation) at selected wells to address hexavalent chromium (Cr(VI)) and nitrate contamination.
- **Alternative 4 –** Enhanced Pump and Treat. Installation and operation of an expanded Pump and Treat system considering ex-situ treatment for all COCs.

100-HR-3: (after DOE/RL-2010-95 Rev. 0). No final Record of Decision has been signed for 100-HR-3. Remedial alternatives are provided from the RI/FS for Remedial Investigation/Feasibility Study for the 100-DR-1, 100-DR-2, 100-HR-1, 100-HR-2, and100-HR-3 Operable Units (DOE/RL-2010-95 Rev 0).

- **Alternative 1 – (No Action [as required by the NCP]).** This alternative is required by the NCP ("Remedial Investigation/Feasibility Study and Selection of Remedy" [40 CFR 300.430(e)(6)]). For this alternative, it is assumed that all site remedial activities and interim actions, with the possible exception of backfilling any unsafe open excavations, will be discontinued in December 2012. Operation of the existing DX and HX pump-and-treat systems and any other monitoring would cease. The groundwater model simulations (*Modeling of RI/FS Design Alternatives for 100-HR-3* [ECF-100HR3-11-0114]) assume no continuing sources for groundwater contamination. Because the pump-and-treat systems are shut down after 2012, extraction wells along the river are turned off and no longer provide containment of inland contamination from migrating and reaching the river, as can be seen in the model prediction after 3 years of terminating interim actions. Some mass removal is predicted to occur through natural flushing, as can be seen in the changes in concentrations out through 75 years. However, relatively large areas with greater than 10 µg/L Cr(VI) are predicted to remain after 75 years. If waste site remediation is not complete, as assumed, then the area with greater than 10 µg/L Cr(VI) would be larger.
- **Alternative 2 – RTD and Void-Fill Grouting for Waste Sites and Pump-and-Treat with Biological Treatment for Groundwater.** This alternative uses RTD for removal of contamination to cleanup levels for waste sites. Void-fill grouting will be used for the box flume of waste site 100-H-36 where RTD would have large ecological impacts near the river. For groundwater, a pump-and-treat system and biological treatment targeting Cr(VI) will be used. Nitrate and strontium-90 contaminated groundwater are within the treatment footprint of the Cr(VI) plume. Based on operational data from the currently operating pump-and-treat facilities and groundwater

simulation modeling results, the groundwater treatment system effluent has not and is not expected to exceed MCLs for co-extracted strontium-90 or nitrate, so no treatment is proposed for these groundwater COCs. However, if, through normal operation of the groundwater treatment system, concentrations of co-extracted COCs exceed MCLs in the effluent, specific treatment would be evaluated for the respective COCs before reinjection or other approved discharge.

- **Alternative 3 – RTD and Void-Fill Grouting for Waste Sites and Increased Capacity Pump-and-Treat for Groundwater.** This alternative uses RTD for removal of contamination to cleanup levels for waste sites. Void-fill grouting will be used for the box flume of waste site 100-H-36 where RTD would have large ecological impacts near the river. For groundwater, an expanded pump-and-treat system for treatment of Cr(VI) will be used. Nitrate and strontium-90 contaminated groundwater plumes are within the treatment footprint for the Cr(VI) plume. As identified in Alternative 2, the groundwater treatment system effluent at the 100-D and 100-H pump-and-treat systems has not, and is not, expected to exceed MCLs, so no treatment is proposed for strontium-90 or nitrate. However, if through normal operation of the groundwater treatment system, concentrations of co-extracted COCs exceed MCLs in the effluent, specific treatment would be evaluated for the respective COCs before reinjection or other approved discharge. The application of MNA (such as radioactive decay), the use of dispersion and diffusion, ongoing monitoring, and ICs for each of the groundwater co-contaminants and the vadose zone are discussed under Section 9.2.2 (Common Elements for Alternatives 2, 3, and 4). A detailed description for this alternative is provided in Section 9.2.4.
- **Alternative 4 – RTD for Waste Sites and Pump-and-Treat for Groundwater.** This alternative uses RTD for removal of contamination to cleanup levels for waste sites. For groundwater, pump-and-treat system for treatment of Cr(VI) will be used. Nitrate and strontium-90 contaminated groundwater plumes are within the treatment footprint for the Cr(VI) plume and will be co-extracted by the extraction well network used for the Cr(VI) plume remediation. As identified in Alternative 2, the groundwater treatment system effluent at the 100-D and 100-H pump-and-treat systems has not, and is not, expected to exceed MCLs, so no treatment is proposed for strontium-90 or nitrate. However, if, through normal operation of the groundwater treatment system, concentrations of co-extracted COCs exceed MCLs in the effluent, specific treatment would be evaluated for the respective COCs before reinjection or other approved discharge.

100-KR-4: (after DOE/RL-2010-97 Draft A). No final Record of Decision has been signed for 100-KR-4. Remedial alternatives are provided from the RI/FS for Remedial Investigation/Feasibility Study for the 100-KR-1, 100-KR-2, and100-KR-4 Operable Units (DOE/RL-2010-97 Draft A).

- **Alternative 1 – (No Action [as required by the NCP]).** This alternative is required by the NCP ("Remedial Investigation/Feasibility Study and Selection of Remedy" [40 CFR 300.430(e)(6)]). For this alternative, it is assumed that all site remedial activities and interim actions, with the possible exception of backfilling any unsafe open excavations, will be discontinued in December 2012. This includes ceasing operation of the existing KR-4, KW, and KX pump-and-treat systems and any additional monitoring. Since the pump-and-treat systems are shut down after 2012, the containment of the plume along the river that is obvious at 2012 is lost, as can be seen in the 2020 model prediction. Some mass removal is predicted to occur via natural flushing, as can be seen in the changes in concentrations out to 2087. However, relatively large areas with greater than 10 µg/L Cr(VI) are predicted to remain at 2087. For nitrate, the K-West plume migrates toward the river in 2037 and has mostly dissipated by 2087.

- **Alternative 2 – RTD and Groundwater P&T Optimized with Other Technologies.** Alternative 2 uses a strategy of optimizing the risk reduction as well as the cost by using a mixture of RTD with other technologies. The actions will vary, depending on the nature and extent of contamination at the waste site, as will be determined following the Decision Logic flowchart. The actions could include one or more of the following:
  - RTD of shallow vadose zone areas. RTD would also include demolition of structures (e.g., buildings) when necessary.
  - Soil flushing with treatment of groundwater.
  - Biological infiltration.
  - Bioventing or land farming for sites with TPH as a COC.
  - Temporary surface barriers.
  - For groundwater, optimization of the pump-and-treat system with biological infiltration and biological injection.
  - Supplemental ICs to mitigate exposure, where potentially required.

  Based on the modeling results, by 2020, hexavalent chromium plumes will have been remediated to meet DWS, with a few pockets above the 10 µg/L aquatic standard. Wells downgradient of areas above 10 µg/L will continue remediation of the plume and maintain containment while the rest of the inland systems are shut down. The pump-and-treat systems will continue operating through 2037 to remediate the Cr(VI) plume below 10 µg/L. Three new extraction wells are included in this alternative to capture the nitrate plume between K-West and K-East. Based on modeling, the nitrate plume is nearly completely below 45 mg/L in the K-West area by 2020 and is reduced to below 45 mg/L by 2037. To deal with the uncertainty in groundwater modeling simulations, RPO activities will be conducted throughout the life of the project.
- **Alternative 3 – RTD and Void-Fill Grouting for Waste Sites and Increased Capacity Pump-and-Treat for Groundwater.** Alternative 3 uses a strategy of RTD almost exclusively for waste site contamination to rapidly achieve the RAOs, with the greatest degree of certainty, as well as aggressive pump-and-treat for groundwater. The remedial action will include the following activities:
- RTD for waste sites, with excavation until standards are achieved. RTD would also include demolition of structures (e.g., buildings) when necessary.
- Temporary surface barriers.
- For Cr(VI) in groundwater, aggressive pump-and-treat.
- Supplemental ICs to mitigate exposure, where potentially required.

  The groundwater extracted from within the carbon-14 plume are likely to have carbon-14 greater than the DWS. Water from this well will be treated in an air stripper to reduce the carbon-14 to below the DWS prior to re-injection. The modeling predicts that by 2020, the majority of plumes are gone with only very small pockets of chromium remaining at low concentrations. The modeling further predicts that by 2020, only low concentrations of nitrate remain in the K-West plume in a small, localized area. When evaluating these groundwater modeling results, the uncertainty in the model needs to be appreciated. To deal with the uncertainty, RPO activities will be conducted throughout the life of the project.

Contaminant Inventory Remaining at the Conclusion of Planned Active Cleanup Period

After the Active Cleanup period, only the hexavalent chromium in 100-BC-5 and C-14 in 100-KR-4 have ratings that include Medium indicating inventories that might translate to appreciable plumes. There are also a few others that might represent small plumes after the Active Cleanup period.

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 RC-GW-3 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

As described in Part V, some constituents may be significantly impacted by cleanup operations or radioactive decay. To summarize, the modified results for the River Corridor include:

- Hexavalent chromium (Group A) – For 100-HR-3 it is assumed that the P&T and ISRM systems would continue to be effective resulting in *Medium* and *Low* ratings for Active and Near-term, Post-Cleanup periods, respectively (to account for inventory and treatment uncertainties and because the final ROD has yet to be signed). For 100-KR-4 it is assumed that the P&T system would continue to be effective resulting in *Medium* and *Low* ratings for Active and Near-term, Post-Cleanup periods, respectively (to account for inventory and treatment uncertainties and because the final ROD has yet to be signed).

- Sr-90 (Group B) – The maximum concentrations for OUs other than 100-KR-4 would result in a *Low* rating in the Near-term, Post-Cleanup period.

Columbia River

For those contaminants currently in contact with the River, the following changes would be made to ratings (Part V):

- 100-HR-3: Hexavalent chromium is expected to reach the cleanup level (10 µg/L) during the Active Cleanup period (DOE/RL-2011-111, Draft A) using the P&T and ISRM systems resulting in an *Medium* rating and a corresponding *Low* rating for the Near-term, Post-Cleanup period to account for uncertainties in inventory and treatment.
- 100-KR-4: Hexavalent chromium is expected to reach the cleanup level (10 µg/L) over much of 100-KR during the Active Cleanup period (DOE/RL-2010-97, Draft A) resulting in a *Medium* rating and a corresponding *Low* rating for the Near-term, Post-Cleanup period to account for uncertainties in inventory and treatment.

As described in Part V, because most of the plumes (not already in contact with the River) are unlikely to contact the Columbia River over the next 150 years (unless hydrologic conditions change significantly), the ratings (primarily *ND* or *Low*) for most of the contaminants not currently in contact with the Columbia River will not be modified. However, for Sr-90 (100-FR-3) even though the plume moves very slowly, there is a chance that it could reach the River in the Active Cleanup period (*Low* rating) but decay would likely result in no plume (all things being equal) for an *Not Discernible* rating during the Near-term, Post-Cleanup period.

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

The CP-GW-1 EU CERCLA Groundwater Operable Units (OUs), 100-BC-5, 100-FR-3, 100-HR-3, and 100-KR-4, have each undergone extensive characterization, assessment, and remediation. More than 85% of the former waste sites in the River Corridor have been remediated or are classified as not needing remediation under interim Records of Decision (RODs). The rest of the waste sites will be remediated in the next few years. As such, potential sources of additional groundwater contamination are being removed from the region that poses the most immediate threat to the Columbia River. Delaying planned new actions or halting current active remedial actions could result in increased contaminant release to the Columbia River. Summarized below are brief descriptions of remedial actions completed to date (DOE/RL-2014-32 Revision 0).

- ***100-BC***. New wells and sampling points were installed in 2013 to provide data that will support final decisions about groundwater cleanup in 2016. This includes ongoing, intensive sampling of water in the shallow river bed. The last remedial action in the area included a very large soil excavation down to the water table (~24 m), backfilling with native soil and revegetation.

- ***100-FR**.* Decision documents are being finalized and final cleanup decisions are expected in 2014. Groundwater contaminants are present at relatively low concentrations and do not appear to be impacting the river. Monitored natural attenuation (MNA) of contaminants is proposed.
- ***100-HR***. Two P&T systems continued to operate under an interim ROD. In 2013 2.4 billion liters of groundwater were pumped from 72 extraction wells. A total of 2,039 kg of hexavalent chromium have been removed from groundwater to date. The plume area (>20 µg/L) was estimated to be 4.0 km2 in 2013 about the same as in 2012. Since 2005 the plume has shrunk by approximately 50%. Final cleanup decisions are expected in 2015; additional P&T is proposed. For 100-HR-3, by the end of 2013, more than 75% of the waste sites had been addressed (closed, interim closed, no action, etc.).

100-KR. Three P&T systems continued to operate under an interim ROD. In 2013 over 2 billion liters of groundwater was pumped from 36 extraction wells. A total of 1,647 kg of hexavalent chromium have been removed from groundwater to date. The plume area (>20 µg/L) was estimated to be 1.0 km^2 in 2013, about the same as in 2012. Since 2007, the plume area has decreased by approximately two-thirds. Final cleanup decisions are expected after 2015; additional pump and treat is proposed. For 100-KR-4, at the end of 2013, approximately 60 percent of the waste sites were addressed (closed, interim closed, no action, etc.), with approximately 37 percent having undergone active remediation to remove secondary sources of contamination that could migrate to groundwater and reduce the risk of direct exposure at the surface.

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

Please see Part V for a discussion of the impact of cleanup, recharge, and decay on groundwater and Columbia River ratings in the Near-term, Post-Cleanup period. For potential impacts to groundwater, the ratings for the four 100 Area OUs tend to be either *ND* to *Low* to reflect presumed treatment effectiveness. An exception is hexavalent chromium in 100-BC-5 (with *Medium* rating) indicating no selected final remedial actions and inventories that might translate to appreciable plumes in this evaluation period.

For the ratings related to threats to the Columbia River, the hexavalent chromium in 100-BC-5 has a rating (*Medium*) in this period above an *ND* or *Low* indicating again that monitoring and treatment are needed.

Populations and Resources at Risk or Potentially Impacted After Cleanup Actions (from residual contaminant inventory or long-term activities)

Table D.4-4. 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	100-BC-5 OU: Medium (Cr-VI) 100-HR-3 OU: Low (Cr-VI) 100-FR-3 OU: Medium (NO3) 100-KR-4 OU: Low (Cr-VI) Overall: Medium (Cr-VI, NO3)	As discussed in Part V, Cr-VI drives the risk in 100-BC-5 (no final treatment selected). Treatment continuing in 100-HR-3 and 100-KR-4. For 100-FR-3, nitrate (Group C) drives risk (no treatment).
	Columbia River	Benthic/Riparian: 100-BC-5: Medium (Cr-VI) 100-HR-3: Low (Cr-VI) 100-FR-3: Low (Cr-VI) 100-KR-4: Low (Cr-VI) Free-flowing: All OUs: Not Discernible **Overall**: Medium (Cr-VI)	As discussed in Part V, Cr-VI drives the risk in 100-BC-5 (no final treatment selected). Treatment continuing in 100-HR-3 and 100-KR-4. For 100-FR-3, Cr-VI drives some risk (no treatment).
	Ecological Resources*	Low	Contamination remaining in areas for monitored natural attenuation may still result in uptake in biota, but is not likely to cause an effect to the biota. Continued long-term monitoring activities may disrupt riparian and terrestrial habitats. Re-vegetation in EU will result in additional level 3 resources, and potentially creation of level 4 resources potentially at risk because of disturbance, especially from invasive species.

Social	Cultural Resources*	**Native American:** Direct: Known Indirect: Known **Historic Pre-Hanford:** Direct: Known Indirect: Known **Manhattan/Cold War**: Direct: Unknown Indirect: Unknown	Permanent direct and indirect effects are possible due to high sensitivity of area.

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.

Long-Term, Post-Cleanup Status – Inventories and Risks and Potential Impact Pathways

Because final remedial actions have not been selected for the 100-BC-5 and 100-FR-3 Groundwater Operable Units, the ratings (*Medium* for threats to groundwater and the Columbia River) indicate the need for monitoring and treatment of groundwater in these areas.

PART VII. SUPPLEMENTAL INFORMATION AND CONSIDERATIONS

The 100-B/D/H/F/K Area needs to remain under DOE control to maintain institutional control for all remediation activities until all soil and groundwater contaminants reach CULs, to include areas outside 100-B/D/H/F/K which have the potential to also contaminant groundwater in this area.

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APPENDIX D.5

Operable Units 200-BP-5 and 200-PO-1 in 200-East
(CP-GW-1, Central Plateau)
Evaluation Unit Summary Template

Table of Contents

List of Tables

List of Figures

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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-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: 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 OUs because available data has been arranged based on the OUs. The primary contaminants (i.e., those with areas of concentration exceeding drinking water standards) for the 200-BP-5 OU are nitrate, I-129, Tc-99, uranium, Sr-90, cyanide (CN), and tritium (H-3) (DOE/RL-2014-32, Rev. 0, p. BP-3). 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-2014-32, Rev. 0, p. BP-1).

The primary contaminants for the 200-PO-1 OU are tritium (H-3), I-129, nitrate, Sr-90, Tc-99, and uranium (DOE/RL-2014-32, Rev. 0, p. PO-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-2014-32, Rev. 0, p. PO-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-2014-32, Rev. 0, p. PO-5). Thus these are not considered primary contaminants for the 200-PO-1 OU.

BRIEF NARRATIVE DESCRIPTION

The CP-GW-1 EU is related to two Hanford interest areas: 200-BP and 200-PO; however, we will focus on the two corresponding CERCLA groundwater Operable Units (OUs), 200-BP-5 and 200-PO-1, respectively, for this discussion.

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-2014-32, Rev. 0, p. BP-1). The primary separation facilities overlying the 200-BP-5 OU were B Plant and Hot Semi-Works; however, liquid waste from the other separation facilities were stored or released at sites overlying the OU 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 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-5, the following actions are being conducted:

- Ongoing perched water treatability test (200-DV-1) at WMA B-BX-BY to remove uranium. By 2013, approximately 691,000 L of perched water containing approximately 373 Kg of nitrate, 0.022 Ci of Tc-99, and 31.9 kg of uranium was extracted (DOE/RL-2013-22, Rev. 0; DOE/RL-2014-32, Rev. 0, page BP-8).
- Waste Management Area (WMA) C Tank Waste Retrieval. Tank wastes are currently being retrieved from WMA C. Waste retrieval has been completed in nine of the 16 tanks, has been completed to various limits of technology in four tanks, and retrievals are in progress in the remaining three tanks (Weyns 2015).
- The final action record of decision for the 200-BP-5 OU is scheduled for 2016 (DOE/RL-2014-32, Rev. 0, p. BP-3).

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-2014-32, Rev. 0, p. PO-1). Groundwater within the 200-PO-1 OU 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 *Very High*. The estimated mitigated exposure that takes engineered and administrative controls and protections into consideration, is shown in parenthesis.

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: No risk ratings are provided for Cultural Resources. The Table 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.

Table D.5-1. Risk Rating Summary (for Human Health, unmitigated nuclear safety basis indicated, mitigated basis indicated in parenthesis (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-5 OU: Low to High (I-129, Tc-99, Sr-90) 200-PO-1 OU: Low to Very High (I-129) Overall: Very High (I-129)	200-BP-5 OU: Low to High (I-129, Tc-99) 200-PO-1 OU: 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*	Low	Very High
Social	Cultural Resources*	**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

*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.

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); 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-5 Group A and B primary contaminants range from *Low* for cyanide to *Medium* for uranium to *High* for I-129, Tc-99, and Sr-90. The nitrate and tritium plume areas (Group C) translate to *Medium*. For 200-PO-1, 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-1.

Columbia River: For 200-BP-5, 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-5 OU to the Columbia River benthic and riparian ecology are rated as *Not Discernible*.

For 200-PO-1, 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 OU. 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 (as described in Part V), only Sr-90 from the 200-BP-5 OU and nitrate from the 200-PO-1 OU have different (i.e., lower) ratings from those for Current conditions. During the Near-term, Post-Cleanup period, not only the contaminants mentioned above but also the Tc-99 in the 200-PO-1 OU has a lower rating. 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, the ratings (*High* for 200-BP-5 and *Very High* for 200-PO-1) 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-5 and 200-PO-1 Operable Units

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) have either interim or final Records of Decision.

A draft decisional remedial investigation report (RIR) was completed 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-2014-32, Rev. 0, p. BP-8). Other ongoing CERCLA activities related to the 200-BP-5 OU 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 is underway 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-5: A draft decisional remedial investigation report (RIR) (no document number provided) mentioned in DOE/RL-2014-32, Rev. 0. Sampling and Analysis Plan (DOE/RL-2001-49, Rev. 1) issued in 2005. Final action 200-BP-5 record of decision scheduled for 2016.

200-PO-1: 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

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 August 2015

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)4 in the 200-PO-1 and 200-BP-5 OUs in the 200-East Area.

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-2014-32, Rev. 0):

- Nitrate continues to represent the most extensive plume in 200-BO 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 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: 7.9 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 decreasing in areal extent (Figure D.5-1).
    - Maximum concentration: 7.54 pCi/L (299-E27-22) versus a DWS of 1 pCi/L
    - Areal extent of the plume: 4.5 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 Gable Gap. 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: 36,000 pCi/L (299-E33-18) versus a DWS of 900 pCi/L
    - Areal extent of the plume: 2.4 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 over the last two years but is still higher than that in 2010 (Figure D.5-1).
    - Maximum concentration: 3,300 µg/L (299-E33-18) versus a DWS of 30 µg/L
    - Areal extent of the plume: 0.5 km^2

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[4] 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.

  - 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 since 2011 (Figure D.5-1).
  - Maximum concentration: 980 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. The cyanide plume area increased between 2012 and 2013 (Figure D.5-1).
  - Maximum concentration: 1,520 µg/L (299-E33-47) versus a DWS of 2,000 µg/L
  - Areal extent of the plume: 0.4 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 2013, tritium results exceeding DWS were detected at 4 locations. New wells have been planned in this area to depict the extent of the tritium at depth in this area.
  - Maximum concentrations: 22,000 pCi/L (299-E33-15) versus a DWS of 20,000 pCi/L
  - Areal extent of the plume: 0.2 km^2
  - Shoreline impact: 0 m
  - Riparian zone intersected: 0 ha

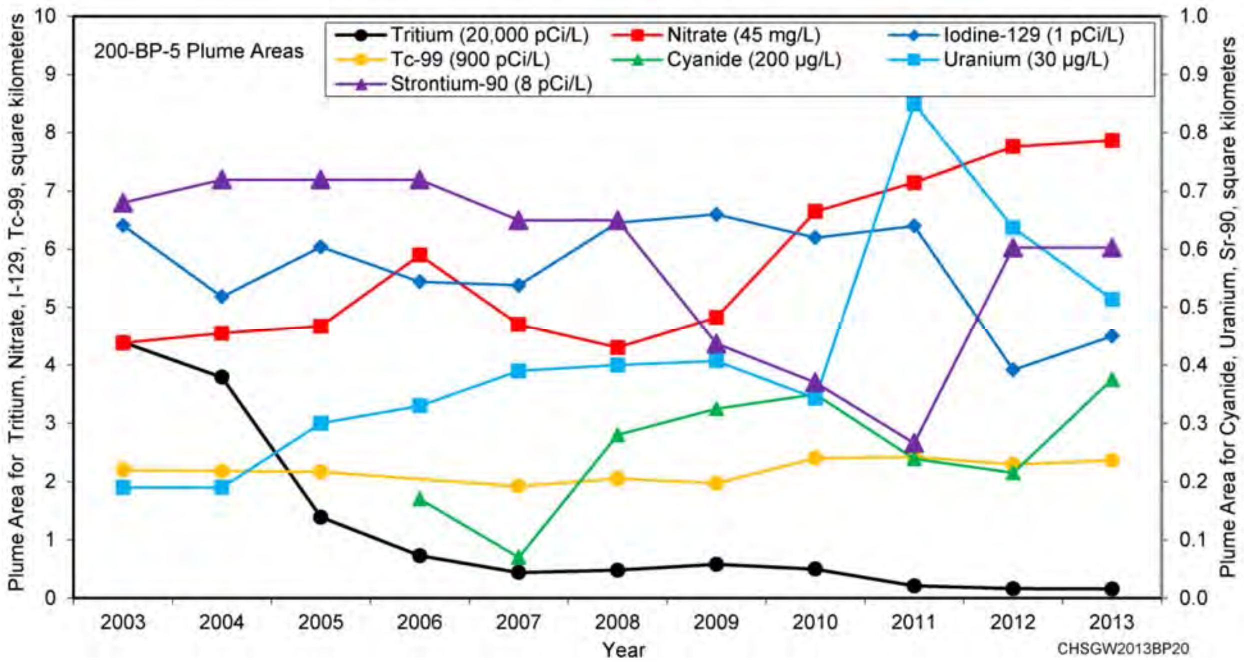

Figure D.5-1. 200-BP 2013 Plume Areas (DOE/RL-2014-32, Rev. 0, p. BP-10)

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-2014-32, 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: 490,000 pCi/L (299-E17-19) versus a DWS of 20,000 pCi/L.
    - Areal extent of the plume: 83.4 km^2.
    - Shoreline impact: ~4300 m (i.e., no shoreline impact provided in 2013 Groundwater Report (DOE/RL-2014-32, Rev. 0); this distance estimated using PHOENIX (http://phoenix.pnnl.gov/)
    - Riparian zone intersected: 21.4 ha (52.84 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: 9.1 pCi/L (299-E17-19) versus a DWS of 1 pCi/L.
    - Areal extent of the plume: 52.1 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 increasing since 2007 (Figure D.5-2). The highest concentrations of nitrate have been detected near the PUREX cribs and trenches.
  - Maximum concentration: 126,000 µg/L (299-E17-19) versus a DWS of 45,000 µg/L.
  - Areal extent of the plume: 3.71 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). A small plume remains near the 216-A-36B crib; Sr-90 was detected above the DWS in only one well in 2013 (and was not detected in 2012).
  - Maximum concentration: 15 pCi/L (299-E17-14) versus a DWS of 8 pCi/L.
  - Areal extent of the plume: 0.01 km^2.
  - 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: 4,200 pCi/L (299-E25-93) versus a DWS of 900 pCi/L.
  - Areal extent of the plume: 0.03 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 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: 58.8 µg/L (299-E25-36) versus a DWS of 30 µg/L.
  - Areal extent of the plume: 0.02 km^2.
  - Shoreline impact: 0 m
  - Riparian zone intersected: 0 ha

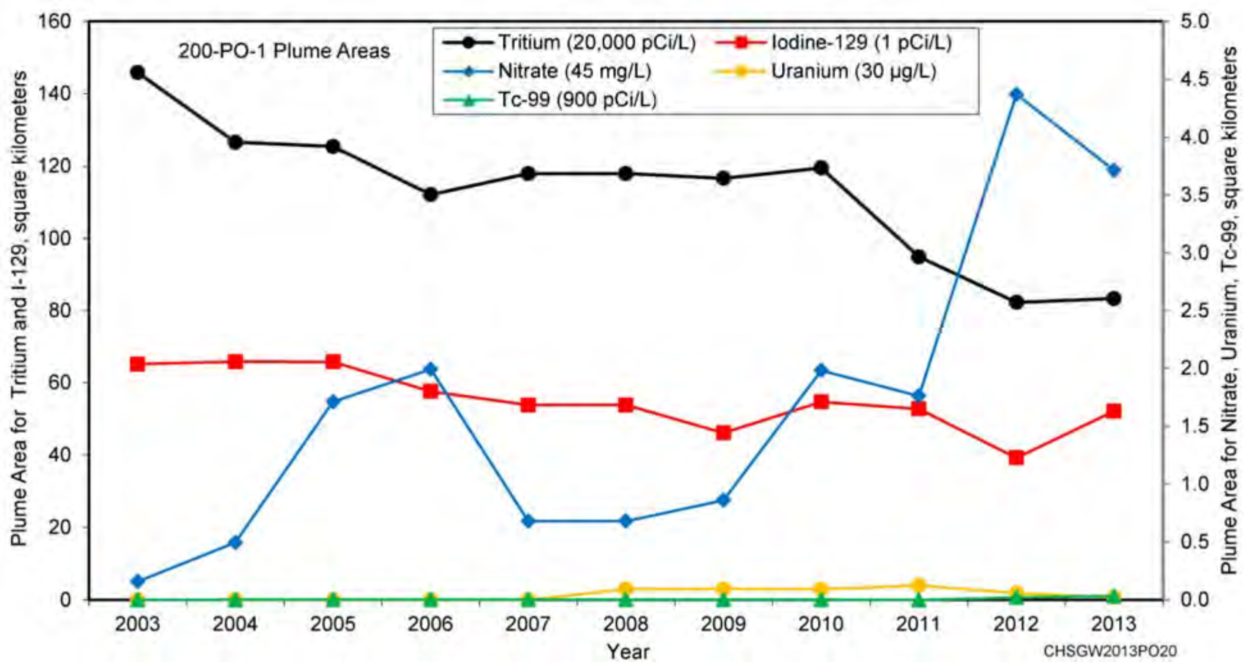

Figure D.5-2. 200-PO 2013 Plume Areas (DOE/RL-2014-32, Rev. 0, p. PO-7)

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.

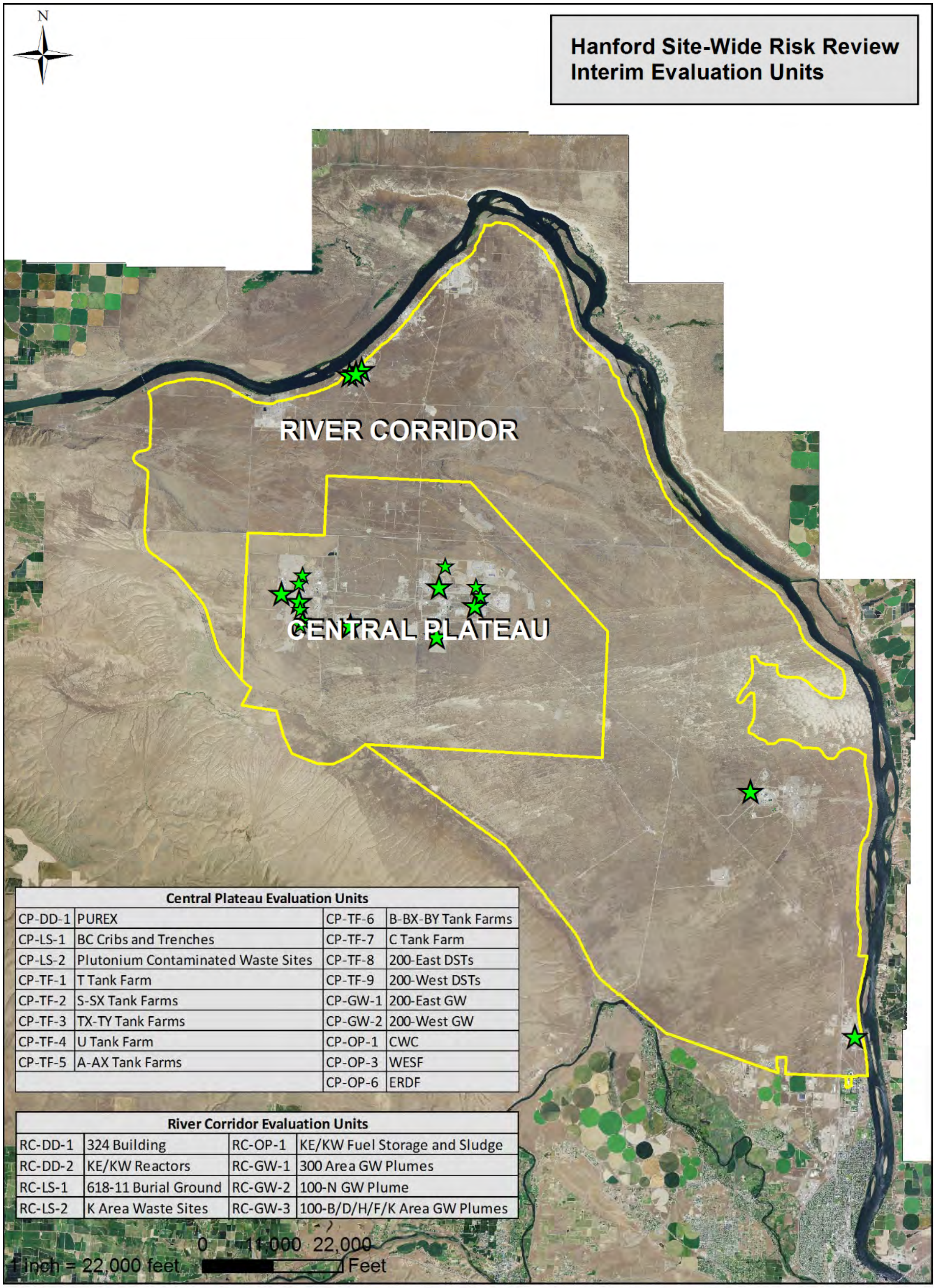

Figure D.5-3. Location of the Evaluation Units in Relation to the Hanford Site.

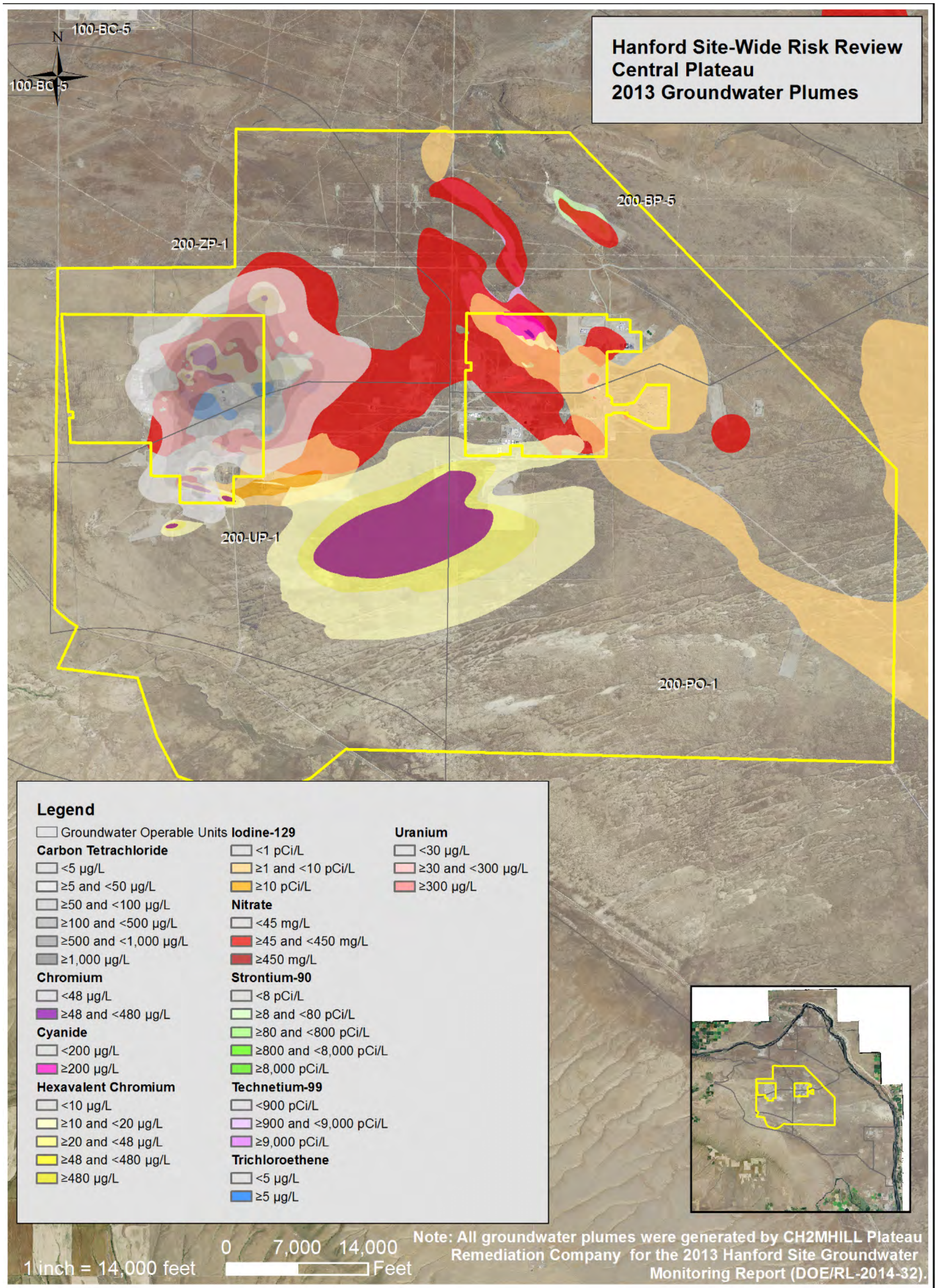

Figure D.5-4. Groundwater Contamination in the Hanford Central Plateau in 2013

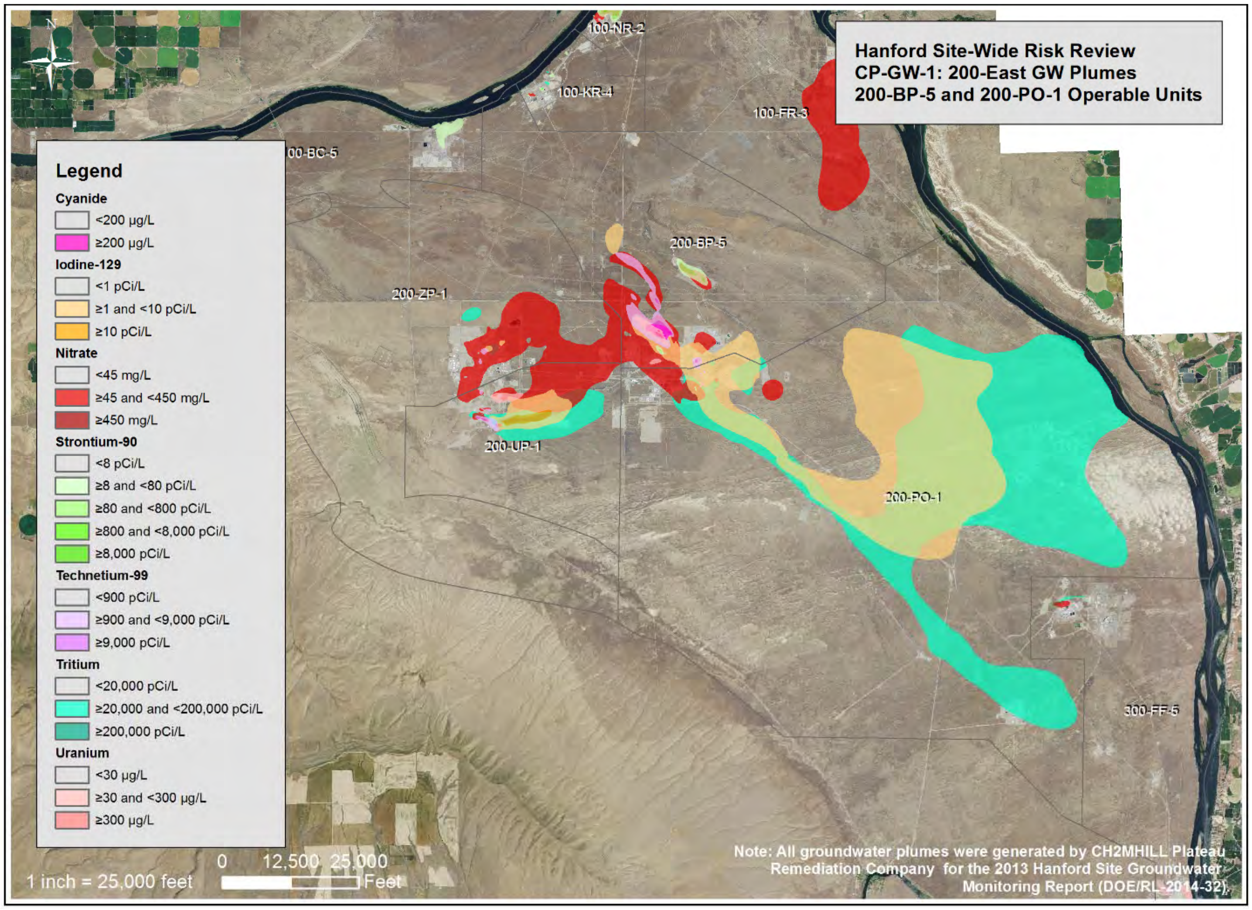

Figure D.5-5. Groundwater Plumes near the 200-BP-5 and 200-PO-1 Operable Units in 2013

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-5 OU were B Plant and Hot Semi-Works; however, liquid waste from the other separation facilities were stored or released at sites overlying the OU 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-1 OU 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 and 200-PO 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-5, the following actions are being conducted:

- Ongoing perched water treatability test (200-DV-1) at WMA B-BX-BY to remove uranium. By 2013, approximately 691,000 L of perched water containing approximately 373 kg of nitrate, 0.022 Ci of Tc-99, and 31.9 kg of uranium was extracted (DOE/RL-2013-22, Rev. 0; DOE/RL-2014-32, Rev. 0, page BP-8).
- WMA C Tank Waste Retrieval. Tank wastes are currently being retrieved from WMA C. Waste retrieval has been completed in nine of the 16 tanks, has been completed to various limits of technology in four tanks, and retrievals are in progress in the remaining three tanks (Weyns 2015).
- The final action ROD for the 200-BP-5 OU is scheduled for 2016 (DOE/RL-2014-32, Rev. 0, p. BP-3).

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 109.5 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-5 and 200-PO-1 Operable Units. Because estimated plume depths in the 200 East OUs were not available, either the depth from the corresponding contaminant in the 200-UP-1 OU 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-1 and 200-BP-5 OUs 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-5 and 200-PO-1 groundwater plumes (DOE/RL-2014-32, Rev. 0), the following information is provided:

- Maximum measured groundwater concentration in 2013 (DOE/RL-2014-32, Rev. 0);

- Upper 95% confidence limit (UCL) on the log-transformed 2013 groundwater and aquifer tube (AT) data from PHOENIX (http://phoenix.pnnl.gov/) exceeding the WQS where the AT can also be used if the plume is in contact with the Columbia River;
- Plume area in 2013 (exceeding the water quality standard (WQS), often the DWS or risk-based cleanup level) (DOE/RL-2014-32, 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-5 OU Group A and B primary contaminants range from *Low* for cyanide to *Medium* for uranium to *High* for I-129, Tc-99, and Sr-90. A perched water treatability test is being conducted in the 200-DV-1 OU under the B Complex to remove uranium. The nitrate and tritium (Group C) plume areas translate to *Medium* ratings.

The saturated zone (SZ) GTM values (Table D.5-2) for the 200-PO-1 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-1.

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)[5]. 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-5 and 200-PO-1 OUs, respectively. Despite potentially including sources other than those directly related to the 200-PO-1 and 200-BP-5 OUs, the groundwater screening analysis was considered reasonable to assess rate of movement of contaminants 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-5 (7.9 km^2) near the B Barrier and 200-PO-1 (3.71 km^2) near the A Barrier. Peak concentrations at the B Barrier and A Barrier are

[5] 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).

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-5 OU nitrate remains *Medium* for these evaluation periods. Since the predicted peak concentration for 200-PO-1 (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 (4.5 km^2) near the B Barrier and 200-PO-1 (83.4 km^2) where the 200-PO-1 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-5 and 200-PO-1, the same plume areas and peak concentrations for the Landfill Scenario (for lack of better information) would translate to *High* 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-1 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-5 and 200-PO-1 OUs, the ratings remain *High* 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-5 (2.4 km^2) near the B Barrier and 200-PO-1 (0.03 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-5, 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 *High* and the Near-term, Post-Cleanup rating is *Medium* (accounting for uncertainty) indicating a need for monitoring and treatment. For the 200-PO-1 OU, 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-1, 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-5, 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-5 (0.2 km^2) near the B Barrier and 200-PO-1 (83.4 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, the groundwater rating for the 200-BP-5 and 200-PO-1 would remain *Medium* into these evaluation periods indicating the need for monitoring and treatment.

- No values are reported at the B Barrier (200-BP-5) or A Barrier (200-PO-1) 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 these contaminants, only Sr-90 in 200-BP-5 have current ratings (*High*) higher than *Low*. Because the contaminants already have plumes, ratings (i.e., CN in 200-BP-5 and Sr-90 in 200-PO-1) remain *Low* for the Active and Near-term, Post-Cleanup periods (to account for uncertainty). For Sr-90 in 200-BP-5, 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 17 and 112 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 above results are summarized in. 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 2013 Hanford Annual Groundwater Report (DOE/RL-2014-32, Rev. 0) and PHOENIX (http://phoenix.pnnl.gov/), no plume from the 200-BP-5 OU currently intersects the Columbia River at concentrations exceeding the appropriate water quality standard (WQS). Thus current impacts from the 200-BP-5 OU to the Columbia River benthic and riparian ecology would be rated as *Not Discernible*. For example, potential impacts related to the 200-BP-5 OU are described in Appendix E.7 for CP-TF-6 (WMA B-BX-BY).

Based on the information in the 2013 Hanford Annual Groundwater Report (DOE/RL-2014-32, Rev. 0) and PHOENIX (http://phoenix.pnnl.gov/), only the tritium (Group C) plume from the 200-PO-1 OU currently intersects the Columbia River at concentrations exceeding the appropriate water quality standard (WQS) [6]. 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 1.5 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

[6] 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-2014-32 Rev. 0). There are plumes associated with River Corridor GW OUs that are also in contact with the Columbia River.

(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-1 OU would also apply to these evaluation periods. Because other 200-PO-1 OU 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[7]. 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-5 OU 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 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[8]:

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[7] 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).

[8] 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)

> "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

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-5 and 200-PO-1 Operable Units)

OU	PC	Grp	WQS[a]	Area (km^2)[b]	Thick-ness (m)[c]	Pore Vol. (Mm^3)	Max GW Conc.	95th % GW UCL	Porosity[d]	K_d (mL/g)[d]	ρ (kg/L)[d]	R	SZ Total M^{SZ}	SZ GTM (Mm^3)	SZ Rating[e]
200-BP-5	NO3	C	45 mg/L	7.9	24	4.74E+01	1680 mg/L	210 mg/L	0.25	0	1.82	1.00E+00	9.95E+06 kg	---	Medium*
	I-129	A	1 pCi/L	4.5	30	3.38E+01	7.54 pCi/L	3.31 pCi/L	0.25	0.2	1.82	2.46E+00	1.12E-01 Ci	1.12E+02	High
	Tc-99	A	900 pCi/L	2.4	20	1.20E+01	36000 pCi/L	8230 pCi/L	0.25	0	1.82	1.00E+00	9.88E+01 Ci	1.10E+02	High*
	U	B	30 µg/L	0.5	15	1.88E+00	3300 µg/L[e]	328 µg/L	0.25	0.8	1.82	6.82E+00	6.15E+02 kg	2.05E+01	Medium*
	Sr-90	B	8 pCi/L	0.6	15	2.25E+00	980 pCi/L	530 pCi/L	0.25	22	1.82	1.61E+02	1.19E+00 Ci	1.49E+02	High
	CN	B	200 µg/L	0.4	24	2.40E+00	1520 µg/L	530 µg/L	0.25	0	1.82	1.00E+00	1.27E+03 kg	6.36E+00	Low
	H-3	C	20000 pCi/L	0.2	30	1.50E+00	22000 pCi/L	35800 pCi/L	0.25	0	1.82	1.00E+00	5.37E+01 Ci	---	Medium
200-PO-1	H-3	C	20000 pCi/L	83.4	30	6.26E+02	490000 pCi/L	108000 pCi/L	0.25	0	1.82	1.00E+00	6.76E+04 Ci	---	Medium
	I-129	A	1 pCi/L	52.1	30	3.91E+02	9.1 pCi/L	3.49 pCi/L	0.25	0.2	1.82	2.46E+00	1.36E+00 Ci	1.36E+03	Very High
	NO3	C	45 mg/L	3.71	24	2.23E+01	126 mg/L	65.6 mg/L	0.25	0	1.82	1.00E+00	1.46E+06 kg	---	Medium
	Sr-90	B	8 pCi/L	0.01	15	3.75E-02	15 pCi/L	10.9 pCi/L	0.25	22	1.82	1.61E+02	4.11E-04 Ci	5.13E-02	Low
	Tc-99	A	900 pCi/L	0.03	20	1.50E-01	4200 pCi/L	2530 pCi/L	0.25	0	1.82	1.00E+00	3.80E-01 Ci	4.22E-01	Low
	U	B	30 µg/L	0.02	15	7.50E-02	58.8 µg/L	42 µg/L	0.25	0.8	1.82	6.82E+00	3.15E+00 kg	1.05E-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-2014-32, 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 2013, approximately 691,000 L of perched water containing approximately 373 kg of nitrate, 0.022 Ci of Tc-99, and 31.9 kg of uranium was extracted (DOE/RL-2013-22, Rev. 0; DOE/RL-2014-32, Rev. 0, page BP-8). The contaminants with perched water extraction amounts are indicated in the table with an asterisk (*).

f. In the 200-BP summary table (DOE/RL-2014-32, Rev. 0, p. BP-3), it was indicated that maximum concentration (22,000 pCi/L) excluded the perched aquifer beneath the B Complex. These values are included to estimate the 95% confidence limit (UCL) exceeding the DWS, which is larger than the maximum reported.

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-5 and 200-PO-1 Operable Units)

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-5	NO3	C	45 mg/L	9.95E+06 kg	---	Medium*	Yes/Yes	No*	Undefined	Medium	Yes/Yes	Medium
	I-129	A	1 pCi/L	1.12E-01 Ci	1.12E+02	High	Yes/Yes	No	Undefined	High	Yes/Yes	High
	Tc-99	A	900 pCi/L	9.88E+01 Ci	1.10E+02	High*	Yes/Yes	No*	Undefined	High	Yes/Yes	Medium
	U	B	30 µg/L	6.15E+02 kg	2.05E+01	Medium*	Yes/No	No*	Undefined	Medium	Yes/No	Medium
	Sr-90	B	8 pCi/L	1.19E+00 Ci	1.49E+02	High	No/No	No	Undefined	Medium[g]	No/No	Low[g]
	CN	B	200 µg/L	1.27E+03 kg	6.36E+00	Low	No[f]	No	Undefined	Low	No[f]	Low
	H-3	C	20000 pCi/L	5.37E+01 Ci	---	Medium	No/No	No	Undefined	Medium	No/No	Medium
200-PO-1	H-3	C	20000 pCi/L	6.76E+04 Ci	---	Medium	No/No	No	Undefined	Medium	No/No	Medium
	I-129	A	1 pCi/L	1.36E+00 Ci	1.36E+03	Very High	Yes/Yes	No	Undefined	Very High	Yes/Yes	Very High
	NO3	C	45 mg/L	1.46E+06 kg	---	Medium	Yes/No	No	Undefined	Low	Yes/No	Low
	Sr-90	B	8 pCi/L	4.11E-04 Ci	5.13E-02	Low	No/No	No	Undefined	Low	No/No	Low
	Tc-99	A	900 pCi/L	3.80E-01 Ci	4.22E-01	Low	Yes/No	No	Undefined	Low	Yes/No	Low
	U	B	30 µg/L	3.15E+00 kg	1.05E-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 2013, approximately 691,000 L of perched water containing approximately 373 kg of nitrate, 0.022 Ci of Tc-99, and 31.9 kg of uranium was extracted (DOE/RL-2013-22, Rev. 0; DOE/RL-2014-32, Rev. 0, page BP-8). 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-5 and 200-PO-1 Operable Units)

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-5	NO3	C	45 mg/L	7100 mg/L	1680 mg/L	210 mg/L	4.93E+00	6.16E-01	---	---	---	---	ND*
	I-129	A	1 pCi/L	38500 pCi/L	7.54 pCi/L	3.31 pCi/L	1.96E-04	8.60E-05	---	---	---	---	ND
	Tc-99	A	900 pCi/L	6.67E+05 pCi/L	36000 pCi/L	8230 pCi/L	5.40E-02	1.23E-02	---	---	---	---	ND*
	U	B	30 µg/L	5 µg/L	3300 µg/L	328 µg/L	6.60E+02	6.56E+01	---	---	---	---	ND*
	Sr-90	B	8 pCi/L	279 pCi/L	980 pCi/L	530 pCi/L	3.51E+00	1.90E+00	---	---	---	---	ND
	CN	B	200 µg/L	5.2 µg/L	1520 µg/L	530 µg/L	2.92E+02	1.02E+02	---	---	---	---	ND
	H-3	C	20000 pCi/L	2.65E+08 pCi/L	22000 pCi/L	35800 pCi/L	8.30E-05	1.35E-04	---	---	---	---	ND
200-PO-1	H-3	C	20000 pCi/L	2.65E+08 pCi/L	49000 pCi/L	108000 pCi/L	1.85E-04	4.08E-04	---	2.14E+01	---	---	ND
	I-129	A	1 pCi/L	38500 pCi/L	9.1 pCi/L	3.49 pCi/L	2.36E-04	9.06E-05	---	---	---	---	ND
	NO3	C	45 mg/L	7100 mg/L	126 mg/L	65.6 mg/L	3.70E-01	1.92E-01	---	---	---	---	ND
	Sr-90	B	8 pCi/L	279 pCi/L	15 pCi/L	10.9 pCi/L	5.38E-02	3.93E-02	---	---	---	---	ND
	Tc-99	A	900 pCi/L	6.67E+05 pCi/L	4200 pCi/L	2530 pCi/L	6.30E-03	3.79E-03	---	---	---	---	ND
	U	B	30 µg/L	5 µg/L	58.8 µg/L	42 µg/L	1.18E+01	8.40E+00	---	---	---	---	ND

a. Biota Concentration Guide (BCG) from RESRAD-BIOTA v1.5 (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-2014-32, Rev. 0)

c. The intersection area between the groundwater plume and the riparian zone was provided by PNNL based on the 2013 Hanford Site Groundwater Monitoring Report (DOE/RL-2014-32, 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[9]. 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-1) 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-5 and 200-PO-1 OUs).

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,

[9] 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-5 Group A and B primary contaminants range from *Low* for cyanide to *Medium* for uranium to *High* for I-129, Tc-99, and Sr-90. The nitrate and tritium plume areas (Group C) translate to *Medium*. The corresponding saturated zone (SZ) GTM values (Table D.5-2) for the 200-PO-1 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-1.

Columbia River

As described in Part V, although tritium (Group C) from the 200-PO-1 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 100.25 acres of riparian habitat and resources along the river shoreline that could potentially be affected.

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

- Injection and pumping wells might alter the hydrology in the vadose zone, and change soil water availability for plants.

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

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

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

CLEANUP APPROACHES AND END-STATE CONCEPTUAL MODEL

The 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). For 200-BP-5, and ongoing perched water treatability test (200-DV-1) is being conducted at WMA B-BX-BY to remove uranium and the Waste Management Area (WMA) C Tank Waste is currently under retrieval (including being completed in nine of the 16 tank. The final action record of decision for the 200-BP-5 OU is scheduled for 2016 (DOE/RL-2014-32, Rev. 0, p. BP-3).

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[10]:

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

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[10] 400 Area groundwater cleanup actions are included as part of 200-PO-1 OU.

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-5 OU (from those for Current conditions) include:

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

For the 200-PO-1 OU, 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-5 OU from recharge and decay considerations during this evaluation period include:

- Tc-99 would be rated *Medium* (versus *High* for Current conditions)
- Sr-90 would be rated *Low* (versus *High* for Current conditions)

For the 200-PO-1 OU, 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.
Human	Co-located Person	Low to Not Discernible (Not Discernible)	Following completion of active cleanup activities, groundwater concentrations should be below AWQS.
Human	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-5 OU: Low to High (I-129) 200-PO-1 OU: 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-5 Group A&B PCs range from *Low* for cyanide to *Low* for Sr-90 to *Medium* for Tc-99 and uranium to *High* for I-129 and Group C (nitrate and tritium) translate to *Medium*. 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.
Environmental	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*	Low	Contamination remaining in areas for monitored natural attenuation may still result in uptake in biota, but is not likely to cause an effect to the biota. Continued long-term monitoring activities may disrupt riparian and terrestrial habitats.

			Re-vegetation in EU will result in additional level 3 resources, and potentially creation of level 4 resources potentially at risk because of disturbance, especially from invasive species.
Social	Cultural Resources*	**Native American:** Direct: Known Indirect: Known **Historic Pre-Hanford:** Direct: Known Indirect: Known **Manhattan/Cold War**: Direct: Unknown Indirect: Unknown	Permanent direct and indirect effects are possible due to high sensitivity of area.

*For both Ecological and Cultural Resources see Appendices J and K respectively for a complete description of Ecological Field Assessments and literature review for Cultural Resources.

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 (High for 200-BP-5 and Very High for 200-PO-1) 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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APPENDIX D.6

CP-GW-2 (Operable Units 200-UP-1 and 200-ZP-1 in 200-West, Central Plateau)
Evaluation Unit Summary Template

Table of Contents

List of Tables

List of Figures

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PART I. EXECUTIVE SUMMARY

EU LOCATION

200-West

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-1 (200-East Plumes), CP-LS-2 (Plutonium-contaminated Waste Sites), CP-TF-1 (WMA T), CP-TF-2 (WMA S-SX), CP-TF-3 (WMA TX-TY), and CP-TF-4 (WMA U).

PRIMARY CONTAMINANTS, CONTAMINATED MEDIA AND WASTES

The CP-GW-2 Evaluation Unit (EU) is related to two Hanford groundwater interest areas: 200-UP (including the 200-UP-1 CERCLA [Groundwater] Operable Unit (OU)) and 200-ZP (including the 200-ZP-1 CERCLA GW OU)[1]. The focus in this Appendix will on the selected groundwater OUs because available data has been arranged based on the GW OUs. The primary contaminants (i.e., those with areas of concentration exceeding cleanup levels or water quality standards) for the 200-UP-1 OU are carbon tetrachloride, chromium (hexavalent and total), nitrate, I-129, Tc-99, tritium (H-3), and uranium (DOE/RL-2014-32, Rev. 0, p. UP-2). All of these contaminants originated within 200-UP except for carbon tetrachloride, which migrated from 200-ZP. Within the 200-UP and 200-ZP interest areas, groundwater in the unconfined aquifer (Ringold unit E with base in the Ringold lower mud unit) has been directly impacted by past waste disposal operations; there are also a confined aquifer below the Ringold lower mud unit and among basalt flows (DOE/RL-2014-32, Rev. 0, p. UP-1 and ZP-1).

The primary contaminants for the 200-ZP-1 OU are carbon tetrachloride, chromium (hexavalent and total), I-129, nitrate, Tc-99, trichloroethene (TCE), tritium (H-3), and uranium (DOE/RL-2014-32, Rev. 0, p. ZP-3). Except for nitrate, the plumes for the other contaminants fall within that for the carbon tetrachloride. Within the 200-ZP interest area, groundwater is in an unconfined aquifer (Ringold unit E with base in the Ringold lower mud unit) directly impacted by past waste disposal operations. In those areas where the Ringold lower mud unit is missing, carbon tetrachloride has migrated below the mud unit into the confined aquifer (DOE/RL-2014-32, Rev. 0, p. ZP-1).

BRIEF NARRATIVE DESCRIPTION

The CP-GW-2 EU is related to two Hanford interest areas: 200-UP and 200-ZP; however, we will focus on the two corresponding CERCLA groundwater Operable Units (OUs), 200-UP-1 and 200-ZP-1, respectively, for this discussion. The 200-UP interest area, in the southern part of 200-West, includes the 200-UP-1 Groundwater OU and adjacent parts of the surrounding 600 Area; these areas are primarily associated with early operations at the REDOX and U Plants, with the exception of the Environmental Restoration Disposal Facility (ERDF) (DOE/RL-2014-32, Rev. 0, p. UP-1). The 200-UP-1 OU has an interim Record of

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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).

Decision (ROD) (EPA 2012) and is being monitored (DOE/RL-2013-07) 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). A number of groundwater (GW) interim remedial actions have been conducted in 200-UP-1 (EPA 2012) as described in Part IV. The final ROD for the 200-UP-1 OU will be pursued when future groundwater impacts are adequately understood and studies to evaluate potential technologies to treat I-129 are completed (EPA 2012).

The 200-ZP interest area, in the northern and central parts of 200-West and nearby parts of 600 Area, includes the 200-ZP-1 groundwater OU and legacy source sites (cribs and trenches) primarily related to discharges of liquid wastes from the Plutonium Finishing Plant (PFP) (DOE/RL-2014-32, Rev. 0, p. ZP-1). Remedial actions have been or are being taken to address groundwater contamination in the 200-ZP-1 OU as described in Part IV.

Summary Tables of Risks and Potential Impacts to Receptors

Table D.6-1 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-UP and 200-ZP interest areas; a Co-located Person (CP) is an individual located 100 meters from the physical boundaries of the 200-UP and 200-ZP 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 Non-Discernable (ND) to Very High. The estimated mitigated exposure that takes engineered and administrative controls and protections into consideration, is shown in parenthesis.

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 Discernable* (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: No risk ratings are provided for Cultural Resources. The Table 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.

Table D.6-1. Risk Rating Summary (for Human Health, unmitigated nuclear safety basis indicated, mitigated basis indicated in parenthesis (e.g., "Very High" (Low))

Population or Resource		Evaluation Time Period	
		Active Cleanup (to 2064)	
		Current Condition: Monitoring	**From Cleanup Actions:** P&T / Monitoring
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-UP-1 OU: Low to Medium (NO3, Cr-VI, H-3, and I-129) 200-ZP-1 OU: Low to Very High (CCl4) Overall: Very High (CCl4)	200-UP-1 OU: ND to High (I-129) 200-ZP-1 OU: ND to Very High (CCl4) Overall: Very High (CCl4)
	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*	ND to Low	ND to Low
Social	Cultural Resources*	**Native American:** Direct: Known Indirect: Known **Historic Pre-Hanford:** Direct: Unknown Indirect: Unknown **Manhattan/Cold War:** Direct: Unknown Indirect: Unknown	**Native American:** Direct: Known Indirect: Known **Historic Pre-Hanford:** Direct: Unknown Indirect: Unknown **Manhattan/Cold War:** Direct: Unknown Indirect: Unknown

*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.

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., P&T operations, 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 been selected for the 200-West Groundwater OUs (200-UP-1 and 200-ZP-1), including pump-and-treat (P&T), 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* to *Medium*.

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.6-2, the saturated zone (SZ) GTM values for the 200-UP-1 OU Group A and B primary contaminants range from *Low* for uranium, total chromium, and Tc-99 to *Medium* for hexavalent chromium and I-129. The nitrate and tritium plume areas (Group C) translate to *Medium* ratings. The saturated zone (SZ) GTM values for the 200-ZP-1 Group A and B primary contaminants range from *Low* for hexavalent chromium, I-129, and Tc-99 to *Medium* for TCE to *Very High* for carbon tetrachloride. The tritium and nitrate plume areas (Group C) translate to *Low* and *Medium* ratings, respectively, based on current plume areas. Most of these contaminants are being treated using the 200-West P&T System. Thus the overall rating for the CP-GW-2 EU is *Very High* related to carbon tetrachloride in 200-ZP-1 (which is currently being treated).

Columbia River: For 200-UP-1 and 200-ZP-1, no plume currently intersects the Columbia River at concentrations exceeding the appropriate water quality standard (WQS) as described in Part V. Thus current impacts to the Columbia River benthic and riparian ecology would be rated as *Not Discernible*. 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: Groundwater wells on Central Plateau are in sensitive ecological areas. There is the potential for disturbance and invasion of exotic species in EU. Ecological resources at locations of new wells are evaluated prior to activities to assess potential impacts.

<u>Risks and Potential Impacts from Selected or Potential Cleanup Approaches</u>

Groundwater: During the Active Cleanup period (as described in Part V), most contaminants in the 200-UP-1 and 200-ZP-1 OUs have lower ratings than those for Current conditions, primarily due to treatment in the 200-West P&T facility. However, because of the large amount of carbon tetrachloride in groundwater and the time predicted for cleanup effectiveness (125 years), the rating of *Very High* is maintained for the Active Cleanup period to represent uncertainty in cleanup effectiveness and timing. Furthermore, because the remedial action for I-129 has not been selected for the 200-UP-1 OU, the rating (*Medium*) was increased to *High*.

Columbia River: Based on the information in Part V, no radioactive or chemical contaminants are predicted to be discharged to the Columbia River in concentrations that would pose risk to benthic or riparian zone receptors during the Active Cleanup period. Similarly, because of the large dilution effect in the Columbia River, the free-flowing ratings are *Not Discernible* for all the Tank Farm EUs for all contaminants and evaluation periods.

Ecological Resources: Remediation could degrade habitats, disturb wildlife and affect animal behavior, and introduce exotic plant species.

Social – Cultural Resources

<u>Current</u>

There are unevaluated cultural resources located within this EU. 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.

<u>Risks and Potential Impacts from Selected or Potential Cleanup Approaches</u>

There are unevaluated cultural resources located within this EU. Upland areas where characterization and monitoring activities take place may be culturally sensitive regions as well. Traditional cultural places in viewshed. Indirect effects are possible from capping.

Considerations for timing of the cleanup actions

Because remedial actions have not been defined for the 200-East Groundwater Operable Units, the ratings (High for 200-BP-5 and Very High for 200-PO-1) 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 (described in Table D.6-5), most of the ratings for contaminants are *ND* to account for expected treatment effectiveness. The noticeable exceptions are carbon tetrachloride (*Medium* to reflect both the large inventory and treatment uncertainty) and I-129 (*High*) where the remedial action has yet to be selected.

Columbia River: As indicated in Part V, no radionuclides or chemicals from the 200-West Area are predicted to have concentrations exceeding screening values in this evaluation period. Thus the rating will not be modified and all ratings are *Not Discernible* as is the overall rating (Table D.6-5).

Ecological Resources: Permanent indirect effects to viewshed are possible from remediation activities. Permanent effects may be possible due to presence of contamination if monitored natural attenuation is the preferred remedial action. No other expected cultural resources impacts.

PART II. ADMINISTRATIVE INFORMATION

OU AND/OR TSDF DESIGNATION(S)

200-UP-1 and 200-ZP-1

COMMON NAME(S) FOR EU

200-UP-1 and 200-ZP-1 Operable Units

KEY WORDS

200 Area, CP-GW-2, 200-UP-1, 200-ZP-1, Soils, Sediments, Central Plateau

REGULATORY STATUS

Regulatory basis: An interim action Record of Decision (ROD) was published in September 2012 (EPA 2012) that addressed all major contaminant plumes within the 200-UP-1 OU and superseded the prior interim action ROD issued in 1997 (EPA/ROD/R10-97/048). The selected remedy in the 2012 ROD includes a combination of:

- Groundwater extraction and treatment for Tc-99, uranium, and chromium;
- A combination of pump and treat (P&T) and monitored natural attenuation (MNA) for nitrate and carbon tetrachloride[2];
- MNA for tritium;
- Hydraulic containment for iodine-129 while treatment technologies are investigated; and
- Institutional Controls (ICs).

Groundwater contaminants in the 200-ZP-1 OU are being treated under a ROD (EPA 2008) where the selected remedy is a combination of: monitored natural attenuation (MNA), institutional controls (ICs), flow-path controls, and pump and treat (P&T). The 200 West P&T System began operations in 2012 and operated continuously in 2013. Groundwater is monitored to assess the effectiveness of the remedy (DOE/RL-2009-115).

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[2] Soil vapor extraction (SVE) was effective at treating carbon tetrachloride in the 200-PW-1 OU overlying the 200-ZP-1 groundwater OU (removing approximately 80,000 kg of carbon tetrachloride). There is also a large groundwater plume currently being treated using the 200 West P&T System and an additional source of carbon tetrachloride in the vadose zone where SVE could be used. SVE was not operated in 2013.

Applicable regulatory documentation

200-UP-1: Interim action Record of Decision (ROD) (EPA 2012) superseding the prior interim action ROD (EPA/ROD/R10-97/048). Remedial Design/Remedial Action Work Plan (DOE/RL-2013-07).

200-ZP-1: Record of Decision (ROD) (EPA 2008) and Performance Monitoring Plan (DOE/RL-2009-115, Rev. 0)

Applicable Consent Decree or TPA milestones

M-016-190 by 09/30/2015 Lead Agency: EPA

Milestone: Complete the installation of extraction and injection wells for the U Plant area pump & treat system for uranium and technetium-99, and the iodine-129 hydraulic containment system as defined in the 200-UP-1 RD/RA WP.

M-016-192 by 06/17/2016 Lead Agency: EPA

Milestone: Submit I-129 Technology Evaluation Plan Draft A to EPA as defined in the 200-UP-1 RD/RA WP.

M-016-193 by 09/30/2017 Lead Agency: EPA

Milestone: Complete the remedial design investigation of the southeast chromium plume, including the installation of new wells and evaluation of groundwater monitoring data and install monitoring wells needed for remedy performance monitoring as defined in the 200-UP-1 RD/RA WP.

There are no milestones related to the 200-ZP-1 OU.

RISK REVIEW EVALUATION INFORMATION

Completed: Revised 18 August 2015

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-West 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-West 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)[3] in the 200-UP-1 and 200-ZP-1 OUs In the 200-UP interest area, Tc-99, uranium, tritium (H-3), I-129, nitrate, chromium, and carbon tetrachloride form extensive groundwater plumes (DOE/RL-2014-32, Rev. 0, p. UP-1); these contaminants (except for carbon tetrachloride from 200-ZP) originated from operations in the area. Limited amounts of other contaminants including chloroform, 1,4-dioxane, Sr-90, selenium-79, and trichloroethene (TCE) have been found in groundwater and are routinely sampled in selected wells; however, no plumes are associated with these contaminants. To summarize (DOE/RL-2014-32, Rev. 0):

- Tc-99 concentrations have been measured above the DWS (900 pCi/L) downgradient of WMA S-SX, the 216-U-1 and 216-U-2 cribs, and WMA U (DOE/RL-2014-32, Rev. 0, p. UP-7). The plume near WMA S-SX is attributed primarily to a 190,000-liter leak from tank SX-115 in 1965. Between 1966 and 1970, approximately 91,000 liters of waste was released from tank S-104 in an overfill event. A plume originated from 216-U-1 and 216-U-2 Cribs near U Plant. The WMA U area is also a source of Tc-99 groundwater contamination. The plume area has been fairly stable over the past decade (Figure D.6-1).
  - Maximum concentration: 62,000 pCi/L (299-W23-19) versus a DWS of 900 pCi/L
  - Areal extent of the plume: 0.29 km^2
  - Shoreline impact: 0 m
  - Riparian zone intersected: 0 ha
- Uranium has been measured above the 30 µg/L DWS in two regions within 200-UP: downgradient of the 216-U-1 and 216-U-2 Cribs, which were the source of the this plume, and near the 216-U-10 Pond, which received an estimated 2,100 kg of uranium (DOE/RL-2014-32, Rev. 0, p. UP-13). The plume area has been decreasing over the past decade (Figure D.6-1).

[3] 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.

    - Maximum concentration: 298 µg/L (299-W19-43) versus a DWS of 30 µg/L.
    - Areal extent of the plume: 0.34 km^2.
    - Shoreline impact: 0 m
    - Riparian zone intersected: 0 ha
- Tritium in 200-UP primarily originated from disposal facilities associated with the REDOX Plant, which operated from 1952 until 1967 where a large plume from the REDOX Plant cribs extends 5 kilometers toward the east and northeast at concentrations above the 20,000 pCi/L DWS. Other sources include the 216-S-3, 216-S-21, and 216-S-25 Cribs. The plume area has been decreasing over the past few years (Figure D.6-1).
    - Maximum concentration: 310,000 pCi/L (699-36-66B) versus a DWS of 20,000 pCi/L.
    - Areal extent of the plume: 5.5 km^2.
    - Shoreline impact: 0 m
    - Riparian zone intersected: 0 ha
- Iodine-129 plumes in 200-UP primarily originated from REDOX Plant waste sites with some contribution from U Plant resulting in two plumes, one from the 216-U-1 and 216-U-2 cribs and a second from the REDOX Plant waste sites that merge downgradient. The SX Tank Farm is the source of an additional small plume. The plume area was relatively stable over the past decade with a noticeable decrease between 2012 and 2013 (Figure D.6-1).
    - Maximum concentration: 9.14 pCi/L (299-W22-88) versus a DWS of 1 pCi/L
    - Areal extent of the plume: 3.1 km^2
    - Shoreline impact: 0 m
    - Riparian zone intersected: 0 ha
- Nitrate plumes in 200-UP originated from U Plant and REDOX Plant disposal facilities, with the U Plant sources more significant (DOE/RL-2014-32, Rev. 0, p. UP-20). WMA U is also a source of nitrate to the groundwater. The nitrate plume size has decreased in size since 2011 (Figure D.6-1).
    - Maximum concentration: 3,210 mg/L (288-W19-43) versus a DWS (equivalent) of 45 mg/L
    - Areal extent of the plume: 5.8 km^2
    - Shoreline impact: 0 m
    - Riparian zone intersected: 0 ha
- Chromium plumes are found in two 200-UP areas including two plumes near WMA S-SX, a larger plume in the 600 Area Concentrations, and also near the 216-S-20 Crib and 216-S-10 Pond and Ditch (DOE/RL-2014-32, Rev. 0, p. UP-23). Sources include an overfill event involving tank S-104, effluent disposal to the 216-S-20 Crib, and REDOX Plant ponds and ditches south of the 200 West Area. The total chromium plume has been decreasing over the past four years (Figure D.6-1).
    - Maximum concentration: 907 µg/L (299-W23-19) versus a "Model Toxics Control Act—Cleanup" (WAC 173-340) Method B groundwater cleanup level for hexavalent chromium of 48 µg/L and a DWS for total chromium of 100 µg/L
    - Areal extent of the plume: 3.86 km^2 (hexavalent) and 0.37 km^2 (total)
    - Shoreline impact: 0 m
    - Riparian zone intersected: 0 ha
- Carbon tetrachloride is widespread within 200-UP where measured concentrations were greater than 10 times the cleanup level (3.4 µg/L) in 32 wells during 2013. Since the plume originated from Plutonium Finishing Plant (PFP) waste disposal sites in 200-ZP, the carbon tetrachloride plume will be evaluated as part of 200-ZP (where both 200-UP and 200-ZP are part of this EU).

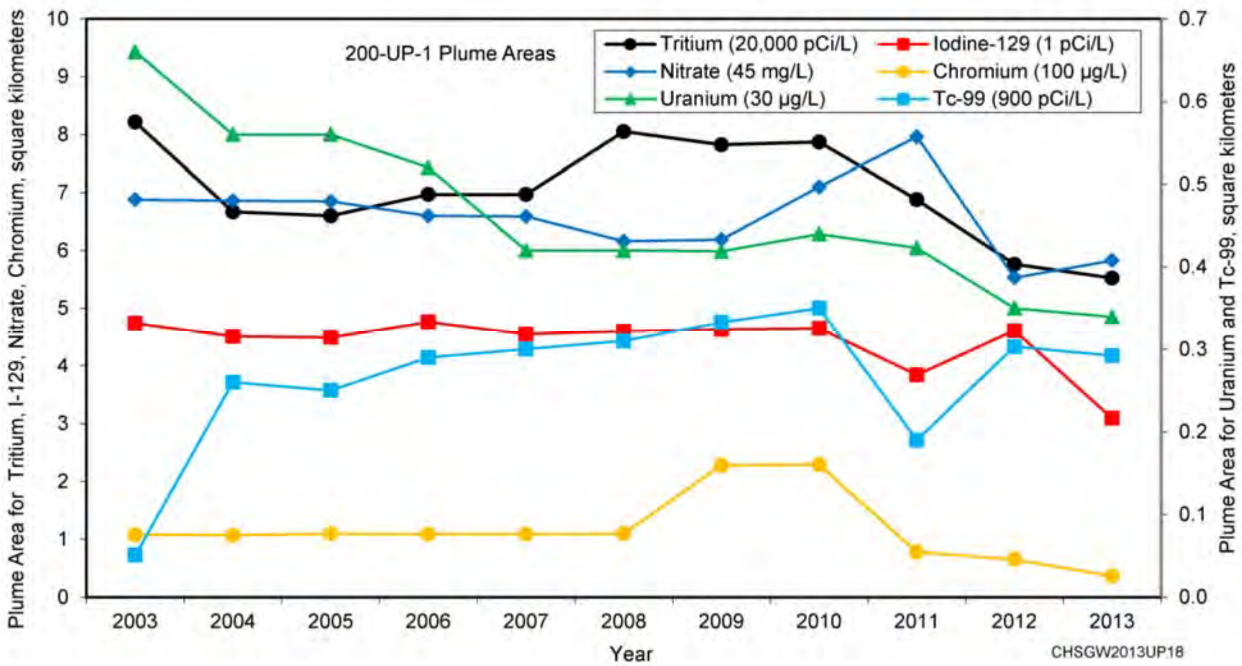

Figure D.6-1. 200-UP 2013 Plume Areas (DOE/RL-2014-32, Rev. 0, p. UP-7)

In the 200-ZP interest area, contaminant include carbon tetrachloride, chromium (total and hexavalent), I-129, nitrate, Tc-99, trichloroethene (TCE), and tritium where carbon tetrachloride is the main contaminant of concern (DOE/RL-2014-32, Rev. 0, p. ZP-1). To summarize (DOE/RL-2014-32, Rev. 0):

- Carbon tetrachloride has been detected at concentrations exceeding the DWS (5 µg/L) and cleanup level (3.4 µg/L) under most of the 200-West Area (DOE/RL-2014-32, Rev. 0, p. ZP-6). The primary source is from discharges of liquid waste from the Plutonium Finishing Plant (PFP) to the 216-Z-1A, 216-Z-9, and 216-Z-18 cribs and trenches. Concentrations of carbon tetrachloride are declining across 200-ZP as a result of capture by extraction wells and by natural attenuation processes where declines in both maximum concentration and in the number of wells exceeding 2,000 µg/L demonstrates the effectiveness of the remedial actions. The plume area has been declining since 2011 (Figure D.6-2).
    - Maximum concentration: 2,600 µg/L (299-W14-22) versus a DWS of 5 µg/L and cleanup level of 3.4 µg/L
    - Areal extent of the plume: 13.30 km^2 (including that in 200-UP and for all depths in the unconfined aquifer)
    - Shoreline impact: 0 m
    - Riparian zone intersected: 0 ha
- Chromium concentrations have been measured above the final cleanup level (100 µg/L for total chromium and 48 µg/L for hexavalent chromium) beneath and downgradient of the single-shell tanks at WMA T and WMA TX-TY where sources include past leaks from single-shell tanks and from REDOX and PUREX plant operations (DOE/RL-2014-32, Rev. 0, p. ZP-10). Maximum chromium concentrations decreased in 200-ZP wells as a result of the 200 West P&T remedial actions where the aerial extent of the chromium plume exceeding 48 µg/L decreased from 0.52 km^2 in 2012 to 0.22 km^2 in 2013.

  - Maximum concentration: 186 µg/L (299-W11-43) versus a "Model Toxics Control Act—Cleanup" (WAC 173-340) Method B groundwater cleanup level for hexavalent chromium of 48 µg/L and a DWS for total chromium of 100 µg/L
  - Areal extent of the plume: 0.2246 km^2 (hexavalent) and 0 km^2 (total)
  - Shoreline impact: 0 m
  - Riparian zone intersected: 0 h
- Iodine-129 concentrations exceed the 1 pCi/L DWS in three wells east and south of WMA T where sources include past leaks from single-shell tanks containing metal and liquid waste and from chemical processing at T plant (DOE/RL-2014-32, Rev. 0, p. ZP-13). The plume size appears to have been decreasing over the past five years (Figure D.6-2).
  - Maximum concentration: 3.64 pCi/L (299-W11-33Q) versus a DWS of 1 pCi/L.
  - Areal extent of the plume: 0.10 km^2.
  - Shoreline impact: 0 m
  - Riparian zone intersected: 0 ha
- Nitrate concentrations exceed the DWS (45 mg/L as nitrate) beneath much of 200-ZP where sources include liquid waste disposal from PFP processes to the cribs near WMA T and the 216-Z cribs and trenches (DOE/RL-2014-32, Rev. 0, p. ZP-15). There are two high concentration plumes: one beneath WMA T and WMA TX-TY and another near the 216-Z cribs and trenches that merge extending from the 216-Z cribs and trenches to beyond the 200 West Area boundary. The size and concentration of contours in 2013 were similar to those reported in 2012 (Figure D.6-2).
  - Maximum concentration: 846 mg/L (299-W10-27 and 299-W18-16) versus a DWS of 45 mg/L (equivalent)
  - Areal extent of the plume: 9.77 km^2
  - Shoreline impact: 0 m
  - Riparian zone intersected: 0 ha
- Technetium-99 exceeded the 900 pCi/L DWS in five wells in 2013 where sources were releases from leaks in single-shell tanks and pipelines in WMA T and WMA TX-TY and liquid waste disposal from plutonium processing operations to cribs and trenches adjacent to the WMAs (DOE/RL-2014-32, Rev. 0, p. ZP-17) There are two plumes, one centered at the north end of WMA TX-TY and the other beneath and east of WMA T. The Tc-99 plume has decreased over the past two years (Figure D.6-2).
  - Maximum concentration: 8,600 pCi/L (299-W14-13) versus a DWS of 900 pCi/L
  - Areal extent of the plume: 0.07 km^2
  - Shoreline impact: 0 m
  - Riparian zone intersected: 0 ha
- TCE is detected at levels above the cleanup standard (1 µg/L) throughout much of 200-ZP and is co-located with the carbon tetrachloride plume (i.e., found above cleanup level from the water table to the bottom of the aquifer). No source information was provided; however, it will be assume that it has the same source as carbon tetrachloride (liquid effluent discharges relating to PFP operations). Plume size increased between 2012 and 2013 because additional data were used to better define the plume size (Figure D.6-2).
  - Maximum concentration: 19 µg/L (299-W17-2) versus a DWS of 5 µg/L and cleanup standard of 1 µg/L
  - Areal extent of the plume: 1.16 km^2
  - Shoreline impact: 0 m
  - Riparian zone intersected: 0 ha

- Tritium concentrations exceeded the DWS at two locations: adjacent to WMA T and adjacent to the SALDS[4] (ongoing source) where additional sources are the liquid waste from plutonium processing to disposal facilities, including 216-T-25 Trench, and past leaks from tanks and pipelines adjacent to WMA TX-TY (DOE/RL-2014-32, Rev. 0, p. ZP-21). The tritium plume area has been steadily decreasing over the past decade (Figure D.6-2).
    - Maximum concentrations: 24,000 pCi/L (299-W11-33Q) versus a DWS of 20,000 pCi/L.
    - Areal extent of the plume: 0.08 km^2
    - Shoreline impact: 0 m
    - Riparian zone intersected: 0 ha
- Uranium is not a contaminant of concern in the 200-ZP-1 OU; however, it is extracted from wells in the 200-UP-1 OU (DOE/RL-2014-32, Rev. 0, p. ZP-3). No information is provided on sources.

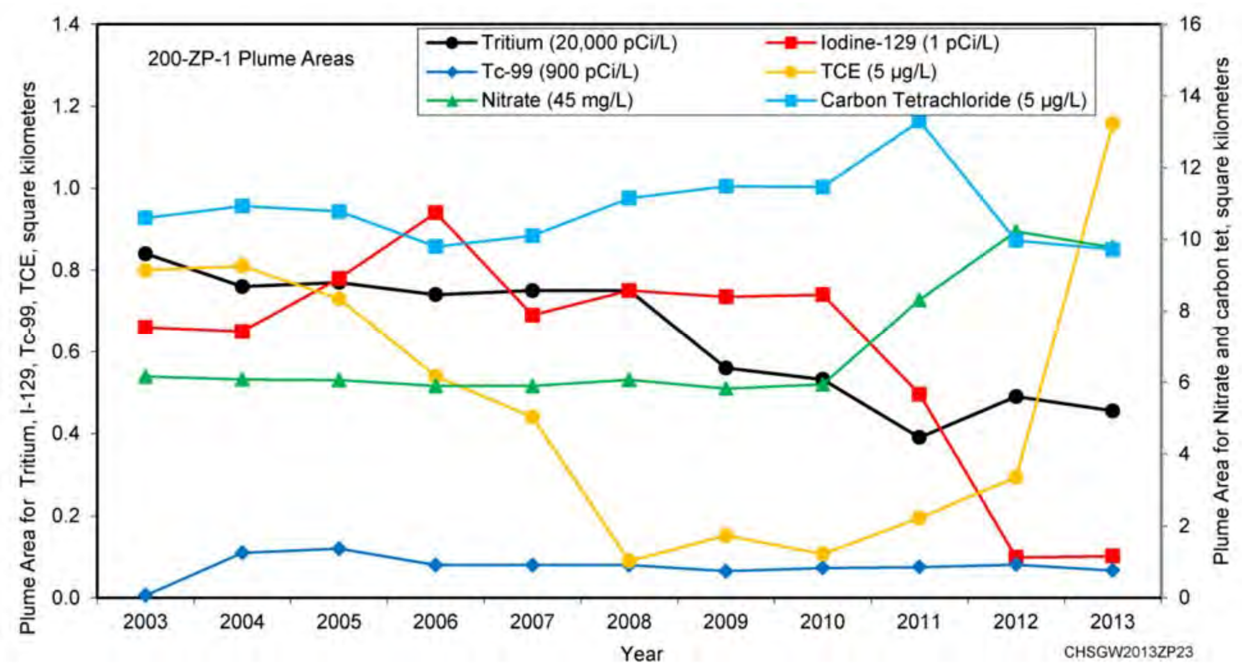

Figure D.6-2. 200-ZP 2013 Plume Areas (DOE/RL-2014-32, Rev. 0, p. ZP-4)

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-2 EU relative to the Hanford Site. Figure D.6-3 shows the relationship among the various Evaluation Units studied in the Interim Report and the Hanford Site. Figure D.6-4 illustrates the extent of groundwater contamination in the Central Plateau. Figure D.6-5 shows a detailed view of the groundwater plumes in and near the 200-UP-1 and 200-ZP-1 Operable Units.

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[4] Permitted discharges at SALDS are a continuing source of tritium to groundwater in 200-ZP (DOE/RL-2014-32, Rev. 0, p. ZP-21).

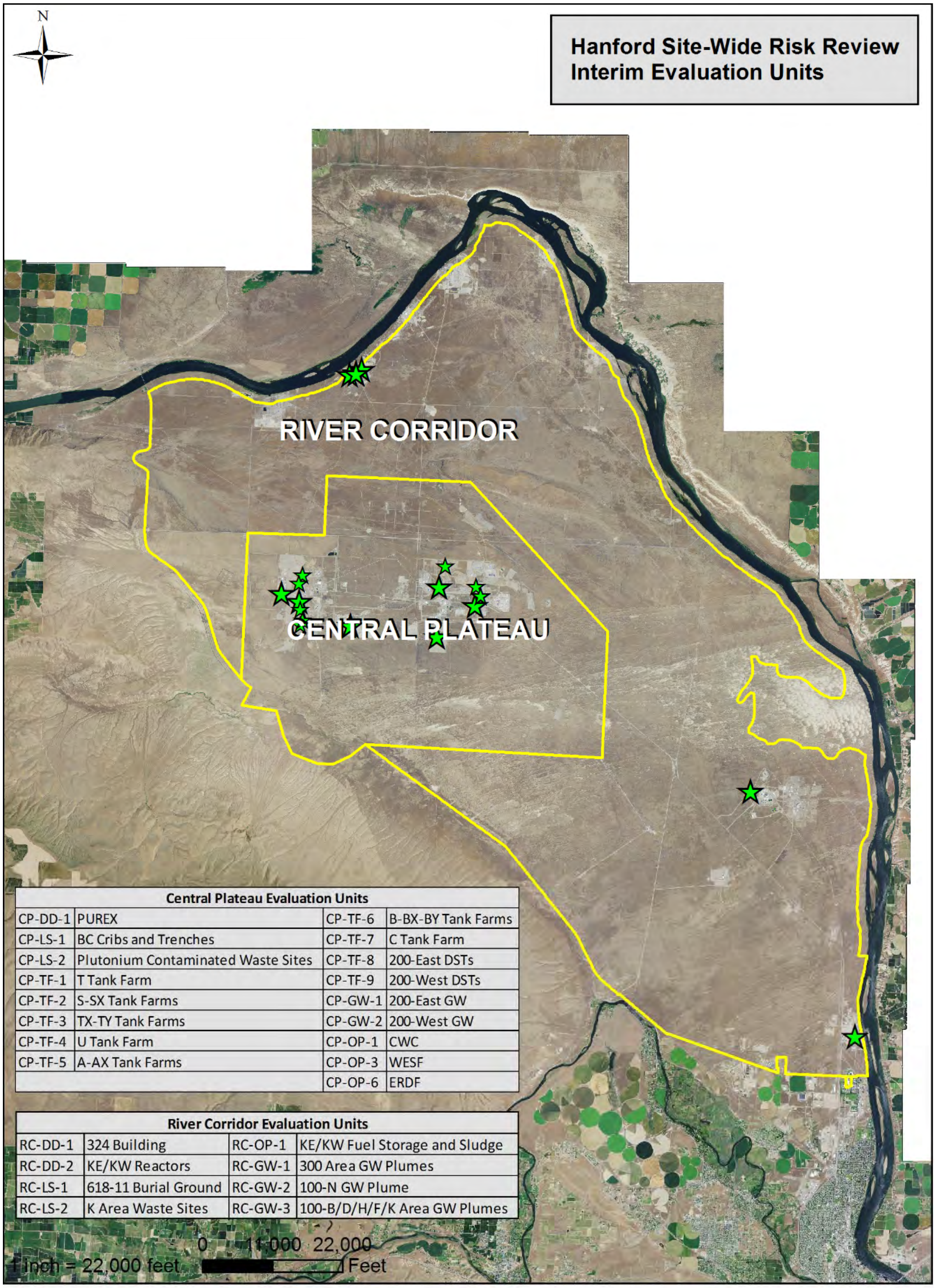

Figure D.6-3. Location of the Evaluation Units in Relation to the Hanford Site.

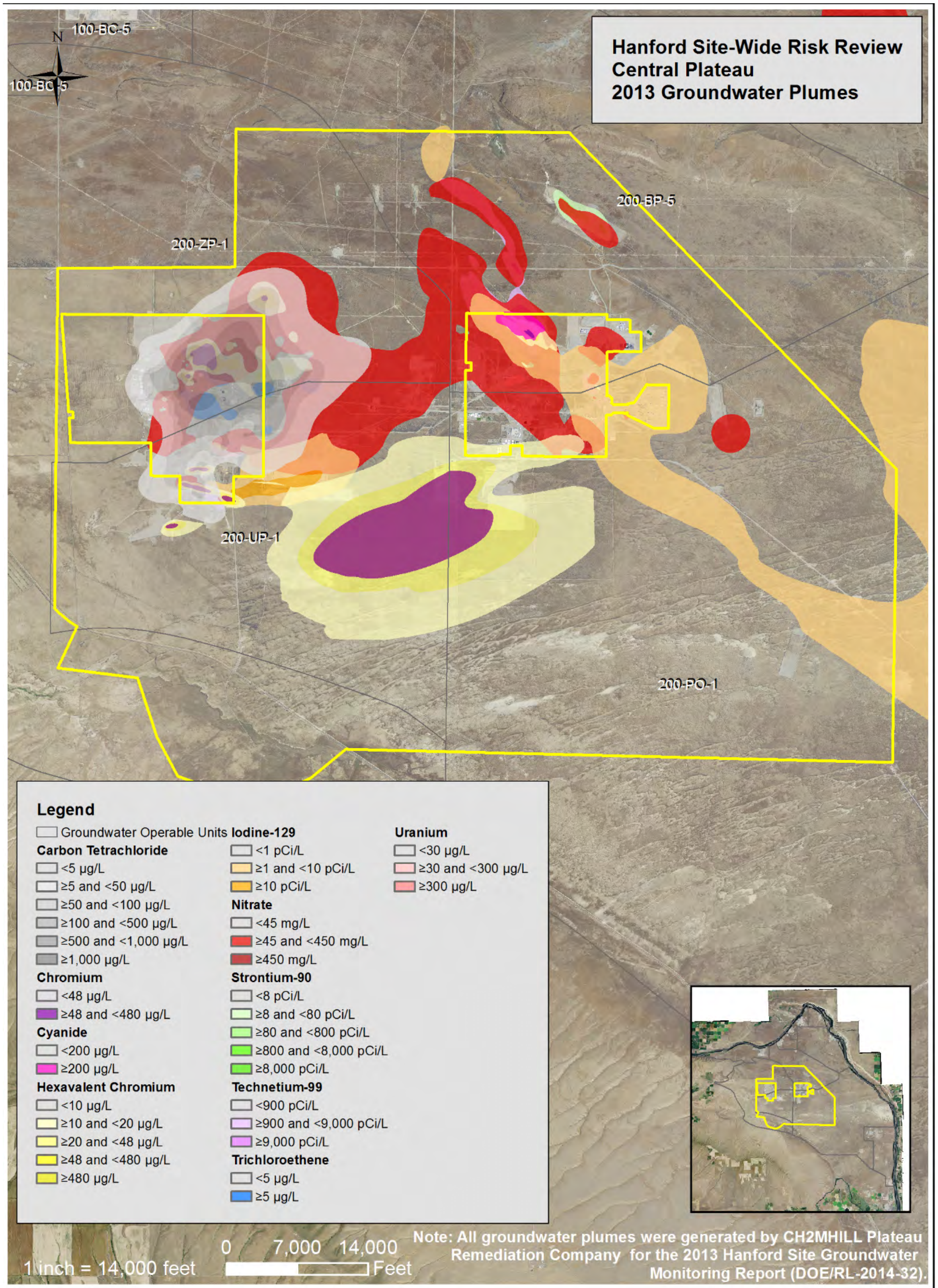

Figure D.6-4. Groundwater Contamination in the Hanford Central Plateau in 2013

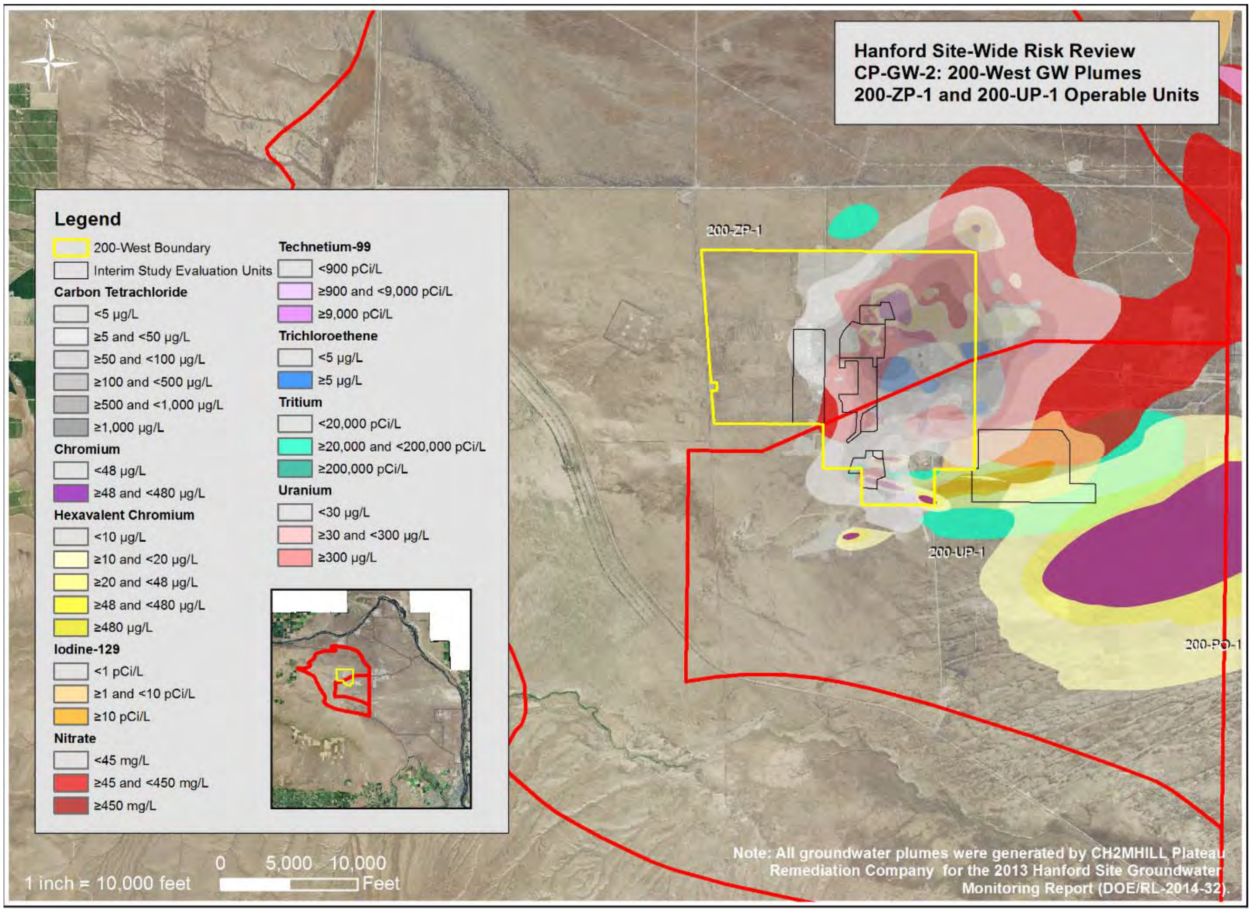

Figure D.6-5. Groundwater Plumes near the 200-UP-1 and 200-ZP-1 Operable Units in 2013

PART IV. UNIT DESCRIPTION AND HISTORY

EU Former/Current Use(s)

The CP-GW-2 EU is related to two Hanford interest areas: 200-UP and 200-ZP containing two CERCLA groundwater Operable Units (OUs), 200-UP-1 and 200-ZP-1, respectively.

The 200-UP interest area, which is in the southern part of 200-West, includes the 200-UP-1 Groundwater OU and adjacent parts of the surrounding 600 Area; these areas are primarily associated with early operations at the REDOX and U Plants, with the exception of the Environmental Restoration Disposal Facility (ERDF) (DOE/RL-2014-32, Rev. 0, p. UP-1). The 200-UP-1 OU has an interim Record of Decision (ROD) (EPA 2012) and is being monitored (DOE/RL-2013-07) 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). A number of groundwater (GW) interim remedial actions have been conducted in 200-UP-1 including (EPA 2012):

- *216-U-1 Crib and 216-U-2 Crib Groundwater Interim Remedial Action (1985)*: An interim remedial action was designed to pump and treat groundwater below these cribs. Pumping started in June 1985 and continued until November 1985. The system removed 687 kg of uranium via ion exchange treatment.

- *200-UP-1 Groundwater OU Interim Remedial Action (1997, amended in 2009 & 2010)*: A pilot-scale treatability test consisting of a P&T system was constructed adjacent to the 216-U-17 Crib. Phase I operations commenced September 1995 and continued until February 1997. The test demonstrated that the ion exchange resin and granular activated carbon were effective at removing Tc-99, uranium, and carbon tetrachloride from groundwater. Based on the success of the treatability study, an interim action (i.e., groundwater extraction and treatment system) was implemented. Cleanup started in 1997 and met its remedial action objective of reducing highest concentrations to below 10 times the cleanup level of 48 µg/L for uranium and 10 times the maximum contaminant level of 900 pCi/L for Tc-99. This system removed 220.5 kg of uranium, 127 g (2.17 Curies) of Tc-99, 41 kg of carbon tetrachloride, and 49,000 kg of nitrate. The system was shut down in 2012.
- *WMA S-SX Groundwater Extraction System*: A groundwater extraction system for Tc-99 was constructed in 2011 and started operation in August 2012. The design consists of a three-well extraction system, aboveground pipelines, and a transfer building to pump extracted groundwater to the 200 West Groundwater Treatment Facility for treatment and reinjection. As of the 2013, the system has removed 60.8 g (1.03) Ci of Tc-99, 17.9 kg of chromium, 9,560 kg of nitrate, and 121 kg of carbon tetrachloride since startup (DOE/RL-2014-32, Rev. 0, p. UP-34).
- The final ROD for the 200-UP-1 OU will be pursued when future groundwater impacts are adequately understood and potential technologies to treat I-129 are completed (EPA 2012).

The 200-ZP interest area, in the northern and central parts of 200-West and nearby parts of 600 Area, include the 200-ZP-1 groundwater OU and legacy source sites (cribs and trenches) primarily related to discharges of liquid wastes from the Plutonium Finishing Plant (PFP) (DOE/RL-2014-32, Rev. 0, p. ZP-1). The following actions have been or are being taken to address groundwater contamination in the 200-ZP-1 OU:

- *200-ZP-1 OU Interim Remedial Action (1995)*: In 1996, a pump-and-treat system was started to reduce the mass of carbon tetrachloride (as well as secondary contaminants TCE and chloroform) in the groundwater primarily from waste sites south and east of the Plutonium Finishing Facility (DOE/RL-2012-03, Rev. 0). This action was completed and the interim P&T system was deactivated in May 2012 (with startup of the 200 West Area P&T facility). From 1996 through 2012, the system removed 13,911 kg of carbon tetrachloride, 14.5 kg of chromium, 84,693 kg of nitrate, 81.7 g (1.3 Ci) of Tc-99, and 0.73 kg of TCE (DOE/RL-2014-32, Rev. 0, p. ZP-25).
- *200-ZP-1 Record of Decision (2008)*: The 200-ZP-1 Record of Decision was issued in 2008 and selected P&T, MNA, and Institutional Controls (ICs) to remediate contaminated groundwater including impacting the direction of groundwater flow and further reducing the levels of carbon tetrachloride present and migrating towards the 200-UP-1 OU. The P&T system was started in 2012 and removed 3,580 kg of carbon tetrachloride, 91.24 kg of chromium, 0.000242 µCi of I-129, 243,905 kg of nitrate, 98.03 g (1.5 Ci) of Tc-99, and 15.49 kg of TCE, and 1.08 kg of U[5] by 2013 (DOE/RL-2014-32, Rev. 0, p. ZP-25).

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[5] Uranium is not a contaminant of concern for the 200-ZP-1 OU; it is including to track 200-UP-1 groundwater treated.

- *200-PW-1 Interim Record of Decision (1992)*: Soil vapor extraction was implemented as an interim action in 1992 to remove carbon tetrachloride from the vadose zone in 200-PW-1 overlying the 200-ZP-1 groundwater (DOE/RL-2014-32, Rev. 0). The system has removed 80,107 kg of carbon tetrachloride to date; however, the mass removed each year has been decreasing (DOE/RL-2014-32, Rev. 0, p. ZP-28). The system did not operate in 2013.

Legacy Source Sites

Not Applicable

High-Level Waste Tanks

Not Applicable

Groundwater Plumes

Please see groundwater plume description in Part III above.

D&D of Inactive Facilities

Not Applicable

Operating Facilities

Not Applicable

Ecological Resources Setting

The 200-W groundwater plumes are located on the Central Plateau, and do not intercept the Columbia River. On the Central Plateau Site, the potential for terrestrial ecological receptors to interact directly with any of the groundwater plumes is unlikely because the depth of groundwater exceeds the depth of terrestrial plant roots and burrowing animals, arthropods, and birds. Locations of groundwater wells have currently been assessed for ecological resources, and the reviews will continue for future activities.

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. A literature review of the setting for the 200-W Groundwater EU 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-UP-1 and 200-ZP-1 Operable Units.

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-UP-1 and 200-ZP-1 OUs as described in Part III, Primary EU Source Components. For example, the carbon tetrachloride plume, the largest in the CP-GW-2 EU, the originated from waste disposal sites associated with the Plutonium Finishing Plant (PFP) in 200-ZP (DOE/RL-2014-32, Rev. 0); these waste sites are associated with the CP-LS-2 (Plutonium Contaminated Waste Sites) EU. 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.6-2 where the process outlined in Chapter 6 of the Methodology Report (CRESP 2015). For the 200-UP-1 and 200-ZP-1 groundwater plumes (DOE/RL-2014-32, Rev. 0), the following information is provided:

- Maximum measured groundwater concentration in 2013 (DOE/RL-2014-32, Rev. 0);
- Upper 95% confidence limit (UCL) on the log-transformed 2013 groundwater and aquifer tube (AT) data from PHOENIX (http://phoenix.pnnl.gov/) exceeding the WQS, where the AT can also be used if the plume is in contact with the Columbia River;
- Plume area in 2013 (exceeding the water quality standard (WQS), often the DWS or risk-based cleanup level) (DOE/RL-2014-32, 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 or the unconfined aquifer thickness is used for the contaminant depth interval;
- 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.

As illustrated in Table D.6-2, the saturated zone (SZ) GTM values for the 200-UP-1 OU Group A and B primary contaminants range from *Low* for uranium, total chromium, and Tc-99 to *Medium* for hexavalent chromium and I-129. The nitrate and tritium plume areas (Group C) translate to *Medium* ratings. These contaminants (except for I-129) have been treated and will be treated in the 200 West P&T System.

The saturated zone (SZ) GTM values (Table D.6-2) for the 200-ZP-1 OU Group A and B primary contaminants range from *Low* for hexavalent chromium, I-129, and Tc-99 to *Medium* for TCE to *Very High* for carbon tetrachloride, which is being treated using the 200-West P&T System. The tritium and nitrate plume areas (Group C) translate to *Low* and *Medium* ratings, respectively. Thus the overall rating for the CP-GW-2 EU would be *Very High* related to carbon tetrachloride in 200-ZP-1. The carbon tetrachloride and other contaminants are being treated using the 200 West P&T System.

Impact of Cleanup, Recharge Rate, and Radioactive Decay on Groundwater Ratings

For this analysis, predicted impacts for a given plume at either the Core Zone Boundary for large plumes or the nearest "barrier" for smaller plumes from the TC&WM EIS groundwater screening analysis (DOE/EIS-0391 2012, Appendix O) are used to gauge potential impacts of recharge rate, transport, and radioactive decay on groundwater ratings. In the TC&WM EIS, 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). The Core Zone Boundary[6] 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). Despite potentially including sources other than those directly related to the 200-UP-1 and 200-ZP-1 OUs, the groundwater screening analysis was considered reasonable to assess rate of movement of contaminants through the Hanford subsurface for this Review. The S and U Barriers are proximate to 200-UP, and the T Barrier is proximate to 200-ZP.

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 near the groundwater plumes. To summarize, the results for Central Plateau sources (DOE/EIS-0391 2012, Appendix O) include:

- Uranium (Group B) – There is a current plume in 200-UP-1 OU but not in the 200-ZP-1 OU (where uranium is not a contaminant of concern but is extracted from wells in the 200-UP-1 OU). Peak predicted concentrations at the S, T, and U Barriers are 5 µg/L (CY 11,827), 9 µg/L (CY 11,840), and 8 µg/L (CY 11,816), respectively, for the No Action Alternative (DOE/EIS-0391 2012, p. O-59) and 0 to 1 µg/L (at the S, T, and U Barriers) for the Landfill Closure scenario (DOE/EIS-0391 2012, p. O-67) indicating uranium is relatively immobile, there are not major additional sources (considered in the TC&WM EIS screening evaluation), and that any residual effects would likely be localized. Thus the ratings for the 200-ZP-1 OU would be *Not Discernible* for the Active Cleanup and Near-term, Post-Cleanup periods. The 200-UP-1 Interim ROD (EPA 2012) indicates that active cleanup (P&T) and monitored natural attenuation (MNA) are expected to reduce uranium concentrations to cleanup levels in 25 years (EPA 2012) (i.e., before the Active Cleanup period begins). Thus ratings for the Active Cleanup and Near-term, Post-Cleanup periods would be *Not Discernible* for the 200-UP-1 OU.

- Nitrate (Group C) – There are current plumes in both 200-UP-1 (where S and U Barriers are closest) and 200-ZP-1 (where T Barrier is closest). Peak concentrations at the S and U Barriers

[6] Groundwater beneath the western portions of the northern and southern Boundary would be impacted by contaminants released at the S, T, and U Barriers. Because the western portion of the aquifer has relatively low groundwater flux, impacts would be relatively high. The eastern portion of the Boundary is in an area of high groundwater flux, and peak groundwater impacts along the eastern part of the Core Zone Boundary would be correspondingly lower (DOE/EIS-0391 2012, p. 2-209).

(maximum of the two) and T Barrier are 37.9 mg/L (CY 3435) and 62 mg/L (CY 2056), respectively, for the No Action Alternative and 4.78 mg/L (CY 2051) and 62.1 mg/L (CY 2053), respectively, for Landfill Closure where the DWS (equivalent) is 45 mg/L. Since the T Barrier peak concentration (used here to indicate 200-ZP-1 OU contaminant movement) exceeds 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 exceeding 0.1 km^2, the groundwater rating for the 200-ZP-1 OU nitrate would remain *Medium* for these evaluation periods, that is, without additional information. However, according to the 200-ZP-1 OU ROD (EPA 2008), planned active treatment is predicted to reduce the groundwater nitrate inventory by 95% during the cleanup period and to the cleanup level in 125 years; these predictions result in ratings of *Medium* and *Low* for the Active Cleanup and Near-term, Post-Cleanup periods, respectively. Since the predicted peak concentrations for 200-UP-1 (both No Action and Landfill Scenario) are less than the threshold and the 200-UP-1 Interim ROD (EPA 2012) suggests that active cleanup and monitored natural attenuation will reduce nitrate concentrations to cleanup levels in 35 years (i.e., before the Active Cleanup period begins), the resulting 200-UP-1 OU plume area would likely be insignificant during the Active Cleanup and Near-term, Post-Cleanup periods; the ratings for these periods would be *Not Discernible*.

- Chromium (Group A – hexavalent and Group B – total) – There is a total chromium plume in 200-UP-1 and hexavalent chromium plumes in both 200-UP-1 and 200-ZP-1. Peak chromium concentrations at the S and U Barriers (maximum of the two) and T Barrier are 541 µg/L (CY 3242) and 336 µg/L (CY 2036), respectively, for the No Action Alternative and 156 µg/L (CY 2050) and 353 µg/L (CY 2045), respectively, for Landfill Closure where the DWS is 100 µg/L for total chromium and the cleanup limit is 48 µg/L for hexavalent chromium. Because both the No Action and Landfill scenarios exceed standards[7], the current ratings would not be modified based on the EIS screening results. However, the 200-UP-1 Interim ROD (EPA 2012) indicates that cleanup levels are predicted to be achieved for chromium (total and hexavalent) in 25 years (i.e., before the Active Cleanup period begins) resulting in ratings of *Not Discernible* for the Active Cleanup and Near-term, Post-Cleanup periods, respectively. The 200-ZP-1 ROD (EPA 2008) indicates that treatment is predicted to reduce the groundwater chromium inventory by 95+% during the cleanup period and to the cleanup level in 125 years resulting in ratings of *Low* for both the Active and Near-term, Post-Cleanup periods to account for uncertainty in treatment.
- Tritium (Group C) – There are current plumes in both 200-UP-1 (S and U Barriers) and 200-ZP-1 (T Barrier). Peak predicted concentrations at the S and U Barriers (maximum of the two) and T Barrier are 1,290 pCi/L (CY 2128) and 2,640 pCi/L (CY 2051), respectively, for the No Action Alternative and 32 pCi/L (CY 2050) and 2,870 pCi/L (CY 2050), respectively, for Landfill Closure where the DWS is 20,000 pCi/L. Since the tritium concentrations do not exceed the standard at any Barrier, any impacts are assumed to be localized. For the 200-ZP-1 (with a small current plume < 0.1 km^2), it is considered possible that local hot spots might persist to the Active Cleanup period that exceed the 20,000 pCi/L standard (since the maximum measured concentration is many times the standard, the half-life of tritium is 12.3 years, and there is no indication of removal of tritium) resulting in *Low* and *Not Discernible* ratings for the Active Cleanup and the Near-term, Post-Cleanup period, respectively (considering radioactive decay).

[7] Furthermore, the Landfill Closure scenario result for hexavalent chromium in 200-UP-1 (*Medium* rating) would still result in a *Medium* rating unless the plume area would decrease by a factor of almost seven to reduce the rating. Thus the *Medium* rating is maintained for 200-UP-1 hexavalent chromium.

For the 200-UP-1 OU with a much larger current plume (5.5 km^2), it is possible that the plume may exceed 0.1 km^2 when the Active Cleanup period begins but is likely to fall below 0.1 km^2 (and perhaps no plume) after cleanup. This results in a *Low* rating for the Active Cleanup period (MNA and radioactive decay) and an *ND* rating for the Near-term, Post-Cleanup period for the 200-UP-1 OU (MNA and decay).

- Tc-99 (Group A) – There are current plumes in both 200-UP-1 (S and U Barriers) and 200-ZP-1 (T Barrier). Peak predicted concentrations at the S and U Barriers (maximum of the two) and T Barrier are 22,800 pCi/L (CY 3072) and 6,480 pCi/L (CY 2050), respectively, for the No Action Alternative and 1,510 pCi/L (CY 2051) and 6,600 pCi/L (CY 2051), respectively, for Landfill Closure where the DWS is 900 pCi/L. However, since peak concentrations for both OUs exceed the 900 pCi/L standard for the Landfill Closure scenario, there is no basis in the TC&WM EIS analysis to reduce the ratings below *Low* for either (based on this information alone). However, groundwater is being treated in both 200-UP-1 and 200-ZP-1 including removing Tc-99. The 200-ZP-1 ROD indicates that cleanup levels will be obtained in 125 years resulting in *Low* and *ND* ratings for the Active Cleanup and Near-term, Post-Cleanup periods, respectively. The interim 200-UP-1 ROD indicates the Tc-99 concentrations are projected to be below the 900 pCi/L standard by the end of the Active Cleanup period (i.e., a rating of ND). Thus the ratings are *ND-Low* for the Active Cleanup and *ND* for the Near-term, Post-Cleanup periods for 200-UP-1 and 200-ZP-1.
- I-129 (Group A) – There are current plumes in both 200-UP-1 (S and U Barriers) and 200-ZP-1 (T Barrier). Peak predicted concentrations at the S and U Barriers (maximum of the two) and T Barrier are 29.1 pCi/L (CY 3136) and 26.1 pCi/L (CY 4560), respectively, for the No Action Alternative and 2.8 pCi/L (CY 2050) and 12.6 pCi/L (CY 2050), respectively, for Landfill Closure where the DWS is 1 pCi/L. However, since peak concentrations for both OUs exceed the 1 pCi/L standard for the Landfill Closure scenario, there is no basis in the TC&WM EIS analysis to reduce the ratings for either (based on this information alone). However, the 200-ZP-1 ROD indicates that 95% of the I-19 mass would be removed in 25 years and I-129 concentrations are projected to be below the cleanup level in 125 years resulting in a *Low* rating for the Active Cleanup and *ND* for the Near-term, Post-Cleanup period. For 200-UP-1, there is no effective treatment currently defined for I-129 in 200-UP-1, thus the rating would increase to *High* for the Active and Near-term, Post-Cleanup periods, indicating the need for monitoring and treatment.
- Carbon Tetrachloride (Group A) – The carbon tetrachloride plume is managed in the 200-ZP-1 (source area) OU; there is a large, current plume emanating from 200-ZP. No values are reported at the S and U or T Barriers or Core Zone Boundary for carbon tetrachloride for either No Action or landfill Closure scenario, which indicates that either predicted peak fluxes were less than 1×10^{-8} g/yr (Appendix O, TC&WM EIS, p. O-2) or the relevant source sites were not included in the screening evaluation. The EIS screening results are assumed to not be informative for the analysis of the movement of carbon tetrachloride for this evaluation. The interim 200-UP-1 ROD indicates that it is expected to take 125 years of combined active P&T and MNA (i.e., after the Active Cleanup period) for the carbon tetrachloride concentrations to meet cleanup requirements. Thus the ratings for the Active Cleanup and Near-term, Post-Cleanup ratings for TCE would be *Very High* and *Medium*, respectively, to account for uncertainties including in treatment effectiveness. These ratings reflect the need for continued monitoring (as planned) during treatment.
- Trichloroethene (TCE) (Group B) – There is a TCE plume associated with 200-ZP. No values are reported at the S and U or T Barriers or Core Zone Boundary for carbon tetrachloride or TCE for

either No Action or landfill Closure scenario, which indicates that either predicted peak fluxes were less than 1×10^{-8} g/yr (Appendix O, TC&WM EIS, p. O-2) or relevant source sites were not included in the screening evaluation. The 200-ZP-1 ROD (selected remedy) indicates that 95% of the TCE mass is expected to be removed within 25 years with the cleanup level being achieved in 125 years. Thus the Active Cleanup and Near-term, Post-Cleanup ratings for TCE would be *Low* and *ND*, respectively.

The results and ratings for the 200-UP-1 and 200-ZP-1 OUs are summarized in Table D.6-3

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.6-4.

Benthic and Riparian Zone – Current Impacts

Based on the information in the 2013 Hanford Annual Groundwater Report (DOE/RL-2014-32 Rev. 0) and PHOENIX (http://phoenix.pnnl.gov/), even though 200-UP-1 and 200-ZP-1 OU contaminants are in the saturated zone at concentrations exceeding thresholds, no plumes from the 200-UP-1 and 200-ZP-1 OUs are currently intersecting the Columbia River at concentrations exceeding the WQS[8]. Thus current impacts to the Columbia River from the 200-UP-1 and 200-ZP-1 OUs would be rated as *Not Discernible*.

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

Because the 200-UP-1 and 200-ZP-1 OU plumes originate from 200-West, it is considered unlikely that a plume might reach the Columbia River since the water travel time is greater than 50 years (and likely significantly more) from the 200 West Area to the 200 East Area and ~10-30 years from the 200 East Area to the Columbia River (Gephart 2003; PNNL-6415 Rev. 18), and significantly more time would likely be required to reach the river in sufficient quantity to exceed the WQS or appropriate aquatic screening values.[9] Any contaminants *predicted* to impact the Columbia River in sufficient amounts from the Central Plateau (e.g., as described in Appendix P in the TC&WM EIS (DOE/EIS-0391 2012)) would thus likely come from 200-East sources[10] and not the 200-UP-1 and 200-ZP-1 OUs. Thus the impacts to the Columbia River benthic and riparian ecology for the Active Cleanup and Near-term, Post Cleanup periods are rated as *Not Discernible*.

Benthic and Riparian Zone – Long-term

An ecological screening analysis was performed in the TC&WM EIS (DOE/EIS-0391 2012, Appendix P) to evaluate potential long-term impacts of radioactive and chemical contaminants (*from selected Central*

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[8] 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-2014-32 Rev. 0). There are plumes associated with River Corridor GW OUs that are also in contact with the Columbia River.

[9] Based on current and expected subsurface conditions, the only path from the 200 West Area to the Columbia River currently being considered is from 200 West to 200 East to the Columbia River (CRESP 2015).

[10] Note that TC&WM EIS predictions indicate possible impacts from chromium to the benthic and riparian zones within the next decade; however, actual well measurements for chromium and other contaminants show no likely impacts in the foreseeable future from 200-West or 200-East sources, including the next 150 years. Note there was a path north from 200-West to the Columbia River that is no longer considered reasonable due to changing hydrologic patterns across the Hanford Site.

Plateau sources under a No Action Alternative[11]) discharged with groundwater on aquatic and riparian receptors at the Columbia River. The screening results 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[12]) (DOE/EIS-0391 2012, Appendix P, p. P-52), indicating there should be no expected adverse effects from radionuclides for Columbia River benthic and riparian receptors over the time period evaluated (10,000 years).[13]

The corresponding (No Action) evaluation in the TC&WM EIS for potential long-term impacts of chemical contaminants discharged with groundwater to the near-river ecology (benthic and riparian) indicate that chromium and nitrate (both of which have current plumes) would have expected Hazard Quotients exceeding unity for aquatic and riparian receptors over the evaluation period in the TC&WM EIS. 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 future concentrations would appear to not exceed either the drinking water standard or ambient water quality criterion in the next 10,000 years. Furthermore, the potential impact of increased nitrate levels may depend on other factors (e.g., phosphorus). Thus, nitrate is considered to have a *Not Discernible* rating for the benthic and riparian ecology.

The EIS results of the screening evaluation at the near-shore region under the No Action Alternative (TC&WM EIS, Appendix O) indicate that the concentration could exceed the drinking water standard for total chromium (100 μg/L) and the EIS benchmark threshold[14] (as well as the ambient water quality criterion of 10 μg/L) for hexavalent chromium. The predicted concentrations are likely overestimated since all discharge is assumed to occur in a 40-m near-shore region. Furthermore, because of the long travel time of water from 200-West (200-ZP-1 OU) to 200-East (then to the Columbia River) relative to that from 200-East to the Columbia River, it is likely that the 200-West sources would provide an insignificant contribution of the chromium predicted to reach the Columbia River exceeding screening values (unless this was assumed to occur via the now defunct northern path from 200-West to the Columbia River), which would likely lead to insignificant long-term impacts to the benthic and riparian ecology from 200-West sources, including those associated with the 200-UP-1 and 200-ZP-1 OUs.

Threats to the Columbia River Free-flowing Ecology

As described in Appendix E.2 and the Methodology Report (CRESP 2015), the large dilution effect of the Columbia River on the contamination from the seeps and groundwater upwellings results in *Not*

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[11] Despite including sources other than those directly related to the 200-UP-1 and 200-ZP-1 OUs, the analysis in the TC&WM EIS was considered a reasonable basis to assess the potential for impact of contaminants on the benthic and riparian zones. However, because the sources are not limited to GW OUs, the evaluation is not restricted to just the GW OU sources but instead those for many Central Plateau sources. Furthermore, the results can thus be divided by the 200-West and 200-East areas based on differences in travel times of water and contaminants to the Columbia River.

[12] The standard also indicates the screening values were used for riparian receptors.

[13] Because these expected impacts are likely to be small, the potential indirect impacts on the ecosystem are assumed to be correspondingly minor (DOE/EIS-0391 2012, Appendix P, p. P-52). Based on the results in the TC&WM EIS (Appendix P), the benchmark values in the DOE Technical Standard would have to be significantly lower in the future to change the evaluation results.

[14] The benchmark value used for chromium (hexavalent) in the TC&WM EIS was the sensitive-species-test-effect concentration that affects 20 percent of a test population (EC_{20}) despite the fact that the less toxic trivalent form of chromium is more like to be present in oxygenated, aquatic environs (DOE/EIS-0391 2012, Appendix P, pp. P-52 to P-53).

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 Cleanup and Recharge Rate on Threats to the Columbia River

The alternatives evaluation (No Action versus Landfill Closure) in the TC&WM EIS suggests that remedial actions (e.g., surface barrier emplacement that would decrease recharge in the areas near the Tank Farms) would appear to not have significant impacts on the long-term peak concentrations in the near-shore area (benthic and riparian receptors) of the Columbia River. These results are not due to ineffectiveness of the barrier but instead due to large amounts of contaminants already in the groundwater. Ratings are not changed based on the remedial actions assumed in the TC&WM EIS (DOE/EIS-0391 2012).

Facilities for D&D

Not Applicable

Operating Facilities

Not Applicable

Table D.6-2. Summary of the Evaluation of Current Threats to Groundwater as a Protected Resource from Saturated Zone (SZ) Contamination associated with the CP-GW-2 Evaluation Unit (200-UP-1 and 200-ZP-1 Operable Units)

OU	PC	Grp	WQS[a]	Area (km^2)[b]	Thick-ness (m)[c]	Pore Vol. (Mm^3)	Max GW Conc	95th % GW UCL	Porosity[a]	K_d (mL/g)[b]	ρ (kg/L)[b]	R	SZ Total, M^{SZ} (kg or Ci)	SZ GTM (Mm^3)	SZ Rating[e]
200-UP-1	U	B	30 µg/L	0.34	15	1.17E+00	298 µg/L	188 µg/L	0.23	0.8	1.84	7.40E+00	2.21E+02	7.35E+00	Low*
	NO3	C	45 mg/L	5.8	24	3.20E+01	3210 mg/L	116 mg/L	0.23	0	1.84	1.00E+00	3.71E+06	---	Medium*
	Cr	B	100 µg/L	0.37	24	2.04E+00	907 µg/L	294 µg/L	0.23	0	1.84	1.00E+00	6.00E+02	6.00E+00	Low*
	Cr-VI	A	48 µg/L	3.85	24	2.13E+01	907 µg/L	118 µg/L	0.23	0	1.84	1.00E+00	2.51E+03	5.22E+01	Medium*
	H-3	C	20000 pCi/L	5.5	30	3.80E+01	310000 pCi/L	57600 pCi/L	0.23	0	1.84	1.00E+00	2.19E+03	---	Medium
	Tc-99	A	900 pCi/L	0.29	20	1.33E+00	62000 pCi/L	6340 pCi/L	0.23	0	1.84	1.00E+00	8.46E+00	9.40E+00	Low*
	I-129	A	1 pCi/L	3.1	30	2.14E+01	9.14 pCi/L	3.59 pCi/L	0.23	0.2	1.84	2.60E+00	7.68E-02	7.68E+01	Medium
	CCl4	A	3.4 µg/L	---	---	---	700 µg/L	74.1 µg/L	0.23	0	1.84	1.00E+00	---	---	See below*
200-ZP-1	CCl4	A	3.4 µg/L	13.3	55	1.68E+02	2600 µg/L	322 µg/L[f]	0.23	0	1.84	1.00E+00	5.42E+04	1.1E+04	Very High*
	Cr	B	100 µg/L	---	---	0.00E+00	182 µg/L	104 µg/L	0.23	0	1.84	1.00E+00	0.00E+00	---	---*
	Cr-VI	A	48 µg/L	0.2246	24	1.24E+00	186 µg/L	90.3 µg/L	0.23	0	1.84	1.00E+00	1.12E+02	2.33E+00	Low*
	I-129	A	1 pCi/L	0.1	30	6.90E-01	3.64 pCi/L	1.51 pCi/L	0.23	0.2	1.84	2.60E+00	1.04E-03	1.04E+00	Low
	NO3	C	45 mg/L	9.77	24	5.39E+01	846 mg/L	180 mg/L	0.23	0	1.84	1.00E+00	9.71E+06	---	Medium*
	Tc-99	A	900 pCi/L	0.07	20	3.22E-01	8600 pCi/L	3550 pCi/L	0.23	0	1.84	1.00E+00	1.14E+00	1.27E+00	Low*
	TCE	B	5 µg/L	1.16	55	1.47E+01	19 µg/L	9.26 µg/L	0.23	0	1.84	1.00E+00	1.36E+02	2.72E+01	Medium*
	H-3	C	20000 pCi/L	0.08	30	5.52E-01	140000 pCi/L	97500 pCi/L	0.23	0	1.84	1.00E+00	5.38E+01	---	Low
	U	B	30 µg/L	---	15	---	3.2 µg/L	---	0.23	0.8	1.84	7.40E+00	---	---	---*

a. The Water Quality Standard (WQS) is typically the drinking water standard (DWS). The exceptions are hexavalent chromium (Cr-VI) where the "Model Toxics Control Act—Cleanup" (WAC 173-340) Method B groundwater cleanup level of 48 µg/L is used and carbon tetrachloride (CCl4) where a risk-based threshold of 3.4 µg/L is used instead of the DWS of 5 µg/L (although the DWS is used to estimate the GTM for CCl4).

b. Plume area (DOE/RL-2014-32, Rev. 0).

c. The thicknesses for contaminants in the 200-UP-1 OU is that from Table 3 from the Hanford 200-UP-1 OU Interim ROD (EPA 2012). 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-ZP-1 OU, only TCE is not a plume in 200-UP-1, and the carbon tetrachloride thickness is used.

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). The Groundwater Threat Metric (GTM) rating based on Table 6-3, Methodology Report (CRESP 2015) for Group A and B contaminants. The 200-West P&T facility is operating, and contaminants with extraction amounts are indicated in the table with an asterisk (*) although other contaminants may be extracted. Very little I-129 has been captured in the system and thus it is not indicated as being treated. Soil vapor extraction has also been used to treat carbon tetrachloride (80,000 kg removed by 2012).

f. The carbon tetrachloride plume covers areas in both the 200-UP-1 and 200-ZP-1 OUs. Measurements from both areas were used to estimate the 95% UCL.

Table D.6-3. Summary of the Evaluation of Future Threats to Groundwater as a Protected Resource from Saturated Zone (SZ) Contamination associated with the CP-GW-2 Evaluation Unit (200-UP-1 and 200-ZP-1 Operable Units)

OU	PC	Group	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-UP-1	U	B	30 µg/L	2.21E+02	7.35E+00	Low	No/No	Yes	25	ND	No/No	ND
	NO3	C	45 mg/L	3.71E+06	---	Medium	No/Yes	Yes	35	ND	No/Yes	ND
	Cr	B	100 µg/L	6.00E+02	6.00E+00	Low	Yes/Yes	Yes	25	ND	Yes/Yes	ND
	Cr-VI	A	48 µg/L	2.51E+03	5.22E+01	Medium	Yes/Yes	Yes	25	ND	Yes/Yes	ND
	H-3	C	20000 pCi/L	2.19E+03	---	Medium	No/No	No	25 (MNA)	Low	No/No	ND[f]
	Tc-99	A	900 pCi/L	8.46E+00	9.40E+00	Low	Yes/Yes	Yes	15	ND	Yes/Yes	ND
	I-129	A	1 pCi/L	7.68E-02	7.68E+01	Medium	Yes/Yes	No	---	High	Yes/Yes	High
	CCl4	A	3.4 µg/L	---	---	See below	Yes[g]	Yes	125	See below	No[g]	See below
200-ZP-1	CCl4	A	3.4 µg/L	5.42E+04	1.1E+04	Very High	Yes[g]	Yes	125	Very High	No[g]	Medium
	Cr	B	100 µg/L	0.00E+00	---	---	Yes/Yes	Yes	125	---	Yes/Yes	---
	Cr-VI	A	48 µg/L	1.12E+02	2.33E+00	Low	Yes/Yes	Yes	125	Low	Yes/Yes	Low
	I-129	A	1 pCi/L	1.04E-03	1.04E+00	Low	Yes/Yes	No	125	Low	Yes/Yes	ND
	NO3	C	45 mg/L	9.71E+06	---	Medium	No/Yes	Yes	125	Medium	No/Yes	Low
	Tc-99	A	900 pCi/L	1.14E+00	1.27E+00	Low	Yes/Yes	Yes	125	Low	Yes/Yes	ND
	TCE	B	5 µg/L	1.36E+02	2.72E+01	Medium	Yes[g]	Yes	125	Low	No[g]	ND
	H-3	C	20000 pCi/L	5.38E+01	---	Low	No/No	No	---	Low	No/No	ND[f]
	U	B	30 µg/L	---	---	---	No/No	Yes	---	ND	No/No	ND

a. The Water Quality Standard (WQS) is typically the drinking water standard (DWS). The exceptions are hexavalent chromium (Cr-VI) where the “Model Toxics Control Act—Cleanup” (WAC 173-340) Method B groundwater cleanup level of 48 µg/L is used and carbon tetrachloride (CCl4) where a risk-based threshold of 3.4 µg/L is used instead of the DWS of 5 µg/L (although the DWS is used to estimate the GTM for CCl4).

b. Ratings provided in Figure D.6-2. 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). The screening results for carbon tetrachloride are assumed to be not informative for this analysis.

d. The 200-West P&T facility has been operating since 2012, and contaminants currently being extracted are indicated although other contaminants may be extracted. Soil vapor extraction has also been used to treat carbon tetrachloride (i.e., 80,000 kg removed by 2012).

e. The 200-UP-1 Interim ROD (EPA 2012) indicates the time (in years) until the selected remedy achieves corresponding cleanup levels. The 200-ZP-1 ROD (EPA 2008) indicates that the selected remedy would remove a minimum of 95% of the mass of the contaminant and would achieve cleanup levels in 125 years.

f. Considering radioactive decay.

g. The screening results in the TC&WM EIS (DOE/EIS-0391 2012, Appendix O) are assumed to be uninformative; results are based on the appropriate ROD.

Table D.6-4. Summary of the Evaluation of Groundwater as Pathway to the Columbia River associated with the CP-GW-2 Evaluation Unit (200-UP-1 and 200-ZP-1 Operable Units)

OU	PC	Group	WQS	BCG or AWQC[a]	Max GW Conc	95th % GW UCL	Max GW Conc / BCG or WQS	95th % GW UCL / BCG or WQS	Shoreline Impact (m)[b]	Riparian Area (ha)[c]	Benthic rating	Riparian rating	Overall rating[d]
200-UP-1	U	B	30 µg/L	5 µg/L	298 µg/L	188 µg/L	5.96E+01	3.76E+01	---	---	---	---	ND*
	NO3	C	45 mg/L	7100 mg/L	3210 mg/L	116 mg/L	9.42E+00	3.40E-01	---	---	---	---	ND*
	Cr	B	100 µg/L	55 µg/L	907 µg/L	294 µg/L	1.65E+01	5.35E+00	---	---	---	---	ND*
	Cr-VI	A	48 µg/L	10 µg/L	907 µg/L	118 µg/L	9.07E+01	1.18E+01	---	---	---	---	ND*
	H-3	C	20000 pCi/L	2.65E+08 pCi/L	310000 pCi/L	57600 pCi/L	1.17E-03	2.17E-04	---	---	---	---	ND
	Tc-99	A	900 pCi/L	667000 pCi/L	62000 pCi/L	6340 pCi/L	9.30E-02	9.51E-03	---	---	---	---	ND*
	I-129	A	1 pCi/L	38500 pCi/L	9.14 pCi/L	3.59 pCi/L	2.37E-04	9.32E-05	---	---	---	---	ND
	CCl4	A	3.4 µg/L	9.8 µg/L	700 µg/L	74.1 µg/L	7.14E+01	7.56E+00	---	---	---	---	ND*
200-ZP-1	CCl4	A	3.4 µg/L	9.8 µg/L	2600 µg/L	714 µg/L	2.65E+02	7.29E+01	---	---	---	---	ND*
	Cr	B	100 µg/L	55 µg/L	182 µg/L	104 µg/L	3.31E+00	1.89E+00	---	---	---	---	ND*
	Cr-VI	A	48 µg/L	10 µg/L	186 µg/L	90.3 µg/L	1.86E+01	9.03E+00	---	---	---	---	ND*
	I-129	A	1 pCi/L	38500 pCi/L	3.64 pCi/L	1.51 pCi/L	9.45E-05	3.92E-05	---	---	---	---	ND
	NO3	C	45 mg/L	7100 mg/L	846 mg/L	180 mg/L	2.48E+00	5.28E-01	---	---	---	---	ND*
	Tc-99	A	900 pCi/L	667000 pCi/L	8600 pCi/L	3550 pCi/L	1.29E-02	5.32E-03	---	---	---	---	ND*
	TCE	B	5 µg/L	47 µg/L	19 µg/L	9.26 µg/L	4.04E-01	1.97E-01	---	---	---	---	ND*
	H-3	C	20000 pCi/L	2.65E+08 pCi/L	140000 pCi/L	97500 pCi/L	5.28E-04	3.68E-04	---	---	---	---	ND
	U	B	30 µg/L	12.9 µg/L	3.2 µg/L	---	2.48E-01	---	---	---	---	---	ND*

a. Biota Concentration Guide (BCG) from RESRAD-BIOTA v1.5 (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 available.

b. Shoreline impact (m) (DOE/RL-2014-32, Rev. 0)

c. The intersection area between the groundwater plume and the riparian zone was provided by PNNL based on the 2013 Hanford Site Groundwater Monitoring Report (DOE/RL-2014-32, Rev. 0).

d. No plumes are currently in contact with the Columbia River resulting in a ND rating. The 200-West P&T facility has been operating since 2012, and contaminants currently being extracted are indicated (*) although other contaminants may be extracted. Soil vapor extraction has also been used to treat carbon tetrachloride (i.e., 80,000 kg removed by 2012).

PART VI. POTENTIAL RISK/IMPACT PATHWAYS AND EVENTS

CURRENT CONCEPTUAL MODEL

Large and small contaminant plumes in the 200-West Area comprising the CP-GW-2 EU pose a current and continuing risk to protected natural resources in the area including groundwater. 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 remedial work being done in the 200-West Area, including monitoring and pump-and-treat activities; 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-West 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 would tend to dilute 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-West 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[15]. 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 potential, long-term future pathway (e.g., I-129 and nitrate) for impact to the Columbia River (a protected natural resource) from the CP-GW-2.

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 200-West to 200-East (50+ years) and then from 200 East to the Columbia River is (~10-30 years) limits impacts to the River to very mobile contaminants over very long time frames. 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.

8. *Are there current on-going releases to the environment or receptors?*

Large and small contaminant plumes in the 200-West Area comprising the CP-GW-2 EU pose a current and continuing risk to protected natural resources in the area including groundwater and the Columbia River in the very long-term. 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

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, 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

[15] 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.

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.6-2, the saturated zone (SZ) GTM values for the 200-UP-1 Group A and B primary contaminants range from *Low* for uranium, total chromium, and Tc-99 to *Medium* for hexavalent chromium and I-129. The nitrate and tritium plume areas (Group C) translate to *Medium* since both areas are greater than 0.1 km^2. The saturated zone (SZ) GTM values for the 200-ZP-1 Group A and B primary contaminants range from *Low* for hexavalent chromium, I-129, and Tc-99 to *Medium* for TCE to *Very High* for carbon tetrachloride, which is being treated using the 200-West P&T System. The tritium and nitrate plume areas (Group C) translate to *Low* and *Medium* ratings, respectively, based on current plume areas. Thus the overall rating for the CP-GW-2 EU would be *Very High* related to carbon tetrachloride in 200-ZP-1 (which is being treated).

Columbia River

As described in Part V, no plumes currently intersect the Columbia River, thus current ratings for all contaminants for the benthic, riparian, and free-flowing ecology are *Not Discernible*.

Ecological Resources

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

- Injection and pumping wells might alter the hydrology in the vadose zone, and change soil water availability for plants.
- Injection of barrier constituents might alter soil chemistry and nutrient availability depending on rate or distance of migration of those constituents and whether the constituents interact with soils within the rooting zone
- Well pad and road construction may disturb the surface, degrade available habitat, and impact ecological resources/receptors

- Pedestrian and vehicle traffic during construction, maintenance, monitoring, and decommission of subsurface barrier systems may degrade habitats, disturb wildlife and affect animal behavior, and introduce exotic plant species.

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

Cultural Resources

The potential for cultural resources in the area of the groundwater plumes is high and likely to affect the Native American, Historic Pre-Hanford, and Manhattan Project/Cold War landscapes. A literature review of the setting for the 200-W Groundwater EU 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-UP interest area, which is in the southern part of 200-West, includes the 200-UP-1 Groundwater OU and adjacent parts of the surrounding 600 Area; these areas are primarily associated with early operations at the REDOX and U Plants, with the exception of the Environmental Restoration Disposal Facility (ERDF) (DOE/RL-2014-32, Rev. 0, p. UP-1). The 200-UP-1 OU has an interim Record of Decision (ROD) (EPA 2012) and is being monitored (DOE/RL-2013-07) 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). A number of groundwater (GW) interim remedial actions, including pump and treat and groundwater extraction have been conducted in 200-UP-1 including (EPA 2012). The final ROD for the 200-UP-1 OU will be pursued when future groundwater impacts are adequately understood and potential technologies to treat I-129 are completed (EPA 2012).

The 200-ZP interest area, in the northern and central parts of 200-West and nearby parts of 600 Area, include the 200-ZP-1 groundwater OU and legacy source sites (cribs and trenches) primarily related to discharges of liquid wastes from the Plutonium Finishing Plant (PFP) (DOE/RL-2014-32, Rev. 0, p. ZP-1). Remedial actions have been or are being taken to address groundwater contamination in the 200-ZP-1 OU including P&T, MNA, and Institutional Controls (ICs).

Contaminant Inventory Remaining at the Conclusion of Planned Active Cleanup Period

Remedial actions have been defined (primarily P&T, MNA, and ICs) for both the 200-UP-1 and 200-ZP-1 OUs; however, some of the actions are predicted to require more time than the 50-year Active Cleanup period to return groundwater to a state that allows most beneficial use (as drinking water). Thus it is assumed that certain mobile contaminants with large current plumes (e.g., tritium, TCE, and carbon tetrachloride) will continue to have plumes above cleanup standards after the Active Cleanup period. Furthermore, the remedial action for I-129 in the 200-UP-1 OU has not been selected so its plume is assumed to not be impacted by current treatment in 200-West.

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-2 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

As described in Part V, cleanup (primarily), recharge, and decay will have significant impacts on groundwater ratings during the Active Cleanup period. To summarize, ratings for most contaminants are lower during this period than for Current conditions with two notable exceptions. The rating for carbon tetrachloride is rated *Low-Very High* to reflect both the large inventory in groundwater and uncertainty in treatment effectiveness (predicted to require 125 years). Furthermore, since no remedial action has been selected for I-129 in the 200-UP-1 OU, this rating was not modified (also based on predictions in the TC&WM EIS).

Columbia River

Please see Part V for a discussion of the impact of treatment, 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

Despite on-going treatment, some contaminant plumes (e.g., I-129) in the 200-West Area may continue to increase in size (Figure D.6-1 and Figure D.6-2) and impact additional groundwater. A remedial decision for I-129 in 200-UP-1 is needed.

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

Please see Part V for a discussion of the impact of cleanup, recharge, and decay on groundwater and Columbia River ratings in the Near-term, Post-Cleanup period. For potential impacts to groundwater, the ratings for the 200-West GW OUs tend to be *ND* to reflect presumed treatment effectiveness. Notable exceptions are carbon tetrachloride (*Medium* rating) to reflect the large contaminant inventory in groundwater and uncertainties in treatment effectiveness and I-129 (*High* rating) in 200-UP-1 since no remedial decision has been made.

Populations and Resources at Risk or Potentially Impacted After Cleanup Actions (from residual contaminant inventory or long-term activities)

Table D.6-5. 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.
Human	Co-located Person	Low to Not Discernible (Not Discernible)	Following completion of active cleanup activities, groundwater concentrations should be below AWQS.
Human	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-UP-1 OU: ND to High (I-129) 200-ZP-1 OU: ND to Medium (CCl4) Overall: High (I-129)	As discussed in Part V (and summarized in Table D.6-3), there are significant impacts to future groundwater threats from transport (recharge), radioactive decay, and cleanup (200-W P&T) on contaminants. The risk driver (*High*) is I-129 in 200-UP-1 where monitoring is continuing until a remedial action is defined.
Environmental	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*	ND to Low	Contamination remaining in areas for monitored natural attenuation may still result in uptake in biota, but is not likely to cause an effect to the biota. Continued long-term monitoring activities may disrupt riparian and terrestrial habitats. Re-vegetation in EU will result in additional level 3 resources, and potentially creation of level 4 resources potentially at risk

			because of disturbance, especially from invasive species.
Social	Cultural Resources*	**Native American:** Direct: Known Indirect: Known **Historic Pre-Hanford:** Direct: Unknown Indirect: Unknown **Manhattan/Cold War**: Direct: Unknown Indirect: Unknown	Permanent indirect effects to viewshed are possible from remediation activities. Permanent effects may be possible due to presence of contamination if monitored natural attenuation is the preferred remedial action. No other expected cultural resources impacts.

*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.

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

Because of the large carbon tetrachloride plume that may take 125 years or more to treat and the fact that remedial actions have not been defined for the I-129 in the 200-UP-1 OU, the corresponding ratings (*Medium-High*, respectively) indicate the need for continued monitoring and treatment of groundwater in these areas.

PART VII. SUPPLEMENTAL INFORMATION AND CONSIDERATIONS

The final Record of Decision (ROD) was signed for the 200-ZP-1 OU in 2008 (EPA 2008). An interim ROD was signed in 2012 for the 200-UP-1 OU (EPA 2012); the final remedy selection for I-129 in the 200-UP-1 OU is pending additional characterization and analysis.

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APPENDIX E.1

Tank Waste and Farms

Common Elements of the Tank Waste and Farms Evaluation Unit Summary Templates

Table of Contents

List of Figures

List of Tables

PART 1. COMMON ELEMENTS OF TANK WASTE AND FARMS EVALUATION UNITS

1.1. EXECUTIVE SUMMARY

Nine Tank Waste and Farms Evaluation Units (EUs) have been identified for the Interim Report as indicated in Table E.1-1. These evaluation units (also denoted Tank Farm Evaluation Units, Tank Farm EUs or TF EUs), include the 149 Hanford single-shell tanks (SSTs) and 28 double-shell tanks (DSTs) and ancillary equipment and geographically co-located legacy disposal sites located in the Central Plateau on the Hanford Site.

EU LOCATION:

The locations of the nine Tank Waste and Farms EUs are indicated in Table E.1-1.

RELATED EUS:

The nine Tank Waste and Farms EUs listed in Table E.1-1, 200-E Groundwater (CP-GW-1), 200-W Groundwater (CP-GW-2), and 200 Area HLW Transfer Pipeline (CP-LS-7).

Table E.1-1. Tank and Waste Farms Evaluation Units and Tank Information included in the Interim Report (corresponding co-located legacy sites not listed). These evaluation units include all 149 single-shell and 28 double-shell tanks on the Hanford Site.

Evaluation Unit	Tank Farm(s)	Waste Management Area(s)	Tank Type	No. of Tanks	Location	Section
CP-TF-1	241-T (T)	WMA T	Single-shell	16	200-West	Part 2
CP-TF-2	241-S/SX (S-SX)	WMA S-SX	Single-shell	27	200-West	Part 3
CP-TF-3	241-TX/TY (TX-TY)	WMA TX-TY	Single-shell	24	200-West	Part 4
CP-TF-4	241-U (U)	WMA U	Single-shell	16	200-West	Part 5
CP-TF-5	241-A/AX (A-AX)	WMA A-AX	Single-shell	10	200-East	Part 6
CP-TF-6	241-B/BX/BY (B-BX-BY)	WMA B-BX-BY	Single-shell	40	200-East	Part 7
CP-TF-7	241-C (C)	WMA C	Single-shell	16	200-East	Part 8
CP-TF-8	241-AN/AP/AW/AY/AZ (AN-AP-AW-AY-AZ)	Not applicable	Double-shell	25	200-East	Part 9
CP-TF-9	241-SY (SY)	Not applicable	Double-shell	3	200-West	Part 10

PRIMARY CONTAMINANTS, CONTAMINATED MEDIA AND WASTES

See information for the specific Tank Waste and Farms EU for information.

BRIEF NARRATIVE DESCRIPTION:

Brief narratives are provided for each specific Tank Waste and Farms EU.

SUMMARY TABLES OF RISKS AND POTENTIAL IMPACTS TO RECEPTORS

Table E.1-2 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* (FW) is an individual located anywhere within the boundaries of the Tank and Waste Farms Evaluation Units (typically within the fence line surrounding the Tank Farm Waste Management Unit and those surrounding areas where tank wastes have been discharged into legacy waste sites). Quantitative estimates of radiological and toxicological consequences for a *Facility Worker* (either with or without controls) are not provided in the Tank Farms Documented Safety Analysis (DSA) (RPP-13033) or Hazard Evaluation Database Report (RPP-13482, Rev. 10-O); however, the results of a qualitative assessment of significant impacts to a *Facility Worker* (e.g., prompt death, serious injury, or significant radiological or chemical exposure) are provided in the DSA and described in the Hazard Evaluation Database Report. For the Tank Farms evaluation, it is assumed that the *Facility Worker* would be exposed to at least as severe consequences as the *Co-located Person* (see below) although there are circumstances (e.g., stack release) where the *Facility Worker* would likely be less impacted. Thus the *Facility Worker* receives the same rating as the analogous *Co-located Person* unless the *Facility Worker* is subject to a significant impact; in this case, the rating is *High*.

A *Co-located Person (CP)* is an on-site individual located 100 meters from the boundary of the Tank and Waste Farms Evaluation Units. For the purpose of evaluating on-site postulated accidents in the Tank Farms DSA (RPP-13033), radiological and toxicological consequences for the *maximum onsite individual* are calculated at or beyond 100 m from the point of release at which the maximum dose occurs from a ground-level release. The individual may be further than 100 m from the release point for elevated releases from ventilation system stacks. The DSA provides estimates of likelihood and consequence for these workers *without controls* (i.e., “unmitigated”). When there are credited controls, the corresponding (“mitigated”) likelihood and consequence are also provided. If no results (particularly consequences) are provided in the DSA for “mitigated” conditions (i.e., those with controls), then the ratings are assumed to be *Low* (otherwise the DOE Standard would indicate that additional controls would be required until consequences are sufficiently low to proceed).

The *Public* is represented by an individual located at the closest point on the Hanford Site security boundary, which is the bank of the Columbia River near the 100-B/C area 8,690 m N / NNW of the Tank Farm areas (RPP-13482, Rev. 7, p. 2-4). For the purpose of evaluating postulated off-site accidents in the Tank Farms DSA (RPP-13033), radiological and toxicological consequences for the *maximum offsite individual* are calculated at or beyond the Hanford Site boundary location at the distance from the point of release at which the maximum dose occurs.

Human health risks are based on unmitigated (uncontrolled conditions) consequences expressed as ratings ranging from Not Discernible (ND) and Low to Very High. The estimated mitigated consequence, that takes credited engineered and administrative controls and protections into consideration, is shown in parentheses.

Groundwater and Columbia River: Direct and potential impacts to groundwater resources and the Columbia River (including potential contaminant impacts on the benthic and riparian zones) have been evaluated for each of the TF EUs based on available information for the current state and for the future evaluation periods described in the Methodology. These impacts are also expressed as ratings ranging from Not Discernible (ND) and Low to Very High in each TF EU section.

Ecological Resources: Ratings are based on the degree of physical disruption (and potential additional exposure to contaminants) in the current state and as a potential result of remediation options for the future evaluation periods as described in Chapter 7 of the Methodology Report.

Cultural Resources: No ratings are provided for Cultural Resources. The Table 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. The Cultural Resources evaluation is specific to each TF EU and described in the appropriate section.

Table E.1-2. Impact Rating Summary for Human Health (unmitigated basis with mitigated basis provided in parentheses (e.g., "High (Low)").

Population or Resource		Evaluation Time Period: Active Cleanup (to 2064) — **Current Condition:** Maintenance & Monitoring (M&M)	**From Cleanup Actions:** Retrieval & Closure
Human Health	Facility Worker	***M&M***: Low-High[a] (Low-High)[a] ***Soil***: ND-High (ND-Low)	***Preferred method***: High (Low) ***Alternative***: High (Low)
	Co-located Person	***M&M***: Low-Moderate (Low) ***Soil***: ND (ND)	***Preferred method***: Low-Moderate (Low) ***Alternative***: Low-Moderate (Low)
	Public	***M&M***: Low (Low) ***Soil***: ND (ND)	***Preferred method***: Low (Low) ***Alternative***: Low (Low)
Environmental	Groundwater (A&B) from remaining vadose zone contamination	Single-shell Tank (SST) Farm EUs[c] 200-W Overall: Low to High CP-TF-1 (T): High -- Cr(tot,VI) CP-TF-2 (S-SX): High -- Cr(tot,VI) CP-TF-3 (TX-TY): High -- Tc-99, CCl4, & Cr(tot,VI) CP-TF-4 (U): Low (all PCs) 200-E Overall: Medium to High CP-TF-5 (A-AX): Med -- Cr(tot,VI) CP-TF-6 (B-BX-BY): High -- I-129, Tc-99, Cr(tot,VI) CP-TF-7 (C): Medium -- I-129 Double-shell Tank (DST) Farm EUs[c] CP-TF-8 (200 East): Low (multiple) CP-TF-9 (200 West): ND	SST Farm EUs[c] 200-W Overall: Low to High CP-TF-1 (T): High -- Cr(tot,VI) CP-TF-2 (S-SX): High -- Cr(tot,VI) CP-TF-3 (TX-TY): High -- Tc-99, CCl4, & Cr(tot,VI) CP-TF-4 (U): Low (all PCs) 200-E Overall: Medium to High CP-TF-5 (A-AX): Med -- Cr(tot,VI) CP-TF-6 (B-BX-BY): High – I-129, Tc-99, Cr(tot,VI) CP-TF-7 (C): Medium -- I-129 DST Farm EUs[c] CP-TF-8 (200 East): Low (multiple) CP-TF-9 (200 West): ND
	Columbia River from remaining vadose zone contamination	All SST and DST Farm EUs[d] Benthic: Not Discernible (all) Riparian: Not Discernible (all) Free-flowing: Not Discernible (all) **Overall**: Not Discernible	All SST and DST Farm EUs[d] Benthic: Not Discernible (all) Riparian: Not Discernible (all) Free-flowing: Not Discernible (all) **Overall**: Not Discernible
	Ecological Resources[b]	Refer to specific Tank and Waste Farms EU	Refer to specific Tank and Waste Farms EU

Population or Resource		Evaluation Time Period	
		Active Cleanup (to 2064)	
		Current Condition: Maintenance & Monitoring (M&M)	**From Cleanup Actions:** Retrieval & Closure
Social	Cultural Resources[b]	Refer to specific Tank and Waste Farms EU	Refer to specific Tank and Waste Farms EU

a. ***Industrial safety*** consequences range from low to high (based on the evaluation scale used) for both mitigated (with controls) and unmitigated (without controls). ***Radiological and toxicological*** consequences to facility workers are high (unmitigated) and low (mitigated).

b. 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.

c. Refer to Table E.1-3 for details. The Overall *High* ratings for the 200-West SST and Waste Farms EUs are driven by chromium (total and hexavalent) for most EUs; whereas, the U Tank Waste and Farms EU has a *Low* rating. The Overall *Medium* and *High* ratings for the 200-East SST Waste and Farms tend to be related to chromium (total and hexavalent) and I-129. Uranium and Sr-90 would be risk drivers; however, they are predicted to be relatively immobile in the subsurface and Sr-90 will decay significantly during the evaluation periods. There is little variation across the evaluation periods.

d. Refer to Table E.1-4 for details. The ratings with respect to radionuclides are all Not Discernible. Overall *Medium* (benthic) and *High* (riparian zone) ratings for the 200-East SST Farm EUs would be related to hexavalent chromium from Central Plateau sources including others than those for the specific Tank and Waste Farms EU; however, well data indicate that contaminants are moving much more slowly than predicted in the TC&WM EIS (DOE/EIS-0391 2012), which was the basis for the evaluation. There is no variation across the evaluation periods.

SUPPORT FOR RISK AND IMPACT RATINGS FOR EACH POPULATION OR RESOURCE

Human Health

Current

Monitoring & Maintenance: The work being conducted associated with the Tank Farms in the 200 Areas (Hanford Central Plateau) can have impacts related to the following accidents:

Flammable gas accidents: This accident involves flammable gas deflagrations in waste storage vessels/containers (including SSTs) where the bounding event is a flammable gas deflagration from the steady-state generation and accumulation or a gas release event in a DST/SST.

Unmitigated Consequences: Facility Worker – High; CP – Moderate; Public – Low

Mitigation: Based on the results of hazard and accident analyses, safety-significant structures, systems, and components (SSC), Specific Administrative Controls (SAC), and Limiting Conditions for Operations (LCO) have been identified for the Tank Farms. The safety significant SSCs are:

- The *DST primary tank ventilation systems* maintain the concentration of flammable gases below the lower flammability limit in the DST headspace and induced gas release events.
- The *waste transfer primary piping systems* provide confinement of waste to protect the facility worker from flammable gas accidents.

Mitigated Consequences: Facility Worker – Low; CP – Low; Public – Low

Waste transfer leaks: This accident involves a wide spectrum of waste leaks where the bounding event is a fine spray leak using a high head waste transfer pump.

Unmitigated Consequences: Facility Worker – High; CP – Low-Medium; Public – Low

Mitigation: Based on the results of hazard and accident analyses, safety-significant structures, systems, and components (SSC), Specific Administrative Controls (SAC), and Limiting Conditions for Operations (LCO) have been identified for the Tank Farms. The safety significant SSCs are:

- The *waste transfer primary piping systems* to provide confinement of waste to decrease the frequency of a fine spray leak thus protecting the facility worker.
- The *hose-in-hose transfer line systems (HIHTL)* to provide confinement of waste thus decreasing the frequency of a fine spray leak and thus protecting the facility worker.
- The *isolation valves for double valve isolation* to limit the leakage of waste decreasing the consequences of a fine spray leak due to a misroute and thus protecting the facility worker.

Mitigated Consequences: Facility Worker – Low; CP – Low; Public – Low

Releases from a contaminated facility: This accident involves various release mechanisms (i.e., flammable gas deflagrations, fires, load handling accidents, or compressed gas system failures) in contaminated facilities.

Unmitigated Consequences: Facility Worker – High; CP – Low-Moderate; Public – Low

Mitigation: The safety significant SSCs for releases from a contaminated facility are the same as those defined above for waste transfer leaks.

Mitigated Consequences: Facility Worker – Low; CP – Low; Public – Low

Air blow accidents: This accident involves a waste release from a contaminated hose-in-hose transfer line (HIHTL) primary hose assembly and connected waste transfer piping system pressurized by compressed air where the bounding event is a small crack leak below the waste surface.

Unmitigated Consequences: Facility Worker – Low-Moderate; CP – Low-Moderate; Public – Low

Mitigation: Based on the results of hazard and accident analyses, safety-significant structures, systems have been identified for the Tank Farms. The safety significant SSCs are:

- *Compressed air system pressure relieving devices* to limit compressed air system pressure and thus mitigating the consequences of an air blow accident.
- The *waste transfer primary piping systems* to provide confinement of waste.

Mitigated Consequences: Facility Worker – Low; CP – Low; Public – Low

Industrial Safety: An extensive assessment of potential occupational health and safety hazards to Tank Farm workers was completed (Quilici 1993) where hazards were rated based on available information. Rated hazards included:[1]

- *"Low"*: chemicals (separate from vapor issue; see below), noise (task dependent), cold, asbestos (task dependent), electrical

[1] These ratings of low, medium, and high are not to be confused with the rating system developed by CRESP for the Risk Review.

- *"Moderate"*: heat stress, ergonomics (lifting), biological (insect bites), confined spaces
- *"High"*: heat stress (depending on variables), slips, trips, falls, moving vehicles

Among the unmitigated hazards related to the Hanford Tank Farms are reports of exposure to vapors from the tanks where short-term, intermittent vapor exposure has led to respiratory irritation symptoms. In 2014 The Hanford Tank Vapor Assessment Team of the Savannah River National Laboratory concluded that available information suggested a causal link between tank vapor releases and the adverse health effects experienced by Hanford tank farm workers (SRNL 2014). Furthermore, an industrial hygiene program emphasizing full-shift exposure measurements and compliance with standard occupational exposure limits cannot adequately characterize the complex, episodic nature of likely tank vapor releases. The team recommended the increased use of personal respiratory protection, improved personal sampling, and further tank vapor characterization.

Unmitigated Consequences: Facility Worker – Low-High, CP – Low-High; Public – Not Discernible

Mitigation: The above ratings are subjective and many factors can affect the rating. A high hazard potential may not mean that much can be done to reduce the potential. For example, slips, trips, and falls remain important hazards throughout industry even when all regulations are met. Moving vehicle accidents also are always high on the list. Conversely, potential hazards associated more with environmental conditions, such as heat stress, noise, mechanical guarding, and chemical exposures usually can be monitored, defined, compared with regulations, and controlled.

Mitigated Consequences: Facility Worker – Low-High, CP – Low-High; Public – Not Discernible

Contaminated Soils: Facility workers are at risk when working in or around the Tank Farm waste tanks not only from tank contents (e.g., radioactive "shine"), vapors, and contaminated equipment, but also to contaminated soil. Exposure to such contaminants is limited because the tanks and contaminated soils in the Tank Farm areas are located below grade. However, during certain operations (e.g., waste tank sampling), there may be the potential for large exposures to radioactive contaminants near the tanks; however, the potential exposure would be very small outside the tank farm area.

Unmitigated Consequences: Facility Worker – Not Discernible (ND)-High, CP – ND; Public – ND

As indicated above, potential exposure to contaminants in the soil is limited because the tanks and contaminated soils in the Tank Farm areas are located below grade. Furthermore, a radiological control program (e.g., radiological work planning and access control) is in place for the Hanford Tank Farms further limits exposures to below accepted standards. Historically, sealing materials and limited engineered barriers have been applied to Tank Farm areas to help control the spread of potentially contaminated soils.

Mitigated Consequences: Facility Worker – Not Discernible (ND)-Low, CP – ND; Public – ND

Potential Impacts from Selected or Potential Cleanup Approaches

There is the potential for radiological, toxicological, industrial impacts to facility workers and co-located persons from accidents during both normal operations and remedial activities (both under the preferred and other alternatives) in the Tank Farms. These activities have been evaluated in the Tank Farms DSA (RPP-13033) as described in Section 1.6.

Unmitigated Consequences: Facility Worker – High; CP – Low-Moderate; Public – Low

Mitigation: Safety-significant SSCs and controls have been defined (as described in Section 1.6) to mitigate consequences associated with potential accidents during cleanup.

Mitigated Consequences: Facility Worker – Low; CP – Low; Public – Low

Environmental

Current

Groundwater: The ratings for potential impacts or threats to groundwater as a protected resource are described in the appropriate section for each Tank and Waste Farms EU and are summarized in Table E.1-3. The Overall High ratings for the 200-West SST Farm EUs are driven by chromium (total and hexavalent) for most EUs with the TX-TY Tank and Waste Farms EU including chromium (total and hexavalent), carbon tetrachloride (CCl_4), and Tc-99. On the other hand, the U Tank and Waste Farms EU has a Low rating. The Overall Medium and High ratings for the 200-East SST Farms tend to be related I-129 and chromium (total and hexavalent) with the B-BX-BY TF EU also includes Tc-99. Despite the large amounts of uranium and Sr-90 in the vadose zone, these primary contaminants are predicted to be relatively immobile in the Central Plateau and thus these ratings do not drive the risks to groundwater.

Table E.1-3. Summary of Overall Groundwater Threat Ratings for the Hanford Tank and Waste Farms Evaluation Units[a]

	EU Name	EU	Current	Active Cleanup	Near-term Post-Cleanup
200-W SSTs	T Tank Farm	CP-TF-1	◕ – Cr(tot, VI)	◕ – Cr(tot, VI)	◕ – Cr(tot, VI)
	S-SX Tank Farms	CP-TF-2	◕ – Cr(tot, VI)	◕ – Cr(tot, VI)	◕ – Cr(tot, VI)
	TX-TY Tank Farms	CP-TF-3	◕ – Tc-99, CCl_4, Cr(tot,VI)	◕ – Tc-99, CCl_4, Cr(tot,VI)	◕ – Tc-99, CCl_4, Cr(tot,VI)
	U Tank Farm	CP-TF-4	◔ – Various PCs	◔ – Various PCs	◔ – Various PCs
200-E SSTs	A-AX Tank Farms	CP-TF-5	◑ – Cr(tot, VI)	◑ – Cr(tot, VI)	◑ – Cr(VI)
	B-BX-BY Tank Farms	CP-TF-6	◕ – I-129, Tc-99, Cr(tot,VI)	◕ – I-129, Tc-99, Cr(tot,VI)	◕ – I-129, Tc-99, Cr(tot,VI)
	C Tank Farms	CP-TF-7	◑ – I-129	◑ – I-129	◑ – I-129
DSTs	200-East (DSTs)	CP-TF-8	◔ – All PCs	◔ – All PCs	◔ – All PCs
	200-West (DSTs)	CP-TF-9	○ – All PCs	○ – All PCs	○ – All PCs

a. Ratings: ○ = Not Discernible ◔ = Low ◑ = Medium ◕ = High ● = Very High

Columbia River: The ratings for potential impacts or threats to groundwater as a protected resource are described in the appropriate section for each Tank and Waste Farms EU and summarized in Table E.1-4. Ratings with respect to radionuclides are all *Not Discernible*. The TC&WM EIS screening results would suggest *Medium* (benthic) and *High* (riparian zone) ratings for the 200-East SST Farm EUs for hexavalent chromium; however, well data indicate that contaminants from the Central Plateau are moving toward the Columbia River much slower than predicted in the TC&WM EIS. These results are generally in agreement with the TC&WM EIS conclusions regarding the near-shore region of the Columbia River; that is, there are no adverse effects from groundwater releases to the Columbia River from radioactive or chemical contaminant of potential concern (DOE/EIS-0391 2012, Appendix P, pp. P–53-54). However, because of the uncertainties in such assessments, it is possible that long-term effects (i.e., after the Near-term, post-Cleanup period) are possible to aquatic biota from hexavalent chromium originating from the Central Plateau area (DOE/EIS-0391 2012, p. 2–235).

Table E.1-4. Summary of Columbia River Threat Ratings for the Hanford Tank and Waste Farms Evaluation Units[a]

	EU Name	EU	Current	Active Cleanup	Near-term Post-Cleanup
200-W	T Tank Farm S-SX Tank Farms TX-TY Tank Farms U Tank Farm	CP-TF-1 CP-TF-2 CP-TF-3 CP-TF-4	Benthic – ○ (all) Riparian – ○ (all) **Overall:** ○ [b]	Benthic – ○ (all) Riparian – ○ (all) **Overall:** ○ [b]	Benthic – ○ (all) Riparian – ○ (all) **Overall:** ○ [b]
200-E	A-AX Tank Farms B-BX-BY Tank Farms C Tank Farms	CP-TF-5 CP-TF-6 CP-TF-7	Benthic – ○ (all) Riparian – ○ (all) **Overall:** ○ [c]	Benthic – ○ (all) Riparian – ○ (all) **Overall:** ○ [c]	Benthic – ○ (all) Riparian – ○ (all) **Overall:** ○ [c]
200-E	200-East DSTs	CP-TF-8	Benthic – ○ (all) Riparian – ○ (all) **Overall:** ○ [d]	Benthic – ○ (all) Riparian – ○ (all) **Overall:** ○ [d]	Benthic – ○ (all) Riparian – ○ (all) **Overall:** ○ [d]
200-W	200-West DSTs	CP-TF-9	Benthic – ○ (all) Riparian – ○ (all) **Overall:** ○ [d]	Benthic – ○ (all) Riparian – ○ (all) **Overall:** ○ [d]	Benthic – ○ (all) Riparian – ○ (all) **Overall:** ○ [d]

a. Ratings: ○ = Not Discernible ◔ = Low ◑ = Medium ◕ = High ● = Very High
b. As described in Section 2.5 (Appendix E.2) for the T TF EU, the screening analysis in the TC&WM EIS (DOE/EIS-0391 2012) was used to evaluate the potential for existing groundwater plumes or remaining vadose zone contamination from the 200 West TF EUs to impact groundwater. Because of the nature of the TC&WM EIS screening analysis, the evaluation was divided into the 200 West EUs and 200 East EUs. Water and contaminant travel time precludes radionuclide or chemical impacts to the Columbia River from the 200 West TF EUs during these evaluation periods.
c. As described in Section 6.5 (Appendix E.6) for the A-AX TF EU, the screening analysis in the TC&WM EIS (DOE/EIS-0391 2012) was used to evaluate the potential for existing groundwater plumes or remaining vadose zone contamination from the 200 East TF EUs to impact groundwater. Because of the nature of the TC&WM EIS screening analysis, the evaluation was divided into the 200 West EUs and 200 East EUs. Based on the EIS screening results, radionuclides do not pose a threat to the Columbia River, but there are possible chemical threats (e.g., hexavalent chromium) to the Columbia River. However, well data suggest that any contaminant in the 200 East sources are moving much slower than predicted in the TC&WM EIS.
d. There are no current plumes associated with the DST TF EUs. Furthermore, vadose sources are either insignificant (200-E DSTs) or non-existent (200-W DSTs); thus there is insufficient vadose zone contamination to support plumes and impacts to the Columbia River.

Ecological Resources: Please refer to the appropriate Tank and Waste Farms EU section.

<u>**Risks and Potential Impacts from Selected or Potential Cleanup Approaches**</u>

Groundwater: The ratings for potential impacts or threats to groundwater as a protected resource are described in the appropriate section for each Tank and Waste Farms EU and are summarized in Table E.1-3. The Overall High ratings for the 200-West SST Farm EUs are driven by chromium (total and hexavalent) for most EUs with the TX-TY Tank and Waste Farms EU including chromium (total and hexavalent), carbon tetrachloride (CCl_4), and Tc-99. On the other hand, the U Tank and Waste Farms EU has a Low rating. The Overall Medium and High ratings for the 200-East SST Farms tend to be related I-129 and chromium (total and hexavalent) with the B-BX-BY TF EU also includes Tc-99. Despite the large amounts of uranium and Sr-90 in the vadose zone, these primary contaminants are predicted to be relatively immobile in the Central Plateau and thus these ratings do not drive the risks to groundwater. The variation across the evaluation periods is very small.

Columbia River: The ratings for potential impacts or threats to groundwater as a protected resource are described in the appropriate section for each Tank and Waste Farms EU and summarized in Table E.1-4. Ratings with respect to radionuclides are all *Not Discernible*. The TC&WM EIS screening results would suggest *Medium* (benthic) and *High* (riparian zone) ratings for the 200-East SST Farm EUs for hexavalent chromium; however, well data indicate that contaminants from the Central Plateau are moving toward the Columbia River much slower than predicted in the TC&WM EIS. There is no variation across the evaluation periods because of how the analysis was performed. Predictions from the TC&WM EIS were used that included sources in addition to those for the TF EUs.

Ecological Resources: Please refer to the appropriate Tank and Waste Farms EU section.

Social

<u>Current</u>
Cultural Resources: Please refer to the appropriate Tank and Waste Farms EU section.

<u>Risks and Potential Impacts from Selected or Potential Cleanup Approaches</u>
Cultural Resources: Please refer to the appropriate Tank and Waste Farms EU section.

Considerations for Timing of the Cleanup Actions

There is potential for additional tank degradation and further leaks and contaminant transport through the vadose and saturated zones if Tank Farm closure activities are delayed. There is also potential risk from direct radiation and tank waste contaminants to workers (and ecological receptors) from routine Tank Farm operations. However, there would be no *additional* risk to facility workers, co-located persons, or the public if cleanup is delayed.

Near-Term, Post-Cleanup Risks and Potential Impacts

The preferred HLW tank closure alternative includes 99 percent retrieval of waste from the single-shell tanks (SSTs) for staging in double-shell tanks and treatment elsewhere onsite[2]; operations and necessary maintenance, waste transfers and associated operations, and upgrades to existing tanks or construction of waste receipt facilities (DOE/EIS-0391 2012, Chapter 2, p. 2-321). SST closure operations include filling the tanks and ancillary equipment with grout to immobilize residual waste contaminants. Disposal of contaminated equipment and soil would occur on site. Decisions on the extent of soil removal and/or treatment would be made on a tank farm or Waste Management Area basis through the RCRA closure permitting process. The tanks would be stabilized with grout, and an engineered modified RCRA Subtitle C barrier put in place followed by post-closure care.

Thus workers and the public would be isolated from the residual contamination in the tanks by both grout and soil cover. Tank waste contamination already in the vadose and saturated zones would experience reduced infiltrating water (the primary driver for the release and transport of contaminants) because of the surface barrier.

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[2] According to the Hanford Tri-Party Agreement (TPA), the retrieval limits are 360 ft^3 and 30 ft^3 for 100-Series and 200-Series tanks, respectively, (Ecology, EPA, and DOE 1996, Appendix H, p. H-5).

Continued monitoring could result in some disturbance to the Ecological Resources in the T TF EU, and buffer lands. Remediation may improve habitat through re-vegetation (and increased monitoring may lead to increases in exotic species, and changes in species composition).

Indirect effects to trail may be permanent (Cultural Resources). Permanent indirect effects to viewshed are possible from capping. Permanent effects may be possible due to presence of contamination if capping occurs.

1.2. ADMINISTRATIVE INFORMATION

OU and/or TSDF Designation(s)

The Hanford single-shell tank (SST) farms will be closed under the rubric of Waste Management Areas (WMAs). There are seven WMAs that correspond to the seven Tank Waste and Farms EUs for the Hanford SSTs and two EUs that correspond to the DST farms as indicated in Table E.1-1.

Regulatory Status

DOE is the responsible agency for the closure of all single-shell tank (SST) waste management areas (WMAs) and double-shell tank (DST) farms through post closure, in close coordination with other closure and cleanup activities of the Hanford Central Plateau (CP). Washington State has a program that is authorized under RCRA and implemented through Washington State's Hazardous Waste Management Act (HWMA) and its associated regulations; Ecology is the lead regulatory agency responsible for the closure of the SST system. Specifically, the SSTs are regulated under RCRA as modified in 40 CFR Part 265, Subpart F and HWMA (HWMA, RCW 70.105 and its implementing requirements in the Washington State dangerous waste regulations [WAC 173-303-400]). EPA is the support regulatory agency providing oversight of the state's authorized program. The 200 Areas of the Hanford Site (where the Tank and Waste Farms EUs are located) were placed by EPA on the National Priorities List (NPL). The completion of remediation of the 200 Areas overall will eventually be finalized via CERCLA decisions made by the EPA, and permitting decisions made by Ecology. The primary focus of SST remedial activities involves retrieval of the wastes and transfer to DSTs prior to closure; the relationship among the tank waste retrieval work plans and the overall tank waste retrieval and closure process is described in Appendix I of the Hanford Federal Facility Agreement and Consent Order (HFFACO), along with requirements for the content of TWRWPs.

Decisions concerning the closure of the Hanford double-shell tank (DST) farms are pending; however, it is assumed for the purpose of this Review that the DSTs will be closed in a similar fashion to the SSTs after the SST waste has been staged and treated using the DSTs.

Applicable Consent Decree or TPA Milestones

Federal Facility Agreement and Consent Order, 1989 and amended through June 16, 2014: Milestone M-045-00; Lead Agency Ecology: *Complete the closure of all Single Shell Tank Farms by 01/31/2043*

Risk Review Evaluation Information

Completed: Revised August 24, 2015

Evaluated by: K. G. Brown

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

1.3. SUMMARY DESCRIPTION

CURRENT AND FUTURE LAND USE

All current land-use activities in the 200-West and 200-East Areas (where the Hanford Tank Farms are located) are *industrial* in nature (Hanford 200-Area ROD[3]). All four (future) land-use scenarios listed in the Comprehensive Land Use Plan (CLUP) indicate that the 200-West and 200-East Areas are 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

The primary source components (legacy source sites, waste tanks and ancillary equipment, groundwater plumes, operating facilities, etc.) are described in the specific sections as indicated in Table E.1-1.

LOCATION AND LAYOUT MAPS

Figure E.1-1 shows the locations of the Tank Waste and Farms EUs within the Central Plateau of the Hanford Site. Detailed views of the waste tanks, ancillary equipment, legacy source units in each Tank and Waste Farms EU are provided in the relevant EU description as indicated in Table E.1-1.

[3] http://www.epa.gov/region10/pdf/sites/hanford/200/hanford_200_rod.pdf

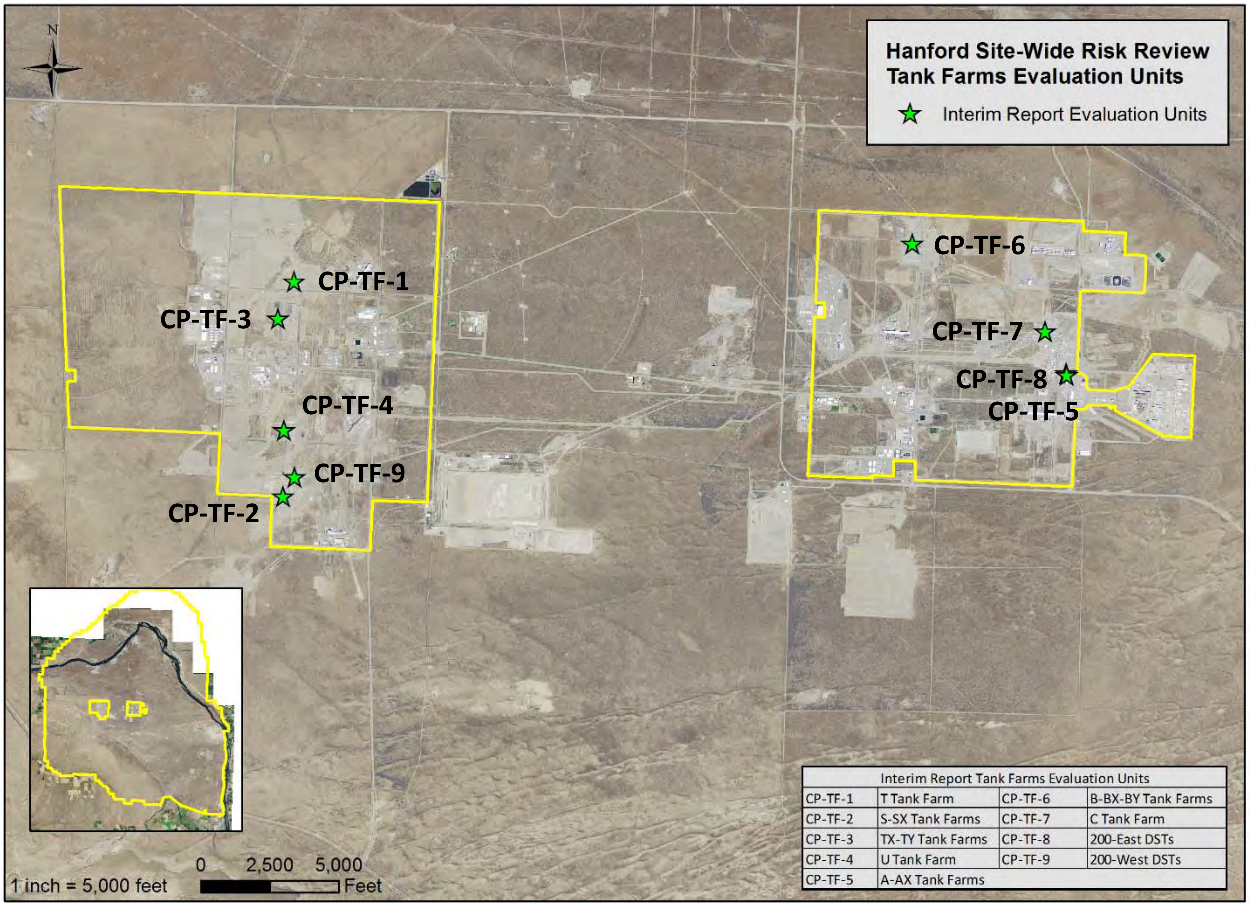

Figure E.1-1. General Location of the Hanford Tank and Waste Farms Evaluation Units. The location of the 200-East and 200-West Areas in relation to the Hanford Site Boundary is shown in the inset.

1.4. UNIT DESCRIPTION AND HISTORY

EU Former/Current Uses(s)

The 177 underground waste storage tanks at the Hanford Site were constructed in groups of similarly designed structures called tank farms. Eighteen tank farms are distributed between the 200 East and 200 West areas and are connected by a cross-site transfer line that allows for waste transfers between the areas. Over 50 million gallons of waste are stored in the tank farms. The tanks contain a mixture of liquid, sludge, and saltcake (precipitated solid salts) waste with both radioactive and chemically hazardous constituents. Liquids in the tanks exist as supernatant (liquid above solids) and interstitial liquid (liquid filling the voids between solids). Sludge consists primarily of solids (hydrous metal oxides) precipitated by the neutralization of acid wastes. Saltcake, when present, generally exists from evaporation of water from the waste. These waste types do not necessarily exist as distinct layers but may be intermingled at the interface (RPP-13033).

LEGACY SOURCES

Each Single-shell Tank (SST) Waste and Farms EU has legacy sources (often cribs, trenches, and contaminated near-tank soil sites) associated with it. Please refer to each SST Waste and Farms EU for additional details.

HIGH-LEVEL WASTE TANKS

Hanford Single-Shell Tanks

Of the 18 tank farms, 12 are single-shell tank farms that contain 149 of the 177 tanks. The single-shell tank farms, constructed between 1943 and 1964, are in groups of 4 to 18 tanks and are divided between the 200 East and 200 West areas. The original single-shell tank design was a reinforced concrete shell and dome with an internal liner (structurally independent from the reinforced concrete tank) of mild carbon steel covering the bottom and sidewalls. The first single-shell tanks were designed with operating volumes of 530,000 gallons. The succeeding generations of single-shell tanks were built with operating volumes of 758,000 gallons and 1 million gallons. Included among the 149 single-shell tanks are 16 smaller tanks that share the same design as the larger tanks, but have operating volumes of only 55,000 gallons. A typical single-shell tank configuration is shown in Figure E.1-2 (RPP-13033).

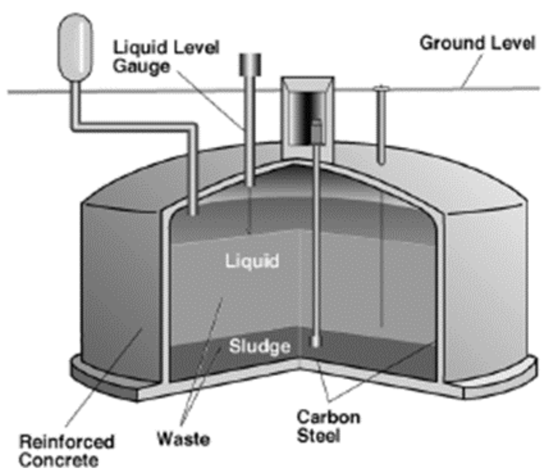

Figure E.1-2. Typical Hanford Single-Shell Tank Design

Hanford Double-Shell Tanks

To provide additional storage capacity, 28 double-shell tanks were built in six tank farms between 1968 and 1986. Five of these tank farms are located in the 200 East Area, and one is located in the 200 West Area. All double-shell tanks are similar in design and each has a storage capacity of approximately 1 million gallons. A typical double-shell tank configuration is shown in Figure E.1-3 (RPP-13033).

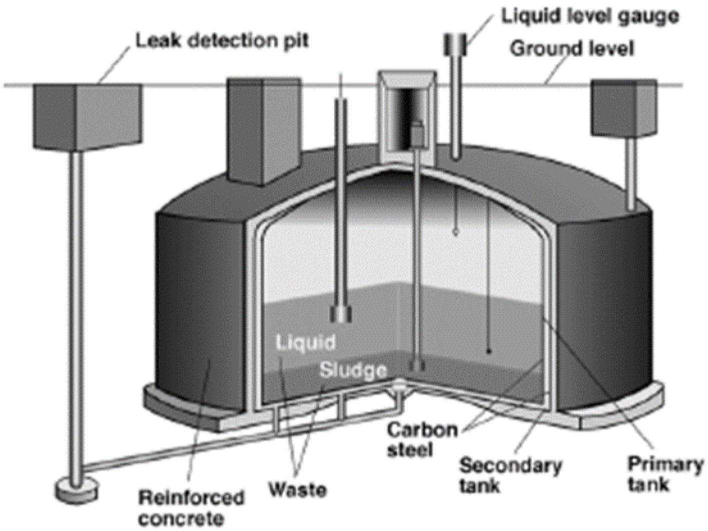

Figure E.1-3. Typical Hanford Double-Shell Tank Design

Each double-shell tank consists of a carbon-steel primary tank and a carbon-steel secondary tank within a protective reinforced concrete shell. The primary tank contains waste, is freestanding, and rests on an insulating concrete pad. The insulating pad rests on the secondary tank and was cast with air distribution and drain grids to provide for leak detection, to maintain a uniform tank bottom temperature, to facilitate heat removal, and to eliminate pockets of water condensation. The secondary tank is 5 feet larger in diameter than the primary tank, providing an air space, or annulus, that separates the two steel tank walls. The secondary tank serves as a barrier to the environment in the event that the primary tank leaks. No double-shell tanks are known to have leaked to the environment.

Classification of Waste in Tanks

The waste in the Hanford single- and double-shell tanks is currently classified as high-level waste. However, there may be as many as 11 Hanford tanks (T and B Tank Farms) that contain wastes that potentially could be reclassified as contact-handled TRU (CH-TRU) waste (Figure E.1-4) (Tingley, et al. 2004). It has been estimated that processing these 11 tanks for disposal at WIPP could shorten WTP operation by up to 1 year and save as many as 100 canisters of HLW glass. These tanks are undergoing a classification analysis to determine whether the waste may be properly and legally classified as CH-TRU. To change the classification from HLW to TRU, DOE would have to follow the appropriate steps in DOE 435.1.

GROUNDWATER PLUMES

There are existing groundwater plumes in the 200-West and 200-East Areas that result from contamination from the Hanford SSTs and legacy sources. The tank and vadose zone sources are described in detail in the corresponding SST Waste and Farms EU section. The resulting plumes are described in Appendix G.5 and Appendix G.6 for the 200-East (CP-GW-1) and 200-West (CP-GW-2) areas, respectively.

D&D OF INACTIVE FACILITIES – NOT APPLICABLE

OPERATING FACILITIES

The Hanford single-shell tanks SSTs were declared a non-compliant treatment, storage, and disposal (TSD) facility under RCRA. Furthermore, there was a Congressional mandate that prohibited waste additions to Hanford SSTs after January 1, 1981[4]. Because of concerns with risks resulting from SSTs, the tank waste retrieval process currently planned at Hanford consists of two general phases: 1) retrieving wastes from SSTs to double-shell tanks (that are RCRA-compliant) for staging and subsequent tank closure and 2) mixing of the retrieved and staged SST waste for delivery to treatment facilities at the WTP. Because of the prohibition on waste additions to the Hanford SSTs,[5] the SSTs in the seven SST Waste and Farms EUs are not considered Operating Facilities for this review. However, the double-shell tanks (DSTs) in the two DST Waste and Farms EUs are considered Operating Facilities for this Review since they will be used to process the single-shell tank waste.

ECOLOGICAL RESOURCES SETTING – PLEASE REFER TO SPECIFIC TANK WASTE AND FARMS EU FOR DETAILS.

CULTURAL RESOURCES SETTING – PLEASE REFER TO SPECIFIC TANK WASTE AND FARMS EU FOR DETAILS.

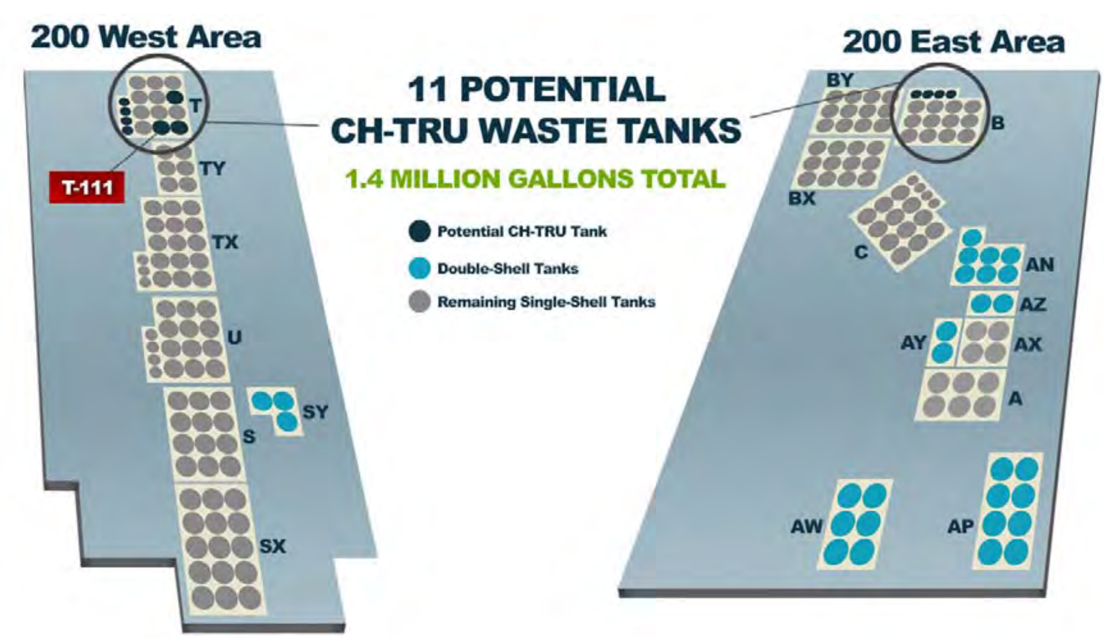

Figure E.1-4. Location of Potential CH-TRU Tanks in the 200 East and 200 West Area Tank Farms (After Figure 4 in (DOE 2013))

[4] Berman presentation on July 29, 2009, entitled "Hanford Single-Shell Tank Integrity Program." Available at www.em.doe.gov.

[5] Berman presentation on July 29, 2009, titled "Hanford Single-Shell Tank Integrity Program." Available at www.em.doe.gov.

1.5. WASTE AND CONTAMINATION INVENTORY

Several models have been used to estimate characteristics of the Hanford tank wastes based on historical information (Remund, et al. 1995). For example, the Hanford Defined Wastes/Tank Layering Model (HDW/TLM) (Agnew 1994) was used to estimate tank contents for all 149 single-shell tanks (Brevick et al., 1994). Tank wastes are categorized based on the major waste types (primary and secondary) that were deposited in them and on process histories. A chemical composition is specified for each waste type, and tanks are identified by volume percentages of all possible waste types (based on historic information). The chemical compositions are then volume averaged to get a final waste composition estimate for each single-shell tank.

The primary and secondary waste stream designations based on the HDW/TLM for the 149 Hanford single-shell tanks are shown in Table E.1-5. The wastes in the Tank and Waste Farms Evaluation Units can be summarized as (Remund et al. 1995):

- CP-TF-1 (T TF) – 1st cycle decontamination from bismuth phosphate process, lanthanum fluoride finishing waste, and Purex and REDOX cladding wastes
- CP-TF-2 (S-SX TFs) – redox wastes and salt and slurry cake from evaporator campaigns
- CP-TF-3 (TX-TY TFs) – salt cake from evaporator campaigns T1 and T2
- CP-TF-4 (U TF) – aluminum cladding Redox wastes, salt and slurry cake from evaporator campaigns
- CP-TF-5 (A-AX TFs) – salt cake and slurry from evaporator campaigns A1 and A2 and washed Purex sludge
- CP-TF-6 (B-BX-BY TFs) – salt cake from evaporator campaigns B and BY, metal waste from bismuth phosphate process, 1st / 2nd cycle decontamination from bismuth phosphate process, and lanthanum fluoride finishing waste
- CP-TF-7 (C TF) – 1st cycle decontamination from bismuth phosphate process, aluminum cladding Purex wastes, metal waste from bismuth phosphate process, and ferrocyanide sludge

There are other, more recent estimates of what is currently in the Hanford waste tanks (e.g., the best-basis inventory); however, the SSTs were declared a non-compliant treatment, storage, and disposal (TSD) facility under RCRA (RPP-46459, Rev. 3). Furthermore, there was a Congressional mandate that prohibited waste additions to Hanford SSTs after January 1, 1981[6]. Thus the information presented in Table E.1-5 should be a reasonable snapshot of the major waste streams in the Hanford SSTs. Individual waste types identified in Table E.1-5 are defined in Table E.1-6.

The 28 double-shell tanks were built between 1968 and 1986 to provide additional storage capacity for tank wastes. SST waste has been transferred to the DSTs for subsequent treatment elsewhere on the Hanford Site.

CONTAMINATION WITHIN PRIMARY EU SOURCE COMPONENTS

Please refer to Specific Tank Waste and Farms EU Appendices for inventories associated with legacy source sites, waste tanks and ancillary equipment, and vadose zone contamination. The groundwater plumes associated with the SST Farm EUs are described in Appendix G.5 and Appendix G.6. The D&D

[6] Berman presentation on July 29, 2009, entitled "Hanford Single-Shell Tank Integrity Program." Available at www.em.doe.gov.

facilities are not applicable. The Operating Facilities inventories are described in the DST Waste and Farms EUs Sections.

Table E.1-5. HDW/TLM Primary ("1") and Secondary ("2") Waste Stream Designations for the 149 Hanford Single-Shell Tanks using the Types Defined in Table E.1-6 (Remund et al. 1995)

CP-TF EU	Tank	1C44-51/CW	1C52-56/CW	1CFeCN	224	2C44-51	2C52-56	A1-SC	A2-SS	AR	B	BL	B-SC	BY-SC	CWP/AI56-60	CWP/AI61-72	CWR/AI52-60	CWR/AI61-67	MW44-51	MW52-56	P'56-62	P'63-67	PFeCN/1	PFeCN/2	R'52-58	R'59-67	R-SC	S1-SC	S2-SS	SRR/FMJ	T1-SC	T2-SC	TFeCN	UR/TBP	Z/PFP
1	T-101																	1	2																
1	T-102															1			2																
1	T-103															1																2			
1	T-104		1																																
1	T-105		2			1																													
1	T-106		1														2																		
1	T-107	1																																	
1	T-108	2																													1				
1	T-109																														1				
1	T-110					1	2																												
1	T-111					2	1																												
1	T-112						1																												
1	T-201				1																														
1	T-202				1																														
1	T-203				1																														
1	T-204				1																														
2	S-101																								1			2							
2	S-102																											2	1						
2	S-103																											1	2						
2	S-104																	2							1										
2	S-105																								2			1							
2	S-106																	2										1							
2	S-107																								1							2			
2	S-108																								2			1							
2	S-109																	2										1							
2	S-110																								2			1							
2	S-111																								2			1							
2	S-112																								2			1							
2	SX-101																								1			2							
2	SX-102																											1	2						
2	SX-103																								2			1							
2	SX-104																								2			1							
2	SX-105																								2			1							
2	SX-106																											2	1						
2	SX-107																								1	2									
2	SX-108																								1	2									
2	SX-109																								2		1								
2	SX-110																									1	2								
2	SX-111																								1	2									
2	SX-112																								1	2									
2	SX-113																								1										
2	SX-114																									2	1								
2	SX-115																									1	2								

CP-TF EU	Tank	1C44-51/CW	1C52-56/CW	1CFeCN	224	2C44-51	2C52-56	A1-SC	A2-SS	AR	B	BL	B-SC	BY-SC	CWP/Al56-60	CWP/Al61-72	CWR/Al52-60	CWR/Al61-67	MW44-51	MW52-56	P'56-62	P'63-67	PFeCN/1	PFeCN/2	R'52-58	R'59-67	R-SC	S1-SC	S2-SS	SRR/FMJ	T1-SC	T2-SC	TFeCN	UR/TBP	Z/PFP
3	TX-101																								1							2			
3	TX-102																		2													1			
3	TX-103																		2													1			
3	TX-104																		2													1			
3	TX-105																			2												1			
3	TX-106																								2							1			
3	TX-107																			2												1			
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3	TX-109	1																																	
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3	TX-111		2																													1			
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3	TX-116																														1	2			
3	TX-117																														2	1			
3	TX-118																															1			2
3	TY-101			1																											2				
3	TY-102																														2	1			
3	TY-103																															2		1	
3	TY-104																																	1	
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3	TY-106																																	1	
4	U-101																		1																
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4	U-112	1																							2										
4	U-201																1																		
4	U-202																1																		
4	U-203																1																		
4	U-204																1																		
5	A-101							1	2																										
5	A-102							1	2																										
5	A-103							1		2																									
5	A-104									1											2														
5	A-105																					1													
5	A-106							1	2																										
5	AX-101							1	2																										
5	AX-102							1			2																								
5	AX-103							1														2													
5	AX-104																					1													
6	B-101											2	1																						

CP-TF EU	Tank	1C44-51/CW	1C52-56/CW	1CFeCN	224	2C44-51	2C52-56	A1-SC	A2-SS	AR	B	BL	B-SC	BY-SC	CWP/AI56-60	CWP/AI61-72	CWR/AI52-60	CWR/AI61-67	MW44-51	MW52-56	P'56-62	P'63-67	PFeCN/1	PFeCN/2	R'52-58	R'59-67	R-SC	S1-SC	S2-SS	SRR/FMJ	T1-SC	T2-SC	TFeCN	UR/TBP	Z/PFP
6	B-102												1						2																
6	B-103												1						2																
6	B-104	1				2																													
6	B-105	2											1																						
6	B-106												1																						
6	B-107	1																																	
6	B-108	2											1																						
6	B-109												1			2																			
6	B-110					1																2													
6	B-111					1																2													
6	B-112					2								1																					
6	B-201				1																														
6	B-202				1																														
6	B-203				1																														
6	B-204				1																														
6	BX-101											2							1																
6	BX-102															2			1																
6	BX-103															2			1																
6	BX-104																		1																
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6	BX-108	1																																	
6	BX-109	2																																1	
6	BX-110	1												2																					
6	BX-111	2												1																					
6	BX-112	1											2																						
6	BY-101													1					2																
6	BY-102													1					2																
6	BY-103													1		2																			
6	BY-104													1										2											
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6	BY-107													1									2												
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6	BY-109													1					2																
6	BY-110													1									2												
6	BY-111													1					2																
6	BY-112													1					2																
7	C-101															2																		1	
7	C-102														2	1																			
7	C-103									2						1																			
7	C-104															1														2					
7	C-105														1	2																			
7	C-106									1		2																							
7	C-107	1																												2					
7	C-108	2																																1	
7	C-109	2																															1		
7	C-110	1																																	
7	C-111	1													2																				
7	C-112															2																	1		

CP-TF EU	Tank	1C44-51/CW	1C52-56/CW	1CFeCN	224	2C44-51	2C52-56	A1-SC	A2-SS	AR	B	BL	B-SC	BY-SC	CWP/Al56-60	CWP/Al61-72	CWR/Al52-60	CWR/Al61-67	MW44-51	MW52-56	P'56-62	P'63-67	PFeCN/1	PFeCN/2	R'52-58	R'59-67	R-SC	S1-SC	S2-SS	SRR/FMJ	T1-SC	T2-SC	TFeCN	UR/TBP	Z/PFP
7	C-201																		1																
7	C-202																		1																
7	C-203																		1																
7	C-204																		1																
	Primary	12	3	1	8	4	2	0	7	2	0	0	7	13	1	5	4	1	12	0	0	2	1	0	10	2	2	16	5	0	4	16	2	7	0
	Secondary	8	3	0	0	3	1	4	0	2	1	3	1	2	2	7	1	3	15	2	1	3	3	2	11	5	2	5	6	2	5	6	0	2	1

Table E.1-6. Hanford HDW/TLM Model Types (i.e., waste identifiers) as used in Table E.1-5 (Remund et al. 1995)

Model Type	Definition	Model Type	Definition
1C44-51/CW	1st cycle decontamination from bismuth phosphate process, 1944-1951 - includes cladding waste	MW44-51	metal waste from bismuth phosphate process, 1944-1951
1C52-56/CW	1st cycle decontamination from bismuth phosphate process, 1952-1956 - includes cladding waste	MW52-56	metal waste from bismuth phosphate process, 1952-1956
1CFeCN	ferrocyanide scavenged, 1st decontamination process supernates	P'56-62	Purex high level waste, 1956-1962
224	lanthanum fluoride finishing waste from 224-U	P'63-67	Purex high level waste, 1963-1967
2C44-51	2nd cycle decon waste from bismuth phosphate process, 1944-1951	PFeCN/1	ferrocyanide sludge produced by in-plant scavenging of waste from uranium recovery, using 0.005 M ferrocyanide
2C52-56	2nd cycle decon waste from bismuth phosphate process, 1952-1956 - includes supernates formerly cribbed at T Plant	PFeCN/2	same as PFeCN1, except using 0.0025 M ferrocyanide
A1-SC	salt cake from evaporator campaign A1	R'52-58	redox waste, 1952-1958
A2-SS	salt slurry from evaporator campaign A2	R'59-67	redox waste, 1959-1967
AR	AR Solids = washed Purex sludge - also used to derive strontium recovery waste	R-SC	salt cake from evaporator run of redox wastes
B	high level waste from Purex Acidified Waste - also refers to aluminum	S1-SC	salt cake from evaporator campaign S1
BL	low level waste from all operations	S2-SS	salt slurry from evaporator campaign S2
B-SC	salt cake from evaporator campaign B	SRR/FMJ	strontium recovery waste from sluiced Purex sludge
BY-SC	salt cake from evaporator campaign BY	T1-SC	salt cake from evaporator campaign T1
CWP/Al56-60	aluminum cladding Purex wastes, 1956-1960	T2-SC	salt cake from evaporator campaign T2
CWP/Al61-72	aluminum cladding Purex wastes, 1961-1972	TFeCN	ferrocyanide sludge produced by in-tank or in-farm scavenging in CN
CWR/Al52-60	aluminum cladding Redox wastes, 1952-1960	UR/TBP	tri-butyl phosphate waste from solvent-based uranium recovery operation in 1950s
CWR/Al61-67	aluminum cladding Redox wastes, 1961-1967	Z/PFP	234-5Z waste from Z-Plant plutonium finishing

1.6. POTENTIAL RISK/IMPACT PATHWAYS AND EVENTS

The Documented Safety Analysis (DSA) represents a common safety analysis across all Hanford tank farms, including safety concerns and safety measures (RPP-13033). The facilities covered by the TF DSA include:

- SSTs, DSTs, catch tanks, double-contained receiver tanks (DCRTs), and inactive miscellaneous underground storage tanks (IMUSTs)
- 204-AR Waste Unloading Facility
- 244-AR and 244-CR Vaults
- Cribs, ditches, and ponds
- 616 Facility
- Vertical storage units
- Waste transfer system
- 242-S and 242-T Evaporators
- 241-AX-IX Ion Exchanger
- ITS-1 In-Tank Solidification System
- 241-SX-401 and 241-SX-402 Condenser Shielding Buildings
- 241-A-431 Ventilation Building
- 241-C-801 Cesium Loadout Facility
- Unplanned release sites

However, risks and potential impacts in each Tank and Waste Farms EU are specific, and any potential impacts not captured by the Tank Farms DSA (RPP-13033) will be discussed within the specific Tank and Waste Farms EU section.

CURRENT CONCEPTUAL MODEL

Safety Accident Scenarios that Dominate Risk at the Facility and Response Times

The potential accidents evaluated in the Tank Farms DSA include: flammable gas accident leading to fire/explosion; nuclear criticality resulting in a localized high-energy event; waste transfer leak or air blow accident leading to a spill, leak, or aerosolized spray; release from a contaminated facility; excessive load resulting in partial or total tank (dome) failure; mixing of incompatible materials resulting in unwanted chemical reactions; tank bump leading thermally-induced release; and filter failure leading to unfiltered releases of contaminants (RPP-13033).

There are four accidents designated as *anticipated*[7] for the Hanford waste tanks *if no controls were in place* (i.e., unmitigated):

- *Flammable gas accidents* – This accident involves flammable gas deflagrations in waste storage

[7] An anticipated event has frequency greater than once in 100 operating years (RPP-13033). In other words, these accidents are "anticipated" because they have occurred at least once before. External and natural events are not treated separately since they lead to the same accident types.

vessels/containers (including SSTs) where the bounding event is a flammable gas deflagration from the steady-state generation and accumulation or a gas release event in a DST/SST.

- *Waste transfer leaks* – This accident involves a wide spectrum of waste leaks where the bounding event is a fine spray leak using a high head waste transfer pump.
- *Releases from a contaminated facility* – This accident involves various release mechanisms (i.e., flammable gas deflagrations, fires, load handling accidents, or compressed gas system failures) in contaminated facilities.
- *Air blow accidents* – This accident involves a waste release from a contaminated hose-in-hose transfer line (HIHTL) primary hose assembly and connected waste transfer piping system pressurized by compressed air where the bounding event is a small crack leak below the waste surface.

A nuclear criticality accident is considered *beyond extremely unlikely* (BEU) (i.e., a frequency of less than or equal to once in a million operating years) (RPP-13033). The flammable gas accident (specifically a detonation in a DST/SST) and waste transfer leaks (specifically a fine spray when using a high head pump) were selected as bounding accidents for evaluation proposes in the TF DSA.

For the four anticipated accidents listed above, only the waste transfer leak had an onsite radiological total effective dose (consequence) > 100 rem. None of the design basis accidents had an offsite dose greater than the 25-rem Evaluation Standard that would require Safety-Class SSCs. For onsite toxicological consequences, both the waste transfer leak and air blow accidents are < Protective Action Criteria[8] (PAC) 3, and all accidents had off-site toxicological consequences of < PAC-2. Qualitatively, only the air blow accident (of the four accidents listed above) *was not* judged to represent a significant impact to a facility worker (i.e., result in "prompt death, serious injury, or significant radiological or chemical exposure to the facility worker") (RPP-13033).

Other representative accidents have consequences that are less than onsite worker guidelines and do not pose significant facility worker hazards. However, defense-in-depth features have been selected for these accidents (RPP-13033):

- SST failure may be caused by excessive concentrated loads or excessive uniform loads, excessive vacuum, load drops, or seismic events and failures of other tanks; dome loading requirements are selected as the defense-in-depth protection feature.
- SST failure could result from chemical reactions resulting from mixing incompatible materials; paperwork must be verified to ensure that the correct chemical is being delivered has been selected as a defense-in-depth feature.
- Contaminated soils may be released (from a crib, ditch, pond) from unplanned excavations or drilling into contaminated soils or ruptures of underground pressurized lines in contaminated soils; environmental air permitting requirements and the excavation permitting process are selected as defense-in-depth features.

[8] Protective Action Criteria (PAC) may be used "to evaluate the severity of the event, to identify potential outcomes, and to decide what protective actions should be taken" and may be used "to estimate the severity of consequences of an uncontrolled release and to plan for an effective emergency response". There are benchmark values (i.e., PAC-1, -2, and -3) for a set of evaluated chemicals. Each successive benchmark represents an increasingly severe effect involving a higher exposure level: 1) mild, transient health effects, 2) irreversible or other serious health effects that could impair the ability to take protective action, and 3) life-threatening health effects. http://orise.orau.gov/emi/scapa/chem-pacs-teels/.

- A thermally induced upset (e.g., steam bump in an SST liner gap) could cause a failure in an SST.

There are other representative accidents (aboveground tank or structure failure, transportation-related waste sample handling accidents, filtration failures, organic solvent fires, etc.) with consequences less than the guidelines for an onsite worker, do not pose significant facility worker hazards, and have no defense-in-depth features.

Hanford Tank Farm Vapor Exposures

Among the unmitigated hazards related to the Hanford Tank Farms are reports of exposure to vapors from the tanks. Short-term, intermittent vapor exposure has led to respiratory irritation symptoms. Several dozen workers have complained over the last year of upper respiratory symptoms requiring medical evaluation; exposures have been attributed to vapors from the tanks. Such events have occurred for more than a decade (NIOSH 2004), although the specific offending agent(s) and sources have not been identified.

An independent review of WRPS Tank Farm Chemical Vapors Strategy (jointly requested by WRPS and Hanford Challenge) found (Hanford Concerns Council 2010) that the proposed periodic sampling strategy should be expanded to strengthen the exposure assessment process, the WRPS job hazard analysis should be expanded, and site Industrial Hygienists should expand their capabilities (especially when quantitative data are not available).

In 2014 The Hanford Tank Vapor Assessment Team (TVAT) of the Savannah River National Laboratory concluded that available information suggested a causal link between tank vapor releases and the adverse health effects experienced by Hanford tank farm workers (SRNL 2014). Furthermore, an industrial hygiene program emphasizing full-shift exposure measurements and compliance with standard occupational exposure limits cannot adequately characterize the complex, episodic nature of likely tank vapor releases. The team recommended the increased use of personal respiratory protection, improved personal sampling, and further tank vapor characterization.

Safety Class and Safety Significant Systems and Controls

No safety-class structures, systems, and components (SSC) were identified for tank farm operations (RPP-13033).

Based on the results of hazard and accident analyses, *safety-significant* structures, systems, and components (SSC); technical safety requirements (TSR), including Specific Administrative Controls (SAC), Limiting Conditions for Operations (LCO), and Key Elements of Administrative Controls; and defense-in-depth features have been identified for protection of the public, onsite workers, and facility workers (RPP-13033).

Flammable Gas Accidents

The following Safety-Significant SSC for flammable gas accidents in the Hanford Tank Farms are identified in the DSA (RPP-13033, p. T3.3.2.4.1-4):

- *DST primary tank ventilation systems* to maintain the concentration of flammable gases below the lower flammability limit (LFL) in the DST headspace for steady-state releases and induced gas release events (GREs) due to water or chemical additions and waste transfers into DSTs.
- *Waste transfer primary piping systems* to provide confinement of waste including to protect the facility worker from flammable gas accidents in a DST annulus due to a misroute.

The following flammable gas controls for the Hanford Tank Farms are defined (RPP-13033, p. T3.3.2.4.1-

5&6):[9]

- *LCO: DST Primary Tank Ventilation Systems* for all DSTs ensures the DST primary tank ventilation systems are operable and operating to prevent flammable gas hazards from steady-state releases and slow, continuing induced gas releases following water additions, chemical additions, and waste transfers into DSTs.
- *SAC: SST Steady-State Flammable Gas Control* for all SSTs except those in the 241-AX and 241-SX Tank Farms to protect the facility worker from a flammable gas deflagration due to steady-state flammable gas releases in an SST by monitoring the flammable gas concentration, verifying passive ventilation for 241-B-203 and 241-B-204, and taking action to reduce the flammable gas concentration or eliminate potential ignition sources prior to the flammable gas concentration exceeding the LFL.
- *SAC: DST Induced Gas Release Event Flammable Gas Controls* for all DSTs to protect the facility worker from a flammable gas deflagration in a DST due to an operations induced GRE by requiring evaluations of waste transfers from DSTs and water additions, chemical additions, and waste transfers into DSTs to determine restrictions or required controls to prevent an induced GRE flammable gas deflagration. [10]
- *LCO: DST Induced Gas Release Event Flammable Gas Control* for all DSTs (when required) to ensure the DST primary tank ventilation systems are operable and operating to prevent flammable gas hazards from induced GREs during water additions, chemical additions, and waste transfers into DSTs.
- *SAC: DST Annulus Flammable Gas Control* for all DSTs to protect the facility worker from a flammable gas deflagration in a DST annulus caused by steady-state flammable gas releases from waste in the DST annulus by monitoring the DST annulus waste level and taking action to control the flammable gas concentration or eliminate potential ignition sources if a significant quantity of waste is detected in the DST annulus.

The key elements related to flammable gas accidents in the Hanford Tank Farms are (RPP-13033, p. T3.3.2.4.1-7):

- *DST and SST Time to Lower Flammability Limit (LFL)* to protect assumptions used to develop surveillance frequencies and action completion times in the LCO DST Primary Tank Ventilation Systems and SACs: SST Steady-State Flammable Gas Control and DST Annulus Flammable Gas Control.
- *Ignition Controls* to establish requirements consistent with NFPA requirements for eliminating potential flammable gas ignition sources; to evaluate activities, equipment, and materials to determine the applicability of and compliance with ignition source control requirements; and to be an important contributor to defense-in-depth by applying ignition controls for the

[9] There are additional controls related to DCRTs; inactive/miscellaneous tanks/facilities and waste intruding equipment; and waste packaging that are external to the waste tanks.

[10] In 2012 the Defense Nuclear Facilities Safety Board submitted Recommendation 2012-2, *Hanford Tank Farms Flammable Gas Safety Strategy* that identified the need to take actions to reduce risk posed by flammable gas events at the Hanford Tank Farms. DOE responded with an Implementation Plan including a revision to the DSA to include a new control that measures ventilation flow through each DST on a periodic basis, supplementing the existing flammable gas monitoring control. This DSA revision also placed requirements on operability of the in-service and standby primary ventilation trains. DOE is working towards installing safety-significant (SS) instrumentation for real-time monitoring of the ventilation exhaust flow from each DST.

spontaneous GRE hazard in DSTs 241-AN-103, 241-AN-104, 241-AN-105, 241-AW-101, and 241-SY-103.

- *Waste Characteristics Controls* to protect assumptions used to develop controls for flammable gas deflagrations due to GRE by preventing the formation of waste gel in DSTs and SSTs.
- *Emergency Preparedness* to establish emergency preparedness requirements to reduce the risk from seismic induced flammable gas accidents in DSTs.

As an indication of the likelihood of flammable gas-related accidents in the Hanford Tank Farms, the hydrogen generation rates (HGRs) and times to lower flammability limit (LFL) are provided for each tank in each Tank and Waste Farms EU Summary Section. A summary showing those tanks with times to lower flammability limit under the zero ventilation scenario (i.e., most restrictive) of less than 6 months[11] is provided in Figure E.1-5. Most of the tanks shown are double-shell tanks in the 200-East Area.

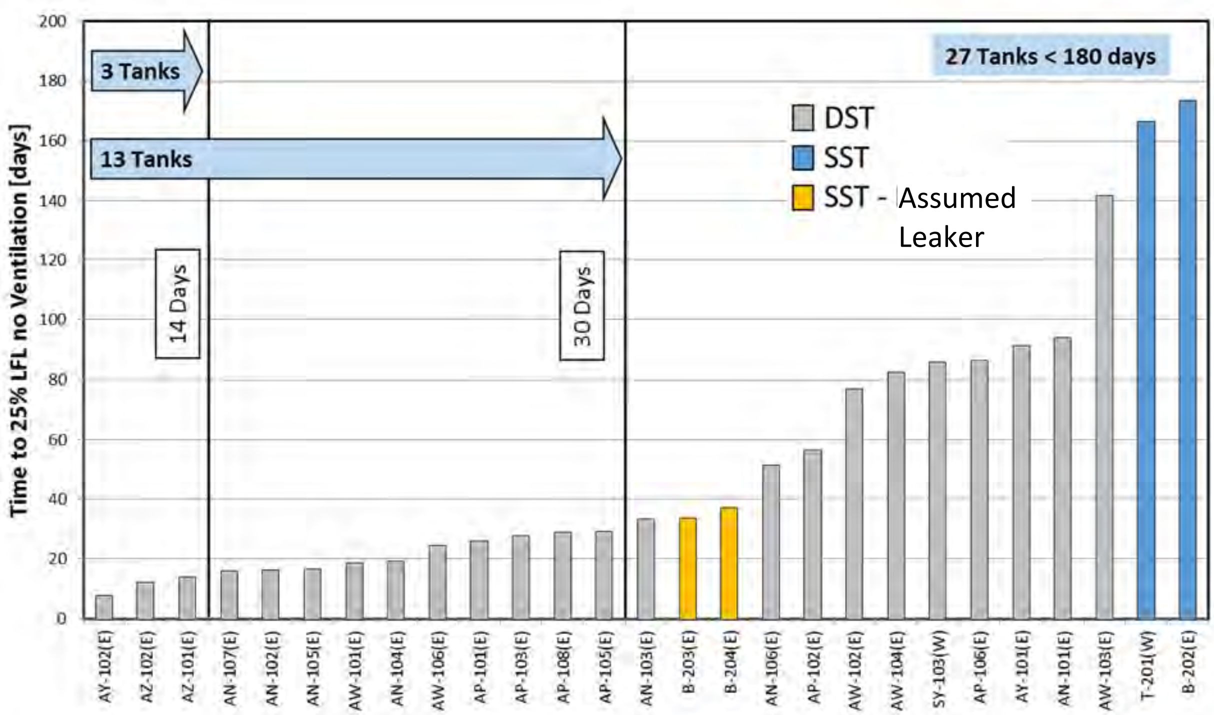

Figure E.1-5. Time to 25% Lower Flammability Limit for Tanks with Less Than 6 Months (assuming no ventilation) (RPP-5926, Rev. 15). The location (E = 200-East or W = 200-West) is provided after the Tank Name.

<u>Nuclear Criticality</u>

No Safety Significant SSCs or controls related to nuclear criticality were identified in the Tank Farm DSA.

<u>Waste Transfer Leak Accidents and Release from a Contaminated Facility</u>

The following Safety-Significant SSC related to waste transfer leak accidents and release from

[11] Typical response times of 14 and 30 days are shown in Figure E.1-5 for reference.

contaminated facilities are identified (RPP-13033, p. T3.3.2.4.3-2):

- *Waste transfer primary piping systems* to provide confinement of waste to decrease the frequency of a fine spray leak, which also protects the facility worker from wetting spray/jet/stream leaks into a normally occupied area and from flammable gas deflagrations in a waste transfer-associated structure due to a waste transfer leak.
- *Hose-in-hose transfer line systems (HIHTL)* to provide confinement of waste thus decreasing the frequency of a fine spray leak and thus protecting the facility worker from wetting spray/jet/stream leaks into a normally occupied area and from flammable gas deflagrations in a waste transfer-associated structure due to a waste transfer leak; this is also an important contributor to defense-in-depth by providing secondary confinement of leaks in the HIHTL primary hose assemblies.
- *Isolation valves for double valve isolation* to limit the leakage of waste (through valve leakage) decreasing the consequences of a fine spray leak due to a misroute and thus protecting the facility worker from wetting spray/jet/stream leaks into a normally occupied area and from flammable gas deflagrations in a waste transfer-associated structure (or other facility) due to a misroute.

The following waste transfer leak and release from contaminated facilities control for the Hanford Tank Farms is defined (RPP-13033, p. T3.3.2.4.1-5&6):

- *SAC: Double valve isolation* to ensure that safety-significant isolation valves for double valve isolation are in the closed or block flow position when used to physically disconnect waste transfer primary piping systems, HIHTL primary hose assemblies, and interfacing water systems to limit waste leakage into the physically disconnected systems thus decreasing the consequences of a fine spray leak due to a misroute and protecting the facility worker from a wetting spray/jet/stream leak and from a flammable gas deflagration in a waste transfer-associated structure (or other facility) due to a misroute.

The key element related to waste transfer leak accidents and release from contaminated facilities in the Hanford Tank Farms is (RPP-13033, p. T3.3.2.4.1-7):

- *Waste transfer-associated structure cover installation and door closure* which is an important contributor to defense-in-depth by providing secondary confinement of leaks into waste transfer-associated structures.

<u>Air Blow Accidents</u>

The following Safety-Significant SSC related to air blow accidents are identified (RPP-13033, p. T3.3.2.4.5-2):

- *Compressed air system pressure relieving devices* to limit compressed air system pressure and thus mitigating the consequences of an air blow accident.
- *Waste transfer primary piping systems* to provide confinement of waste.

No controls were defined for air blow accidents related to the Hanford Tank Farms.

<u>External and Natural Events</u>

No Safety Significant SSCs or controls related to external or natural events were identified in the Tank Farm DSA. The external events evaluated in the DSA include aircraft crash, vehicle accident, range fire, and rail accident. The external event frequencies range from beyond extremely unlikely for accidents like commercial or military aircraft impacting a tank or facility to anticipated for range fires. The consequences, which relate to the operating accidents described above, would not be increased. The natural events evaluated in the DSA include lightning, high winds, earthquakes, volcanic eruptions / ashfall, severe dust storms, heavy snow, hail storms, and floods. For natural events, frequencies range from not credible for floods to anticipated for extreme temperatures, high winds, hail storms, and dust storms. The only unique aspect related to natural events is the possibility that these events cause multiple failures. It was considered unreasonable to expect all releases to be at their highest estimated releases for individual accidents (RPP-13033, p. 3.3.2.4.7-3). The consequences, which relate to the operating accidents described above, would not be increased and are those for operating accidents.

Tank Farm Safety Analysis Summary

A summary of selected results (i.e., those that are iconic or are anticipated or with significant consequences) for the representative accidents in the DSA both unmitigated ("without controls") and mitigated ("with controls") is provided in Table E.1-7.

Table E.1-7. Representative Accidents without (above) and with (below) Controls Summary (RPP-13033)

Accident	Accident Type	Frequency[e]	Onsite radiological consequence	Offsite toxicological consequence[f]	Onsite toxicological consequence[f]	Significant impact to worker[a]
DST headspace deflagration due to an induced gas release event	Flammable gas / Release from Contaminated Facility	Anticipated (---)[b]	< 100 rem (---)[b]	< PAC-2 (---)[b]	< PAC-3 (---)[b]	Yes
Deflagration in waste-intruding equipment	Flammable gas / Release from Contaminated Facility	Anticipated (---)[b]	< 100 rem (---)[b]	< PAC-2 (---)[b]	< PAC-3 (---)[b]	No
Deflagration in a waste sample container	Flammable gas / Release from Contaminated Facility	Anticipated (---)[b]	< 100 rem (---)[b]	< PAC-2 (---)[b]	< PAC-3 (---)[b]	No
Nuclear criticality	Nuclear criticality	Beyond Extremely Unlikely (---)[b]	< 100 rem (---)[b]	< PAC-2 (---)[b]	< PAC-3 (---)[b]	No
Fine spray leak during a transfer using a high head waste transfer pump	Waste transfer leak	Unlikely (Prevented)[c]	> 100 rem (--)[c]	< PAC-2 (--)[c]	> PAC-3 (--)[c]	Yes
Fine spray leak due to a misroute during a transfer using a high head waste transfer pump	Waste transfer leak	Extremely Unlikely (Extremely Unlikely)[c]	> 100 rem (< 5 rem)[c]	< PAC-2 (< PAC-2)[c]	> PAC-3 (< PAC-2)[c]	Yes

Accident	Accident Type	Frequency[e]	Onsite radiological consequence	Offsite toxicological consequence[f]	Onsite toxicological consequence[f]	Significant impact to worker[a]
Waste release from a HIHTL primary hose assembly and connected waste transfer primary piping system during compressed air blowout	Air blow / Waste transfer leak	Anticipated (Anticipated)[c]	< 100 rem (< 5 rem)[c]	< PAC-2 (< PAC-2)[c]	< PAC-3 (< PAC-2)[c]	No
Waste release from a waste transfer primary piping system encasement during encasement pneumatic testing	Air blow / Waste transfer leak	Anticipated (Prevented)[c]	< 100 rem (--)[c]	< PAC-2 (--)[c]	< PAC-3 (--)[c]	No
External Events	External events (e.g., aircraft crash, vehicular accident, range fire) and natural events (e.g., lightning, high winds, earthquakes, volcanic, dust, floods) are initiators of operational accidents listed above but do not create unique accidents that would change the overall ratings.					
Natural Events[d]						

a. Qualitatively judged to result in prompt death, serious injury, or significant radiological or chemical exposure to the facility worker.

b. No results due to credited preventative or mitigative safety-significant SSCs or TSR SACs provided in the DSA; it is assumed that the consequences would be sufficiently low or additional controls would be required.

c. Mitigated frequency and consequences from credited preventative or mitigative safety-significant SSCs or TSR SACs provided in the DSA.

d. Natural events can initiate multiple common cause accidents (e.g., more than one flammable gas deflagration), but do not increase the cumulative consequences beyond those shown above.

e. Likelihoods: A – Anticipated (> 10^{-2}/yr); U – Unlikely (10^{-2} – 10^{-4}/yr); Extremely Unlikely (10^{-4} – 10^{-6}/yr); and BEU – Beyond Extremely Unlikely (<10^{-6} /yr).

f. Protective Action Criteria (PAC) may be used "to evaluate the severity of the event, to identify potential outcomes, and to decide what protective actions should be taken" and may be used "to estimate the severity of consequences of an uncontrolled release and to plan for an effective emergency response". There are benchmark values (i.e., PAC-1, -2, and -3) for a set of evaluated chemicals. Each successive benchmark represents an increasingly severe effect involving a higher exposure level: 1) mild, transient health effects, 2) irreversible or other serious health effects that could impair the ability to take protective action, and 3) life-threatening health effects.[12]

The accident analysis represented in Table E.1-7 can be summarized according to the process outlined in Chapter 4 of the Methodology Report where likelihoods (or frequencies) range from beyond extremely unlikely to anticipated and impacts (or consequences) range from Low to Very High. An example summary for onsite impacts related to the Hanford Tank Farms is provided in Table E.1-8.

[12] http://orise.orau.gov/emi/scapa/chem-pacs-teels/

Table E.1-8. Initiating Events and Onsite (Facility Worker and Co-located Person) Consequences for the Tank Farms (adapted from RPP-13033). Note all Offsite (Public) Consequences for Credible Events are <5 rem or <PAC-1 Corresponding to a Consequence Level of Low.

EVENT TYPE[a]	Likelihood[b]/Impact[c] Active Cleanup	Near-term	Long-term	Discussion
Flammable Gas Accident	A/L-M* (---/L)	NA (---)	NA (---)	Flammable gas deflagration in waste storage vessels/containers (ranging from DSTs to SSTs to waste packaging drums).
Nuclear Criticality	BEU/L (---/L)	NA (---)	NA (---)	Nuclear criticality in waste tanks/vessels. Near- and long-term assessments based on 99% retrieval of tank wastes assuming less than critical mass remaining. A nuclear criticality is deemed not credible.
Waste Transfer Leak	A/H* (EU/L)	NA (NA)	NA (NA)	Involves a broad spectrum of waste leaks. The bounding event is a fine spray leak using a high head waste transfer pump.
Release from Contaminated Facility	A/L-M* (---/L)	NA (NA)	NA (NA)	Involves release mechanisms (i.e., flammable gas deflagrations, fires, load handling accidents, or compressed gas system failures) in contaminated facilities. Bounding event is a flammable gas deflagration in a waste transfer-associated structure.
Air Blow Accident	A/L-M (A/L)	NA (NA)	NA (NA)	Involves a waste release from a contaminated HIHTL primary hose assembly and connected waste transfer primary piping system that is pressurized by compressed air.
External Events	These accidents are captured by the above operating events.			Events evaluated include aircraft crash, vehicular accident, range fire
Natural Events[d]				Events evaluated include lightning, high winds, earthquakes, volcanic, dust, floods

a. RPP-13033, Tank Farms Documented Safety Analysis (DSA). Only the representative accidents (without controls or unmitigated) are considered; however, the likelihood/impact is assessed both without controls or unmitigated (top pair) and with controls or mitigated (bottom pair).

b. Likelihoods: A – Anticipated (> 10^{-2}/yr); U – Unlikely (10^{-2} – 10^{-4}/yr); Extremely Unlikely (10^{-4} – 10^{-6}/yr); and BEU – Beyond Extremely Unlikely (<10^{-6}/yr). NA – Not applicable.

c. Consequence Levels: L – Low (*Co-located*: <25 rem TED or <PAC-2 and *Public*: <5 rem TED or <PAC-1); M – Moderate (*Co-located:* ≥25 rem TED or ≥PAC-2 and *Public:* ≥5 rem TED or ≥PAC-1); and H – High (*Facility Worker:* Prompt death, serious injury, or significant exposure and *Co-located:* ≥100 rem TED or ≥PAC-3 and *Public:* ≥25 rem TED or ≥PAC-2) (DOE-STD-3009-2014). An asterisk (*) indicates that there is an event that is qualitatively judged to result in prompt death, serious injury, or significant radiological or chemical exposure to the facility worker. NA – Not applicable.

d. Natural events can initiate multiple common cause accidents (e.g., more than one flammable gas deflagration), but do not increase the cumulative consequences beyond those shown above.

Summary of Mitigated Risks and Potential Impacts

Hazards associated with potential high-consequence accidents primarily relate to the characteristics of the tank waste constituents. With controls (i.e., mitigated), the air blow accident remains anticipated, however, with low consequences to both workers (<5 rem total effective dose for the air blow accident) and the offsite public (Table E.1-8). All mitigated accidents have *Low* consequence ratings. The nuclear criticality accident has been deemed not credible.

The air blow accident and most other accidents evaluated in the DSA pertain during the Active Cleanup period (to 2064). After closure, the single shell tank farms will likely have at least 99% of the waste retrieved and the tanks filled with grout and covered with a cap that would mitigate the events related to the Tank and Waste Farms EUs; these events involve fire and natural events that degrade barriers and increase infiltration of water. The manner in which the DSTs will be closed after tank wastes are treated is still to be determined.

Institutional, Engineered, and Natural Barriers

In general, the Tank Farm Vadose Zone Program implemented several interim measures to mitigate impacts from past tank farm leaks and discharges (i.e., limiting contaminant mobility by controlling the amount of water introduced into the shallow vadose zone) (DOE/ORP-2008-01, p. 11-1):

- Installation of well caps on dry wells
- Decommissioned monitoring wells and drywells
- Tested and decommissioned waterlines
- Construction of surface water control measures (berms and gutters)
- Construction of surface barriers.

The waste tanks themselves are the primary barriers to the further spread of tank waste contaminants to the environment (albeit waste has leaked in the past and may be currently leaking from some tanks). However, the risk of further leaks from the tanks has been largely mitigated by interim stabilizing (i.e., removing the supernatant and drainable liquid from the tanks and transferring to DSTs). The barriers represented by the tanks are then coupled with the large vadose zone (~64-71 meters (Hartman 2000, p. 4.12)) and travel through the saturated zone 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.

<u>Structural Integrity of Tanks</u>

The *structural integrity* of the Hanford SSTs and DSTs is being evaluated per a Tri-Party Agreement to "determine the SST system integrity, and whether or not the SST tank system is adequately designed and has sufficient structural strength and compatibility with the waste to be stored or treated to ensure that it will not collapse, rupture, or fail" (RPP-10435, Rev. 0). Based on the SST integrity assessment (RPP-10435, Rev. 0), the reinforced concrete SST structures were concluded to have an adequate collapse margin so that continued safe storage of interim-stabilized waste could continue. "However, given the tank leak history and current condition of the tank liners, long-term leak integrity, for the liquids remaining in the tanks, cannot be proven for any of the SSTs" (RPP-10435, Rev. 0).

To ensure adequate margin against dome collapse through closure, potential reinforced concrete degradation mechanisms were reviewed including the primary potential degradation mechanisms for the SSTs (RPP-10435, Rev. 0):

- Corrosion of reinforcing bars,
- Degradation of concrete mechanical properties from high temperature exposure, and
- Exposure of the concrete to caustic waste in leaking tanks and resulting damage.

Based on the structural integrity assessment and evaluations of possible degradation mechanisms, the SSTs were declared structurally adequate (RPP-10435, Rev. 0). Because of the relatively benign operating environment and reduced liquid waste volumes, future degradation is assumed to be small and the dome collapse margin will remain adequate through closure.

The most significant structural uncertainty pertains to the condition of the concrete basemat and footing, which cannot be inspected. However, dome surveillance indicates no current evidence of significant distress in the dome. Periodic monitoring of the SST domes is needed to maintain sufficient confidence in the SST structural integrity for future operations through closure (RPP-10435, Rev. 0.

Mitigation of Past Contamination

Interim measures were completed to minimize contaminant infiltration from artificial water sources such as waterline leaks or surface run-on. These interim measures include (RPP-23752, Rev. 0, p. xvi):

- Emplacing upgradient surface water run-on control measures (barriers and diversions).
- Performing leak tests of the waterlines to tank farms. No leaks in the tank farm area were detected at the time of the survey. The raw water lines serving tank farms were cut and capped in 2001.
- Verifying that the sanitary waterlines to Tank Farm had been cut and capped.
- Capping existing drywells to prevent water intrusion.
- Decommissioning pre-1980 monitoring wells at Tank Farm.

A number of groundwater (GW) interim remedial actions have been conducted in the 200-UP-1 and 200-ZP-1 Operable Units (OUs). In the 200-UP-1 OU, these actions include (EPA 2012):

- *216-U-1 Crib and 216-U-2 Crib Groundwater Interim Remedial Action (1985)*: An interim remedial action was designed to pump and treat groundwater below these cribs. Pumping started in June 1985 and continued until November 1985. The system removed 687 kg of uranium via ion exchange treatment.
- *200-UP-1 Groundwater OU Interim Remedial Action (1997, amended in 2009 & 2010)*: A pilot-scale treatability test consisting of a P&T system was constructed adjacent to the 216-U-17 Crib. Phase I operations commenced September 1995 and continued until February 1997. The test demonstrated that the ion exchange resin and granular activated carbon were effective at removing Tc-99, uranium, and carbon tetrachloride from groundwater. Based on the success of the treatability study, an interim action (i.e., groundwater extraction and treatment system) was implemented. Cleanup started in 1997 and met its remedial action objective of reducing highest concentrations to below 10 times the cleanup level of 48 µg/L for uranium and 10 times the maximum contaminant level of 900 pCi/L for Tc-99. This system removed 220.5 kg of uranium, 127 g (2.17 Curies) of Tc-99, 41 kg of carbon tetrachloride, and 49,000 kg of nitrate. The system was shut down in 2012.
- *WMA S-SX Groundwater Extraction System*: A groundwater extraction system for Tc-99 was constructed in 2011 and started operation in August 2012. The design consists of a three-well extraction system, aboveground pipelines, and a transfer building to pump extracted groundwater to the 200 West Groundwater Treatment Facility for treatment and reinjection. As of the 2013, the system has removed 60.8 g (1.03 Ci) of Tc-99, 17.9 kg of chromium, 9,560 kg of nitrate, and 121 kg of carbon tetrachloride since startup (DOE/RL-2014-32, Rev. 0, p. UP-34).
- The final ROD for the 200-UP-1 OU will be pursued when future groundwater impacts are adequately understood and potential technologies to treat I-129 are completed (EPA 2012).

In addition to the actions above, the following actions have been or are being taken to address groundwater contamination in the 200-ZP-1 OU:

- *200-ZP-1 OU Interim Remedial Action (1995)*: In 1996, a pump-and-treat system was started to reduce the mass of carbon tetrachloride (as well as secondary contaminants TCE and chloroform) in the groundwater primarily from waste sites south and east of the Plutonium Finishing Facility (DOE/RL-2012-03, Rev. 0). This action was completed and the interim P&T system was deactivated in May 2012 (with startup of the 200 West Area P&T facility). From 1996 through 2012, the system removed 13,911 kg of carbon tetrachloride, 14.5 kg of chromium, 84,693 kg of nitrate, 81.7 g (1.3 Ci) of Tc-99, and 0.73 kg of TCE (DOE/RL-2014-32, Rev. 0, p. ZP-25).
- *200-ZP-1 Record of Decision (2008)*: The 200-ZP-1 Record of Decision was issued in 2008 and selected P&T, MNA, and Institutional Controls (ICs) to remediate contaminated groundwater including impacting the direction of groundwater flow and further reducing the levels of carbon tetrachloride present and migrating towards the 200-UP-1 OU. The P&T system was started in 2012 and removed 3,580 kg of carbon tetrachloride, 91.24 kg of chromium, 0.000242 µCi of I-129, 243,905 kg of nitrate, 98.03 g (1.5 Ci) of Tc-99, and 15.49 kg of TCE, and 1.08 kg of U[13] by 2013 (DOE/RL-2014-32, Rev. 0, p. ZP-25).
- *200-PW-1 Interim Record of Decision (1992)*: Soil vapor extraction (SVE) was implemented as an interim action in 1992 to remove carbon tetrachloride from the vadose zone in 200-PW-1 overlying the 200-ZP-1 groundwater (DOE/RL-2014-32, Rev. 0). The system has removed 80,107 kg of carbon tetrachloride to date; however, the mass removed each year has been decreasing (DOE/RL-2014-32, Rev. 0, p. ZP-28). The system did not operate in 2013.

The 200-BP and 200-PO OUs have neither interim nor final RODs with groundwater 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). The 200-PO-1 OU is being monitored to determine the impact to groundwater prior to determining the path forward for remedial action. For 200-BP-5, the following actions are being conducted:

- Ongoing perched water treatability test (200-DV-1) at WMA B-BX-BY to remove uranium. By 2013, approximately 691,000 L of perched water containing approximately 373 kg of nitrate, 0.022 Ci of Tc-99, and 31.9 kg of uranium was extracted (DOE/RL-2013-22, Rev. 0; DOE/RL-2014-32, Rev. 0, page BP-8).
- Waste Management Area (WMA) C Tank Waste Retrieval. Tank wastes are currently being retrieved from WMA C. Waste retrieval has been completed in nine of the 16 tanks, has been completed to various limits of technology in four tanks, and retrievals are in progress in the remaining three tanks (Weyns 2014).
- The final action record of decision for the 200-BP-5 OU is scheduled for 2016 (DOE/RL-2014-32, Rev. 0, p. BP-3).

Events that could lead to Degradation or Failure of Barriers

The HLW tanks, that represent the primary barriers to significant tank waste release, were originally built for limited operations. Past practices including the intentional discharge of tank waste liquids (at least some of which is retained in vadose zone pore spaces) may present a larger and much more uncertain source than leaks and even current tank waste for some constituents. However, there is an

[13] Uranium is not a contaminant of concern for the 200-ZP-1 OU; it is including to track 200-UP-1 groundwater treated.

increased likelihood that there could be additional or increased leaking for those Tank Farm tanks storing liquids as the tanks age. Both accidents and degradation/aging processes (e.g., carbonation) could lead to eventual tank failure. For example, a series of possible accidents involving SSTs and DSTs were evaluated in the DSA (RPP-13033). There may also be unplanned excavation or drilling in the areas near the tank farm that could disturb contaminated soil. The DSA indicates that the flammable gas accident, waste transfer leak, air blow accident, and release from a contaminated facility would be anticipated without controls (Table E.1-8). With controls, both a flammable gas accident and an air blow accident would be anticipated during waste transfer.

A specific analysis of the structural integrity of 241-C-106 (SST) was also made for *in situ* load conditions (Julyk 1994). In this study, tank failure modes fell into two categories: local (concrete cracking and spallation, shear failures, and crushing and rebar bond and splice failures) and global (structural instability associated with either collapse or buckling). However, based on the structural integrity assessment and evaluations of possible degradation mechanisms, the SSTs have been declared structurally adequate (RPP-10435, Rev. 0).

The thick vadose zone under the Tank Farms 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 and around the Tank Farms 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[14]. The vadose and saturated zones have been contaminated from the Tank and Waste Farms EU wastes; however, the travel times from the waste tanks to potential receptors has been sufficiently long that no off-site receptors are known to have been exposed to tank wastes other than tritium.

Primary Pathways and Populations or Resources at Risk

The primary pathway represented is release of contaminants from the Tank and Waste Farms EUs and ancillary equipment (primary sources) and legacy source sites including cribs, trenches, and contaminated vadose zone (exposure medium and secondary source) through the vadose zone (medium) to the saturated zone (medium and receptor) to the Columbia River (medium and receptor) to various biological and human receptors (receptors) that can be potentially exposed by external radiation and dermal, inhalation (vapors), or ingestion routes. There are current restrictions on Hanford groundwater use so this path is not currently complete and considered to remain under federal control in perpetuity.

There are complete pathways for the exposure of ecological receptors to vadose zone contaminants in the Tank Farm legacy source areas. Mitigation efforts (e.g., pump-and-treat, surface water control, interim capping) are underway to reduce contaminant migration and potential exposure to ecological receptors. 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.

[14] Because the waste tanks divert water, there are areas of low moisture content and regions of higher moisture denoted an ”umbrella effect” (RPP-23752); thus there is increased flux in the vadose zone in the areas around the tanks due to the resulting focused flow. 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.

Time Frames for Human Exposure or Impacts to Resources

Several tanks may constitute primary source (tank wastes via leaking) and secondary sources (vadose zone pore spaces from legacy sources) that are releasing contaminants into the Hanford subsurface environment. The primary driver for contaminant transport following release from a tank is infiltrating water (vadose zone) and recharge rate to saturated zone influencing contaminant movement toward the Columbia River. However, the tanks still represent a major barrier to additional large-scale contaminant release, and there are interim measures (e.g., pump-and-treat, surface water control, interim capping) underway to mitigate additional transport of materials. The typical initiating events including likelihood and impacts related to HLW tanks are provided in Table E.1-7. The four event types (i.e., flammable gas accident, waste transfer leak, air blow accident, and release from a contaminated facility) from the DSA (RPP-13033) that would be anticipated without controls and the iconic nuclear criticality accident.

The relatively long residence times in the Hanford saturated zone 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 (although the gradient produced from this practice is flattening out) and 2) the relatively high permeability of Hanford formation sediments (that are below the water table). Travel time from the 200 West Area is longer because of the lower permeability of Ringold Formation sediments. Groundwater from the 200 West Area has moved about 6 km (3.7 mi) during the past 50 years (or approximately 0.1 km/yr) (PNNL-6415 Rev. 18, p. 4.72). 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.

Current Releases from the Tank and Waste Farms EUs to the Environment

The nine Tank and Waste Farms EUs evaluated in this study comprise the single-shell and double-shell tanks, ancillary equipment, and legacy source sites (cribs, trenches, near-tank soil) associated with the tank farms. A number of SSTs are ***assumed*** to be capable of further leaking into the environment if there are drainable liquids in the tank (Table E.1-9). For the SSTs, there are Tank Farms (e.g., TX-TY and B-BX-BY) where more than one-half of the tanks are denoted as assumed leakers. However, as much of the pumpable liquid wastes (supernatant and drainable liquids) in the SSTs has been transferred to the DSTs during the interim stabilization project (Weyns 2014). Only one DST (AY-102) is classified as an assumed leaker; however, the small quantities of leaked tank waste has been found and is confined to the tank annulus.

There are also 15 SSTs where water has intruded into the tanks (primarily from rainfall and snow melt) increasing the water levels in the tanks.

Table E.1-9. Hanford Tank Status Summary (Weyns 2014)

EU	Description	Area	Total No. of Tanks (by TF)	No. of Sound Tanks (No. with WI)[c]	No. of Assumed Leakers (No. with WI)[c]	Supernate (kgal)	Drainable (kgal)
CP-TF-1	T Tank Farm	200-W	16	9(1)	7(2)	29	215
CP-TF-2	S-SX Tank Farms[a]	200-W	27 (12+15)	11(1)+7(2)	1+8	3	645
CP-TF-3	TX-TY Tank Farms	200-W	24 (18+6)	10+1(1)	8+5	11	371

EU	Description	Area	Total No. of Tanks (by TF)	No. of Sound Tanks (No. with WI)[c]	No. of Assumed Leakers (No. with WI)[c]	Supernate (kgal)	Drainable (kgal)
CP-TF-4	U Tank Farm	200-W	16	12(1)	4	8	331
CP-TF-5	A-AX Tank Farms	200-E	10 (6+4)	4(1)+4	2+0	12	207
CP-TF-6	B-BX-BY Tank Farms	200-E	40 (16+12+12)	6(1)+7(1)+7(1)	10+5(2)+5(1)	48	799
CP-TF-7	C Tank Farm[b]	200-E	16	10	6	16	---
CP-TF-8	200-East DSTs – AN/AP/AW/AY/AZ	200-E	25 (7+8+6+2+2)	7+8+6+1+2	0+0+0+1[d]+0	18812	---
CP-TF-9	200-West DSTs – SY	200-W	3	3	0	1604	---
SSTs	Single-shell Farms	---	149	88(10)	61(5)	127	2568
DSTs	Double-shell Farms	---	28	27	1[d]	20416	---

a. S-112 Retrieval Completed 03/02/07 - Total waste 2,387 gallons; sludge/saltcake 2,263 gallons; and supernate 124 gallons.

b. C-103, C-104, C-106, C-110, C-112, C-201 through C-204 – Declared "Retrieval Completed".
C-101, C-107, C-108, and C-109 – Retrieved to at least one limit of technology.
C-102, C-105, and C-111 – Retrievals in progress.

c. WI = Water intrusion

d. Primary tank for 241-AY-102 has leaked into the secondary tank but not the environment.

Populations and Resources Currently at Risk or Potentially Impacted

Facility Worker: Both regular and construction workers are at risk from wastes (including vapors and direct radiation exposure) and activities related to on-going Tank Farm operations. Controls have been implemented to limit radiological and toxicological risks to workers.

Co-Located Person (CP): Co-located persons may be at risk from wastes (including vapors and direct radiation exposure) during on-going Tank Farm operations. Controls have been implemented to limit radiological and toxicological risks to workers and other persons in this area.

Public: The Tank Farms, which are in a secure and controlled area that prevents intentional and inadvertent intruders, are several miles interior to the Hanford Site boundary so any potential impact via the air pathway to the general public would be minimal. Hanford groundwater use is restricted so there is no significant pathway to the public.

Groundwater: There are existing plumes (e.g., chromium, Tc-99, I-129, and nitrate) associated with the Tank and Waste Farms EUs including legacy source sites (e.g., past leaks, cribs and trenches) that represent impacts (e.g., exceed drinking water standards) to groundwater as a protected resource. Evaluations are provided for each of the Groundwater EUs (200-East and 200-West) and Tank and Waste Farms EUs in the appropriate sections.

Columbia River: Tank Farm primary contaminants have migrated through the vadose zone and into the saturated zone but have not reached the nearshore or surface water portions of the Columbia River in measureable concentrations (except for tritium which is a Group C primary contaminant per the Groundwater Framework in the Methodology (Chapter 6). Thus there is no significant current impact to the Columbia River; however, it is projected that plumes from the Central Plateau (especially those from

200-East) may impact the Columbia River in the future. Evaluations are provided for each of the Groundwater and Tank and Waste Farms EUs in the appropriate sections.

Ecological Resources: Evaluations are provided for each of the Tank and Waste Farms EUs in the appropriate section.

Cultural Resources: Evaluations are provided for each of the Tank and Waste Farms EUs in the appropriate section.

CLEANUP APPROACHES AND END-STATE CONCEPTUAL MODEL

Selected or Potential Cleanup Approaches

The preferred HLW tank closure alternative includes 99 percent retrieval of waste (by volume) from the SSTs[15] for staging in DSTs and treatment elsewhere onsite; operations and necessary maintenance, waste transfers and associated operations, and upgrades to existing tanks or construction of waste receipt facilities (DOE/EIS-0391 2012). SST closure operations include filling the tanks and ancillary equipment with grout to immobilize residual waste. Disposal of contaminated equipment and soil would occur on site. Decisions on the extent of soil removal or treatment would be made on a tank farm or waste management area basis through the RCRA closure permitting process. The tanks would be stabilized with grout, and an engineered modified RCRA Subtitle C barrier put in place followed by post-closure care. The other tank closure alternatives evaluated in the TC&WM EIS (other than No Action) tended to be a variation on the above theme. The proposed duration of each phase is illustrated in Figure E.1-6.

[15] According to the Hanford Tri-Party Agreement (TPA), the retrieval limits are 360 ft^3 and 30 ft^3 for 100-Series and 200-Series tanks, respectively, (Ecology, EPA, and DOE 1996, Appendix H, p. H-5).

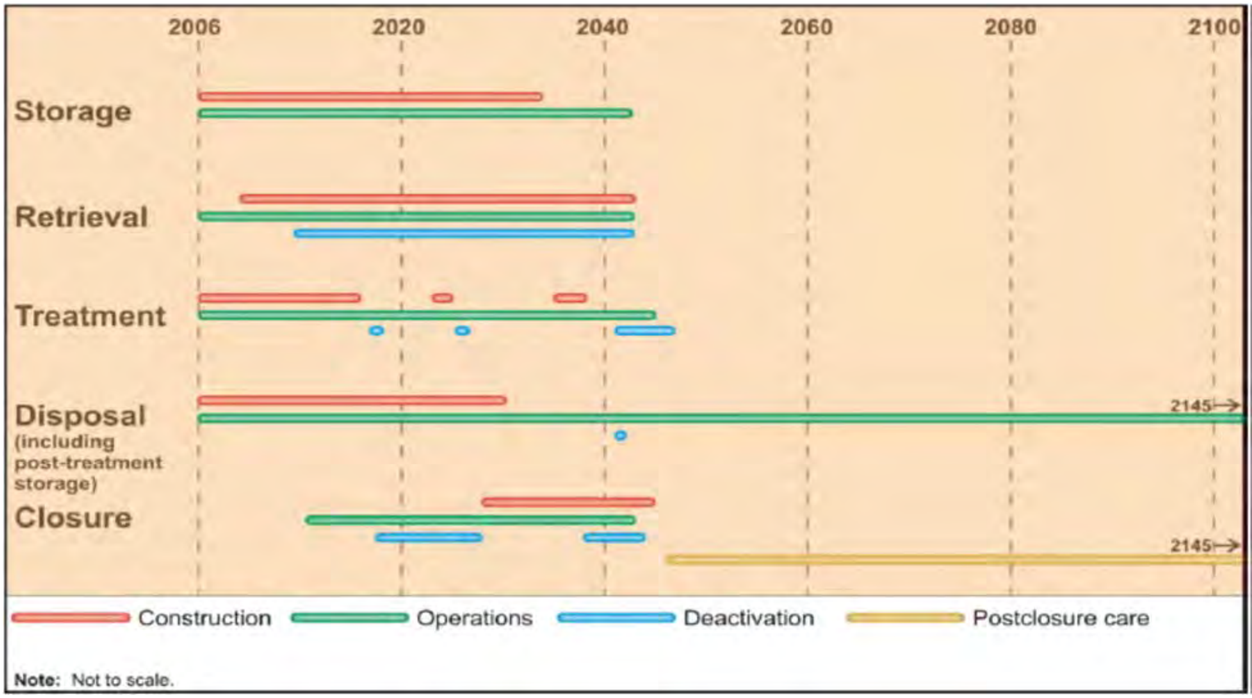

Figure E.1-6. Preferred Tank Closure Alternative Proposed Schedule (DOE/EIS-0391 2012, p. 2-73)

Contaminant Inventory Remaining at the Conclusion of Planned Active Cleanup Period:

The projected single- and double- shell tank inventories remaining after planned (99%) retrieval activities are provided in Table E.1-10 and Table E.1-11. However, residual tank waste contaminants will remain in the vadose and saturated zone after planned cleanup activities are completed. Estimates of the residual contaminants related to the 200 Areas are described in Appendix G.5 (CP-GW-1) and Appendix G.6 (CP-GW-2) and the appropriate Tank and Waste Farms EU section.

Table E.1-10. Selected Hanford Single-Shell Tank Radionuclide Inventories after 99% Retrieval is Complete (BBI[16]; HNF-EP-0182, Rev. 315)

Analyte	CP-TF-1	CP-TF-2		CP-TF-3		CP-TF-4	CP-TF-5		CP-TF-6			CP-TF-7	
Radionuclide (Ci)	**T**	**S**	**SX**	**TX**	**TY**	**U**	**A**	**AX**	**B**	**BX**	**BY**	**C**	**Total**
H-3	3.39E-01	3.51E+00	3.24E+00	3.78E+00	7.53E-02	1.91E+00	3.69E-01	2.56E-01	1.34E-01	7.00E-01	4.61E+00	2.56E+00	2.15E+01
C-14	5.66E-02	6.76E-01	4.24E-01	7.35E-01	2.14E-02	4.58E-01	1.28E-01	1.01E-01	5.09E-02	8.80E-02	8.04E-01	2.09E-01	3.75E+00
Sr-90	1.46E+03	1.86E+04	1.17E+05	4.74E+03	2.80E+03	6.34E+03	5.44E+04	2.68E+04	5.12E+03	7.43E+03	1.14E+04	1.50E+05	4.06E+05
Tc-99	1.51E+00	2.22E+01	1.48E+01	2.52E+01	9.57E-01	1.66E+01	7.15E+00	3.87E+00	2.08E+00	3.66E+00	1.55E+01	5.67E+00	1.19E+02
I-129	7.69E-04	2.23E-02	1.60E-02	2.65E-02	8.55E-04	1.62E-02	3.75E-03	3.80E-03	9.96E-04	3.29E-03	2.41E-02	2.60E-02	1.44E-01
Cs-137	6.24E+02	1.70E+04	2.08E+04	2.08E+04	5.79E+02	1.78E+04	7.82E+03	5.44E+03	1.97E+03	3.26E+03	1.83E+04	1.57E+04	1.30E+05
Chemical (kg)	**T**	**S**	**SX**	**TX**	**TY**	**U**	**A**	**AX**	**B**	**BX**	**BY**	**C**	**Total**
Chromium	1.20E+02	1.01E+03	1.08E+03	5.13E+02	7.60E+01	4.88E+02	1.49E+02	8.40E+01	1.11E+02	2.42E+02	7.62E+02	9.68E+01	4.73E+03
Nitrate	6.26E+03	7.88E+04	5.22E+04	1.33E+05	6.61E+03	4.25E+04	5.63E+03	4.31E+03	1.70E+04	1.59E+04	5.89E+04	1.12E+04	4.32E+05
Uranium	2.98E+02	4.82E+02	3.39E+02	6.45E+02	3.20E+02	4.07E+02	1.24E+02	2.56E+01	3.86E+02	8.60E+02	6.78E+02	3.59E+03	8.15E+03

Table E.1-11. Selected Hanford Double-Shell Tank Chemical Inventories after 99% Retrieval is Complete (BBI[16]; HNF-EP-0182, Rev. 315)

Analyte	CP-TF-8					CP-TF-9	
Radionuclide (Ci)	**AN**	**AP**	**AW**	**AY**	**AZ**	**SY**	**Total**
H-3	1.36E+00	2.54E+00	2.77E+00	4.98E-01	7.71E-01	2.71E-01	8.21E+00
C-14	5.83E-01	7.30E-01	3.89E-01	3.21E-02	8.15E-02	1.39E-01	1.95E+00
Sr-90	5.53E+04	5.47E+02	3.48E+03	6.34E+04	8.35E+04	3.24E+03	2.10E+05
Tc-99	3.95E+01	4.79E+01	2.90E+01	2.40E+00	1.63E+01	1.55E+01	1.51E+02
I-129	5.65E-02	6.05E-02	2.94E-02	6.24E-03	5.47E-03	1.48E-02	1.73E-01
Cs-137	7.81E+04	6.73E+04	4.44E+04	7.60E+03	6.33E+04	1.39E+04	2.75E+05
Chemical (kg)	**AN**	**AP**	**AW**	**AY**	**AZ**	**SY**	**Total**
Chromium	2.32E+02	2.05E+02	1.52E+02	4.01E+01	5.08E+01	6.11E+02	1.29E+03
Nitrate	4.17E+04	5.10E+04	2.70E+04	4.65E+03	4.34E+03	9.85E+03	1.39E+05
Uranium	8.05E+02	1.00E+01	5.53E+02	2.53E+01	8.73E+01	6.05E+01	1.54E+03

[16] Best Basis Inventory (BBI) Summary (March 24, 2014) provided in spreadsheet form by Mark Triplett (PNNL). The current version of the BBI is stored online and can be accessed using the Tank Waste Information Network System (TWINS) at: https://twinsweb.labworks.org/ (July 2015).

Risks and Potential Impacts Associated with Cleanup:

Tank closure activities specific to the Tank and Waste Farms EUs include retrieval of SST waste for treatment elsewhere onsite; operations and necessary maintenance, waste transfers and associated operations, and upgrades to existing tanks or construction of waste receipt facilities; filling the tanks and ancillary equipment with grout; disposal of contaminated equipment and soil; and installing an engineered modified RCRA Subtitle C barrier followed by post-closure maintenance. The information in Table E.1-7 and Table E.1-8 suggests that there are anticipated events associated with Tank Farm closure operations that may have moderate impacts. Controls have been put in place to address events with known significant risks (RPP-13033).

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

Facility Worker: As described in Section 1.1, regular and construction workers will be at risk from exposure to direct radiation and waste contaminants during Tank Farm retrieval and closure operations. Controls will be implemented to limit radiological and toxicological risks to workers.

Co-located Person: As described in Section 1.1, these persons may be at risk from exposure to direct radiation and waste contaminants during Tank Farm retrieval and closure operations. Controls will be implemented to limit radiological and toxicological risks to persons in these areas.

Public: The Tank Farms, which are in secure and controlled areas that prevent intentional and inadvertent intruders, are several miles interior to the Hanford Site boundary so the impact from the air pathway (e.g., dust) or other pathways (e.g., surface water, traffic, or transportation accidents) to the general public is considered low even during closure activities. Hanford groundwater use will be restricted during this period so there is no significant pathway to the public. These results would be different if portions of the site are opened for public access more proximate to the 200 Areas.

Groundwater: There will be a continuing impact during this period to groundwater (as a protected resource) from those mobile Tank Farm primary contaminants (e.g., chromium, Tc-99, I-129, and nitrate) currently with plumes that exceed thresholds. These impacts are described in either Appendix G.5 or Appendix G.6 for CP-GW-1 (200-East) or CP-GW-2 EU (200-West), respectively.

Furthermore, there are primary (e.g., tank wastes) and secondary contaminant sources (legacy source sites) in the vadose zone that pose risk to groundwater. Specific ratings for individual Tank and Waste Farms EUs are developed in the corresponding Tank and Waste Farms EU sections. The vadose zone (VZ) GTM values for the Group A and B primary contaminants for the Single-Shell Tank (SST) Farm EUs translate to overall ratings for the Active Near-term and Post-Cleanup period from Low (CP-TF-4 for WMA U) to High (e.g., CP-TF-6 for WMA B-BX-BY) (Table E.1-3)[17].

Potential impacts from the 200-East and 200-West DST Farm EUs (CP-TF-8 and CP-TF-9, respectively) to groundwater were rated as *Not Discernible* for all contaminants and evaluation periods.

The 200-West Area pump-and-treat system is assumed to be operational during this evaluation period, which will be treating groundwater contamination.

Columbia River: Based on the screening evaluation in the TC&WM EIS (DOE/EIS-0391 2012) and summarized in Table E.1-4, no radioactive contaminants are predicted to be discharged to the Columbia River in concentrations that would pose risk to benthic or riparian zone receptors. Similarly, because of

[17] The vadose zone inventory of Sr-90 would translate to *Very High* ratings in multiple TF EUS; however, its relative immobility in the subsurface (compounded by radioactive decay) indicated that Sr-90 would not be a risk driver.

the large dilution effect in the Columbia River, the free-flowing ratings are *Not Discernible* for all the Tank and Waste Farms EUs for all contaminants and evaluation periods.

However, based on the TC&WM EIS, some chemical contaminants (nitrate and chromium) were predicted to be discharged into the Columbia River in concentrations above benthic and riparian threshold values before the end of the Active Cleanup period[18] that would result in *Medium* benthic and *High* riparian zone ratings. However, well data suggest that water and contaminants are moving toward the Columbia River much more slowly than predicted leading to *Not Discernible* ratings.

Potential impacts from the 200-East and 200-West DST Farm EUs (CP-TF-8 and CP-TF-9, respectively) to the Columbia River receptors were rated as *Not Discernible* for all contaminants and evaluation periods.

Ecological Resources:

Truck and heavy equipment on roads through non-target areas or remediation site, as well as heavy, wide hoses, 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. Effects continue if hoses remain or are moved over time. Heavy equipment often leads to permanent or long-term compaction, 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. Effects continue if hoses remain or are moved over time. Additional water from dust suppression could lead to more diverse and abundant vegetation in areas that receive water, which could encourage invasion of exotic species. The latter could displace native plant communities. Excessive dust suppression activities could lead to compaction, which can decrease plant growth in those areas, decrease abundance and diversity of soil invertebrates, and prevent fossorial snakes or mammals from using the area. Irrigation for re-vegetation requires a system of pumps and water, resulting in physical disturbance. Repeated irrigation from the same locations could result in some soil compaction, which can decrease plant growth in those areas, decrease abundance and diversity of soil invertebrates, and prevent fossorial snakes or mammals from using the area. Soil removal can cause complete destruction of existing ecosystem, all of the above effects on adjacent sites, but these effects are potentially more severe because of blowing soil (and seeds) and the potential for exposure of dormant seeds. In the re-vegetation stage, there is the potential for invasion of exotic species, changing the species diversity of native communities. 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. Caps and other containment systems can disrupt local resources and drainage; often non-native plants used on caps (which can become exotic/alien adjacent to the containment site).

Cultural Resources:

Personnel, car, and truck traffic on paved roads as well as use of heavy equipment will not have any direct impact on archaeological resources because there is no disturbance to soil/ground or alteration to the landscape. Assuming heavy equipment locations 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 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

[18] The results were the same for both the No Action and Landfill Closure scenarios.

are on roads located on TCP and if personnel are unaware of cultural resource sensitivity, appropriate behaviors and protocols. For traffic on paved roads located on TCP, direct effects include visual, auditory and vibrational alterations to landscape/setting. Heavy equipment 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. Construction of buildings, staging areas, caps 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 building locations and staging areas 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 buildings and staging areas 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, capping 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 include 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, car, and truck traffic on paved roads as well as use of heavy equipment 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. Existing road causes no alteration to 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 construction, 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

There is potential for additional tank degradation and further leaks and contaminant transport through the vadose and saturated zones if Tank Farm closure activities are delayed. There is also potential risk from direct radiation and tank waste contaminants to workers (and ecological receptors) from routine Tank Farm operations.

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

The preferred Hanford tank closure alternative includes 99 percent retrieval of waste from the SSTs (although this may not be practically achievable) for staging in DSTs and treatment elsewhere onsite; operations and necessary maintenance, waste transfers and associated operations, and upgrades to existing tanks or construction of waste receipt facilities (DOE/EIS-0391 2012, Chapter 2, p. 2-321)[19]. SST closure operations include filling the tanks and ancillary equipment with grout to immobilize residual waste contaminants. Disposal of contaminated equipment and soil would occur on site. Decisions on the extent of soil removal and/or treatment would be made on a tank farm or waste management area basis through the RCRA closure permitting process. The tanks would be stabilized with grout, and an engineered modified RCRA Subtitle C barrier put in place followed by post-closure care.

Thus workers and the public would be isolated from the residual contamination in the tanks by both grout and soil cover. Tank waste contamination already in the vadose and saturated zones would experience reduced infiltrating water (the primary driver for the release and transport of contaminants) because of the surface barrier.

[19] According to the Tri-Party Agreement (Ecology, EPA, and DOE, 1998), retrieval limits for residual wastes are 360 ft^3 and 30 ft^3 for 100-Series and 200-Series tanks, respectively, corresponding to the 99% waste retrieval goal as defined in TPA Milestone M-45-00.

Populations and Resources at Risk or Potentially Impacted after Cleanup Actions (from residual contaminant inventory or long-term activities)

Table E.1-12. Summary of Populations and Resources at Risk or Potentially Impacted after Cleanup

Population or Resource		Impact Rating	Comments
Human	Facility Worker	Low	Workers will be low risk from exposure to direct radiation and waste contaminants after waste retrieval, grouting, and capping.
Human	Co-located Person	Low	These persons will be at low risk from exposure to direct radiation and waste contaminants after waste retrieval, grouting, and capping.
Human	Public	Not Discernible (ND)	The Tank Farms will be in secure and controlled areas that prevent intentional and inadvertent intruders. No complete groundwater pathway and no impact from air pathway.
Environmental	Groundwater (A&B) from vadose zone	Overall Ratings: SST Farm EUs 200-W: Low to High 200-E: Medium to High DST Farm EUs Not Discernible (ND)	GTM values for Group A and B PCs (modified by transport and decay, where appropriate). High ratings in 200-W primarily related to chromium in both groundwater and vadose zone. High ratings in 200-E driven by chromium and I-129 in vadose zone.
Environmental	Columbia River from vadose zone	All SST and DST Tank Farm EUs Benthic: Not Discernible (all) Riparian: Not Discernible (all) Free-flowing: Not Discernible (all) **Overall**: Not Discernible	The ratings with respect to radionuclides are all ND. Only chemicals (nitrate and chromium) are predicted (DOE/EIS-0391 2012) to have near-shore concentrations that could threaten the River ecology. However, due to transport considerations based on well data, contaminant are unlikely to impact the River.
Environmental	Ecological Resources*	Refer to individual Tank Farm /Groundwater EUs	Refer to individual Tank Farm /Groundwater EUs
Social	Cultural Resources*	Refer to individual Tank Farm /Groundwater EUs	Refer to individual Tank Farm /Groundwater EUs

*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.

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

After closure, the Tank and Waste Farms EUs are expected to have waste tanks and ancillary equipment grouted in place with residual contamination in tanks, ancillary equipment, and legacy source sites (e.g., cribs, trenches, and soil). Mobile primary contaminants have migrated from Tank and Waste Farms EU sources through the vadose zone to the saturated zone and will continue to move through the vadose zone and groundwater posing a continuing threat to groundwater as a protected resource. An engineered modified RCRA Subtitle C barrier will be emplaced over the tank farm site to reduce infiltrating water and contaminant migration for the time that the cap performs according to specifications. Upon cap failure, the recharge rate would likely increase significantly and thus so will the primary driver for contaminant transport. However, waste retrieval operations and grouting activities would help reduce the potential for release from residual waste source terms.

Because closure activities (including waste retrieval and surface barrier emplacement) would help isolate workers and the public from residual contamination, worker and public impacts are expected to remain *Low* during the Long-Term, Post-Cleanup period. The continuation of remedial actions such as pump and treat would help reduce groundwater contamination. The emplacement of a surface barrier would help reduce recharge in the areas near the Tank Farms; however, an evaluation of the groundwater transport analysis in the TC&WM EIS (DOE/EIS-0391 2012) indicated that the impacts of reduced recharge on groundwater contamination near the Tank Farms is mixed based on the area being considered. Furthermore, consideration of surface barrier emplacement (and its impact on recharge and transport) was predicted to have little impact on the nearshore region of the Columbia River. This result is not due to an ineffective barrier but instead likely due to large amounts of contaminants already in the subsurface and possible impacts from sources outside the Tank Waste and Farms EUs that were considered in the TC&WM EIS evaluation. Thus the ratings summarized in Table E.1-12 were not altered significantly based on long-term impacts or differing recharge assumptions.

Ecological Resources: Personnel, car, and pick-up truck traffic through non-target and remediated areas will likely no longer cause an effect on the ecological resources, unless heavy traffic caused ruts. If alien/exotic species became established during remediation, their presence could continue to affect the ecological resources. Permanent effects remain in the area of site with barrier or cap. Permanent effects remain in area surrounding cap or containment, depending upon traffic and current activities. 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 community.

Cultural Resources: Personnel, car and truck traffic on paved roads will likely have no direct effects on the cultural resources assuming the resources were not disturbed during remediation. If the remedial action included construction of buildings, cap or other type of containment then there are permanent effects in the area of the site. If archaeological resources or TCPs were directly or indirectly damaged or altered during construction of buildings or cap, cumulative effects include continued erosion and adverse effects to both archaeological site and TCP. If contamination is left behind and controlled by a barrier or other containment, then permanent effects to the cultural resources may occur in the area. If archaeological resources or TCPs were directly or indirectly damaged or altered during contamination, then cumulative effects include permanent adverse effects to both archaeological site and TCP..

1.7. SUPPLEMENTAL INFORMATION AND CONSIDERATIONS

The primary risk drivers related to the Tank and Waste Farms EUs will be contaminated groundwater and residual vadose zone contamination that could lead to additional groundwater contamination and possible impact to Columbia River benthic and riparian receptors. There is a restriction on groundwater use in the 200 Areas, except for treatment and monitoring (Ranade 2009). Furthermore, appropriate use restrictions (including that on groundwater use) will be attached to any real estate transaction if DOE transfer property to other entities. The restriction on groundwater use needs to remain in place in perpetuity to maintain the safety margins considered in this review. Possible impacts to benthic and riparian receptors along the River Corridor would not be moderated by the aforementioned groundwater restrictions on use.

APPENDIX E.2

Tank Waste and Farms

CP-TF-1 (T Tank Waste and Farm)
Evaluation Unit Summary Template

Table of Contents

List of Figures

List of Tables

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PART 2. CP-TF-1 T SINGLE-SHELL TANK WASTE AND FARM (200-W)

2.1. EXECUTIVE SUMMARY

Much of the information related to the T Tank and Waste Farms Evaluation Unit (EU) is organized around the corresponding Waste Management Area (namely WMA T) that is regulated under the Resource Conservation and Recovery Act (RCRA) as modified in 40 CFR Part 265, Subpart F and Washington State's Hazardous Waste Management Act (HWMA, RCW 70.105 and its implementing requirements in the Washington State dangerous waste regulations [WAC 173-303-400]) (Horton 2006).

EU LOCATION:

North-Central part of 200-West on the Hanford Reservation; Central Plateau

RELATED EUS:

S-SX Tank Waste and Farms (CP-TF-2), TX-TY Tank Waste and Farms (CP-TF-3), U Tank Waste and Farms (CP-TF-4), A-AX Tank Waste and Farms (CP-TF-5), B-BX-BY Tank Waste and Farms (CP-TF-6), C Tank Waste and Farms (CP-TF-7), 200-East DST Waste and Farms (CP-TF-8), 200-West DST and Waste Farms (CP-TF-9), 200-E Groundwater Plumes (CP-GW-1), 200-W Groundwater Plumes (CP-GW-2), and 200 Area Waste Transfer Pipeline (CP-LS-7)

PRIMARY CONTAMINANTS, CONTAMINATED MEDIA AND WASTES:

The TC&WM EIS describes tank wastes as including radioactive (tritium or H-3, C-14, Sr-90, Tc-99, I-129, Cs-137, U-233, U-234, U-235, U-238, Np-237, Pu-239, and Pu-240)[20] and non-radioactive contaminants (chromium, mercury, nitrate, lead, total uranium, and PCBs) of potential concern (DOE/EIS-0391 2012, Appendix D). The tank wastes contain saltcake, sludge, and supernatant phases. Contaminated media related to the T Tank Farm include ancillary equipment and surrounding vadose zone (including cribs and trenches) down to the saturated zone (for some mobile contaminants) from past and current discharges. The Record of Decision for the 200-ZP-1 Operable Unit (OU) (EPA 2008) associated with WMA T and WMA TX-TY identifies Tc-99, I-129, chromium, and nitrate (NO3) as tank waste constituents that must be addressed in cleanup. The 2013 Groundwater Monitoring Report (DOE/RL-2014-32, Rev. 0) lists tank wastes including chromium, nitrate, I-129, Tc-99, H-3, and uranium and non-tank wastes including carbon tetrachloride and tricholorethene (TCE) for the 200-ZP-1 OU.

After evaluating the contaminants associated with T Tank Farm tanks, ancillary equipment, legacy sources, and contaminated vadose zone, the primary contaminants from the tank wastes that drive human health risk to groundwater associated with the T Tank and Waste Farms Evaluation Unit are: Tc-99, I-129, chromium, and H-3. Those primary contaminants that may drive risk from groundwater discharge to the Columbia River are nitrate and chromium; however, any potential impacts are highly uncertain[21]. Cs-137 and Sr-90 are important from a safety standpoint and uranium isotopes, plutonium

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[20] Other isotopes considered include U-232 and U-236 and Pu-238, Pu-241, and Pu-242 to be consistent with other EUs. These additional uranium and plutonium isotopes are included in the totals presented but are not used for rating because 1) uranium toxicity impacts (represented by total uranium drives corresponding risks and 2) plutonium has been found relatively immobile in the Hanford subsurface and has not been identified as a risk driver for groundwater impacts.

[21] "For groundwater discharging to the Columbia River…, potential long-term impacts on aquatic and riparian receptors would be unlikely for all COPCs and receptors except for chromium and aquatic biota..." (DOE/EIS-0391

isotopes, and tritium are iconic constituents; these contaminants are included in the inventory summary even though they are not considered risk drivers for impacts to or from groundwater in this Review. Carbon tetrachloride and TCE are not tank wastes and thus are captured in Appendix G.6 for the CP-GW-2 EU (200-ZP-1 GW OU).

BRIEF NARRATIVE DESCRIPTION:

Waste Management Area T (WMA T) occupies approximately 32,000 m^2 (7.9 acres) and contains 16 underground single-shell tanks (SSTs) constructed in 1943 and 1944 (Horton 2006, p. 2.1) that constitute the T Tank Farm. The Tank Farm contains 12 carbon steel tanks with capacities of $2{\times}10^6$ liters (530 kGal) and four smaller carbon steel tanks with capacities of $2{\times}10^5$ liters (55 kGal) in additional to ancillary equipment (e.g., diversion boxes, pumps, valves, and pipes). The SSTs in WMA T began receiving waste in 1944 and were in use until 1980 when the tanks were removed from service. The tanks received primarily high-level metal and first cycle waste from chemical processing (bismuth phosphate process) of uranium-bearing spent fuel rods. When there was a shortage of tank capacity, supernatant from tanks was sent to cribs. Waste management operations created a complex intermingling of tank wastes; natural processes resulted in settling, stratification, and segregation of waste components.

Historic liquid waste disposal practices as well as leaks and unplanned release has resulted in contamination near the T Tank Farm as summarized in Section 2.3.

The SSTs in WMA T have been interim stabilized (i.e., liquid transferred to DSTs to <50 kgal drainable interstitial liquid and <5 kgal of supernatant). Initial corrective actions (including berms, ditches, water line testing and sealing, and a partial cover) have been implemented at WMA T (Horton 2006, p. 2.2; Zhang, et al. 2009).

SUMMARY TABLES OF RISKS AND POTENTIAL IMPACTS TO RECEPTORS

Table E.2-1 provides a summary of nuclear and industrial safety related consequences from CP-TF-1 (T Tank and Waste Farms EU) to humans and impacts to important physical Hanford Site resources. Receptors are described in Section 1.6 (Appendix E.1).

2012, p. 2–235). For the COPC (i.e., hexavalent chromium) with the highest risk indices for aquatic biota, Hazard Quotients exceeded 40 (versus a limit of 1). However, the TC&WM EIS states "… Only estimated exposures of aquatic biota to hexavalent chromium in nearshore surface water under all Tank Closure … exceeded the Hazard Quotient criterion of 1 at the Columbia River. 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 … groundwater releases to the Columbia River..." (DOE/EIS-0391 2012, Appendix P, pp. P–53-54). "The potential impact on aquatic biota in the Hanford Reach of nitrate in groundwater discharge is uncertain." (DOE/EIS-0391 2012, Appendix P, pp. P–54).

Table E.2-1. CP-TF-1 (T Tank Farm) impact Rating Summary for Human Health (unmitigated basis with mitigated basis provided in parentheses (e.g., "High (Low)").

Population or Resource		Evaluation Time Period[a] Active Cleanup (to 2064) **Current Condition:** Maintenance & Monitoring (M&M)	 **From Cleanup Actions:** Retrieval & Closure
Human Health	Facility Worker[b]	***M&M***: Low-High[d] (Low-High)[d] ***Soil***: ND-High (ND-Low)	***Preferred method***: High (Low) ***Alternative***: High (Low)
	Co-located Person[b]	***M&M***: Low-Moderate (Low) ***Soil***: ND (ND)	***Preferred method***: Low-Moderate (Low) ***Alternative***: Low-Moderate (Low)
	Public[b]	***M&M***: Low (Low) ***Soil***: ND (ND)	***Preferred method***: Low (Low) ***Alternative***: Low (Low)
Environmental	Groundwater (A&B) from vadose zone[c]	High -- Cr(tot, VI)[f] **Overall**: High	High -- Cr(tot, VI)[f] **Overall**: High
	Columbia River from vadose zone[c]	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[e]	ND to Low **Overall**: Low	Low to Medium **Overall**: Medium
Social	Cultural Resources[e]	**Native American:** Direct: Unknown Indirect: Known **Historic Pre-Hanford:** Direct: None Indirect: Unknown **Manhattan/Cold War:** Direct: Known Indirect: Known	**Native American:** Direct: Unknown Indirect: Known **Historic Pre-Hanford:** Direct: None Indirect: Unknown **Manhattan/Cold War:** Direct: Known Indirect: Known

a. A rating for cultural resources is not being made because cultural resources will be evaluated under Section 106 of the National Historic Preservation Act (16 USC 470, et. seq.) during the planning for remedial action.

b. Evaluated in Section 1.6 (Appendix E.1).

c. Groundwater threat for Group A and B contaminants remaining in the vadose zone or to the Columbia River for all primary contaminants. Threats from existing plumes associated with the T Tank and Waste Farms EU are described in Section 2.5 and Appendix G.6 (CP-GW-2) for the 200-ZP-1 Groundwater Operable Unit.

d. Industrial safety consequences range from low to high (based on the evaluation scale used) for both mitigated (with controls) and unmitigated (without controls). Mitigated radiological and toxicological consequences to facility workers are high (unmitigated) and low (mitigated).

e. 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.

f. The large amount of Sr-90 disposed of in the T Tank and Waste Farms EU would translate to a *Very High* rating; however, there is no current Sr-90 plume in the 200-ZP-1 OU and it would likely require more than 150 years to reach groundwater in a sufficient amount to exceed the drinking water standard over an appreciable area (Section 2.5). The uranium inventory would translate to a *Low* rating, but also is unexpected to reach groundwater in 150 years. Thus uranium and Sr-90 are not considered risk drivers for the T Tank and Waste Farms EU.

SUPPORT FOR RISK AND IMPACT RATINGS FOR EACH POPULATION OR RESOURCE

Human Health

The current and cleanup-related consequences related to work being conducted at the Tank Farms in the 200 Areas (Hanford Central Plateau) was evaluated in Section 1.6 (Appendix E.1).

Groundwater, Vadose Zone, and Columbia River

T Tank Farm contaminants are currently impacting groundwater, and treatment is not predicted to decrease concentrations to below thresholds before active cleanup commences. Secondary sources (e.g., total and hexavalent chromium) in the vadose also threaten to continue to impact groundwater in the future, including the Active Cleanup period[22]. Note that there is also a current plume for chromium in the 200-ZP-1 Operable Unit (CP-GW-2 (200-ZP-1 OU), Appendix G.6). As described in the TC&WM EIS (and summarized in Section 2.5), there appears to be insufficient impact from radioactive decay (since chromium is the risk driver in this case) and recharge rate (due to large amounts of these contaminants already in the groundwater) on peak concentrations in the groundwater and near-shore region of the Columbia River during or after cleanup to modify ratings. Thus the values for these receptors are the same as those shown in Table E.2-8.

Ecological Resources

<u>Current</u>
There is little habitat in the T Tank and Waste Farms EU (>1% level 3 resources), but over 10% in buffer area is level 3 resources. Effect in ND in EU, but may be up to Low in buffer due to truck disturbance.

<u>Risks and Potential Impacts from Selected or Potential Cleanup Approaches</u>
Effects to resources are due to increased disturbance and potential for contaminant release, increases in exotic species, and potential loss of some nesting habitat in buffer area, run over lizards and other wildlife during cleanup.

[22] Note that Sr-90, which has a large vadose zone source, is not considered a significant threat to groundwater due to its limited mobility in the Hanford subsurface. See Section 2.5 for details.

Cultural Resources

Current
Historical evidence of National Register eligible historic trail through the EU, however, extensive disturbance in area indicates low likelihood of remaining archaeological resources. Manhattan Project/Cold War significant resources have already been mitigated. Area is very disturbed and there is no evidence of archaeological sites being recorded within the EU. There is evidence of ethno historic and historic land use within the EU that has been destroyed by the Tank Farms.

Risks and Potential Impacts from Selected or Potential Cleanup Approaches
Due to presence of historic and ethno-historic land use within this EU, consultation will be necessary. Little to no potential for intact surface or subsurface archaeological material to be present due to heavy disturbance throughout EU.

Considerations for Timing of the Cleanup Actions

See Section 1.1 (Appendix E.1).

Near-Term, Post-Cleanup Risks and Potential Impacts

See Section 1.1 (Appendix E.1).

2.2. ADMINISTRATIVE INFORMATION

OU AND/OR TSDF DESIGNATION(S):

The T Tank and Waste Farms Evaluation Unit (EU), denoted *CP-TF-1 – T Tank Waste and Farms*, consists of 16 waste tanks, ancillary structures, associated liquid waste sites, and soils contamination; much of this EU is contained within Waste Management Area T (WMA T). Waste Management Area (WMA) T is regulated under the Resource Conservation and Recovery Act (RCRA) as modified in 40 CFR Part 265, Subpart F and Washington State's Hazardous Waste Management Act (HWMA, RCW 70.105 and its implementing requirements in the Washington State dangerous waste regulations [WAC 173-303-400]) (Horton 2006).

COMMON NAME(S) FOR EU:

There is no common name for the T Tank and Waste Farms EU because the EU is comprised of elements from other waste management units including Waste Management Area T (WMA T) that includes the 241-T (or T) Tank Farm. The Tank Farm contains 16 waste tanks (T-101 through T-112 and T-201 through T-204). These tanks often are designated as 241-T-101 through 241-T-112 and 241-T-201 through 241-T-204 or 241-T-TK-101 through 241-T-TK-112 and 241-T-TK-201 through 241-T-TK-204. Other components in the EU (including associated legacy waste sites) are listed below in the *Primary EU Source Components* section.

KEY WORDS:

T Tank Farm, 241-T Tank Farm, waste tanks, tank farm, Waste Management Area T, WMA T

REGULATORY STATUS

Regulatory Basis

DOE is the responsible agency for the closure of all single-shell tank (SST) waste management areas (WMAs) through post closure, in close coordination with other closure and cleanup activities of the Hanford Central Plateau. Washington State has a program that is authorized under RCRA and implemented through the HWMA and its associated regulations; Ecology is the lead regulatory agency responsible for the closure of the SST system. Please refer to Section 1.2 (Appendix E.1) for more information.

Applicable Regulatory Documentation

The relationship among the tank waste retrieval work plans (TWRWP) and the overall single-shell tank (SST) waste retrieval and closure process is described in Appendix I of the Hanford Federal Facility Agreement and Consent Order (HFFACO), along with requirements for the content of TWRWPs. In 1993 WMA T was placed in assessment monitoring because of elevated specific conductance, which is a RCRA indicator parameter, in a downgradient well (Horton 2006). A groundwater quality assessment plan was written (Caggiano & Chou 1993; Hodges & Chou 2001) describing the monitoring activities used in deciding whether WMA T has affected groundwater.

Applicable Consent Decree or TPA Milestones

Federal Facility Agreement and Consent Order, 1989 and amended through June 16, 2014: Milestone M-045-00; Lead Agency Ecology: *Complete the closure of all Single Shell Tank Farms by 01/31/2043*

RISK REVIEW EVALUATION INFORMATION

Completed: Revised August 25, 2015

Evaluated by: K. G. Brown

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

2.3. SUMMARY DESCRIPTION

CURRENT LAND USE

DOE Hanford Site for industrial use. All current land-use activities in the 200-West 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-West Area (of which T Tank and Waste Farms EU is a part) 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: The legacy source sites associated with the T Tank and Waste Farms EU are described in Attachment Section 2.8. To summarize, historic liquid waste disposal practices as well as leaks and unplanned release has resulted in contamination near the T Tank Farm (Horton 2006, p. 2.2-

2.3) including cribs: 216-T-7 (110×10^6 L of waste), 216-T-32 (29×10^6 L of waste), 216-T-36 (0.5×10^6 L of waste), and 216-T-5 (2.6×10^6 L of waste); specific retention trenches: 216-T-14 through 216-T-17 (0.8-1×10^6 L of waste each); and unplanned releases of which there were nine in or near WMA T. Seven of the SSTs in WMA T are "assumed leakers" with leaks estimates ranging from <1,000 gallons (T-103, T-108, and T-109) to 115,000 gallons (T-106 in 1973) (Weyns 2014, pp. 18-22). Additional details are provided In Section 2.4.

High-Level Waste Tanks and Ancillary Equipment: The 16 waste tanks in the T Tank and Waste Farms EU are:

- (241-)T-101 (241-T-TK-101)
- (241-)T-102 (241-T-TK-102)
- (241-)T-103 (241-T-TK-103)
- (241-)T-104 (241-T-TK-104)
- (241-)T-105 (241-T-TK-105)
- (241-)T-106 (241-T-TK-106)
- (241-)T-107 (241-T-TK-107)
- (241-)T-108 (241-T-TK-108)
- (241-)T-109 (241-T-TK-109)
- (241-)T-110 (241-T-TK-110)
- (241-)T-111 (241-T-TK-111)
- (241-)T-112 (241-T-TK-112)
- (241-)T-201 (241-T-TK-201)
- (241-)T-202 (241-T-TK-202)
- (241-)T-203 (241-T-TK-203)
- (241-)T-204 (241-T-TK-204)

The ancillary equipment included in the T Tank and Waste Farms EU is listed in Attachment Section 2.8 and consists primarily of pipelines, diversion boxes, and catch tanks.

Groundwater Plumes:

The T Tank and Waste Farms EU is associated with the 200-ZP-1 Operable Unit (OU). The current 200-ZP-1 Operable Unit (OU) plumes associated with the T Tank and Waste Farms EU sources that exceed water quality standards are chromium (assumed hexavalent chromium), I-129, Tc-99, and tritium (DOE/RL-2014-32, Rev. 0). Uranium is not a contaminant of concern in the 200-ZP OU; however, it is extracted from wells in the 200-UP OU. There are other contaminants of concern (i.e., carbon tetrachloride, nitrate, and TCE) associated with the 200-ZP-1 OU that exceed final cleanup levels (EPA 2008); however, these contaminants do not result from sources associated with the T Tank and Waste Farms EU. Only the nitrate plume is not contained within the current footprint of the carbon tetrachloride plume. An interim pump-and-treat (P&T) system was operated in 200-ZP-1 from 1996 until 2012 when the final P&T system came on line (EPA 2008) to reduce the mass of carbon tetrachloride (as well as secondary contaminants TCE and chloroform) in the groundwater. Soil vapor extraction has also been used to reduce the vadose zone source of carbon tetrachloride.

See Appendix G.6 (CP-GW-2 EU) for additional details.

Operating Facilities: Because of the prohibition on waste additions to the Hanford SSTs,[23] the T Tank and Waste Farms EU components are not considered Operating Facilities for this Review. See Section 1.4 (Appendix E.1) for details.

D&D of Inactive Facilities: Not Applicable.

Location and Layout Maps

A series of maps are used to illustrate the location of the components within the CP-TF-1 EU and the T Tank and Waste Farms EU relative to the Hanford Site. Figure E.2-1 shows the relationship between the

[23] Berman presentation on July 29, 2009, titled "Hanford Single-Shell Tank Integrity Program." Available at www.em.doe.gov.

200-W (200 West) Area (where the T Tank Farm and Waste management Area T are located) and the Hanford Site. Figure E.2-2 illustrates the T Tank and Waste Farms EU boundary. Figure E.2-3 shows a detailed view of the waste tanks, ancillary equipment, and legacy source units in the T Tank and Waste Farms EU.

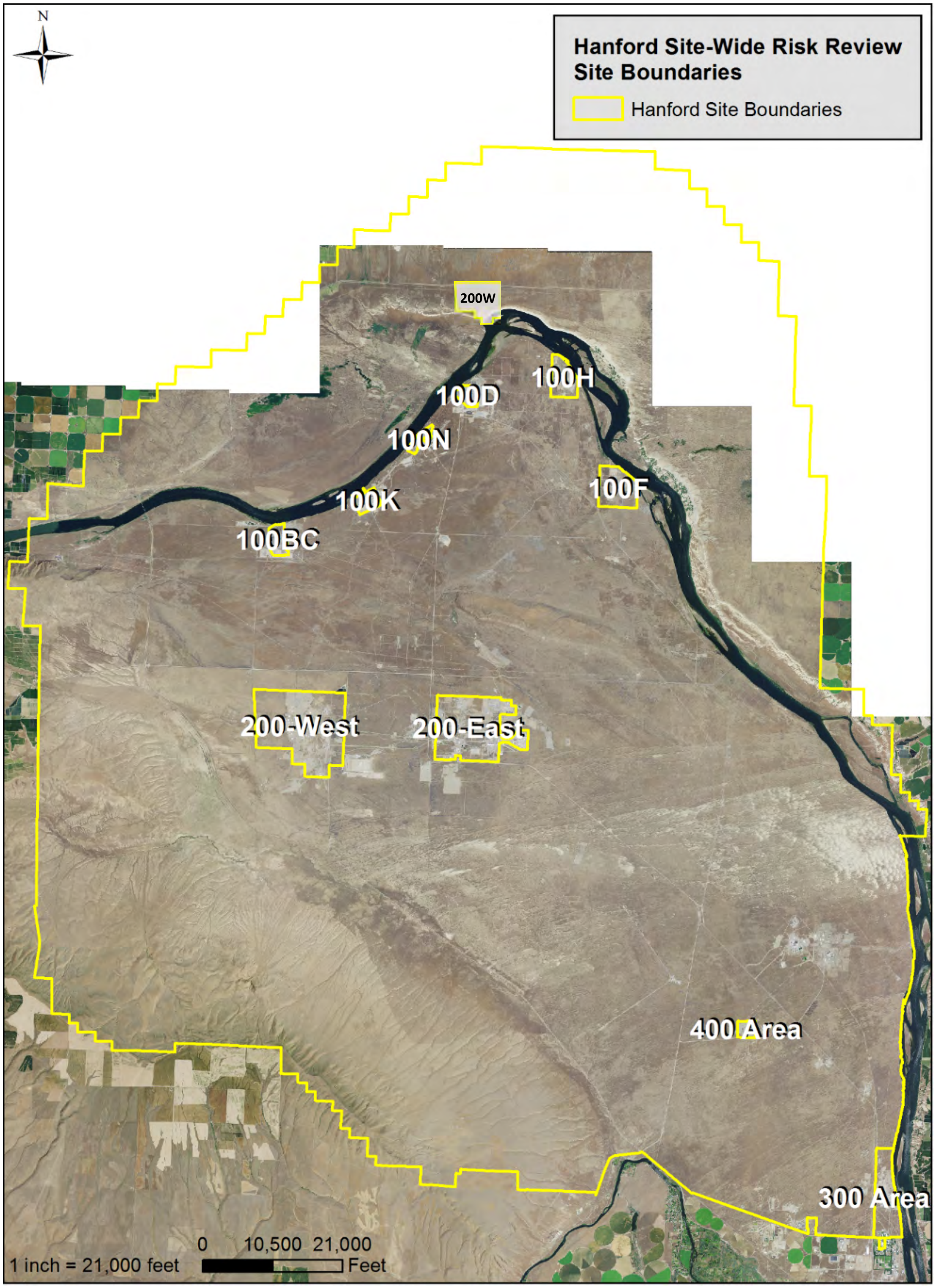
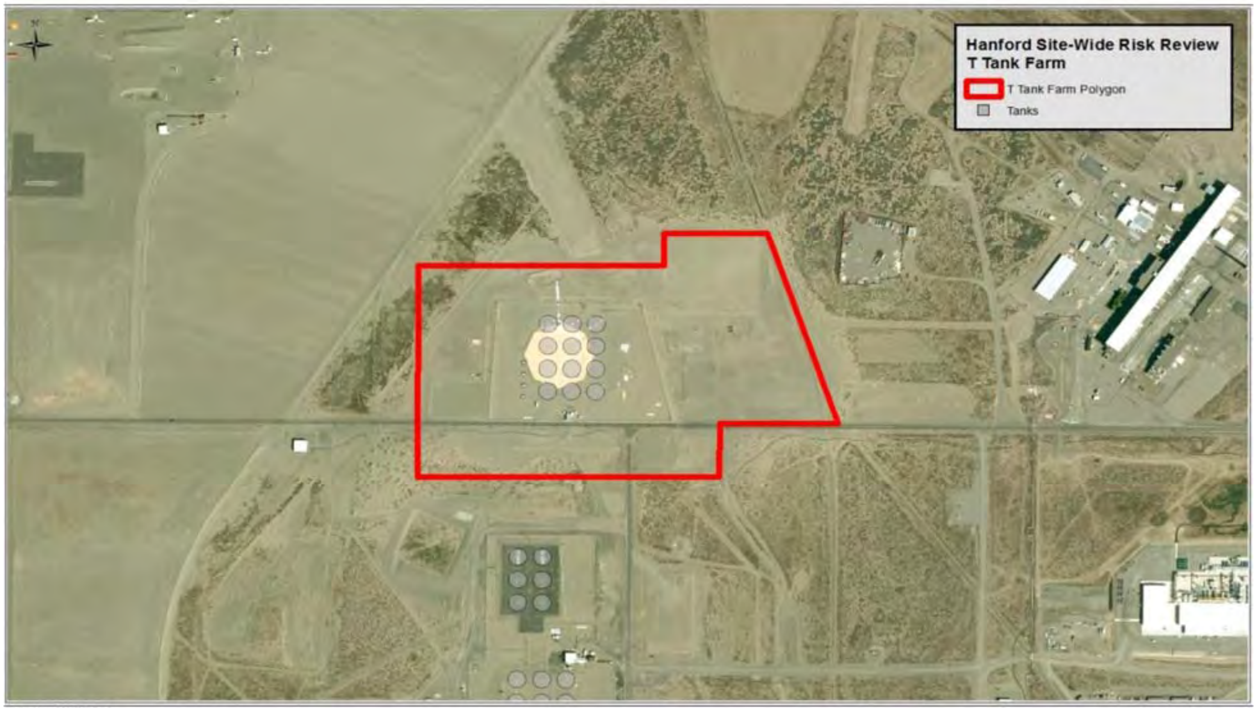
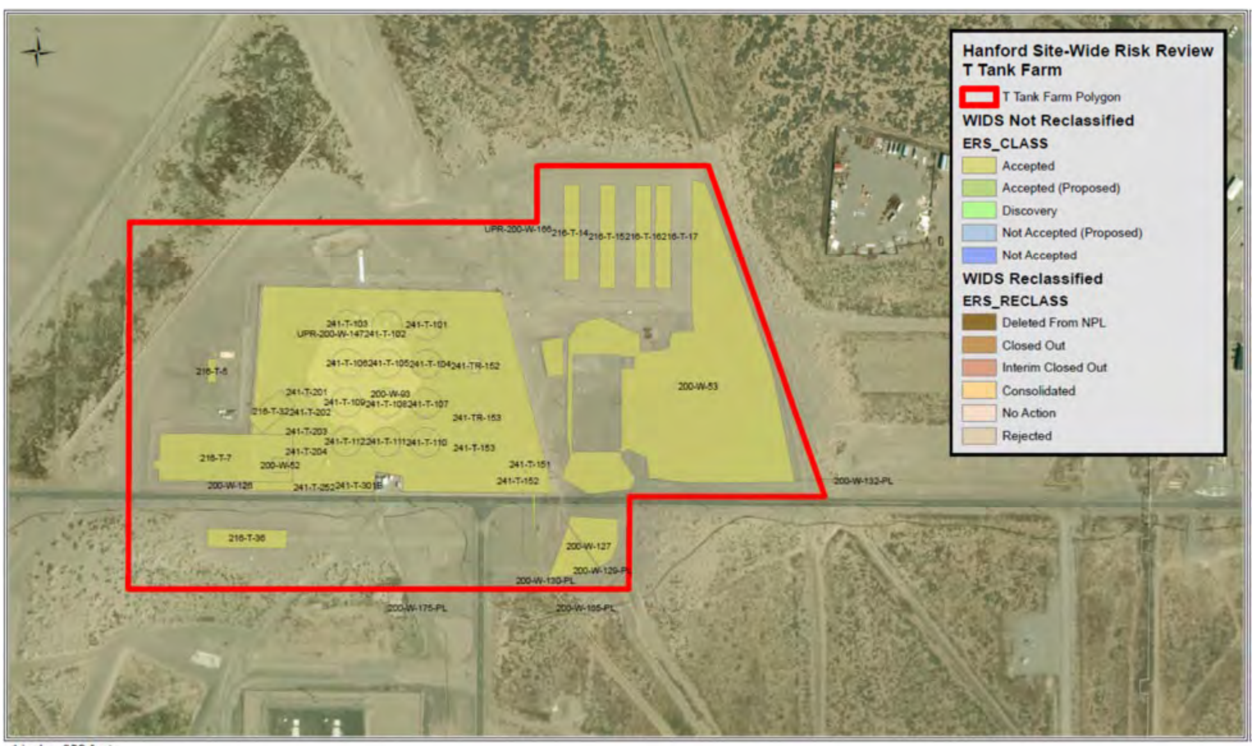


Figure E.2-1. Hanford Site Boundary showing 200-W Area. The T Tank Farm and Waste Management Area T (WMA T) are located in the 200-W Area (http://phoenix.pnnl.gov/).



1 inch = 500 feet

Figure E.2-2. Polygon representing the boundary of the T Tank and Waste Farms Evaluation Unit (see Attachment Section 2.8).



1 inch = 300 feet

Figure E.2-3. Hanford T Tank and Waste Farms Evaluation Unit including tanks, legacy source units, and ancillary equipment (see Attachment Section 2.8).

2.4. UNIT DESCRIPTION AND HISTORY

EU Former / Current Uses

Waste Management Area T (WMA T) occupies approximately 32,000 m^2 (7.9 acres) and contains 16 underground single-shell tanks (SSTs) constructed in 1943 and 1944 (Horton 2006, p. 2.1) that constitute the T Tank Farm. The Tank Farm contains 12 carbon steel tanks with capacities of 2×10^6 liters (530 kGal) and four smaller carbon steel tanks with capacities of 2×10^5 liters (55 kGal) in additional to ancillary equipment (e.g., diversion boxes, pumps, valves, and pipes). The SSTs in WMA T began receiving waste in 1944 and were in use until 1980 when the tanks were removed from service. The tanks received primarily high-level metal and first cycle waste from chemical processing (bismuth phosphate process) of uranium-bearing spent fuel rods. When there was a shortage of tank capacity, supernatant from tanks was sent to cribs. Waste management operations created a complex intermingling of tank wastes; natural processes resulted in settling, stratification, and segregation of waste components. Initial corrective actions (including berms, ditches, water line testing and sealing, and a partial cover) have been implemented at WMA T (Horton 2006, p. 2.2; Zhang, et al. 2009). The SSTs in WMA T have been interim stabilized (i.e., liquid transferred to DSTs to <50 kgal drainable interstitial liquid and <5 kgal of supernatant). The T Tank Farm tanks are currently awaiting retrieval and closure.

Legacy Source Sites

The contamination in the legacy source sites (cribs, trenches, and near-tank soil contaminated by past tank leaks and unplanned releases) associated with the T Tank and Waste Farms EU comes from intentional and unintentional discharges of T Tank Farm wastes (Horton 2006, p. 2.2-2.3):

- The 216-T-7 crib operated from 1948-1955 and received 110×10^6 L of second-cycle, T-Plant cell drainage waste, and plutonium concentrator waste.
- The 216-T-32 crib operated from 1946-1952 and received 29×10^6 L of waste from the 224-T building by way of the 241-T-201 single-shell tank.
- The 216-T-14 through 216-T-17 specific retention trenches each received 785,000 to 1×10^6 L of first-cycle waste in 1954.
- The 216-T-36 crib southwest of the T Tank Farm received about 522,000 L of decontamination waste and condensate in 1967-68.
- The 216-T-5 crib, located just west of the T Tank Farm, received about 2.6×10^6 L of second cycle waste in 1955.
- Seven of the SSTs in WMA T are declared "assumed leakers" [24] with leaks estimates ranging from < 1,000 gallons (T-103, T-108, and T-109 in 1973) to 115,000 gallons (T-106 in 1973) (Weyns 2014, pp. 18-22).
- Nine unplanned releases (UPRs) have been documented in or near WMA T.

High-Level Waste Tanks

See Section 2.3 for details.

[24] Tanks that are either known or suspected of leaking at any time (including the present) are denoted "assumed leakers" (Weyns 2014).

GROUNDWATER PLUMES

The 200-ZP-1 OU groundwater plumes (Tc-99, I-129, chromium, and H-3) considered to be associated with the T Tank Farm and co-located liquid waste disposal facilities are described in Section 2.5 with detailed information in Appendix G.6 for the CP-GW-2 EU (200-ZP-1 OU). Note that no source inventory was provided for TCE (not a tank waste); the TCE plume near the T Tank and Waste Farms EU is not associated with the T Tank and Waste Farms EU legacy sites (DOE/RL-2014-32, Rev. 0).

D&D OF INACTIVE FACILITIES – NOT APPLICABLE

OPERATING FACILITIES – NOT APPLICABLE

Because of the prohibition on waste additions to the Hanford SSTs,[25] the T Tank and Waste Farms EU components are not considered Operating Facilities for this Review.

ECOLOGICAL RESOURCES SETTING

Landscape Evaluation and Resource Classification:

The amount and proximity of biological resources to the T Tank and Waste Farms EU was examined within the adjacent landscape buffer area radiating 574 m from the geometric center of the EU (equivalent to 256 acres). Approximately 44% of the adjacent landscape buffer area is classified as level 0 biological resources in the existing resource map (Appendix J, Table 2, p. J-57 and Figure 8, p. J-58). The nearest level 3 resources within the buffer area are located south of the evaluation site (individual occurrences of sensitive plant species) and north and northeast of the evaluation site (Appendix J, Figure 8). Review of historical ECAP data indicates the areas north and northwest of the EU contained shrub-steppe with a native climax big sagebrush (*Artemisia tridentata*) overstory with cheatgrass (*Bromus tectorum*) co-dominant in the understory with native bunchgrasses. These habitats have been degraded over the past 5 years with blowing sand and invasion by Russian thistle (*Salsola tragus*). No level 4 or 5 resources are present within the T Tank Farm adjacent landscape buffer.

Field Survey:

Approximately 90% of the T Tank and Waste Farms EU consists of graveled surfaces and paved areas. No vegetation measurements were taken in the areas adjacent to the actual tank farm. The existing resource level map indicates the presence of level 3 resources in the southwest corner of the EU to the south of the paved road associated with a point occurrence of a sensitive species (*Erigeron piperianus*) that has been observed at this location in past ECAP surveys but was not observed in 2010. No wildlife was observed in the area during a vehicle reconnaissance of the boundary, and in 2010, a previous PNNL ECAP survey of the habitat surrounding the tank farm noted only coyote (*Canis latrans*) tracks in the habitat to the west and northwest of the tank farm.

CULTURAL RESOURCES SETTING

Cultural resources known to be recorded within the T Tank and Waste Farms EU are limited to the National Register-eligible 241T Tank Farm associated with the Manhattan Project and Cold War Era Historic District, with documentation required. All National-Register-eligible Manhattan Project and Cold War Era buildings have been documented as described in the *Hanford Site Manhattan Project and Cold War Era Historic District Treatment Plan* (DOE/RL-97-56). Additionally, the non-

[25] Berman presentation on July 29, 2009, titled "Hanford Single-Shell Tank Integrity Program." Available at www.em.doe.gov.

contributing/ineligible portion of the National Register-eligible White Bluffs Trail/Road which is associated with both the Native American Precontact and Ethnographic and the Pre-Hanford Early Settlers/Farming Landscapes, passes through the T Tank and Waste Farms EU.

None of the T Tank and Waste Farms EU has been inventoried for archaeological resources and closure and remediation of the tank farms located within the T Tank and Waste Farms EU have been addressed in an NHPA Section 106 review. There is a possibility that intact archaeological material is present in the T Tank and Waste Farms EU because it has not have not been inventoried for archaeological resources (both on the surface and in the subsurface) and particularly if undisturbed soil deposits exist within the T Tank and Waste Farms EU. Given the extensive disturbance this is unlikely. The National Register-eligible Hanford Site Plant Railroad, associated with the Manhattan Project/Cold War era Historic District with documentation required is the closest recorded cultural resource located within 500 meters of the T Tank and Waste Farms EU. All National-Register-eligible Manhattan Project and Cold War Era buildings been documented as described in the *Hanford Site Manhattan Project and Cold War Era Historic District Treatment Plan* (DOE/RL-97-56).

Despite no physical evidence of an historic/ethnohistoric trail/road within the T Tank and Waste Farms EU, historic maps reveal that this trail existed prior to excavation for the T Tank Farm. Given the extensive ground disturbance within the entire EU and the geomorphology in the area, overall the potential for the presence of intact archaeological resources to be present subsurface within the T Tank and Waste Farms EU is unlikely.

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 associated with these landscapes (e.g., East Benton Historical Society, the Franklin County Historical Society, the Prosser Cemetery Association, the Reach and B-Reactor Museum Association) may need to occur. Indirect effects are always possible when TCPs are known to be located in the general vicinity. Consultation with Hanford Tribes may also 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.

2.5. WASTE AND CONTAMINATION INVENTORY

Table E.2-2 provides inventory estimates of the various source components associated with the T Tank and Waste Farms EU including tank wastes and ancillary equipment, legacy sources including leaks, cribs, trenches, unplanned releases (UPRs), vadose zone sources, saturated zone (plume) estimates, treatment amounts, and remaining vadose zone estimates (i.e., the difference of the vadose zone estimates and the saturated zone and treatment estimates)[26]. This information is further summarized in Figure E.2-4 through Figure E.2-12 before and after planned 99% retrieval[27].

For example, the major sources for Tc-99 and I-129 in the EU before retrieval are the T Tank Farm tanks and leaks from these tanks. The maximum groundwater threat metric (GTM) (Figure E.2-13)[28] is dominated by the T Tank Farm wastes before retrieval and by leaks after planned retrieval. The tritium

[26] The basis for the saturated and vadose zone estimates are provided in Chapter 6 of the Methodology Report (CRESP 2015) and examples are provided in the demonstration section for the 200-UP-1 Operable Unit. These estimates tend to have very high associated uncertainties.

[27] According to the Tri-Party Agreement (Ecology, EPA, and DOE, 1998), retrieval limits for residual wastes are 360 ft^3 and 30 ft^3 for 100-Series and 200-Series tanks, respectively, corresponding to the 99% waste retrieval goal as defined in TPA Milestone M-45-00.

[28] Maximum of the GTMs for Tc-99 and I-129 only.

inventory, both pre- and post-retrieval, is dominated by leaks and trenches. After planned retrieval, leaks dominate the T Tank and Waste Farms EU sources for Tc-99 and I-129. For chromium and nitrate, cribs and trenches and the T Tank Farm tanks are major sources before retrieval. After retrieval, the cribs and trenches dominate the source of these PCs. Current uranium, Sr-90, Cs-137, and plutonium isotope inventories tend to be dominated by the tank wastes; the post-retrieval inventories tend to be dominated by legacy sources in the vadose zone.

CONTAMINATION WITHIN PRIMARY EU SOURCE COMPONENTS

Legacy Source Sites

The estimated T Tank Farm inventory for the Legacy / Vadose Zone Source Sites (i.e., cribs, trenches, and soil contaminated by tank leaks and unplanned releases) is summarized in Table E.2-2 and further described in Figure E.2-4 through Figure E.2-12 before and after planned 99% retrieval (which will have no impact on the current legacy source site inventories). These values constitute estimates of the initial amounts of contaminants discharged to the vadose zone that are then used to estimate the remaining inventory in the vadose zone as described below (i.e., by difference using the process described in Chapter 6 of the Methodology Report (CRESP 2015)). These estimates necessarily have large associated uncertainties.

Waste Tanks and Ancillary Equipment

The estimated total inventory for all the T TF EU waste tanks and Ancillary Equipment is provided in Table E.2-2 for both the 90% and planned 99% retrieval scenarios. The tank-by-tank inventories are provided in Table E.2-3 through Table E.2-6. Safety-related information (i.e., hydrogen generation rates and times to the lower flammability limit are also provided in Table E.2-3. The inventories for the various contaminant in the T Tank Farm tanks vary over several orders of magnitude as does the GTM. This information is further summarized in Figure E.2-4 through Figure E.2-12 before and after planned 99% retrieval and for the maximum GTM (I-129 and Tc-99) in Figure E.2-13.

Vadose Zone Contamination

The estimated inventories for the vadose zone, saturated zone, and treatment amounts are found in Table E.2-7. These inventories represent the vadose zone contamination *outside* the tanks and ancillary equipment (i.e., that are generally available for transport through the environment). These inventories are used to estimate the inventory remaining in the vadose zone using the process described in Chapter 6 of the Methodology Report (CRESP 2015). The focus in this section will be on the Group A and B contaminants in the vadose zone due to their mobility and persistence in the environment and potential threats to groundwater. To summarize:

- *Tc-99, I-129* – There are existing Tc-99 and I-129 plumes in groundwater (200-ZP-1 GW OU) that are associated with T Tank and Waste Farms EU sources. For example, Tc-99 (and assuming I-129) contamination in groundwater resulted from past leaks in SSTs and pipelines in WMA T and WMA TX-TY (DOE/RL-2014-32, Rev. 0). The vadose zone inventory is dominated by past leaks.
- *Sr-90* – There is not currently a Sr-90 plume. The vadose zone inventory is dominated by past tank leaks. Thus the majority of the Sr-90 originally discharged into the vadose zone would have had to travel through much of the vadose zone to impact groundwater. The TC&WM EIS screening groundwater transport analysis (Appendix O, DOE/EIS-0391 2012) indicates that Sr-90 (albeit from sources in addition to those in the T TF EU) is not expected to reach the T Barrier (i.e., less than 1×10^{-8} Ci/yr within the 10,000-year TC&WM EIS evaluation period (Appendix O,

DOE/EIS-0391 2012, p. O-2))[29], which is interpreted here to indicate that Sr-90 is not very mobile in the vadose zone near the T Tank and Waste Farms EU. Furthermore, the average water travel time through the vadose zone for a recharge rate of 100 mm/yr is 64 years for the 200-West Area (Table N-52, DOE/EIS-0391 2012), and thus the resulting average Sr-90 travel time accounting for retardation would be more than 300 years (i.e., 64 yr × 5 or 10+ half-lives leaving less than 0.10%) to move through the vadose zone[30]. It would likely require significantly more than 150 years to reach groundwater in a sufficient amount to exceed the drinking water standard over an appreciable area. Thus a Sr-90 plume is not expected in the next 150 years due to retardation in the vadose zone or after due to radioactive decay (+99.9% reduction in Sr-90 inventory). Thus Sr-90 is not considered a significant threat to the Hanford groundwater.

- *Chromium* – There is currently a chromium plume that is associated with T Tank and Waste Farms EU sources (i.e., from past leaks from WMA T and WMA TX-TY SSTs (DOE/RL-2014-32, Rev. 0)). However, the T TF EU vadose zone inventory is dominated by past discharges to cribs.
- *Uranium* – Uranium has been measured in the 200-ZP groundwater interest area, but not exceeding the standard (i.e., there is no current plume). The vadose zone inventory is fairly equally divided among past leaks and discharges to trenches and cribs. Thus at least part of the uranium originally discharged into the vadose may have been driven deeper into the vadose zone (i.e., associated with high volume discharges) and may have less of the vadose zone to travel through until potentially impacting groundwater. The TC&WM EIS groundwater transport analysis (Appendix O, DOE/EIS-0391 2012) indicates that uranium is not expected to reach the T Barrier (i.e., less than 1×10^{-8} g/yr within the 10,000-year TC&WM EIS evaluation period (Appendix O, DOE/EIS-0391 2012, p. O-2)). Furthermore, the average water travel time through the vadose zone for a recharge rate of 100 mm/yr is 64 years for the 200-West Area (Table N-52, DOE/EIS-0391 2012), or the uranium travel time might be more than 100 years (i.e., 64 yr × 1.7) for an appreciable amount of uranium to move through the vadose zone[31]. It would likely require significantly more than 100 years (from the original discharge) to reach groundwater in a sufficient amount to exceed the drinking water standard over an appreciable area. Thus an appreciable uranium plume would not be expected in the next 150 years but perhaps during the 1,000-year period after cleanup. Thus total uranium is not considered a significant threat to the Hanford groundwater during the Active Cleanup or Near-term, Post Cleanup periods.

Using the process outlined in Chapter 6 of the Methodology Report (CRESP 2015), the vadose zone inventories in Table E.2-2 are estimated by difference and used to calculate Groundwater Threat Metric (GTM) values for the Group A and B contaminants remaining in the vadose zone as illustrated in Table E.2-7. The resulting vadose zone (VZ) ratings for threats to groundwater are *ND* for uranium and Sr-90[32],

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[29] The 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). The T Barrier is the closest to the T Tank and Waste Farms EU. Despite including sources other than those for the T Tank and Waste Farms EU, the analysis in the TC&WM EIS was considered reasonable to assess the rate of movement of contaminants to groundwater through the vadose zone.

[30] The minimum best-estimate K_d for Sr-90 for WMAs T and TX-TY is 1 mL/g (PNNL-17154, p. 3.87), which translates to a retardation factor of ~4.6.

[31] The minimum best-estimate K_d for uranium for WMAs T and TX-TY is 0.2 mL/g (PNNL-17154, p. 3.87), which translates to a retardation factor of ~1.7.

[32] The remaining vadose zone inventories for uranium and Sr-90 would translate to *Low* and *Very High* ratings, respectively. However, no appreciable Sr-90 or uranium plume would be expected in the next 150 years due to transport considerations; however, uranium may impact groundwater after the 150-year period. Thus *Low* ratings are applied to the period after Active Cleanup is completed to account for uncertainties.

Medium for the mobile Tc-99 and I-129 (where significant amounts of these contaminants are already in the saturated zone near the T Tank and Waste Farms EU), and *High* for chromium (total and hexavalent). The overall rating for current conditions would be *High* related to the remaining chromium (total and hexavalent) in the vadose zone.

Groundwater Plumes

In general groundwater plumes are evaluated in separate EUs; however, those portions of groundwater plumes that can be associated with the TF EU (i.e., a plume with sources associated with the TF EU) will be evaluated to provide a better idea of the saturated zone versus remaining vadose zone threats to groundwater. The estimated inventory for the saturated zone contamination is provided in Table E.2-2 where Photoshop was used to estimate the fraction of the plumes considered associated with the T Tank and Waste Farms EU (Attachment 6-4 in the Methodology Report (CRESP 2015)[33]). This information is also used to estimate amounts treated and remaining in the vadose zone. For the groundwater plumes described in the 200-ZP-1 OU (DOE/RL-2014-32, Rev. 0), apportionment of plumes and ratings to the T Tank and Waste Farms EU would be as follows:

- *Carbon tetrachloride and TCE* – There are plumes for both carbon tetrachloride and TCE in the OU, but no major sources related to the waste tanks; thus no portion of these plumes are considered associated with the T Tank and Waste Farms EU. The corresponding ratings would be ND.
- *Chromium* – There are plumes in the OU (assumed to be hexavalent chromium); the single plume near the T Tank and Waste Farms EU is considered associated with the T Tank and Waste Farms EU and the area of this plume is 92% of the area of the chromium plumes (CRESP 2015). The area is assumed to describe both the total chromium and hexavalent chromium contaminants.
- *I-129* – There are plumes in the OU; the single plume near the T Tank and Waste Farms EU is considered associated with the T Tank and Waste Farms EU, and the area of this plume is 59% of the area of the plumes (CRESP 2015).
- *Nitrate* – It is difficult to distinguish areas related to the various sources. Based on information in the Annual Groundwater Report (DOE/RL-2014-32, Rev. 0), the major source of nitrate is from liquid waste disposal from Plutonium Finishing Plant (PFP) processes to the cribs near WMA T and the 216-Z Cribs and Trenches. Thus the nitrate contribution from the T Tank and Waste Farms EU is assumed not significant and the plume is assumed to not be associated with the T TF EU.
- *Tc-99* – There are plumes in the OU; the single plume near the T Tank and Waste Farms EU is considered associated with the T Tank and Waste Farms EU, and the area of this plume is 70% of the area of the plumes (CRESP 2015).
- *H-3* – There are plumes in the OU; the single plume near the T Tank and Waste Farms EU is considered associated with the T Tank and Waste Farms EU, and the area of this plume is 33% of the area of the plumes (CRESP 2015).

The groundwater plumes (e.g., Tc-99, I-129, chromium, and H-3) associated with the T TF EU and co-located liquid waste disposal facilities are described in detail in Appendix G.6 for the 200-ZP-1 GW OU

[33] From the graphic map files provided by PNNL, the PhotoShop Magic Wand Tool was used to select areas representing plumes and then the “Record Measurements” Tool was used to provide relative areal extents (CRESP 2015). A Custom Measurement Scale was set to that of the map.

within the CP-GW-2 EU. Note that carbon tetrachloride (*Very High*), nitrate (*Medium*), and TCE (*Medium*) are the risk drivers for the 200-ZP-1 GW OU; however, there are no T TF EU sources associated with these plumes, and the remaining vadose zone sources would drive the risks associated with the T TF EU.

Impact of Recharge Rate and Radioactive Decay on Groundwater Ratings

The TC&WM EIS screening groundwater transport analysis (Appendix O, DOE/EIS-0391 2012) indicates that there is little impact of emplacing an engineered surface barrier (and resulting reduction of infiltrating water) on the predicted peak groundwater concentrations (relative to thresholds) at the T Barrier[34]. This result is likely due to the significant amounts of contaminants already in the groundwater and not due to an ineffective surface barrier. To summarize, the screening groundwater results at the T Barrier (Appendix O, DOE/EIS-0391 2012) include:

- Tc-99 peak concentration is 6,480 pCi/L (CY 2050) for the No Action Alternative versus 6,600 pCi/L (CY 2051) for Landfill Closure where the threshold value is 900 pCi/L.
- I-129 peak concentration is 26.1 pCi/L (CY 4560) for the No Action Alternative versus 12.6 pCi/L (CY 2050) for Landfill Closure where the threshold value of 1 pCi/L.
- Chromium peak concentration is 336 µg/L (CY 2036) for the No Action Alternative versus 353 µg/L (CY 2045) for Landfill Closure where the threshold value is 100 µg/L (total) or 48 µg/L (hexavalent).
- No values are reported at the T Barrier for uranium or Sr-90 for either scenario, which indicates that predicted peak fluxes that were less than 1×10^{-8} Ci/yr for Sr-90 or 1×10^{-8} g/yr for uranium (Appendix O, DOE/EIS-0391 2012, p. O-2).

Since the predicted peak concentrations are predicted to remain above thresholds for Tc-99, I-129, and chromium even after surface barrier emplacement, it is decided to not alter the T Tank and Waste Farms EU ratings related to groundwater based on different recharge rate scenarios. This effect is likely not due to an ineffective surface barrier but instead the amount of these contaminants already in the groundwater and possible contributions of sources outside the T Tank and Waste Farms EU (used in the TC&WM EIS analysis[35]).

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.

Benthic and Riparian Zone – Current Impacts

Based on the information in the 2013 Hanford Annual Groundwater Report (DOE/RL-2014-32, Rev. 0) and PHOENIX (http://phoenix.pnnl.gov/), even though 200-ZP-1 Operable Unit (OU) contaminants are in

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[34] The 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). The T Barrier is the closest to the T Tank and Waste Farms EU. Despite including sources other than those for the T Tank and Waste Farms EU, the analysis in the TC&WM EIS was considered a reasonable source of information to assess the potential impact of the engineered surface barrier emplacement.

[35] Analyses specific to each Tank Farm or Central Plateau EU are not available; thus the aggregate screening analysis provided in the TC&WM EIS was used as an indication.

the saturated zone, no plumes from the 200-ZP-1 OU (and thus associated with the T Tank and Waste Farms EU) are currently intersecting the Columbia River at concentrations exceeding the WQS. Thus *current* impacts from the T Tank and Waste Farms EU to the Columbia River benthic and riparian zone ecology are rated as *Not Discernible*.

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

Because the 200-ZP-1 GW OU plumes originate from 200-West, it is unlikely that a current or future plume would reach the Columbia River in the next 150 years (at concentrations sufficient to exceed thresholds) since the water travel time is greater than 50 years (and likely significantly more) from 200-West to 200-East and ~10-30 years from 200-East to the Columbia River (Gephart 2003; PNNL-6415 Rev. 18). It is also likely that significantly more time would likely be required to reach the Columbia River in sufficient quantity to exceed the WQS or appropriate aquatic screening values[36]. Any contaminants *predicted* to impact the Columbia River in sufficient amounts from the Central Plateau (e.g., as described in Appendix P in the TC&WM EIS (DOE/EIS-0391 2012)) would thus likely come from 200-East sources[37] and not the 200-ZP-1 OU or those related to the T Tank and Waste Farms EU.

Thus the impacts to the Columbia River benthic and riparian ecology for the Active Cleanup and Near-term, Post Cleanup periods are also rated as *Not Discernible*.

Benthic and Riparian Zone – Long-term

An ecological screening analysis was performed in the TC&WM EIS (Appendix P, DOE/EIS-0391 2012) to evaluate potential long-term impacts of radioactive and chemical contaminants (*under a No Action Alternative for sources including but not limited to those associated with the T Tank and Waste Farms EU*[38]) discharged with groundwater on aquatic and riparian receptors at the Columbia River. The screening results 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[39]) (DOE/EIS-0391 2012, Appendix P, p. P-52), indicating there should be no expected adverse effects (and *Not Discernible* ratings) from radionuclides from Central Plateau sources for Columbia River benthic and riparian receptors over the time period evaluated (10,000 years).

The corresponding (No Action) evaluation in the TC&WM EIS for potential long-term impacts of chemical contaminants discharged with groundwater to the near-river ecology (benthic and riparian) indicate that chromium and nitrate would have expected Hazard Quotients exceeding unity for aquatic and riparian receptors over the evaluation period in the TC&WM EIS. The results of the screening evaluation at the

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[36] Based on current and expected subsurface conditions, the only path currently considered from 200-West to the Columbia River is that from 200-West to 200-East to the Columbia River (Chapter 6, Methodology Report).

[37] Note that TC&WM EIS predictions indicate possible impacts from chromium to the benthic and riparian zones within the next decade; however, actual well measurements for chromium and other contaminants show no likely impacts in the foreseeable future from 200-West or 200-East sources, including the next 150 years. Note there was a path north from 200-West to the Columbia River that is no longer considered reasonable due to changing hydrologic patterns across the Hanford Site.

[38] Despite including sources other than those for the T Tank and Waste Farms EU, the analysis in the TC&WM EIS was considered a reasonable and consistent information source to assess the potential for potential impacts of contaminants on the benthic and riparian zones. However, because the sources are not limited to the Tank and Waste Farms EUs, the evaluation is not restricted to just the T Tank and Waste Farms EUs sources but instead those for many Central Plateau sources, including other Tank and Waste Farms EUs. Furthermore, the results are divided by the 200-West and 200-East areas based on differences in travel times of water and contaminants to the Columbia River.

[39] The standard also indicates the screening values were used for riparian receptors.

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 future concentrations would appear to not exceed either the drinking water standard or ambient water quality criterion in the next 10,000 years, resulting in a *Not Discernible* rating. Furthermore, the potential impact of increased nitrate levels may depend on other factors (e.g., phosphorus) and is highly uncertain.

The TC&WM EIS results of the screening evaluation at the near-shore region under the No Action Alternative (DOE/EIS-0391 2012, Appendix O) indicate that the concentration could exceed the drinking water standard for total chromium (100 µg/L) and the EIS benchmark threshold[40] (as well as the ambient water quality criterion of 10 µg/L) for hexavalent chromium. The predicted concentrations are likely overestimated since all discharge is assumed to occur in a 40-m near-shore region. Furthermore, because of the long travel time of water from 200-West (200-ZP-1 OU) to 200-East (then to the Columbia River) relative to that from 200-East to the Columbia River, it is likely that the 200-West sources provide an insignificant contribution of the chromium predicted to reach the Columbia River exceeding screening values (unless this was assumed to occur via the now defunct northern path from 200-West to the Columbia River), which would likely lead to insignificant impacts (and *Not Discernible* ratings) to the benthic and riparian ecology from 200-West sources, including those associated with the T Tank Farm EU.

Threats to the Columbia River Free-flowing Ecology

The threat determination process for the free-flowing River ecology was evaluated in a manner similar to that described above for benthic receptors (Chapter 6, Methodology Report (CRESP 2015)). However, because of the large dilution effect of the Columbia River on the contamination from the seeps and groundwater upwellings[41], the differences from EU to EU were not found distinguishing and the potential for groundwater contaminant discharges from Hanford to achieve concentrations above relevant thresholds is very remote. Thus 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 No Action Alternative evaluation in the TC&WM EIS suggests that remedial actions (e.g., surface barrier emplacement that would decrease recharge in the areas near the Tank Farms) would appear to not have significant impacts on the long-term peak concentrations in the near-shore area (benthic and riparian receptors) of the Columbia River. Again this result is likely not due to ineffectiveness of the barrier but instead due to large amounts of contaminants already in the groundwater. Thus ratings are not changed based on the remedial actions assumed in the TC&WM EIS.

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[40] The benchmark value used for chromium (hexavalent) in the TC&WM EIS was the sensitive-species-test-effect concentration that affects 20 percent of a test population (EC_{20}) despite the fact that the less toxic trivalent form of chromium is more like to be present in oxygenated, aquatic environs (DOE/EIS-0391 2012, Appendix P, pp. P-52 to P-53).

[41] "Groundwater is a potential pathway for contaminants to enter the Columbia River. Groundwater flows into the river from springs located above the water line and through areas of upwelling in the river bed. Hydrologists estimate that groundwater currently flows from the Hanford unconfined aquifer to the Columbia River at a rate of ~ 0.000012 cubic meters per second (Section 4.1 of PNNL-13674). For comparison, the average flow of the Columbia River is ~3,400 cubic meters per second (DOE/RL-2014-32, Rev. 0)." This represents a dilution effect of more than eight orders of magnitude (a dilution factor of greater than 100 million).

Facilities for D&D – Not Applicable

Operating Facilities – Not Applicable

Because of the prohibition on waste additions to the Hanford SSTs,[42] the T Tank and Waste Farms EU components are not considered Operating Facilities for this Review.

[42] Berman presentation on July 29, 2009, titled "Hanford Single-Shell Tank Integrity Program." Available at www.em.doe.gov.

Table E.2-2. Summary Table of Infrastructure and Subsurface Contamination Inventory for the T Tank and Waste Farms Evaluation Unit (CP-TF-1) [(a)(b)]

Contaminated Media	Primary Contaminants	Total Amount. of Each Contaminant Before Retrieval	90% Retrieval Scenario	99% Retrieval Scenario
Infrastructure (Tanks and Ancillary Equipment)				
Tank Waste	Waste (kGal)	1852	185.2	18.52
	Sludge (kGal)	1690	169	16.9
	Saltcake (kGal)	135	13.5	1.35
	Supernatant (kGal)	27	2.7	0.27
Tank Waste (rad)	Am-241 (Ci)	350	35	3.5
	C-14 (Ci)	5.7	0.57	0.057
	Co-60 (Ci)	18	1.8	0.18
	Cs-137 (Ci)	62000	6200	620
	Eu-152 (Ci)	0.35	0.035	0.0035
	Eu-154 (Ci)	55	5.5	0.55
	H-3 (Ci)	34	3.4	0.34
	I-129 (Ci)	0.077	0.0077	0.00077
	Ni-59 (Ci)	6.3	0.63	0.063
	Ni-63 (Ci)	580	58	5.8
	Pu (total) (Ci)	2200	220	22
	Sr-90 (Ci)	150000	15000	1500
	Tc-99 (Ci)	150	15	1.5
	U (total) (Ci)	25	2.5	0.25
Tank Waste (non-rad)	Cr (kg)	12000	1200	120
	Hg (kg)	18	1.8	0.18
	NO3 (kg)	630000	63000	6300
	Pb (kg)	8500	850	85
	U (total) (kg)	30000	3000	300
Ancillary Equipment (rad)	C-14 (Ci)	0.2	0.2	0.2
	Cs-137 (Ci)	2200	2200	2200
	H-3 (Ci)	0.46	0.46	0.46
	I-129 (Ci)	0.0015	0.0015	0.0015

Contaminated Media	Primary Contaminants	Total Amount. of Each Contaminant Before Retrieval	90% Retrieval Scenario	99% Retrieval Scenario
	Pu (total) (Ci)	19	19	19
	Sr-90 (Ci)	5000	5000	5000
	Tc-99 (Ci)	2.2	2.2	2.2
	U (total) (Ci)	0.35	0.35	0.35
Ancillary Equipment (non-rad)	Cr (kg)	160	160	160
	Hg (kg)	0.27	0.27	0.27
	NO3 (kg)	10000	10000	10000
	Pb (kg)	58	58	58
	U (total) (kg)	500	500	500
Vadose Zone Source (Leaks and Intentional Discharges into Cribs and Trenches)				
Leaks (rad)	C-14 (Ci)	9.5	9.5	9.5
	Cs-137 (Ci)	25000	25000	25000
	H-3 (Ci)	53	53	53
	I-129 (Ci)	0.13	0.13	0.13
	Pu (total) (Ci)	13	13	13
	Sr-90 (Ci)	24000	24000	24000
	Tc-99 (Ci)	67	67	67
	U (total) (Ci)	0.35	0.35	0.35
Leaks (non-rad)	Cr (kg)	1100	1100	1100
	Hg (kg)	0.24	0.24	0.24
	NO3 (kg)	67000	67000	67000
	Pb (kg)	35	35	35
	U (total) (kg)	380	380	380
Cribs (rad)	Am-241 (Ci)	7.4	7.4	7.4
	C-14 (Ci)	0.38	0.38	0.38
	Co-60 (Ci)	0.32	0.32	0.32
	Cs-137 (Ci)	430	430	430
	Eu-152 (Ci)	0.18	0.18	0.18
	Eu-154 (Ci)	14	14	14
	H-3 (Ci)	0.093	0.093	0.093
	I-129 (Ci)	0.00031	0.00031	0.00031
	Ni-59 (Ci)	0.1	0.1	0.1

Contaminated Media	Primary Contaminants	Total Amount. of Each Contaminant Before Retrieval	90% Retrieval Scenario	99% Retrieval Scenario
	Ni-63 (Ci)	8.8	8.8	8.8
	Pu (total) (Ci)	460	460	460
	Sr-90 (Ci)	370	370	370
	Tc-99 (Ci)	0.19	0.19	0.19
	U (total) (Ci)	1.6	1.6	1.6
Cribs (non-rad)	Cr (kg)	39000	39000	39000
	NO3 (kg)	9100000	9100000	9100000
	U (total) (kg)	510	510	510
Trenches (rad)	Am-241 (Ci)	2.4	2.4	2.4
	C-14 (Ci)	0.34	0.34	0.34
	Co-60 (Ci)	1.3	1.3	1.3
	Cs-137 (Ci)	1800	1800	1800
	Eu-152 (Ci)	0.057	0.057	0.057
	Eu-154 (Ci)	4	4	4
	H-3 (Ci)	100	100	100
	I-129 (Ci)	0.0068	0.0068	0.0068
	Ni-59 (Ci)	0.11	0.11	0.11
	Ni-63 (Ci)	15	15	15
	Pu (total) (Ci)	26	26	26
	Sr-90 (Ci)	310	310	310
	Tc-99 (Ci)	0.8	0.8	0.8
	U (total) (Ci)	0.25	0.25	0.25
Trenches (non-rad)	Cr (kg)	2600	2600	2600
	Hg (kg)	1.4	1.4	1.4
	NO3 (kg)	730000	730000	730000
	U (total) (kg)	370	370	370
UPR (rad)	Am-241 (Ci)	0.0022	0.0022	0.0022
	C-14 (Ci)	0.00032	0.00032	0.00032
	Co-60 (Ci)	0.0012	0.0012	0.0012
	Cs-137 (Ci)	1.8	1.8	1.8
	Eu-152 (Ci)	5.20E-05	5.20E-05	5.20E-05
	Eu-154 (Ci)	0.0036	0.0036	0.0036

Contaminated Media	Primary Contaminants	Total Amount. of Each Contaminant Before Retrieval	90% Retrieval Scenario	99% Retrieval Scenario
	H-3 (Ci)	0.023	0.023	0.023
	I-129 (Ci)	6.70E-06	6.70E-06	6.70E-06
	Ni-59 (Ci)	0.00011	0.00011	0.00011
	Ni-63 (Ci)	0.014	0.014	0.014
	Pu (total) (Ci)	0.014	0.014	0.014
	Sr-90 (Ci)	0.27	0.27	0.27
	Tc-99 (Ci)	0.00078	0.00078	0.00078
	U (total) (Ci)	9.00E-05	9.00E-05	9.00E-05
UPR (non-rad)	Cr (kg)	2.1	2.1	2.1
	Hg (kg)	0.0012	0.0012	0.0012
	NO3 (kg)	560	560	560
	U (total) (kg)	0.13	0.13	0.13
Vadose Zone (from Vadose Zone Sources)				
VZ Remaining (rad)	Am-241 (Ci)	9.9	9.9	9.9
	C-14 (Ci)	10	10	10
	Co-60 (Ci)	1.6	1.6	1.6
	Cs-137 (Ci)	27000	27000	27000
	Eu-152 (Ci)	0.24	0.24	0.24
	Eu-154 (Ci)	18	18	18
	H-3 (Ci)	140	140	140
	I-129 (Ci)	0.14	0.14	0.14
	Ni-59 (Ci)	0.21	0.21	0.21
	Ni-63 (Ci)	24	24	24
	Pu (total) (Ci)	500	500	500
	Sr-90 (Ci)	25000	25000	25000
	Tc-99 (Ci)	66	66	66
	U (total) (Ci)	2.2	2.2	2.2
VZ Remaining (non-rad)	Cr (kg)	42000[(c)]	42000[(c)]	42000[(c)]
	Cr-VI (kg)	42000[(c)]	42000[(c)]	42000[(c)]
	Hg (kg)	1.6	1.6	1.6
	NO3 (kg)	9900000	9900000	9900000
	Pb (kg)	35	35	35

Contaminated Media	Primary Contaminants	Total Amount. of Each Contaminant Before Retrieval	90% Retrieval Scenario	99% Retrieval Scenario
	U (total) (kg)	1300	1300	1300
VZ Treatment (rad)	I-129 (Ci)	1.40E-10	1.40E-10	1.40E-10
	Tc-99 (Ci)	2	2	2
VZ Treatment (non-rad)	Cr (kg)	97	97	97
	Cr-VI (kg)	97	97	97
Saturated Zone (from Vadose Zone Sources)				
SZ Inventory (rad)	H-3 (Ci)	18	18	18
	I-129 (Ci)	0.00062	0.00062	0.00062
	Tc-99 (Ci)	0.81	0.81	0.81
SZ Inventory (non-rad)	Cr (kg)	0	0	0
	Cr-VI (kg)	100	100	100

a. Tanks (SST and DST): Best Basis Inventory (BBI) March 2014; Ancillary Equipment (Anc Eq): Tank Farm Closure & Waste Management (TC&WM) Environmental Impact Statement (DOE/EIS-0391) Appendix D; Unplanned Releases (UPRs): Soil Inventory Model (SIM) Rev 1 (RPP-26744, Rev 0); Ponds: Soil Inventory Model (SIM) Rev 1 (RPP-26744, Rev 0); Cribs: Soil Inventory Model (SIM) Rev 1 (RPP-26744, Rev 0); Trenches: Soil Inventory Model (SIM) Rev 1 (RPP-26744, Rev 0) and Tank Farm Closure & Waste Management (TC&WM) Environmental Impact Statement (DOE/EIS-0391) Appendix S; Leaks: Tank Farm Closure & Waste Management (TC&WM) Environmental Impact Statement (DOE/EIS-0391) Appendix D; MUSTs: Soil Inventory Model (SIM) Rev 1 (RPP-26744, Rev 0) and Tank Farm Closure & Waste Management (TC&WM) Environmental Impact Statement (DOE/EIS-0391) Appendix S.

b. All primary contaminant inventories are reported to 2 significant figures. The source document should be consulted for greater precision data.

c. Differences in inventories for Cr vs Cr-IV are due to differing Water Quality Standards (WQS) and thus plume extents: 100 mg/L for total chromium vs 48 mg/L for chromium (IV). The difference is not distinguishable within the number of significant digits (2) displayed.

Table E.2-3. Current Bulk Inventory and Steady State Flammability Results (by Tank) for the T Tank Farm (CP-TF-1)

Tank ID	Tank Type	Capacity (kGal)[(a)]	Sludge (kGal)[(a)]	Saltcake (kGal)[(a)]	Supernatant (kGal)[(a)]	HGR(c) (ft3/d)[(b)]	Days to 25% LFL Barometric[(c)]	Days to 25% LFL Zero Ventilation[(d)]
T-101	SST	530	37	62	0	0.41	NA	>1826
T-102	SST	530	19	0	13	0.84	NA	1226
T-103	SST	530	23	0	4	0.33	NA	>1826
T-104	SST	530	317	0	0	0.5	NA	1369
T-105	SST	530	98	0	0	0.44	NA	>1826
T-106	SST	530	22	0	0	0.32	NA	>1826
T-107	SST	530	173	0	0	0.59	NA	1436
T-108	SST	530	5	11	0	0.32	NA	>1826
T-109	SST	530	0	62	0	0.34	NA	>1826
T-110	SST	530	369	0	1	1.2	NA	475
T-111	SST	530	447	0	0	0.6	NA	844
T-112	SST	530	60	0	7	0.35	NA	>1826
T-201	SST	55	28	0	2	0.21	304	166
T-202	SST	55	20	0	0	0.063	NA	748
T-203	SST	55	36	0	0	0.094	NA	294
T-204	SST	55	36	0	0	0.094	NA	294

a. Volumes from the Waste Tank Summary Report coinciding with the BBI (Rodgers 2014).

b. Hydrogen generation rate (ft^3/d) (RPP-5926 Rev. 15). Note in 2001 all 24 tanks were removed from the flammable gas watch list (including T-110 in the T Tank and Waste Farms EU) (Johnson, et al. 2001, p. iii).

c. Time (in days) to 25% of the Lower Flammability Limit (LFL) under a barometric (barom) breathing scenario (RPP-5926, Rev. 15). “NA” indicates that the headspace will not reach specified flammability level.

d. Time (in days) to 25% of the LFL under a zero ventilation scenario (RPP-5926, Rev. 15).

Table E.2-4. Current Primary Contaminant Inventory (by Tank) for the T Tank Farm (CP-TF-1) [(a)]

Tank ID	Decay Date	Am-241 (Ci)	C-14 (Ci)	Cl-36 (Ci)	Co-60 (Ci)	Cs-137 (Ci)	Eu-152 (Ci)	Eu-154 (Ci)	H-3 (Ci)
T-101	2001	68	0.89	NP[(b)]	15	36000	0.29	17	23
T-102	2001	21	4	NP	0.72	4200	0.03	15	0.8
T-103	2001	0.67	0.14	NP	0.53	370	0.012	0.72	2.1
T-104	2001	28	0.069	NP	0.047	220	0.0026	1.5	0.3
T-105	2001	32	0.17	NP	0.14	4600	0.00032	20	0.71
T-106	2001	5.6	0.067	NP	1.6	1800	0.00046	0.027	5.7
T-107	2001	60	0.18	NP	0.19	14000	0.0031	0.19	0.45
T-108	2001	0.44	0.013	NP	0.0044	570	0.00035	0.022	0.085
T-109	2001	0.085	0.026	NP	0.012	750	0.0011	0.068	0.3
T-110	2001	8.7	0.0023	NP	0.00064	24	0.00046	0.029	0.00026
T-111	2001	98	0.0015	NP	0.00045	200	0.00049	0.03	0.00016
T-112	2001	4.8	0.056	NP	0.14	190	0.011	0.69	0.2
T-201	2001	5.5	1.90E-05	NP	3.70E-06	2.8	5.30E-06	0.00041	5.90E-09
T-202	2001	2.9	1.80E-05	NP	6.60E-06	0.56	1.90E-05	0.0011	2.90E-07
T-203	2001	6.2	3.20E-05	NP	1.20E-05	1	3.30E-05	0.002	5.30E-07
T-204	2001	3.7	3.30E-05	NP	1.20E-05	1	3.40E-05	0.002	5.30E-07

a. From Best Basis Inventory (BBI) Summary (March 24, 2014) provided in spreadsheet form by Mark Triplett. All primary contaminant inventories are reported to 2 significant figures. The source document should be consulted for greater precision data.

b. NP = Not present at significant quantities

Table E.2-5. Current Primary Contaminant Inventory [(a)] and Groundwater Threat Metric (by Tank) for the T Tank Farm (CP-TF-1)

Tank ID	I-129 (Ci)	Ni-59 (Ci)	Ni-63 (Ci)	Pu (total) (Ci)[(b)]	Sr-90 (Ci)	Tc-99 (Ci)	U (total) (Ci)[(c)]	GTM (Mm3)[(d)]
T-101	0.036	4.2	380	470	350	34	3.9	38
T-102	0.019	0.75	68	10	15000	7.1	4.1	7.9
T-103	0.014	0.6	55	9.2	630	2.3	2.7	5.3
T-104	0.00051	0.012	1.7	280	2900	0.97	1.1	1.1
T-105	2.10E-05	0.076	7	200	26000	35	0.83	39
T-106	7.70E-05	0.26	23	27	590	2.9	0.67	3.2
T-107	0.0059	0.25	24	410	93000	48	6.5	54
T-108	0.00012	0.018	1.7	7.2	150	0.77	0.076	0.86
T-109	0.00042	0.07	6.8	4.5	92	0.3	0.12	0.34
T-110	2.60E-07	0.00059	0.049	120	43	0.0012	0.025	0.0014
T-111	1.50E-07	0.11	11	340	7800	17	5	18
T-112	0.0013	0.011	0.95	80	32	2.1	0.15	2.4
T-201	7.80E-10	5.10E-06	0.00041	110	8.6	1.80E-06	6.90E-07	1.90E-06
T-202	0	4.70E-06	0.00039	20	0.19	1.70E-06	0.0066	1.80E-06
T-203	0	8.40E-06	0.00071	49	0.33	3.00E-06	0.00036	3.30E-06
T-204	0	8.60E-06	0.00072	41	0.59	3.00E-06	0.00012	3.30E-06

a. From Best Basis Inventory (BBI) Summary (March 24, 2014) provided in spreadsheet form by Mark Triplett. All primary contaminant inventories are reported to 2 significant figures. The source document should be consulted for greater precision data.

b. Sum of plutonium isotopes 238, 239, 240, 241, and 242

c. Sum of uranium isotopes 232, 233, 234, 235, 236, and 238

d. The Groundwater Threat Metric (GTM) shown for tanks is equal to the maximum of the GTM for Tc-99 and I-129.

Table E.2-6. Current Primary Contaminant Inventory (by Tank) for the T Tank Farm (CP-TF-1) [(a)]

Tank ID	CCl4 (kg)	CN (kg)	Cr (kg)	Cr-VI (kg)	Hg (kg)	NO3 (kg)	Pb (kg)	TBP (kg)	TCE (kg)	U (total) (kg)
T-101	NP[(b)]	NP	570	NP	0.32	120000	3900	NP	NP	4300
T-102	NP	NP	150	NP	1.2	8200	50	NP	NP	3800
T-103	NP	NP	68	NP	0.34	4500	410	NP	NP	2400
T-104	NP	NP	1400	NP	0.19	90000	77	NP	NP	1400
T-105	NP	NP	880	NP	5.4	13000	420	NP	NP	1200
T-106	NP	NP	120	NP	0.046	16000	570	NP	NP	850
T-107	NP	NP	420	NP	0.13	72000	780	NP	NP	7900
T-108	NP	NP	30	NP	0.32	26000	33	NP	NP	110
T-109	NP	NP	31	NP	1.2	13000	100	NP	NP	170
T-110	NP	NP	2000	NP	4.9	110000	1400	NP	NP	37
T-111	NP	NP	3500	NP	3	120000	550	NP	NP	7400
T-112	NP	NP	630	NP	0.54	5600	190	NP	NP	200
T-201	NP	NP	590	NP	0	6500	33	NP	NP	0.001
T-202	NP	NP	290	NP	0	5600	8.6	NP	NP	9.7
T-203	NP	NP	590	NP	0	9700	3.5	NP	NP	0.54
T-204	NP	NP	740	NP	0	9100	51	NP	NP	0.18

a. From Best Basis Inventory (BBI) Summary (March 24, 2014) provided in spreadsheet form by Mark Triplett. All primary contaminant inventories are reported to 2 significant figures. The source document should be consulted for greater precision data.

b. NP = Not present at significant quantities

Table E.2-7. Summary of the Evaluation of Threats to Groundwater as a Protected Resource from Remaining Vadose Zone (VZ) Contamination associated with the T Tank and Waste Farms Evaluation Unit (CP-TF-1)

PC	Group	WQS	Porosity[a]	K_d (mL/g)[a]	ρ (kg/L)[a]	VZ Source M^{Source}	SZ Total M^{SZ}	Treated[c] M^{Treat}	VZ Remaining $M^{Tot\ (d)}$	VZ GTM (Mm^3)	VZ Rating[e]
C-14	A	2000 pCi/L	0.23	0	1.84	1.02E+01 Ci	---	---	1.02E+01 Ci	5.12E+00	Low
I-129	A	1 pCi/L	0.23	0.2	1.84	1.37E-01 Ci	6.19E-04 Ci	1.44E-10 Ci	1.37E-01 Ci	5.25E+01	Medium
Sr-90	B	8 pCi/L	0.23	22	1.84	2.50E+04 Ci	---	---	2.50E+04 Ci	1.76E+04	ND[f]
Tc-99	A	900 pCi/L	0.23	0	1.84	6.84E+01 Ci	8.05E-01 Ci	1.97E+00 Ci	6.56E+01 Ci	7.29E+01	Medium
CCl_4	A	5 µg/L	0.23	0	1.84	---	---	---	---	---	ND
Cr	B	100 µg/L	0.23	0	1.84	4.23E+04 kg	---	9.68E+01 kg	4.22E+04 kg	4.22E+02	High
Cr-VI	A	48 µg/L[b]	0.23	0	1.84	4.23E+04 kg	1.02E+02 kg	9.68E+01 kg	4.21E+04 kg	8.76E+02	High
TCE	B	5 µg/L	0.23	2	1.84	---	---	---	---	---	ND
U(tot)	B	30 µg/L	0.23	0.8	1.84	1.27E+03 kg	---	---	1.27E+03 kg	5.70E+00	ND[f]

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

b. "Model Toxics Control Act—Cleanup" (WAC 173-340) Method B groundwater cleanup level for hexavalent chromium. Other WQS values represent drinking water standards.

c. Treatment amounts from the 2013 Hanford Annual Groundwater Report (DOE/RL-2014-32, Rev. 0).

d. The remaining vadose zone inventory is estimated by difference (CRESP 2015) and thus has a high associated uncertainty.

e. Groundwater Threat Metric rating based on Table 6-3, Methodology Report (CRESP 2015). These contaminants are being treated using the 200-West Groundwater Treatment Facility.

f. As discussed in Section 2.5, no appreciable uranium or Sr-90 plume would be expected in the next 150 years due to transport and decay (Sr-90) considerations. Thus the *Low* rating would apply to the period *after* the Active Cleanup is complete to account for uncertainties.

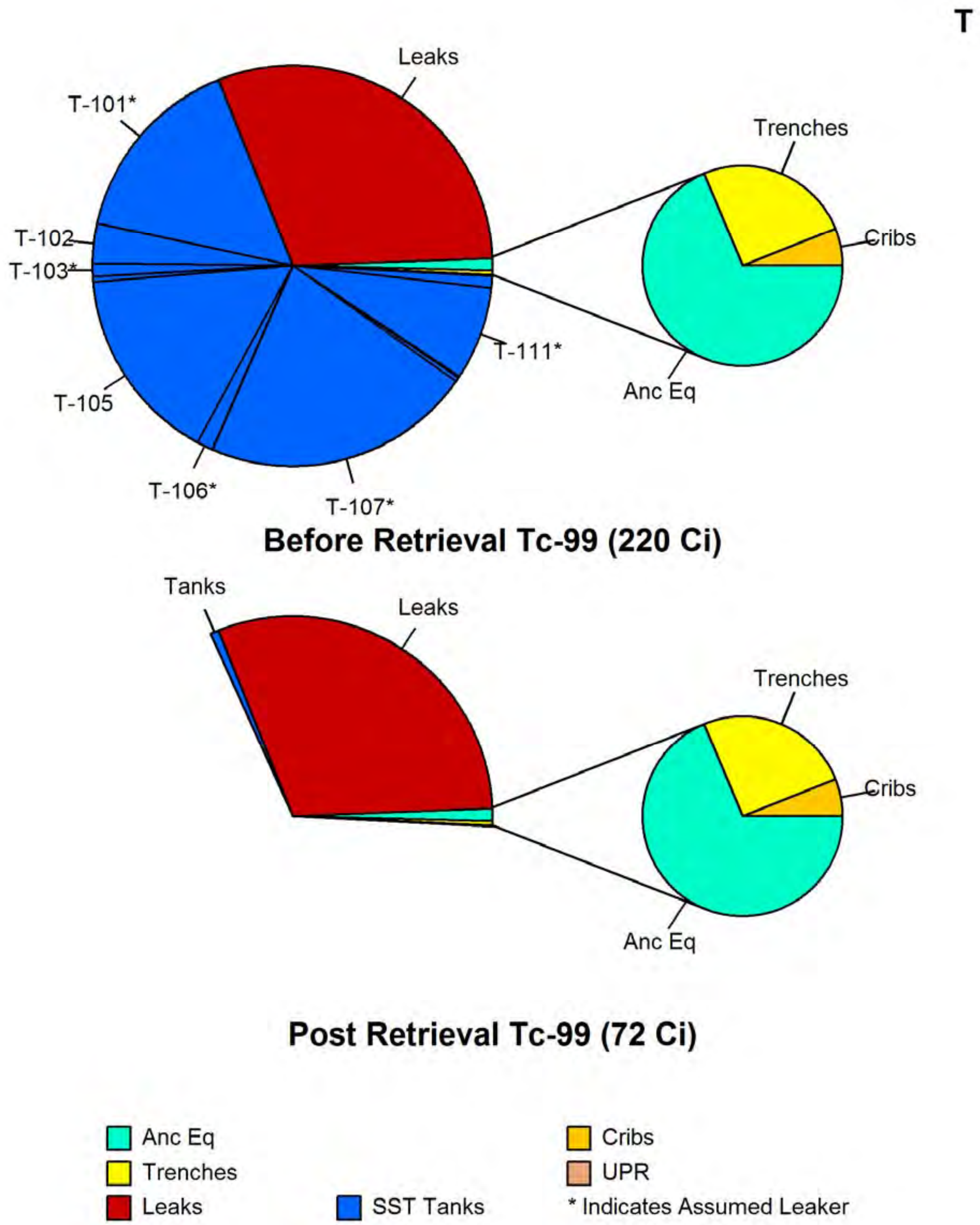


Figure E.2-4. T Tank and Waste Farms Evaluation Unit Inventory Estimates for Tc-99 Before and After 99% Retrieval

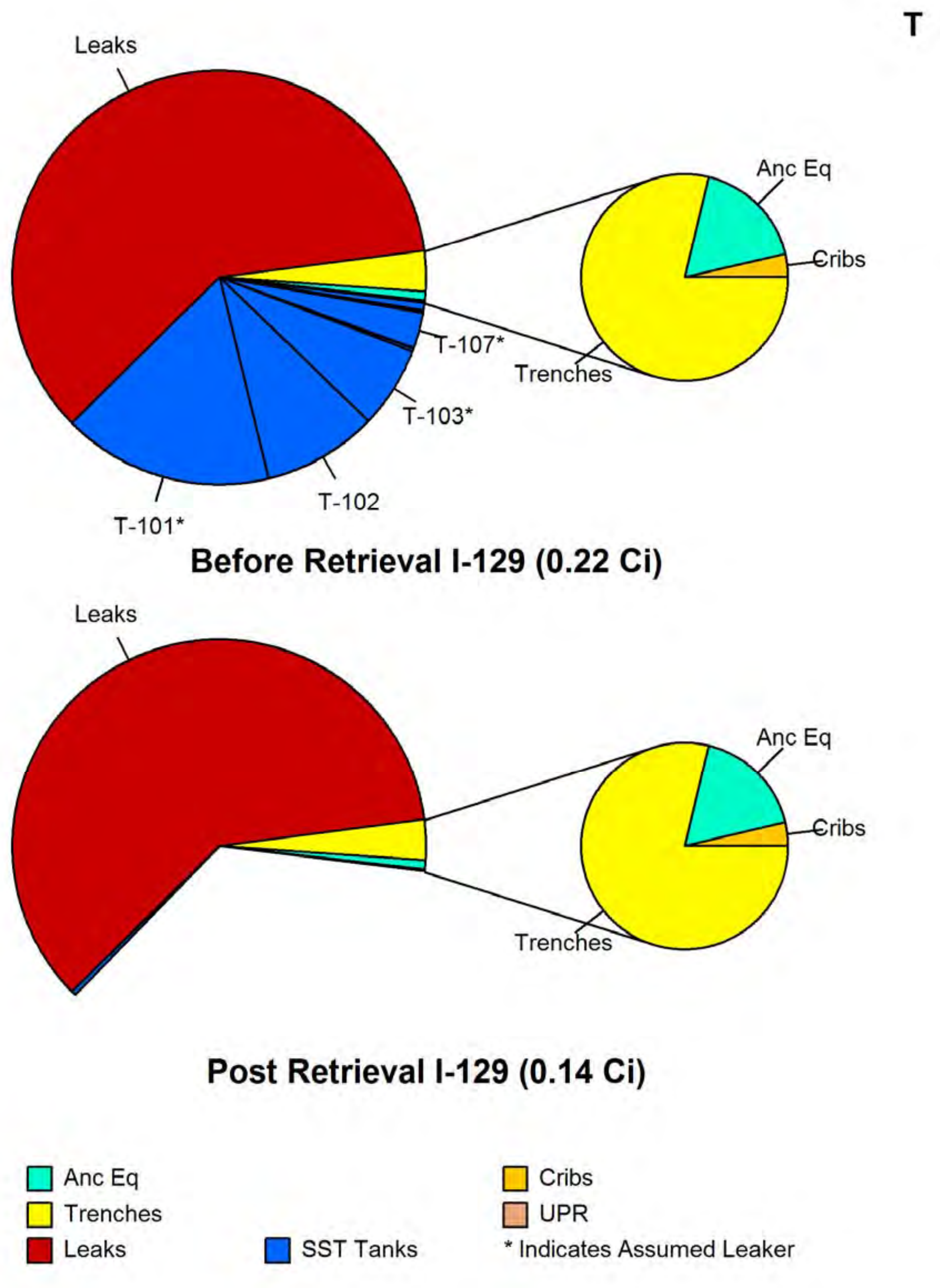


Figure E.2-5. T Tank and Waste Farms Evaluation Unit Inventory Estimates for I-129 Before and After 99% Retrieval

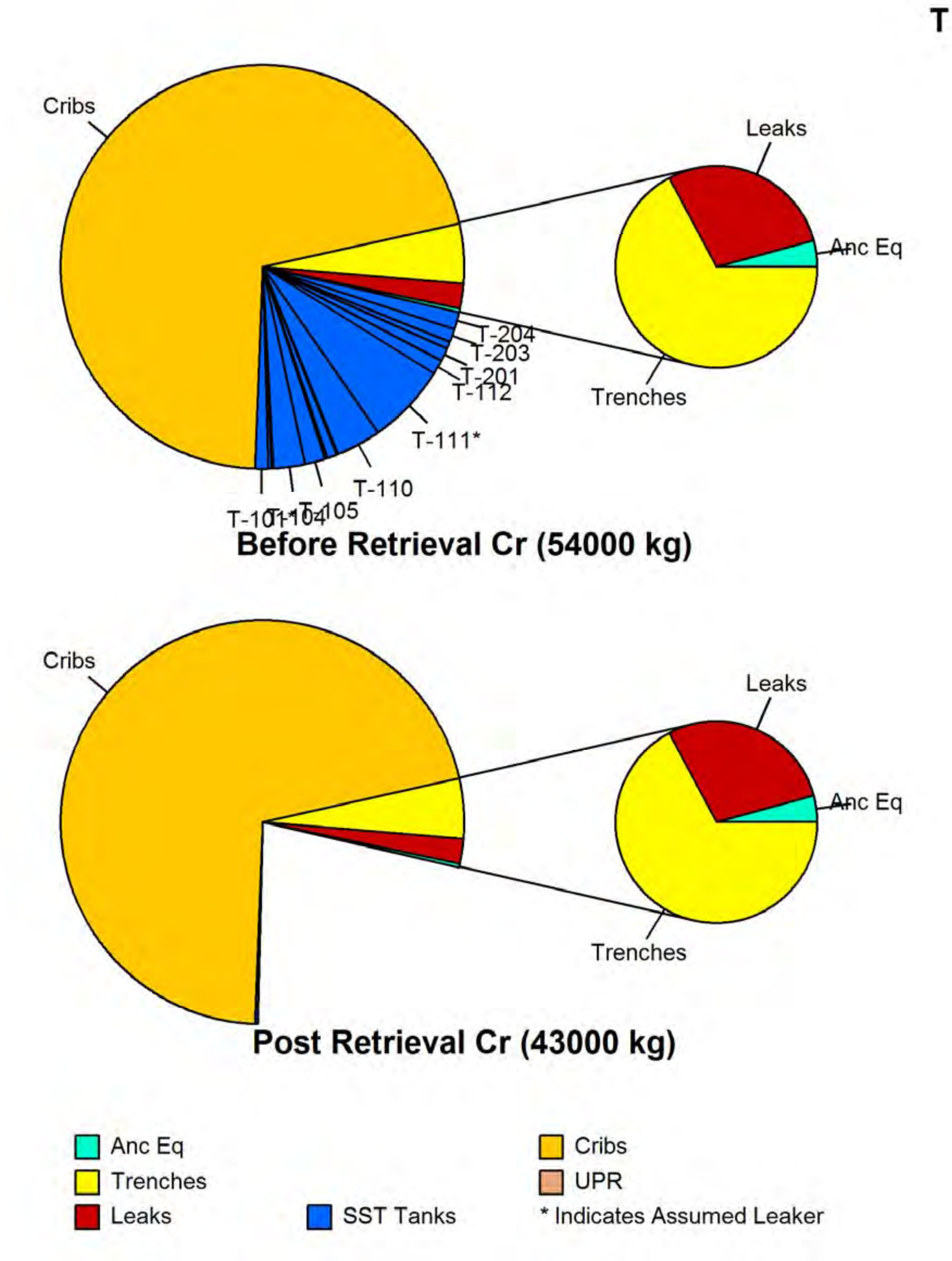


Figure E.2-6. T Tank and Waste Farms Evaluation Unit Inventory Estimates for Chromium Before and After 99% Retrieval

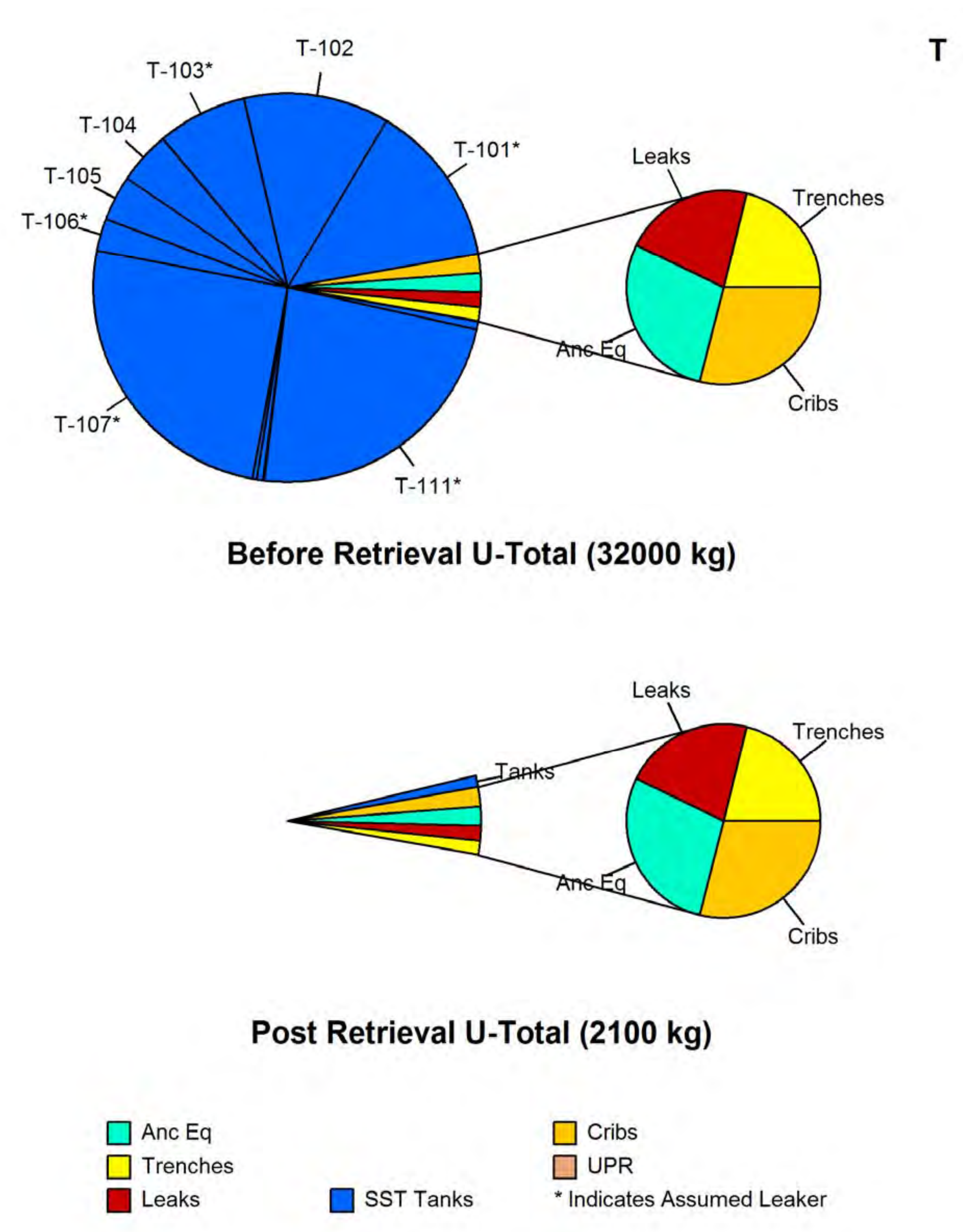


Figure E.2-7. T Tank and Waste Farms Evaluation Unit Inventory Estimates for U(tot) Before and After 99% Retrieval

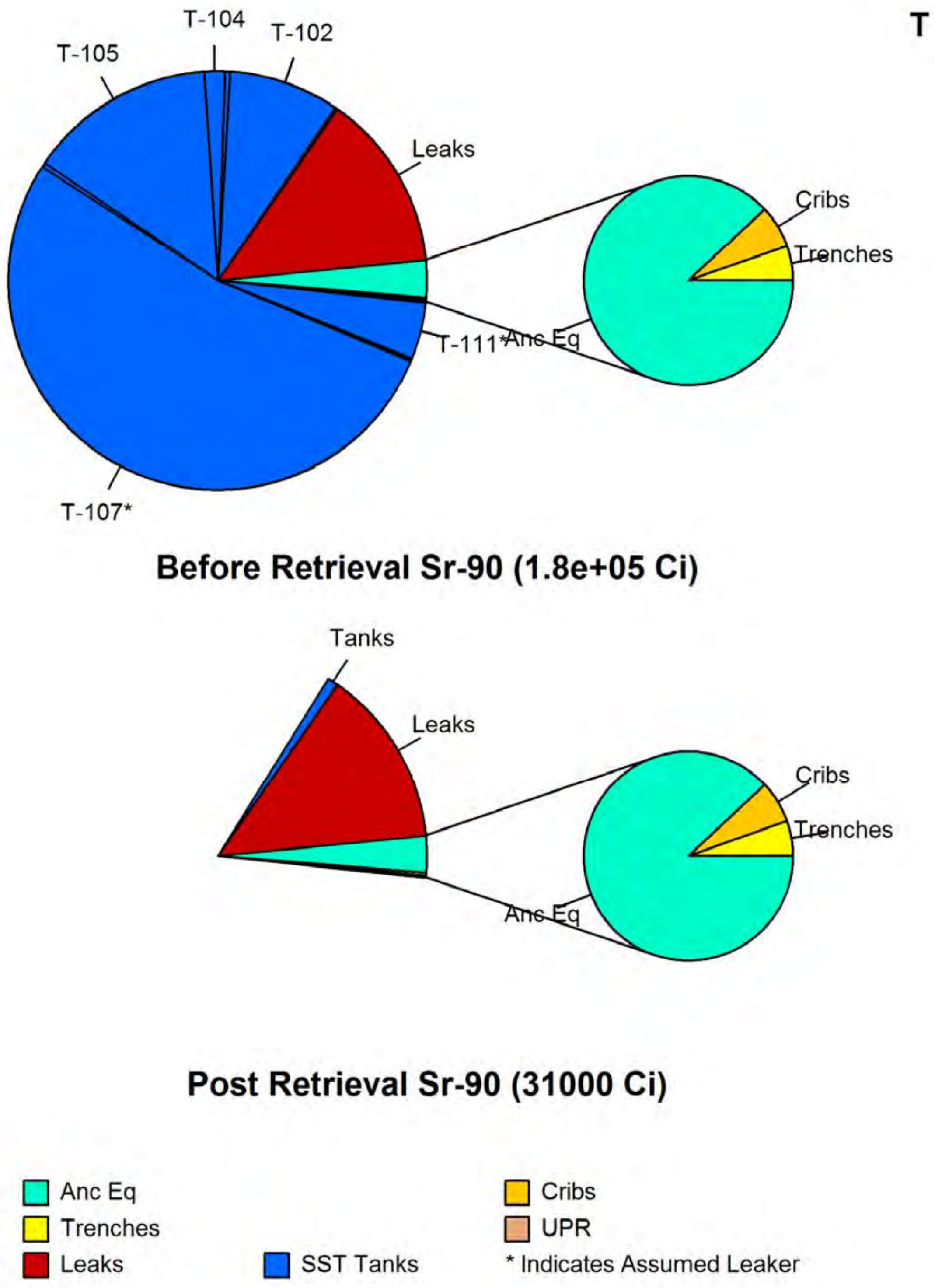


Figure E.2-8. T Tank and Waste Farms Evaluation Unit Inventory Estimates for Sr-90 Before and After 99% Retrieval

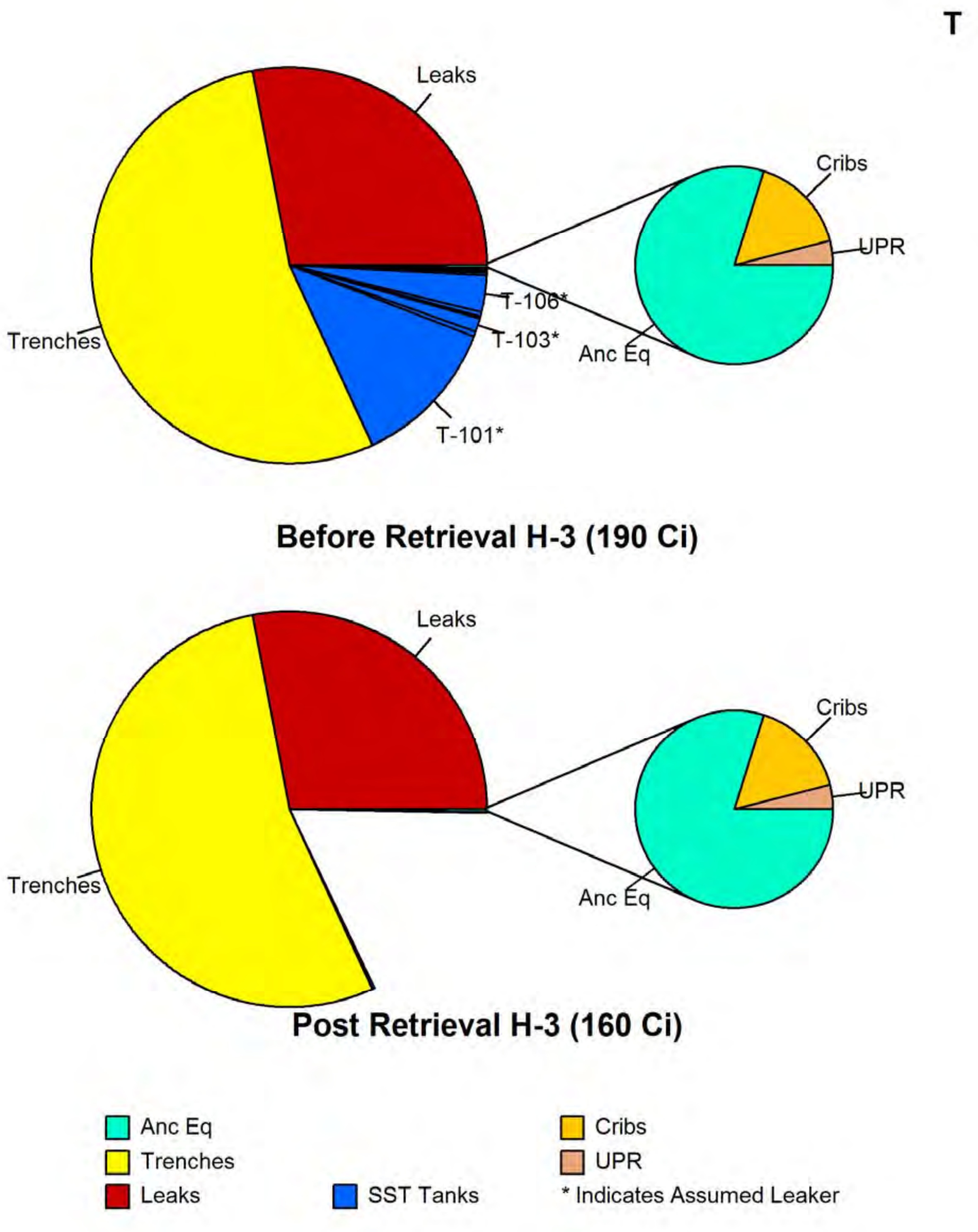


Figure E.2-9. T Tank and Waste Farms Evaluation Unit Inventory Estimates for Tritium (H-3) Before and After 99% Retrieval

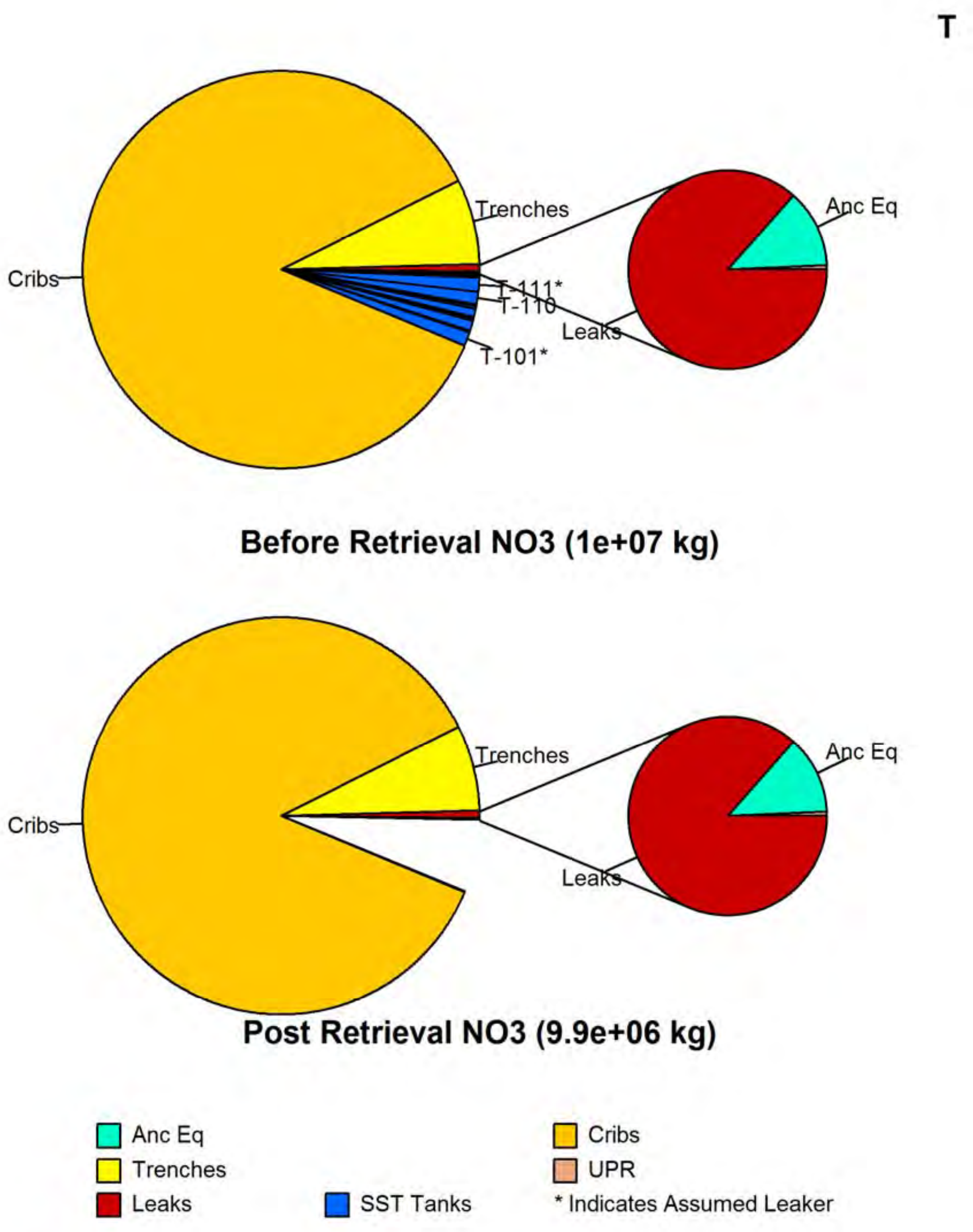


Figure E.2-10. T Tank and Waste Farms Evaluation Unit Inventory Estimates for Nitrate (NO3) Before and After 99% Retrieval

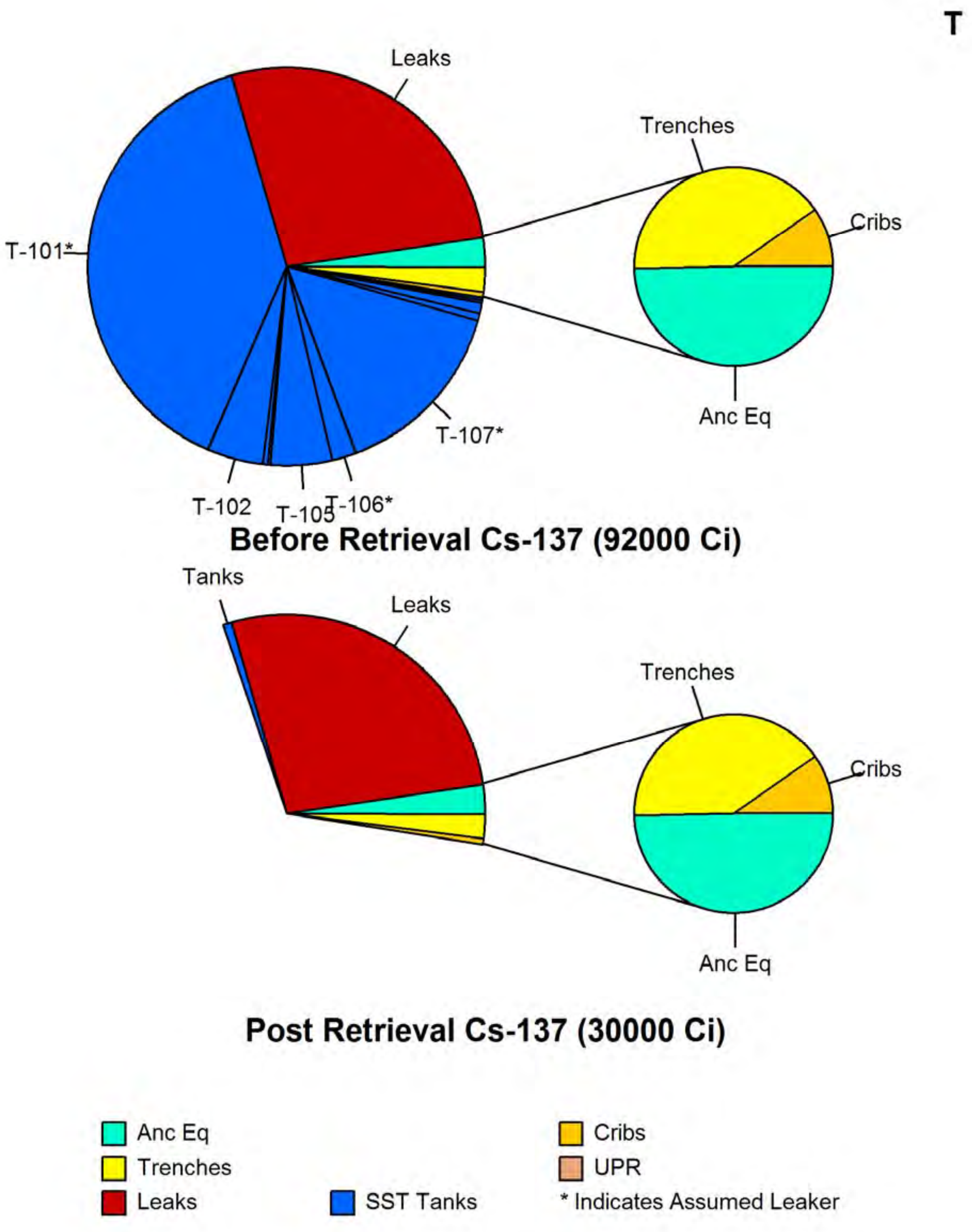


Figure E.2-11. T Tank and Waste Farms Evaluation Unit Inventory Estimates for Cs-137 Before and After 99% Retrieval

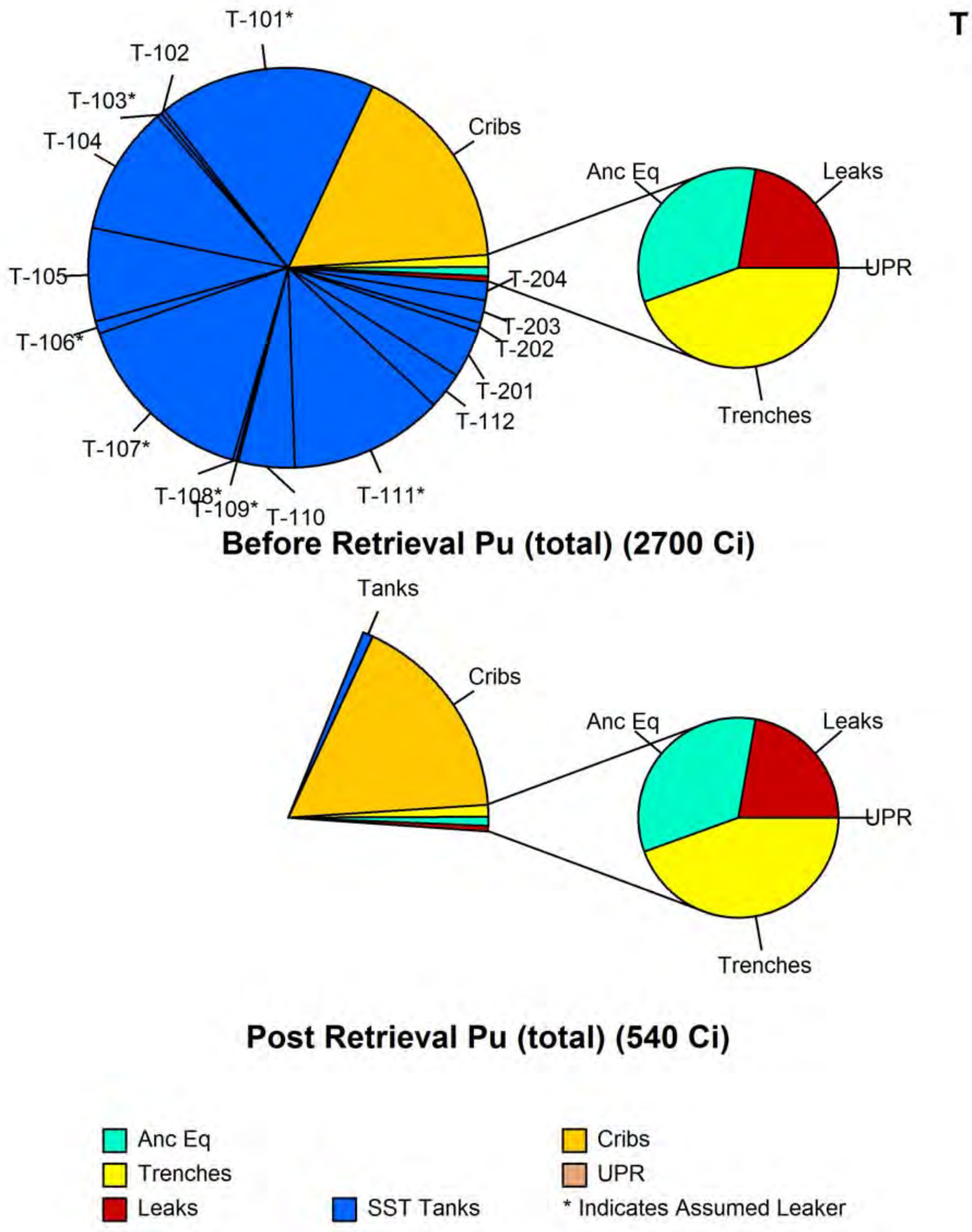


Figure E.2-12. T Tank and Waste Farms Evaluation Unit Inventory Estimates for Plutonium (total) Before and After 99% Retrieval

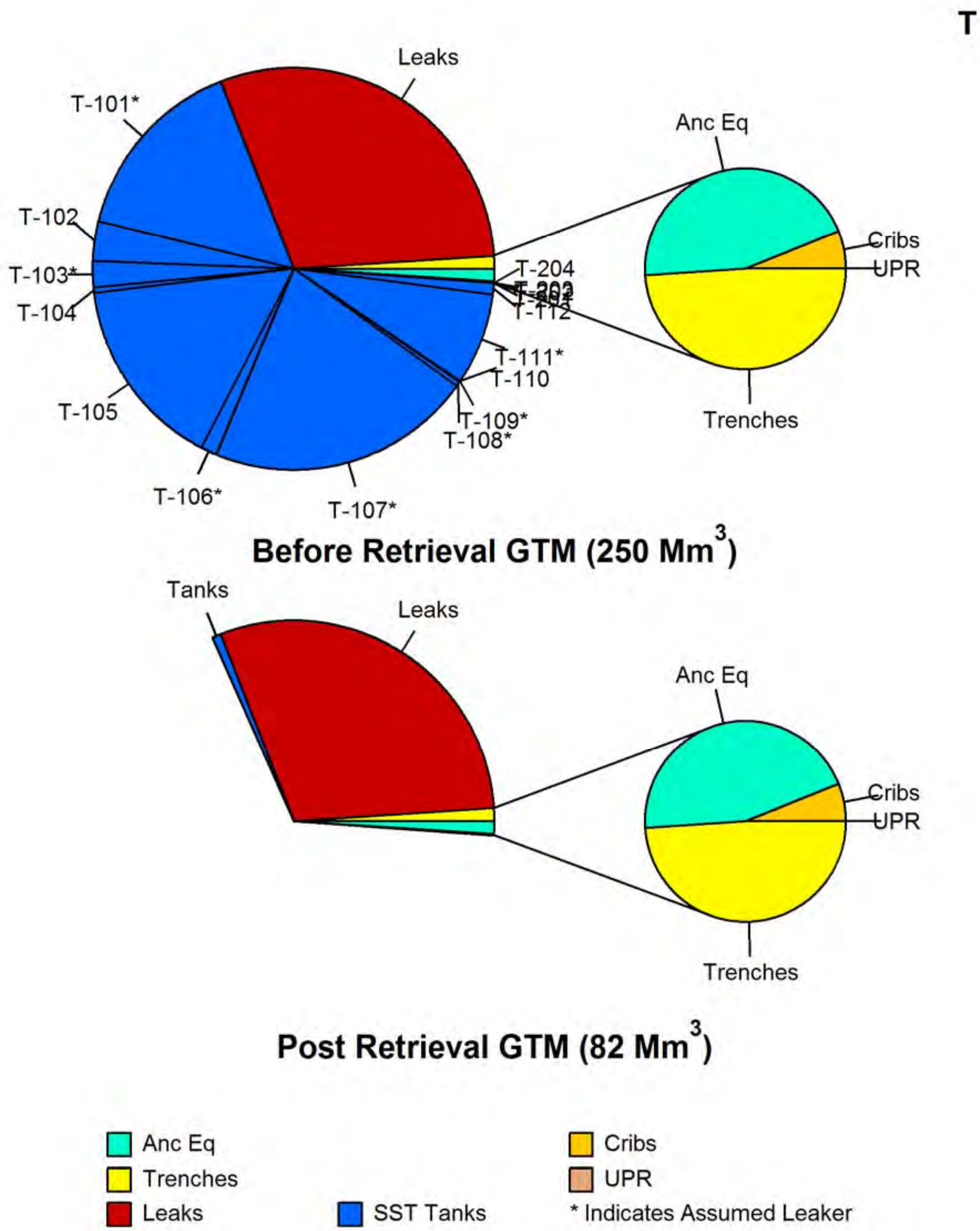


Figure E.2-13. T Tank and Waste Farms Evaluation Unit Maximum Groundwater Threat Metric (GTM) of I-129 and Tc-99 Estimates Before and After 99% Retrieval

2.6. POTENTIAL RISK/IMPACT PATHWAYS AND EVENTS

CURRENT CONCEPTUAL MODEL

A common safety analysis was performed for all the single- and double-shell tanks including pathways and barriers (safety scenarios that dominate risk, safety systems and controls, barriers to release, failure mechanisms, pathways and receptors, time frames for exposure). See Section 1.6 in Appendix E.1 for details.

POPULATIONS AND RESOURCES CURRENTLY AT RISK OR POTENTIALLY IMPACTED

Facility Worker, Co-located Person, and Public

A common analysis was performed for the Facility Worker, Co-located Person, and Public. See Section 1.6 (Appendix E.1) for details.

Groundwater

The current groundwater plumes (Tc-99, I-129, chromium, and H-3) associated with the T Tank and Waste Farms EU and liquid waste disposal facilities are described in Section 2.5, and details including ratings are provided in Appendix G.6 for the CP-GW-2 EU (200-ZP-1 GW OU).

As shown in Table E.2-7 (Section 2.5), the vadose zone (VZ) GTM values for the Group A and B primary contaminants translate into ratings from *Not Discernible* for uranium (with a *Low* rating after the Active Cleanup period as described in Section 2.5) and Sr-90 (which has an inventory that would translate to a *Very High* rating but appears relatively immobile in the area as described in Section 2.5) to *High* for chromium (total and hexavalent) for the T Tank and Waste Farms EU. The overall rating for potential groundwater impacts from vadose zone sources is *High*.

Columbia River

As described in Section 2.5, no plumes associated with the T Tank and Waste Farms EU currently intersect the Columbia River above benthic or riparian standards, which corresponds to *Not Discernible* ratings. The large dilution effect of the Columbia River results in a rating of *Not Discernible* for the free-flowing ecology.

Additional information concerning potential threats to the Columbia River from Tank Farm and liquid waste disposal facilities in the 200-West Area is provided in Appendix G.6 for the CP-GW-2 EU (especially the 200-ZP-1 GW EU).

Ecological Resources

- Approximately 90% of the T Tank and Waste Farms EU consists of graveled surfaces and paved areas.
- Individual occurrences of level 3 species have been previously documented at the T Tank and Waste Farms EU, however, no level 3 or greater habitat resources occur in patches greater than 0.5 ac within the EU.
- Loss of individual Piper's daisy plants would not be likely to affect the viability of populations of this species in the region.
- No wildlife was observed in the area during a vehicle reconnaissance of the boundary, and in 2010, a previous PNNL ECAP survey of the habitat surrounding the tank farm noted only coyote (*Canis latrans*) tracks in the habitat to the west and northwest of the tank farm.

- Cleanup activities would result in no net change in the amount of level 3 or higher resources within a 0.97 km radius.
- Because the EU is adjacent to paved roadways and multiple industrial areas and waste sites—no significant change in habitat connectivity would be expected if habitat resources within the EU are lost.

Cultural Resources

- Segment C, a non-contributing un-intact segment of the National Register-eligible historic/ethnohistoric Road/Trail runs through the T Tank and Waste Farms EU.
- The 241T Tank Farm a contributing property within the Manhattan Project and Cold War Era Historic District, with documentation required, that is located within the T Tank and Waste Farms EU. In accordance with the 1998 *Hanford Site Manhattan Project and Cold War Era Historic District Treatment Plan (*DOE/RL-97-56), all documentation requirements have been completed for this property.

Archaeological sites and TCPs located within 500 meters of the EU

- The Hanford Site Plant Railroad, a contributing property within the Manhattan Project and Cold War Era Historic District, with documentation required, is located within 500 meters of the T Tank and Waste Farms EU. In accordance with the 1998 *Hanford Site Manhattan Project and Cold War Era Historic District Treatment Plan (*DOE/RL-97-56), all documentation requirements have been completed for this property.

Recorded TCPs Visible from the EU

- There are two recorded TCPs associated with the Native American Precontact and Ethnographic Landscape that are visible from the T Tank and Waste Farms EU.

Cleanup Approaches and End-State Conceptual Model

Selected or Potential Cleanup Approaches

A common analysis was performed for all the single- and double-shell tanks. See Section 1.6 (Appendix E.1) for details.

Contaminant Inventory Remaining at the Conclusion of Planned Active Cleanup Period

See Section 2.5 including Table E.2-2 and Figure E.2-4 through Figure E.2-12 for the inventory information after planned 99% retrieval. Furthermore, a more general analysis was performed for all the single- and double-shell tanks. See Section 1.6 (Appendix E.1) for details.

Risks and Potential Impacts Associated with Cleanup

A general analysis was performed for all the single- and double-shell tanks for workers and the Public. See Section 1.6 (Appendix E.1) for details.

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

Facility Worker, Co-located Person, and Public

A common analysis was performed for the Facility Worker, Co-located Person, and Public. See Section 1.6 (Appendix E.1) for details.

Groundwater

As described in Section 2.5, there will be a continuing impact during this period to groundwater (as a protected resource) from those mobile T Tank Farm primary contaminants (e.g., Tc-99, I-129, chromium, and H-3) currently with plumes that exceed thresholds. These impacts are described in Appendix G.6 for the CP-GW-2 EU (200-ZP-1 OU).

Furthermore, there are primary (e.g., tank wastes) and secondary contaminant sources (legacy source sites) in the vadose zone that pose risk to groundwater. The vadose zone (VZ) GTM values for the Group A and B primary contaminants for the T Tank and Waste Farms EU translate to ratings of *Not Discernible* for uranium and Sr-90, *Medium* for Tc-99 and I-129, and *High* for chromium (total and hexavalent) during this period (because of insufficient impact of recharge rates under treatment likely due to the large amounts of contaminants already in the groundwater and possibly from sources outside the T Tank and Waste Farms EU). These ratings corresponding to an overall rating of *High*.

The 200-West Area pump-and-treat system is assumed to be operational during this evaluation period, which will be treating groundwater contamination.

It is considered unlikely that additional groundwater resources would be impacted as a result of either interim remedial actions (e.g., pump and treat) or final closure activities (that are not covered in the Ecological or Cultural Resources results).

Columbia River

As described in Section 2.5, the impacts to the Columbia River benthic, riparian, and free-flowing ecology for the Active Cleanup and Near-term, Post Cleanup periods are rated as *Not Discernible*. Additional information on groundwater plumes and potential threats associated with the T Tank Farm and liquid waste disposal facilities are described in Appendix G.6 for the CP-GW-2 EU (200-ZP-1 GW OU).

It is considered unlikely that additional benthic or riparian resources would be impacted as a result of either interim remedial actions (e.g., pump and treat) or final closure activities (that are not covered in the Ecological or Cultural Resources results).

Ecological Resources

See Section 1.6 (Appendix E.1) for details.

Cultural Resources

See Section 1.6 (Appendix E.1) for details.

Additional Risks and Potential Impacts if Cleanup is Delayed

A common analysis was performed for all the single- and double-shell tanks. See Section 1.6 (Appendix E.1) for details.

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

A common analysis was performed for all the single- and double-shell tanks. See Section 1.6 (Appendix E.1) for details.

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

Table E.2-8. Summary of Populations and Resources at Risk or Potentially Impacted after Cleanup

Population or Resource		Impact Rating	Comments
Human	Facility Worker	Low	Workers will be low risk from exposure to direct radiation and waste contaminants after waste retrieval, grouting, and capping.
	Co-located Person	Low	These persons will be at low risk from exposure to direct radiation and waste contaminants after waste retrieval, grouting, and capping.
	Public	Not Discernible (ND)	The Tank Farms will be in secure and controlled areas that prevent intentional and inadvertent intruders. No complete groundwater pathway and no impact from air pathway.
Environmental	Groundwater (A&B) from vadose zone[a]	Low (uranium, Sr-90) to High (Cr-tot and Cr-VI) **Overall**: High	GTM values for Group A and B primary contaminants (Table E.2-7): *Low* (uranium, Sr-90), Medium (Tc-99 and I-129) and High (total and hexavalent chromium). Uranium and Sr-90 (which would have a *Very High* rating otherwise) are not likely to impact groundwater (Section 2.5). Insufficient predicted impact from decay (since chromium is risk driver) or changes in recharge rates to modify ratings.
	Columbia River from vadose zone[a]	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 (Section 2.5). Dilution factor of greater than 100 million between River and upwellings.
	Ecological Resources[a]	ND to Low	Continued monitoring could result in some disturbance to EU, and buffer lands. Remediation may improve habitat through re-

Population or Resource		Impact Rating	Comments
			vegetation (and increased monitoring may lead to increases in exotic species, and changes in species.
Social	Cultural Resources [a]	**Native American:** Direct: Unknown Indirect: Known **Historic Pre-Hanford:** Direct: None Indirect: Unknown **Manhattan/Cold War**: Direct: None Indirect: None	Indirect effects to trail may be permanent. Permanent indirect effects to viewshed are possible from capping. Permanent effects may be possible due to presence of contamination if capping occurs.

a. Groundwater threat for Group A and B contaminants remaining in the vadose zone or to the Columbia River for all primary contaminants. Threats from existing plumes associated with the T Tank and Waste Farms EU are described in Section 2.5 and Appendix G.6 (CP-GW-2) for the 200-ZP-1 Groundwater Operable Unit.
b. 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.

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

As described in Section 2.5, the TC&WM ecological screening analysis indicate that that exposure to radioactive contaminants from peak groundwater discharge was below screening levels at the Columbia River near-shore region, indicating there should be no expected adverse effects from radionuclides. Furthermore, results of the corresponding TC&WM screening evaluation for chemicals indicated that predicted chromium and nitrate concentrations could exceed screening values (i.e., Hazard Quotient of unity) in the near-shore region. However, the predicted nitrate peak concentration was in the past and would be unlikely to exceed human or aquatic standards in the future. For chromium the long travel time from 200-West to the Columbia River likely indicates that little of the chromium predicted to impact the near-shore region would be from 200-West sources (including the T Tank and Waste Farms EU), which would also likely lead to insignificant impacts from the T Tank and Waste Farms EU.

For more information, see Section 1.6 (Appendix E.1).

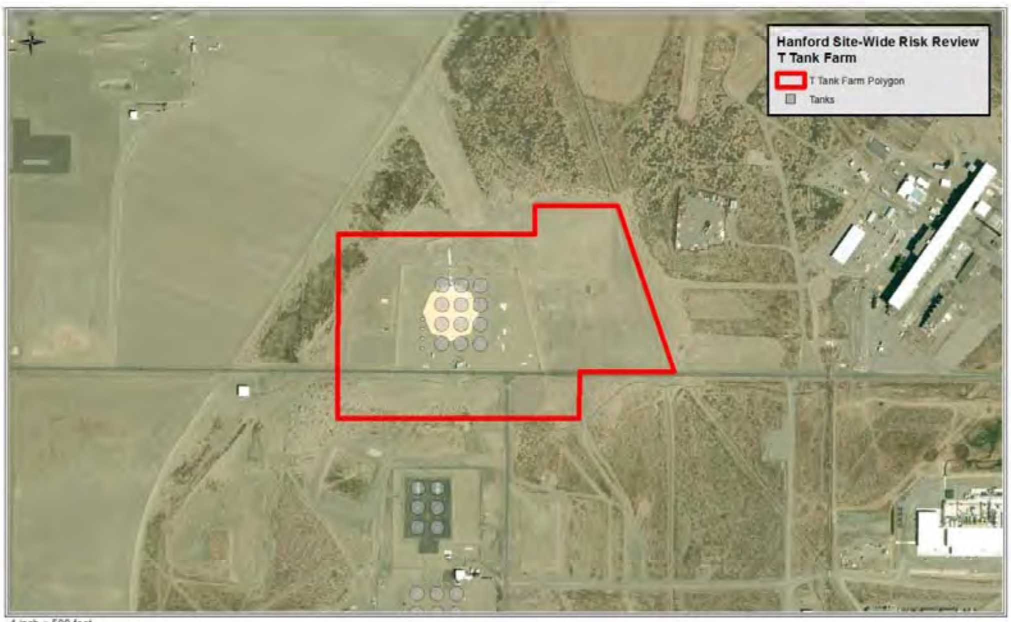
2.7. SUPPLEMENTAL INFORMATION AND CONSIDERATIONS

A common analysis was performed for all the single- and double-shell tanks. See Section 1.7 (Appendix E.1) for details.

2.8. ATTACHMENT – T TANK AND WASTE FARMS EVALUATION UNIT WIDS REVIEW

Hanford Site-Wide Risk Review

Evaluation Unit:	T Tank Farm
ID:	CP-21
Group:	TF
Operable Unit Cross-Walk:	
Related EU:	
Sites & Facilities:	T Tank Farm Ancillary structures Associated liquid waste sites Associated soils contamination
Key Data Sources Docs:	



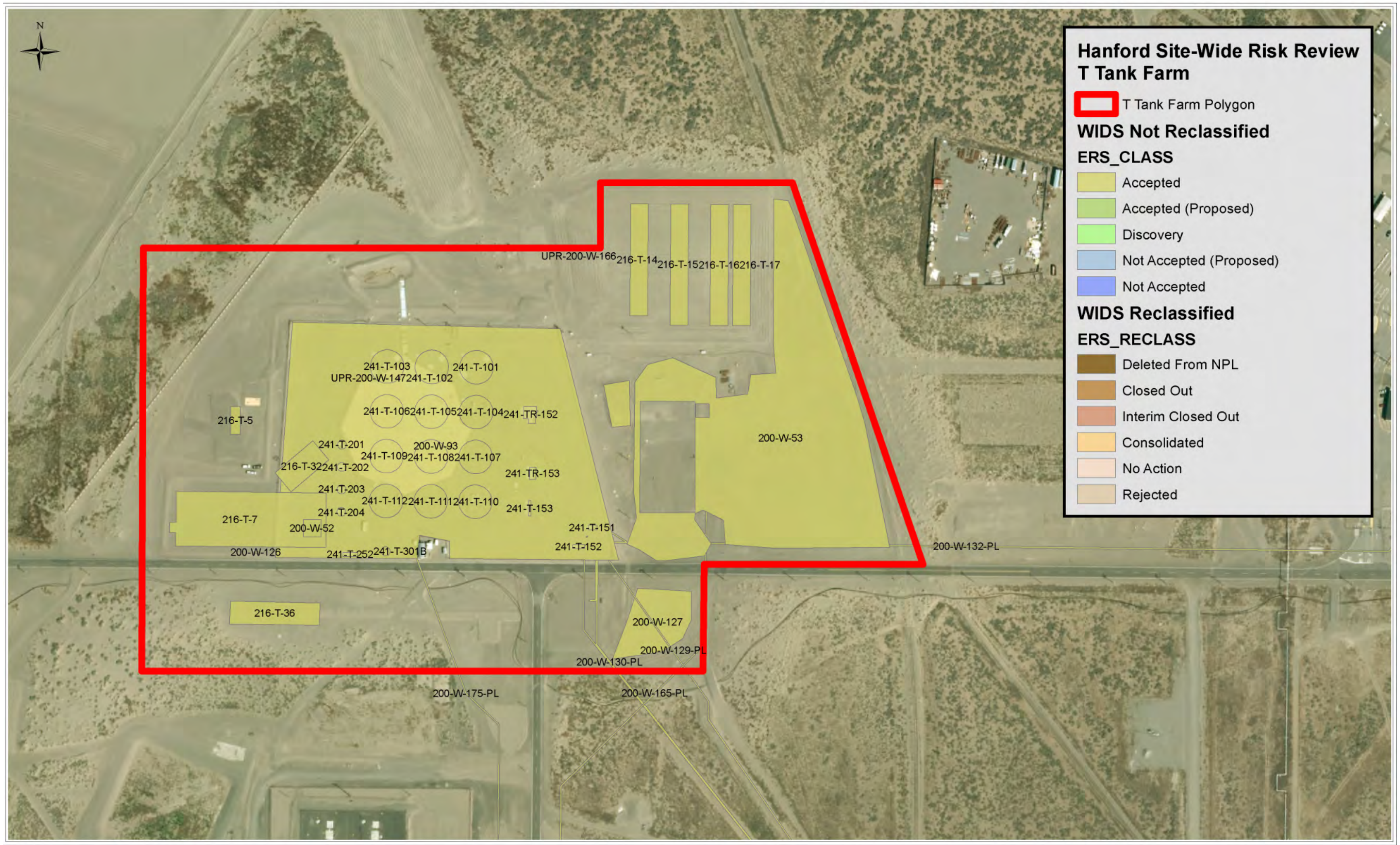
1 inch = 500 feet

Hanford Site-Wide Risk Review

Waste Sites Associated with T Tank Farm	Waste Sites Not Associated with T Tank Farm
200-W-126 (Tank Farm Vertical Storage Units; Vertical Storage Units West of 241-T Tank Farm)	200-W-163-PL (T Plant Process Sewer)
200-W-127 (Surface Stabilized Area East of UPR-200-W-29/UPR-200-W-97 (UN-216-W-5))	200-W-164-PL (Pipeline from 207-T Retention Basin to the 216-T-4 Ditch)
200-W-129-PL (Encased Pipeline from 241-T-151 and 241-T-152 to 241-TX-155 Diversion Box; Lines V399, V405 and V411)	200-W-166-PL (Pipeline from 242-T Evaporator Building to the 207-T Retention Basin)
200-W-130-PL (Pipelines from 241-T-151 and 241-T-152 Diversion Boxes to 241-U-151 Diversion Box)	200-W-167-PL (Pipeline from 242-T Evaporator to 207-T Retention Basin)
200-W-132-PL (Pipelines from 221-T to 241-T-151 and 241-T-152)	200-W-226-PL (Pipeline from 224-T (Plutonium Concentration Facility) to 241-T-361 Settling Tank and 216-T-3 Reverse Well)
200-W-165-PL (Pipeline from Tank 241-TX-112 to 207-T Retention Basin)	200-W-231 (Temporary Facilities Construction Trailer Septic Tank and Tile Field)
200-W-175-PL; (Pipeline to Route Waste from 241-T-112 to 216-TY-201 Flush Tank and 216-T-26, 216-T-27 and 216-T-28 Cribs)	200-W-88-PL (221-T Process Sewer)
200-W-52 (216-T-7 Crib; 241-T-3 Crib)	207-T (T Plant Retention Basin)
200-W-53 (UN-216-W-31; UPR-200-W-166)	200-W-90 (Underground Radioactive Material Areas Posted Along 23rd Street in 200 West Area)
200-W-78-PL (Pipeline Between 241-TX/TY and 241-T Tank Farms)	216-T-12 (207-T Sludge Grave)
200-W-79-PL (216-T-36 Crib Pipeline)	UPR-200-W-29 (23rd and Camden Line Break; Transfer Line Leak; UN-200-W-27; UN-200-W-29; UN-216-W-5; UPR-200-W-27)
200-W-93 (Contaminated Soil at 241-T Tank Farm)	UPR-200-W-63 (Road Contamination Along the South Shoulder of 23rd Street; UN-200-W-63)
216-T-14 (241-T-1 Trench; 216-T-1 Grave)	UPR-200-W-64 (Road Contamination at 23rd and Camden; UN-200-W-64)
216-T-15 (216-T-15 Crib; 241-T-2 Grave; 241-T-2 Trench)	UPR-200-W-97 (Transfer Line Leak; UN-200-W-97; UN-216-W-5)
216-T-16 (216-T-16 Crib; 241-T-3 Grave; 241-T-3 Trench)	
216-T-17 (216-T-4 Grave; 241-T-4 Trench)	
216-T-32 (216-T-6; 241-T #1 & 2 Cribs)	
216-T-36 (216-T-36 Crib)	
216-T-5 (216-T-5 Grave; 216-T-5 Trench; 241-T-5 Trench)	
216-T-7 (216-T-7 Tile Field; 216-T-7TF; 241-T-3 Tile Field)	
241-T-101 (241-T-TK-101)	
241-T-102 (241-T-TK-102)	
241-T-103 (241-T-TK-103)	

Hanford Site-Wide Risk Review

241-T-104 (241-T-TK-104)	
241-T-105 (241-T-TK-105)	
241-T-106 (241-T-TK-106)	
241-T-107 (241-T-TK-107)	
241-T-108 (241-T-TK-108)	
241-T-109 (241-T-TK-109)	
241-T-110 (241-T-TK-110)	
241-T-111 (241-T-TK-111)	
241-T-112 (241-T-TK-112)	
241-T-151 (241-T-151 Diversion Box)	
241-T-152 (241-T-152 Diversion Box)	
241-T-153 (241-T-153 Diversion Box)	
241-T-201 (241-T-TK-201)	
241-T-202 (241-T-TK-202)	
241-T-203 (241-T-TK-203)	
241-T-204 (241-T-TK-204)	
241-T-252 (241-T-252 Diversion Box)	
241-T-301B (241-T-301-B; IMUST; Inactive Miscellaneous Underground Storage Tank; Lines V664 and V727; 241-T-0301; 241-T-301 Catch Tank)	
241-T-302 (241-T-302 Catch Tank)	
241-TR-152 (241-TR-152 Diversion Box)	
241-TR-153 (241-TR-153 Booster Pump Pit; 241-TR-153 Diversion Box)	
UPR-200-W-147 (241-T-103 Leak)	
UPR-200-W-148 (241-T-106 Leak)	
UPR-200-W-166 (Contamination Migration from 241-T Tank Farm; UN-216-W-31)	
UPR-200-W-7 (Contamination Spread from the 241-T-151 and 241-T-152 Diversion Boxes; UN-200-W-7)	



1 inch = 300 feet

Hanford Site-Wide Risk Review
T Tank Farm
WIDS Export from PHOENIX

No.	Name	Site Code	Site ID	Class Status	Reclass Status	Site Status	Site Type	Hanford Area	Operable Unit
1	200-W-126; Tank Farm Vertical Storage Units; Vertical Storage Units West of 241 T Tank Farm	200 W 126	2939	Accepted	None	Inactive	Storage	200W	TBD
2	200-W-127; Surface Stabilized Area East of UPR-200-W-29/UPR-200-W-97 (UN-216-W-5)	200-W-127	2940	Accepted	None	Inactive	Unplanned Release	200W	TBD
3	200 W 129 PL; Encased Pipeline from 241 T 151 and 241 T 152 to 241-TX-155 Diversion Box; Lines V399, V405 and V411	200-W-129-PL	2938	Accepted	None	Inactive	Encased Tank Farm Pipeline	200W	TBD
4	200-W-130-PL; Lines V445, V663, V601 and V416 and Spare Lines V662, V663, V682 and V683; Pipelines from 241-T-151 and 241-T-152 Diversion Boxes to 241-U-151 Diversion Box	200-W-130-PL	2935	Accepted	None	Inactive	Direct Buried Tank Farm Pipeline	200W	TBD
5	200-W-132-PL; Pipelines from 221-T to 241-T-151 and 241-T-152; V653, V654, V667, V668, V669, V706, and V707	200 W 132 PL	2937	Accepted	None	Inactive	Direct Buried Tank Farm Pipeline	200W	TBD
6	200-W-163-PL; T Plant Process Sewer; 18-Inch 221-T Process Sewer Pipeline	200-W-163-PL	2893	Accepted	None	Inactive	Radioactive Process Sewer	200W	TBD
7	200-W-164-PL; Pipeline from 207-T Retention Basin to the 216-T-4 Ditch	200 W 164 PL	2901	Accepted	None	Inactive	Radioactive Process Sewer	200W	TBD
8	200-W-165-PL; Pipeline from Tank 241-TX-112 to 207-T Retention Basin	200 W 165 PL	2898	Accepted	None	Inactive	Radioactive Process Sewer	200W	TBD
9	200-W-166-PL; Pipeline from 242-T Evaporator Building to the 207-T Retention Basin	200-W-166-PL	2899	Accepted	None	Inactive	Radioactive Process Sewer	200W	TBD
10	200-W-167-PL; Pipeline from 242-T Evaporator to 207-T Retention Basin	200 W 167 PL	2900	Accepted	None	Inactive	Radioactive Process Sewer	200W	TBD
11	200 W 175 PL; Line V681; Pipeline to Route Waste from 241 T 112 to 216 TY 201 Flush Tank and 216 T 26, 216 T 27 and 216-T-28 Cribs	200 W 175 PL	2964	Accepted	None	Inactive	Radioactive Process Sewer	200W	TBD
12	200 W 226 PL; Lines V326, V671 and V706; Pipeline from 224 T (Plutonium Concentration Facility) to 241 T 361 Settling Tank and 216 T 3 Reverse Well	200 W 226 PL	2975	Accepted	None	Inactive	Radioactive Process Sewer	200W	TBD
13	200-W-231; Temporary Facilities Construction Trailer Septic Tank and Tile Field	200 W 231	3013	Accepted	None	Inactive	Septic Tank	200W	TBD
14	200-W-52; 216-T-7 Crib; 241-T-3 Crib	200-W-52	3202	Accepted	None	Inactive	Crib	200W	WMA T
15	200 W 53; UN 216 W 31; UPR 200 W 166	200 W 53	3203	Accepted	None	Inactive	Unplanned Release	200W	200 WA 1
16	200-W-78-PL; 6025; 7624 and 7630; Lines 6012; Pipeline Between 241-TX/TY and 241-T Tank Farms	200 W 78 PL	3236	Accepted	None	Inactive	Encased Tank Farm Pipeline	200W	TBD
17	200 W 79 PL; 216 T 36 Crib Pipeline; V663	200 W 79 PL	3237	Accepted	None	Inactive	Radioactive Process Sewer	200W	TBD
18	200-W-88-PL; 221-T Process Sewer; 24 Inch Process Sewer; T Plant Process Sewer Pipeline; 200-W-88	200 W 88 PL	3241	Accepted	None	Inactive	Radioactive Process Sewer	200W	TBD
19	200 W 90; Underground Radioactive Material Areas Posted Along 23rd Street in 200 West Area	200 W 90	2931	Accepted	None	Inactive	Unplanned Release	200W	200 WA 1
20	200-W-93; Contaminated Soil at 241-T Tank Farm	200-W-93	2930	Accepted	None	Inactive	Unplanned Release	200W	WMA T
21	207-T; 207-T Retention Basin; T Plant Retention Basin	207-T	622	Accepted	None	Inactive	Retention Basin	200W	200-WA-1
22	216 T 12; 207 T Sludge Grave; 207 T Sludge Pit; 216 T 11	216 T 12	607	Accepted	None	Inactive	Trench	200W	200 WA 1

Hanford Site-Wide Risk Review
T Tank Farm
WIDS Export from PHOENIX

No.	Name	Site Code	Site ID	Class Status	Reclass Status	Site Status	Site Type	Hanford Area	Operable Unit
23	216-T-14; 241-T-1 Trench; 216-T-1 Grave; 216-T-13	216-T-14	601	Accepted	None	Inactive	Trench	200W	200-DV-1
24	216 T 15; 216 T 15 Crib; 241 T 2 Grave; 241 T 2 Trench; 216-T-14	216-T-15	602	Accepted	None	Inactive	Trench	200W	200-DV-1
25	216-T-16; 216-T-16 Crib; 241-T-3 Grave; 241-T-3 Trench; 216-T-15	216 T 16	603	Accepted	None	Inactive	Trench	200W	200 DV 1
26	216 T 17; 216 T 4 Grave; 241 T 4 Trench; 216 T 16	216 T 17	623	Accepted	None	Inactive	Trench	200W	200 DV 1
27	216 T 32; 216 T 6; 241 T #1 & 2 Cribs	216 T 32	648	Accepted	None	Inactive	Crib	200W	200 DV 1
28	216 T 36; 216 T 36 Crib	216 T 36	630	Accepted	None	Inactive	Crib	200W	200 WA 1
29	216-T-5; 216-T-5 Grave; 216-T-5 Trench; 241-T-5 Trench; 216 T 12	216-T-5	600	Accepted	None	Inactive	Trench	200W	200-DV-1
30	216-T-7; 216-T-7 Tile Field; 216-T-7TF; 241-T-3 Tile Field	216-T-7	594	Accepted	None	Inactive	Drain/Tile Field	200W	200-DV-1
31	241-T-101; 241-T-TK-101	241-T-101	631	Accepted	None	Inactive	Single-Shell Tank	200W	WMA T
32	241-T-102; 241-T-TK-102	241-T-102	632	Accepted	None	Inactive	Single-Shell Tank	200W	WMA T
33	241-T-103; 241-T-TK-103	241-T-103	633	Accepted	None	Inactive	Single-Shell Tank	200W	WMA T
34	241-T-104; 241-T-TK-104	241-T-104	1897	Accepted	None	Inactive	Single-Shell Tank	200W	WMA T
35	241-T-105; 241-T-TK-105	241-T-105	3161	Accepted	None	Inactive	Single-Shell Tank	200W	WMA T
36	241 T 106; 241 T TK 106	241 T 106	3162	Accepted	None	Inactive	Single Shell Tank	200W	WMA T
37	241-T-107; 241-T-TK-107	241-T-107	3163	Accepted	None	Inactive	Single-Shell Tank	200W	WMA T
38	241 T 108; 241 T TK 108	241 T 108	3160	Accepted	None	Inactive	Single Shell Tank	200W	WMA T
39	241 T 109; 241 T TK 109	241 T 109	3157	Accepted	None	Inactive	Single Shell Tank	200W	WMA T
40	241 T 110; 241 T TK 110	241 T 110	3158	Accepted	None	Inactive	Single Shell Tank	200W	WMA T
41	241 T 111; 241 T TK 111	241 T 111	3159	Accepted	None	Inactive	Single Shell Tank	200W	WMA T
42	241 T 112; 241 T TK 112	241 T 112	3168	Accepted	None	Inactive	Single Shell Tank	200W	WMA T
43	241 T 151; 241 T 151 Diversion Box	241 T 151	3169	Accepted	None	Inactive	Diversion Box	200W	WMA T
44	241-T-152; 241-T-152 Diversion Box	241-T-152	3170	Accepted	None	Inactive	Diversion Box	200W	WMA T
45	241 T 153; 241 T 153 Diversion Box	241 T 153	3167	Accepted	None	Inactive	Diversion Box	200W	WMA T
46	241-T-201; 241-T-TK-201	241-T-201	3164	Accepted	None	Inactive	Single-Shell Tank	200W	WMA T
47	241-T-202; 241-T-TK-202	241-T-202	3165	Accepted	None	Inactive	Single-Shell Tank	200W	WMA T
48	241-T-203; 241-T-TK-203	241-T-203	3166	Accepted	None	Inactive	Single-Shell Tank	200W	WMA T
49	241-T-204; 241-T-TK-204	241-T-204	3156	Accepted	None	Inactive	Single-Shell Tank	200W	WMA T
50	241-T-252; 241-T-252 Diversion Box	241-T-252	3146	Accepted	None	Inactive	Diversion Box	200W	WMA T
51	241-T-301B; 241-T-301-B; IMUST; Inactive Miscellaneous Underground Storage Tank; Lines V664 and V727; 241-T-0301; 241 T 301 Catch Tank	241-T-301B	3147	Accepted	None	Inactive	Catch Tank	200W	WMA T
52	241-T-302; 241-T-302 Catch Tank	241-T-302	3148	Accepted	Rejected	Inactive	Catch Tank	200W	Not Applic
53	241 TR 152; 241 TR 152 Diversion Box; Line 6053	241 TR 152	3154	Accepted	None	Inactive	Diversion Box	200W	WMA T
54	241-TR-153; 241-TR-153 Booster Pump Pit; 241-TR-153 Diversion Box; Line 6172	241-TR-153	3155	Accepted	None	Inactive	Diversion Box	200W	WMA T
55	UPR 200 W 147; 241 T 103 Leak	UPR 200 W 147	2563	Accepted	Consolidated	Inactive	Unplanned Release	200W	Not Applic
56	UPR-200-W-148; 241-T-106 Leak	UPR-200-W-148	2560	Accepted	Consolidated	Inactive	Unplanned Release	200W	Not Applic
57	UPR-200-W-166; Contamination Migration from 241-T Tank Farm; UN 216 W 31	UPR-200-W-166	2603	Accepted	None	Inactive	Unplanned Release	200W	200-WA-1

Hanford Site-Wide Risk Review
T Tank Farm
WIDS Export from PHOENIX

No.	Name	Site Code	Site ID	Class Status	Reclass Status	Site Status	Site Type	Hanford Area	Operable Unit
58	UPR-200-W-29; 23rd and Camden Line Break; Transfer Line Leak; UN-200-W-27; UN-200-W-29; UN-216-W-5; UPR-200-W-27	UPR-200-W-29	2487	Accepted	None	Inactive	Unplanned Release	200W	200-IS-1
59	UPR-200-W-63; Road Contamination Along the South Shoulder of 23rd Street; UN-200-W-63	UPR-200-W-63	2397	Accepted	None	Inactive	Unplanned Release	200W	200-WA-1
60	UPR-200-W-64; Road Contamination at 23rd and Camden; UN-200-W-64	UPR-200-W-64	2394	Accepted	None	Inactive	Unplanned Release	200W	200-IS-1
61	UPR-200-W-7; Contamination Spread from the 241-T-151 and 241-T-152 Diversion Boxes; UN-200-W-7	UPR-200-W-7	2434	Accepted	Consolidated	Inactive	Unplanned Release	200W	Not Applic
62	UPR-200-W-97; Transfer Line Leak; UN-200-W-97; UN-216-W-5	UPR-200-W-97	2427	Accepted	None	Inactive	Unplanned Release	200W	200-IS-1

Hanford Site-Wide Risk Review
T Tank Farm
WIDS Export from PHOENIX

No.	Name	Contractor	Responsible Project	Unit Category	Photos	Map Authority
1	200-W-126; Tank Farm Vertical Storage Units; Vertical Storage Units West of 241-T Tank Farm	Washington River Protection Solutions	Not Specified	Waste Management Area (WMA) Related	Yes	CHPRC
2	200-W-127; Surface Stabilized Area East of UPR-200-W-29/UPR-200-W-97 (UN-216-W-5)	CH2M HILL Plateau Remediation Company	Central Plateau Surveillance and Maintenance	To Be Determined (TBD)	Yes	CHPRC
3	200 W 129 PL; Encased Pipeline from 241 T 151 and 241 T 152 to 241 TX 155 Diversion Box; Lines V399, V405 and V411	CH2M HILL Plateau Remediation Company	Not Specified	Treatment, Storage and Disposal (TSD)	0	CHPRC
4	200-W-130-PL; Lines V445, V663, V601 and V416 and Spare Lines V662, V663, V682 and V683; Pipelines from 241-T 151 and 241 T 152 Diversion Boxes to 241 U 151 Diversion Box	CH2M HILL Plateau Remediation Company	Not Specified	Treatment, Storage and Disposal (TSD)	0	CHPRC
5	200 W 132 PL; Pipelines from 221 T to 241 T 151 and 241 T 152; V653, V654, V667, V668, V669, V706, and V707	CH2M HILL Plateau Remediation Company	Not Specified	Treatment, Storage and Disposal (TSD)	0	CHPRC
6	200 W 163 PL; T Plant Process Sewer; 18 Inch 221 T Process Sewer Pipeline	None	Not Specified	To Be Determined (TBD)	0	CHPRC
7	200 W 164 PL; Pipeline from 207 T Retention Basin to the 216-T-4 Ditch	None	Not Specified	To Be Determined (TBD)	0	CHPRC
8	200-W-165-PL; Pipeline from Tank 241-TX-112 to 207-T Retention Basin	None	Not Specified	To Be Determined (TBD)	0	CHPRC
9	200-W-166-PL; Pipeline from 242-T Evaporator Building to the 207-T Retention Basin	None	Not Specified	To Be Determined (TBD)	0	CHPRC
10	200-W-167-PL; Pipeline from 242-T Evaporator to 207-T Retention Basin	None	Not Specified	Treatment, Storage and Disposal (TSD)	0	CHPRC
11	200 W 175 PL; Line V681; Pipeline to Route Waste from 241-T-112 to 216-TY-201 Flush Tank and 216-T-26, 216-T-27 and 216-T-28 Cribs	None	Not Specified	To Be Determined (TBD)	0	CHPRC
12	200-W-226-PL; Lines V326, V671 and V706; Pipeline from 224-T (Plutonium Concentration Facility) to 241-T-361 Settling Tank and 216-T-3 Reverse Well	None	Not Specified	To Be Determined (TBD)	0	CHPRC
13	200 W 231; Temporary Facilities Construction Trailer Septic Tank and Tile Field	None	Not Specified	To Be Determined (TBD)	0	CHPRC
14	200-W-52; 216-T-7 Crib; 241-T-3 Crib	Washington River Protection Solutions	Not Specified	RCRA Past Practice (RPP)	Yes	CHPRC
15	200-W-53; UN-216-W-31; UPR-200-W-166	CH2M HILL Plateau Remediation Company	Not Specified	CERCLA Past Practice (CPP)	Yes	CHPRC
16	200-W-78-PL; 6025; 7624 and 7630; Lines 6012; Pipeline Between 241-TX/TY and 241-T Tank Farms	CH2M HILL Plateau Remediation Company	Not Specified	Treatment, Storage and Disposal (TSD)	Yes	CHPRC
17	200 W 79 PL; 216 T 36 Crib Pipeline; V663	CH2M HILL Plateau Remediation Company	Central Plateau Surveillance and Maintenance	Treatment, Storage and Disposal (TSD)	Yes	CHPRC
18	200-W-88-PL; 221-T Process Sewer; 24 Inch Process Sewer; T Plant Process Sewer Pipeline; 200-W-88	CH2M HILL Plateau Remediation Company	Central Plateau - Surveillance and Maintenance	To Be Determined (TBD)	Yes	CHPRC
19	200-W-90; Underground Radioactive Material Areas Posted Along 23rd Street in 200 West Area	CH2M HILL Plateau Remediation Company	Central Plateau - Surveillance and Maintenance	CERCLA Past Practice (CPP)	Yes	CHPRC
20	200 W 93; Contaminated Soil at 241 T Tank Farm	Washington River Protection Solutions	Not Specified	Waste Management Area (WMA) Related	Yes	CHPRC
21	207-T; 207-T Retention Basin; T Plant Retention Basin	CH2M HILL Plateau Remediation Company	Central Plateau - Surveillance and Maintenance	CERCLA Past Practice (CPP)	Yes	CHPRC
22	216-T-12; 207-T Sludge Grave; 207-T Sludge Pit; 216-T-11	CH2M HILL Plateau Remediation Company	Central Plateau - Surveillance and Maintenance	CERCLA Past Practice (CPP)	0	CHPRC

Hanford Site-Wide Risk Review
T Tank Farm
WIDS Export from PHOENIX

No.	Name	Contractor	Responsible Project	Unit Category	Photos	Map Authority
23	216-T-14; 241-T-1 Trench; 216-T-1 Grave; 216-T-13	CH2M HILL Plateau Remediation Company	Central Plateau - Surveillance and Maintenance	RCRA-CERCLA Past Practice (R-CPP)	Yes	CHPRC
24	216 T 15; 216 T 15 Crib; 241 T 2 Grave; 241 T 2 Trench; 216-T-14	CH2M HILL Plateau Remediation Company	Central Plateau - Surveillance and Maintenance	RCRA-CERCLA Past Practice (R-CPP)	0	CHPRC
25	216-T-16; 216-T-16 Crib; 241-T-3 Grave; 241-T-3 Trench; 216-T-15	CH2M HILL Plateau Remediation Company	Central Plateau Surveillance and Maintenance	RCRA CERCLA Past Practice (R CPP)	0	CHPRC
26	216 T 17; 216 T 4 Grave; 241 T 4 Trench; 216 T 16	CH2M HILL Plateau Remediation Company	Central Plateau Surveillance and Maintenance	RCRA CERCLA Past Practice (R CPP)	0	CHPRC
27	216 T 32; 216 T 6; 241 T #1 & 2 Cribs	CH2M HILL Plateau Remediation Company	Not Specified	RCRA CERCLA Past Practice (R CPP)	Yes	CHPRC
28	216 T 36; 216 T 36 Crib	CH2M HILL Plateau Remediation Company	Central Plateau Surveillance and Maintenance	CERCLA Past Practice (CPP)	0	CHPRC
29	216-T-5; 216-T-5 Grave; 216-T-5 Trench; 241-T-5 Trench; 216 T 12	CH2M HILL Plateau Remediation Company	Central Plateau - Surveillance and Maintenance	RCRA-CERCLA Past Practice (R-CPP)	Yes	CHPRC
30	216-T-7; 216-T-7 Tile Field; 216-T-7TF; 241-T-3 Tile Field	CH2M HILL Plateau Remediation Company	Central Plateau - Surveillance and Maintenance	RCRA-CERCLA Past Practice (R-CPP)	Yes	CHPRC
31	241-T-101; 241-T-TK-101	Washington River Protection Solutions	Not Specified	Treatment, Storage and Disposal (TSD)	Yes	CHPRC
32	241-T-102; 241-T-TK-102	Washington River Protection Solutions	Not Specified	Treatment, Storage and Disposal (TSD)	Yes	CHPRC
33	241-T-103; 241-T-TK-103	Washington River Protection Solutions	Not Specified	Treatment, Storage and Disposal (TSD)	Yes	CHPRC
34	241-T-104; 241-T-TK-104	Washington River Protection Solutions	Not Specified	Treatment, Storage and Disposal (TSD)	Yes	CHPRC
35	241-T-105; 241-T-TK-105	Washington River Protection Solutions	Not Specified	Treatment, Storage and Disposal (TSD)	Yes	CHPRC
36	241 T 106; 241 T TK 106	Washington River Protection Solutions	Not Specified	Treatment, Storage and Disposal (TSD)	Yes	CHPRC
37	241-T-107; 241-T-TK-107	Washington River Protection Solutions	Not Specified	Treatment, Storage and Disposal (TSD)	Yes	CHPRC
38	241 T 108; 241 T TK 108	Washington River Protection Solutions	Not Specified	Treatment, Storage and Disposal (TSD)	Yes	CHPRC
39	241 T 109; 241 T TK 109	Washington River Protection Solutions	Not Specified	Treatment, Storage and Disposal (TSD)	Yes	CHPRC
40	241 T 110; 241 T TK 110	Washington River Protection Solutions	Not Specified	Treatment, Storage and Disposal (TSD)	Yes	CHPRC
41	241 T 111; 241 T TK 111	Washington River Protection Solutions	Not Specified	Treatment, Storage and Disposal (TSD)	Yes	CHPRC
42	241 T 112; 241 T TK 112	Washington River Protection Solutions	Not Specified	Treatment, Storage and Disposal (TSD)	Yes	CHPRC
43	241 T 151; 241 T 151 Diversion Box	Washington River Protection Solutions	Not Specified	Treatment, Storage and Disposal (TSD)	Yes	CHPRC
44	241-T-152; 241-T-152 Diversion Box	Washington River Protection Solutions	Not Specified	Treatment, Storage and Disposal (TSD)	Yes	CHPRC
45	241 T 153; 241 T 153 Diversion Box	Washington River Protection Solutions	Not Specified	Treatment, Storage and Disposal (TSD)	Yes	CHPRC
46	241-T-201; 241-T-TK-201	Washington River Protection Solutions	Not Specified	Treatment, Storage and Disposal (TSD)	Yes	CHPRC
47	241-T-202; 241-T-TK-202	Washington River Protection Solutions	Not Specified	Treatment, Storage and Disposal (TSD)	Yes	CHPRC
48	241-T-203; 241-T-TK-203	Washington River Protection Solutions	Not Specified	Treatment, Storage and Disposal (TSD)	Yes	CHPRC
49	241-T-204; 241-T-TK-204	Washington River Protection Solutions	Not Specified	Treatment, Storage and Disposal (TSD)	Yes	CHPRC
50	241-T-252; 241-T-252 Diversion Box	Washington River Protection Solutions	Not Specified	Treatment, Storage and Disposal (TSD)	Yes	CHPRC
51	241-T-301B; 241-T-301-B; IMUST; Inactive Miscellaneous Underground Storage Tank; Lines V664 and V727; 241-T-0301; 241 T 301 Catch Tank	Washington River Protection Solutions	Not Specified	Waste Management Area (WMA) Related	Yes	CHPRC
52	241-T-302; 241-T-302 Catch Tank	Washington River Protection Solutions	Not Specified	To Be Determined (TBD)	0	CHPRC
53	241 TR 152; 241 TR 152 Diversion Box; Line 6053	Washington River Protection Solutions	Not Specified	Treatment, Storage and Disposal (TSD)	Yes	CHPRC
54	241-TR-153; 241-TR-153 Booster Pump Pit; 241-TR-153 Diversion Box; Line 6172	Washington River Protection Solutions	Not Specified	Treatment, Storage and Disposal (TSD)	Yes	CHPRC
55	UPR 200 W 147; 241 T 103 Leak	Washington River Protection Solutions	Not Specified	To Be Determined (TBD)	Yes	CHPRC
56	UPR-200-W-148; 241-T-106 Leak	Washington River Protection Solutions	Not Specified	To Be Determined (TBD)	0	CHPRC
57	UPR-200-W-166; Contamination Migration from 241-T Tank Farm; UN 216 W 31	CH2M HILL Plateau Remediation Company	Central Plateau - Surveillance and Maintenance	CERCLA Past Practice (CPP)	Yes	CHPRC

Hanford Site-Wide Risk Review
T Tank Farm
WIDS Export from PHOENIX

No.	Name	Contractor	Responsible Project	Unit Category	Photos	Map Authority
58	UPR-200-W-29; 23rd and Camden Line Break; Transfer Line Leak; UN-200-W-27; UN-200-W-29; UN-216-W-5; UPR-200-W-27	CH2M HILL Plateau Remediation Company	Not Specified	RCRA-CERCLA Past Practice (R-CPP)	Yes	CHPRC
59	UPR-200-W-63; Road Contamination Along the South Shoulder of 23rd Street; UN-200-W-63	CH2M HILL Plateau Remediation Company	Central Plateau - Surveillance and Maintenance	CERCLA Past Practice (CPP)	0	CHPRC
60	UPR-200-W-64; Road Contamination at 23rd and Camden; UN-200-W-64	CH2M HILL Plateau Remediation Company	Not Specified	RCRA-CERCLA Past Practice (R-CPP)	Yes	CHPRC
61	UPR-200-W-7; Contamination Spread from the 241-T-151 and 241-T-152 Diversion Boxes; UN-200-W-7	Washington River Protection Solutions	Not Specified	To Be Determined (TBD)	0	CHPRC
62	UPR-200-W-97; Transfer Line Leak; UN-200-W-97; UN-216-W-5	CH2M HILL Plateau Remediation Company	Not Specified	RCRA-CERCLA Past Practice (R-CPP)	Yes	CHPRC

Hanford Site-Wide Risk Review
T Tank Farm
WIDS Export from PHOENIX

No.	Name	ERS_OP_DES	SWMUFLAG
1	200-W-126; Tank Farm Vertical Storage Units; Vertical Storage Units West of 241-T Tank Farm	0	Yes
2	200-W-127; Surface Stabilized Area East of UPR-200-W-29/UPR-200-W-97 (UN-216-W-5)	0	No
3	200 W 129 PL; Encased Pipeline from 241 T 151 and 241 T 152 to 241 TX 155 Diversion Box; Lines V399, V405 and V411	0	Yes
4	200-W-130-PL; Lines V445, V663, V601 and V416 and Spare Lines V662, V663, V682 and V683; Pipelines from 241-T 151 and 241 T 152 Diversion Boxes to 241 U 151 Diversion Box	0	Yes
5	200 W 132 PL; Pipelines from 221 T to 241 T 151 and 241 T 152; V653, V654, V667, V668, V669, V706, and V707	0	Yes
6	200 W 163 PL; T Plant Process Sewer; 18 Inch 221 T Process Sewer Pipeline	0	Yes
7	200 W 164 PL; Pipeline from 207 T Retention Basin to the 216-T-4 Ditch	0	Yes
8	200-W-165-PL; Pipeline from Tank 241-TX-112 to 207-T Retention Basin	0	Yes
9	200-W-166-PL; Pipeline from 242-T Evaporator Building to the 207-T Retention Basin	0	Yes
10	200-W-167-PL; Pipeline from 242-T Evaporator to 207-T Retention Basin	0	Yes
11	200 W 175 PL; Line V681; Pipeline to Route Waste from 241-T-112 to 216-TY-201 Flush Tank and 216-T-26, 216-T-27 and 216-T-28 Cribs	0	Yes
12	200-W-226-PL; Lines V326, V671 and V706; Pipeline from 224-T (Plutonium Concentration Facility) to 241-T-361 Settling Tank and 216-T-3 Reverse Well	0	Yes
13	200 W 231; Temporary Facilities Construction Trailer Septic Tank and Tile Field	0	Yes
14	200-W-52; 216-T-7 Crib; 241-T-3 Crib	0	Yes
15	200-W-53; UN-216-W-31; UPR-200-W-166	0	No
16	200-W-78-PL; 6025; 7624 and 7630; Lines 6012; Pipeline Between 241-TX/TY and 241-T Tank Farms	0	Yes
17	200 W 79 PL; 216 T 36 Crib Pipeline; V663	0	Yes
18	200-W-88-PL; 221-T Process Sewer; 24 Inch Process Sewer; T Plant Process Sewer Pipeline; 200-W-88	0	No
19	200-W-90; Underground Radioactive Material Areas Posted Along 23rd Street in 200 West Area	0	No
20	200 W 93; Contaminated Soil at 241 T Tank Farm	0	No
21	207-T; 207-T Retention Basin; T Plant Retention Basin	0	Yes
22	216-T-12; 207-T Sludge Grave; 207-T Sludge Pit; 216-T-11	0	Yes

Hanford Site-Wide Risk Review
T Tank Farm
WIDS Export from PHOENIX

No.	Name	ERS_OP_DES	SWMUFLAG
23	216-T-14; 241-T-1 Trench; 216-T-1 Grave; 216-T-13	0	Yes
24	216 T 15; 216 T 15 Crib; 241 T 2 Grave; 241 T 2 Trench; 216-T-14	0	Yes
25	216-T-16; 216-T-16 Crib; 241-T-3 Grave; 241-T-3 Trench; 216-T-15	0	Yes
26	216 T 17; 216 T 4 Grave; 241 T 4 Trench; 216 T 16	0	Yes
27	216 T 32; 216 T 6; 241 T #1 & 2 Cribs	0	Yes
28	216 T 36; 216 T 36 Crib	0	Yes
29	216-T-5; 216-T-5 Grave; 216-T-5 Trench; 241-T-5 Trench; 216 T 12	0	Yes
30	216-T-7; 216-T-7 Tile Field; 216-T-7TF; 241-T-3 Tile Field	0	Yes
31	241-T-101; 241-T-TK-101	0	Yes
32	241-T-102; 241-T-TK-102	0	Yes
33	241-T-103; 241-T-TK-103	0	Yes
34	241-T-104; 241-T-TK-104	0	Yes
35	241-T-105; 241-T-TK-105	0	Yes
36	241 T 106; 241 T TK 106	0	Yes
37	241-T-107; 241-T-TK-107	0	Yes
38	241 T 108; 241 T TK 108	0	Yes
39	241 T 109; 241 T TK 109	0	Yes
40	241 T 110; 241 T TK 110	0	Yes
41	241 T 111; 241 T TK 111	0	Yes
42	241 T 112; 241 T TK 112	0	Yes
43	241 T 151; 241 T 151 Diversion Box	0	Yes
44	241-T-152; 241-T-152 Diversion Box	0	Yes
45	241 T 153; 241 T 153 Diversion Box	0	Yes
46	241-T-201; 241-T-TK-201	0	Yes
47	241-T-202; 241-T-TK-202	0	Yes
48	241-T-203; 241-T-TK-203	0	Yes
49	241-T-204; 241-T-TK-204	0	Yes
50	241-T-252; 241-T-252 Diversion Box	0	Yes
51	241-T-301B; 241-T-301-B; IMUST; Inactive Miscellaneous Underground Storage Tank; Lines V664 and V727; 241-T-0301; 241 T 301 Catch Tank	0	Yes
52	241-T-302; 241-T-302 Catch Tank	0	Yes
53	241 TR 152; 241 TR 152 Diversion Box; Line 6053	0	Yes
54	241-TR-153; 241-TR-153 Booster Pump Pit; 241-TR-153 Diversion Box; Line 6172	0	Yes
55	UPR 200 W 147; 241 T 103 Leak	0	No
56	UPR-200-W-148; 241-T-106 Leak	0	No
57	UPR-200-W-166; Contamination Migration from 241-T Tank Farm; UN 216 W 31	0	No

Hanford Site-Wide Risk Review
T Tank Farm
WIDS Export from PHOENIX

No.	Name	ERS_OP_DES	SWMUFLAG
58	UPR-200-W-29; 23rd and Camden Line Break; Transfer Line Leak; UN-200-W-27; UN-200-W-29; UN-216-W-5; UPR-200 W 27	Infrastructure	No
59	UPR-200-W-63; Road Contamination Along the South Shoulder of 23rd Street; UN-200-W-63	0	No
60	UPR-200-W-64; Road Contamination at 23rd and Camden; UN-200-W-64	Infrastructure	No
61	UPR-200-W-7; Contamination Spread from the 241-T-151 and 241-T-152 Diversion Boxes; UN-200-W-7	0	No
62	UPR-200-W-97; Transfer Line Leak; UN-200-W-97; UN-216-W 5	Infrastructure	No

APPENDIX E.3

Tank Waste and Farms

CP-TF-2 (S-SX Tank Waste and Farms)
Evaluation Unit Summary Template

Table of Contents

List of Figures

List of Tables

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PART 3. CP-TF-2 S-SX SINGLE-SHELL TANK WASTE AND FARMS (200-W)

3.1. EXECUTIVE SUMMARY

Much of the information related to the S-SX Tank and Waste Farms Evaluation Unit (EU) is organized around the corresponding Waste Management Area (namely WMA S-SX) that is regulated under the Resource Conservation and Recovery Act (RCRA) and Washington's Hazardous Waste Management Act (HWMA, RCW 70.105) and its implementing requirements (Washington's Dangerous Waste Regulations, WAC 173-303) (Johnson&Chou 1999).

EU LOCATION:

South-Central part of 200-West on the Hanford Reservation; Central Plateau

RELATED EUS:

T Tank Waste and Farms (CP-TF-1), TX-TY Tank Waste and Farms (CP-TF-3), U Tank Waste and Farms (CP-TF-4), A-AX Tank Waste and Farms (CP-TF-5), B-BX-BY Tank Waste and Farms (CP-TF-6), C Tank Waste and Farms (CP-TF-7), 200-East DST Waste and Farms (CP-TF-8), 200-West DST Waste and Farms (CP-TF-9), 200-E Groundwater Plumes (CP-GW-1), 200-W Groundwater Plumes (CP-GW-2), and 200 Area Waste Transfer Pipeline (CP-LS-7)

PRIMARY CONTAMINANTS, CONTAMINATED MEDIA AND WASTES:

The TC&WM EIS describes tank wastes as including radioactive (tritium or H-3, C-14, Sr-90, Tc-99, I-129, Cs-137, U-233, U-234, U-235, U-238, Np-237, Pu-239, and Pu-240)[43] and non-radioactive contaminants (chromium, mercury, nitrate, lead, total uranium, and PCBs) of potential concern (DOE/EIS-0391 2012, Appendix D). The tank wastes contain saltcake, sludge, and supernatant phases. Contaminated media related to the S-SX Tank Farms include ancillary equipment and surrounding vadose zone (including cribs and trenches) down to the saturated zone (for some mobile contaminants) from past and current discharges. The Interim Record of Decision for the 200-UP-1 Operable Unit (OU) (EPA 2012) associated with WMA S-SX identifies I-129, Tc-99, tritium, uranium, nitrate, and chromium as tank waste constituents that must be addressed in cleanup; carbon tetrachloride is also listed but is not a tank waste. The 2013 Groundwater Monitoring Report (DOE/RL-2014-32, Rev. 0) lists tank wastes including chromium, nitrate, I-129, Tc-99, H-3, and uranium and the carbon tetrachloride (non-tank) waste for the 200-UP-1 OU.

After evaluating the contaminants associated with S-SX Tank Farm tanks, ancillary equipment, legacy sources, and contaminated vadose zone, the primary contaminants from the tank wastes that drive human health risk to groundwater for the S-SX Tank and Waste Farms Evaluation Unit are: Tc-99, chromium, and nitrate. Those primary contaminants that may drive risk from groundwater discharge to the Columbia River are nitrate and chromium; however, any impacts are highly uncertain (see Section 2.1). Cs-137 and Sr-90 are important from a safety standpoint and uranium isotopes, plutonium

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[43] Other isotopes considered include U-232 and U-236 and Pu-238, Pu-241, and Pu-242 to be consistent with other EUs. These additional uranium and plutonium isotopes are included in the totals presented but are not used for rating because 1) uranium toxicity impacts (represented by total uranium drives corresponding risks and 2) plutonium has been found relatively immobile in the Hanford subsurface and has not been identified as a risk driver for groundwater impacts.

isotopes, and tritium are iconic constituents; these contaminants are included in the inventory summary even though they are not considered risk drivers for impacts to or from groundwater in this review. Carbon tetrachloride is not tank wastes and thus is captured in Appendix G.6 for the CP-GW-2 EU (200-UP-1 GW OU).

BRIEF NARRATIVE DESCRIPTION:

Waste Management Area S-SX (WMA S-SX) occupies approximately 15 acres and contains 12 underground single-shell tanks (SSTs) in S Tank Farm and 15 SSTs in SX Tank Farm in additional to ancillary equipment (e.g., diversion boxes, pumps, valves, and pipes). The S Tank Farm was constructed in 1950-1951 and the SX Tank Farm in 1953-1955 (ORP-11242, Rev. 6, p. 3-2). The S-SX Tank Farm tanks received primarily redox wastes and salt and slurry cake from evaporator campaigns (Agnew 1997; Remund et al. 1995).

The S Tank Farm contains 12 carbon steel tanks with capacities of 758 kGal and began receiving REDOX wastes in 1951. Some S Tank Farm tanks began to boil because of the high radioactive decay heat load in the REDOX wastes (Wood et al. 1999). A condenser was added to remove excess liquid from the S Tank Farm tanks, and collected liquids were discharged to cribs. The S Tank Farm tanks received 242-S Evaporator solids after the REDOX Plant was decommissioned. Only one S Tank Farm tank (241-S-104) is classified an assumed leaker (Weyns 2014). The S Tank Farms tanks were removed from service beginning in the late 1970s with completion in the early 1980s.

The SX Tank Farm contains 15 carbon steel tanks with capacities of 1,000 Kgal in additional to ancillary equipment (e.g., diversion boxes, pumps, valves, and pipes). The first six SX Tank Farm tanks began receiving REDOX Plant wastes in 1954 (and are currently at least half full of mostly saltcake and some sludge solids); the remaining nine tanks began receiving REDOX Plant wastes in 1955. Ten SX Tank Farm tanks (241-SX-105 and 241-SX-107 through 241-SX-115) were designed to manage high-boiling REDOX wastes by allowing collecting and returning condensates from evaporated supernate to the tanks; this process helped reduce high heat loads in the tanks (Wood et al. 1999). Eight of the ten SX Tank Farm tanks that operated as “boiling waste tanks” are currently considered assumed leakers (Weyns 2014). The SX Tank Farms tanks were removed from service by 1980.

There are various cribs in the area around the S-SX Tank Farms that received large volumes of slightly contaminated waste from Tank Farms and other waste streams (although it appears that tank wastes were not directly cascaded from the S-SX Tank Farm tanks to the cribs). Nine of the SSTs in WMA S-SX are declared “assumed leakers,” and there have been 25 unplanned releases documented in or near WMA S-SX. This information is summarized in Section 3.3.

The SSTs in WMA S-SX have been interim stabilized (i.e., liquid transferred to DSTs to <50 kgal drainable interstitial liquid and <5 kgal of supernatant), and a groundwater extraction system has been in operation since 2012 to extract Tc-99 and other contaminants.

SUMMARY TABLES OF RISKS AND POTENTIAL IMPACTS TO RECEPTORS

Table E.3-1 provides a summary of nuclear and industrial safety related consequences from CP-TF-2 (S-SX Tank and Waste Farms EU) to humans and impacts to important physical Hanford Site resources. Receptors are described in Section 1.6 (Appendix E.1).

Table E.3-1. CP-TF-2 (S-SX Tank Farms) impact Rating Summary for Human Health (unmitigated basis with mitigated basis provided in parentheses (e.g., "High (Low)").

Population or Resource		Evaluation Time Period[a] – Active Cleanup (to 2064): **Current Condition:** Maintenance & Monitoring (M&M)	Evaluation Time Period[a] – Active Cleanup (to 2064): **From Cleanup Actions:** Retrieval & Closure
Human Health	Facility Worker[b]	***M&M***: Low-High[d] (Low-High)[d] ***Soil***: ND-High (ND-Low)	***Preferred method***: High (Low) ***Alternative***: High (Low)
Human Health	Co-located Person[b]	***M&M***: Low-Moderate (Low) ***Soil***: ND (ND)	***Preferred method***: Low-Moderate (Low) ***Alternative***: Low-Moderate (Low)
Human Health	Public[b]	***M&M***: Low (Low) ***Soil***: ND (ND)	***Preferred method***: Low (Low) ***Alternative***: Low (Low)
Environmental	Groundwater (A&B) from vadose zone[c]	High -- Cr(tot, VI)[f] **Overall**: High	High -- Cr(tot, VI)[f] **Overall**: High
Environmental	Columbia River from vadose zone[c]	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
Environmental	Ecological Resources[e]	ND to Low	Low to Medium
Social	Cultural Resources[e]	**Native American:** Direct: Unknown Indirect: Known **Historic Pre-Hanford:** Direct: Known Indirect: Unknown **Manhattan/Cold War:** Direct: Known Indirect: Unknown	**Native American:** Direct: Unknown Indirect: Known **Historic Pre-Hanford:** Direct: Known Indirect: Unknown **Manhattan/Cold War:** Direct: Known Indirect: Unknown

a. A rating for cultural resources is not being made because cultural resources will be evaluated under Section 106 of the National Historic Preservation Act (16 USC 470, et. seq.) during the planning for remedial action.

b. Evaluated in Section 1.6 (Appendix E.1).

c. Groundwater threat for Group A and B contaminants remaining in the vadose zone or to the Columbia River for all primary contaminants. Threats from existing plumes associated with the S-SX

Tank and Waste Farms EU are described in Section 3.5 and Appendix G.6 (CP-GW-2) for the 200-UP-1 Groundwater Operable Unit

d. Industrial safety consequences range from low to high (based on the evaluation scale used) for both mitigated (with controls) and unmitigated (without controls). Mitigated radiological and toxicological consequences to facility workers are high (unmitigated) and low (mitigated).
e. 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.
f. The large amount of Sr-90 disposed of in the S-SX Tank and Waste Farms EU would translate to a *Very High* rating; however, there is no current Sr-90 plume in the 200-UP-1 OU and it would likely require more than 150 years to reach groundwater in a sufficient amount to exceed the drinking water standard over an appreciable area (Section 3.5). The uranium inventory would translate to a *Medium* rating, but also is unexpected to reach groundwater in 150 years. Thus uranium and Sr-90 are not considered risk drivers.

SUPPORT FOR RISK AND IMPACT RATINGS FOR EACH POPULATION OR RESOURCE

Human Health

The current and cleanup-related consequences related to work being conducted at the Tank Farms in the 200 Areas (Hanford Central Plateau) was evaluated in Section 1.6 (Appendix E.1).

Groundwater, Vadose Zone, and Columbia River

S-SX Tank Farm contaminants are currently impacting groundwater and treatment is not predicted to decrease concentrations to below thresholds before active cleanup commences. Secondary sources (e.g., total and hexavalent chromium) in the vadose also threaten to continue to impact groundwater in the future, including the Active Cleanup period. Note that there are current plumes for total and hexavalent chromium in the 200-UP-1 Operable Unit (CP-GW-2, Appendix G.6). As described in the TC&WM EIS (and summarized in Section 3.5), there appears to be insufficient expected impact from radioactive decay (since chromium is risk driver) or recharge rate (due to large amounts of these contaminants already in the groundwater) on peak concentrations in the groundwater or near-shore region of the Columbia River during or after cleanup to modify ratings. Thus the ratings for these receptors are the same as those shown in Table E.3-8.

Ecological Resources

<u>Current</u>
There is little habitat in EU (level 2 only), but over 10% in buffer is level 3 resources. Effect is ND in EU, but may be up to Low in buffer due to current truck disturbance.

<u>Risks and Potential Impacts from Selected or Potential Cleanup Approaches</u>
Effects due to increased disturbance and potential for contaminant release, increases in exotic species, and could lose some nesting habitat, run over lizards and other wildlife during cleanup.

Cultural Resources

<u>Current</u>
Manhattan Project/Cold War significant resources have already been mitigated. Area is very disturbed and there are no known recorded archaeological resources within the EU. There is evidence of ethno historic and historic land use.

Risks and Potential Impacts from Selected or Potential Cleanup Approaches
Because area has not been investigated either on the surface or subsurface, archaeological investigations may need to occur within pockets of undisturbed land if any prior to remediation. Potential for intact archaeological material to be present is very low.

Considerations for Timing of the Cleanup Actions

See Section 1.1 (Appendix E.1).

Near-Term, Post-Cleanup Risks and Potential Impacts

See Section 1.1 (Appendix E.1).

3.2. ADMINISTRATIVE INFORMATION

OU AND/OR TSDF DESIGNATION(S):

The S-SX Tank and Waste Farms Evaluation Unit (EU), denoted *CP-TF-2 – S-SX Tank Waste and Farms*, consists of 27 waste tanks, ancillary structures, associated liquid waste sites, and soils contamination; much of this EU is contained within Waste Management Area S-SX (WMA S-SX). Waste Management Area (WMA) S-SX is regulated under the Resource Conservation and Recovery Act (RCRA) as modified in 40 CFR Part 265, Subpart F and Washington State's Hazardous Waste Management Act (HWMA, RCW 70.105 and its implementing requirements in the Washington State dangerous waste regulations [WAC 173-303-400]) (Johnson&Chou 1999).

COMMON NAME(S) FOR EU:

There is no common name for the S-SX Tank and Waste Farms EU because the EU is comprised of elements from other waste management units including Waste Management Area S-SX (WMA S-SX) that includes the 241-S (or S) and 241-SX (or SX) Tank Farms.

The S Tank Farm contains 12 waste tanks (S-101 through S-112); these tanks often are designated as 241-S-101 through 241-S-112. The SX Tank Farm contains 15 waste tanks (SX-101 through SX-115); these tanks often are designated as 241-SX-101 through 241-SX-115. Other components in the EU are listed below in the *Primary EU Source Components* section.

KEY WORDS:

S Tank Farm, SX Tank Farm, 241-S Tank Farm, 241-SX Tank Farm, waste tanks, tank farm, Waste Management Area S-SX, WMA S-SX

REGULATORY STATUS

Regulatory Basis

DOE is the responsible agency for the closure of all single-shell tank (SST) waste management areas (WMAs) through post closure, in close coordination with other closure and cleanup activities of the Hanford Central Plateau. Washington State has a program that is authorized under RCRA and implemented through the HWMA and its associated regulations; Ecology is the lead regulatory agency responsible for the closure of the SST system. Please refer to Section 1.2 (Appendix E.1) for more information.

Applicable Regulatory Documentation

The relationship among the tank waste retrieval work plans (TWRWP) and the overall single-shell tank (SST) waste retrieval and closure process is described in Appendix I of the Hanford Federal Facility Agreement and Consent Order (HFFACO), along with requirements for the content of TWRWPs. WMA S-SX was placed in assessment monitoring (40 CFR 265.93[d][4]) after elevated waste constituents and indicator parameter measurements (specific conductance, chromium, and Tc-99) in downgradient monitoring wells were observed and confirmed (Johnson & Chou 1999). A groundwater quality assessment plan was written (Caggiano 1996) describing the monitoring activities used in deciding whether WMA S-SX has affected groundwater.

Applicable Consent Decree or TPA Milestones

Federal Facility Agreement and Consent Order, 1989 and amended through June 16, 2014: Milestone M-045-00; Lead Agency Ecology: *Complete the closure of all Single Shell Tank Farms by 01/31/2043*

Risk Review Evaluation Information

Completed: Revised August 25, 2015

Evaluated by: K. G. Brown

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

3.3. SUMMARY DESCRIPTION

Current land use

DOE Hanford Site for industrial use. All current land-use activities in the 200-West 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-West Area (of which the S-SX Tank and Waste Farms EU is a part) 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: The legacy source sites associated with the S-SX Tank and Waste Farms EU are described in Attachment Section 3.8. The contamination in the legacy source sites (cribs, trenches, and near-tank soil) associated with the S-SX Tank and Waste Farms EU comes from intentional and unintentional discharges of S-SX Tank Farm and other wastes. There are various trenches and cribs in the area around the S-SX Tank Farms; these sources received large volumes of slightly contaminated waste and other waste streams in trenches: 216-S-8 (2.6×10^6 gallons of REDOX waste) and 216-S-23 trench (76×10^6 gallons of evaporator condensate) and cribs: ranging from 216-S-3 (1.1×10^6 gallons of stream condensate) to 216-S-6 ($1,200\times10^6$ gallons condenser waste) (Wood et al. 1999). From historic monitoring activities, there is one “assumed leaker” (S-104) in the S Tank Farm and eight (SX-107 through SX-109 and SX-111 through SX-115) “assumed leakers” in the SX Tank Farm (Weyns 2014).

Estimates of leaks for the S-SX Tank Farm range from 500-2000 gallons (SX-111 in 1974) to 50,000 gallons (SX-115 in 1965). There are also 25 documented unplanned releases in or near WMA S-SX.

High-Level Waste Tanks and Ancillary Equipment: The 12 waste tanks in the S Tank and Waste Farms EU are:

- (241-)S-101 (241-S-TK-101)
- (241-)S-102 (241-S-TK-102)
- (241-)S-103 (241-S-TK-103)
- (241-)S-104 (241-S-TK-104)
- (241-)S-105 (241-S-TK-105)
- (241-)S-106 (241-S-TK-106)
- (241-)S-107 (241-S-TK-107)
- (241-)S-108 (241-S-TK-108)
- (241-)T-109 (241-S-TK-109)
- (241-)T-110 (241-S-TK-110)
- (241-)T-111 (241-S-TK-111)
- (241-)T-112 (241-S-TK-112)

The 15 waste tanks in the SX Tank and Waste Farms EU are:

- (241-)SX-101 (241-SX-TK-101)
- (241-)SX-102 (241-SX-TK-102)
- (241-)SX-103 (241-SX-TK-103)
- (241-)SX-104 (241-SX-TK-104)
- (241-)SX-105 (241-SX-TK-105)
- (241-)SX-106 (241-SX-TK-106)
- (241-)SX-107 (241-SX-TK-107)
- (241-)SX-108 (241-SX-TK-108)
- (241-)SX-109 (241-SX-TK-109)
- (241-)SX-110 (241-SX-TK-110)
- (241-)SX-111 (241-SX-TK-111)
- (241-)SX-112 (241-SX-TK-112)
- (241-)SX-113 (241-SX-TK-113)
- (241-)SX-114 (241-SX-TK-114)
- (241-)SX-115 (241-SX-TK-115)

The ancillary equipment included in the S-SX Tank and Waste Farms EU is listed in the Attachment in Section 3.8 and primarily consists of pipelines, diversion boxes, and catch tanks.

Groundwater Plumes:

The S-SX Tank and Waste Farms EU is in the 200-UP-1 Operable Unit (OU). The current 200-UP-1 OU plumes that exceed water quality standards are carbon tetrachloride, chromium, nitrate, I-129, Tc-99, tritium, and uranium (DOE/RL-2014-32, Rev. 0). However, carbon tetrachloride does not result from tank wastes and is being managed as part of the 200-ZP-1 OU. An interim action pump-and-treat system was in operation from 1997 until 2012 (when the 200-West P&T Facility started operations). The WMA S-SX groundwater extraction system has also been in operation since 2012 to extract Tc-99, nitrate, chromium, and carbon tetrachloride (DOE/RL-97-36). The final ROD for the 200-UP-1 OU will be pursued when future groundwater impacts are adequately understood and potential technologies to treat I-129 are completed (EPA 2012).

See Appendix G.6 for the CP-GW-2 EU (200-UP-1 OU) for additional details.

Operating Facilities: Because of the prohibition on waste additions to the Hanford SSTs,[44] the S-SX Tank and Waste Farms EU components are not considered Operating Facilities for this review. See Section 1.4 (Appendix E.1) for details.

D&D of Inactive Facilities: Not Applicable.

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[44] Berman presentation on July 29, 2009, titled "Hanford Single-Shell Tank Integrity Program." Available at www.em.doe.gov.

LOCATION AND LAYOUT MAPS

A series of maps are used to illustrate the location of the components within the CP-TF-2 EU and the S-SX Tank and Waste Farms EU relative to the Hanford Site. Figure E.2-1 shows the relationship between the 200-W (200 West) Area (where the S-SX Tank Farms and Waste management Area S-SX are located) and the Hanford Site. Figure E.3-1 illustrates the S-SX Tank and Waste Farms EU boundary. Figure E.3-2 shows a detailed view of the waste tanks, ancillary equipment, and legacy source units in the S-SX Tank and Waste Farms EU.

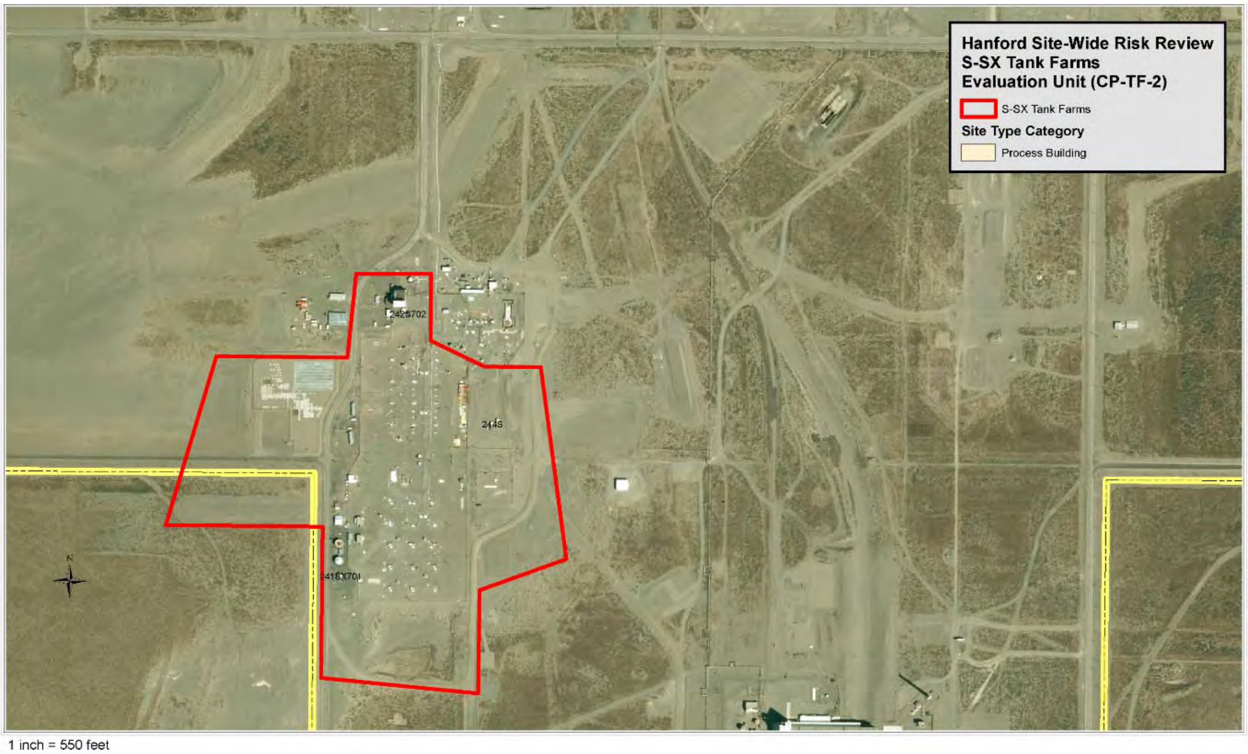
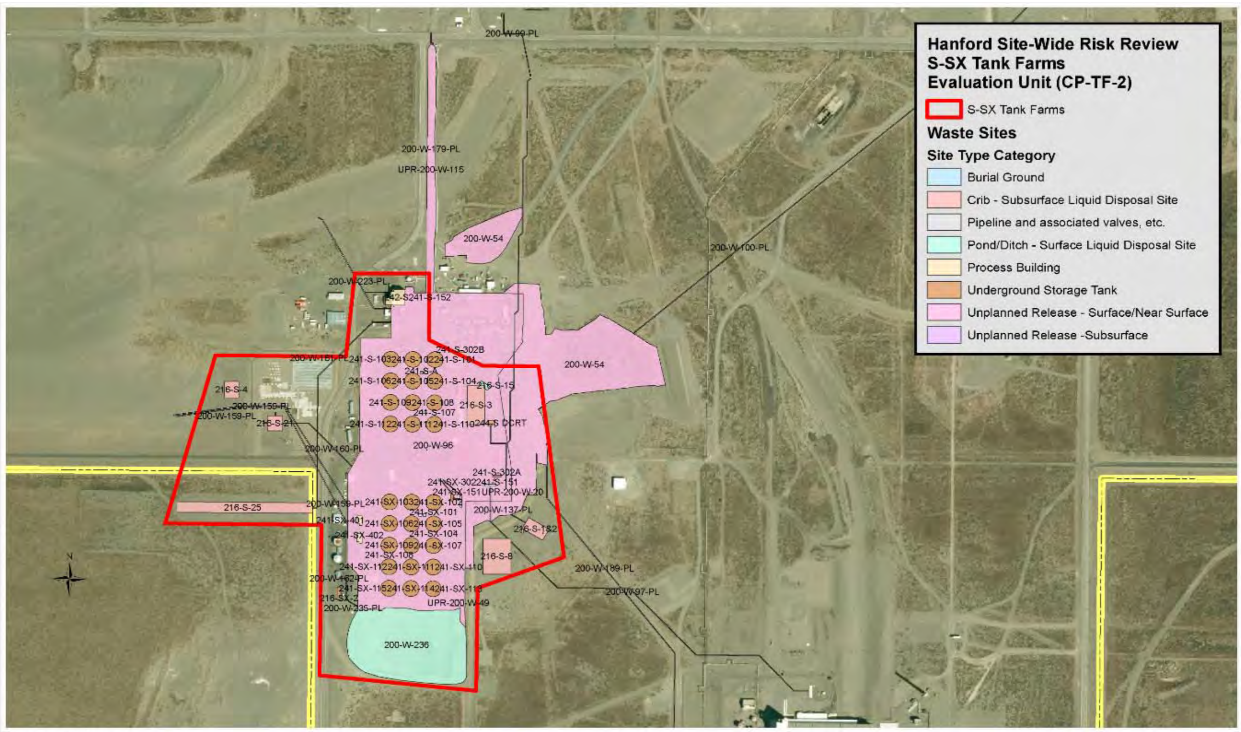


Figure E.3-1. Polygon representing the boundary of the S-SX Tank and Waste Farms Evaluation Unit (Attachment Section 3.8).



1 inch = 550 feet

Figure E.3-2. Hanford S-SX Tank and Waste Farms Evaluation Unit including tanks, legacy source units, and ancillary equipment (Attachment Section 3.8).

3.4. UNIT DESCRIPTION AND HISTORY

EU Former / Current Uses

Waste Management Area S-SX (WMA S-SX) occupies approximately 15 acres and contains 12 underground single-shell tanks (SSTs) in S Tank Farm and 15 SSTs in SX Tank Farm in additional to ancillary equipment (e.g., diversion boxes, pumps, valves, and pipes). The S Tank Farm was constructed in 1950-1951 and the SX Tank Farm in 1953-1955 (ORP-11242, Rev. 6, p. 3-2). The S-SX Tank Farm tanks received primarily redox wastes and salt and slurry cake from evaporator campaigns (Agnew 1997; Remund et al. 1995). The S Tank Farm began receiving REDOX wastes in 1951 and received 242-S Evaporator solids after the REDOX Plant was decommissioned. The first six SX Tank Farm tanks began receiving REDOX Plant wastes in 1954; the remaining nine tanks began receiving REDOX Plant wastes in 1955. The S and SX Tank Farms tanks were removed from service by 1980. The SSTs in WMA S-SX have been interim stabilized (i.e., liquid transferred to DSTs to <50 kgal drainable interstitial liquid and <5 kgal of supernatant). The S-SX Tank Farm tanks are currently awaiting retrieval and closure.

Legacy Source Sites

The contamination in the legacy source sites (cribs, trenches, and near-tank soil) associated with the S-SX Tank and Waste Farms EU comes from intentional and unintentional discharges of S-SX Tank Farm and other wastes. There are various trenches and cribs in the area around the S-SX Tank Farms; these legacy source received large volumes of slightly contaminated waste and other waste streams (where the largest include) (Wood et al. 1999):

- 216-S-8 trench (east of WMA SX) received 2.6×10^6 gallons of REDOX waste (including unirradiated uranium) in 1951-52.
- 216-S-23 trench (northeast of S TF) received 76×10^6 gallons of evaporator condensate in 1973-95.
- 216-S-1 crib (east of WMA SX) received 42×10^6 gallons of process condensate in 1952-56.
- 216-S-3 crib (east of WMA SX) received 1.1×10^6 gallons of stream condensate in 1953-56.
- 216-S-5 crib (southwest of WMA SX) received $1{,}100\times10^6$ gallons of stream condensate in 1954-57.
- 216-S-6 crib (southwest of WMA SX) received $1{,}200\times10^6$ gallons condenser waste (REDOX) in 1954-57.
- 216-S-7 crib (east of WMA SX) received 82×10^6 gallons of stream condensate in 1956-65.
- 216-S-9 crib (east of S TF) received 13×10^6 gallons of redistilled process condensate in 1965-75 (replacing 216-S-7 crib).
- 216-S-21 crib (west of S TF) received 23×10^6 gallons of stream condensate in 1954-70.
- 216-S-25 crib (west of S TF) received 76×10^6 gallons of evaporator condensate in 1973-95.
- Nine of the SSTs in WMA S-SX are declared “assumed leakers” with leaks estimates ranging from <5,000 gallons (SX-114 and SX-107) to 50,000 gallons (SX-115 in 1965) (Weyns 2014, pp. 18-22).
- 25 unplanned releases have been documented in or near WMA S-SX.

It appears that tank wastes were not directly cascaded from the S-SX Tank Farm tanks to the cribs.

High-Level Waste Tanks

See Section 3.3 for details.

Groundwater Plumes

The 200-UP-1 OU groundwater plumes (Tc-99, I-129, nitrate, and chromium) considered to be associated with the S-SX Tank Farm and co-located liquid waste disposal facilities are described in detail in Section 3.5 with additional information in Appendix G.6 for the CP-GW-2 EU (200-UP-1 GW OU).

D&D of Inactive Facilities – Not Applicable

Operating Facilities – Not Applicable

Because of the prohibition on waste additions to the Hanford SSTs,[45] the S-SX Tank and Waste Farms EU components are not considered Operating Facilities for this Review.

[45] Berman presentation on July 29, 2009, titled “Hanford Single-Shell Tank Integrity Program.” Available at www.em.doe.gov.

ECOLOGICAL RESOURCES SETTING

Landscape Evaluation and Resource Classification:

The amount of each category of biological resources at and near the S-SX Tank and Waste Farms EU was examined within a circular area radiating 623 m from the geometric center of the unit (equivalent to 300.9 acres). The majority of the area within the 47.7 acres of the EU is classified as level 0 (41.2 ac) biological resources, with the remainder classified as level 1 and 2. The adjacent landscape buffer consists primarily of level 0, 1, and 2. Small patches of level 3 resources are located to the north and south of the EU, including several point occurrences of sensitive species (Appendix J, Figure 2, p. J-65). Overall, approximately 5.3 percent of the total combined area currently consists of level 3 or higher biological resources (Appendix J, Table 2, p. J-66 and Figure 2, p. J-65).

Field Survey:

PNNL biologists conducted a reconnaissance and visual survey of the S-SX Tank and Waste Farms EU in October 2014. The major portion of the unit consists of graveled surfaces, buildings, parking areas, and infrastructure related to the tanks. Small areas of remnant shrub-steppe vegetation occur within the EU near the west and south boundaries. The canopy cover was visually evaluated in the field for these patches. In the overstory successional shrub (gray rabbitbrush, *Ericameria nauseosa*) cover was approximately 5%, with mixed native and alien grasses and forbs in the understory ((Appendix J, Table 1, p. J-64).

No wildlife were observed within the EU during the October reconnaissance, however, PNNL ECAP surveys conducted in 2009 and 2010 noted the following wildlife: an American kestrel (*Falco sparverius*) apparently nesting in a building at the north end of the EU, loggerhead shrike (*Lanius ludovicianus*), Say's phoebe (*Sayornis saya*), barn swallow (*Hirundo rustica*), white-crowned sparrow (*Zonotrichia leucophrys*), western meadowlark (*Sturnella neglecta*), and black-tailed jackrabbit (*Lepus californicus*). All the bird species noted are protected by the Migratory Bird Treaty Act and, additionally, the loggerhead shrike is listed as a Washington State Species of Concern. The black-tailed jackrabbit is listed as a Washington State Candidate Species.

CULTURAL RESOURCES SETTING

Cultural resources known to be recorded within the S-SX Tank Farms EU are limited to one National Register-eligible building; the 242S Evaporator Facility, associated with the Manhattan Project/Cold War Era Landscape with no documentation required. All have been documented as described in the *Hanford Site Manhattan Project and Cold War Era Historic District Treatment Plan* (DOE/RL-97-56).

Much of the S-SX Tank and Waste Farms EU has not been inventoried for archaeological resources with the exception of a very small area with negative findings. Closure and remediation of the tank farms located within the S-SX Tank and Waste Farms EU has been addressed in an NHPA Section 106 review completed. There are no archaeological sites or TCPs known to have been recorded or identified within the S-SX Tank and Waste Farms EU. Although unlikely given the presence of heavy disturbance, there is a possibility that intact archaeological material is present in the areas that have not been inventoried for archaeological resources (both on the surface and in the subsurface), particularly if undisturbed soil deposits exist within the S-SX Tank and Waste Farms EU.

One isolated archaeological find associated with the Pre-Hanford Early Settlers/Farming Landscape has been identified within 500 meters of the S-SX Tank and Waste Farms EU. Additionally, the National Register-eligible Hanford Site Plant Railroad and the 272S Maintenance Shop both of which are associated with the Manhattan Project and Cold War Era landscape with documentation required are located within 500 meters of the S-SX Tank and Waste Farms EU. Both have been documented as described in the *Hanford Site Manhattan Project and Cold War Era Historic District Treatment Plan* (DOE/RL-97-56).

Historic maps indicate that there is no evidence of historic settlement in or near the S-SX Tank and Waste Farms EU. Geomorphology and extensive ground disturbance further indicates a low potential for the presence of intact archaeological sites associated with all three landscapes to be present subsurface within the S-SX Tank and Waste Farms EU. Because none of the S-SX Tank and Waste Farms EU has been investigated for archaeological sites and pockets of undisturbed soil may exist, it may be appropriate to conduct surface and subsurface archaeological investigations in these areas prior to initiating a remediation activity. 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 associated with these landscapes (e.g. East Benton Historical Society, the Franklin County Historical Society, Prosser Cemetery Association, the Reach and B-Reactor Museum Association) may need to occur. Indirect effects are always possible when TCPs are known to be located in the general vicinity. Consultation with Hanford Tribes may also 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.

3.5. WASTE AND CONTAMINATION INVENTORY

Table E.3-2 provides inventory estimates of the various source components associated with the S-SX Tank and Waste Farms EU including tank wastes and ancillary equipment, legacy sources including leaks, cribs, trenches, unplanned releases (UPRs), vadose zone sources, saturated zone (plume) estimates, treatment amounts, and remaining vadose zone estimates (i.e., the difference of the vadose zone estimates and the saturated zone and treatment estimates)[46]. This information is further summarized in Figure E.3-3 through Figure E.3-11 before and after planned 99% retrieval[47].

For example, the major sources for Tc-99 and I-129 before retrieval are the S-SX Tank Farm tanks with leaks from these tanks being a distant second. The maximum groundwater threat metric (GTM) (Figure E.3-12)[48] is dominated by the S-SX Tank Farm wastes before retrieval and by tank wastes, leaks and cribs after planned retrieval. After planned retrieval, leaks and ancillary equipment dominate the S-SX Tank and Waste Farms EU legacy sources for Tc-99. After planned retrieval, cribs and leaks dominate the S-SX Tank and Waste Farms EU legacy sources for I-129. The tritium inventory, both pre- and post-retrieval, is dominated by cribs with a minor contribution from historic leaks. For chromium and nitrate, tank wastes and trenches are major sources before retrieval. After retrieval, trenches and past leaks dominate the chromium legacy sources whereas trenches and cribs dominate the legacy sources for nitrate. Current uranium, Sr-90, Cs-137, and plutonium isotope inventories in the S-SX Tank and Waste Farms EU tend to be dominated by the tank wastes; whereas post-retrieval legacy zone inventories are dominated by cribs and past leaks (uranium), ancillary equipment and past leaks (Sr-90), past leaks and ancillary equipment (Cs-137), and cribs and ancillary equipment (plutonium isotopes).

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[46] The basis for the saturated and vadose zone estimates are provided in Chapter 6 of the Methodology Report (CRESP 2015) and examples are provided in the demonstration section for the 200-UP-1 Operable Unit. These estimates tend to have very high associated uncertainties.

[47] According to the Tri-Party Agreement (Ecology, EPA, and DOE, 1998), retrieval limits for residual wastes are 360 ft^3 and 30 ft^3 for 100-Series and 200-Series tanks, respectively, corresponding to the 99% waste retrieval goal as defined in TPA Milestone M-45-00.

[48] Maximum of the GTMs for Tc-99 and I-129 only.

CONTAMINATION WITHIN PRIMARY EU SOURCE COMPONENTS

Legacy Source Sites

The estimated S-SX Tank Farm inventory for the Legacy / Vadose Zone Source Sites (i.e., cribs, trenches, and soil contaminated by tank leaks and unplanned releases) is summarized in Table E.3-2 and further described in Figure E.3-3 through Figure E.3-11 before and after planned 99% retrieval (which will have no impact on the legacy source site inventories). These values constitute estimates of the initial amounts of contaminants discharged to the vadose zone that are then used to estimate the remaining inventory in the vadose zone as described below (i.e., by difference using the process described in Chapter 6 of the Methodology Report). These estimates necessarily have large associated uncertainties.

Waste Tanks and Ancillary Equipment

The estimated total inventory for all the S-SX Tank Farm High Level Waste Tanks and Ancillary Equipment is provided in Table E.3-2 for both the 90% and planned 99% retrieval scenarios. The tank-by-tank inventories are provided in Table E.3-3 through Table E.3-6. Safety-related information (i.e., hydrogen generation rates and times to the lower flammability limit are also provided in Table E.3-3. The inventories for the various contaminant in the S-SX Tank Farm tanks vary over several orders of magnitude as does the GTM. This information is further summarized in Figure E.3-3 through Figure E.3-11 before and after planned 99% retrieval and for the maximum GTM in Figure E.3-12.

Vadose Zone Contamination

The estimated inventories for the vadose zone, saturated zone, and treatment amounts are found in Table E.3-7. These inventories represent the vadose zone contamination *outside* the tanks and ancillary equipment (i.e., that are generally available for transport through the environment). These inventories are used to estimate the inventory remaining in the vadose zone using the process described in Chapter 6 of the Methodology Report (CRESP 2015). The focus in this section will be on the Group A and B contaminants in the vadose zone due to their mobility and persistence and potential threats to groundwater. To summarize (DOE/RL-2014-32, Rev. 0):

- *Uranium* – There is a current uranium plume; however, this plume is not associated with Tank Farm operations. The vadose zone inventory is dominated by past leaks and ancillary equipment. Furthermore, uranium would not be expected to significantly move through the environment in the next 150 years (Section 2.5). Thus uranium is not considered a significant threat to the Hanford groundwater.
- *Tc-99* – There is a current Tc-99 plume, which is attributed primarily to a past leak from tank SX-115 and an overfill event related to tank S-104.
- *Sr-90* – There is no current plume for Sr-90. The vadose zone inventory is dominated by past leaks and ancillary equipment. Thus the majority of the Sr-90 originally discharged into the vadose zone would have had to travel through much of the vadose zone to impact groundwater. Using an analysis similar to that in Section 2.5 for Sr-90 in the WMA T (200-West), a Sr-90 plume is not expected in the next 150 years due to retardation in the vadose zone or after due to radioactive decay (+99.9% reduction in Sr-90 inventory). Thus Sr-90 is not considered a significant threat to the Hanford groundwater.
- *I-129* – There is a small current plume for I-129 that is associated with the SX Tank Farm. The vadose zone inventory is dominated by cribs and leaks.

- *Chromium* – There are current plumes for chromium near the S-SX Tank and Waste Farms EU that are considered associated with the EU. The vadose zone inventory is dominated by trenches and past leaks.

Using the process outlined in Chapter 6 of the Methodology Report (CRESP 2015), the vadose zone inventories in Table E.3-2 are estimated by difference and used to calculate Groundwater Threat Metric (GTM) values for the Group A and B contaminants remaining in the vadose zone as illustrated in Table E.3-7. The resulting vadose zone (VZ) ratings are *ND* for uranium and Sr-90[49], *Medium* for Tc-99 and I-129, and *High* for chromium (total and hexavalent). The overall current rating would be *High* related to chromium (total and hexavalent) in the vadose zone.

Groundwater Plumes

In general groundwater plumes are evaluated in separate EUs; however, those portions of groundwater plumes that can be associated with the TF EU (i.e., a plume with sources associated with the TF EU) will be evaluated to provide a better idea of the saturated zone versus remaining vadose zone threats to groundwater. The estimated inventory for the saturated zone contamination is provided in Table E.3-2 where Photoshop was used to estimate the fraction of the plumes considered associated with the S-SX Tank and Waste Farms EU (Attachment 6-4 in the Methodology Report (CRESP 2015[50]). This information is also used to estimate amounts treated and remaining in the vadose zone. For the groundwater plumes described in the 200-UP-1 OU (DOE/RL-2014-32, Rev. 0), apportionment of plumes to the S-SX Tank and Waste Farms EU is as follows:

- Uranium -- There is a plume in the OU, but no major sources related to the waste tanks; thus there is no portion of the uranium plume considered associated with the S-SX Tank and Waste Farms EU.
- *Nitrate* – There are plumes in the OU; the single plume near the S-SX Tank and Waste Farms EU is considered associated with the EU, and the area of this plume is 2% of the area of the plumes (CRESP 2015). The corresponding rating would be ND.
- *Chromium* – There are plumes in the OU; the plumes near the S-SX Tank and Waste Farms EU are considered associated with the EU. Total plume areas in the 200-UP-1 OU and those considered associated with the plume near the S-SX Tank and Waste Farms EU for both total chromium (above 100 µg/L) and hexavalent chromium (above 48 µg/L) were estimated (CRESP 2015). The small area of the plume considered associated with the S-SX Tank and Waste Farms EU was estimated at approximately 1% of the total and was assumed to describe both total chromium and hexavalent chromium contributions.
- *H-3* – There are plumes in the OU, but no major sources related to the waste tanks; thus there is no portion of the H-3 plume considered associated with the S-SX Tank and Waste Farms EU. The corresponding rating would be ND.

[49] The remaining vadose zone inventories for uranium and Sr-90 would translate to *Medium* and *Very High* ratings, respectively. However, no appreciable Sr-90 or uranium plume would be expected in the next 150 years due to transport considerations (Section 2.5); however, uranium may impact groundwater after the 150-year period. Thus *Low* ratings are applied to the period after Active Cleanup is completed to account for uncertainties.

[50] From the graphic map files provided by PNNL, the PhotoShop Magic Wand Tool was used to select areas representing plumes and then the “Record Measurements” Tool was used to provide relative areal extents (CRESP 2015). A Custom Measurement Scale was set to that of the map.

- *Tc-99* – There are plumes in the OU; the single plume near the S-SX Tank and Waste Farms EU is considered associated with the EU, and the area of this plume is 82% of the area (CRESP 2015).
- *I-129* – There are plumes in the OU; the major plumes in the 200-UP-1 OU primarily originated from U Plant and REDOX Plant waste sites. There is a small plume interpreted to occur beneath the SX Tank Farm; the likely source is the SX Tank Farm. The contribution is less than 1% and considered insignificant for this study.
- *Carbon tetrachloride* – The carbon tetrachloride plume is managed in the 200-ZP-1 OU (Appendix G.6). Furthermore, there are no sources of carbon tetrachloride related to this EU.

The groundwater plumes (e.g., Tc-99, I-129, nitrate, and chromium) associated with the S-SX Tank Farm and co-located liquid waste disposal facilities are described in detail in Appendix G.6 for the CP-GW-2 EU (200-UP-1 GW OU). Note that nitrate, chromium (total and hexavalent), and I-129 (*Medium*) are the risk drivers for the 200-UP-1 GW OU; however, there are no *major* S-SX TF EU sources associated with these plumes (i.e., less than 2% of the total plume areas), and the remaining vadose zone sources would drive the risks associated with the S-SX TF EU.

Impact of Recharge Rate and Radioactive Decay on Groundwater Ratings

The TC&WM EIS screening groundwater transport analysis (Appendix O, DOE/EIS-0391 2012) indicates that there is an impact of emplacing the engineered surface barrier (and resulting reduction of infiltrating water) on the predicted peak groundwater concentrations at the S Barrier[51]. This result is likely due to the significant amounts of contaminants already in the groundwater and not due to an ineffective surface barrier. To summarize, the results for all Central Plateau sources (Appendix O, DOE/EIS-0391 2012) include:

- Tc-99 peak concentration is 22,800 pCi/L (CY 3072) for the No Action Alternative versus 1,510 pCi/L (CY 2051) for the Landfill Scenarios where the threshold value is 900 pCi/L.
- I-129 peak concentration is 29.1 pCi/L (CY 3136) for the No Action Alternative versus 2.8 pCi/L (CY 2050) for the Landfill Scenarios versus a threshold value of 1 pCi/L.
- Chromium peak concentration is 541 µg/L (CY 3242) for the No Action Alternative versus 156 µg/L (CY 2050) for the Landfill Scenarios versus a threshold value of 100 µg/L (total) or 48 µg/L (hexavalent).
- No values are reported at the S Barrier for uranium, Sr-90, or carbon tetrachloride for either scenario, which indicates that the appropriate sources were not considered in the analysis (e.g., for carbon tetrachloride), or peak fluxes that were less than 1×10^{-8} Ci/yr for radioactive contaminants, or 1×10^{-8} g/yr for chemical contaminants (Appendix O, DOE/EIS-0391 2012, p. O-2).

Despite the large impacts on the predicted peak concentrations, these peak values at the S Barrier still exceed threshold values within 50 years and thus the saturated and vadose ratings will not be altered even though predicted impacts due to barrier emplacement may be large[52].

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[51] The 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). The S Barrier is the closest to the S-SX Tank and Waste Farms EU. Despite including sources other than those for the S-SX Tank and Waste Farms EU, the analysis in the TC&WM EIS was considered a reasonable source of information to assess the potential impact of the engineered surface barrier emplacement.

[52] Analyses specific to each Tank Farm or Central Plateau EU are not available; thus the aggregate screening analysis provided in the TC&WM EIS was used as an indication.

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.

Benthic and Riparian Zone – Current Impacts
Based on the information in the 2013 Hanford Annual Groundwater Report (DOE/RL-2014-32, Rev. 0) and PHOENIX (http://phoenix.pnnl.gov/), even though 200-UP-1 Operable Unit (OU) contaminants are in the saturated zone, no plumes from the 200-UP-1 OU are currently intersecting the Columbia River at concentrations exceeding the WQS. Thus current impacts from the S-SX Tank and Waste Farms EU to the Columbia River benthic and riparian ecology would be rated as *Not Discernible*.

Benthic and Riparian Zone – Active Cleanup and Near-term, Post Cleanup
Based on a similar analysis to that in Section 2.5 for CP-TF-1 (T Tank and Waste Farms EU also in 200-West), the impacts to the Columbia River benthic and riparian ecology for the Active Cleanup and Near-term, Post Cleanup periods are also rated as *Not Discernible*.

Benthic and Riparian Zone – Long-term
As described in Section 2.5, the ecological screening analysis performed in the TC&WM EIS (Appendix P, DOE/EIS-0391 2012) to evaluate potential long-term impacts of radioactive and chemical contaminants indicated that there should be no expected adverse effects from radionuclides for Columbia River benthic and riparian receptors over the time period evaluated (10,000 years).

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) suggest that only chromium and nitrate would be *predicted* to exceed thresholds. However, the screening results indicate that future nitrate peak concentration (and discharge) appear to not exceed either the drinking water standard or ambient water quality criterion in the next 10,000 years. Furthermore, because of the long travel time of water from 200-West (200-UP-1 OU) to the River relative to that from 200-East to the Columbia River, it is unlikely that 200-West sources (including the S-SX Tank and Waste Farms EU) would present any threat to the Columbia River, which would likely lead to insignificant impacts to the benthic and riparian ecology from S-SX sources. Additional details are provided in Section 2.5.

Threats to the Columbia River Free-flowing Ecology
As described in Section 2.5, 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
Finally, the No Action Alternative evaluation in the TC&WM EIS suggests that remedial actions (e.g., surface barrier emplacement that would decrease recharge in the areas near the Tank Farms) appear to not have significant impacts on the long-term peak concentrations in the near-shore area (benthic and riparian receptors) of the Columbia River. This result is likely not due to ineffectiveness of the barrier but instead due to large amounts of contaminant already in the groundwater. Thus ratings are not changed based on the remedial actions assumed in the TC&WM EIS.

Facilities for D&D – Not Applicable

Operating Facilities – Not Applicable

Because of the prohibition on waste additions to the Hanford SSTs,[53] the S-SX Tank and Waste Farms EU components are not considered Operating Facilities for this Review.

[53] Berman presentation on July 29, 2009, titled "Hanford Single-Shell Tank Integrity Program." Available at www.em.doe.gov.

Table E.3-2. Summary Table of Infrastructure and Subsurface Contamination Inventory for the S-SX Tank and Waste Farms Evaluation Unit (CP-TF-2) [(a)(b)]

Contaminated Media	Primary Contaminants	Total Amount. of Each Contaminant Before Retrieval	90% Retrieval Scenario	99% Retrieval Scenario
Infrastructure (Tanks and Ancillary Equipment)				
Tank Waste	Waste (kGal)	7385	738.5	73.85
	Sludge (kGal)	1992	199.2	19.92
	Saltcake (kGal)	5390	539	53.9
	Supernatant (kGal)	3	0.3	0.03
Tank Waste (rad)	Am-241 (Ci)	10000	1000	100
	C-14 (Ci)	110	11	1.1
	Co-60 (Ci)	230	23	2.3
	Cs-137 (Ci)	3800000	380000	38000
	Eu-152 (Ci)	85	8.5	0.85
	Eu-154 (Ci)	4500	450	45
	H-3 (Ci)	670	67	6.7
	I-129 (Ci)	3.8	0.38	0.038
	Ni-59 (Ci)	180	18	1.8
	Ni-63 (Ci)	17000	1700	170
	Pu (total) (Ci)	16000	1600	160
	Sr-90 (Ci)	14000000	1400000	140000
	Tc-99 (Ci)	3700	370	37
	U (total) (Ci)	66	6.6	0.66
Tank Waste (non-rad)	Cr (kg)	210000	21000	2100
	Hg (kg)	370	37	3.7
	NO3 (kg)	13000000	1300000	130000
	Pb (kg)	3300	330	33
	U (total) (kg)	82000	8200	820
Ancillary Equipment (rad)	C-14 (Ci)	3.7	3.7	3.7
	Cs-137 (Ci)	27000	27000	27000
	H-3 (Ci)	16	16	16
	I-129 (Ci)	0.044	0.044	0.044

Contaminated Media	Primary Contaminants	Total Amount. of Each Contaminant Before Retrieval	90% Retrieval Scenario	99% Retrieval Scenario
	Pu (total) (Ci)	65	65	65
	Sr-90 (Ci)	44000	44000	44000
	Tc-99 (Ci)	22	22	22
	U (total) (Ci)	0.38	0.38	0.38
Ancillary Equipment (non-rad)	Cr (kg)	1100	1100	1100
	Hg (kg)	1.2	1.2	1.2
	NO3 (kg)	84000	84000	84000
	Pb (kg)	20	20	20
	U (total) (kg)	400	400	400
Vadose Zone Source (Leaks and Intentional Discharges into Cribs and Trenches)				
Leaks (rad)	C-14 (Ci)	5.3	5.3	5.3
	Cs-137 (Ci)	140000	140000	140000
	H-3 (Ci)	100	100	100
	I-129 (Ci)	0.078	0.078	0.078
	Pu (total) (Ci)	9.9	9.9	9.9
	Sr-90 (Ci)	27000	27000	27000
	Tc-99 (Ci)	41	41	41
	U (total) (Ci)	0.5	0.5	0.5
Leaks (non-rad)	Cr (kg)	4700	4700	4700
	Hg (kg)	0.1	0.1	0.1
	NO3 (kg)	140000	140000	140000
	Pb (kg)	68	68	68
	U (total) (kg)	670	670	670
Cribs (rad)	Am-241 (Ci)	24	24	24
	C-14 (Ci)	0.0094	0.0094	0.0094
	Co-60 (Ci)	0.056	0.056	0.056
	Cs-137 (Ci)	1500	1500	1500
	Eu-152 (Ci)	0.023	0.023	0.023
	Eu-154 (Ci)	2.9	2.9	2.9
	H-3 (Ci)	8900	8900	8900
	I-129 (Ci)	0.14	0.14	0.14
	Ni-59 (Ci)	0.0016	0.0016	0.0016

Contaminated Media	Primary Contaminants	Total Amount. of Each Contaminant Before Retrieval	90% Retrieval Scenario	99% Retrieval Scenario
	Ni-63 (Ci)	0.15	0.15	0.15
	Pu (total) (Ci)	140	140	140
	Sr-90 (Ci)	970	970	970
	Tc-99 (Ci)	2.8	2.8	2.8
	U (total) (Ci)	1.5	1.5	1.5
Cribs (non-rad)	Cr (kg)	190	190	190
	Hg (kg)	7.4	7.4	7.4
	NO3 (kg)	430000	430000	430000
	Pb (kg)	10	10	10
	U (total) (kg)	2200	2200	2200
Trenches (rad)	U (total) (Ci)	0.21	0.21	0.21
Trenches (non-rad)	Cr (kg)	29000	29000	29000
	Hg (kg)	3.2	3.2	3.2
	NO3 (kg)	1400000	1400000	1400000
	U (total) (kg)	310	310	310
Pond (rad)	Co-60 (Ci)	8.30E-09	8.30E-09	8.30E-09
	Cs-137 (Ci)	4.40E-09	4.40E-09	4.40E-09
	H-3 (Ci)	0.29	0.29	0.29
	Pu (total) (Ci)	1.00E-05	1.00E-05	1.00E-05
	Sr-90 (Ci)	1.80E-09	1.80E-09	1.80E-09
	U (total) (Ci)	2.10E-09	2.10E-09	2.10E-09
Pond (non-rad)	Cr (kg)	0.005	0.005	0.005
	Hg (kg)	0.0002	0.0002	0.0002
	NO3 (kg)	0.0052	0.0052	0.0052
	Pb (kg)	5.30E-05	5.30E-05	5.30E-05
	U (total) (kg)	3.00E-06	3.00E-06	3.00E-06
UPR (rad)	Co-60 (Ci)	9.10E-10	9.10E-10	9.10E-10
	Cs-137 (Ci)	4.90E-10	4.90E-10	4.90E-10
	H-3 (Ci)	0.032	0.032	0.032
	Pu (total) (Ci)	1.80E-06	1.80E-06	1.80E-06
	Sr-90 (Ci)	2.00E-10	2.00E-10	2.00E-10
	U (total) (Ci)	2.80E-10	2.80E-10	2.80E-10

Contaminated Media	Primary Contaminants	Total Amount. of Each Contaminant Before Retrieval	90% Retrieval Scenario	99% Retrieval Scenario
UPR (non-rad)	Cr (kg)	0.00056	0.00056	0.00056
	Hg (kg)	2.20E-05	2.20E-05	2.20E-05
	NO3 (kg)	0.00057	0.00057	0.00057
	Pb (kg)	5.90E-06	5.90E-06	5.90E-06
	U (total) (kg)	3.30E-07	3.30E-07	3.30E-07
Vadose Zone (from Vadose Zone Sources)				
VZ Remaining (rad)	Am-241 (Ci)	24	24	24
	C-14 (Ci)	5.4	5.4	5.4
	Co-60 (Ci)	0.056	0.056	0.056
	Cs-137 (Ci)	140000	140000	140000
	Eu-152 (Ci)	0.023	0.023	0.023
	Eu-154 (Ci)	2.9	2.9	2.9
	H-3 (Ci)	9000	9000	9000
	I-129 (Ci)	0.21	0.21	0.21
	Ni-59 (Ci)	0.0016	0.0016	0.0016
	Ni-63 (Ci)	0.15	0.15	0.15
	Pu (total) (Ci)	150	150	150
	Sr-90 (Ci)	28000	28000	28000
	Tc-99 (Ci)	35	35	35
	U (total) (Ci)	2.2	2.2	2.2
VZ Remaining (non-rad)	Cr (kg)	34000[(c)]	34000[(c)]	34000[(c)]
	Cr-VI (kg)	34000[(c)]	34000[(c)]	34000[(c)]
	Hg (kg)	11	11	11
	NO3 (kg)	1900000	1900000	1900000
	Pb (kg)	79	79	79
	U (total) (kg)	3200	3200	3200
VZ Treatment (rad)	Tc-99 (Ci)	2.6	2.6	2.6
VZ Treatment (non-rad)	Cr (kg)	0.24	0.24	0.24
	Cr-VI (kg)	0.24	0.24	0.24
	NO3 (kg)	1300	1300	1300
Saturated Zone (from Vadose Zone Sources)				
SZ Inventory (rad)	Tc-99 (Ci)	6.9	6.9	6.9

Contaminated Media	Primary Contaminants	Total Amount. of Each Contaminant Before Retrieval	90% Retrieval Scenario	99% Retrieval Scenario
SZ Inventory (non-rad)	Cr (kg)	8.2	8.2	8.2
	Cr-VI (kg)	34	34	34
	NO3 (kg)	84000	84000	84000

a. Tanks (SST and DST): Best Basis Inventory (BBI) March 2014; Ancillary Equipment (Anc Eq): Tank Farm Closure & Waste Management (TC&WM) Environmental Impact Statement (DOE/EIS-0391) Appendix D; Unplanned Releases (UPRs): Soil Inventory Model (SIM) Rev 1 (RPP-26744, Rev 0); Ponds: Soil Inventory Model (SIM) Rev 1 (RPP-26744, Rev 0); Cribs: Soil Inventory Model (SIM) Rev 1 (RPP-26744, Rev 0); Trenches: Soil Inventory Model (SIM) Rev 1 (RPP-26744, Rev 0) and Tank Farm Closure & Waste Management (TC&WM) Environmental Impact Statement (DOE/EIS-0391) Appendix S; Leaks: Tank Farm Closure & Waste Management (TC&WM) Environmental Impact Statement (DOE/EIS-0391) Appendix D; MUSTs: Soil Inventory Model (SIM) Rev 1 (RPP-26744, Rev 0) and Tank Farm Closure & Waste Management (TC&WM) Environmental Impact Statement (DOE/EIS-0391) Appendix S.

b. All primary contaminant inventories are reported to 2 significant figures. The source document should be consulted for greater precision data.

c. Differences in inventories for Cr vs Cr-IV are due to differing Water Quality Standards (WQS) and thus plume extents: 100 mg/L for total chromium vs 48 mg/L for chromium (IV). The difference is not distinguishable within the number of significant digits (2) displayed.

Table E.3-3. Current Bulk Inventory and Steady State Flammability Results (by Tank) for the S-SX Tank Farm (CP-TF-2)

Tank ID	Tank Type	Capacity (kGal)[(a)]	Sludge (kGal)[(a)]	Saltcake (kGal)[(a)]	Supernatant (kGal)[(a)]	HGR(c) (ft3/d)[(b)]	Days to 25% LFL Barometric[(c)]	Days to 25% LFL Zero Ventilation[(d)]
S-101	SST	758	235	117	0	1	NA	803
S-102	SST	758	22	69	2	0.42	NA	>1826
S-103	SST	758	9	227	1	0.88	NA	1118
S-104	SST	758	132	156	0	0.79	NA	1182
S-105	SST	758	2	404	0	0.54	NA	1530
S-106	SST	758	0	455	0	0.71	NA	1046
S-107	SST	758	320	38	0	0.94	NA	891
S-108	SST	758	5	545	0	0.6	NA	1062
S-109	SST	758	13	520	0	0.61	NA	1083
S-110	SST	758	96	293	0	0.95	NA	843
S-111	SST	758	76	325	0	0.82	NA	883
S-112	SST	758	2	0	0	0.78	NA	1710
SX-101	SST	1000	144	276	0	0.9	NA	NA
SX-102	SST	1000	55	287	0	1.6	NA	NA
SX-103	SST	1000	78	431	0	5	356	NA
SX-104	SST	1000	136	310	0	2.6	NA	NA
SX-105	SST	1000	63	312	0	5.9	349	NA
SX-106	SST	1000	0	396	0	0.76	NA	NA
SX-107	SST	1000	94	0	0	1.9	NA	NA
SX-108	SST	1000	74	0	0	0.68	NA	NA
SX-109	SST	1000	66	175	0	6.1	479	NA
SX-110	SST	1000	49	7	0	2.8	NA	NA
SX-111	SST	1000	97	18	0	3.2	NA	NA
SX-112	SST	1000	75	0	0	1.2	NA	NA
SX-113	SST	1000	19	0	0	0.33	NA	NA
SX-114	SST	1000	126	29	0	3.2	NA	NA

Tank ID	Tank Type	Capacity (kGal)[a]	Sludge (kGal)[a]	Saltcake (kGal)[a]	Supernatant (kGal)[a]	HGR(c) (ft3/d)[b]	Days to 25% LFL Barometric[c]	Days to 25% LFL Zero Ventilation[d]
SX-115	SST	1000	4	0	0	0.47	NA	NA

a. Volumes from the Waste Tank Summary Report coinciding with the BBI (Rodgers 2014).

b. Hydrogen generation rate (ft^3/d) (RPP-5926 Rev. 15). Note in 2001 all 24 tanks were removed from the flammable gas watch list (including T-110 in the T Tank and Waste Farms EU) (Johnson, et al. 2001, p. iii).

c. Time (in days) to 25% of the Lower Flammability Limit (LFL) under a barometric (barom) breathing scenario (RPP-5926, Rev. 15). “NA” indicates that the headspace will not reach specified flammability level.

d. Time (in days) to 25% of the LFL under a zero ventilation scenario (RPP-5926, Rev. 15).

Table E.3-4. Current Primary Contaminant Inventory (by Tank) for the S-SX Tank Farm (CP-TF-2) [(a)]

Tank ID	Decay Date	Am-241 (Ci)	C-14 (Ci)	Cl-36 (Ci)	Co-60 (Ci)	Cs-137 (Ci)	Eu-152 (Ci)	Eu-154 (Ci)	H-3 (Ci)
S-101	2001	220	3.3	NP[(b)]	6.2	220000	1.5	65	36
S-102	2001	44	1.6	NP	0.41	42000	0.74	5.2	5.4
S-103	2001	140	3.8	NP	7.5	180000	1.6	95	11
S-104	2001	200	1.8	NP	2.7	71000	1.1	59	8.3
S-105	2001	7.8	10	NP	11	79000	1.8	110	29
S-106	2001	58	8.5	NP	15	250000	1.5	90	24
S-107	2001	750	2.5	NP	56	150000	0.31	33	120
S-108	2001	270	11	NP	19	310000	1.9	110	31
S-109	2001	38	13	NP	15	40000	2.3	91	38
S-110	2001	300	6.9	NP	8.9	160000	1.2	72	29
S-111	2001	32	5.4	NP	9.2	200000	0.95	57	21
S-112	2001	0.013	0.0011	NP	0.0069	2.9	0.0018	0.097	0.0013
SX-101	2001	510	5.1	NP	8.8	240000	2.5	150	43
SX-102	2001	270	5	NP	8.7	280000	1.2	69	16
SX-103	2001	720	8.4	NP	15	380000	1.6	96	32
SX-104	2001	360	6	NP	10	230000	1.4	80	31
SX-105	2001	600	5.3	NP	9.3	200000	3.3	180	21
SX-106	2001	350	7.3	NP	15	280000	4.3	260	21
SX-107	2001	560	0.43	NP	0.72	47000	6	320	15
SX-108	2001	720	0.43	NP	0.72	75000	6.1	180	15
SX-109	2001	460	2.2	NP	4.8	110000	6	330	44
SX-110	2001	710	0.24	NP	1	39000	9.4	510	18
SX-111	2001	870	0.59	NP	1.5	65000	11	570	25
SX-112	2001	600	0.32	NP	0.74	42000	7.1	380	15
SX-113	2001	11	0.088	NP	0.048	1900	0.012	0.67	1.1
SX-114	2001	840	0.89	NP	1.8	82000	9.4	510	27

Tank ID	Decay Date	Am-241 (Ci)	C-14 (Ci)	Cl-36 (Ci)	Co-60 (Ci)	Cs-137 (Ci)	Eu-152 (Ci)	Eu-154 (Ci)	H-3 (Ci)
SX-115	2001	400	0.015	NP	6.9	530	0.94	110	1.7

a. From Best Basis Inventory (BBI) Summary (March 24, 2014) provided in spreadsheet form by Mark Triplett. All primary contaminant inventories are reported to 2 significant figures. The source document should be consulted for greater precision data.

b. NP = Not present at significant quantities

Table E.3-5. Current Primary Contaminant Inventory [(a)] and Groundwater Threat Metric (by Tank) for the S-SX Tank Farm (CP-TF-2)

Tank ID	I-129 (Ci)	Ni-59 (Ci)	Ni-63 (Ci)	Pu (total) (Ci)[(b)]	Sr-90 (Ci)	Tc-99 (Ci)	U (total) (Ci)[(c)]	GTM (Mm3)[(d)]
S-101	0.12	5.9	530	570	410000	110	7.3	120
S-102	0.046	1.3	120	63	57000	20	3.4	22
S-103	0.16	3.1	280	210	38000	170	0.85	190
S-104	0.084	5.4	480	660	350000	51	3.9	57
S-105	0.33	13	1100	17	5900	350	0.73	390
S-106	0.27	11	950	43	33000	290	0.83	320
S-107	0.036	8.1	720	2600	280000	31	12	34
S-108	0.32	13	1200	220	67000	340	2.4	380
S-109	0.4	16	1500	85	45000	420	0.52	460
S-110	0.23	9.8	880	560	210000	240	4.8	260
S-111	0.19	7.7	690	32	360000	190	0.58	210
S-112	0.00034	0.061	0.061	0.038	49	0.14	0.00013	0.15
SX-101	0.2	9.9	880	870	270000	160	4	180
SX-102	0.18	6.4	580	270	160000	180	1.4	200
SX-103	0.28	12	1100	500	470000	280	1.8	310
SX-104	0.22	11	950	870	370000	210	4	230
SX-105	0.19	8.4	760	1200	530000	200	1.4	220
SX-106	0.25	3	270	500	26000	260	1.2	290
SX-107	0.022	4.3	380	660	1.10E+06	14	2.2	15
SX-108	0.022	4.3	380	1300	1.20E+06	14	1.9	15
SX-109	0.12	8.8	800	570	820000	77	1.8	85
SX-110	0.024	4.5	410	480	1.60E+06	15	1.3	17
SX-111	0.038	6.4	580	790	1.80E+06	25	2.4	27
SX-112	0.02	4.2	370	570	1.30E+06	13	1.8	14
SX-113	0.0025	0.062	5.3	8.5	2600	1.6	0.0096	1.7
SX-114	0.048	6.9	620	920	1.70E+06	31	3	34

Tank ID	I-129 (Ci)	Ni-59 (Ci)	Ni-63 (Ci)	Pu (total) (Ci)[b]	Sr-90 (Ci)	Tc-99 (Ci)	U (total) (Ci)[c]	GTM (Mm3)[d]
SX-115	0.0019	0.43	39	1200	350000	1.3	0.13	1.4

a. From Best Basis Inventory (BBI) Summary (March 24, 2014) provided in spreadsheet form by Mark Triplett. All primary contaminant inventories are reported to 2 significant figures. The source document should be consulted for greater precision data.

b. Sum of plutonium isotopes 238, 239, 240, 241, and 242

c. Sum of uranium isotopes 232, 233, 234, 235, 236, and 238

d. The Groundwater Threat Metric (GTM) shown for tanks is equal to the maximum of the GTM for Tc-99 and I-129.

Table E.3-6. Current Primary Contaminant Inventory (by Tank) for the S-SX Tank Farm (CP-TF-2) [(a)]

Tank ID	CCl4 (kg)	CN (kg)	Cr (kg)	Cr-VI (kg)	Hg (kg)	NO3 (kg)	Pb (kg)	TBP (kg)	TCE (kg)	U (total) (kg)
S-101	NP[(b)]	NP	14000	NP	16	310000	120	NP	NP	9800
S-102	NP	NP	1500	NP	3.7	120000	41	NP	NP	4600
S-103	NP	NP	5700	NP	2.4	360000	130	NP	NP	780
S-104	NP	NP	4100	NP	0.23	390000	31	NP	NP	5700
S-105	NP	NP	2400	NP	3.6	1.40E+06	190	NP	NP	600
S-106	NP	NP	16000	NP	2.7	980000	190	NP	NP	650
S-107	NP	NP	9000	NP	19	140000	310	NP	NP	17000
S-108	NP	NP	18000	NP	4.3	1.10E+06	320	NP	NP	1900
S-109	NP	NP	5400	NP	6.4	1.70E+06	200	NP	NP	600
S-110	NP	NP	13000	NP	14	910000	110	NP	NP	6400
S-111	NP	NP	11000	NP	11	500000	92	NP	NP	490
S-112	NP	NP	18	NP	0.00069	0.34	1.1	NP	NP	0.19
SX-101	NP	NP	27000	NP	26	780000	160	NP	NP	4100
SX-102	NP	NP	12000	NP	8.8	490000	150	NP	NP	1200
SX-103	NP	NP	16000	NP	17	990000	290	NP	NP	1700
SX-104	NP	NP	12000	NP	26	710000	210	NP	NP	5200
SX-105	NP	NP	7500	NP	16	480000	190	NP	NP	1500
SX-106	NP	NP	9600	NP	0.91	550000	220	NP	NP	820
SX-107	NP	NP	1900	NP	26	71000	42	NP	NP	3000
SX-108	NP	NP	4500	NP	26	180000	120	NP	NP	2600
SX-109	NP	NP	8400	NP	21	550000	44	NP	NP	2400
SX-110	NP	NP	1300	NP	24	58000	22	NP	NP	1600
SX-111	NP	NP	2700	NP	34	120000	45	NP	NP	3200
SX-112	NP	NP	1500	NP	25	56000	33	NP	NP	2400
SX-113	NP	NP	6.3	NP	0.39	8800	0.68	NP	NP	14
SX-114	NP	NP	3500	NP	37	160000	58	NP	NP	4100

Tank ID	CCl4 (kg)	CN (kg)	Cr (kg)	Cr-VI (kg)	Hg (kg)	NO3 (kg)	Pb (kg)	TBP (kg)	TCE (kg)	U (total) (kg)
SX-115	NP	NP	98	NP	2.4	3700	2.2	NP	NP	160

a. From Best Basis Inventory (BBI) Summary (March 24, 2014) provided in spreadsheet form by Mark Triplett. All primary contaminant inventories are reported to 2 significant figures. The source document should be consulted for greater precision data.

b. NP = Not present at significant quantities

Table E.3-7. Summary of the Evaluation of Threats to Groundwater as a Protected Resource from Remaining Vadose Zone (VZ) Contamination associated with the S-SX Tank and Waste Farms Evaluation Unit (CP-TF-2)

PC	Group	WQS	Porosity[(a)]	K_d (mL/g)[(a)]	ρ (kg/L)[(a)]	VZ Source M^{Source}	SZ Total M^{SZ}	Treated[(c)] M^{Treat}	VZ Remain M^{Tot} (d)	VZ GTM (Mm^3)	VZ Rating[(e)]
C-14	A	2000 pCi/L	0.23	0	1.84	5.35E+00 Ci	---	---	5.35E+00 Ci	2.68E+00	Low
I-129	A	1 pCi/L	0.23	0.2	1.84	2.15E-01 Ci	---	---	2.15E-01 Ci	8.25E+01	Medium
Sr-90	B	8 pCi/L	0.23	22	1.84	2.84E+04 Ci	---	---	2.84E+04 Ci	2.00E+04	ND[(f)]
Tc-99	A	900 pCi/L	0.23	0	1.84	4.42E+01 Ci	6.90E+00 Ci	2.61E+00 Ci	3.47E+01 Ci	3.85E+01	Medium
CCl_4[(g)]	A	5 µg/L	0.23	0	1.84	---	---	---	---	---	---
Cr	B	100 µg/L	0.23	0	1.84	3.36E+04 kg	8.21E+00 kg	2.45E-01 kg	3.36E+04 kg	3.36E+02	High
Cr-VI	A	48 µg/L[(b)]	0.23	0	1.84	3.36E+04 kg	3.43E+01 kg	2.45E-01 kg	3.36E+04 kg	7.00E+02	High
TCE	B	5 µg/L	0.23	2	1.84	---	---	---	---	---	ND
U(tot)	B	30 µg/L	0.23	0.8	1.84	3.20E+03 kg	---	---	3.20E+03 kg	1.44E+01	ND[(f)]

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

b. "Model Toxics Control Act−Cleanup" (WAC 173-340) Method B groundwater cleanup level for hexavalent chromium.

c. Treatment amounts from the 2013 Hanford Annual Groundwater Report (DOE/RL-2014-32, Rev. 0).

d. The remaining vadose zone inventory is estimated by difference (CRESP 2015) and thus has a high associated uncertainty.

e. Groundwater Threat Metric rating based on Table 6-3, Methodology Report (CRESP 2015). These contaminants are being treated using the 200-West Groundwater Treatment Facility.

f. As discussed in Section 2.5, no appreciable uranium or Sr-90 plume would be expected in the next 150 years due to transport and decay (Sr-90) considerations. Thus the *Low* rating would apply to the period *after* the Active Cleanup is complete to account for uncertainties.

g. Carbon tetrachloride is managed in the 200-ZP-1 Operable Unit (Appendix G.6 for CP-GW-2).

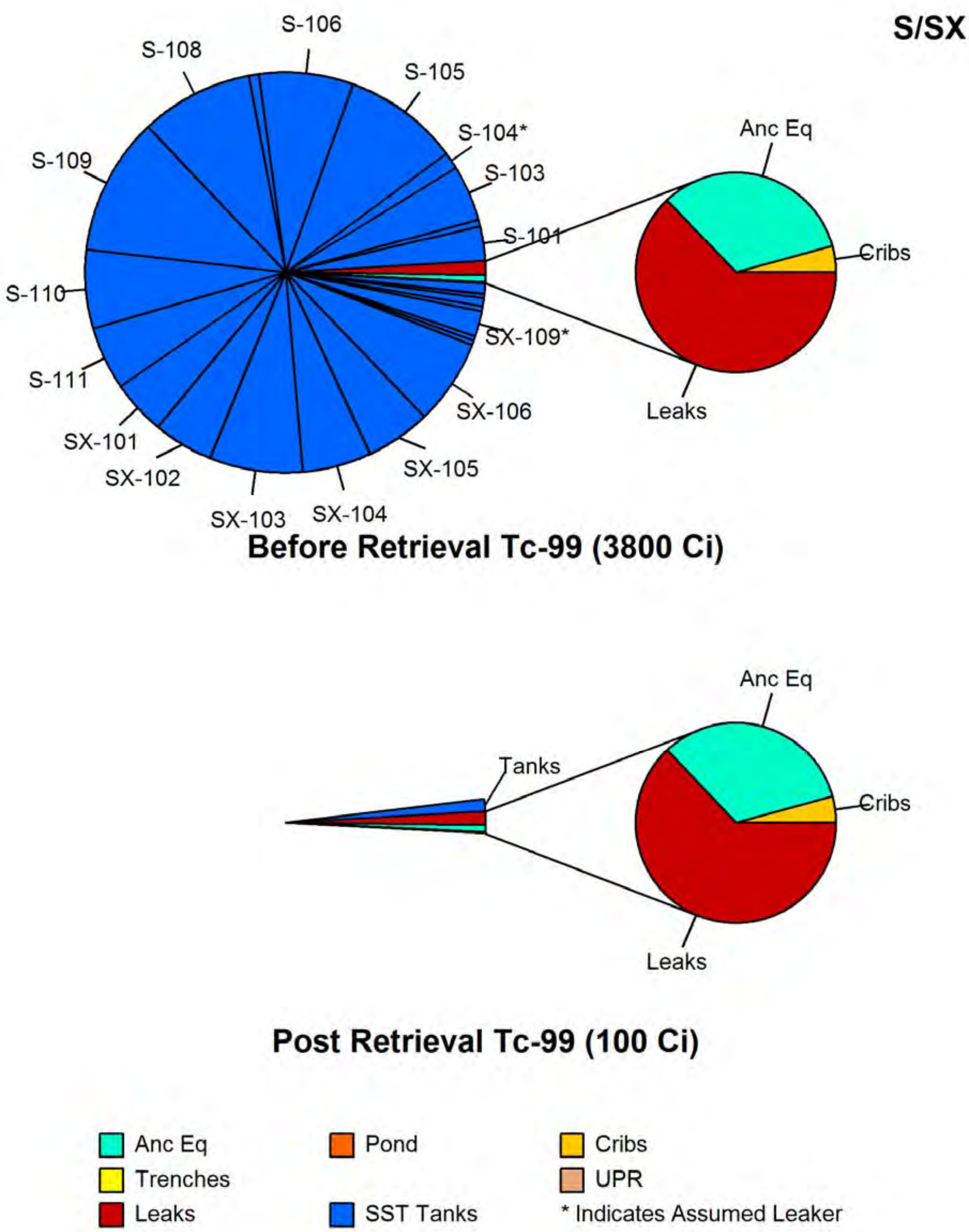

Figure E.3-3. S-SX Tank and Waste Farms Evaluation Unit Inventory Estimates for Tc-99 Before and After 99% Retrieval

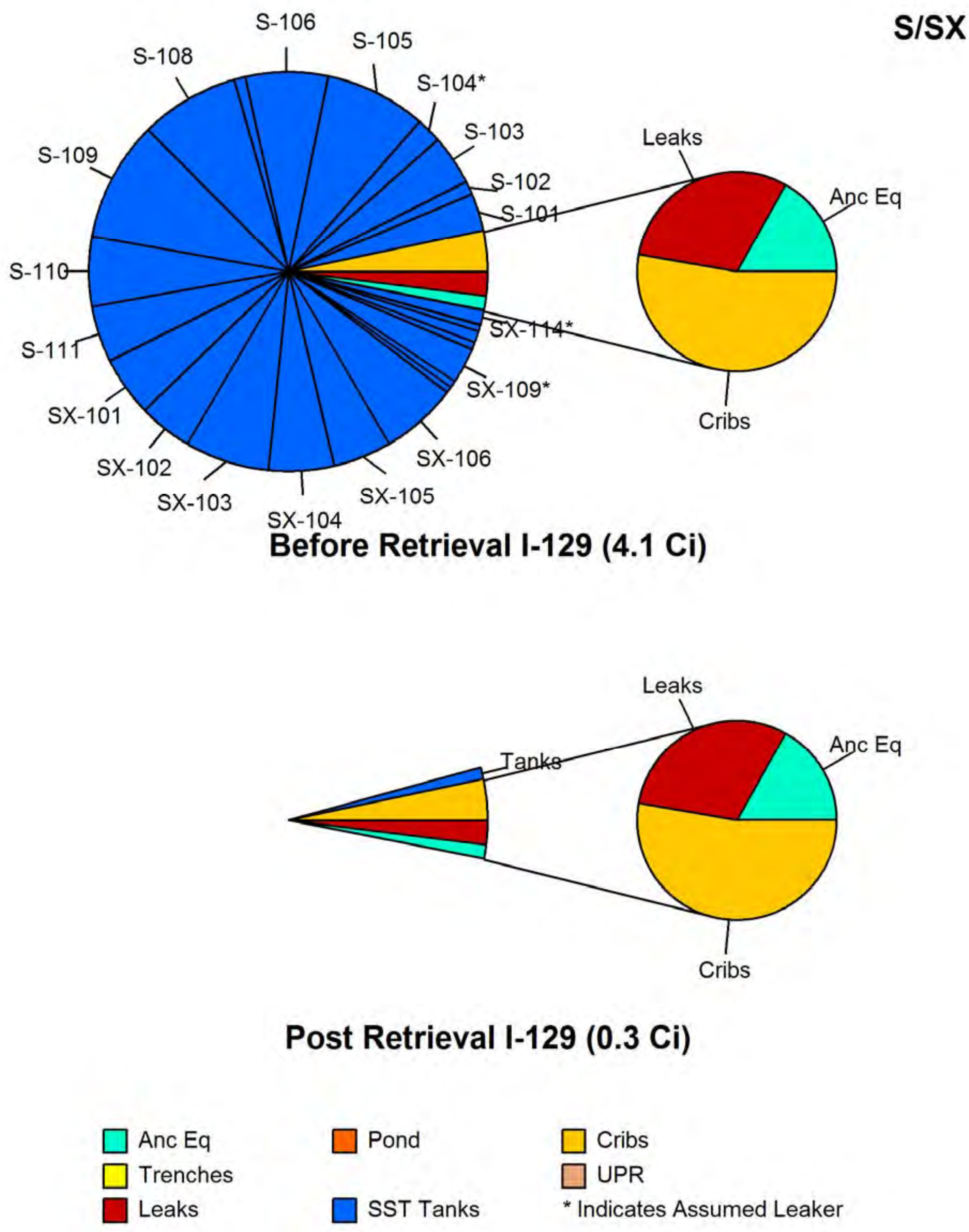

Figure E.3-4. S-SX Tank and Waste Farms Evaluation Unit Inventory Estimates for I-129 Before and After 99% Retrieval

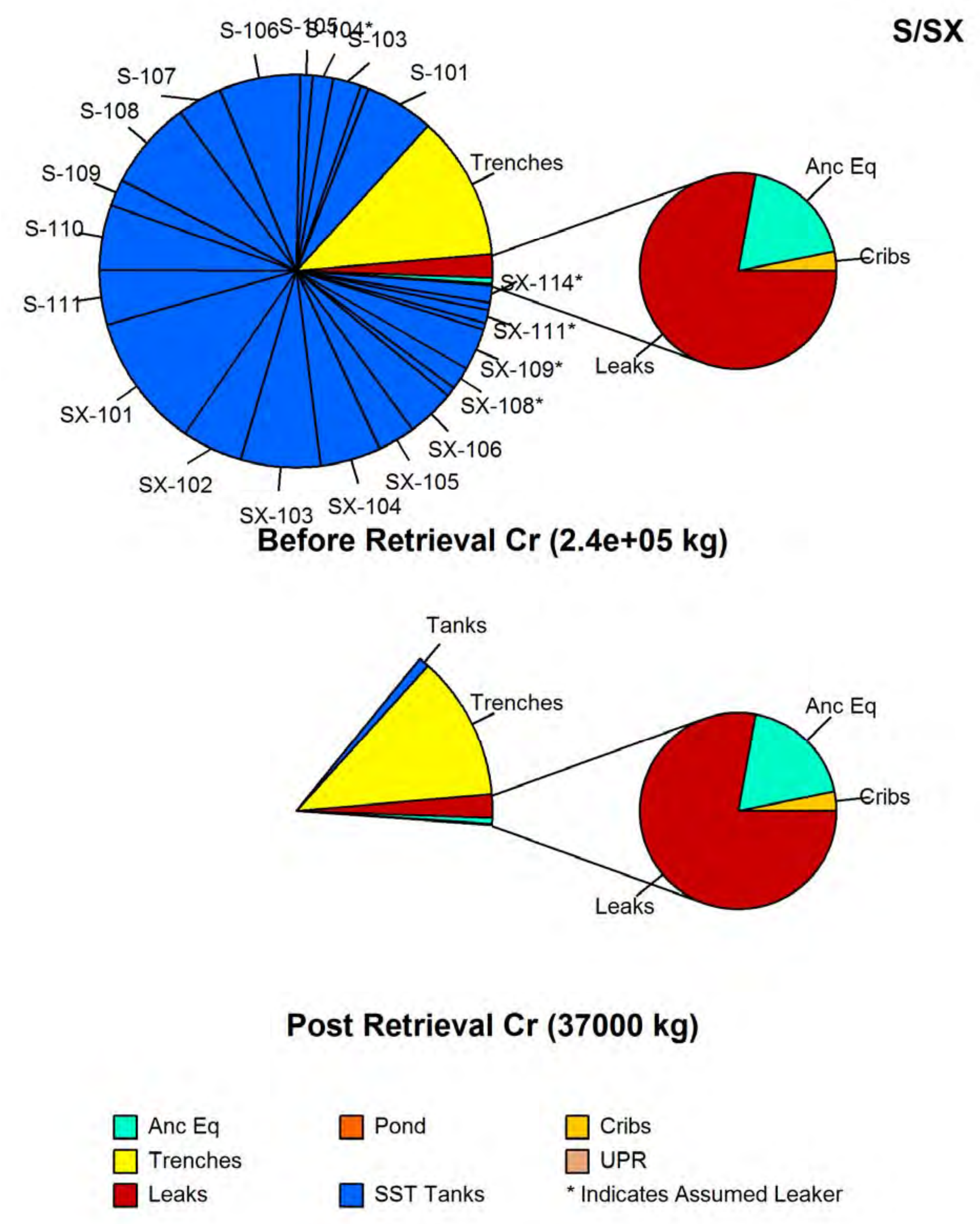

Figure E.3-5. S-SX Tank and Waste Farms Evaluation Unit Inventory Estimates for Chromium Before and After 99% Retrieval

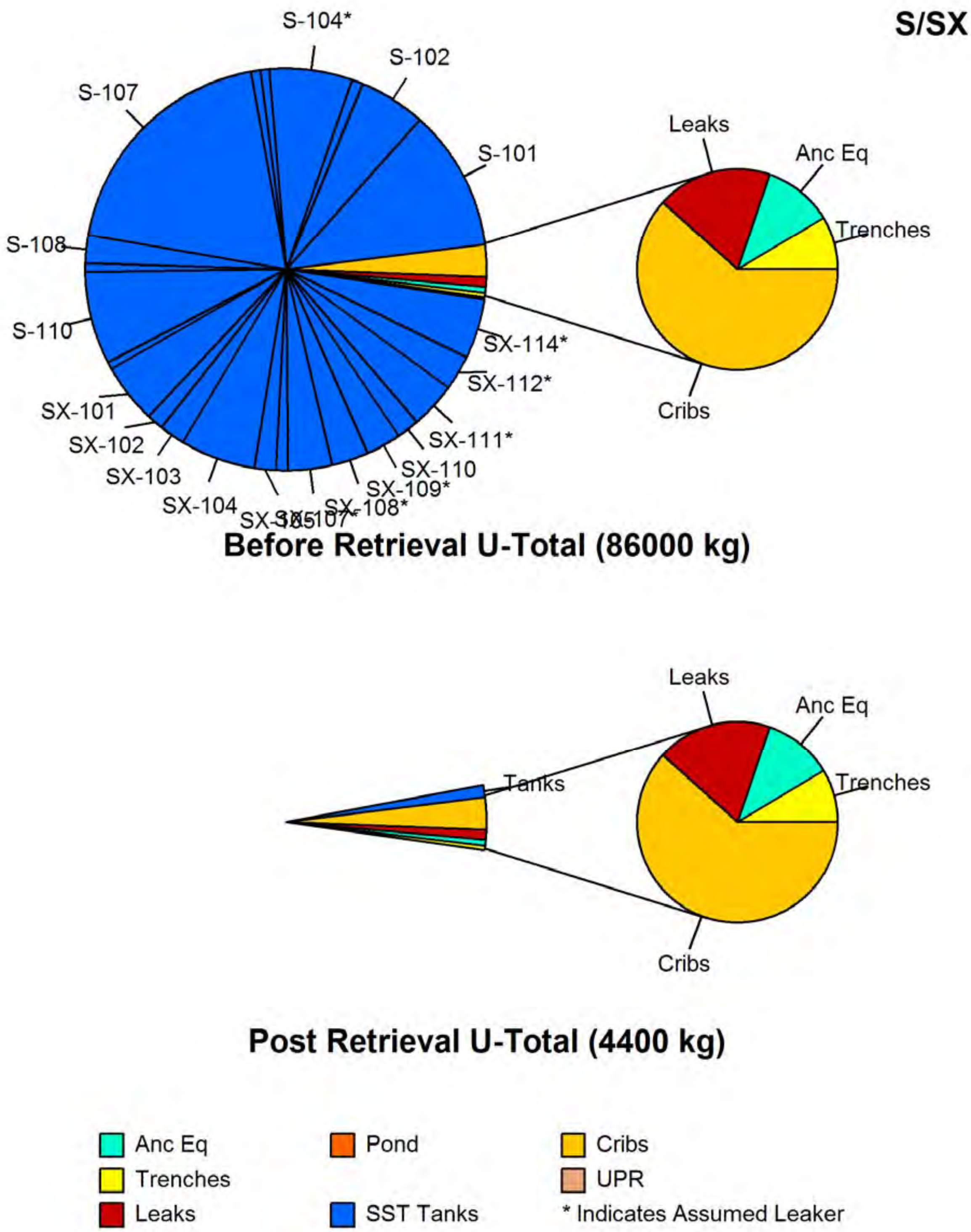

Figure E.3-6. S-SX Tank and Waste Farms Evaluation Unit Inventory Estimates for U(tot) Before and After 99% Retrieval

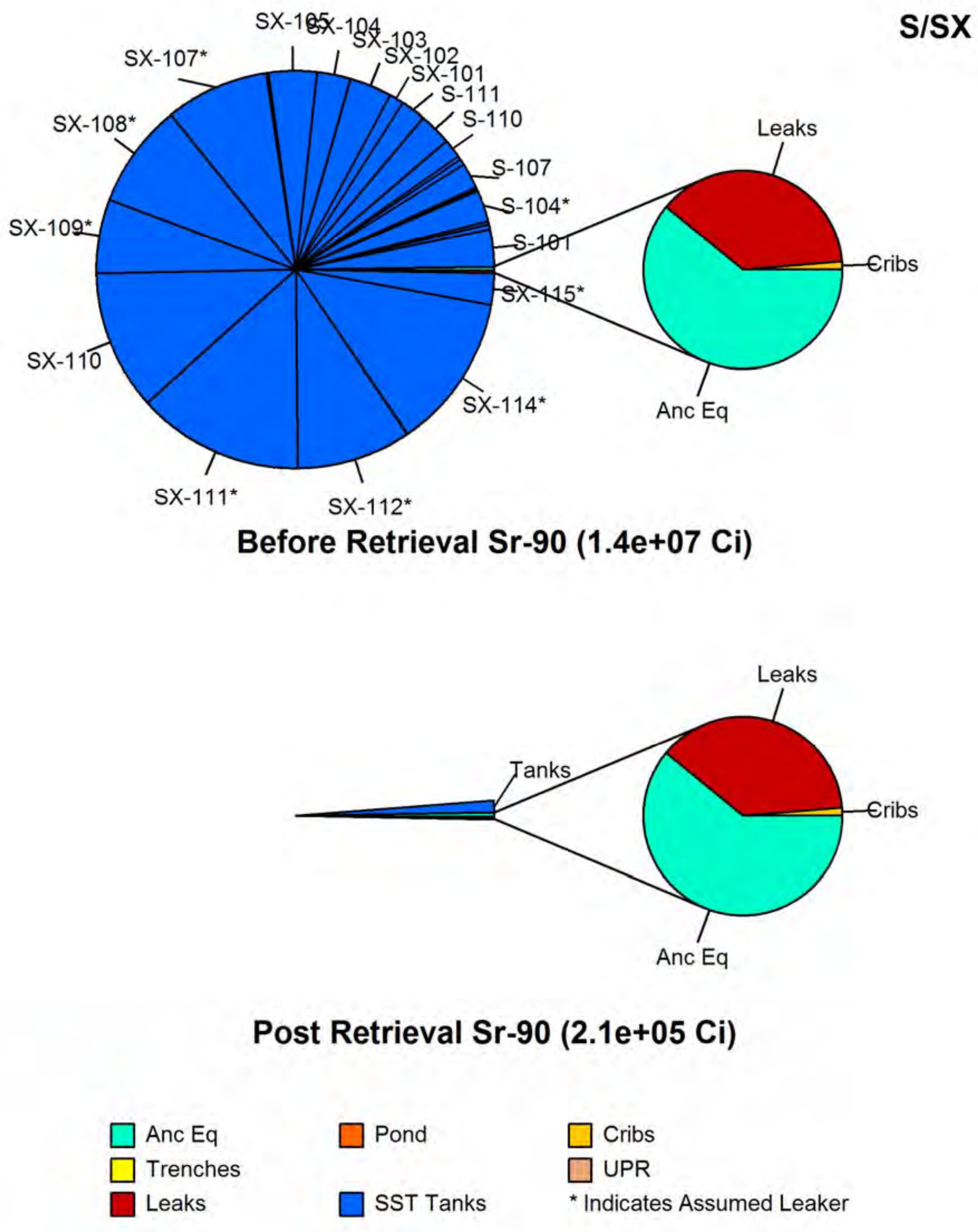

Figure E.3-7. S-SX Tank and Waste Farms Evaluation Unit Inventory Estimates for Sr-90 Before and After 99% Retrieval

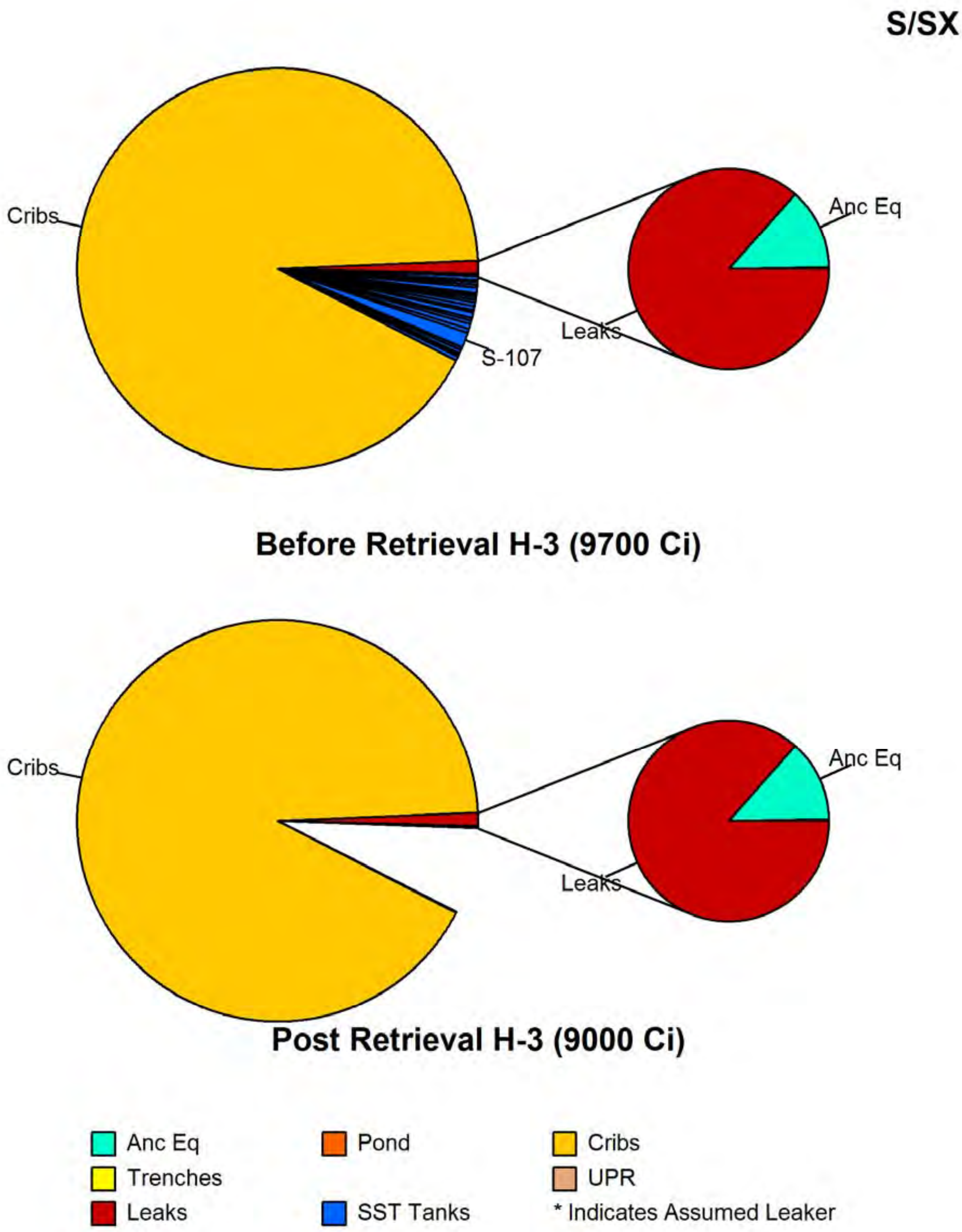

Figure E.3-8. S-SX Tank and Waste Farms Evaluation Unit Inventory Estimates for Tritium (H-3) Before and After 99% Retrieval

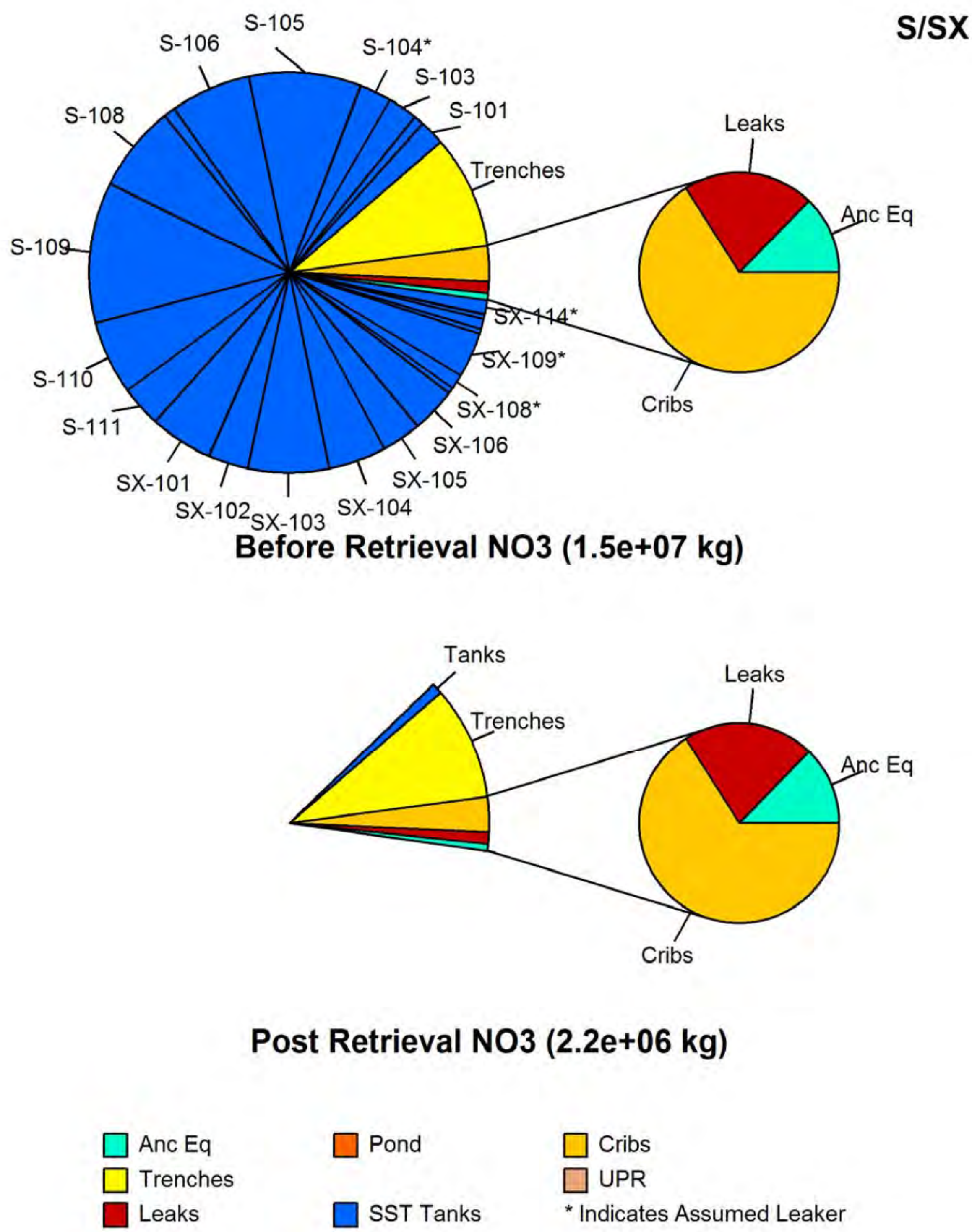

Figure E.3-9. S-SX Tank and Waste Farms Evaluation Unit Inventory Estimates for Nitrate (NO3) Before and After 99% Retrieval

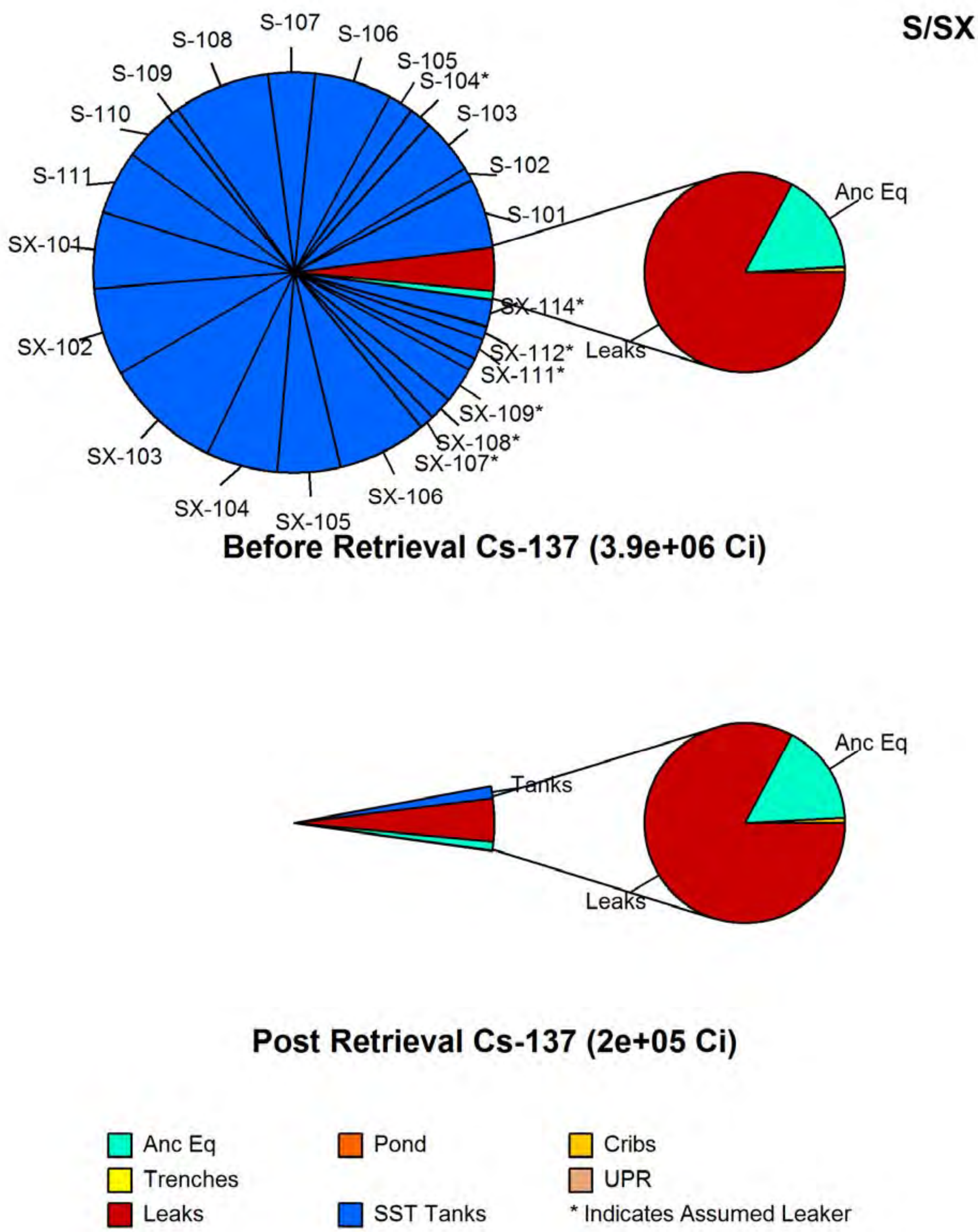

Figure E.3-10. S-SX Tank and Waste Farms Evaluation Unit Inventory Estimates for Cs-137 Before and After 99% Retrieval

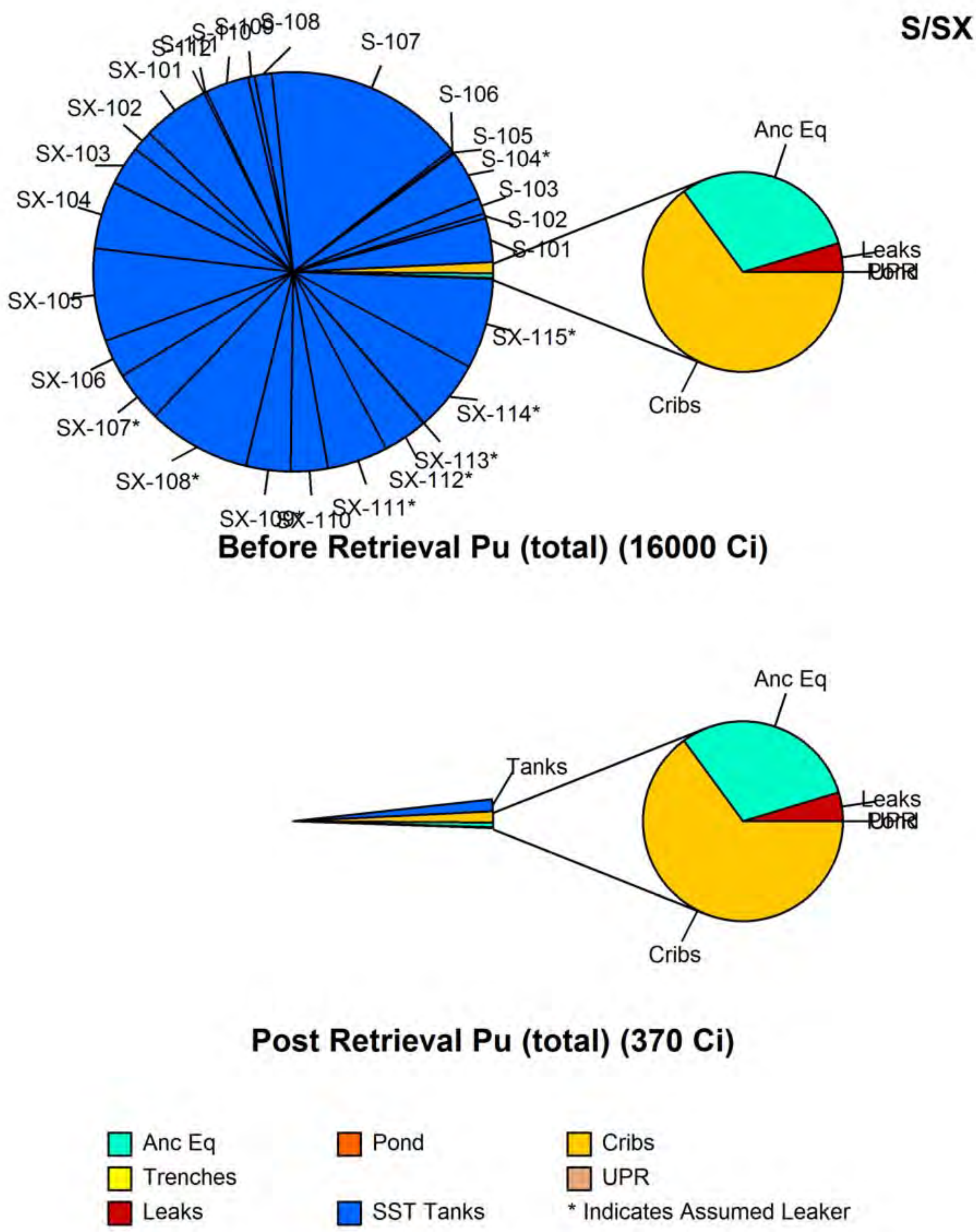

Figure E.3-11. S-SX Tank and Waste Farms Evaluation Unit Inventory Estimates for Plutonium (total) Before and After 99% Retrieval

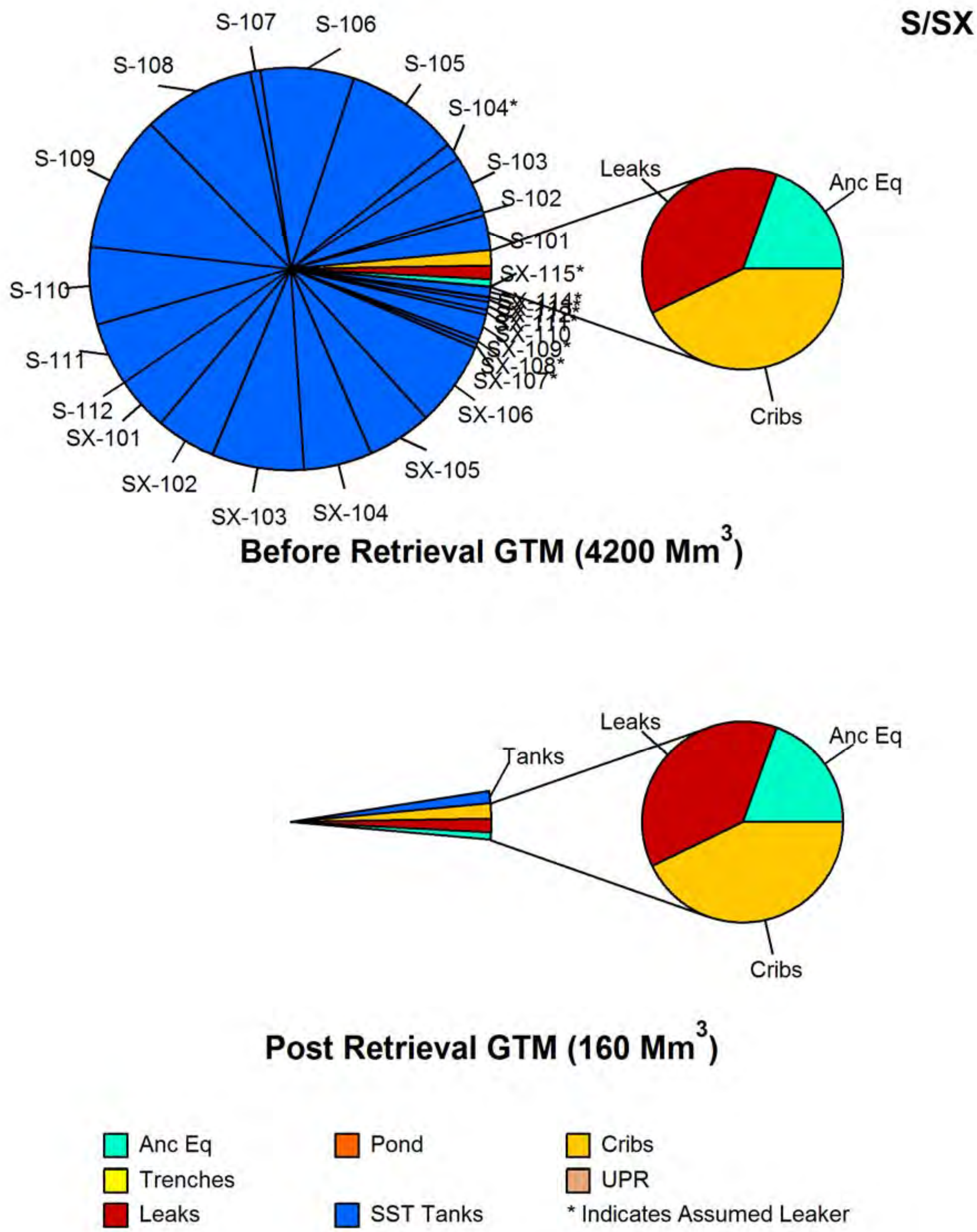

Figure E.3-12. S-SX Tank and Waste Farms Evaluation Unit Maximum Groundwater Threat Metric (GTM) of I-129 and Tc-99 Estimates Before and After 99% Retrieval

3.6. POTENTIAL RISK/IMPACT PATHWAYS AND EVENTS

CURRENT CONCEPTUAL MODEL

A common safety analysis was performed for all the single- and double-shell tanks including pathways and barriers (safety scenarios that dominate risk, safety systems and controls, barriers to release, failure mechanisms, pathways and receptors, time frames for exposure). See Section 1.6 in Appendix E.1 for details.

POPULATIONS AND RESOURCES CURRENTLY AT RISK OR POTENTIALLY IMPACTED

Facility Worker, Co-located Person, and Public

A common analysis was performed for the Facility Worker, Co-located Person, and Public. See Section 1.6 (Appendix E.1) for details.

Groundwater

The groundwater plumes (nitrate, Tc-99, and chromium) considered associated with the S-SX Tank and Waste Farms EU and liquid waste disposal facilities are described in Section 3.5 and further details are provided in Appendix G.6 for the CP-GW-2 EU (200-UP-1 GW OU).

As shown in Table E.3-7 (Section 3.5), the vadose zone (VZ) GTM values for the Group A and B primary contaminants translate into ratings that range from *ND* for uranium (with a *Low* rating after the Active Cleanup period as described in Section 2.5) and Sr-90 (which has an inventory that would translate to a *Very High* rating but appears relatively immobile in the area as described in Section 2.5) to *Medium* for Tc-99 and I-129 to *High* for chromium (total and hexavalent) or the S-SX Tank and Waste Farms EU. Thus the overall rating for groundwater impact from vadose zone sources is *High*.

Columbia River

As described in Section 3.5, no plumes associated with the S-SX Tank and Waste Farms EU currently intersect the Columbia River above benthic or riparian standards, which corresponds to *Not Discernible* ratings. The large dilution effect of the Columbia River results in a rating of *Not Discernible* for the free-flowing ecology.

Additional information concerning potential threats to the Columbia River from Tank Farm and liquid waste disposal facilities in the 200-West Area is provided in Appendix G.6 for the CP-GW-2 EU (200-UP-1 GW OU).

Ecological Resources

- The major portion of the unit (>85%) consists of graveled surfaces, buildings, parking areas, and infrastructure related to the tanks.
- No wildlife were observed within the EU during the October reconnaissance, however, 6 bird species as well as black tailed jackrabbit sign were noted in the vicinity during previous surveys.
- No level 3 or higher quality habitat patches occur within the S-SX Tank and Waste Farms EU.
- Cleanup activities undertaken within the EU boundary would result in no net change in the amount of level 3 or higher resources within a 0.6 km radius.
- Because the area is an industrial site, and is contiguous with adjacent tank farms and other industrial areas—no significant change in habitat connectivity would be expected if habitat resources within the EU are lost.

Cultural Resources

- There are no archaeological sites known to be located within the S-SX Tank and Waste Farms EU.
- The 242S Evaporator Facility a contributing property within the Manhattan Project and Cold War Era Historic District, with no documentation required is located within the S-SX Tank and Waste Farms EU.

<u>Archaeological sites and TCPs located within 500 meters of the EU</u>

- The 272S Maintenance Shop also a contributing property within the Manhattan Project and Cold War Era Historic District, with no documentation required is located adjacent to the S-SX Tank and Waste Farms EU.
- The Hanford Site Plant Railroad, a contributing property within the Manhattan Project and Cold War Era Historic District, with documentation required is located in the vicinity of the S-SX Tank and Waste Farms EU.
- An historic isolate is likely associated with the Pre-Hanford Early Settlers/Farming Landscape.is located in the vicinity of the S-SX Tank and Waste Farms EU. This isolated find is not considered to be eligible to the National Register of Historic Places.

<u>Closest Recorded TCP</u>

- There are two recorded TCPs associated with the Native American Precontact and Ethnographic Landscape that are visible from the S-SX Tank and Waste Farms EU.

CLEANUP APPROACHES AND END-STATE CONCEPTUAL MODEL

Selected or Potential Cleanup Approaches

A common analysis was performed for all the single- and double-shell tanks. See Section 1.6 (Appendix E.1) for details.

Contaminant Inventory Remaining at the Conclusion of Planned Active Cleanup Period

See Section 3.5 including Table E.3-2 and Figure E.3-3 through Figure E.3-11 for the inventory information after planned 99% retrieval. Furthermore, a more general analysis was performed for all the single- and double-shell tanks. See Section 1.6 (Appendix E.1) for details.

Risks and Potential Impacts Associated with Cleanup

A general analysis was performed for all the single- and double-shell tanks for workers and the Public. See Section 1.6 (Appendix E.1) for details.

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

Facility Worker, Co-located Person, and Public

A common analysis was performed for the Facility Worker, Co-located Person, and Public. See Section 1.6 (Appendix E.1) for details.

Groundwater

As described in Section 3.5, there will be a continuing impact during this period to groundwater (as a protected resource) from those mobile S-SX Tank Farm primary contaminants currently with plumes that exceed thresholds. These impacts are described in Appendix G.6 for the CP-GW-2 EU (200-UP-1 OU).

Furthermore, there are primary (e.g., tank wastes) and secondary contaminant sources (legacy source sites) in the vadose zone that pose risk to groundwater. The vadose zone (VZ) GTM values for the Group A and B primary contaminants for the S-SX Tank and Waste Farms EU translate to ratings of ND for uranium and Sr-90 to *Medium* for Tc-99 and I-129 to *High* for chromium (total and hexavalent) during this period (because of insufficient impact of recharge rates under treatment likely due to the large amounts of contaminants already in the groundwater and possible impacts from sources outside the S-SX Tank and Waste Farms EU). These ratings correspond to an overall rating of *High*.

However, the 200-West Area pump-and-treat system is assumed to be operational during this evaluation period, which will be treating groundwater contamination.

It is considered unlikely that additional groundwater resources would be impacted as a result of either interim remedial actions (e.g., pump and treat) or final closure activities (that are not covered in the Ecological or Cultural Resources results).

Columbia River

As described in Section 3.5, the impacts to the Columbia River benthic, riparian, and free-flowing ecology for the Active Cleanup and Near-term, Post Cleanup periods are rated as *Not Discernible*. Additional information on groundwater plumes and potential threats associated with the S-SX Tank Farms and liquid waste disposal facilities are described in Appendix G.6 for the CP-GW-2 EU (200-UP-1 GW OU).

It is considered unlikely that additional benthic or riparian resources would be impacted as a result of either interim remedial actions (e.g., pump and treat) or final closure activities (that are not covered in the Ecological or Cultural Resources results).

Ecological Resources

See Section 1.6 (Appendix E.1) for details.

Cultural Resources

See Section 1.6 (Appendix E.1) for details.

ADDITIONAL RISKS AND POTENTIAL IMPACTS IF CLEANUP IS DELAYED

A common analysis was performed for all the single- and double-shell tanks. See Section 1.6 (Appendix E.1) for details.

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

A common analysis was performed for all the single- and double-shell tanks. See Section 1.6 (Appendix E.1) for details.

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

Table E.3-8. Summary of Populations and Resources at Risk or Potentially Impacted after Cleanup

Population or Resource		Impact Rating	Comments
Human	Facility Worker	Low	Workers will be low risk from exposure to direct radiation and waste contaminants after waste retrieval, grouting, and capping.
	Co-located Person	Low	These persons will be at low risk from exposure to direct radiation and waste contaminants after waste retrieval, grouting, and capping.
	Public	Not Discernible (ND)	The Tank Farms will be in secure and controlled areas that prevent intentional and inadvertent intruders. No complete groundwater pathway and no impact from air pathway.
Environmental	Groundwater (A&B) from vadose zone[a]	ND (uranium, Sr-90) to High (Cr-tot and Cr-VI) **Overall**: High	GTM values for Group A and B primary contaminants (Table E.3-7): *Low* (uranium, Sr-90), *Medium* (Tc-99, I-129) and *High* (total and hexavalent chromium). Uranium and Sr-90 not likely to impact groundwater (Section 3.5). Insufficient predicted impact from decay (since chromium is risk driver) or changes in recharge rates to modify ratings.
	Columbia River from vadose zone[a]	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 (Section 3.5). Dilution factor of greater than 100 million between River and upwellings.
	Ecological Resources[b]	ND to Low	Continued monitoring could result in some disturbance to EU, and buffer lands. Remediation may improve habitat (and increased monitoring may lead to increases in exotic species, changes in species composition).

Population or Resource		Impact Rating	Comments
Social	Cultural Resources[b]	**Native American:** Direct: Unknown Indirect: Known **Historic Pre-Hanford:** Direct: Known Indirect: Unknown **Manhattan/Cold War**: Direct: None Indirect: None	Permanent indirect effects to viewshed are possible from capping. Permanent effects may be possible due to presence of contamination if capping occurs. No other expected cultural resources impacts.

a. Groundwater threat for Group A and B contaminants remaining in the vadose zone or to the Columbia River for all primary contaminants. Threats from existing plumes associated with the S-SX Tank and Waste Farms EU are described in Section 3.5 and Appendix G.6 (CP-GW-2) for the 200-UP-1 Groundwater Operable Unit.
b. 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.

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

As described in Section 3.5, the TC&WM ecological screening analysis indicate that that exposure to radioactive contaminants from peak groundwater discharge was below screening levels at the Columbia River near-shore region, indicating there should be no expected adverse effects from radionuclides. Furthermore, results of the corresponding TC&WM screening evaluation for chemicals indicated that predicted chromium and nitrate concentrations could exceed screening values (i.e., Hazard Quotient of unity) in the near-shore region. However, the predicted nitrate peak concentration was in the past and would be unlikely to exceed human or aquatic standards in the future. For chromium the long travel time from 200-West to the Columbia River likely indicates that little chromium predicted to impact the near-shore region would be from 200-West sources (including the S-SX Tank and Waste Farms EU), which would also likely lead to insignificant impacts from the S-SX Tank and Waste Farms EU.

For more information, see Section 1.6 (Appendix E.1).

3.7. SUPPLEMENTAL INFORMATION AND CONSIDERATIONS

A common analysis was performed for all the single- and double-shell tanks. See Section 1.7 (Appendix E.1) for details.

3.8. ATTACHMENT -- S-SX TANK FARMS EVALUATION UNIT WIDS REVIEW

Hanford Site-Wide Risk Review

Evaluation Unit:	S-SX Tank Farms
ID:	CP-TF-2
Group:	Tank Farm
Operable Unit Cross-Walk:	WMA S/SX 200-DV-1 200-WA-1
Related EU:	CP-LS-7 CP-TF-9 CP-GW-2
Sites & Facilities:	S-SX Tank Farms, ancillary structures, associated liquid waste sites, and soils contamination. Includes 242-S Evaporator.
Key Data Sources Docs:	RPP-13033 RPP-40545 RPP-PLAN-40145 RPP-10435

Figure 1. Site Map with Evaluation Unit Boundaries and Tank Locations

Attached:

- Waste Site and Facility List
- Site Map with Evaluation Unit Boundaries and Associated Waste Sites
- Site Map with Evaluation Unit Boundaries and Associated Facilities

Prepared by: AMG, 08/29/2014
Reviewed by: GVL, 08/29/2014
Revisions: AMG, 09/10/2014

Hanford Site-Wide Risk Review
CP-TF-2 (S-SX Tank Farms)
Waste Site and Facility List

Site Code	Name	Site Status	Site Type	Site Type Category	Operable Unit	Exclude from Evaluation
200-W-100-PL	200-W-100-PL; Encased Pipeline from 241-UX-154 to 241-SX-152 Diversion Box; Lines 4700, 4701, 4853, V762, V503 and V505	Inactive	Encased Tank Farm Pipeline	Pipeline and associated valves, etc.	TBD	
200-W-137-PL	200-W-137-PL; Line V533; Pipeline from 241-S-151 Diversion Box to 216-S-1 & 2 Cribs	Inactive	Radioactive Process Sewer	Pipeline and associated valves, etc.	TBD	
200-W-159-PL	200-W-159-PL; Cooling Water Lines from 241-SX-401 and 241-SX-402 to 216-U-10 Pond	Inactive	Radioactive Process Sewer	Pipeline and associated valves, etc.	TBD	
200-W-160-PL	200-W-160-PL; Pipeline from 241-SX-401 and 241-SX-402 to 216-S-21 Crib	Inactive	Radioactive Process Sewer	Pipeline and associated valves, etc.	TBD	
200-W-161-PL	200-W-161-PL; Line 557; Pipeline from 242-S to 216-S-25 Crib	Inactive	Radioactive Process Sewer	Pipeline and associated valves, etc.	TBD	
200-W-162-PL	200-W-162-PL; Pipeline from 241-SX-701 to 216-SX-2 Crib	Inactive	Radioactive Process Sewer	Pipeline and associated valves, etc.	TBD	
200-W-179-PL	200-W-179-PL; Lines SL100, SL101, SN216/281 and DR327; Pipelines Between 241-S-152 Diversion Box and 241-U Tank Farm	Inactive	Direct Buried Tank Farm Pipeline	Pipeline and associated valves, etc.	TBD	
200-W-189-PL	200-W-189-PL; Lines SNL-5350 and SNL-5351; Transfer Lines from 219-S to 241-SY Tank Farm	Active	Direct Buried Tank Farm Pipeline	Pipeline and associated valves, etc.	Not Applic	
200-W-223-PL	200-W-223-PL; Pipeline from 242-S Evaporator to 216-U-14 Ditch	Inactive	Radioactive Process Sewer	Pipeline and associated valves, etc.	TBD	
200-W-235-PL	200-W-235-PL; Pipeline from 241-SX-701 Building to S Pit; 200-W-162-PL Replacement Pipeline	Inactive	Process Sewer	Pipeline and associated valves, etc.	TBD	
200-W-236	200-W-236; Pit South of 241-SX Tank Farm	Inactive	Depression/Pit (nonspecific)	Pond/Ditch - Surface Liquid Disposal Site	TBD	
200-W-37	200-W-37; Buried Tygon Tubing Near 241-S-101	Inactive	Dumping Area	Burial Ground	Not Applic	
200-W-54	200-W-54; Contamination Migration from 241-SX Tank Farm	Inactive	Contamination Migration	Unplanned Release - Surface/Near Surface	200-WA-1	
200-W-96	200-W-96; Contaminated Soil at 241-S/SX/SY Tank Farm	Inactive	Unplanned Release	Unplanned Release - Surface/Near Surface	WMA S/SX	
200-W-97-PL	200-W-97-PL; Encased Pipeline from 240-S-151 Diversion Box to 241-S-151 Diversion Box; Lines V508, V509, V512, V513, V514, V515, V516, V517/3603 and V519/1115	Inactive	Encased Tank Farm Pipeline	Pipeline and associated valves, etc.	TBD	
200-W-99-PL	200-W-99-PL; Encased Pipeline from 241-U-151 to 241-S-151 Diversion Boxes; Lines V455 and V456	Inactive	Encased Tank Farm Pipeline	Pipeline and associated valves, etc.	TBD	
216-S-1&2	216-S-1&2; 216-S-5 Crib; 216-S-1 & 2	Inactive	Crib	Crib - Subsurface Liquid Disposal Site	200-WA-1	
216-S-15	216-S-15; 216-S-2; 241-S-110 Pond; UN-216-W-3; 110-S Tank Overflow Pond	Inactive	Pond	Pond/Ditch - Surface Liquid Disposal Site	WMA S/SX	
216-S-21	216-S-21; 216-SX-1; 216-SX-1 Cavern or Crib	Inactive	Crib	Crib - Subsurface Liquid Disposal Site	200-DV-1	
216-S-25	216-S-25; 216-S-25 Crib	Inactive	Crib	Crib - Subsurface Liquid Disposal Site	200-WA-1	
216-S-3	216-S-3; 216-S-3 Crib; 216-S-5	Inactive	Crib	Crib - Subsurface Liquid Disposal Site	WMA S/SX	
216-S-4	216-S-4; 216-S-4 Sump or Crib; 216-S-7; UN-216-W-1	Inactive	French Drain	Crib - Subsurface Liquid Disposal Site	200-WA-1	
216-S-8	216-S-8; Cold Aqueous Crib; Cold Aqueous Grave; Cold Aqueous Trench; Unirradiated Uranium Waste Trench; 216-S-3	Inactive	Trench	Crib - Subsurface Liquid Disposal Site	200-WA-1	
216-SX-2	216-SX-2; 216-SX-2 Crib	Inactive	Crib	Crib - Subsurface Liquid Disposal Site	200-WA-1	
241-S-101	241-S-101; 241-S-TK-101	Inactive	Single-Shell Tank	Underground Storage Tank	WMA S/SX	
241-S-102	241-S-102; 241-S-TK-102	Inactive	Single-Shell Tank	Underground Storage Tank	WMA S/SX	
241-S-103	241-S-103; 241-S-TK-103	Inactive	Single-Shell Tank	Underground Storage Tank	WMA S/SX	
241-S-104	241-S-104; 241-S-TK-104	Inactive	Single-Shell Tank	Underground Storage Tank	WMA S/SX	
241-S-105	241-S-105; 241-S-TK-105	Inactive	Single-Shell Tank	Underground Storage Tank	WMA S/SX	
241-S-106	241-S-106; 241-S-TK-106	Inactive	Single-Shell Tank	Underground Storage Tank	WMA S/SX	
241-S-107	241-S-107; 241-S-TK-107	Inactive	Single-Shell Tank	Underground Storage Tank	WMA S/SX	
241-S-108	241-S-108; 241-S-TK-108	Inactive	Single-Shell Tank	Underground Storage Tank	WMA S/SX	
241-S-109	241-S-109; 241-S-TK-109	Inactive	Single-Shell Tank	Underground Storage Tank	WMA S/SX	
241-S-110	241-S-110; 241-S-TK-110	Inactive	Single-Shell Tank	Underground Storage Tank	WMA S/SX	

Note that only those waste sites with a WIDS (Waste Information Data System) Classification of "Accepted" are shown, along with non-duplicate facilities, identified via the Hanford Geographic Information System (HGIS).

Hanford Site-Wide Risk Review
CP-TF-2 (S-SX Tank Farms)
Waste Site and Facility List

Site Code	Name	Site Status	Site Type	Site Type Category	Operable Unit	Exclude from Evaluation
241-S-111	241-S-111; 241-S-TK-111	Inactive	Single-Shell Tank	Underground Storage Tank	WMA S/SX	
241-S-112	241-S-112; 241-S-TK-112	Inactive	Single-Shell Tank	Underground Storage Tank	WMA S/SX	
241-S-151	241-S-151; 241-S-151 Diversion Box	Inactive	Diversion Box	Pipeline and associated valves, etc.	WMA S/SX	
241-S-152	241-S-152; 241-S-152 Diversion Box	Inactive	Diversion Box	Pipeline and associated valves, etc.	WMA S/SX	
241-S-302A	241-S-302A; 241-S-302-A Catch Tank; IMUST; Inactive Miscellaneous Underground Storage Tank; Lines V542, V763, V764, and DR324	Inactive	Catch Tank	Underground Storage Tank	WMA S/SX	
241-S-302B	241-S-302B; 241-S-302-B Catch Tank; IMUST; Inactive Miscellaneous Underground Storage Tank	Inactive	Catch Tank	Underground Storage Tank	Not Applic	
241-S-304	241-S-304; 241-S-304 Catch Tank	Inactive	Catch Tank	Underground Storage Tank	WMA S/SX	
241-S-A	241-S-A; 241-S-A Diversion Box; 241-S-A Valve Pit	Inactive	Valve Pit	Pipeline and associated valves, etc.	WMA S/SX	
241-S-B	241-S-B; 241-S-B Diversion Box; 241-S-B Valve Pit	Inactive	Valve Pit	Pipeline and associated valves, etc.	WMA S/SX	
241-S-C	241-S-C; 241-S-C Diversion Box; 241-S-C Valve Pit	Inactive	Valve Pit	Pipeline and associated valves, etc.	WMA S/SX	
241-S-D	241-S-D; 241-S-D Diversion Box; 241-S-D Valve Pit	Inactive	Valve Pit	Pipeline and associated valves, etc.	WMA S/SX	
241-SX-101	241-SX-101; 241-SX-TK-101	Inactive	Single-Shell Tank	Underground Storage Tank	WMA S/SX	
241-SX-102	241-SX-102; 241-SX-TK-102	Inactive	Single-Shell Tank	Underground Storage Tank	WMA S/SX	
241-SX-103	241-SX-103; 241-SX-TK-103	Inactive	Single-Shell Tank	Underground Storage Tank	WMA S/SX	
241-SX-104	241-SX-104; 241-SX-TK-104	Inactive	Single-Shell Tank	Underground Storage Tank	WMA S/SX	
241-SX-105	241-SX-105; 241-SX-TK-105	Inactive	Single-Shell Tank	Underground Storage Tank	WMA S/SX	
241-SX-106	241-SX-106; 241-SX-TK-106	Inactive	Single-Shell Tank	Underground Storage Tank	WMA S/SX	
241-SX-107	241-SX-107; 241-SX-TK-107	Inactive	Single-Shell Tank	Underground Storage Tank	WMA S/SX	
241-SX-108	241-SX-108; 241-SX-TK-108	Inactive	Single-Shell Tank	Underground Storage Tank	WMA S/SX	
241-SX-109	241-SX-109; 241-SX-TK-109	Inactive	Single-Shell Tank	Underground Storage Tank	WMA S/SX	
241-SX-110	241-SX-110; 241-SX-TK-110	Inactive	Single-Shell Tank	Underground Storage Tank	WMA S/SX	
241-SX-111	241-SX-111; 241-SX-TK-111	Inactive	Single-Shell Tank	Underground Storage Tank	WMA S/SX	
241-SX-112	241-SX-112; 241-SX-TK-112	Inactive	Single-Shell Tank	Underground Storage Tank	WMA S/SX	
241-SX-113	241-SX-113; 241-SX-TK-113	Inactive	Single-Shell Tank	Underground Storage Tank	WMA S/SX	
241-SX-114	241-SX-114; 241-SX-TK-114	Inactive	Single-Shell Tank	Underground Storage Tank	WMA S/SX	
241-SX-115	241-SX-115; 241-SX-TK-115	Inactive	Single-Shell Tank	Underground Storage Tank	WMA S/SX	
241-SX-151	241-SX-151; 241-SX-151 Diversion Box	Inactive	Diversion Box	Pipeline and associated valves, etc.	WMA S/SX	
241-SX-152	241-SX-152; 241-SX-152 Diversion Box; 241-SX-152 Transfer Box	Inactive	Diversion Box	Pipeline and associated valves, etc.	WMA S/SX	
241-SX-302	241-SX-302; 241-SX-302 Catch Tank; IMUST; Inactive Miscellaneous Underground Storage Tank; Line V595; SX-304	Inactive	Catch Tank	Underground Storage Tank	200-IS-1	
241-SX-401	241-SX-401; 241-SX-401 Condenser Shielding Building; 241-SX-401 Waste Disposal Condenser House	Inactive	Process Unit/Plant	Process Building	WMA S/SX	
241-SX-402	241-SX-402; 241-SX-402 Condenser Shielding Building; 241-SX-402 Waste Disposal Condenser House	Inactive	Process Unit/Plant	Process Building	WMA S/SX	
241-SX-A	241-SX-A; 241-SX-A Diversion Box; 241-SX-A Valve Pit	Inactive	Valve Pit	Pipeline and associated valves, etc.	WMA S/SX	
241-SX-B	241-SX-B; 241-SX-B Diversion Box; 241-SX-B Valve Pit	Inactive	Valve Pit	Pipeline and associated valves, etc.	WMA S/SX	
242-S	242-S; 242-S Evaporator	Inactive	Evaporator	Process Building	Not Applic	
244-S DCRT	244-S DCRT; 244-S Double-Contained Receiver Tank; 244-S Receiver Tank; 244-S RT; 244-S-TK/SMP; Lines 5350 and 5351; 244-S Catch Station	Inactive	Receiver Tank	Underground Storage Tank	WMA S/SX	
2607-W9	2607-W9; 2707-SX Septic Tank	Inactive	Septic Tank	Septic System	200-WA-1	X
2607-WZ	2607-WZ	Inactive	Septic Tank	Septic System	200-WA-1	X
UPR-200-W-114	UPR-200-W-114; Ground Contamination East of 241-SX Tank Farm; UN-200-W-114; UN-216-W-24	Inactive	Unplanned Release	Unplanned Release - Surface/Near Surface	200-IS-1	

Note that only those waste sites with a WIDS (Waste Information Data System) Classification of "Accepted" are shown, along with non-duplicate facilities, identified via the Hanford Geographic Information System (HGIS).

Hanford Site-Wide Risk Review
CP-TF-2 (S-SX Tank Farms)
Waste Site and Facility List

Site Code	Name	Site Status	Site Type	Site Type Category	Operable Unit	Exclude from Evaluation
UPR-200-W-115	UPR-200-W-115; Ground Contamination Above Transfer Line Along Cooper Street; UN-216-W-25	Inactive	Unplanned Release	Unplanned Release - Surface/Near Surface	200-IS-1	
UPR-200-W-127	UPR-200-W-127; Liquid Release from 242-S Evaporator to the Ground; UN-200-W-127	Inactive	Unplanned Release	Unplanned Release - Surface/Near Surface	Not Applic	
UPR-200-W-140	UPR-200-W-140; 241-SX-107 Leak	Inactive	Unplanned Release	Unplanned Release - Subsurface	Not Applic	
UPR-200-W-141	UPR-200-W-141; 241-SX-108 Leak	Inactive	Unplanned Release	Unplanned Release - Subsurface	Not Applic	
UPR-200-W-142	UPR-200-W-142; 241-SX-109 Leak	Inactive	Unplanned Release	Unplanned Release - Subsurface	Not Applic	
UPR-200-W-143	UPR-200-W-143; 241-SX-111 Leak	Inactive	Unplanned Release	Unplanned Release - Subsurface	Not Applic	
UPR-200-W-144	UPR-200-W-144; 241-SX-112 Leak	Inactive	Unplanned Release	Unplanned Release - Subsurface	Not Applic	
UPR-200-W-145	UPR-200-W-145; 241-SX-113 Leak	Inactive	Unplanned Release	Unplanned Release - Subsurface	Not Applic	
UPR-200-W-146	UPR-200-W-146; 241-SX-115 Leak	Inactive	Unplanned Release	Unplanned Release - Subsurface	Not Applic	
UPR-200-W-20	UPR-200-W-20; Spread of Contamination from a Diversion Box; UN-200-W-20	Inactive	Unplanned Release	Unplanned Release - Surface/Near Surface	TBD	
UPR-200-W-36	UPR-200-W-36; Groundwater Contamination at 216-S-1 and 216-S-2	Inactive	Unplanned Release	Unplanned Release - Surface/Near Surface	200-WA-1	
UPR-200-W-49	UPR-200-W-49; Contamination Southeast of 241-SX; UN-200-W-49	Inactive	Unplanned Release	Unplanned Release - Surface/Near Surface	Not Applic	
UPR-200-W-50	UPR-200-W-50; Contamination Spread from 241-SX-114; UN-200-W-50	Inactive	Unplanned Release	Unplanned Release - Surface/Near Surface	Not Applic	
UPR-200-W-51	UPR-200-W-51; UPR-200-W-52; Release from 241-S Diversion Box; UN-200-W-51	Inactive	Unplanned Release	Unplanned Release - Surface/Near Surface	200-WA-1	
UPR-200-W-80	UPR-200-W-80; 241-S/SX Contamination Migration; UN-200-W-80	Inactive	Unplanned Release	Unplanned Release - Surface/Near Surface	Not Applic	
UPR-200-W-81	UPR-200-W-81; Contamination Specks in 241-S/SX; UN-200-W-81	Inactive	Unplanned Release	Unplanned Release - Surface/Near Surface	Not Applic	
241S271A	ELECTRICAL/INSTRUMENT CONTROL BUILDING	INACTIVE	BUILDING	Infrastructure Building		X
241S271B	ELECTRICAL/INSTRUMENT CONTROL BUILDING	INACTIVE	BUILDING	Infrastructure Building		X
241SX271	TANK FARM CONTROL HOUSE	ACTIVE	BUILDING	Infrastructure Building		X
241SX281	EMERGENCY COOLING WATER PUMP HOUSE	ACTIVE	BUILDING	Infrastructure Building		X
241SX701	WASTE DISPOSAL CONDENSER HOUSE	ACTIVE	BUILDING	Process Building		
241SY271	INSTRUMENT AND ELECTICAL CONTROL HOUSE	ACTIVE	BUILDING	Infrastructure Building		X
242S702	TURBINE BUILDING VENTILATION	ACTIVE	BUILDING	Process Building		
244S	WASTE LIFT STATION -- VAULT	INACTIVE	STRUCTURE	Process Building		
244S271	INSTRUMENT CONTROL HOUSE	ACTIVE	BUILDING	Infrastructure Building		X
244S2904	FLUSH PIT AT 244S TANK FARM	INACTIVE	BUILDING	Process Building		
2508W10	SIREN WEST OF COOPER NORTH SIDE OF 13TH	ACTIVE	STRUCTURE	Infrastructure Building		X
2707SX	CARPENTER SHOP	ACTIVE	BUILDING	Infrastructure Building		X
2724SX	RAD MONITORING AND PROTECTIVE CLOTHING BLDG	INACTIVE	BUILDING	Infrastructure Building		X
2724SY	RAD MONITORING AND PROTECTIVE CLOTHING BLDG	INACTIVE	BUILDING	Infrastructure Building		X
MO2172	DECON TRAILER AT 242S	ACTIVE	BUILDING	Infrastructure Building		X
MO295	CHANGE MOBILE AT SY TANK FARM S/O 242S	INACTIVE	BUILDING	Infrastructure Building		X
MO298	CHANGE TRIALER BY 241SX	ACTIVE	BUILDING	Infrastructure Building		X
MO450	STORAGE MOBILE NORTH OF 241SY TANK FARM	ACTIVE	BUILDING	Infrastructure Building		X
MO563	S102 S112 RETREIVAL CONTROL ROOM TRAILER	INACTIVE	BUILDING	Infrastructure Building		X
MO636	LUNCH/CHG ROOM SW OF 241S // EAST OF COOPER AVE	ACTIVE	BUILDING	Infrastructure Building		X
MO819	CHANGE TRAILER AT SX TANK FARM S OF 242S	ACTIVE	BUILDING	Infrastructure Building		X
MO949	MOBILE LAB WEST OF 241SX401	INACTIVE	BUILDING	Infrastructure Building		X

Note that only those waste sites with a WIDS (Waste Information Data System) Classification of "Accepted" are shown, along with non-duplicate facilities, identified via the Hanford Geographic Information System (HGIS).

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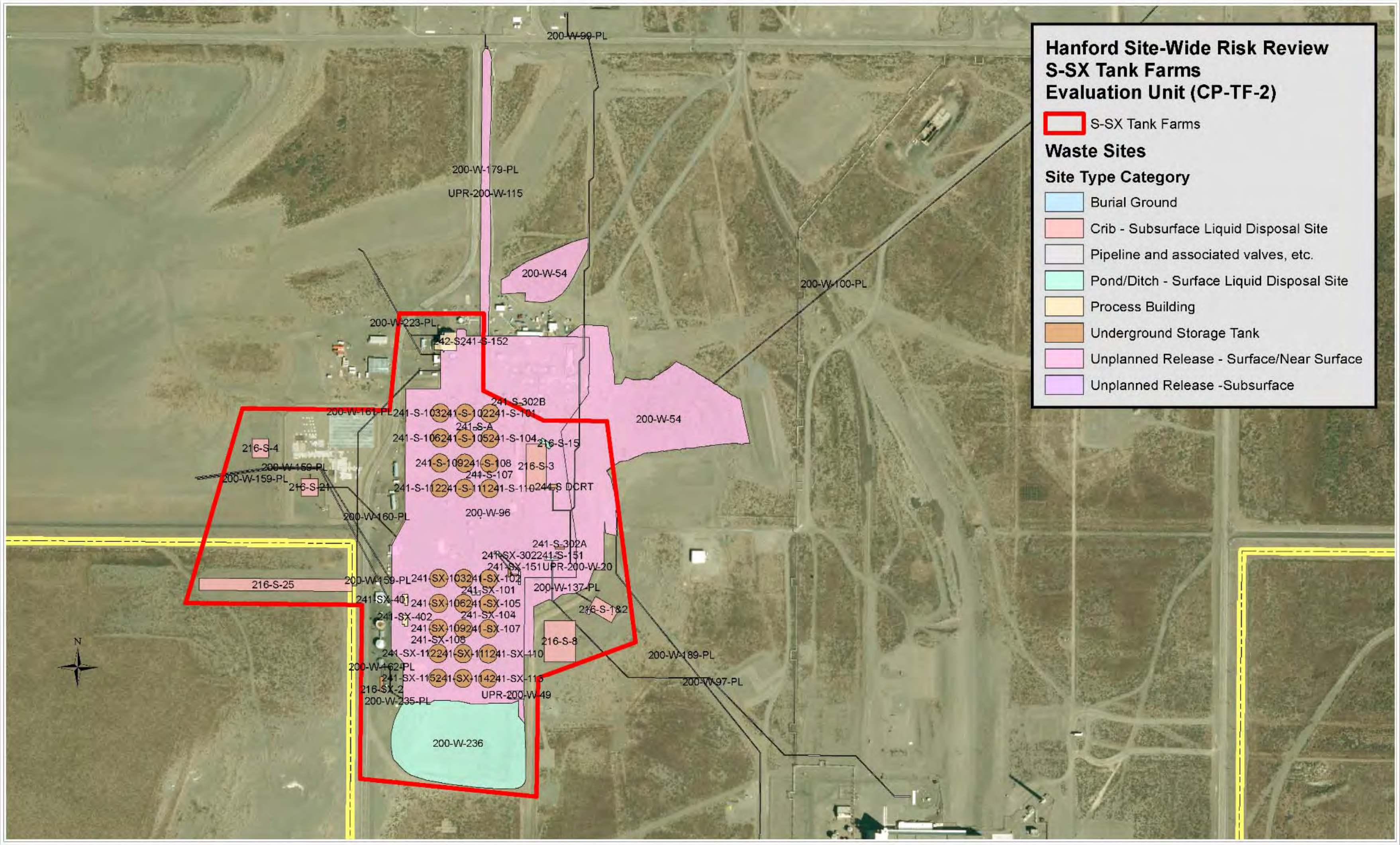
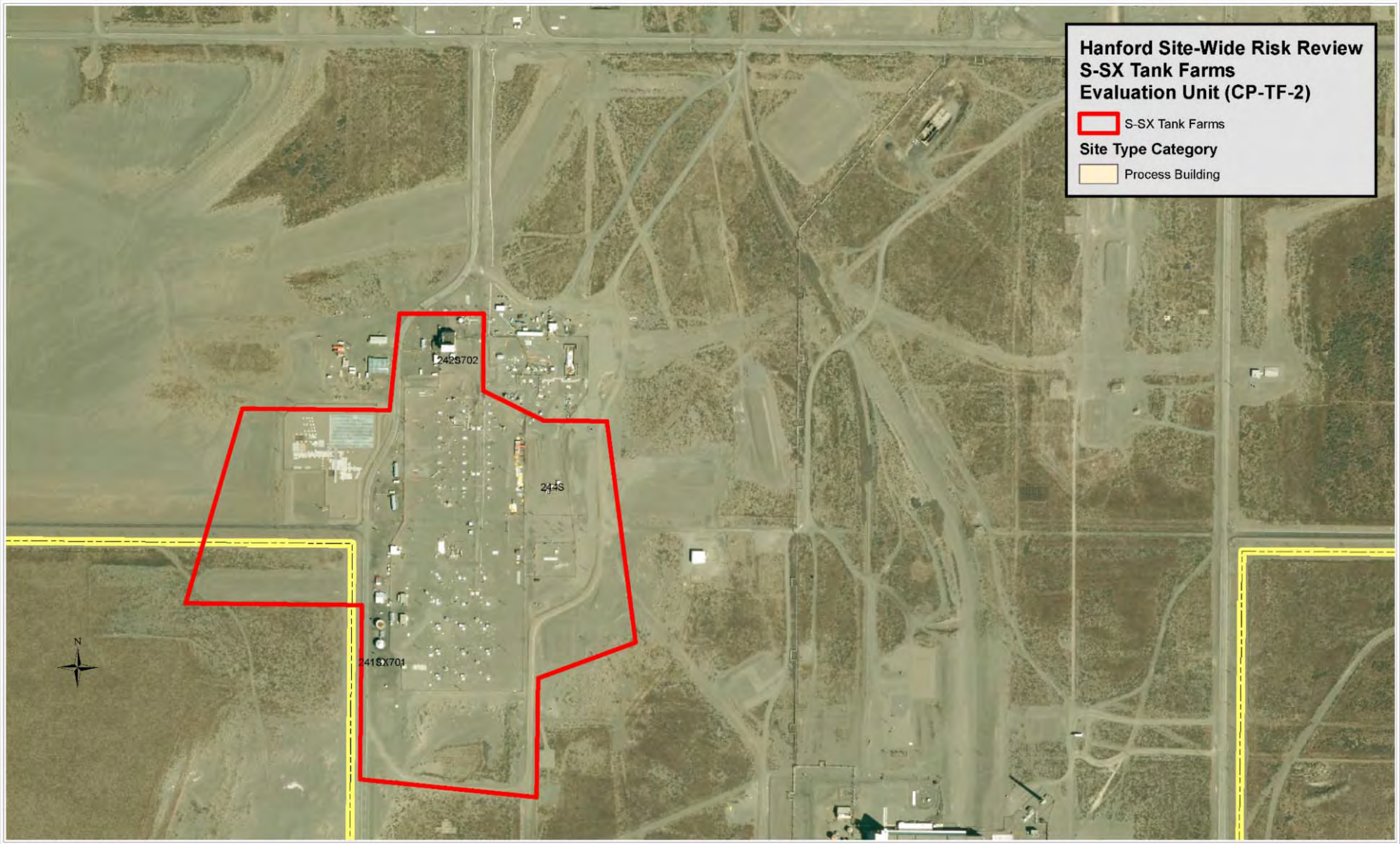


1 inch = 550 feet

DRAFT



1 inch = 550 feet

APPENDIX E.4

Tank Waste and Farms

CP-TF-3 (TX-TY Tank Waste and Farms)
Evaluation Unit Summary Template

Table of Contents

List of Figures

List of Tables

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PART 4. CP-TF-3 TX-TY SINGLE-SHELL TANK WASTE AND FARMS (200-W)

4.1. EXECUTIVE SUMMARY

Much of the information related to the TX-TY Tank and Waste Farms Evaluation Unit (EU) is organized around the corresponding Waste Management Area (namely WMA TX-TY) that is regulated under the Resource Conservation and Recovery Act (RCRA) as modified in 40 CFR Part 265, Subpart F and Washington State's Hazardous Waste Management Act (HWMA, RCW 70.105 and its implementing requirements in the Washington State dangerous waste regulations [WAC 173-303-400]) (Horton 2007).

EU LOCATION:

North-Central part of 200-West on the Hanford Reservation; Central Plateau

RELATED EUS:

T Tank Waste and Farms (CP-TF-1), S-SX Tank Waste and Farms (CP-TF-2), U Tank Waste and Farms (CP-TF-4), A-AX Tank Waste and Farms (CP-TF-5), B-BX-BY Tank Waste and Farms (CP-TF-6), C Tank Waste and Farms (CP-TF-7), 200-East DST Waste and Farms (CP-TF-8), 200-West DST Waste and Farms (CP-TF-9) , 200-E Groundwater Plumes (CP-GW-1), 200-W Groundwater Plumes (CP-GW-2), and 200 Area Waste Transfer Pipeline (CP-LS-7)

PRIMARY CONTAMINANTS, CONTAMINATED MEDIA AND WASTES:

The TC&WM EIS describes tank wastes as including radioactive (tritium or H-3, C-14, Sr-90, Tc-99, I-129, Cs-137, U-233, U-234, U-235, U-238, Np-237, Pu-239, and Pu-240)[54] and non-radioactive contaminants (chromium, mercury, nitrate, lead, total uranium, and PCBs) of potential concern (DOE/EIS-0391 2012, Appendix D). The tank wastes contain saltcake, sludge, and supernatant phases. Contaminated media related to the TX-TY Tank Farms include ancillary equipment and surrounding vadose zone (including cribs and trenches) down to the saturated zone (for some mobile contaminants) from past and current discharges. The Record of Decision for the 200-ZP-1 Operable Unit (OU) (EPA 2008) associated with WMA TX-TY identifies Tc-99, I-129, chromium, and nitrate as tank waste constituents that must be addressed in cleanup. The 2013 Groundwater Monitoring Report (DOE/RL-2014-32, Rev. 0) lists tank wastes including chromium, nitrate, I-129, Tc-99, H-3, and uranium and non-tank wastes including carbon tetrachloride and tricholorethene (TCE) for the 200-ZP-1 OU.

After evaluating the contaminants associated with TX-TY Tank Farm tanks, ancillary equipment, legacy sources, and contaminated vadose zone, the primary contaminants from the tank wastes that drive human health risk to groundwater for the TX-TY Tank and Waste Farms Evaluation Unit are: Tc-99, I-129, chromium, and H-3. Those primary contaminants that may drive risk from groundwater discharge to the Columbia River are nitrate and chromium; however, any impacts are highly uncertain (see Section 2.1). Cs-137 and Sr-90 are important from a safety standpoint and uranium isotopes, plutonium isotopes, and tritium are iconic constituents; these contaminants are included in the inventory summary even though

[54] Other isotopes considered include U-232 and U-236 and Pu-238, Pu-241, and Pu-242 to be consistent with other EUs. These additional uranium and plutonium isotopes are included in the totals presented but are not used for rating because 1) uranium toxicity impacts (represented by total uranium drives corresponding risks and 2) plutonium has been found relatively immobile in the Hanford subsurface and has not been identified as a risk driver for groundwater impacts.

they are not considered risk drivers for impacts to or from groundwater in this review. Carbon tetrachloride and TCE are not tank wastes and thus are captured in Appendix G.6 for the CP-GW-2 EU (200-ZP-1 GW OU).

BRIEF NARRATIVE DESCRIPTION:

Waste Management Area TX-TY (WMA TX-TY) occupies approximately 74,000 m^2 and contains 24 underground single-shell tanks (SSTs) constructed in 1947-48 (TX) and 1951-52 (TY) originally to support the bismuth phosphate process (Horton 2007, p. 2.1). Each of the tanks have capacities of 2.87×10^6 liters (arranged in three 4-tank and two 3-tank cascades) in additional to ancillary support equipment (e.g., diversion boxes, pumps, valves, and pipes). The TX Tank Farm tanks began receiving waste in the late 1940s and the TY Tank Farm tanks began receiving wastes in the early 1950s. Both TX-TY Tank Farms were used to support both the bismuth phosphate process (operated 1944-56) and the uranium recovery program being conducted in the U Plant (operated 1954-57). Some TX and TY Tank Farm tanks also received REDOX and PUREX wastes. Thus waste management operations created a complex intermingling of tank wastes; natural processes resulted in settling, stratification, and segregation of waste components. Waste was cascaded through a series of tanks (where cooling and precipitation of radionuclides and solids occurred in each tank). Some supernatant from the last tank in a cascade was sent to cribs when there was a shortage of tank storage capacity (Horton 2007, p. 2.2).

Past practices and unplanned disposals have resulted in legacy (vadose zone) contamination near the WMA TX-TY as described in Section 4.3.

The SSTs in WMA TX-TY have been interim stabilized (i.e., liquid transferred to DSTs to <50 kgal drainable interstitial liquid and <5 kgal of supernatant). Initial corrective actions (i.e., cutting and capping water lines and stopping run-on of precipitation using surface water controls) have been implemented at WMA TX-TY (Horton 2007, p. 2.3).

SUMMARY TABLES OF RISKS AND POTENTIAL IMPACTS TO RECEPTORS

Table E.4-1 provides a summary of nuclear and industrial safety related consequences from CP-TF-3 (Tank and Waste Farms EU) to humans and impacts to important physical Hanford Site resources. Receptors are described in Section 1.6 (Appendix E.1).

Table E.4-1. CP-TF-3 (TX-TY Tank Waste and Farms) impact Rating Summary for Human Health (unmitigated basis with mitigated basis provided in parentheses (e.g., "High (Low)").

Population or Resource		Evaluation Time Period[a] — Active Cleanup (to 2064) — **Current Condition:** Maintenance & Monitoring (M&M)	Evaluation Time Period[a] — Active Cleanup (to 2064) — **From Cleanup Actions:** Retrieval & Closure
Human Health	Facility Worker[b]	***M&M***: Low-High[d] (Low-High)[d] ***Soil***: ND-High (ND-Low)	***Preferred method***: High (Low) ***Alternative***: High (Low)
	Co-located Person[b]	***M&M***: Low-Moderate (Low) ***Soil***: ND (ND)	***Preferred method***: Low-Moderate (Low) ***Alternative***: Low-Moderate (Low)
	Public[b]	***M&M***: Low (Low) ***Soil***: ND (ND)	***Preferred method***: Low (Low) ***Alternative***: Low (Low)
Environmental	Groundwater (A&B) from vadose zone[c]	High -- Tc-99, CCl4, & Cr(tot,VI)[f] **Overall**: High	High -- Tc-99, CCl4, & Cr(tot,VI)[f] **Overall**: High
	Columbia River from vadose zone[c]	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[e]	ND to Low	Low to Medium
Social	Cultural Resources[e]	**Native American:** Direct: Known Indirect: Known **Historic Pre-Hanford:** Direct: Known Indirect: Known **Manhattan/Cold War:** Direct: Known Indirect: Unknown	**Native American:** Direct: Known Indirect: Known **Historic Pre-Hanford:** Direct: Known Indirect: Known **Manhattan/Cold War:** Direct: Known Indirect: Unknown

a. A rating for cultural resources is not being made because cultural resources will be evaluated under Section 106 of the National Historic Preservation Act (16 USC 470, et. seq.) during the planning for remedial action.

b. Evaluated in Section 1.6 (Appendix E.1).

c. Groundwater threat for Group A and B contaminants remaining in the vadose zone or to the Columbia River for all primary contaminants. Threats from existing plumes associated with the TX-TY

Tank and Waste Farms EU are described in Section 4.5 and Appendix G.6 (CP-GW-2) for the 200-ZP-1 Groundwater Operable Unit.

d. Industrial safety consequences range from low to high (based on the evaluation scale used) for both mitigated (with controls) and unmitigated (without controls). Mitigated radiological and toxicological consequences to facility workers are high (unmitigated) and low (mitigated).

e. 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.

f. The large amount of Sr-90 disposed of in the TX-TY Tank and Waste Farms EU would translate to a *Very High* rating; however, there is no current Sr-90 plume in the 200-ZP-1 OU and it would likely require more than 150 years to reach groundwater in a sufficient amount to exceed the drinking water standard over an appreciable area (Section 4.5). Thus the Sr-90 is not considered a risk driver.

SUPPORT FOR RISK AND IMPACT RATINGS FOR EACH POPULATION OR RESOURCE

Human Health

The current and cleanup-related consequences related to work being conducted at the Tank Farms in the 200 Areas (Hanford Central Plateau) was evaluated in Section 1.6 (Appendix E.1).

Groundwater, Vadose Zone, and Columbia River

TX-TY Tank Farm contaminants are currently impacting groundwater and treatment is not predicted to decrease concentrations to below thresholds before active cleanup commences. Secondary sources (e.g., Tc-99 and total and hexavalent chromium) in the vadose also threaten to continue to impact groundwater in the future, including the Active Cleanup period. Note that there are current plumes for Tc-99, I-129, and chromium in the 200-ZP-1 Operable Unit (CP-GW-2, Appendix G.6) that are associated with the TX-TY TF EU. As described in the TC&WM EIS (and summarized in Section 4.5), there appears to be insufficient expected impact from radioactive decay (since Tc-99 and chromium are risk drivers) or recharge rate (due to large amounts of these contaminants already in the groundwater) on peak concentrations in the groundwater or near-shore region of the Columbia River during or after cleanup to modify ratings. Thus the rating for these receptors are the same as those shown in Table E.4-8.

Ecological Resources

<u>**Current**</u>
There are currently some level 3 resources in EU (4%) and in buffer area (9%). People and trucks are present, which could lead to increases in exotic species and changes in species diversity in level 3 resource areas of EU and buffer.

<u>**Risks and Potential Impacts from Selected or Potential Cleanup Approaches**</u>
Potential for continual disturbance levels with increasing number of trucks, which may cause changes in abundance and diversity in level 3 resources in EU and buffer.

Cultural Resources

<u>**Current**</u>
Manhattan Project/Cold War significant resources have already been mitigated. Area is very disturbed and there are no known recorded archaeological resources within the EU. Traditional cultural places are visible from EU.

Risks and Potential Impacts from Selected or Potential Cleanup Approaches

Because area has not been investigated either on the surface or subsurface, archaeological investigations may need to occur within pockets of undisturbed land if any prior to remediation. Potential for intact archaeological material to be present is very low.

Considerations for Timing of the Cleanup Actions

See Section 1.1 (Appendix E.1).

Near-Term, Post-Cleanup Risks and Potential Impacts

See Section 1.1 (Appendix E.1).

4.2. ADMINISTRATIVE INFORMATION

OU AND/OR TSDF DESIGNATION(S):

The TX-TY Tank Farms Evaluation Unit (EU), denoted *CP-TF-3 – TX-TY Tank Waste and Farms*, consists of 24 waste tanks, ancillary structures, associated liquid waste sites, and soils contamination; much of this EU is contained within Waste Management Area TX-TY (WMA TX-TY). Waste Management Area (WMA) TX-TY is regulated under the Resource Conservation and Recovery Act (RCRA) as modified in 40 CFR Part 265, Subpart F and Washington State's Hazardous Waste Management Act (HWMA, RCW 70.105 and its implementing requirements in the Washington State dangerous waste regulations [WAC 173-303-400]) (Horton 2007).

COMMON NAME(S) FOR EU:

There is no common name for the TX-TY Tank and Waste Farms EU because the EU is comprised of elements from other waste management units including Waste Management Area TX-TY (WMA TX-TY) that includes the 241-TX (or TX) and 241-TY (or TY) Tank Farms. The TX Tank Farm contains 18 waste tanks (TX-101 through TX-118) and the TY Tank Farm contains six waste tanks (TY-101 through TY-106). Other components in the EU (including associated legacy waste sites) are listed below in the *Primary EU Source Components* section.

KEY WORDS:

TX Tank Farm, TY Tank Farm, 241-TX Tank Farm, 241-TY Tank Farm, waste tanks, tank farm, Waste Management Area TX-TY, WMA TX-TY

REGULATORY STATUS

Regulatory Basis

DOE is the responsible agency for the closure of all single-shell tank (SST) waste management areas (WMAs) through post closure, in close coordination with other closure and cleanup activities of the Hanford Central Plateau. Washington State has a program that is authorized under RCRA and implemented through the HWMA and its associated regulations; Ecology is the lead regulatory agency responsible for the closure of the SST system. Please refer to Section 1.2 (Appendix E.1) for more information.

Applicable Regulatory Documentation

The relationship among the tank waste retrieval work plans (TWRWP) and the overall single-shell tank (SST) waste retrieval and closure process is described in Appendix I of the Hanford Federal Facility Agreement and Consent Order (HFFACO), along with requirements for the content of TWRWPs. WMA TX-TY was placed in assessment monitoring because of elevated *specific conductance* (Horton 2007, p. iii). A groundwater quality assessment plan was written (Caggiano & Chou 1993) describing the monitoring activities used in deciding whether WMA TX-TY has affected groundwater.

Applicable Consent Decree or TPA Milestones

Federal Facility Agreement and Consent Order, 1989 and amended through June 16, 2014: Milestone M-045-00; Lead Agency Ecology: *Complete the closure of all Single Shell Tank Farms by 01/31/2043*

Risk Review Evaluation Information

Completed: Revised August 25, 2015

Evaluated by: K. G. Brown

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

4.3. SUMMARY DESCRIPTION

Current land use

DOE Hanford Site for industrial use. All current land-use activities in the 200-West 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-West Area (of which TX-TY Tank and Waste Farms EU is a part) 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: The legacy source sites associated with the TX-TY Tank and Waste Farms EU are enumerated in Attachment Section 4.8. To summarize, past practices and unplanned disposals have resulted in legacy (vadose zone) contamination near the WMA TX-TY (Horton 2007, p. 2.3-2.6)[55] including trenches: 216-T-21 through 216-T-24 (5×10^6 L of first cycle supernatant waste each) and 216-T-25 (3×10^6 L of evaporator waste) and cribs: 216-T-28 (42.3×10^6 L of waste) and 216-T-19 (455×10^6 L of effluent). Thirteen of the 24 SSTs in WMA TX-TY are declared "assumed leakers" (Weyns 2014, p. 19) with leaks estimates ranging from < 1,000 gallons (TY-101 in 1973) to 35,000 gallons (TY-105 in 1960). There are also 11 unplanned releases documented in or near WMA TX-TY. Additional details are provided In Section 4.4.

[55] The wastes disposed to some of the cribs and trenches adjacent to WMA TX-TY were similar to the wastes stored in the single-shell tanks making it difficult to distinguish waste sources for existing groundwater contamination.

High-Level Waste Tanks and Ancillary Equipment: The 24 waste tanks in the TX-TY Tank and Waste Farms EU are:

- (241-)TX-101 (241-TX-TK-101)
- (241-)TX-102 (241-TX-TK-102)
- (241-)TX-103 (241-TX-TK-103)
- (241-)TX-104 (241-TX-TK-104)
- (241-)TX-105 (241-TX-TK-105)
- (241-)TX-106 (241-TX-TK-106)
- (241-)TX-107 (241-TX-TK-107)
- (241-)TX-108 (241-TX-TK-108)
- (241-)TX-109 (241-TX-TK-109)
- (241-)TX-110 (241-TX-TK-110)
- (241-)TX-111 (241-TX-TK-111)
- (241-)TX-112 (241-TX-TK-112)
- (241-)TX-113 (241-TX-TK-109)
- (241-)TX-114 (241-TX-TK-110)
- (241-)TX-115 (241-TX-TK-111)
- (241-)TX-116 (241-TX-TK-112)
- (241-)TX-117 (241-TX-TK-112)
- (241-)TX-118 (241-TX-TK-112)
- (241-)TY-101 (241-TY-TK-101)
- (241-)TY-102 (241-TY-TK-102)
- (241-)TY-103 (241-TY-TK-103)
- (241-)TY-104 (241-TY-TK-104)
- (241-)TY-105 (241-TY-TK-105)
- (241-)TY-106 (241-TY-TK-106)

The ancillary equipment included in the TX-TY Tank and Waste Farms EU is listed in Attachment Section 4.8 and consists of pipelines, diversion boxes, and catch tanks.

Groundwater Plumes:

The TX-TY Tank and Waste Farms EU is associated with the 200-ZP-1 Operable Unit (OU). The current 200-ZP-1 Operable Unit (OU) plumes associated with the TX-TY Tank and Waste Farms EU that exceed water quality standards are chromium, I-129, Tc-99, tritium, and nitrate (DOE/RL-2014-32, Rev. 0). Uranium is not a contaminant of concern in the 200-ZP OU; however, it is extracted from wells in the 200-UP OU. There are other contaminants of concern (i.e., carbon tetrachloride and TCE) associated with the 200-ZP-1 OU that exceed final cleanup levels (EPA 2008); however, these contaminants do not result from sources in the TX-TY Tank and Waste Farms EU. Only the nitrate plume is not contained within the current footprint of the carbon tetrachloride plume. An interim pump-and-treat system was operated in 200-ZP-1 from 1996 until 2012 when the final P&T system came on line (EPA 2008) to reduce the mass of carbon tetrachloride (as well as secondary contaminants TCE and chloroform) in the groundwater.

See Appendix G.6 (CP-GW-2 EU) for additional details.

Operating Facilities: Because of the prohibition on waste additions to the Hanford SSTs,[56] the TX-TY Tank and Waste Farms EU components are not considered Operating Facilities for this review. See Section 1.4 (Appendix E.1) for details.

D&D of Inactive Facilities: Not Applicable.

Location and Layout Maps

A series of maps are used to illustrate the location of the components within the CP-TF-1 EU and the TX-TY Tank and Waste Farms EU relative to the Hanford Site. Figure E.2-1 shows the relationship between the 200-W (200 West) Area (where the TX-TY Tank Farms and Waste Management Area TX-TY are located) and the Hanford Site. Figure E.4-1 illustrates the TX-TY Tank and Waste Farms EU boundary.

[56] Berman presentation on July 29, 2009, titled "Hanford Single-Shell Tank Integrity Program." Available at www.em.doe.gov.

Figure E.4-2 shows a detailed view of the waste tanks, ancillary equipment, and legacy source units in the TX-TY Tank and Waste Farms EU.

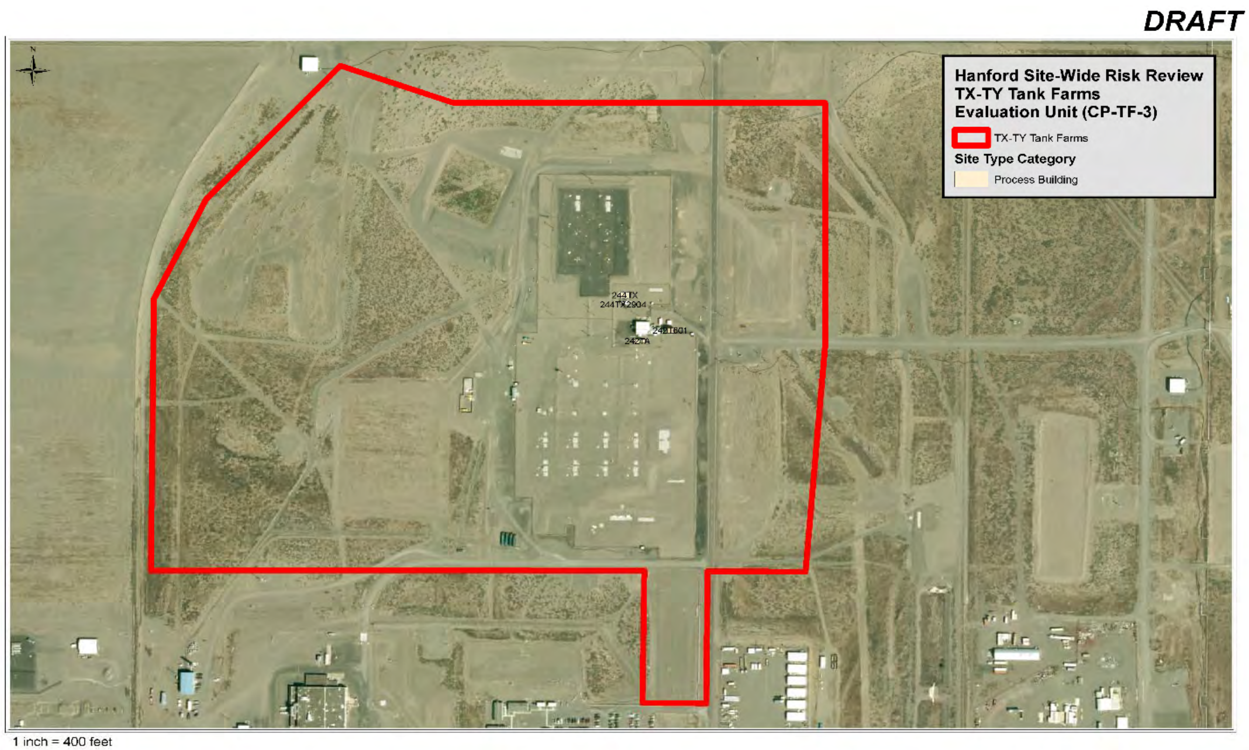
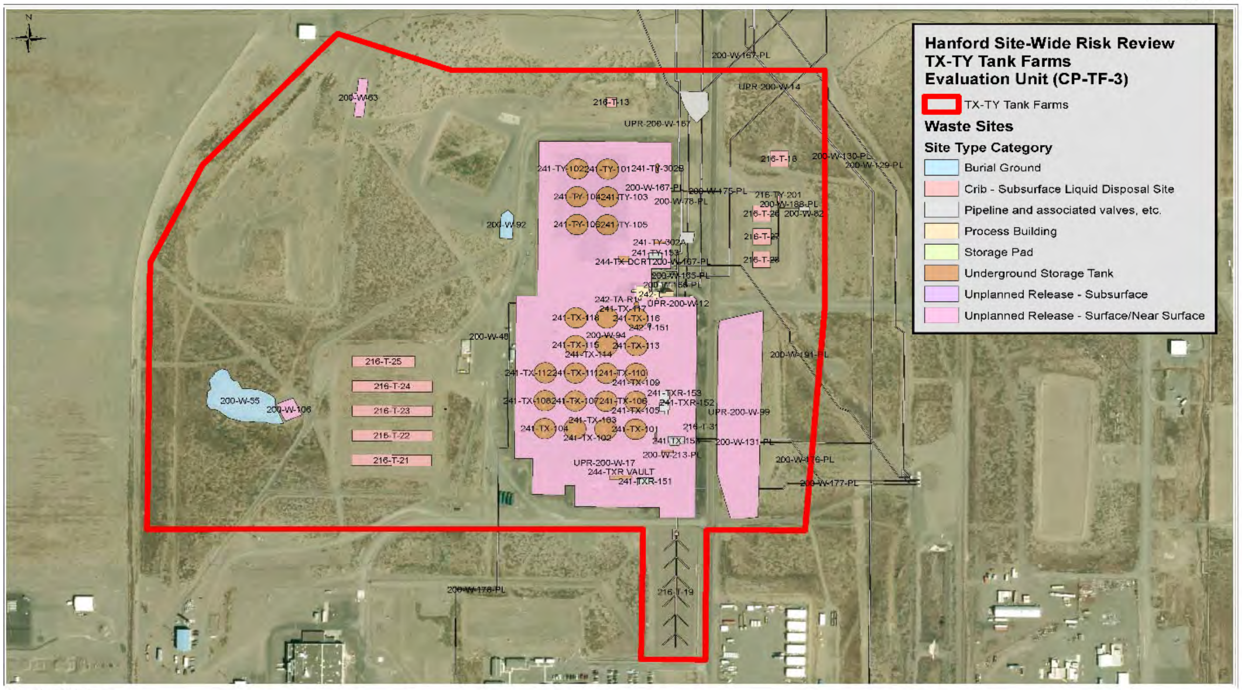


Figure E.4-1. Polygon representing the boundary of the TX-TY Tank Farms Evaluation Unit (Attachment Section 4.8)

DRAFT



1 inch = 400 feet

Figure E.4-2. Hanford TX-TY Tank Farms Evaluation Unit including tanks, legacy source units, and ancillary equipment (Attachment Section 4.8).

4.4. UNIT DESCRIPTION AND HISTORY

EU Former / Current Uses

Waste Management Area TX-TY (WMA TX-TY) occupies approximately 74,000 m^2 and contains 24 underground single-shell tanks (SSTs) constructed in 1947-48 (TX) and 1951-52 (TY) originally to support the bismuth phosphate process (Horton 2007, p. 2.1). Each of the tanks have capacities of 2.87×10^6 liters (arranged in three 4-tank and two 3-tank cascades) in additional to ancillary support equipment (e.g., diversion boxes, pumps, valves, and pipes). The TX Tank Farm tanks began receiving waste in the late 1940s and the TY Tank Farm tanks began receiving wastes in the early 1950s. Both TX-TY Tank Farms were used to support both the bismuth phosphate process (operated 1944-56) and the uranium recovery program being conducted in the U Plant (operated 1954-57). Some TX and TY Tank Farm tanks also received REDOX and PUREX wastes. Thus waste management operations created a complex intermingling of tank wastes; natural processes resulted in settling, stratification, and segregation of waste components. Waste was cascaded through a series of tanks (where cooling and precipitation of radionuclides and solids occurred in each tank). Some supernatant from the last tank in a cascade was sent to cribs when there was a shortage of tank storage capacity (Horton 2007, p. 2.2).

Legacy Source Sites

Past practices and unplanned disposals have resulted in legacy (vadose zone) contamination near the WMA TX-TY (Horton 2007, p. 2.3-2.6)[57]:

- The 216-T-21 through T-24 specific retention trenches were used in 1954 and received a total of 5×10^6 L of first cycle supernatant waste from TX Tank Farm tanks.
- The 216-T-25 trench was active during September 1954 and received 3×10^6 L of evaporator waste from the 242-T Evaporator.
- The 216-T-28 crib was active from 1960-1966 and received 42.3×10^6 L of waste including steam condensate decontamination waste, miscellaneous waste from 221-T Building, and decontamination waste from the 2706-T Building and 300 Area laboratory waste.
- The 216-T-19 crib and tile field, located south of the TX Tank Farm, operated from 1951-1980 and received 455×10^6 L of effluent from the 242-T Evaporator and T Plant operations.
- Thirteen of the 24 SSTs in WMA TX-TY are declared "assumed leakers" (Weyns 2014, p. 19) with leaks estimates ranging from < 1,000 gallons (TY-101 in 1973) to 35,000 gallons (TY-105 in 1960).
- Eleven unplanned releases have been documented in or near WMA TX-TY.

High-Level Waste Tanks

See Section 4.3 for details.

Groundwater Plumes

The 200-ZP-1 OU groundwater plumes (Tc-99, I-129, chromium, and H-3) considered to be associated with the TX-TY Tank Farms and co-located liquid waste disposal facilities are described in detail in Section 4.5 with additional information in Appendix G.6 for the CP-GW-2 EU (200-ZP-1 OU). Note that no source inventory was provided for TCE (not a tank waste), but there is a TCE plume near the TX-TY Tank and Waste Farms EU that is not associated with the TX-TY Tank and Waste Farms EU sites.

D&D of Inactive Facilities – Not Applicable

Operating Facilities – Not Applicable

Because of the prohibition on waste additions to the Hanford SSTs,[58] the TX-TY Tank and Waste Farms EU components are not considered Operating Facilities for this Review.

Ecological Resources Setting

Landscape Evaluation and Resource Classification:

More than 60% of the acreage in the TX-TY Tank and Waste Farms EU is classified as level 0 or level 1 habitat and does not provide significant habitat resources (Appendix J, Table 2, p. J-76 and Figure 10, p. J-77). The EU contains approximately 8 acres of level 3 biological resources. The amount and proximity

[57] The wastes disposed to some of the cribs and trenches adjacent to WMA TX-TY were similar to the wastes stored in the single-shell tanks making it difficult to distinguish waste sources for existing groundwater contamination.
[58] Berman presentation on July 29, 2009, titled "Hanford Single-Shell Tank Integrity Program." Available at www.em.doe.gov.

of the biological resources to the EU was examined within the adjacent landscape buffer area radiating approximately 864 m from the geometric center of the EU (equivalent to 579 acres). More than 60% of the combined total area (EU and adjacent landscape buffer area) is classified as level 0 or 1 habitat. One individual level 3 species occurrence lies within the adjacent landscape buffer—likely Piper's daisy (*Erigeron piperianus*).

Level 2 habitat on the eastern side of the EU is contiguous with larger patches of habitat within the adjacent landscape buffer area that are connected by narrow corridors to habitat outside the 200 West Area. These connections are bisected by various roadways. The level 3 habitat within the EU is isolated from any connections to habitats outside the 200 West Area, although it is contiguous with small amounts of level 3 or level 2 habitats to the south within the adjacent landscape buffer area. Habitats to the south fall within the EU for Plutonium Contaminated Waste Sites and may be affected by remediation actions taken for that unit.

Field Survey:

PNNL biologists conducted pedestrian and vehicle surveys throughout the TX-TY Tank and Waste Farms EU. Canopy cover of species was estimated visually in level 2 resource areas, and measured along a transect in a level 3 resource area (Appendix J, Table 1, p. J-75). Much of the EU (~55 acres) has been previously disturbed by ongoing operations and the installation and operation of various pump and treat wells and remaining habitat occurs in strips and patches surrounded by roads and infrastructure (Appendix J, Table 2, p. J-76 and Figure 10, p. J-77). Several areas have been revegetated with a mixture of crested wheatgrass (*Agropyron cristatum)* and shrubs. Vegetation measurements confirmed the status of level 2 and level 3 resources within the EU (Appendix J, Table 1, p. J-75).

Wildlife sign observed during the October field survey included coyote (*Canis latrans*) tracks, rabbit tracks, small mammal burrows, and harvester ant hills. Previous PNNL ECAP surveys conducted in 2009 and 2010 identified the following wildlife in habitats within the EU: side-blotched lizard (*Uta stansburiana*), western meadowlark (*Sturnella neglecta*), rock dove (*Columba livia*), and northern pocket gopher (*Thomomys talpoides*).

CULTURAL RESOURCES SETTING

Cultural resources known to be recorded within the TX-TY Tank and Waste Farms EU are limited to three Manhattan Project/Cold War Era Landscape National Register-eligible sites with documentation required; two tank farms (241 TY and 241 TX Waste Disposal Tank Farm) and one railroad (the Hanford Site Plant Railroad). All have been documented as described in the *Hanford Site Manhattan Project and Cold War Era Historic District Treatment Plan* (DOE/RL-97-56). Additionally, a non-contributing/ineligible portion of a National Register-eligible historic/ethnohistoric Trail/Road which is associated with both the Native American Precontact and Ethnographic and the Pre-Hanford Early Settlers/Farming Landscapes, passes through the TX-TY Tank and Waste Farms EU.

Much of the TX-TY Tank and Waste Farms EU has not been inventoried for archaeological resources with the exception of a very small portion with negative findings. Closure and remediation of the tank farms located within TX-TY Tank and Waste Farms EU have been addressed in an NHPA Section 106 review completed. Given the extensive disturbance, it is unlikely but there is a possibility that intact archaeological material is present in the areas that have not been inventoried for archaeological resources (both on the surface and in the subsurface), particularly where the undisturbed soil deposits exist within the TX-TY Tank and Waste Farms EU.

One isolated find and one site associated with the Pre-Hanford Farming Landscape and one isolated find associated with the Native American Precontact and Ethnohistoric Landscape are located within 500 meters of the TX-TY Tank and Waste Farms EU. None of these items are considered to be eligible to the National Register of Historic Places.

Historic maps reveal that an historic/ethnohistoric /Trail Road ran through the TX-TY Tank and Waste Farms EU indicating that there was a presence of Native American and Pre-Hanford Farming Landscape cultural resources associated with transportation and travel through the area. Given the extensive ground disturbance within the entire EU and the geomorphology in the area however, overall it is unlikely that intact archaeological resources are present on the surface or in the subsurface within the TX-TY Tank and Waste Farms EU. Pockets of undisturbed soil may exist, it may be appropriate to conduct surface and subsurface archaeological investigations in these areas prior to initiating a remediation activity. 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 associated with these landscapes (e.g. East Benton Historical Society, the Franklin County Historical Society, the Prosser Cemetery Association, the Reach, and B-Reactor Museum Association) may need to occur. Indirect effects are always possible when TCPs are known to be located in the general vicinity. Consultation with Hanford Tribes may also 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.

4.5. WASTE AND CONTAMINATION INVENTORY

Table E.4-2 provides inventory estimates of the various source components associated with the TX-TY Tank and Waste Farms EU including tank wastes and ancillary equipment, legacy sources including leaks, cribs, trenches, unplanned releases (UPRs), vadose zone sources, saturated zone (plume) estimates, treatment amounts, and remaining vadose zone estimates (i.e., the difference of the vadose zone estimates and the saturated zone and treatment estimates)[59]. This information is further summarized in Figure E.4-3 through Figure E.4-11 before and after planned 99% retrieval[60].

For example, the major sources for Tc-99 and I-129 before retrieval are the TX-TY tank wastes and leaks from these tanks. The maximum groundwater threat metric (GTM) (Figure E.4-12)[61] is dominated by the TX-TY Tank Farm wastes before retrieval and by leaks after planned retrieval (as are the Tc-99 and I-129 legacy sources). The tritium inventory, both pre- and post-retrieval, is dominated by cribs and past leaks. For chromium and nitrate, cribs and trenches and the TX-TY Tank Farm tank wastes are major sources before retrieval. After retrieval, the cribs, leaks, and trenches dominate the source of chromium and nitrate. Current uranium, Sr-90, Cs-137, and plutonium isotope inventories tend to be dominated by the tank wastes; the post-retrieval inventories tend to be dominated by various legacy sources in the vadose zone including past leaks and cribs for uranium, leaks for Sr-90 and Cs-137, and cribs for plutonium isotopes.

[59] The basis for the saturated and vadose zone estimates are provided in Chapter 6 of the Methodology Report (CRESP 2015) and examples are provided in the demonstration section for the 200-UP-1 Operable Unit. These estimates tend to have very high associated uncertainties.

[60] According to the Tri-Party Agreement (Ecology, EPA, and DOE, 1998), retrieval limits for residual wastes are 360 ft^3 and 30 ft^3 for 100-Series and 200-Series tanks, respectively, corresponding to the 99% waste retrieval goal as defined in TPA Milestone M-45-00.

[61] Maximum of the GTMs for Tc-99 and I-129 only.

Contamination within Primary EU Source Components

Legacy Source Sites

The estimated TX-TY Tank Farm inventory for the Legacy / Vadose Zone Source Sites (i.e., cribs, trenches, and soil contaminated by tank leaks and unplanned releases) is summarized in Table E.4-2 and further described in Figure E.4-3 through Figure E.4-11 before and after planned 99% retrieval (which will have no impact on the current legacy source site inventories). These values constitute estimates of the initial amounts of contaminants discharged to the vadose zone that are then used to estimate the remaining inventory in the vadose zone as described below (i.e., by difference using the process described in Chapter 6 of the Methodology Report (CRESP 2015)). These estimates necessarily have large associated uncertainties.

Waste Tanks and Ancillary Equipment

The estimated total inventory for all the TX-TY waste tanks and Ancillary Equipment is provided in Table E.4-2 for both the 90% and planned 99% retrieval scenarios. The tank-by-tank inventories are provided in Table E.4-3 through Table E.4-6. Safety-related information (i.e., hydrogen generation rates and times to the lower flammability limit are also provided in Table E.4-3. The inventories for the various contaminant in the TX-TY Tank Farm tanks vary over several orders of magnitude as does the GTM. This information is further summarized in Figure E.4-3 through Figure E.4-11 before and after planned 99% retrieval and for the maximum GTM in Figure E.4-12.

Vadose Zone Contamination

The estimated inventories for the vadose zone, saturated zone, and treatment amounts are found in Table E.4-7. These inventories represent the vadose zone contamination *outside* the tanks and ancillary equipment (i.e., that are generally available for transport through the environment). These are used to estimate the inventory remaining in the vadose zone using the process described in Chapter 6 of the Methodology Report (CRESP 2015). The focus in this section will be on the Group A and B contaminants in the vadose zone due to their mobility and persistence and potential threats to groundwater. To summarize:

- *Tc-99 and I-129* – There are existing Tc-99 and I-129 plumes in the groundwater (200-ZP-1 GW OU) that are associated with the TX-TY TF EU. The vadose zone inventory is dominated by past leaks from SSTs.
- *Sr-90* – There is no current plume for Sr-90. The vadose zone inventory is dominated by past leaks and ancillary equipment. Thus the majority of the Sr-90 originally discharged into the vadose zone would have had to travel through much of the vadose zone to impact groundwater. Using an analysis similar to that in Section 2.5 for Sr-90 in the WMA T (200-West), a Sr-90 plume is not expected in the next 150 years due to retardation in the vadose zone or after due to radioactive decay (+99.9% reduction in Sr-90 inventory). Thus Sr-90 is not considered a significant threat to the Hanford groundwater.
- *Chromium* – There is currently a chromium plume associated with past leaks from SSTs in the TX-TY TF EU. The vadose zone inventory is dominated by cribs, leaks, and trenches.
- *Uranium* – Uranium has been measured in the 200-ZP-1 OU, but not exceeding the drinking water standard. The vadose zone inventory is dominated by leaks and cribs. Based on analysis very similar to that in Section 2.5 for the T Tank and Waste Farms EU, an appreciable uranium plume would not be expected in the next 150 years but perhaps during the 1,000-year period

after cleanup. Thus total uranium is not considered a significant threat to the Hanford groundwater during the Active Cleanup or Near-term, Post Cleanup periods.

- *C-14* – There was C-14 discharged to the TX-TY TF EU; however, no plume has been identified in the 200-ZP-1 GW OU.
- *Carbon tetrachloride* and *TCE* – There are current carbon tetrachloride and TCE plumes in the 200-ZP-1 OU; however, these plumes are not associated with TX-TY Tank and Waste Farms EU sources. The 216-T-19 crib (which is considered part of this EU as described in Attachment Section 4.8) did receive carbon tetrachloride, which serves as the vadose zone source for this EU; however, this source is relatively minor compared to other sources. No TCE discharges to TX-TY TF EU sources were identified.

Using the process outlined in Chapter 6 of the Methodology Report (CRESP 2015), the vadose zone inventories in Table E.4-2 are estimated by difference and used to calculate Groundwater Threat Metric (GTM) values for the Group A and B contaminants remaining in the vadose zone as illustrated in Table E.4-7. The resulting vadose zone (VZ) ratings for threats to groundwater are *Not Discernible* for uranium and Sr-90[62], *Medium* for I-129 and C-14, and *High* for Tc-99, carbon tetrachloride, and chromium (total and hexavalent). The overall rating would be *High.*

Groundwater Plumes

In general groundwater plumes are evaluated in separate EUs; however, those portions of groundwater plumes that can be associated with the TF EU (i.e., a plume with sources associated with the TF EU) will be evaluated to provide a better idea of the saturated zone versus remaining vadose zone threats to groundwater. The estimated inventory for the saturated zone contamination is provided in Table E.4-7 where Photoshop was used to estimate the fraction of the plumes considered associated with the TX-TY Tank and Waste Farms EU (Attachment 6-4 in the Methodology Report (CRESP 2015)[63]). This information is also used to estimate amounts treated and remaining in the vadose zone. For the groundwater plumes described in the 200-ZP-1 OU (DOE/RL-2014-32, Rev. 0), apportionment of plumes and ratings to the TX-TY Tank and Waste Farms EU would be as follows:

- *Carbon tetrachloride* and *TCE* – There are plumes for these contaminants in the 200-ZP-1 OU, but no major sources related to TX-TY Tank and Waste Farms EU sources (including the 216-T-19 crib that is considered a vadose zone source); thus there is no portion of the carbon tetrachloride or TCE plume considered associated with the TX-TY Tank and Waste Farms EU. The corresponding ratings would be ND.
- *Chromium* – There are plumes in the OU (assumed to be hexavalent chromium); the single plume near the TX-TY Tank and Waste Farms EU is considered associated with the EU and the area of this plume is 3% of the area of the chromium plumes (CRESP 2015). The area is assumed to describe both the total chromium and hexavalent chromium contaminants.

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[62] The uranium and Sr-90 GTM values would translate to *Medium* and *Very High* ratings, respectively. However, no appreciable uranium or Sr-90 plume would be expected in the next 150 years due to transport and decay (Sr-90) considerations (e.g., Section 2.5). Uranium or Sr-90 may impact groundwater after the 150-year period. Thus a *Low* rating for uranium and Sr-90 would apply to the period after Active Cleanup is completed to address uncertainties.
[63] From the graphic map files provided by PNNL, the PhotoShop Magic Wand Tool was used to select areas representing plumes and then the "Record Measurements" Tool was used to provide relative areal extents. A Custom Measurement Scale was set to that of the map.

- *I-129* – There are plumes in the OU; the single small plume near the TX-TY Tank and Waste Farms EU is considered associated with the EU, and the area of this plume is 2% of the area of the plumes (CRESP 2015).
- *Nitrate* – It is difficult to distinguish areas related to the various sources. Based on information in the Annual Groundwater Report (DOE/RL-2014-32, Rev. 0), the major source of nitrate is from liquid waste disposal from Plutonium Finishing Plant (PFP) processes to the cribs near WMA T. and the 216-Z Cribs and Trenches. Thus the nitrate contribution from the TX-TY Tank and Waste Farms EU is assumed not significant.
- *Tc-99* – There are plumes in the OU; the single plume near the TX-TY Tank and Waste Farms EU is considered associated with the EU, and the area of this plume is 30% of the area of the plumes using the Photoshop “Record Measurements” Tool for areal extents.
- *H-3* – There are plumes in the OU; the single small plume near the TX-TY Tank and Waste Farms EU is considered associated with the EU, and the area of this plume is less than 1% of the area of the plumes (CRESP 2015).

The groundwater plumes (e.g., Tc-99, I-129, chromium, and H-3) associated with the TX-TY Tank Farm and co-located liquid waste disposal facilities are described in detail in Appendix G.6 for the CP-GW-2 EU (200-ZP-1 GW OU). Note that carbon tetrachloride (*Very High*), nitrate (*Medium*), and TCE (*Medium*) are the risk drivers for the 200-ZP-1 GW OU; however, there are no T TF EU sources associated with these plumes, and the remaining vadose zone sources would drive the risks associated with the TX-TY TF EU.

Impact of Recharge Rate and Radioactive Decay on Groundwater Ratings

The TC&WM EIS screening groundwater transport analysis (Appendix O, DOE/EIS-0391 2012) as discussed in Section 2.5 for the T Tank and Waste Farms EU indicates that there is insufficient impact of emplacing the engineered surface barrier (and resulting reduction of infiltrating water) on the predicted peak groundwater concentrations (relative to thresholds) at the T Barrier[64] to change ratings. Again the impact is not ascribed to ineffectiveness of the surface barrier but instead to the large amount of contamination already present in the subsurface and possible contributions of sources outside the TX-TY Tank and Waste Farms EU (used in the TC&WM EIS analysis[65]).

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. Since the TX-TY and T Tank and Waste Farms EUs are proximate (200-W) and share the 200-ZP-1 OU, the results for potential impacts to the Columbia River for the TX-TY Tank and Waste Farms EU (Section 2.5) are the same for the T Tank and Waste Farms EU. These are summarized in the following sections.

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[64] The 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). The T Barrier is the closest to the TX-TY Tank and Waste Farms EU. Despite including sources other than those for the TX-TY Tank and Waste Farms EU, the analysis in the TC&WM EIS was considered a reasonable source of information to assess the impact of the engineered surface barrier emplacement.

[65] Analyses specific to each Tank Farm or Central Plateau EU are not available; thus the aggregate screening analysis provided in the TC&WM EIS was used as an indication.

<u>Benthic and Riparian Zone – Current Impacts</u>
Current impacts from the T Tank and Waste Farms EU to the Columbia River benthic and riparian zone ecology would be rated as *Not Discernible*.

<u>Benthic and Riparian Zone – Active Cleanup and Near-term, Post Cleanup</u>
The impacts to the Columbia River benthic and riparian ecology for the Active Cleanup and Near-term, Post Cleanup periods are also rated as *Not Discernible*.

<u>Benthic and Riparian Zone – Long-term</u>
There should be no expected adverse effects from radionuclides for Columbia River benthic and riparian receptors over the time period evaluated (10,000 years).

Only chromium and nitrate would be predicted to exceed relevant thresholds. However, the screening results indicate that future nitrate peak concentration (and discharge) appear to not exceed either the drinking water standard or ambient water quality criterion in the next 10,000 years. Furthermore, any chromium predicted to reach the Columbia River from TX-TY Tank Farm sources would likely lead to insignificant long-term impacts to the benthic and riparian ecology.

<u>Threats to the Columbia River Free-flowing Ecology</u>
As described in Section 2.5, 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.

<u>Potential Impact of Recharge Rate on Threats to the Columbia River</u>
The No Action Alternative evaluation in the TC&WM EIS suggests that remedial actions (e.g., surface barrier emplacement that would decrease recharge in the areas near the Tank Farms) would appear to not have significant impacts on the long-term peak concentrations in the near-shore area (benthic and riparian receptors) of the Columbia River. This is not due to ineffectiveness of the barrier but instead due to large amounts of contaminant already in the groundwater. Thus ratings are not changed based on the remedial actions assumed in the TC&WM EIS.

Facilities for D&D – Not Applicable

Operating Facilities – Not Applicable

Because of the prohibition on waste additions to the Hanford SSTs,[66] the TX-TY Tank and Waste Farms EU components are not considered Operating Facilities for this Review.

[66] Berman presentation on July 29, 2009, titled "Hanford Single-Shell Tank Integrity Program." Available at www.em.doe.gov.

Table E.4-2. Summary Table of Infrastructure and Subsurface Contamination Inventory for the TX-TY Tank Farms Evaluation Unit (CP-TF-3) (a)(b)

Contaminated Media	Primary Contaminants	Total Amount. of Each Contaminant Before Retrieval	90% Retrieval Scenario	99% Retrieval Scenario
Infrastructure (Tanks and Ancillary Equipment)				
Tank Waste	Waste (kGal)	7245	724.5	72.45
	Sludge (kGal)	1236	123.6	12.36
	Saltcake (kGal)	6006	600.6	60.06
	Supernatant (kGal)	3	0.3	0.03
Tank Waste (rad)	Am-241 (Ci)	12000	1200	120
	C-14 (Ci)	76	7.6	0.76
	Co-60 (Ci)	370	37	3.7
	Cs-137 (Ci)	2100000	210000	21000
	Eu-152 (Ci)	30	3	0.3
	Eu-154 (Ci)	1600	160	16
	H-3 (Ci)	390	39	3.9
	I-129 (Ci)	2.7	0.27	0.027
	Ni-59 (Ci)	300	30	3
	Ni-63 (Ci)	27000	2700	270
	Pu (total) (Ci)	20000	2000	200
	Sr-90 (Ci)	750000	75000	7500
	Tc-99 (Ci)	2600	260	26
	U (total) (Ci)	99	9.9	0.99
Tank Waste (non-rad)	Cr (kg)	59000	5900	590
	Hg (kg)	350	35	3.5
	NO3 (kg)	14000000	1400000	140000
	Pb (kg)	6100	610	61
	U (total) (kg)	97000	9700	970
Ancillary Equipment (non-rad)	Pb (kg)	40	40	40
	U (total) (kg)	660	660	660
MUST (non-rad)	Pb (kg)	11	11	11
	U (total) (kg)	8.3	8.3	8.3

Contaminated Media	Primary Contaminants	Total Amount. of Each Contaminant Before Retrieval	90% Retrieval Scenario	99% Retrieval Scenario
Vadose Zone Source (Leaks and Intentional Discharges into Cribs and Trenches)				
Leaks (rad)	C-14 (Ci)	15	15	15
	Cs-137 (Ci)	160000	160000	160000
	H-3 (Ci)	110	110	110
	I-129 (Ci)	0.21	0.21	0.21
	Pu (total) (Ci)	30	30	30
	Sr-90 (Ci)	60000	60000	60000
	Tc-99 (Ci)	110	110	110
	U (total) (Ci)	3.3	3.3	3.3
Leaks (non-rad)	Cr (kg)	3200	3200	3200
	Hg (kg)	1.4	1.4	1.4
	NO3 (kg)	290000	290000	290000
	Pb (kg)	130	130	130
	U (total) (kg)	1400	1400	1400
Cribs (rad)	Am-241 (Ci)	19	19	19
	C-14 (Ci)	4.2	4.2	4.2
	Co-60 (Ci)	1.2	1.2	1.2
	Cs-137 (Ci)	690	690	690
	Eu-152 (Ci)	0.05	0.05	0.05
	Eu-154 (Ci)	5.7	5.7	5.7
	H-3 (Ci)	5100	5100	5100
	I-129 (Ci)	0.018	0.018	0.018
	Ni-59 (Ci)	0.034	0.034	0.034
	Ni-63 (Ci)	3.1	3.1	3.1
	Pu (total) (Ci)	350	350	350
	Sr-90 (Ci)	650	650	650
	Tc-99 (Ci)	2	2	2

Contaminated Media	Primary Contaminants	Total Amount. of Each Contaminant Before Retrieval	90% Retrieval Scenario	99% Retrieval Scenario
	U (total) (Ci)	3.2	3.2	3.2
Cribs (non-rad)	CCl4 (kg)	1700	1700	1700
	Cr (kg)	9600	9600	9600
	Hg (kg)	13	13	13
	NO3 (kg)	840000	840000	840000
	Pb (kg)	22	22	22
	U (total) (kg)	1200	1200	1200
Trenches (rad)	Am-241 (Ci)	4.2	4.2	4.2
	C-14 (Ci)	0.65	0.65	0.65
	Co-60 (Ci)	2.5	2.5	2.5
	Cs-137 (Ci)	3700	3700	3700
	Eu-152 (Ci)	0.093	0.093	0.093
	Eu-154 (Ci)	6.5	6.5	6.5
	H-3 (Ci)	49	49	49
	I-129 (Ci)	0.014	0.014	0.014
	Ni-59 (Ci)	0.21	0.21	0.21
	Ni-63 (Ci)	29	29	29
	Pu (total) (Ci)	4.8	4.8	4.8
	Sr-90 (Ci)	580	580	580
	Tc-99 (Ci)	1.6	1.6	1.6
	U (total) (Ci)	0.19	0.19	0.19
Trenches (non-rad)	Cr (kg)	2900	2900	2900
	Hg (kg)	2.9	2.9	2.9
	NO3 (kg)	860000	860000	860000
	U (total) (kg)	270	270	270
UPR (rad)	Am-241 (Ci)	0.005	0.005	0.005
	C-14 (Ci)	0.00078	0.00078	0.00078

Contaminated Media	Primary Contaminants	Total Amount. of Each Contaminant Before Retrieval	90% Retrieval Scenario	99% Retrieval Scenario
	Co-60 (Ci)	0.0031	0.0031	0.0031
	Cs-137 (Ci)	4.6	4.6	4.6
	Eu-152 (Ci)	0.00011	0.00011	0.00011
	Eu-154 (Ci)	0.0078	0.0078	0.0078
	H-3 (Ci)	0.059	0.059	0.059
	I-129 (Ci)	1.70E-05	1.70E-05	1.70E-05
	Ni-59 (Ci)	0.00026	0.00026	0.00026
	Ni-63 (Ci)	0.036	0.036	0.036
	Pu (total) (Ci)	0.00084	0.00084	0.00084
	Sr-90 (Ci)	0.69	0.69	0.69
	Tc-99 (Ci)	0.002	0.002	0.002
	U (total) (Ci)	0.0002	0.0002	0.0002
UPR (non-rad)	Cr (kg)	3.5	3.5	3.5
	Hg (kg)	0.0031	0.0031	0.0031
	NO3 (kg)	1000	1000	1000
	U (total) (kg)	0.3	0.3	0.3
Vadose Zone (from Vadose Zone Sources)				
VZ Remaining (rad)	Am-241 (Ci)	23	23	23
	C-14 (Ci)	20	20	20
	Co-60 (Ci)	3.7	3.7	3.7
	Cs-137 (Ci)	170000	170000	170000
	Eu-152 (Ci)	0.14	0.14	0.14
	Eu-154 (Ci)	12	12	12
	H-3 (Ci)	5300	5300	5300
	I-129 (Ci)	0.24	0.24	0.24
	Ni-59 (Ci)	0.25	0.25	0.25
	Ni-63 (Ci)	33	33	33

Contaminated Media	Primary Contaminants	Total Amount. of Each Contaminant Before Retrieval	90% Retrieval Scenario	99% Retrieval Scenario
	Pu (total) (Ci)	380	380	380
	Sr-90 (Ci)	62000	62000	62000
	Tc-99 (Ci)	110	110	110
	U (total) (Ci)	6.7	6.7	6.7
VZ Remaining (non-rad)	CCl4 (kg)	1300[(c)]	1300[(c)]	1300[(c)]
	Cr (kg)	16000[(d)]	16000[(d)]	16000[(d)]
	Cr-VI (kg)	16000[(d)]	16000[(d)]	16000[(d)]
	Hg (kg)	17	17	17
	NO3 (kg)	2000000	2000000	2000000
	Pb (kg)	150	150	150
	U (total) (kg)	2900	2900	2900
VZ Treatment (rad)	I-129 (Ci)	5.50E-12	5.50E-12	5.50E-12
	Tc-99 (Ci)	0.89	0.89	0.89
VZ Treatment and other sinks (non-rad)	CCl4 (kg)	350[(c)]	350[(c)]	350[(c)]
	Cr (kg)	3.4	3.4	3.4
	Cr-VI (kg)	3.4	3.4	3.4
Saturated Zone (from Vadose Zone Sources)				
SZ Inventory (rad)	H-3 (Ci)	0.14	0.14	0.14
	I-129 (Ci)	2.40E-05	2.40E-05	2.40E-05
	Tc-99 (Ci)	0.36	0.36	0.36
SZ Inventory (non-rad)	Cr (kg)	0	0	0
	Cr-VI (kg)	3.6	3.6	3.6

a. Tanks (SST and DST): Best Basis Inventory (BBI) March 2014; Ancillary Equipment (Anc Eq): Tank Farm Closure & Waste Management (TC&WM) Environmental Impact Statement (DOE/EIS-0391) Appendix D; Unplanned Releases (UPRs): Soil Inventory Model (SIM) Rev 1 (RPP-26744, Rev 0); Ponds: Soil Inventory Model (SIM) Rev 1 (RPP-26744, Rev 0); Cribs: Soil Inventory Model (SIM) Rev 1 (RPP-26744, Rev 0); Trenches: Soil Inventory Model (SIM) Rev 1 (RPP-26744, Rev 0) and Tank Farm Closure & Waste Management (TC&WM) Environmental Impact Statement (DOE/EIS-0391) Appendix S; Leaks: Tank Farm Closure & Waste Management (TC&WM) Environmental Impact Statement

(DOE/EIS-0391) Appendix D; MUSTs: Soil Inventory Model (SIM) Rev 1 (RPP-26744, Rev 0) and Tank Farm Closure & Waste Management (TC&WM) Environmental Impact Statement (DOE/EIS-0391) Appendix S.

b. All primary contaminant inventories are reported to 2 significant figures. The source document should be consulted for greater precision data.

c. The only sink other than treatment that was considered for the Report (because estimates were available in literature) was the loss of carbon tetrachloride (CCl4) to the atmosphere. This sink would likely apply to other contaminants (e.g., tritium), but estimates were not available. Other sinks are likely; however, either estimates were not significant or not available. A total of 21% (or 350 kg) of the original carbon tetrachloride inventory (CCl4) was assumed loss to atmosphere as described in the Methodology Report (CRESP 2015). The amount lost is highly uncertain; a range of 21 to 38% was estimated (DOE/RL-2007-22 2007, p. 4-3).

d. Differences in inventories for Cr vs Cr-IV are due to differing Water Quality Standards (WQS) and thus plume extents: 100 mg/L for total chromium vs 48 mg/L for chromium (IV). The difference is not distinguishable within the number of significant digits (2) displayed.

Table E.4-3. Current Bulk Inventory and Steady State Flammability Results (by Tank) for the TX-TY Tank Farms (CP-TF-3)

Tank ID	Tank Type	Capacity (kGal)[a]	Sludge (kGal)[a]	Saltcake (kGal)[a]	Supernatant (kGal)[a]	HGR(c) (ft3/d)[b]	Days to 25% LFL Barometric[c]	Days to 25% LFL Zero Ventilation[d]
TX-101	SST	758	74	13	0	0.5	NA	>1826
TX-102	SST	758	2	215	0	0.53	NA	>1826
TX-103	SST	758	0	145	0	0.44	NA	>1826
TX-104	SST	758	34	33	2	0.43	NA	>1826
TX-105	SST	758	11	560	0	1	NA	550
TX-106	SST	758	5	343	0	0.68	NA	1281
TX-107	SST	758	0	30	0	0.34	NA	>1826
TX-108	SST	758	6	121	0	0.51	NA	>1826
TX-109	SST	758	359	0	0	0.74	NA	1142
TX-110	SST	758	37	430	0	0.84	NA	840
TX-111	SST	758	43	321	0	0.64	NA	1325
TX-112	SST	758	0	634	0	0.83	NA	612
TX-113	SST	758	93	545	0	0.73	NA	692
TX-114	SST	758	4	528	0	0.69	NA	927
TX-115	SST	758	8	545	0	0.78	NA	782
TX-116	SST	758	66	533	0	0.65	NA	879
TX-117	SST	758	29	597	0	0.72	NA	733
TX-118	SST	758	0	247	0	1	NA	985
TY-101	SST	758	72	46	0	0.38	NA	>1826
TY-102	SST	758	0	69	0	0.36	NA	>1826
TY-103	SST	758	103	51	0	0.52	NA	>1826
TY-104	SST	758	43	0	1	0.39	NA	>1826
TY-105	SST	758	231	0	0	0.75	NA	1331
TY-106	SST	758	16	0	0	0.34	NA	>1826

a. Volumes from the Waste Tank Summary Report coinciding with the BBI (Rodgers 2014).

b. Hydrogen generation rate (ft^3/d) (RPP-5926 Rev. 15). Note in 2001 all 24 tanks were removed from the flammable gas watch list (including T-110 in the T Tank and Waste Farms EU) (Johnson, et al. 2001, p. iii).
c. Time (in days) to 25% of the Lower Flammability Limit (LFL) under a barometric (barom) breathing scenario (RPP-5926, Rev. 15). "NA" indicates that the headspace will not reach specified flammability level.
d. Time (in days) to 25% of the LFL under a zero ventilation scenario (RPP-5926, Rev. 15).

Table E.4-4. Current Primary Contaminant Inventory (by Tank) for the TX-TY Tank Farms (CP-TF-3) [(a)]

Tank ID	Decay Date	Am-241 (Ci)	C-14 (Ci)	Cl-36 (Ci)	Co-60 (Ci)	Cs-137 (Ci)	Eu-152 (Ci)	Eu-154 (Ci)	H-3 (Ci)
TX-101	2001	160	0.53	NP[(b)]	1.1	35000	0.11	6.5	5.3
TX-102	2001	190	2.6	NP	15	110000	1.1	64	13
TX-103	2001	130	1.7	NP	9.8	70000	0.7	42	8.6
TX-104	2001	70	0.42	NP	1.7	29000	0.14	8.1	3.1
TX-105	2001	900	7.5	NP	43	230000	3	180	38
TX-106	2001	330	4.3	NP	25	160000	1.8	110	22
TX-107	2001	340	0.39	NP	1.9	19000	0.2	11	3.1
TX-108	2001	120	1.6	NP	8.9	53000	0.63	37	7.9
TX-109	2001	620	0.44	NP	0.09	28000	0.0051	0.31	0.58
TX-110	2001	440	5.9	NP	33	170000	2.3	140	30
TX-111	2001	340	4.5	NP	25	130000	1.8	110	23
TX-112	2001	620	8.2	NP	47	240000	3.3	200	42
TX-113	2001	26	9.6	NP	11	29000	3.8	41	49
TX-114	2001	490	6.5	NP	37	180000	2.6	160	33
TX-115	2001	550	7.3	NP	42	220000	2.9	180	37
TX-116	2001	260	3.7	NP	20	120000	1.5	87	20
TX-117	2001	440	6	NP	34	180000	2.4	140	31
TX-118	2001	5700	2.5	NP	12	78000	1	95	13
TY-101	2001	9.2	0.41	NP	0.02	270	0.0019	0.16	0.28
TY-102	2001	1.1	0.22	NP	0.14	12000	0.2	12	2.6
TY-103	2001	24	0.62	NP	0.22	25000	0.18	11	2.6
TY-104	2001	21	0.78	NP	0.007	8700	0.00062	0.055	0.12
TY-105	2001	10	0.1	NP	0.032	7600	0.0044	0.27	1.8
TY-106	2001	1.4	0.011	NP	0.0034	4500	0.00046	0.029	0.19

a. From Best Basis Inventory (BBI) Summary (March 24, 2014) provided in spreadsheet form by Mark Triplett. All primary contaminant inventories are reported to 2 significant figures. The source document should be consulted for greater precision data.

b. NP = Not present at significant quantities

Table E.4-5. Current Primary Contaminant Inventory [a] and Groundwater Threat Metric (by Tank) for the TX-TY Tank Farms (CP-TF-3)

Tank ID	I-129 (Ci)	Ni-59 (Ci)	Ni-63 (Ci)	Pu (total) (Ci)[b]	Sr-90 (Ci)	Tc-99 (Ci)	U (total) (Ci)[c]	GTM (Mm3)[d]
TX-101	0.018	2.3	200	530	180000	14	5.1	15
TX-102	0.11	10	950	240	1900	110	4.3	120
TX-103	0.074	6.8	620	160	580	71	1.1	79
TX-104	0.021	1.7	160	100	66000	20	0.58	22
TX-105	0.26	30	2700	2000	6300	240	15	270
TX-106	0.17	17	1600	410	12000	160	4.2	180
TX-107	0.019	1.4	130	420	990	17	0.21	19
TX-108	0.059	6.2	560	140	3700	55	3.8	62
TX-109	0.00098	0.024	3.2	2500	8400	47	2.4	52
TX-110	0.2	23	2100	560	2700	190	4.2	210
TX-111	0.15	18	1600	430	2400	140	3.3	160
TX-112	0.28	33	3000	760	2600	260	5.6	290
TX-113	0.31	38	3500	76	4900	300	1.9	330
TX-114	0.21	26	2400	610	2200	200	4.6	220
TX-115	0.26	29	2700	670	6700	240	5.2	270
TX-116	0.16	15	1300	410	1200	160	3.4	170
TX-117	0.21	24	2200	590	2000	200	4.6	220
TX-118	0.11	9.9	900	9200	170000	110	2.4	120
TY-101	0.001	0.29	25	150	6300	5.3	1.1	5.8
TY-102	0.013	1.9	180	1.1	1100	9.4	0.088	10
TY-103	0.025	1.8	160	240	63000	27	17	30
TY-104	0.00037	0.083	7.1	54	21000	8.9	3.7	9.8
TY-105	0.046	0.027	2.2	36	180000	44	4.9	49
TY-106	0.00022	0.0028	0.24	2.1	9600	1.1	0.35	1.2

a. From Best Basis Inventory (BBI) Summary (March 24, 2014) provided in spreadsheet form by Mark Triplett. All primary contaminant inventories are reported to 2 significant figures. The source document should be consulted for greater precision data.

b. Sum of plutonium isotopes 238, 239, 240, 241, and 242

c. Sum of uranium isotopes 232, 233, 234, 235, 236, and 238

d. The Groundwater Threat Metric (GTM) shown for tanks is equal to the maximum of the GTM for Tc-99 and I-129.

Table E.4-6. Current Primary Contaminant Inventory (by Tank) for the TX-TY Tank Farms (CP-TF-3) [(a)]

Tank ID	CCl4 (kg)	CN (kg)	Cr (kg)	Cr-VI (kg)	Hg (kg)	NO3 (kg)	Pb (kg)	TBP (kg)	TCE (kg)	U (total) (kg)
TX-101	NP[(b)]	NP	1500	NP	13	78000	37	NP	NP	7500
TX-102	NP	NP	2000	NP	1.9	420000	96	NP	NP	4700
TX-103	NP	NP	1300	NP	0.87	280000	69	NP	NP	620
TX-104	NP	NP	1100	NP	4.7	110000	32	NP	NP	360
TX-105	NP	NP	5300	NP	6	1200000	260	NP	NP	17000
TX-106	NP	NP	3300	NP	3	700000	160	NP	NP	3600
TX-107	NP	NP	510	NP	0.25	69000	12	NP	NP	120
TX-108	NP	NP	1100	NP	2.9	250000	66	NP	NP	4600
TX-109	NP	NP	1600	NP	0.72	240000	380	NP	NP	3600
TX-110	NP	NP	4300	NP	2.7	950000	240	NP	NP	2500
TX-111	NP	NP	3300	NP	2.1	730000	200	NP	NP	2000
TX-112	NP	NP	5800	NP	4.4	1400000	340	NP	NP	3100
TX-113	NP	NP	1600	NP	4.5	1700000	360	NP	NP	1600
TX-114	NP	NP	4600	NP	4.5	1100000	350	NP	NP	2600
TX-115	NP	NP	5200	NP	6.3	1200000	280	NP	NP	3200
TX-116	NP	NP	1300	NP	13	1600000	980	NP	NP	2900
TX-117	NP	NP	4300	NP	8.4	1300000	660	NP	NP	3000
TX-118	NP	NP	3200	NP	1.1	120000	180	NP	NP	1300
TY-101	NP	NP	6000	NP	66	110000	160	NP	NP	1700
TY-102	NP	NP	94	NP	1.1	140000	26	NP	NP	67
TY-103	NP	NP	980	NP	64	150000	480	NP	NP	17000
TY-104	NP	NP	390	NP	29	14000	160	NP	NP	5500
TY-105	NP	NP	180	NP	110	240000	510	NP	NP	7200
TY-106	NP	NP	4.2	NP	0.019	14000	23	NP	NP	520

a. From Best Basis Inventory (BBI) Summary (March 24, 2014) provided in spreadsheet form by Mark Triplett. All primary contaminant inventories are reported to 2 significant figures. The source document should be consulted for greater precision data.

b. NP = Not present at significant quantities

Table E.4-7. Summary of the Evaluation of Threats to Groundwater as a Protected Resource from Remaining Vadose Zone (VZ) Contamination associated with the TX-TY Tank and Waste Farms Evaluation Unit (CP-TF-3)

PC	Group	WQS	Porosity[(a)]	K_d (mL/g)[(a)]	ρ (kg/L)[(a)]	VZ Source M^{Source}	SZ Total M^{SZ}	Treated[(c)] M^{Treat}	VZ Remaining M^{Tot} [(d)]	VZ GTM (Mm^3)	VZ Rating[(e)]
C-14	A	2000 pCi/L	0.23	0	1.84	2.02E+01 Ci	---	---	2.02E+01 Ci	1.01E+01	Medium
I-129	A	1 pCi/L	0.23	0.2	1.84	2.43E-01 Ci	2.36E-05 Ci	5.48E-12 Ci	2.43E-01 Ci	9.35E+01	Medium
Sr-90	B	8 pCi/L	0.23	22	1.84	6.17E+04 Ci	---	---	6.17E+04 Ci	4.36E+04	ND[(f)]
Tc-99	A	900 pCi/L	0.23	0	1.84	1.13E+02 Ci	3.65E-01 Ci	8.93E-01 Ci	1.12E+02 Ci	1.24E+02	High
CCl_4	A	5 µg/L	0.23	0	1.84	1.66E+03 kg	---	---	1.31E+03 kg	2.63E+02	High
Cr	B	100 µg/L	0.23	0	1.84	1.57E+04 kg	---	3.45E+00 kg	1.57E+04 kg	1.57E+02	High
Cr-VI	A	48 µg/L	0.23	0	1.84	1.57E+04 kg	3.65E+00 kg	3.45E+00 kg	1.57E+04 kg	3.26E+02	High
TCE	B	5 µg/L	0.23	2	1.84	---	---	---	---	---	ND
U(tot)	B	30 µg/L	0.23	0.8	1.84	2.88E+03 kg	---	---	2.88E+03 kg	1.30E+01	ND[(f)]

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

b. "Model Toxics Control Act−Cleanup" (WAC 173-340) Method B groundwater cleanup level for hexavalent chromium. Other WQS values represent drinking water standards.

c. Treatment amounts from the 2013 Hanford Annual Groundwater Report (DOE/RL-2014-32, Rev. 0).

d. The remaining vadose zone inventory is estimated by difference (CRESP 2015) and thus has a high associated uncertainty.

e. Groundwater Threat Metric rating based on Table 6-3, Methodology Report (CRESP 2015). These contaminants are being treated using the 200-West Groundwater Treatment Facility.

f. As discussed in Section 4.5, no appreciable uranium or Sr-90 plume would be expected in the next 150 years due to transport and decay (Sr-90) considerations. Thus the *Low* rating would apply to the period after the Active Cleanup is complete to account for uncertainties.

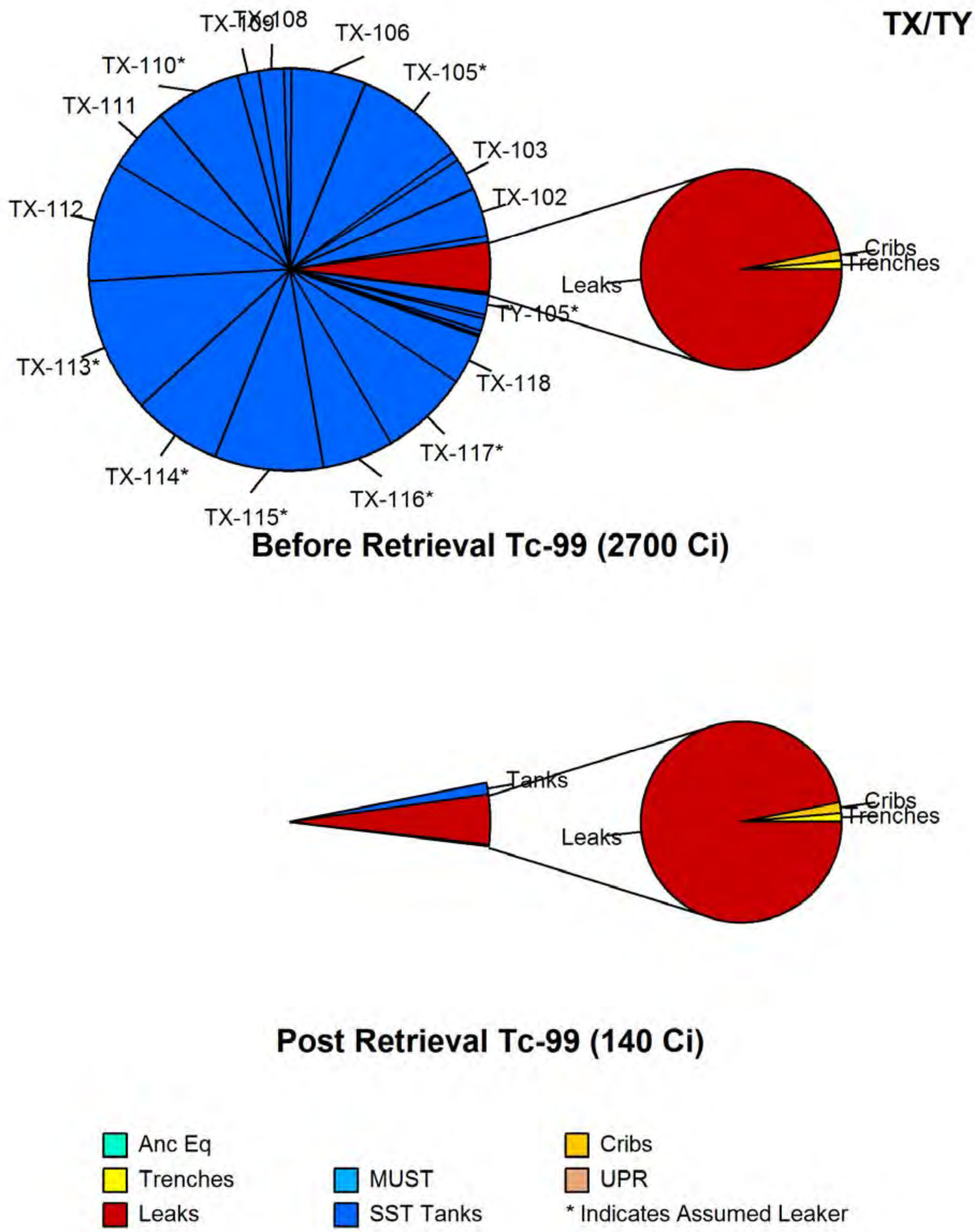

Figure E.4-3. TX-TY Tank and Waste Farms Evaluation Unit Inventory Estimates for Tc-99 Before and After 99% Retrieval

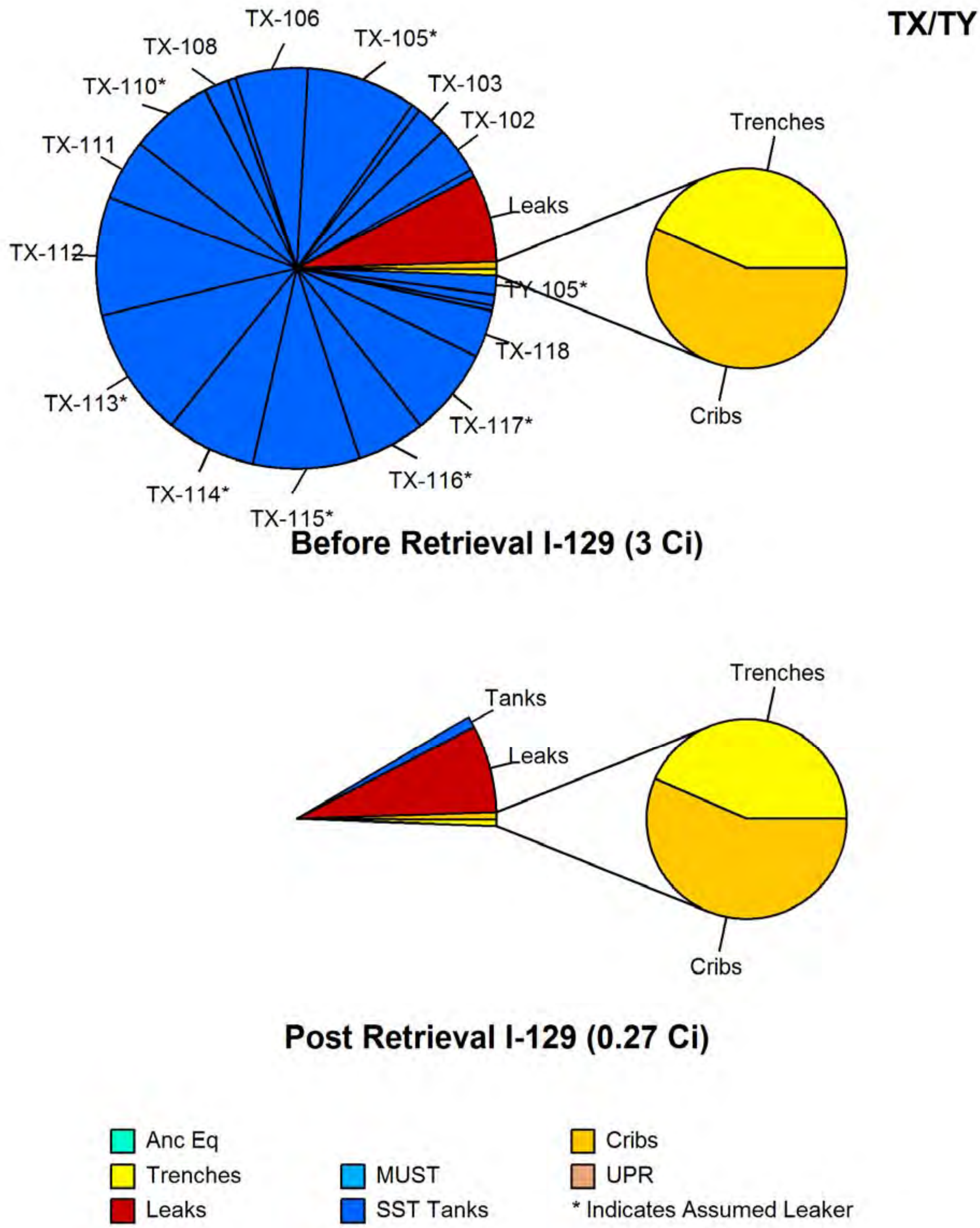

Figure E.4-4. TX-TY Tank and Waste Farms Evaluation Unit Inventory Estimates for I-129 Before and After 99% Retrieval

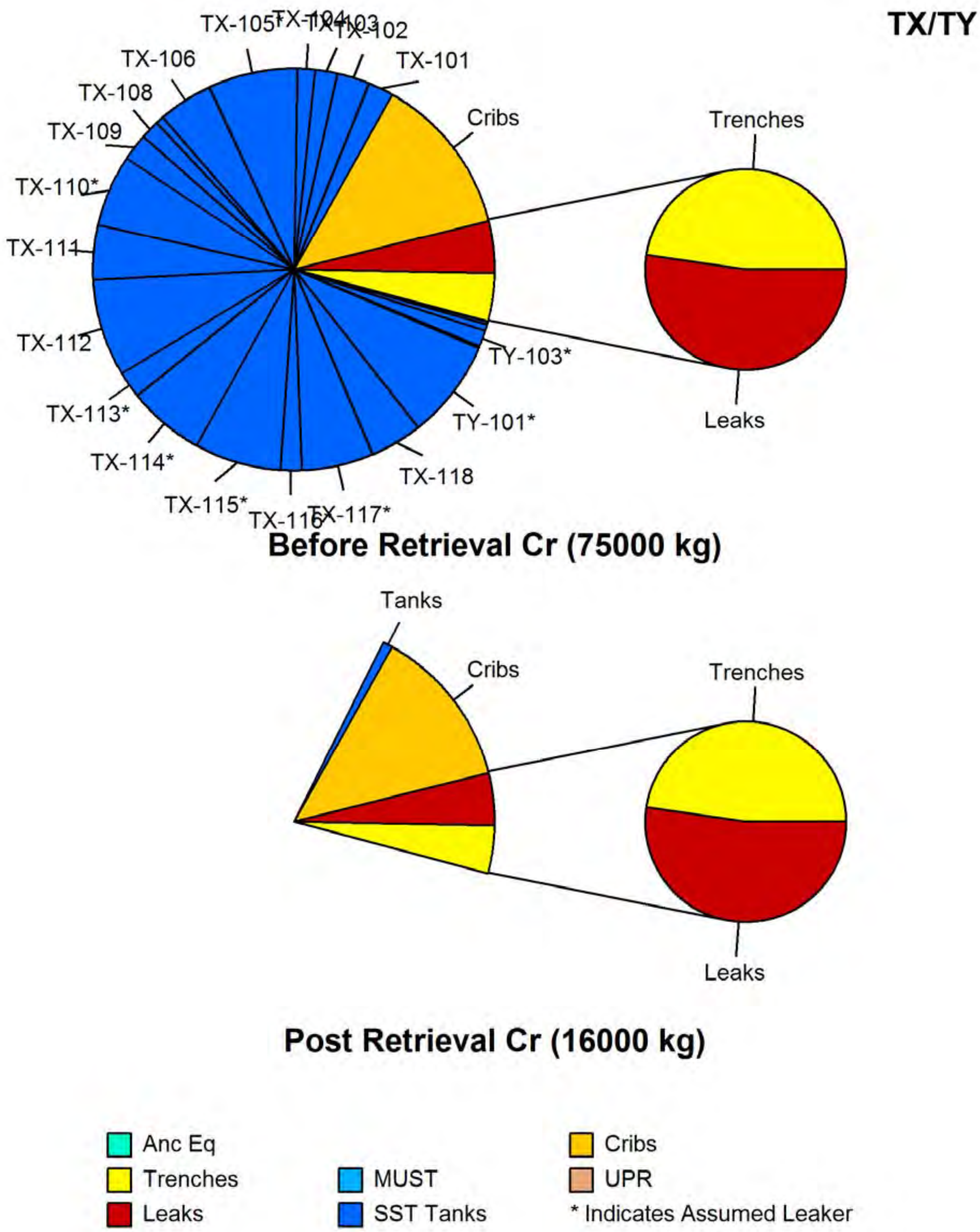

Figure E.4-5. TX-TY Tank and Waste Farms Evaluation Unit Inventory Estimates for Chromium Before and After 99% Retrieval

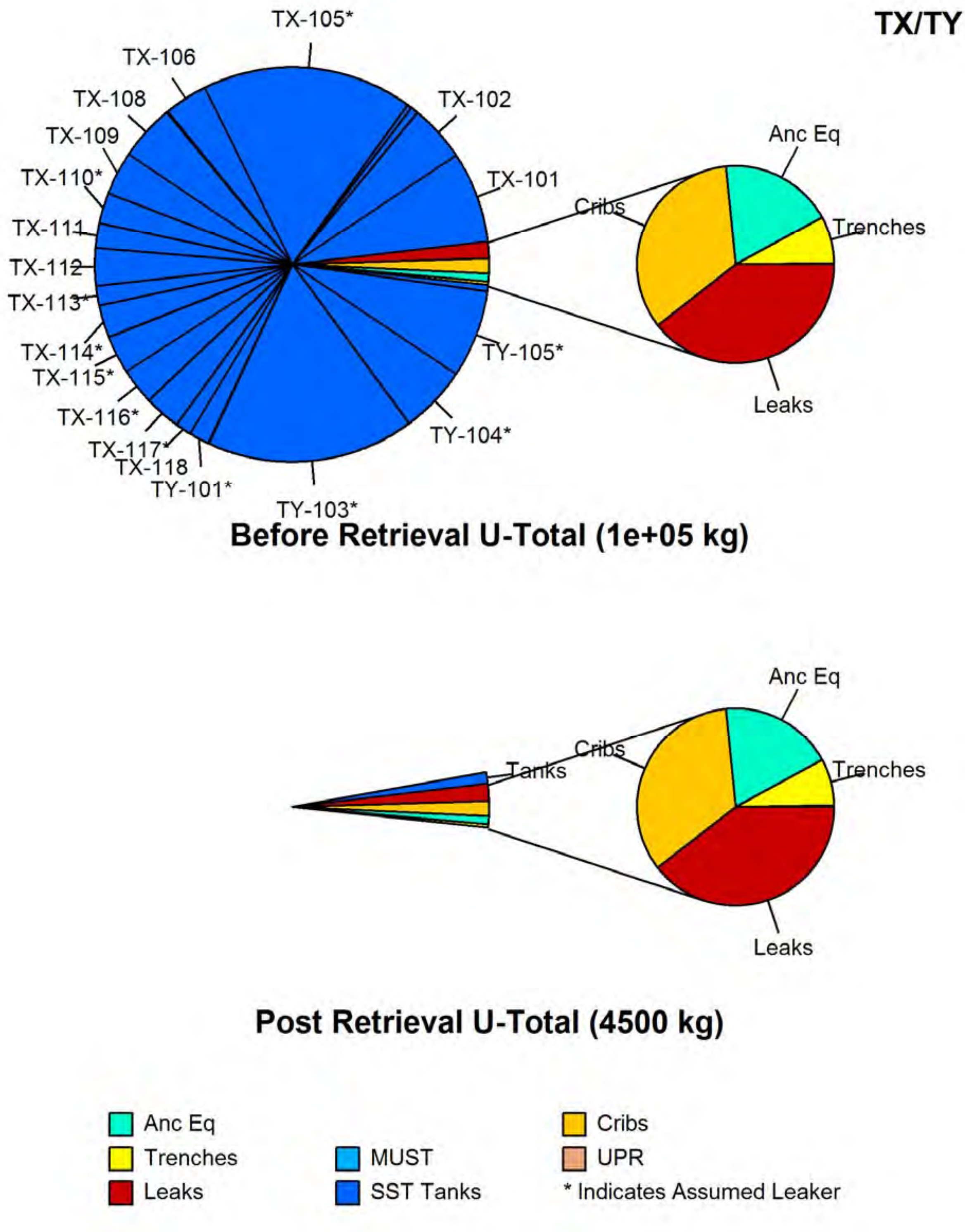

Figure E.4-6. TX-TY Tank and Waste Farms Evaluation Unit Inventory Estimates for U(tot) Before and After 99% Retrieval

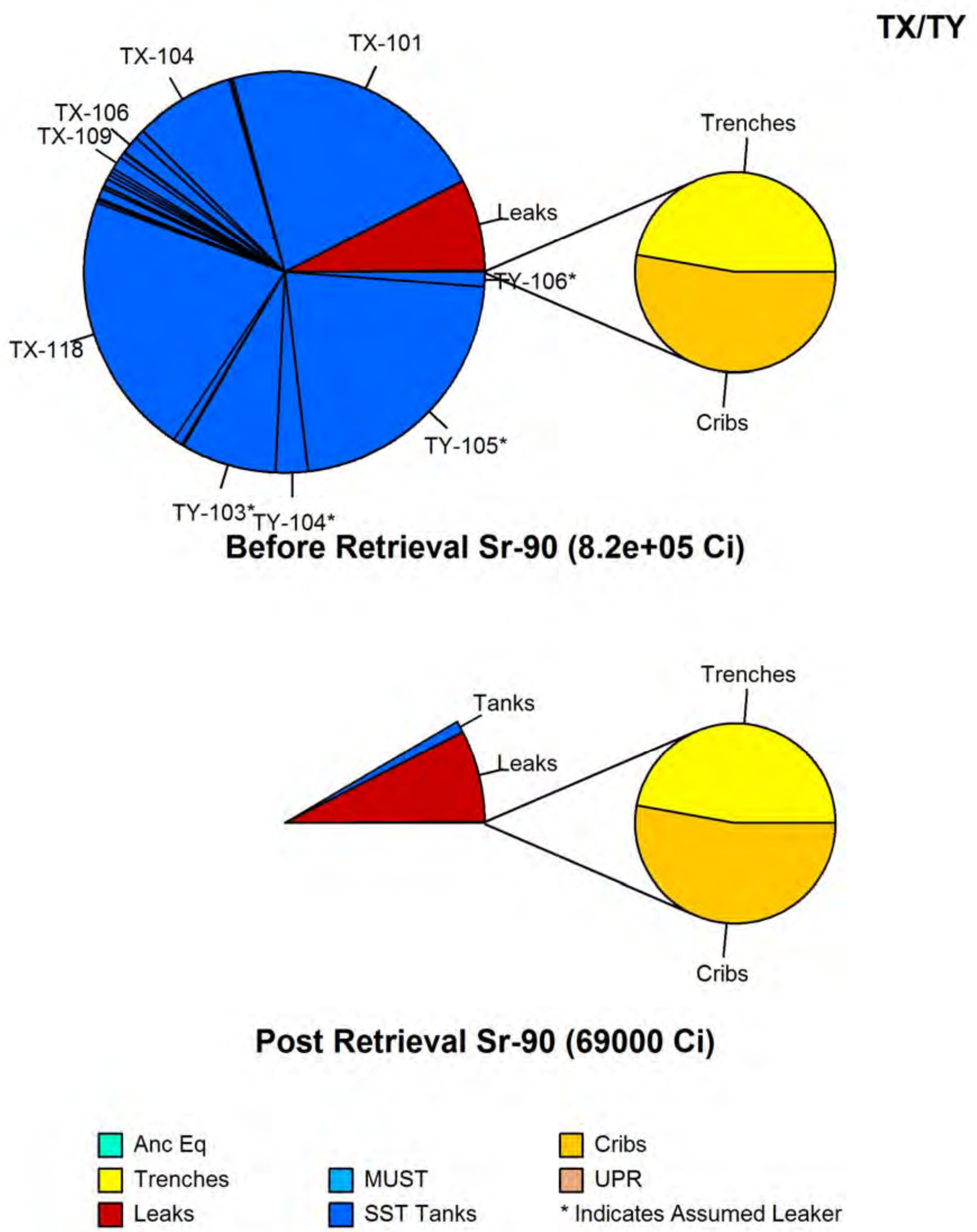

Figure E.4-7. TX-TY Tank and Waste Farms Evaluation Unit Inventory Estimates for Sr-90 Before and After 99% Retrieval

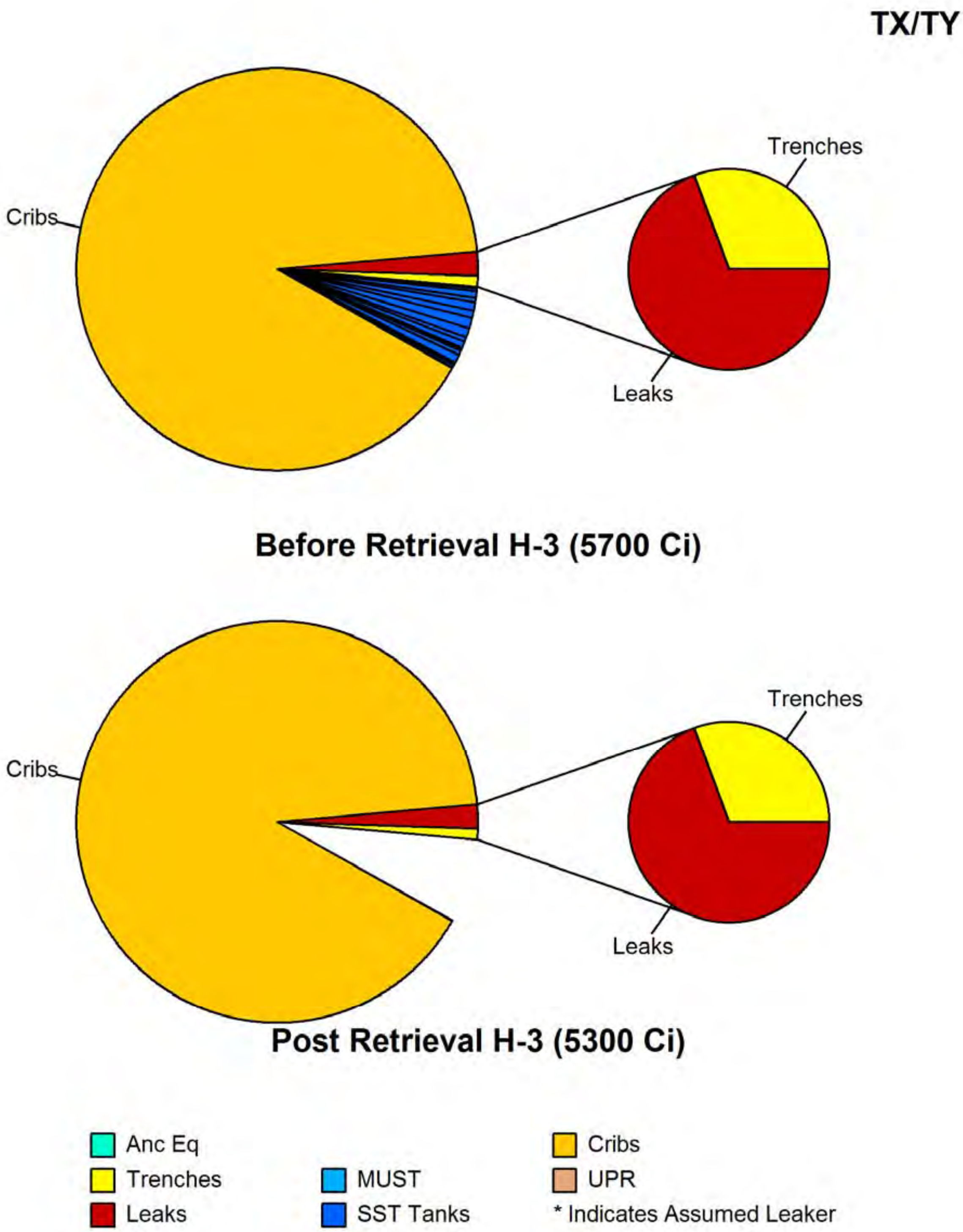

Figure E.4-8. TX-TY Tank and Waste Farms Evaluation Unit Inventory Estimates for Tritium (H-3) Before and After 99% Retrieval

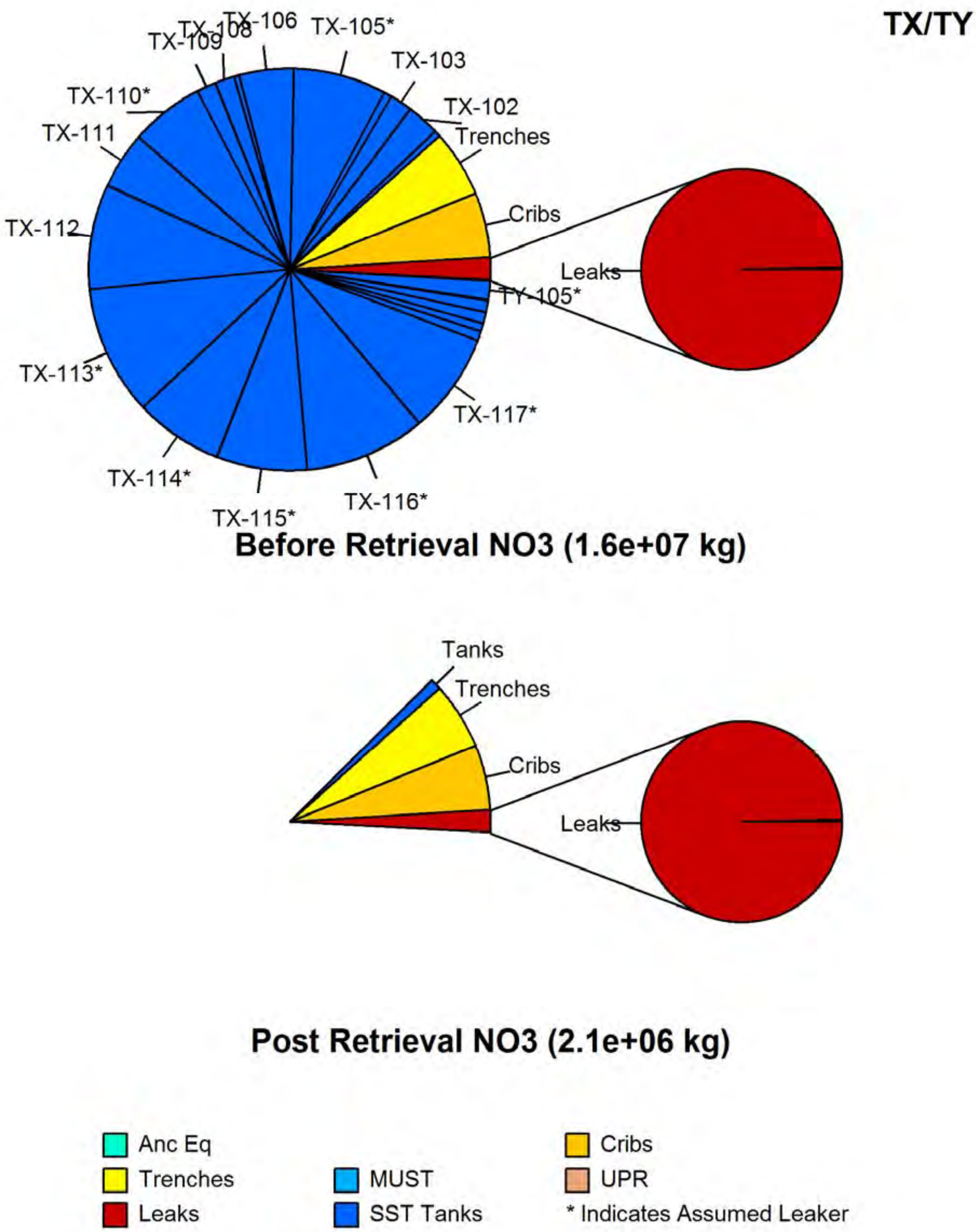

Figure E.4-9. TX-TY Tank and Waste Farms Evaluation Unit Inventory Estimates for Nitrate (NO3) Before and After 99% Retrieval

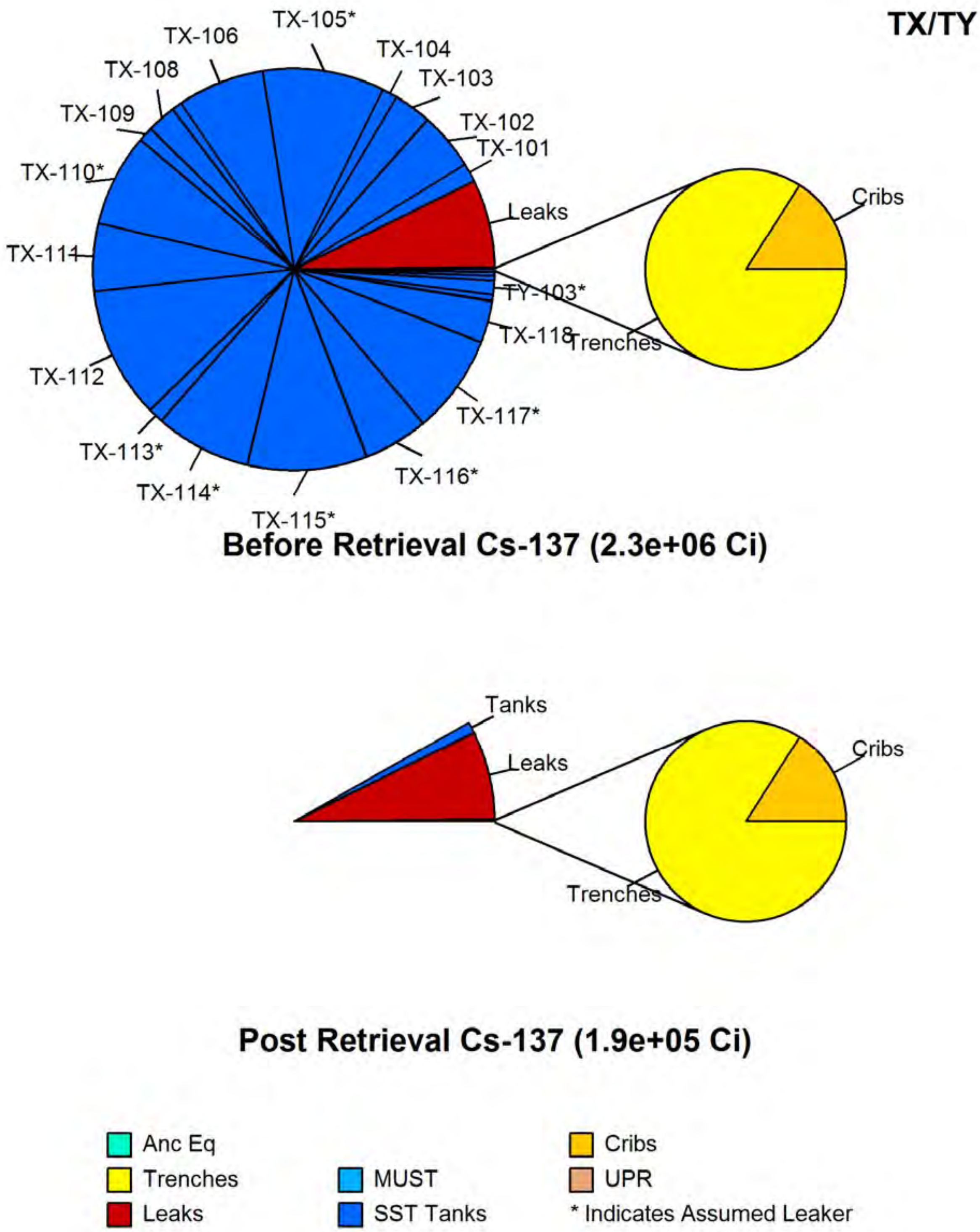

Figure E.4-10. TX-TY Tank and Waste Farms Evaluation Unit Inventory Estimates for Cs-137 Before and After 99% Retrieval

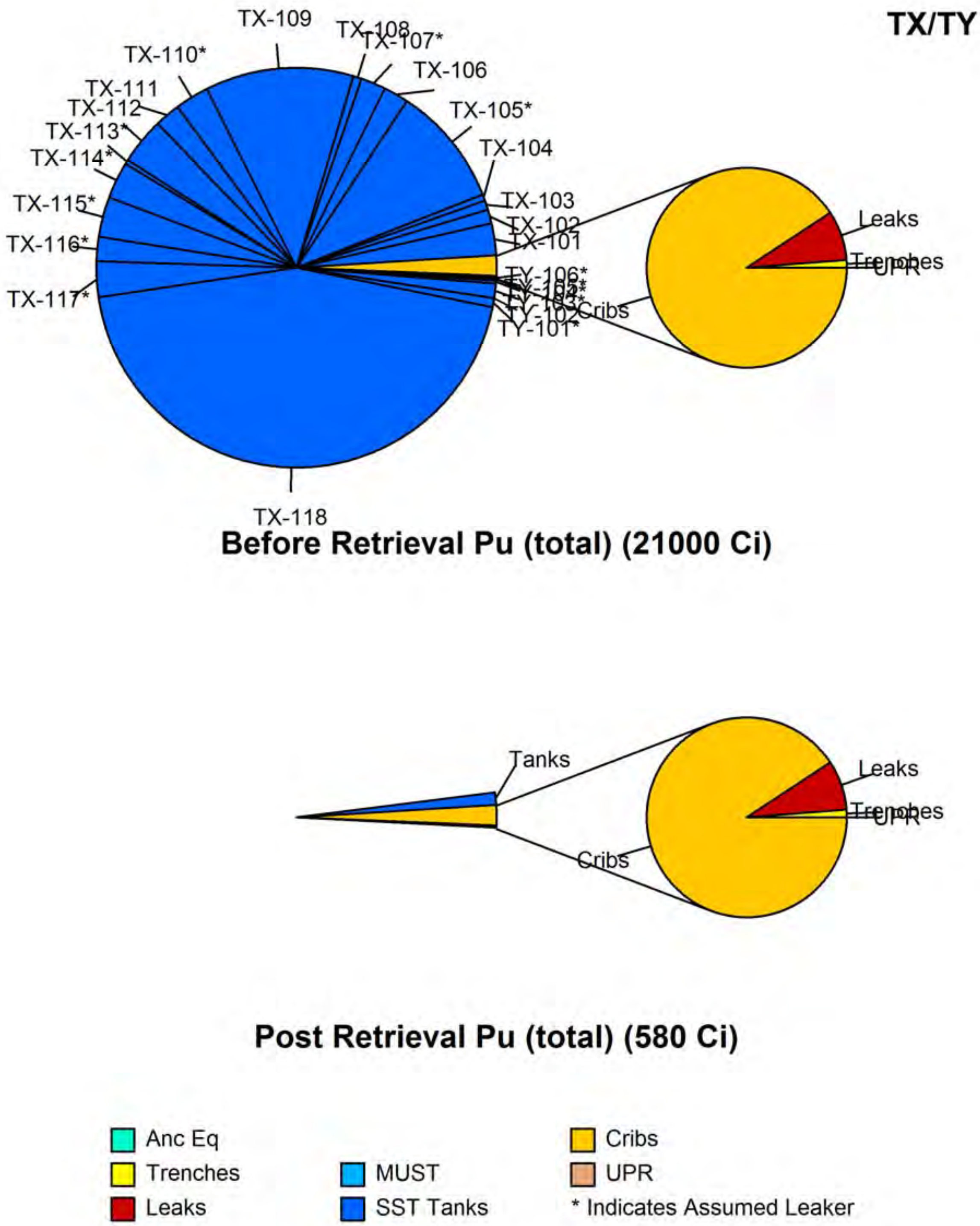

Figure E.4-11. TX-TY Tank and Waste Farms Evaluation Unit Inventory Estimates for Plutonium (total) Before and After 99% Retrieval

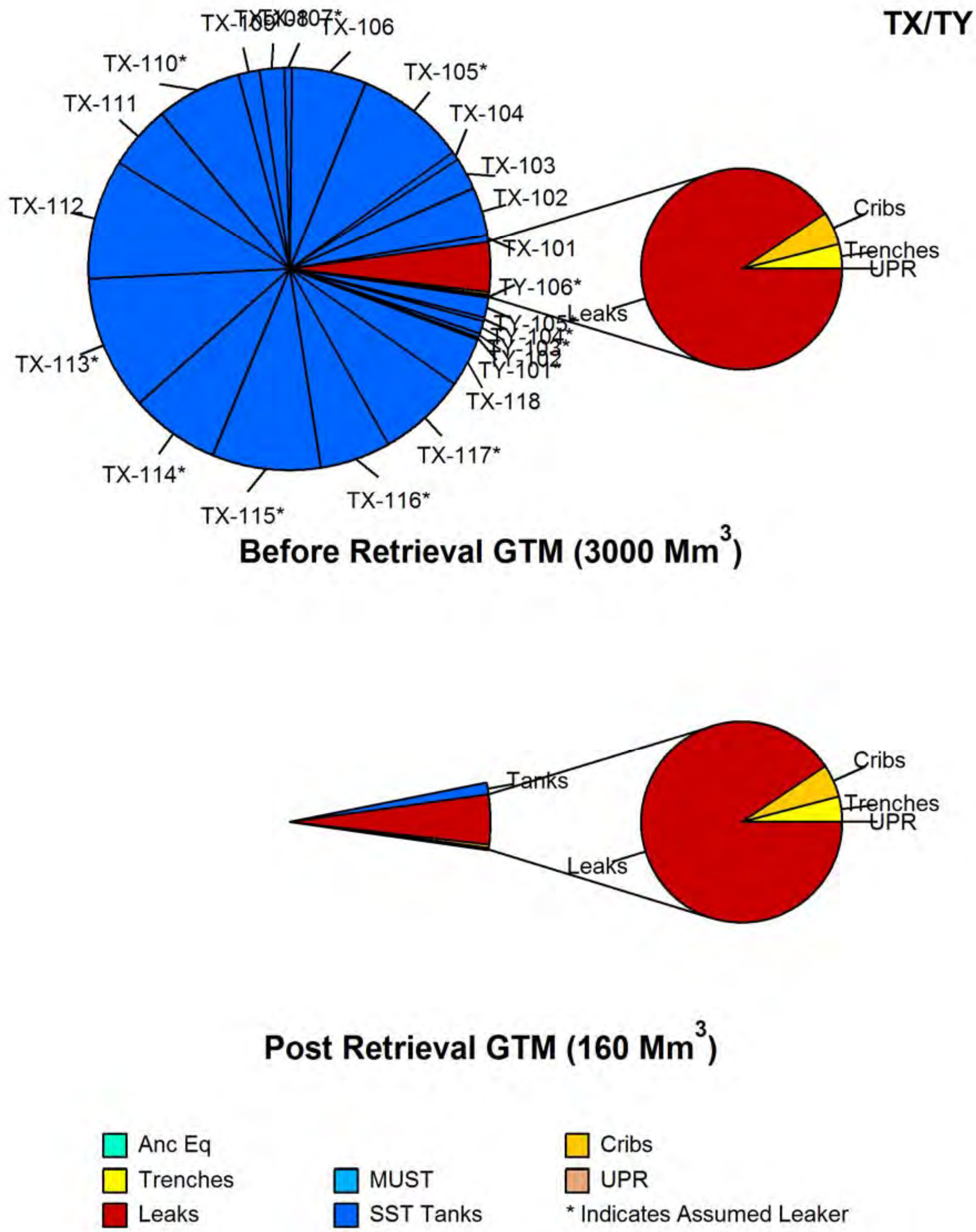

Figure E.4-12. TX-TY Tank and Waste Farms Evaluation Unit Maximum Groundwater Threat Metric (GTM) of the I-129 and Tc-99 Estimates Before and After 99% Retrieval

4.6. POTENTIAL RISK/IMPACT PATHWAYS AND EVENTS

CURRENT CONCEPTUAL MODEL

A common safety analysis was performed for all the single- and double-shell tanks including pathways and barriers (safety scenarios that dominate risk, safety systems and controls, barriers to release, failure mechanisms, pathways and receptors, time frames for exposure). See Section 1.6 in Appendix E.1 for details.

POPULATIONS AND RESOURCES CURRENTLY AT RISK OR POTENTIALLY IMPACTED

Facility Worker, Co-located Person, and Public

A common analysis was performed for the Facility Worker, Co-located Person, and Public. See Section 1.6 (Appendix E.1) for details.

Groundwater

The groundwater plumes (Tc-99, I-129, and chromium) associated with the TX-TY Tank and Waste Farms EU and liquid waste disposal facilities are described in Section 4.5 and further details are provided in the Appendix G.6 for the CP-GW-2 EU (200-ZP-1 GW OU).

As shown in Table E.4-7 (Section 4.5), the vadose zone (VZ) GTM values for the Group A and B primary contaminants translate into ratings from *Not Discernible* for uranium and Sr-90 (where the ratings would be *Low* after the Active Cleanup period to account for uncertainties as described in Section 4.5) to *Medium* for C-14 and I-129 to *High* for Tc-99, carbon tetrachloride, and chromium (total and hexavalent) for the TX-TY Tank and Waste Farms EU. Thus the overall rating for groundwater impact from vadose zone sources is *High*.

Columbia River

As described in Section 4.5, no plumes associated with the TX-TY Tank and Waste Farms EU currently intersect the Columbia River above benthic or riparian standards, which corresponds to *Not Discernible* ratings. The large dilution effect of the Columbia River results in a rating of *Not Discernible* for the free-flowing ecology.

Additional information concerning potential threats to the Columbia River from TX-TY Tank Farm and liquid waste disposal facilities is provided in Appendix G.6 for the CP-GW-2 EU (200-ZP-1 GW OU).

Ecological Resources

- No species of concern were found within the EU.
- Much of the EU (~55 acres) is graveled, or has been previously disturbed by ongoing operations and the installation and operation of various pump and treat wells and remaining habitat occurs in strips and patches surrounded by roads and infrastructure.
- Wildlife sign observed during the October field survey included coyote tracks, rabbit tracks, small mammal burrows, and harvester ant hills; previous surveys identified side-blotched lizard, western meadowlark, rock dove, and northern pocket gopher in the vicinity.
- The TX-TY Tank and Waste Farms EU is adjacent and contiguous to other tank farms and waste site EUs.

- Level 3 habitat within the EU does not connect to any level 2 or level 3 habitat lying outside the 200 West Area. Potential loss of level 2 and level 3 habitats within the EU would not be likely to affect habitat connectivity at the landscape scale.

Cultural Resources

- The 241 TY and 241 TX Waste Disposal Tank Farm are contributing properties within the Manhattan Project and Cold War Era Historic District, with documentation required, are located within the TX-TY Tank and Waste Farms EU.
- Segment C, a non-contributing portion of a National Register-eligible historic/ethnohistoric Trail/Road passes through the TX-TY Tank and Waste Farms EU.
- Portions of the Hanford Site Plant Railroad, a contributing property within the Manhattan Project and Cold War Era Historic District, with documentation required are located inside the TX-TY Tank and Waste Farms EU.

Archaeological sites and TCPs located within 500 meters of the EU

- One isolated find and one site associated with the Pre-Hanford Farming Landscape and one isolated find associated with the Native American Precontact and Ethnohistoric Landscape are located within 500 meters of the TX-TY Tank and Waste Farms EU. None of these items are considered to be eligible to the National Register of Historic Places.

Closest Recorded TCP

There are two TCPs that have been recorded that are associated with the Native American Precontact and Ethnohistoric Landscape that are visible form the TX-TY Tank and Waste Farms EU.

CLEANUP APPROACHES AND END-STATE CONCEPTUAL MODEL

Selected or Potential Cleanup Approaches

A common analysis was performed for all the single- and double-shell tanks. See Section 1.6 (Appendix E.1) for details.

Contaminant Inventory Remaining at the Conclusion of Planned Active Cleanup Period

See Section 4.5 including Table E.4-2 and Figure E.4-3 through Figure E.4-11 for the inventory information after planned 99% retrieval. Furthermore, a more general analysis was performed for all the single- and double-shell tanks. See Section 1.6 (Appendix E.1) for details.

Risks and Potential Impacts Associated with Cleanup

A common analysis was performed for all the single- and double-shell tanks for workers and the Public. See Section 1.6 (Appendix E.1) for details.

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

Facility Worker, Co-located Person, and Public

A common analysis was performed for the Facility Worker, Co-located Person, and Public. See Section 1.6 (Appendix E.1) for details.

Groundwater

As described in Section 4.5, there will be a continuing impact during this period to groundwater (as a protected resource) from those mobile TX-TY Tank Farm primary contaminants currently with plumes that exceed thresholds. These impacts are described in Appendix G.6 for the CP-GW-2 EU (200-ZP-1 OU).

Furthermore, there are primary (e.g., tank wastes) and secondary contaminant sources (legacy source sites) in the vadose zone that pose risk to groundwater. The vadose zone (VZ) GTM values for the Group A and B primary contaminants for the TX-TY Tank Farm EU translate to ratings of *Not Discernible* for uranium and Sr-90[67], *Medium* for C-14 and I-129, and *High* for Tc-99, carbon tetrachloride, and chromium (total and hexavalent). As indicated in Section 4.5, the Sr-90 (with an inventory that would translate to a *Very High* rating all other things being equal) is unlikely to impact the groundwater in sufficient quantity to exceed the drinking water standard and thus is not a future threat. The overall rating is *High* and be related to Tc-99, carbon tetrachloride, and chromium (total and hexavalent) in the vadose zone.

The 200-West Area pump-and-treat system is assumed to be operational during this evaluation period, which will be treating groundwater contamination.

It is considered unlikely that additional groundwater resources would be impacted as a result of either interim remedial actions (e.g., pump and treat) or final closure activities (that are not covered in the Ecological or Cultural Resources results).

Columbia River

As described in Section 4.5, the impacts to the Columbia River benthic, riparian, and free-flowing ecology for the Active Cleanup and Near-term, Post Cleanup periods are rated as *Not Discernible*. Additional information on groundwater plumes and potential threats associated with the T Tank Farm and liquid waste disposal facilities are described in Appendix G.6 for the CP-GW-2 EU (200-ZP-1 OU).

It is considered unlikely that additional benthic or riparian resources would be impacted as a result of either interim remedial actions (e.g., pump and treat) or final closure activities (that are not covered in the Ecological or Cultural Resources results).

Ecological Resources

See Section 1.6 (Appendix E.1) for details.

Cultural Resources

See Section 1.6 (Appendix E.1) for details.

ADDITIONAL RISKS AND POTENTIAL IMPACTS IF CLEANUP IS DELAYED

A common analysis was performed for all the single- and double-shell tanks. See Section 1.6 (Appendix E.1) for details.

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

A common analysis was performed for all the single- and double-shell tanks. See Section 1.6 (Appendix E.1) for details.

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[67] Note that no appreciable uranium or Sr-90 plume would be expected in the next 150 years due to transport considerations; however, these may impact groundwater after the 150-year period. Thus a *Low* rating would apply to the period after Active Cleanup is completed to account for uncertainties.

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

Table E.4-8. Summary of Populations and Resources at Risk or Potentially Impacted after Cleanup

Population or Resource		Impact Rating	Comments
Human	Facility Worker	Low	Workers will be low risk from exposure to direct radiation and waste contaminants after waste retrieval, grouting, and capping.
Human	Co-located Person	Low	These persons will be at low risk from exposure to direct radiation and waste contaminants after waste retrieval, grouting, and capping.
Human	Public	Not Discernible	The Tank Farms will be in secure and controlled areas that prevent intentional and inadvertent intruders. No complete groundwater pathway and no impact from air pathway.
Environmental	Groundwater (A&B) from vadose zone[a]	ND (Sr-90, uranium) to High (Tc-99, CCl_4, Cr-tot, Cr-VI) **Overall**: High	GTM values for Group A and B primary contaminants (Table E.4-7): *Low* (uranium, Sr-90), *Medium* (C-14, I-129) and *High* (Tc-99, CCl4, and total / hexavalent chromium). Sr-90 (which otherwise would have a *Very High* rating) not likely to impact groundwater (Section 4.5). Insufficient predicted impact from decay (since Tc-99, CCl4, and total / hexavalent chromium are risk drivers) or changes in recharge rates to adjust ratings.
Environmental	Columbia River from vadose zone[a]	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 (Section 4.5). Dilution factor of greater than 100 million between River and upwellings.

Population or Resource		Impact Rating	Comments
	Ecological Resources[b]	ND to Low	It will be capped, which results in less frequent monitoring, but monitoring activities can cause some disruption and disturbance to EU and buffer areas. Remediation may improve habitat through re-vegetation (and increased monitoring may lead to increases in exotic species, and changes in species composition).
Social	Cultural Resources[b]	**Native American:** Direct: Known Indirect: Known **Historic Pre-Hanford:** Direct: Known Indirect: Known **Manhattan/Cold War**: Direct: None Indirect: None	Permanent indirect effects to viewshed are possible from capping. Permanent effects may be possible due to presence of contamination if capping occurs. No other expected cultural resources impacts.

a. Groundwater threat for Group A and B contaminants remaining in the vadose zone or to the Columbia River for all primary contaminants. Threats from existing plumes associated with the TX-TY Tank and Waste Farms EU are described in Section 4.5 and Appendix G.6 (CP-GW-2) for the 200-ZP-1 Groundwater Operable Unit.
b. 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.

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

As described in Section 4.5, the TC&WM ecological screening analysis indicate that that exposure to radioactive contaminants from peak groundwater discharge was below screening levels at the Columbia River near-shore region, indicating there should be no expected adverse effects from radionuclides. Furthermore, results of the corresponding TC&WM screening evaluation for chemicals indicated that predicted chromium and nitrate concentrations could exceed screening values (i.e., Hazard Quotient of unity) in the near-shore region. However, the predicted nitrate peak concentration was in the past and would be unlikely to exceed human or aquatic standards in the future. For chromium the long travel time from 200-West to the Columbia River likely indicates that little chromium predicted to impact the near-shore region would be from 200-West sources (including the TX-TY Tank and Waste Farms EU), which would also likely lead to insignificant impacts from the TX-TY Tank and Waste Farms EU.

For more information, see Section 1.6 (Appendix E.1).

4.7. SUPPLEMENTAL INFORMATION AND CONSIDERATIONS

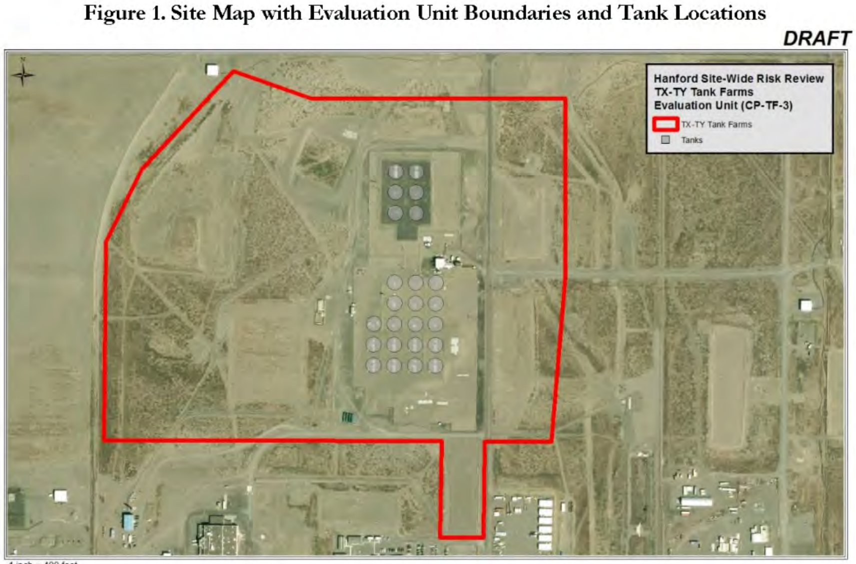
A common analysis was performed for all the single- and double-shell tanks. See Section 1.7 (Appendix E.1) for details.

4.8. ATTACHMENT – TX-TY TANK FARMS EVALUATION UNIT WIDS REVIEW

Hanford Site-Wide Risk Review

Evaluation Unit:	TX-TY Tank Farms
ID:	CP-TF-3
Group:	Tank Farm
Operable Unit Cross-Walk:	WMA TX/TY 200-DV-1 200-WA-1
Related EU:	CP-LS-7 CP-GW-2
Sites & Facilities:	TX-TY tank farms, ancillary structures, associated liquid waste sites, and soils contamination. Includes 242-T Evaporator.
Key Data Sources Docs:	RPP-13033 RPP-23405 RPP-23752 RPP-40545 RPP-PLAN-40145

Figure 1. Site Map with Evaluation Unit Boundaries and Tank Locations



Attached:

- Waste Site and Facility List
- Site Map with Evaluation Unit Boundaries and Associated Waste Sites
- Site Map with Evaluation Unit Boundaries and Associated Facilities

Prepared by:	AMG, 08/29/2014
Reviewed by:	GVL, 08/29/2014
Revisions:	AMG, 09/10/2014

Hanford Site-Wide Risk Revew
CP-TF-3 (TX-TY Farms)
Waste Site and Facility List

Site Code	Name, Aliases, Description	Site Status	Site Type	Site Type Category	Operable Unit	Exclude from Evaluation
200-W-106	200-W-106; Soil Contamination Area Adjacent to 200-W-55 Dump Site	Inactive	Unplanned Release	Unplanned Release - Surface/Near Surface	200-WA-1	
200-W-129-PL	200-W-129-PL; Encased Pipeline from 241-T-151 and 241-T-152 to 241-TX-155 Diversion Box; Lines V399, V405 and V411	Inactive	Encased Tank Farm Pipeline	Pipeline and associated valves, etc.	TBD	
200-W-130-PL	200-W-130-PL; Lines V445, V663, V601 and V416 and Spare Lines V662, V663, V682 and V683; Pipelines from 241-T-151 and 241-T-152 Diversion Boxes to 241-U-151 Diversion Box	Inactive	Direct Buried Tank Farm Pipeline	Pipeline and associated valves, etc.	TBD	
200-W-131-PL	200-W-131-PL; Spur to 241-TX Tank Farm; V601	Inactive	Direct Buried Tank Farm Pipeline	Pipeline and associated valves, etc.	TBD	
200-W-165-PL	200-W-165-PL; Pipeline from Tank 241-TX-112 to 207-T Retention Basin	Inactive	Radioactive Process Sewer	Pipeline and associated valves, etc.	TBD	
200-W-166-PL	200-W-166-PL; Pipeline from 242-T Evaporator Building to the 207-T Retention Basin	Inactive	Radioactive Process Sewer	Pipeline and associated valves, etc.	TBD	
200-W-167-PL	200-W-167-PL; Pipeline from 242-T Evaporator to 207-T Retention Basin	Inactive	Radioactive Process Sewer	Pipeline and associated valves, etc.	TBD	
200-W-175-PL	200-W-175-PL; Line V681; Pipeline to Route Waste from 241-T-112 to 216-TY-201 Flush Tank and 216-T-26, 216-T-27 and 216-T-28 Cribs	Inactive	Radioactive Process Sewer	Pipeline and associated valves, etc.	TBD	
200-W-176-PL	200-W-176-PL; Encased Transfer Lines Between 241-TX-153 Diversion Box and 241-TX-155 Diversion Box; Lines V396, V397, V401, V403, V407, V409, and V413	Inactive	Encased Tank Farm Pipeline	Pipeline and associated valves, etc.	TBD	
200-W-177-PL	200-W-177-PL; Direct Buried Tank Farm Lines Between 241-TXR-151 and 241-TX-155 Diversion Boxes; Lines V7616 and V7653	Inactive	Direct Buried Tank Farm Pipeline	Pipeline and associated valves, etc.	TBD	
200-W-178-PL	200-W-178-PL; Lines HSW-202 and HSW-203; Pipeline from 241-Z to 244-TX DCRT	Inactive	Direct Buried Tank Farm Pipeline	Pipeline and associated valves, etc.	TBD	
200-W-188-PL	200-W-188-PL; Waste Distribution Line from 216-TY-201 Flush Tank to 216-T-26, 216-T-27 and 216-T-28 Cribs and Truck Unloading Station Line	Inactive	Radioactive Process Sewer	Pipeline and associated valves, etc.	TBD	
200-W-191-PL	200-W-191-PL; Encased Transfer Line Between 241-TX-155 and 241-TY-153 Diversion Boxes; Lines V402, V406, V408 and V412	Inactive	Encased Tank Farm Pipeline	Pipeline and associated valves, etc.	TBD	
200-W-213-PL	200-W-213-PL; Lines V795, V606 and V605; Pipelines from 241-TX-153 Diversion Box and 241-TX-302A to 216-T-19 Crib	Inactive	Radioactive Process Sewer	Pipeline and associated valves, etc.	TBD	
200-W-232	200-W-232; 2607-WT Replacement Septic Tank and Dry Well	Inactive	Septic Tank	Septic System	TBD	X
200-W-48	200-W-48; 241-TX 90-Day Waste Accumulation Area	Inactive	Storage Pad (<90 day)	Storage Pad	Not Applic	
200-W-55	200-W-55; Dumping Area North of 231-Z	Inactive	Dumping Area	Burial Ground	200-WA-1	
200-W-63	200-W-63; Contaminated Concrete Pad	Inactive	Unplanned Release	Unplanned Release - Surface/Near Surface	200-WA-1	
200-W-78-PL	200-W-78-PL; 6025; 7624 and 7630; Lines 6012; Pipeline Between 241-TX/TY and 241-T Tank Farms	Inactive	Encased Tank Farm Pipeline	Pipeline and associated valves, etc.	TBD	
200-W-82	200-W-82; Crib Unloading Station; Truck Unloading Station, Risers East of 216-TY-201 and 216-T-26, 216-T-27 and 216-T-28 Cribs	Inactive	Product Piping	Pipeline and associated valves, etc.	200-WA-1	
200-W-92	200-W-92; Contaminated Mound of Soil and Debris; Soil Mound West of 241-TY Tank Farm	Inactive	Dumping Area	Burial Ground	200-WA-1	
200-W-94	200-W-94; Contaminated Soil at 241-TX/TY Tank Farm	Inactive	Unplanned Release	Unplanned Release - Surface/Near Surface	WMA TX/TY	
216-T-13	216-T-13; 269-W Decontamination Pit or Trench; 269-W Regulated Garage; 269-W Regulated Garage Decontamination Pit; 216-T-12	Inactive	Trench	Crib - Subsurface Liquid Disposal Site	200-WA-1	
216-T-18	216-T-18; 241-T-17 Crib; Scavenged TBP Waste; Test Crib for 221-U Building; 216-T-17	Inactive	Crib	Crib - Subsurface Liquid Disposal Site	200-DV-1	
216-T-19	216-T-19; 216-T-19TF; 216-TX-1; 241-TX-153 Crib and Tile Field; 241-TX-3	Inactive	Crib	Crib - Subsurface Liquid Disposal Site	200-DV-1	
216-T-21	216-T-21; 216-TX-1 Grave; 216-TX-3; 241-TX-1 Trench	Inactive	Trench	Crib - Subsurface Liquid Disposal Site	200-DV-1	

Note that only those waste sites with a WIDS (Waste Information Data System) Classification of "Accepted" are shown, along with non-duplicate facilities, identified via the Hanford Geographic Information System (HGIS).

Hanford Site-Wide Risk Revew
CP-TF-3 (TX-TY Farms)
Waste Site and Facility List

Site Code	Name, Aliases, Description	Site Status	Site Type	Site Type Category	Operable Unit	Exclude from Evaluation
216-T-22	216-T-22; 216-TX-2 Grave; 216-TX-4; 241-TX-2 Trench	Inactive	Trench	Crib - Subsurface Liquid Disposal Site	200-DV-1	
216-T-23	216-T-23; 216-TX-3 Grave; 216-TX-5; 241-TX-3 Grave; 241-TX-3 Trench	Inactive	Trench	Crib - Subsurface Liquid Disposal Site	200-DV-1	
216-T-24	216-T-24; 216-TX-4 Grave; 216-TX-6; 241-TX-4 Trench	Inactive	Trench	Crib - Subsurface Liquid Disposal Site	200-DV-1	
216-T-25	216-T-25; 216-TX-5 Grave; 216-TX-7; 241-TX-5 Trench	Inactive	Trench	Crib - Subsurface Liquid Disposal Site	200-DV-1	
216-T-26	216-T-26; 216-TX-1 Crib; 216-TY-1 Cavern; 216-TY-1 Crib; 241-TX-1 Cavern	Inactive	Crib	Crib - Subsurface Liquid Disposal Site	200-DV-1	
216-T-27	216-T-27; 216-TX-2 Cavern; 216-TX-2 Crib; 216-TY-2 Cavern; 216-TY-2 Crib	Inactive	Crib	Crib - Subsurface Liquid Disposal Site	200-WA-1	
216-T-28	216-T-28; 216-TX-3 Cavern; 216-TX-3 Crib; 216-TY-3 Cavern; 216-TY-3 Crib	Inactive	Crib	Crib - Subsurface Liquid Disposal Site	200-WA-1	
216-T-31	216-T-31; 216-T-31 French Drain	Inactive	French Drain	Crib - Subsurface Liquid Disposal Site	200-WA-1	
216-TY-201	216-TY-201; IMUST; Inactive Miscellaneous Underground Storage Tank; Supernatant Disposal Flush Tank	Inactive	Settling Tank	Underground Storage Tank	200-IS-1	
241-TX-101	241-TX-101; 241-TX-TK-101	Inactive	Single-Shell Tank	Underground Storage Tank	WMA TX/TY	
241-TX-102	241-TX-102; 241-TX-TK-102	Inactive	Single-Shell Tank	Underground Storage Tank	WMA TX/TY	
241-TX-103	241-TX-103; 241-TX-TK-103	Inactive	Single-Shell Tank	Underground Storage Tank	WMA TX/TY	
241-TX-104	241-TX-104; 241-TX-TK-104	Inactive	Single-Shell Tank	Underground Storage Tank	WMA TX/TY	
241-TX-105	241-TX-105; 241-TX-TK-105	Inactive	Single-Shell Tank	Underground Storage Tank	WMA TX/TY	
241-TX-106	241-TX-106; 241-TX-TK-106	Inactive	Single-Shell Tank	Underground Storage Tank	WMA TX/TY	
241-TX-107	241-TX-107; 241-TX-TK-107	Inactive	Single-Shell Tank	Underground Storage Tank	WMA TX/TY	
241-TX-108	241-TX-108; 241-TX-TK-108	Inactive	Single-Shell Tank	Underground Storage Tank	WMA TX/TY	
241-TX-109	241-TX-109; 241-TX-TK-109	Inactive	Single-Shell Tank	Underground Storage Tank	WMA TX/TY	
241-TX-110	241-TX-110; 241-TX-TK-110	Inactive	Single-Shell Tank	Underground Storage Tank	WMA TX/TY	
241-TX-111	241-TX-111; 241-TX-TK-111	Inactive	Single-Shell Tank	Underground Storage Tank	WMA TX/TY	
241-TX-112	241-TX-112; 241-TX-TK-112	Inactive	Single-Shell Tank	Underground Storage Tank	WMA TX/TY	
241-TX-113	241-TX-113; 241-TX-TK-113	Inactive	Single-Shell Tank	Underground Storage Tank	WMA TX/TY	
241-TX-114	241-TX-114; 241-TX-TK-114	Inactive	Single-Shell Tank	Underground Storage Tank	WMA TX/TY	
241-TX-115	241-TX-115; 241-TX-TK-115	Inactive	Single-Shell Tank	Underground Storage Tank	WMA TX/TY	
241-TX-116	241-TX-116; 241-TX-TK-116	Inactive	Single-Shell Tank	Underground Storage Tank	WMA TX/TY	
241-TX-117	241-TX-117; 241-TX-TK-117	Inactive	Single-Shell Tank	Underground Storage Tank	WMA TX/TY	
241-TX-118	241-TX-118; 241-TX-TK-118	Inactive	Single-Shell Tank	Underground Storage Tank	WMA TX/TY	
241-TX-153	241-TX-153; 241-TX-153 Diversion Box	Inactive	Diversion Box	Pipeline and associated valves, etc.	WMA TX/TY	
241-TX-302A	241-TX-302A; 241-TX-302-A Catch Tank; IMUST; Inactive Miscellaneous Underground Storage Tank; Lines V627 and V628	Inactive	Catch Tank	Underground Storage Tank	WMA TX/TY	
241-TX-302XB	241-TX-302XB; IMUST; Inactive Miscellaneous Underground Storage Tank; 241-TX-302B Catch Tank; 241-TX-302-X; 241-TX-302-X (B)	Inactive	Catch Tank	Underground Storage Tank	WMA TX/TY	
241-TXR-151	241-TXR-151; 241-TXR-151 Diversion Box; Line 7765	Inactive	Diversion Box	Pipeline and associated valves, etc.	WMA TX/TY	
241-TXR-152	241-TXR-152; 241-TXR-152 Diversion Box; Line 7053	Inactive	Diversion Box	Pipeline and associated valves, etc.	WMA TX/TY	
241-TXR-153	241-TXR-153; 241-TXR-153 Diversion Box; Line 7253	Inactive	Diversion Box	Pipeline and associated valves, etc.	WMA TX/TY	
241-TY-101	241-TY-101; 241-TY-TK-101	Inactive	Single-Shell Tank	Underground Storage Tank	WMA TX/TY	
241-TY-102	241-TY-102; 241-TY-TK-102	Inactive	Single-Shell Tank	Underground Storage Tank	WMA TX/TY	
241-TY-103	241-TY-103; 241-TY-TK-103	Inactive	Single-Shell Tank	Underground Storage Tank	WMA TX/TY	
241-TY-104	241-TY-104; 241-TY-TK-104	Inactive	Single-Shell Tank	Underground Storage Tank	WMA TX/TY	

Note that only those waste sites with a WIDS (Waste Information Data System) Classification of "Accepted" are shown, along with non-duplicate facilities, identified via the Hanford Geographic Information System (HGIS).

Hanford Site-Wide Risk Revew
CP-TF-3 (TX-TY Farms)
Waste Site and Facility List

Site Code	Name, Aliases, Description	Site Status	Site Type	Site Type Category	Operable Unit	Exclude from Evaluation
241-TY-105	241-TY-105; 241-TY-TK-105	Inactive	Single-Shell Tank	Underground Storage Tank	WMA TX/TY	
241-TY-106	241-TY-106; 241-TY-TK-106	Inactive	Single-Shell Tank	Underground Storage Tank	WMA TX/TY	
241-TY-153	241-TY-153; 241-TY-153 Diversion Box	Inactive	Diversion Box	Pipeline and associated valves, etc.	WMA TX/TY	
241-TY-302A	241-TY-302A; 241-TY-302-A Catch Tank; IMUST; Inactive Miscellaneous Underground Storage Tank; Line V651	Inactive	Catch Tank	Underground Storage Tank	WMA TX/TY	
241-TY-302B	241-TY-302B; 241-TY-302-B Catch Tank; IMUST; Inactive Miscellaneous Underground Storage Tank	Inactive	Catch Tank	Underground Storage Tank	WMA TX/TY	
242-T	242-T; 242-T Evaporator Facility; 241-T Evaporator	Inactive	Evaporator	Process Building	WMA TX/TY	
242-T-135	242-T-135; IMUST; Inactive Miscellaneous Underground Storage Tank	Inactive	Storage Tank	Underground Storage Tank	WMA TX/TY	
242-T-151	242-T-151; 242-T-151 Diversion Box. Line V830	Inactive	Diversion Box	Pipeline and associated valves, etc.	WMA TX/TY	
242-TA-R1	242-TA-R1; IMUST; Inactive Miscellaneous Underground Storage Tank; Receiver Tank TK-R1; Receiver TK-Vault; Z Waste; 242-TA; 242-TA Receiver Tank Vault	Inactive	Receiving Vault	Underground Storage Tank	WMA TX/TY	
244-TX DCRT	244-TX DCRT; 244-TX Double-Contained Receiver Tank; 244-TX Receiver Tank; 244-TX Receiver Vessel; 244-TX RT; 244-TX-TK/SMP	Inactive	Receiver Tank	Underground Storage Tank	WMA TX/TY	
244-TXR VAULT	244-TXR VAULT; 244-TXR Vault (Tanks TXR-001, -002, -003); IMUST; Inactive Miscellaneous Underground Storage Tank; 241-TXR-244; 244-TXR	Inactive	Receiving Vault	Underground Storage Tank	WMA TX/TY	
2607-WT	2607-WT; 241-T-601 Control Bldg. Tile Field	Inactive	Septic Tank	Septic System	WMA TX/TY	X
2607-WTX	2607-WTX	Inactive	Septic Tank	Septic System	WMA TX/TY	X
UPR-200-W-100	UPR-200-W-100; 105-TX to 118-TX Process Line Leak; UN-200-W-100; UN-216-W-8	Inactive	Unplanned Release	Unplanned Release - Surface/Near Surface	Not Applic	
UPR-200-W-12	UPR-200-W-12; Ground Contamination Near 242-T	Inactive	Unplanned Release	Unplanned Release - Surface/Near Surface	Not Applic	
UPR-200-W-126	UPR-200-W-126; Contamination Release Inside 241-TX Tank Farm	Inactive	Unplanned Release	Unplanned Release - Surface/Near Surface	Not Applic	
UPR-200-W-129	UPR-200-W-129; Contamination Release Inside 241-TX Tank Farm	Inactive	Unplanned Release	Unplanned Release - Surface/Near Surface	Not Applic	
UPR-200-W-14	UPR-200-W-14; Waste Line Leak at 242-T Evaporator; UN-200-W-14	Inactive	Unplanned Release	Unplanned Release - Surface/Near Surface	200-WA-1	
UPR-200-W-149	UPR-200-W-149; 241-TX-107 Leak	Inactive	Unplanned Release	Unplanned Release - Subsurface	Not Applic	
UPR-200-W-150	UPR-200-W-150; 241-TY-103 Leak	Inactive	Unplanned Release	Unplanned Release - Subsurface	Not Applic	
UPR-200-W-151	UPR-200-W-151; 241-TY-104 Leak	Inactive	Unplanned Release	Unplanned Release - Subsurface	Not Applic	
UPR-200-W-152	UPR-200-W-152; 241-TY-105 Leak	Inactive	Unplanned Release	Unplanned Release - Subsurface	Not Applic	
UPR-200-W-153	UPR-200-W-153; 241-TY-106 Leak	Inactive	Unplanned Release	Unplanned Release - Subsurface	Not Applic	
UPR-200-W-167	UPR-200-W-167; Contamination Migration from 241-TY; UN-216-W-32	Inactive	Unplanned Release	Unplanned Release - Surface/Near Surface	200-IS-1	
UPR-200-W-17	UPR-200-W-17; Contamination Spread form 241-TX-106 Pump Removal; UN-200-W-17	Inactive	Unplanned Release	Unplanned Release - Surface/Near Surface	Not Applic	
UPR-200-W-99	UPR-200-W-99; 241-153-TX Diversion Box Contamination Spread; UN-200-W-99; UN-216-W-7	Inactive	Unplanned Release	Unplanned Release - Surface/Near Surface	200-WA-1	
241TX701	LAUNDRY STORAGE FACILITY	ACTIVE	BUILDING	Infrastructure Building		X
242T271	242T CONTROL BUILDING PASSAGEWAY	ACTIVE	BUILDING	Infrastructure Building		X
242T601	CHEMICAL MAKEUP BUILDING	ACTIVE	BUILDING	Process Building		
242T701	TX/TY COMPRESSED AIR STATION	INACTIVE	STRUCTURE	Infrastructure Building		X
242TA	WASTE RECEIVING VAULT	INACTIVE	STRUCTURE	Process Building		
242TB	VENT HOUSE	INACTIVE	BUILDING	Process Building		
242TC	TANK FARM MICROCOMPUTER EQUIPMENT BLDG	ACTIVE	BUILDING	Infrastructure Building		X
244TX	SALT WELL RECEIVER VAULT	ACTIVE	STRUCTURE	Process Building		

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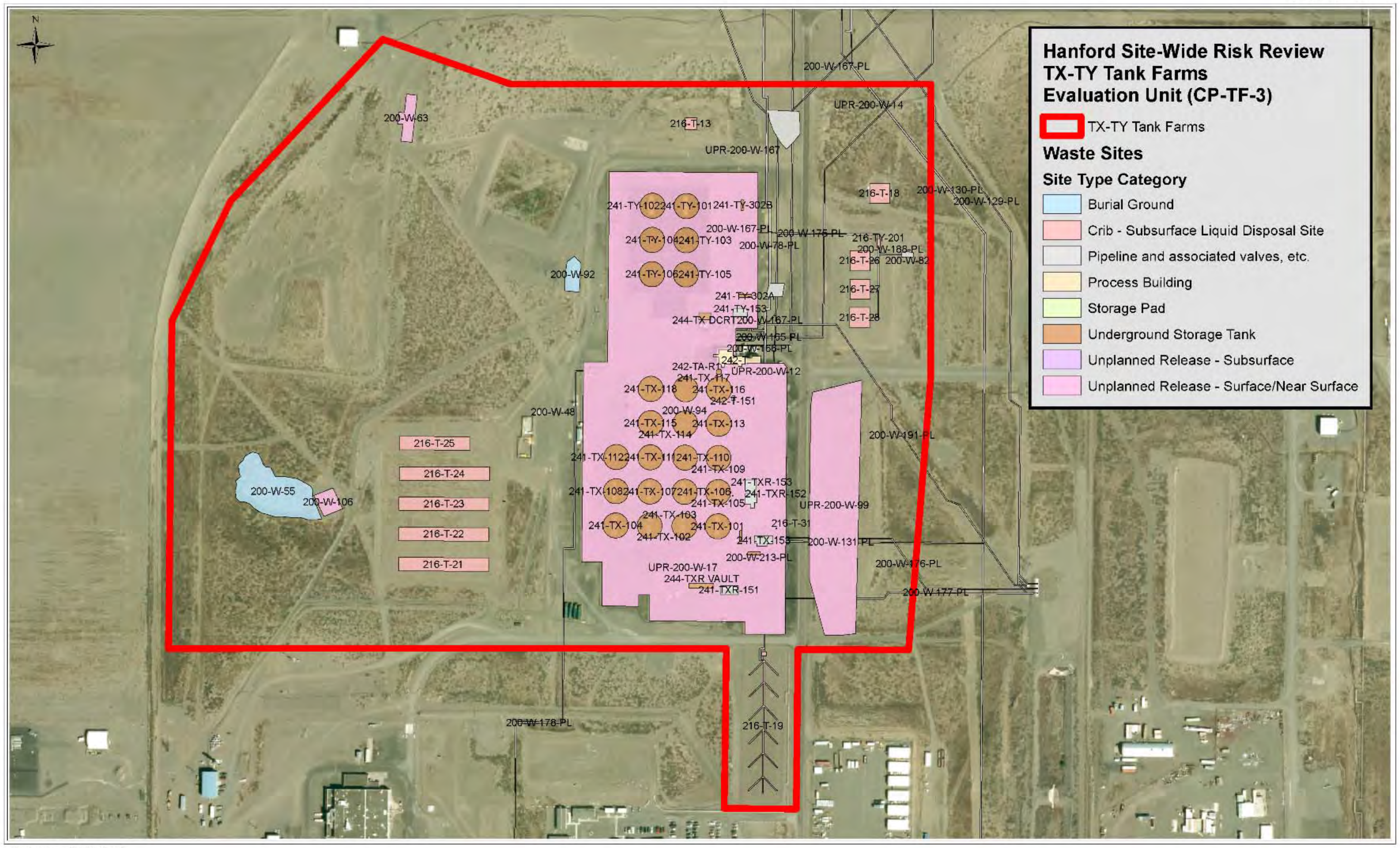
Hanford Site-Wide Risk Revew
CP-TF-3 (TX-TY Farms)
Waste Site and Facility List

Site Code	Name, Aliases, Description	Site Status	Site Type	Site Type Category	Operable Unit	Exclude from Evaluation
244TX271	ELECTRICAL INSTRUMENTATION CONTROL BLDG	ACTIVE	BUILDING	Infrastructure Building		X
244TX2904	SALT WELL RECEIVER FLUSH PIT	INACTIVE	BUILDING	Process Building		
2724TX	RAD MONITORING AND PROTECTIVE CLOTHING BLDG	INACTIVE	BUILDING	Infrastructure Building		X
2724TXA	RAD MONITORING AND PROTECTIVE CLOTHING BLDG	INACTIVE	BUILDING	Infrastructure Building		X
2724TXB	RAD MONITORING AND PROTECTIVE CLOTHING BLDG	INACTIVE	BUILDING	Infrastructure Building		X
MO817	CHANGE TRAILER AT TX TANK FARM	ACTIVE	BUILDING	Infrastructure Building		X

Note that only those waste sites with a WIDS (Waste Information Data System) Classification of "Accepted" are shown, along with non-duplicate facilities, identified via the Hanford Geographic Information System (HGIS).

DRAFT



1 inch = 400 feet

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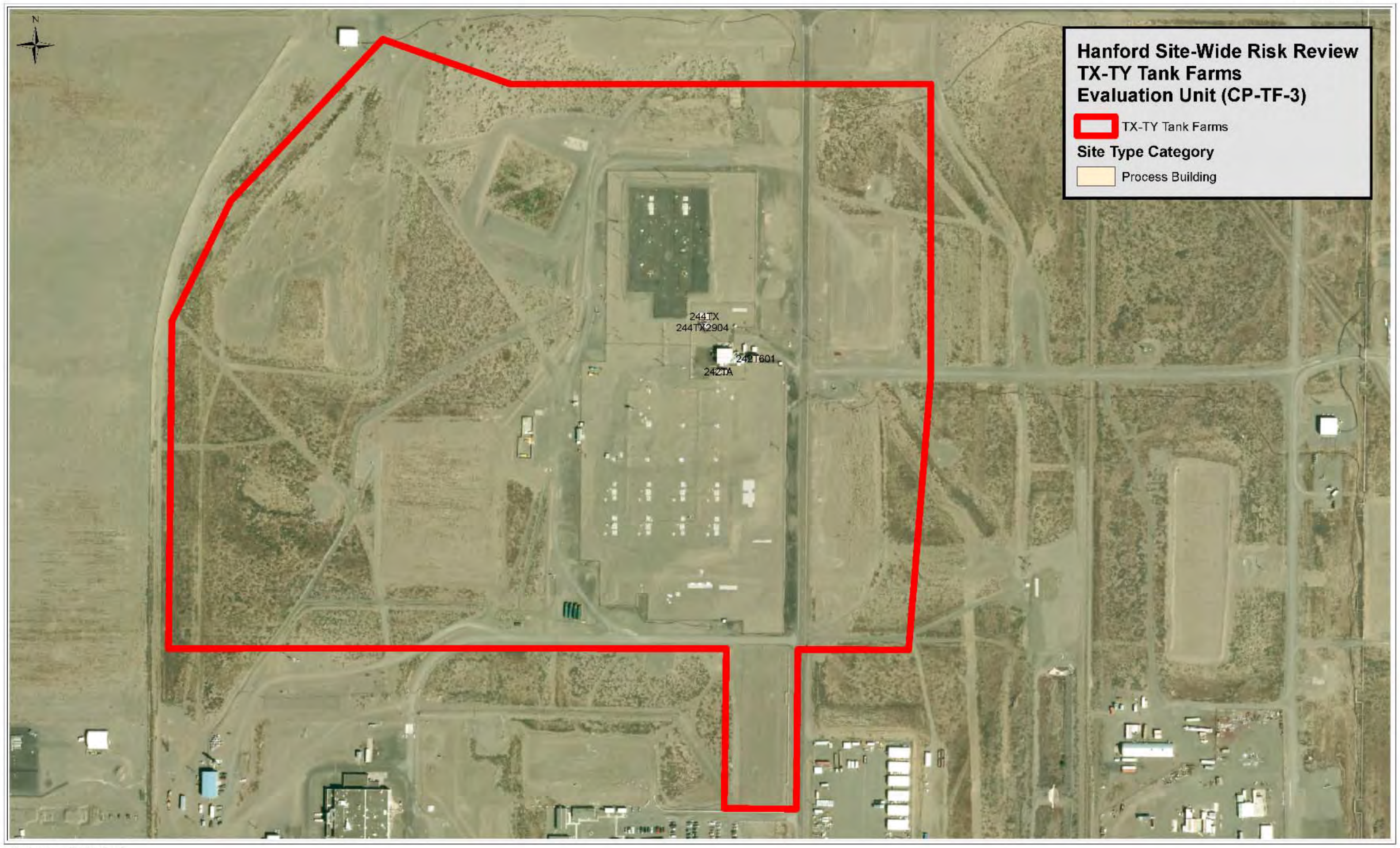

1 inch = 400 feet

APPENDIX E.5

Tank Waste and Farm

CP-TF-4 (U Tank Waste and Farm)
Evaluation Unit Summary Template

Table of Contents

List of Figures

List of Tables

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PART 5. CP-TF-4 U SINGLE-SHELL TANK WASTE AND FARM (200-W)

5.1. EXECUTIVE SUMMARY

Much of the information related to the U Tank and Waste Farms Evaluation Unit (EU) is organized around the corresponding Waste Management Area (namely WMA U) that regulated under the Resource Conservation and Recovery Act of 1976 (RCRA) as codified in 40 CFR Part 265, Subpart F and Washington's Hazardous Waste Management Act (HWMA, RCW 70.105) and its implementing requirements in the Washington State dangerous waste regulations (WAC 173-303-400) (PNNL-13612).

EU LOCATION:

South-Central part of 200-West on the Hanford Reservation; Central Plateau

RELATED EUS:

T Tank Waste and Farms (CP-TF-1), S-SX Tank Waste and Farms (CP-TF-2), TX-TY Tank Waste and Farms (CP-TF-3), A-AX Tank Waste and Farms (CP-TF-5), B-BX-BY Tank Waste and Farms (CP-TF-6), C Tank Waste and Farms (CP-TF-7), 200-East DST Waste and Farms (CP-TF-8), 200-West DST Waste and Farms (CP-TF-9), 200-E Groundwater Plumes (CP-GW-1), 200-W Groundwater Plumes (CP-GW-2), and 200 Area Waste Transfer Pipeline (CP-LS-7)

PRIMARY CONTAMINANTS, CONTAMINATED MEDIA AND WASTES:

The TC&WM EIS describes tank wastes as including radioactive (tritium or H-3, C-14, Sr-90, Tc-99, I-129, Cs-137, U-233, U-234, U-235, U-238, Np-237, Pu-239, and Pu-240)[68] and non-radioactive contaminants (chromium, mercury, nitrate, lead, total uranium, and PCBs) of potential concern (DOE/EIS-0391 2012, Appendix D). The tank wastes contain saltcake, sludge, and supernatant phases. Contaminated media related to the U Tank Farm include ancillary equipment and surrounding vadose zone (including cribs and trenches) down to the saturated zone (for some mobile contaminants) from past and current discharges. The Interim Record of Decision for the 200-UP-1 Operable Unit (OU) (EPA 2012) associated with WMA U identifies I-129, Tc-99, tritium, uranium, nitrate, and chromium as tank waste constituents that must be addressed in cleanup; carbon tetrachloride is also listed but is not a tank waste. The 2013 Groundwater Monitoring Report (DOE/RL-2014-32, Rev. 0) lists tank wastes including chromium, nitrate, I-129, Tc-99, H-3, and uranium and the carbon tetrachloride (non-tank) waste for the 200-UP-1 OU.

After evaluating the contaminants associated with U Tank Farm tanks, ancillary equipment, legacy sources, and contaminated vadose zone, the primary contaminants from the tank wastes that drive human health risk to groundwater for the U Tank and Waste Farms Evaluation Unit are: Tc-99, chromium, and nitrate. Those primary contaminants that may drive risk from groundwater discharge to the Columbia River are nitrate and chromium; however, any impacts are highly uncertain (see Section 2.1). Cs-137 and Sr-90 are important from a safety standpoint and uranium isotopes, plutonium isotopes, and tritium are iconic constituents; these contaminants are included in the inventory summary

[68] Other isotopes considered include U-232 and U-236 and Pu-238, Pu-241, and Pu-242 to be consistent with other EUs. These additional uranium and plutonium isotopes are included in the totals presented but are not used for rating because 1) uranium toxicity impacts (represented by total uranium drives corresponding risks and 2) plutonium has been found relatively immobile in the Hanford subsurface and has not been identified as a risk driver for groundwater impacts.

even though they are not considered risk drivers for impacts to or from groundwater in this review. Carbon tetrachloride is not tank wastes and thus is captured in Appendix G.6 for the CP-GW-2 EU (200-UP-1 GW OU).

BRIEF NARRATIVE DESCRIPTION:

Waste Management Area U (WMA U) occupies approximately 30,000 m^2 and contains 16 underground single-shell tanks (SSTs) in the U Tank Farm in additional to ancillary equipment (e.g., diversion boxes, pumps, valves, and pipes). The U Tank Farm contains 12 carbon steel tanks (U-101 through U-112) with capacities of 533 kgal and four smaller (55 kgal) tanks (U-201 through U-204). The U Tank Farm was constructed in 1943-44 (PNNL-13612, p. 4) and were in operation essentially continually from 1946 to 1980 (PNNL-13282, p. 2.1). The U Tank Farm tanks began receiving metal waste from the bismuth phosphate process in B and T Plants; most of the metal waste was later removed and recycled through U Plant to remove uranium. REDOX wastes and other wastes were then received and transferred among the tanks and other Tank Farms.

Waste was cascaded among the WMA U waste tanks; however, it appears none was released to cribs or ditches in the area. The 216-U-3 french drain (located south of WMA U) received 7.9×10^6 L of liquid from steam condensers on waste tanks in WMA U and likely contains nitrate and minor amounts of fission products and actinides. Trenches located west of WMA U received waste (primarily carbon tetrachloride and nitrate) from the Plutonium Finishing Plant and initially connected with the 216-U-10 Pond.

Four unplanned releases have been documented in or near WMA U with unknown waste volumes. Three unplanned releases may have significant impacts are beta contamination in diversion boxes east of WMA U, a “violent chemical reaction” in a vault that spread first-cycle metal waste contaminants over an unspecified area, and a ruptured waste line at tank U-103 (PNNL-13282, p. 2.3).

Four of the tanks in the WMA (U-101, U-104, U-110, and U-112) are “assumed leakers” (Weyns 2014, p. 20) ranging from 5,000 – 8,100 gallons (U-110 in 1975) to 55,000 gallons (U-104 in 1961).

The SSTs in WMA U have been interim stabilized (i.e., liquid transferred to DSTs to <50 kgal drainable interstitial liquid and <5 kgal of supernatant), including the four “assumed leakers”. The 216-U-13 trench (that never received tank waste) was stabilized by removing contaminated soil and backfilling with clean soil.

SUMMARY TABLES OF RISKS AND POTENTIAL IMPACTS TO RECEPTORS

Table E.5-1 provides a summary of nuclear and industrial safety related consequences from CP-TF-4 (U Tank and Waste Farms EU) to humans and impacts to important physical Hanford Site resources. Receptors are described in Section 1.6 (Appendix E.1).

Table E.5-1. CP-TF-4 (U Tank Farm) impact Rating Summary for Human Health (unmitigated basis with mitigated basis provided in parentheses (e.g., "High (Low)").

Population or Resource		Evaluation Time Period[a]	
		Active Cleanup (to 2064)	
		Current Condition: Maintenance & Monitoring (M&M)	**From Cleanup Actions:** Retrieval & Closure
Human Health	Facility Worker[b]	***M&M***: Low-High[d] (Low-High)[d] ***Soil***: ND-High (ND-Low)	***Preferred method***: High (Low) ***Alternative***: High (Low)
	Co-located Person[b]	***M&M***: Low-Moderate (Low) ***Soil***: ND (ND)	***Preferred method***: Low-Moderate (Low) ***Alternative***: Low-Moderate (Low)
	Public[b]	***M&M***: Low (Low) ***Soil***: ND (ND)	***Preferred method***: Low (Low) ***Alternative***: Low (Low)
Environmental	Groundwater (A&B) from vadose zone[c]	Low – All PCs[f] **Overall**: Low	Low – All PCs[f] **Overall**: Low
	Columbia River from vadose zone[c]	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[e]	ND to Low	Low to Medium
Social	Cultural Resources[e]	**Native American:** Direct: Unknown Indirect: Known **Historic Pre-Hanford:** Direct: Unknown Indirect: Unknown **Manhattan/Cold War:** Direct: Known Indirect: Unknown	**Native American:** Direct: Unknown Indirect: Known **Historic Pre-Hanford:** Direct: Unknown Indirect: Unknown **Manhattan/Cold War:** Direct: Known Indirect: Unknown

a. A rating for cultural resources is not being made because cultural resources will be evaluated under Section 106 of the National Historic Preservation Act (16 USC 470, et. seq.) during the planning for remedial action.

b. Evaluated in Section 1.6 (Appendix E.1).

c. Groundwater threat for Group A and B contaminants remaining in the vadose zone or to the Columbia River for all primary contaminants. Threats from existing plumes associated with the U

Tank and Waste Farms EU are described in Section 5.5 and Appendix G.6 (CP-GW-2) for the 200-UP-1 Groundwater Operable Unit.

d. Industrial safety consequences range from low to high (based on the evaluation scale used) for both mitigated (with controls) and unmitigated (without controls). Mitigated radiological and toxicological consequences to facility workers are high (unmitigated) and low (mitigated).

e. 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.

f. The large amount of Sr-90 disposed of in the U Tank and Waste Farms EU would translates to a *High* rating (based on GTM); however, there is no current Sr-90 plume in the 200-UP-1 OU and it would likely require more than 150 years to reach groundwater in a sufficient amount to exceed the drinking water standard over an appreciable area (Section 5.5). The uranium inventory would translate to a *Low* rating, but also is unexpected to reach groundwater in 150 years. Thus uranium and Sr-90 are not considered risk drivers for the U Tank and Waste Farms EU.

SUPPORT FOR RISK AND IMPACT RATINGS FOR EACH POPULATION OR RESOURCE

Human Health

The current and cleanup-related consequences related to work being conducted at the Tank Farms in the 200 Areas (Hanford Central Plateau) was evaluated in Section 1.6 (Appendix E.1).

Groundwater, Vadose Zone, and Columbia River

U Tank Farm contaminants are currently impacting groundwater, and treatment is not predicted to decrease concentrations to below thresholds before active cleanup commences. Secondary sources in the vadose also threaten to continue to impact groundwater in the future, including the Active Cleanup period, although all ratings are determined to be *Low*. As described in the TC&WM EIS (and summarized in Section 5.5), there appeared to be sufficiently large expected impacts from recharge rate on peak concentrations in the groundwater and near-shore region of the Columbia River during and after cleanup to modify ratings; however, the *Low* rating is maintained to help address uncertainties.

Ecological Resources

Current

There are some level 3 resources in EU (16%) and in buffer area (18%). People and trucks are present, which could lead to increases in exotic species and changes in species diversity in level 3 resource areas of EU and buffer.

Risks and Potential Impacts from Selected or Potential Cleanup Approaches

Potential for continual disturbance levels with increasing number of trucks – results may cause changes in abundance and diversity in level 3 resource areas.

Cultural Resources

Current

Manhattan Project/Cold War significant resources have already been mitigated. Area is very disturbed and there are no known recorded archaeological resources within the EU. Traditional cultural places are visible from EU.

Risks and Potential Impacts from Selected or Potential Cleanup Approaches

Because area has not been investigated either on the surface or subsurface, archaeological investigations may need to occur within pockets of undisturbed land if any prior to remediation. Potential for intact archaeological material to be present is very low.

Considerations for Timing of the Cleanup Actions

See Section 1.1 (Appendix E.1).

Near-Term, Post-Cleanup Risks and Potential Impacts

See Section 1.1 (Appendix E.1).

5.2. ADMINISTRATIVE INFORMATION

OU AND/OR TSDF DESIGNATION(S):

The U Tank and Waste Farms Evaluation Unit (EU), denoted *CP-TF-4 – U Tank Waste and Farms*, consists of 12 high-level waste (HLW) tanks, ancillary structures, associated liquid waste sites, and soils contamination; much of this EU is contained within Waste Management Area U (WMA U). Waste Management Area (WMA) U is regulated under the Resource Conservation and Recovery Act (RCRA) as modified in 40 CFR Part 265, Subpart F and Washington State's Hazardous Waste Management Act (HWMA, RCW 70.105 and its implementing requirements in the Washington State dangerous waste regulations [WAC 173-303-400]) (PNNL-13612).

COMMON NAME(S) FOR EU:

There is no common name for the U Tank and Waste Farms EU because the EU is comprised of elements from other waste management units including Waste Management Area U (WMA U) that includes the 241-U (or U) Tank Farm. The Tank Farm contains 16 waste tanks (U-101 through U-112 and U-201 through U-204). These tanks often are designated as 241-U-101 through 241-U-112 and 241-U-201 through 241-U-204 or 241-U-TK-101 through 241-U-TK-112 and 241-U-TK-201 through 241-U-TK-204. Other components in the EU (including associated legacy waste sites) are listed below in the *Primary EU Source Components* section.

KEY WORDS:

U Tank Farm, 241-U Tank Farm, waste tanks, tank farm, Waste Management Area U, WMA U

REGULATORY STATUS

Regulatory Basis

DOE is the responsible agency for the closure of all single-shell tank (SST) waste management areas (WMAs) through post closure, in close coordination with other closure and cleanup activities of the Hanford Central Plateau. Washington State has a program that is authorized under RCRA and implemented through the HWMA and its associated regulations; Ecology is the lead regulatory agency responsible for the closure of the SST system. Please refer to Section 1.2 (Appendix E.1) for more information.

Applicable Regulatory Documentation

The relationship among the tank waste retrieval work plans (TWRWP) and the overall single-shell tank (SST) waste retrieval and closure process is described in Appendix I of the Hanford Federal Facility Agreement and Consent Order (HFFACO), along with requirements for the content of TWRWPs. In 2000 WMA U was determined to have affected groundwater quality (PNNL-13282). A groundwater quality assessment plan was written (PNNL-13612) describing the monitoring activities used in deciding whether WMA U has affected groundwater.

Applicable Consent Decree or TPA Milestones

Federal Facility Agreement and Consent Order, 1989 and amended through June 16, 2014: Milestone M-045-00; Lead Agency Ecology: *Complete the closure of all Single Shell Tank Farms by 01/31/2043*

Risk Review Evaluation Information

Completed: Revised August 26, 2015

Evaluated by: K. G. Brown

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

5.3. SUMMARY DESCRIPTION

Current land use

DOE Hanford Site for industrial use. All current land-use activities in the 200-West 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-West Area (of which U Tank and Waste Farms EU is a part) 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: The legacy source sites associated with the U Tank and Waste Farms EU are enumerated in Attachment Section 5.8. To summarize, four unplanned releases have been documented in or near WMA U with unknown waste volumes (PNNL-13282).

High-Level Waste Tanks and Ancillary Equipment: The 16 waste tanks in the T Tank and Waste Farms EU are:

- (241-)U-101 (241-U-TK-101)
- (241-)U-102 (241-U-TK-102)
- (241-)U-103 (241-U-TK-103)
- (241-)U-104 (241-U-TK-104)
- (241-)U-105 (241-U-TK-105)
- (241-)U-106 (241-U-TK-106)
- (241-)U-107 (241-U-TK-107)
- (241-)U-109 (241-U-TK-109)
- (241-)U-110 (241-U-TK-110)
- (241-)U-111 (241-U-TK-111)
- (241-)U-112 (241-U-TK-112)
- (241-)U-201 (241-U-TK-201)
- (241-)U-202 (241-U-TK-202)
- (241-)U-203 (241-U-TK-203)

- (241-)U-108 (241-U-TK-108)
- (241-)U-204 (241-U-TK-204)

The ancillary equipment included in the U Tank and Waste Farms EU is listed in Attachment Section 5.8 and consists of pipelines, diversion boxes, and catch tanks.

Groundwater Plumes:

The U Tank and Waste Farms EU is in the 200-UP-1 Operable Unit (OU). The current 200-UP-1 OU plumes associated with the U Tank and Waste Farms EU that exceed water quality standards are nitrate and Tc-99 (DOE/RL-2014-32, Rev. 0). There are current plumes in the 200-UP-1 OU for carbon tetrachloride, chromium, tritium, I-129, and uranium; however, these plumes are not associated with the U Tank and Waste Farms EU. An interim remedial action P&T system operated in 1985 to remove uranium from the 216-U-1 and 216-U-2 cribs and a pilot-scale treatability test (using P&T) was operated adjacent to the 216-U-17 crib in 1995-97. An interim action groundwater extraction and treatment system was operated from 1997-2012 to treat uranium and Tc-99 (and secondary contaminants). The final ROD for the 200-UP-1 OU will be pursued when future groundwater impacts are adequately understood and potential technologies to treat I-129 are completed (EPA 2012).

See Appendix G.6 for the CP-GW-2 EU (and 200-UP-1 OU) for additional details.

Operating Facilities: Because of the prohibition on waste additions to the Hanford SSTs,[69] the U Tank and Waste Farms EU components are not considered Operating Facilities for this review. See Section 1.4 (Appendix E.1) for details.

D&D of Inactive Facilities: Not Applicable.

Location and Layout Maps

A series of maps are used to illustrate the location of the components within the CP-TF-4 EU and the U Tank and Waste Farms EU relative to the Hanford Site. Figure E.2-1 shows the relationship between the 200-W (200 West) Area (where the U Tank Farm and Waste management Area U are located) and the Hanford Site. Figure E.5-1 illustrates the U Tank and Waste Farms EU boundary. Figure E.5-2 shows a detailed view of the waste tanks, ancillary equipment, and legacy source units in the U Tank and Waste Farms EU.

[69] Berman presentation on July 29, 2009, titled “Hanford Single-Shell Tank Integrity Program.” Available at www.em.doe.gov.

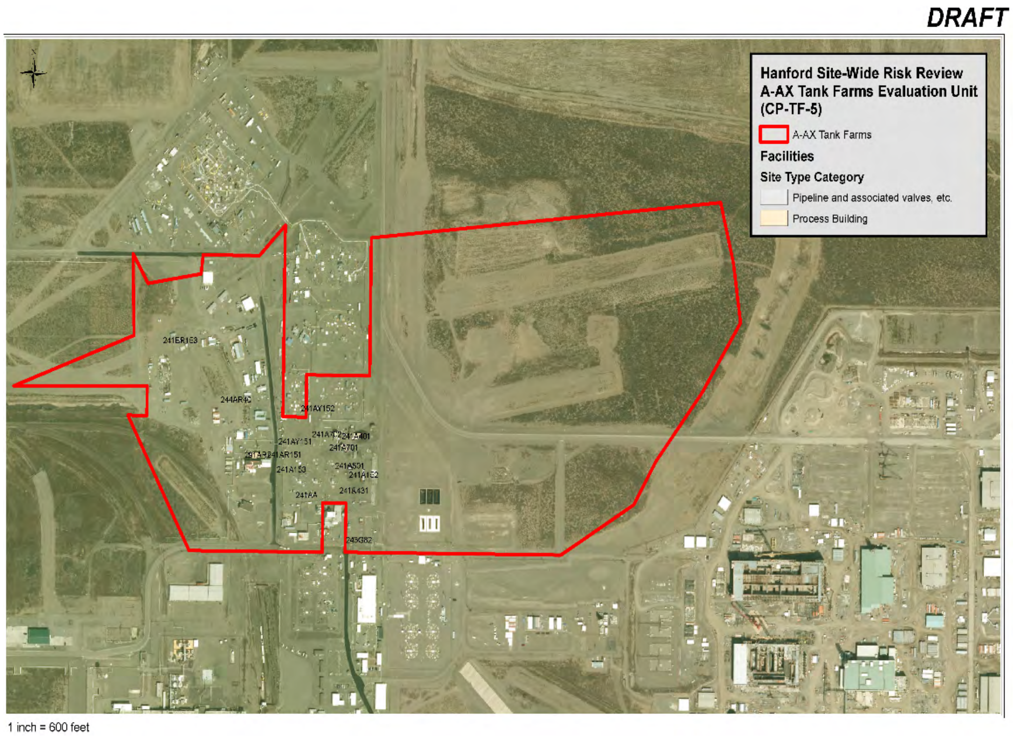

Figure E.5-1. Polygon representing the boundary of the U TF Evaluation Unit (Attachment Section 5.8).

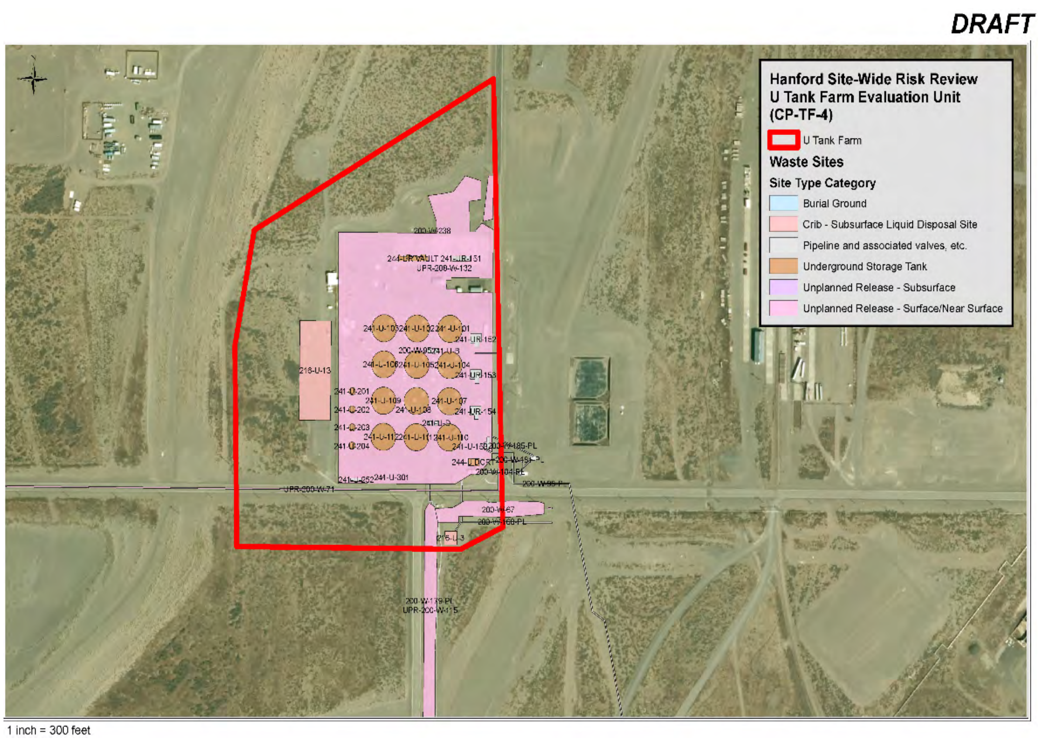

Figure E.5-2. Hanford U Tank and Waste Farms Evaluation Unit including tanks, legacy source units, and ancillary equipment (Attachment Section 5.8).

5.4. UNIT DESCRIPTION AND HISTORY

EU Former / Current Uses

Waste Management Area U (WMA U) occupies approximately 30,000 m^2 and contains 16 underground single-shell tanks (SSTs) in the U Tank Farm in additional to ancillary equipment (e.g., diversion boxes, pumps, valves, and pipes). The U Tank Farm contains 12 carbon steel tanks (U-101 through U-112) with capacities of 533 kgal and four smaller (55 kgal) tanks (U-201 through U-204). The U Tank Farm was constructed in 1943-44 (PNNL-13612, p. 4) and were in operation essentially continually from 1946 to 1980 (PNNL-13282, p. 2.1). The U Tank Farm tanks began receiving metal waste from the bismuth phosphate process in B and T Plants; most of the metal waste was later removed and recycled through U Plant to remove uranium. REDOX wastes and other wastes were then received and transferred among the tanks and other Tank Farms resulting in a complex intermingling of tank wastes; natural processes resulted in settling, stratification, and segregation of waste components. The SSTs in WMA U have been interim stabilized (i.e., liquid transferred to DSTs to <50 kgal drainable interstitial liquid and <5 kgal of supernatant); the tanks are currently awaiting retrieval and closure.

Legacy Source Sites

Waste was cascaded among the WMA U waste tanks; however, it appears none was intentionally released to cribs or ditches in the area. Trenches located west of WMA U received waste (primarily carbon tetrachloride and nitrate) from the Plutonium Finishing Plant and not from the U Tank Farm. Thus the contamination in the legacy source sites (in this case, near-tank soil) associated with the U Tank and Waste Farms EU comes from unintentional discharges of U Tank Farm wastes.

Four unplanned releases have been documented in or near WMA U with unknown waste volumes. Three unplanned releases may have significant impacts are beta contamination in diversion boxes east of WMA U, a “violent chemical reaction” in a vault that spread first-cycle metal waste contaminants over an unspecified area, and a ruptured waste line at tank U-103 (PNNL-13282, p. 2.3).

From historic monitoring activities, there are four “assumed” leakers[70] (U-101, U-104, U-110, and U-112) in the U Tank Farm with leaks that range from 5000-8100 gallons (U-110 in 1975) to 55,000 gallons (U-104 in 1961) (Weyn 2014).

High-Level Waste Tanks

See Section 5.5 for details.

Groundwater Plumes

The groundwater plumes (Tc-99 and nitrate) considered to be associated with the U Tank Farm and co-located liquid waste disposal facilities are described in Section 5.5 with additional information in Appendix G.6 for the CP-GW-2 EU (200-UP-1 GW OU).

[70] Tanks that are either known or suspected of leaking at any time (including the present) are denoted “assumed leakers” (Weyns 2014).

D&D OF INACTIVE FACILITIES – NOT APPLICABLE

OPERATING FACILITIES – NOT APPLICABLE

Because of the prohibition on waste additions to the Hanford SSTs,[71] the U Tank and Waste Farms EU components are not considered Operating Facilities for this Review.

ECOLOGICAL RESOURCES SETTING

Landscape Evaluation and Resource Classification:

Approximately 63% of the EU consists of level 0 habitat with graveled and bare surface conditions (Appendix J, Table 2, p. J-96). Small areas of level 2 (3.6 acres) and level 3 habitat resources (3.5 acres) exist around the perimeter of the EU and are part of larger patches of habitat that extend into the adjacent landscape buffer area as seen in (Appendix J, Figure 12, p. J-96).

The amount and proximity of the biological resources to the EU was examined within the adjacent landscape buffer area radiating approximately 459 m from the geometric center of the EU (equivalent to 163.3 acres). About half of the combined total area (EU and adjacent landscape buffer area) is classified as level 0 or 1 habitat, with level 2 habitat resources comprising 32.6% and level 3 and above resources comprising 16.5% of the area at the landscape level.

Field Survey:

The fenced portion of the U Tank Farm consists of graveled surfaces and tank farm infrastructure. Some level 2 habitat resources remain at the perimeters of the EU outside the fenced area. Pedestrian surveys of the habitat areas were conducted, and the canopy cover of dominant vegetation was estimated visually (Appendix J, Table 1, p. J-95).

Based on the field surveys, two small patches of habitat within the EU were re-classified from level 2 to level 3 because the understory was primarily native bunchgrasses with a mix of climax and successional species in the shrub layer.

Wildlife observations made during the October survey within the habitat along the borders of the EU included coyote tracks (*Canis latrans*), small mammal burrows, and harvester ant hills. These observations agreed with sign noted in previous PNNL ECAP surveys of habitat within and around the EU. Those surveys also identified side-blotch lizard (*Uta stansburiana*), northern pocket gopher (*Thomomys talpoides*), lark sparrow (*Chondestes grammacus*), western kingbird Tyrannus verticalis), Say's phoebe (*Sayornis saya*), American kestrel (*Falco sparverius*), western meadowlark (*Sturnella neglecta*), and mourning dove (*Zenaida macroura*).

CULTURAL RESOURCES SETTING

Cultural resources that are located in the U Tank and Waste Farms EU are limited to the National Register-eligible 244UR Waste Disposal Vault a contributing property within the Manhattan Project and Cold War Era. All documentation has been addressed as described in the *Hanford Site Manhattan Project and Cold War Era Historic District Treatment Plan* (DOE/RL-97-56). None of the U Tank and Waste Farms EU has been inventoried for archaeological resources. Closure and remediation of the tank farms located within the 200-West DSTs has been addressed in an NHPA Section 106 review completed. There is a possibility that intact archaeological material is present in the areas that have not been

[71] Berman presentation on July 29, 2009, titled "Hanford Single-Shell Tank Integrity Program." Available at www.em.doe.gov.

inventoried for archaeological resources (both on the surface and in the subsurface), particularly if undisturbed soil deposits exist within U Tank and Waste Farms EU.

Three National Register-eligible properties associated with the Manhattan Project/Cold War Era Landscape (Hanford Site Plant Railroad with documentation required and the 2727WA Sodium Storage Building and the 2727W also a Sodium Storage Building both with no documentation required are located within 500 meters of the U Tank and Waste Farms EU. All three have also been documented as described in the *Hanford Site Manhattan Project and Cold War Era Historic District Treatment Plan* (DOE/RL-97-56).

Historic maps indicate that there is no evidence of historic settlement in the U Tank and Waste Farms EU. Geomorphology and extensive ground disturbance further indicate a low potential for the presence of intact archaeological sites associated with all three landscapes to be present subsurface within the U Tank and Waste Farms EU. Because none of the U Tank and Waste Farms EU has been investigated for archaeological sites and pockets of undisturbed soil may exist, it may be appropriate to conduct surface and subsurface archaeological investigations in these areas prior to initiating a remediation activity. 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 associated with these landscapes (e.g. East Benton Historical Society, the Franklin County Historical Society, Prosser Cemetery Association, the Reach and B-Reactor Museum Association) may need to occur. Indirect effects are always possible when TCPs are known to be located in the general vicinity. Consultation with Hanford Tribes may also 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.

5.5. WASTE AND CONTAMINATION INVENTORY

Table E.5-2 provides inventory estimates of the various source components associated with the U Tank and Waste Farms EU including tank wastes and ancillary equipment, legacy sources including leaks, cribs, trenches, unplanned releases (UPRs), vadose zone sources, saturated zone (plume) estimates, treatment amounts, and remaining vadose zone estimates (i.e., the difference of the vadose zone estimates and the saturated zone and treatment estimates)[72]. This information is further summarized in Figure E.5-3 through Figure E.5-11 before and after planned 99% retrieval[73].

For example, the major sources for Tc-99 and I-129 before retrieval are the U Tank Farm tanks with ancillary equipment being a distant second. The maximum groundwater threat metric (GTM) (Figure E.5-12)[74] is dominated by the U Tank Farm wastes before retrieval and by tank wastes, ancillary equipment, and past leaks after planned retrieval. After planned retrieval, ancillary equipment and past leaks dominate the U Tank and Waste Farms EU legacy sources for Tc-99 and I-129. This is also true for chromium, uranium, Sr-90, nitrate, Cs-137, and plutonium isotopes. For H-3 the cribs, ancillary equipment, and past leaks provide the majority of the legacy source.

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[72] The basis for the saturated and vadose zone estimates are provided in Chapter 6 of the Methodology Report (CRESP 2015) and examples are provided in the demonstration section for the 200-UP-1 Operable Unit. These estimates tend to have very high associated uncertainties.

[73] According to the Tri-Party Agreement (Ecology, EPA, and DOE, 1998), retrieval limits for residual wastes are 360 ft^3 and 30 ft^3 for 100-Series and 200-Series tanks, respectively, corresponding to the 99% waste retrieval goal as defined in TPA Milestone M-45-00.

[74] Maximum of the GTMs for Tc-99 and I-129 only.

CONTAMINATION WITHIN PRIMARY EU SOURCE COMPONENTS

Legacy Source Sites

The estimated U Tank Farm inventory for the Legacy / Vadose Zone Source Sites (i.e., cribs, trenches, and soil contaminated by tank leaks and unplanned releases) is summarized in Table E.5-2 and further described in Figure E.5-3 through Figure E.5-11 before and after planned 99% retrieval (which will have no impact on the current legacy source site inventories). These values constitute estimates of the initial amounts of contaminants discharged to the vadose zone that are then used to estimate the remaining inventory in the vadose zone as described below (i.e., by difference using the process described in Chapter 6 of the Methodology Report (CRESP 2015)). These estimates necessarily have large associated uncertainties.

Waste Tanks and Ancillary Equipment

The estimated total inventory for all the U Tank Farm High Level Waste Tanks and Ancillary Equipment is provided in Table E.5-2 for both the 90% and planned 99% retrieval scenarios. The tank-by-tank inventories are provided in Table E.5-3 through Table E.5-6. Safety-related information (i.e., hydrogen generation rates and times to the lower flammability limit are also provided in Table E.5-3. The inventories for the various contaminant in the U Tank Farm tanks vary over several orders of magnitude as does the GTM. This information is further summarized in Figure E.5-3 through Figure E.5-11 before and after planned 99% retrieval and for the maximum GTM in Figure E.5-12.

Vadose Zone Contamination

The estimated inventories for the vadose zone, saturated zone, and treatment amounts are found in Table E.5-7. These inventories represent the vadose zone contamination *outside* the tanks and ancillary equipment (i.e., that are generally available for transport through the environment). These are used to estimate the inventory remaining in the vadose zone using the process described in Chapter 6 of the Methodology Report (CREESP 2015). The focus in this section will be on the Group A and B contaminants in the vadose zone due to their mobility and persistence and potential threats to groundwater. To summarize (where current 200-UP-1 plumes for carbon tetrachloride, chromium, I-129, and uranium are not associated with U Tank and Waste Farms EU waste sites):

- *Tc-99, I-129, Chromium, Uranium* – There are numerous, current plumes; however, only the Tc-99 (and nitrate) plumes are associated with U Tank and Waste Farms EU sources. The vadose zone inventory is dominated by ancillary equipment and past leaks.
- *Sr-90* – There is no current plume for Sr-90. The vadose zone inventory is dominated by ancillary equipment and past leaks. Thus the majority of the Sr-90 originally discharged into the vadose zone would have had to travel through much of the vadose zone to impact groundwater. Using an analysis similar to that in Section 2.5 for Sr-90 in the WMA T (200-West), a Sr-90 plume is not expected in the next 150 years due to retardation in the vadose zone or afterwards due to radioactive decay (+99.9% reduction in Sr-90 inventory). A similar case was made in Section 2.5 for uranium. Thus Sr-90 and uranium are not considered significant threats to the Hanford groundwater during the first 150 years.

Using the process outlined in Chapter 6 of the Methodology Report (CRESP 2015), the vadose zone inventories in Table E.5-2 are estimated by difference and used to calculate Groundwater Threat Metric (GTM) values for the Group A and B contaminants remaining in the vadose zone as illustrated in Table E.5-7. Note that the vadose zone (VZ) ratings are *ND* for uranium and Sr-90 (where the inventory for Sr-90 would have translated to a *High* rating all other things being equal) and *Low* for the other primary contaminants (i.e., C-14, Tc-99, I-129, and total and hexavalent chromium). Thus the overall rating is *Low*.

Groundwater Plumes

In general groundwater plumes are evaluated in separate EUs; however, those portions of groundwater plumes that can be associated with the TF EU (i.e., a plume with sources associated with the TF EU) will be evaluated to provide a better idea of the saturated zone versus remaining vadose zone threats to groundwater. The estimated inventory for the saturated zone contamination is provided in Table E.5-2 where Photoshop was used to estimate the fraction of the plumes considered associated with the U Tank and Waste Farms EU (Attachment 6-4 in the Methodology Report (CRESP 2015)[75]). This information is also used to estimate amounts treated and remaining in the vadose zone. For the groundwater plumes described in the 200-UP-1 OU (DOE/RL-2014-32, Rev. 0), apportionment of plumes and ratings to the U Tank and Waste Farms EU would be as follows:

- Uranium -- There is a plume in the OU, but no major sources related to the Tank and Waste Farms EUs; thus there is no portion of the uranium plume considered associated with the U Tank and Waste Farms EU.
- *Nitrate* – There are plumes in the OU; the single plume near the U Tank and Waste Farms EU is considered associated with the EU, and the area of this plume is 5% of the area of the plumes (CRESP 2015).
- *Chromium* – There are plumes in the OU; however, the plumes (including the one near the U Tank and Waste Farms EU) are not considered associated with the U Tank and Waste Farms EU.
- *H-3* – There are plumes in the OU, but no major sources related to the waste tanks; thus there is no portion of the H-3 plume considered associated with the EU.
- *Tc-99* – There are plumes in the OU; the single plume near the U Tank and Waste Farms EU is considered associated with the EU, and the area of this plume is 7% of the area (CRESP 2015).
- *I-129* – There are plumes in the OU; however, the plumes in the 200-UP-1 OU originated from U Plant and REDOX Plant waste sites and thus no portion of the I-129 plume considered associated with the U Tank and Waste Farms EU.
- *Carbon tetrachloride* – The carbon tetrachloride plume is managed in the 200-ZP-1 OU (Appendix G.6). Furthermore, there are no sources of carbon tetrachloride related to this EU.

The groundwater plumes (e.g., Tc-99 and nitrate) associated with the U Tank Farm and co-located liquid waste disposal facilities are described in detail in the Appendix G.6 for the CP-GW-2 EU (200-UP-1 OU). Note that nitrate, chromium (total and hexavalent), and I-129 (*Medium*) are the risk drivers for the 200-UP-1 GW OU; however, there are no *major* U TF EU sources associated with these plumes (i.e., less than 7% of the total plume areas), and the remaining vadose zone sources would drive the risks associated with the U TF EU.

Impact of Recharge Rate and Radioactive Decay on Groundwater Ratings

The TC&WM EIS screening groundwater transport analysis (Appendix O, DOE/EIS-0391 2012) indicates that there is a significant impact of emplacing the engineered surface barrier (and resulting reduction of

[75] From the graphic map files provided by PNNL, the PhotoShop Magic Wand Tool was used to select areas representing plumes and then the “Record Measurements” Tool was used to provide relative areal extents. A Custom Measurement Scale was set to that of the map.

infiltrating water) on the predicted peak groundwater concentrations at the U Barrier[76]. To summarize, the results for Central Plateau sources including those in addition to the U Tank and Waste Farms EU (Appendix O, DOE/EIS-0391 2012) include:

- Tc-99 peak concentration is 9830 pCi/L (CY 3985) for the No Action Alternative versus 259 pCi/L (CY 3296) for the Landfill Scenarios where the threshold value is 900 pCi/L.
- Nitrate peak concentrations were all lower than the standard for both the No Action and Landfill Scenarios.
- No values are reported at the U Barrier for uranium, Sr-90, or various other contaminants for either scenario, which indicates that the appropriate sources were not considered in the analysis, or peak fluxes that were less than 1×10^{-8} Ci/yr for radioactive contaminants, or 1×10^{-8} g/yr for chemical contaminants (Appendix O, DOE/EIS-0391 2012, p. O-2).

The predicted peak concentrations at the U Barrier for the Landfill Scenarios remain below threshold values during the TC&WM EIS evaluation period (10,000 years) and thus the saturated zone ratings for the Active and Near-term Post-Cleanup periods would be *Not Discernible* or *Low* for this period (where the *Low* rating was maintained to account for uncertainty)[77].

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. Since the U and S-SX Tank and Waste Farms EUs are proximate (200-W) and share the 200-UP-1 OU, the results for potential impacts to the Columbia River for the U Tank and Waste Farms EU are the same for the S-SX Tank and Waste Farms EU.

Benthic and Riparian Zone – Current Impacts

As described in in Section 3.5, current impacts from the S-SX and U Tank and Waste Farms EUs to the Columbia River benthic and riparian ecology would be rated as *Not Discernible*.

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

Based on a very similar analysis to that in Section 3.5 for CP-TF-2 (S-SX Tank and Waste Farms EU also in 200-West), the impacts to the Columbia River benthic and riparian ecology for the Active Cleanup and Near-term, Post Cleanup periods are also rated as *Not Discernible*.

Benthic and Riparian Zone – Long-term

As described in Section 3.5, there should be no expected adverse effects from radionuclides for Columbia River benthic and riparian receptors over the time period evaluated (10,000 years).

Only chromium and nitrate would be predicted to exceed relevant thresholds (WM&TC EIS). However, the screening results indicate that future nitrate peak concentration (and discharge) appear to not exceed either the drinking water standard or ambient water quality criterion in the next 10,000 years.

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[76] The 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). The U Barrier is the closest to the U Tank and Waste Farms EU. Despite including sources other than those for the U Tank and Waste Farms EU, the analysis in the TC&WM EIS was considered a reasonable source of information to assess the impact of the engineered surface barrier emplacement.

[77] Analyses specific to each Tank Farm or Central Plateau EU are not available; thus the aggregate screening analysis provided in the TC&WM EIS was used as an indication.

Furthermore, any chromium predicted to reach the Columbia River from U Tank Farm sources would likely lead to insignificant long-term impacts to the benthic and riparian ecology.

Threats to the Columbia River Free-flowing Ecology

As described in Section 2.5, 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 alternatives evaluation in the TC&WM EIS suggests that remedial actions (e.g., surface barrier emplacement that would decrease recharge in the areas near the Tank Farms) would appear to have significant impacts on the predicted long-term peak concentrations in the near-shore area (benthic and riparian receptors) of the Columbia River. However, this would not alter the ratings for this time period since they are already *Not Discernible* (ND).

Facilities for D&D – Not Applicable

Operating Facilities – Not Applicable

Because of the prohibition on waste additions to the Hanford SSTs,[78] the U Tank and Waste Farms EU components are not considered Operating Facilities for this Review.

[78] Berman presentation on July 29, 2009, titled "Hanford Single-Shell Tank Integrity Program." Available at www.em.doe.gov.

Table E.5-2. Summary Table of Infrastructure and Subsurface Contamination Inventory for the U Tank and Waste Farms Evaluation Unit (CP-TF-4) [(a)(b)]

Contaminated Media	Primary Contaminants	Total Amount. of Each Contaminant Before Retrieval	90% Retrieval Scenario	99% Retrieval Scenario
Infrastructure (Tanks and Ancillary Equipment)				
Tank Waste	Waste (kGal)	2930	293	29.3
	Sludge (kGal)	499	49.9	4.99
	Saltcake (kGal)	2423	242.3	24.23
	Supernatant (kGal)	8	0.8	0.08
Tank Waste (rad)	Am-241 (Ci)	2700	270	27
	C-14 (Ci)	46	4.6	0.46
	Co-60 (Ci)	130	13	1.3
	Cs-137 (Ci)	1800000	180000	18000
	Eu-152 (Ci)	18	1.8	0.18
	Eu-154 (Ci)	1700	170	17
	H-3 (Ci)	190	19	1.9
	I-129 (Ci)	1.6	0.16	0.016
	Ni-59 (Ci)	45	4.5	0.45
	Ni-63 (Ci)	4100	410	41
	Pu (total) (Ci)	4200	420	42
	Sr-90 (Ci)	630000	63000	6300
	Tc-99 (Ci)	1700	170	17
	U (total) (Ci)	33	3.3	0.33
Tank Waste (non-rad)	Cr (kg)	49000	4900	490
	Hg (kg)	28	2.8	0.28
	NO3 (kg)	4300000	430000	43000
	Pb (kg)	5800	580	58
	U (total) (kg)	41000	4100	410

Contaminated Media	Primary Contaminants	Total Amount. of Each Contaminant Before Retrieval	90% Retrieval Scenario	99% Retrieval Scenario
Ancillary Equipment (rad)	C-14 (Ci)	2.8	2.8	2.8
	Cs-137 (Ci)	18000	18000	18000
	H-3 (Ci)	11	11	11
	I-129 (Ci)	0.036	0.036	0.036
	Pu (total) (Ci)	30	30	30
	Sr-90 (Ci)	7000	7000	7000
	Tc-99 (Ci)	19	19	19
	U (total) (Ci)	0.3	0.3	0.3
Ancillary Equipment (non-rad)	Cr (kg)	400	400	400
	Hg (kg)	0.2	0.2	0.2
	NO3 (kg)	42000	42000	42000
	Pb (kg)	84	84	84
	U (total) (kg)	380	380	380
Vadose Zone Source (Leaks and Intentional Discharges into Cribs and Trenches)				
Leaks (rad)	C-14 (Ci)	0.16	0.16	0.16
	Cs-137 (Ci)	8600	8600	8600
	H-3 (Ci)	6.4	6.4	6.4
	I-129 (Ci)	0.0045	0.0045	0.0045
	Pu (total) (Ci)	1.4	1.4	1.4
	Sr-90 (Ci)	580	580	580
	Tc-99 (Ci)	3.6	3.6	3.6
	U (total) (Ci)	0.12	0.12	0.12
Leaks (non-rad)	Cr (kg)	160	160	160
	Hg (kg)	0.072	0.072	0.072
	NO3 (kg)	12000	12000	12000
	Pb (kg)	0.84	0.84	0.84
	U (total) (kg)	180	180	180

Contaminated Media	Primary Contaminants	Total Amount. of Each Contaminant Before Retrieval	90% Retrieval Scenario	99% Retrieval Scenario
Cribs (rad)	Co-60 (Ci)	6.40E-07	6.40E-07	6.40E-07
	Cs-137 (Ci)	3.40E-07	3.40E-07	3.40E-07
	H-3 (Ci)	23	23	23
	Pu (total) (Ci)	0.00078	0.00078	0.00078
	Sr-90 (Ci)	1.40E-07	1.40E-07	1.40E-07
	Tc-99 (Ci)	0.00059	0.00059	0.00059
	U (total) (Ci)	0.012	0.012	0.012
Cribs (non-rad)	Cr (kg)	0.39	0.39	0.39
	Hg (kg)	0.016	0.016	0.016
	NO3 (kg)	310	310	310
	Pb (kg)	0.0041	0.0041	0.0041
	U (total) (kg)	17	17	17
Trenches (rad)	Am-241 (Ci)	2.70E-06	2.70E-06	2.70E-06
	C-14 (Ci)	1.10E-06	1.10E-06	1.10E-06
	Co-60 (Ci)	3.80E-07	3.80E-07	3.80E-07
	Cs-137 (Ci)	0.017	0.017	0.017
	Eu-152 (Ci)	2.70E-08	2.70E-08	2.70E-08
	Eu-154 (Ci)	2.10E-06	2.10E-06	2.10E-06
	H-3 (Ci)	1.80E-05	1.80E-05	1.80E-05
	I-129 (Ci)	7.70E-09	7.70E-09	7.70E-09
	Ni-59 (Ci)	1.00E-07	1.00E-07	1.00E-07
	Ni-63 (Ci)	9.30E-06	9.30E-06	9.30E-06
	Pu (total) (Ci)	2.50E-05	2.50E-05	2.50E-05
	Sr-90 (Ci)	0.17	0.17	0.17
	Tc-99 (Ci)	7.50E-06	7.50E-06	7.50E-06
	U (total) (Ci)	0.00037	0.00037	0.00037
Trenches (non-rad)	Cr (kg)	4.7	4.7	4.7

Contaminated Media	Primary Contaminants	Total Amount. of Each Contaminant Before Retrieval	90% Retrieval Scenario	99% Retrieval Scenario
	NO3 (kg)	110	110	110
	U (total) (kg)	0.54	0.54	0.54
UPR (rad)	Am-241 (Ci)	0.0089	0.0089	0.0089
	C-14 (Ci)	0.00086	0.00086	0.00086
	Co-60 (Ci)	0.00093	0.00093	0.00093
	Cs-137 (Ci)	52	52	52
	Eu-152 (Ci)	8.00E-05	8.00E-05	8.00E-05
	Eu-154 (Ci)	0.0059	0.0059	0.0059
	H-3 (Ci)	0.051	0.051	0.051
	I-129 (Ci)	2.50E-05	2.50E-05	2.50E-05
	Ni-59 (Ci)	0.00027	0.00027	0.00027
	Ni-63 (Ci)	0.024	0.024	0.024
	Pu (total) (Ci)	0.015	0.015	0.015
	Sr-90 (Ci)	5	5	5
	Tc-99 (Ci)	0.023	0.023	0.023
	U (total) (Ci)	0.0013	0.0013	0.0013
UPR (non-rad)	Cr (kg)	0.38	0.38	0.38
	Hg (kg)	0.00061	0.00061	0.00061
	NO3 (kg)	23	23	23
	U (total) (kg)	1.9	1.9	1.9
Vadose Zone (from Vadose Zone Sources)				
VZ Remaining (rad)	Am-241 (Ci)	0.0089	0.0089	0.0089
	C-14 (Ci)	0.16	0.16	0.16
	Co-60 (Ci)	0.00093	0.00093	0.00093
	Cs-137 (Ci)	8600	8600	8600
	Eu-152 (Ci)	8.00E-05	8.00E-05	8.00E-05
	Eu-154 (Ci)	0.0059	0.0059	0.0059

Contaminated Media	Primary Contaminants	Total Amount. of Each Contaminant Before Retrieval	90% Retrieval Scenario	99% Retrieval Scenario
	H-3 (Ci)	29	29	29
	I-129 (Ci)	0.0045	0.0045	0.0045
	Ni-59 (Ci)	0.00027	0.00027	0.00027
	Ni-63 (Ci)	0.024	0.024	0.024
	Pu (total) (Ci)	1.4	1.4	1.4
	Sr-90 (Ci)	580	580	580
	Tc-99 (Ci)	2.8	2.8	2.8
	U (total) (Ci)	0.14	0.14	0.14
VZ Remaining (non-rad)	Cr (kg)	170[c]	170[c]	170[c]
	Cr-VI (kg)	170[c]	170[c]	170[c]
	Hg (kg)	0.088	0.088	0.088
	NO3 (kg)	0[d]	0[d]	0[d]
	Pb (kg)	0.85	0.85	0.85
	U (total) (kg)	200	200	200
VZ Treatment (rad)	Tc-99 (Ci)	0.23	0.23	0.23
VZ Treatment (non-rad)	NO3 (kg)	2800	2800	2800
Saturated Zone (from Vadose Zone Sources)				
SZ Inventory (rad)	Tc-99 (Ci)	0.6	0.6	0.6
SZ Inventory (non-rad)	NO3 (kg)	180000	180000	180000

a. Tanks (SST and DST): Best Basis Inventory (BBI) March 2014; Ancillary Equipment (Anc Eq): Tank Farm Closure & Waste Management (TC&WM) Environmental Impact Statement (DOE/EIS-0391) Appendix D; Unplanned Releases (UPRs): Soil Inventory Model (SIM) Rev 1 (RPP-26744, Rev 0); Ponds: Soil Inventory Model (SIM) Rev 1 (RPP-26744, Rev 0); Cribs: Soil Inventory Model (SIM) Rev 1 (RPP-26744, Rev 0); Trenches: Soil Inventory Model (SIM) Rev 1 (RPP-26744, Rev 0) and Tank Farm Closure & Waste Management (TC&WM) Environmental Impact Statement (DOE/EIS-0391) Appendix S; Leaks: Tank Farm Closure & Waste Management (TC&WM) Environmental Impact Statement (DOE/EIS-0391) Appendix D; MUSTs: Soil Inventory Model (SIM) Rev 1 (RPP-26744, Rev 0) and Tank Farm Closure & Waste Management (TC&WM) Environmental Impact Statement (DOE/EIS-0391) Appendix S.

b. All primary contaminant inventories are reported to 2 significant figures. The source document should be consulted for greater precision data.

c. Differences in inventories for Cr vs Cr-IV are due to differing Water Quality Standards (WQS) and thus plume extents: 100 mg/L for total chromium vs 48 mg/L for chromium (IV). The difference is not distinguishable within the number of significant digits (2) displayed.

d. The value obtained by difference was negative.

Table E.5-3. Current Bulk Inventory and Steady State Flammability Results (by Tank) for the U Tank Farm (CP-TF-4)

Tank ID	Tank Type	Capacity (kGal)[a]	Sludge (kGal)[a]	Saltcake (kGal)[a]	Supernatant (kGal)[a]	HGR(c) (ft3/d)[b]	Days to 25% LFL Barometric[c]	Days to 25% LFL Zero Ventilation[d]
U-101	SST	530	23	0	0	0.39	NA	>1826
U-102	SST	530	43	283	1	1.1	NA	574
U-103	SST	530	11	405	1	1.3	NA	335
U-104	SST	530	54	0	0	0.4	NA	>1826
U-105	SST	530	32	321	0	1	NA	570
U-106	SST	530	0	168	2	1	NA	833
U-107	SST	530	15	279	0	0.64	NA	1075
U-108	SST	530	29	405	0	1	NA	493
U-109	SST	530	35	366	0	0.78	NA	626
U-110	SST	530	176	0	0	0.65	NA	1282
U-111	SST	530	26	196	0	0.6	NA	1304
U-112	SST	530	45	0	0	0.41	NA	>1826
U-201	SST	55	3	0	1	0.031	NA	>1826
U-202	SST	55	3	0	1	0.031	NA	>1826
U-203	SST	55	2	0	1	0.03	NA	>1826
U-204	SST	55	2	0	1	0.073	NA	951

a. Volumes from the Waste Tank Summary Report coinciding with the BBI (Rodgers 2014).

b. Hydrogen generation rate (ft^3/d) (RPP-5926 Rev. 15). Note in 2001 all 24 tanks were removed from the flammable gas watch list (including T-110 in the T Tank and Waste Farms EU) (Johnson, et al. 2001, p. iii).

c. Time (in days) to 25% of the Lower Flammability Limit (LFL) under a barometric (barom) breathing scenario (RPP-5926, Rev. 15). “NA” indicates that the headspace will not reach specified flammability level.

d. Time (in days) to 25% of the LFL under a zero ventilation scenario (RPP-5926, Rev. 15).

Table E.5-4. Current Primary Contaminant Inventory (by Tank) for the U Tank Farm (CP-TF-4) [(a)]

Tank ID	Decay Date	Am-241 (Ci)	C-14 (Ci)	Cl-36 (Ci)	Co-60 (Ci)	Cs-137 (Ci)	Eu-152 (Ci)	Eu-154 (Ci)	H-3 (Ci)
U-101	2001	3.2	0.11	NP[(b)]	0.059	8000	0.015	0.84	1.4
U-102	2001	240	4.4	NP	17	270000	2.2	130	20
U-103	2001	200	6.5	NP	13	240000	2.2	130	19
U-104	2001	0.29	0.03	NP	0.00011	46	0.0019	0.11	1.1
U-105	2001	810	6.7	NP	22	280000	4.1	550	31
U-106	2001	680	2.2	NP	34	130000	0.42	440	6.2
U-107	2001	420	6.5	NP	5.5	130000	0.64	39	24
U-108	2001	95	8.1	NP	24	310000	3.3	74	38
U-109	2001	53	7	NP	8.1	230000	2.9	180	29
U-110	2001	84	0.34	NP	0.85	19000	0.061	3.4	0.74
U-111	2001	150	3.8	NP	7.3	160000	1.8	110	11
U-112	2001	1	0.14	NP	0.24	8200	0.013	0.73	6.4
U-201	2001	0.03	0.0084	NP	0.051	180	3.20E-05	0.0017	1.4
U-202	2001	0.029	0.0053	NP	0.026	130	2.90E-05	0.0016	1.3
U-203	2001	0.022	0.005	NP	0.021	120	2.60E-05	0.0014	1.1
U-204	2001	0.23	0.0035	NP	0.019	72	1.60E-05	0.00086	0.7

a. From Best Basis Inventory (BBI) Summary (March 24, 2014) provided in spreadsheet form by Mark Triplett. All primary contaminant inventories are reported to 2 significant figures. The source document should be consulted for greater precision data.

b. NP = Not present at significant quantities

Table E.5-5. Current Primary Contaminant Inventory [a] and Groundwater Threat Metric (by Tank) for the U Tank Farm (CP-TF-4)

Tank ID	I-129 (Ci)	Ni-59 (Ci)	Ni-63 (Ci)	Pu (total) (Ci)[b]	Sr-90 (Ci)	Tc-99 (Ci)	U (total) (Ci)[c]	GTM (Mm3)[d]
U-101	0.0031	0.52	45	11	52000	1.9	0.46	2.1
U-102	0.17	11	960	470	160000	160	1.9	180
U-103	0.22	6	550	230	50000	230	1.4	260
U-104	0.00083	0.0087	0.73	1.5	530	0.73	1.8	0.81
U-105	0.24	5.2	470	1300	23000	240	10	270
U-106	0.1	2.7	250	480	54000	110	0.71	120
U-107	0.23	2.4	220	660	3700	240	0.79	260
U-108	0.27	7	640	410	19000	280	3.3	310
U-109	0.24	5.2	470	58	14000	250	0.42	270
U-110	0.013	2.4	210	330	170000	11	10	12
U-111	0.14	2.5	220	260	47000	140	0.99	160
U-112	0.0027	0.55	48	7.3	45000	3.6	0.6	4
U-201	5.90E-06	0.028	2.6	0.058	2.4	0.12	0.00018	0.14
U-202	5.40E-06	0.025	2.3	0.067	0.85	0.11	0.00016	0.12
U-203	3.30E-05	0.022	2.1	0.037	1.6	0.099	7.50E-05	0.11
U-204	3.00E-06	0.014	1.3	1.1	36	0.036	0.0075	0.04

a. From Best Basis Inventory (BBI) Summary (March 24, 2014) provided in spreadsheet form by Mark Triplett. All primary contaminant inventories are reported to 2 significant figures. The source document should be consulted for greater precision data.

b. Sum of plutonium isotopes 238, 239, 240, 241, and 242

c. Sum of uranium isotopes 232, 233, 234, 235, 236, and 238

d. The Groundwater Threat Metric (GTM) shown for tanks is equal to the maximum of the GTM for Tc-99 and I-129.

Table E.5-6. Current Primary Contaminant Inventory (by Tank) for the U Tank Farm (CP-TF-4) [(a)]

Tank ID	CCl4 (kg)	CN (kg)	Cr (kg)	Cr-VI (kg)	Hg (kg)	NO3 (kg)	Pb (kg)	TBP (kg)	TCE (kg)	U (total) (kg)
U-101	NP[(b)]	NP	410	NP	3.6	16000	9.2	NP	NP	670
U-102	NP	NP	4900	NP	8.7	530000	150	NP	NP	1900
U-103	NP	NP	6600	NP	3	500000	200	NP	NP	1200
U-104	NP	NP	12	NP	0.35	710	0	NP	NP	2700
U-105	NP	NP	5300	NP	0.94	640000	460	NP	NP	12000
U-106	NP	NP	2200	NP	0.72	200000	280	NP	NP	550
U-107	NP	NP	5600	NP	0.64	640000	200	NP	NP	630
U-108	NP	NP	10000	NP	1.6	730000	3200	NP	NP	3600
U-109	NP	NP	7400	NP	1.4	600000	130	NP	NP	350
U-110	NP	NP	670	NP	0.46	41000	840	NP	NP	15000
U-111	NP	NP	5600	NP	2.9	330000	130	NP	NP	1000
U-112	NP	NP	130	NP	3.1	19000	79	NP	NP	870
U-201	NP	NP	11	NP	0.00072	880	2.5	NP	NP	0.26
U-202	NP	NP	9.2	NP	0.00051	840	2.9	NP	NP	0.23
U-203	NP	NP	9.6	NP	0.00045	810	1.7	NP	NP	0.11
U-204	NP	NP	3.2	NP	0.0018	350	59	NP	NP	11

a. From Best Basis Inventory (BBI) Summary (March 24, 2014) provided in spreadsheet form by Mark Triplett. All primary contaminant inventories are reported to 2 significant figures. The source document should be consulted for greater precision data.

b. NP = Not present at significant quantities

Table E.5-7. Summary of the Evaluation of Threats to Groundwater as a Protected Resource from Remaining Vadose Zone (VZ) Contamination associated with the U Tank and Waste Farms Evaluation Unit (CP-TF-4)

PC	Group	WQS	Porosity[(a)]	K_d (mL/g)[(a)]	ρ (kg/L)[(a)]	VZ Source M^{Source}	SZ Total M^{SZ}	Treated[(c)] M^{Treat}	VZ Remaining M^{Tot} [(d)]	VZ GTM (Mm^3)	VZ Rating[(e)]
C-14	A	2000 pCi/L	0.23	0	1.84	1.61E-01 Ci	---	---	1.61E-01 Ci	8.04E-02	Low
I-129	A	1 pCi/L	0.23	0.2	1.84	4.53E-03 Ci	---	---	4.53E-03 Ci	1.74E+00	Low
Sr-90	B	8 pCi/L	0.23	22	1.84	5.84E+02 Ci	---	---	5.84E+02 Ci	4.13E+02	ND[(f)]
Tc-99	A	900 pCi/L	0.23	0	1.84	3.59E+00 Ci	5.95E-01 Ci	2.25E-01 Ci	2.77E+00 Ci	3.08E+00	Low
CCl_4[(g)]	A	5 µg/L	0.23	0	1.84	---	---	---	---	---	ND
Cr	B	100 µg/L	0.23	0	1.84	1.67E+02 kg	---	---	1.67E+02 kg	1.67E+00	Low
Cr-VI	A	48 µg/L[(b)]	0.23	0	1.84	1.67E+02 kg	---	---	1.67E+02 kg	3.47E+00	Low
TCE	B	5 µg/L	0.23	2	1.84	---	---	---	---	---	ND
U(tot)	B	30 µg/L	0.23	0.8	1.84	2.01E+02 kg	---	---	2.01E+02 kg	9.05E-01	ND[(f)]

a. Parameters obtained from the analysis provided in Attachment 6-1 to Methodology Report.

b. "Model Toxics Control Act−Cleanup" (WAC 173-340) Method B groundwater cleanup level for hexavalent chromium. Other WQS values represent drinking water standards.

c. Treatment amounts from the 2013 Hanford Annual Groundwater Report (DOE/RL-2014-32, Rev. 0).

d. The remaining vadose zone inventory is estimated by difference (CRESP 2015) and thus has a high associated uncertainty.

e. Groundwater Threat Metric rating based on Table 6-3, Methodology Report. These contaminants are being treated using the 200-West Groundwater Treatment Facility.

f. As discussed in Section 5.5, no appreciable uranium or Sr-90 plume would be expected in the next 150 years due to transport and decay (Sr-90) considerations. Thus the *Low* rating would apply to the period *after* the Active Cleanup is complete to account for uncertainties.

g. Carbon tetrachloride is managed in the 200-ZP-1 Operable Unit (Appendix G.6 for CP-GW-2).

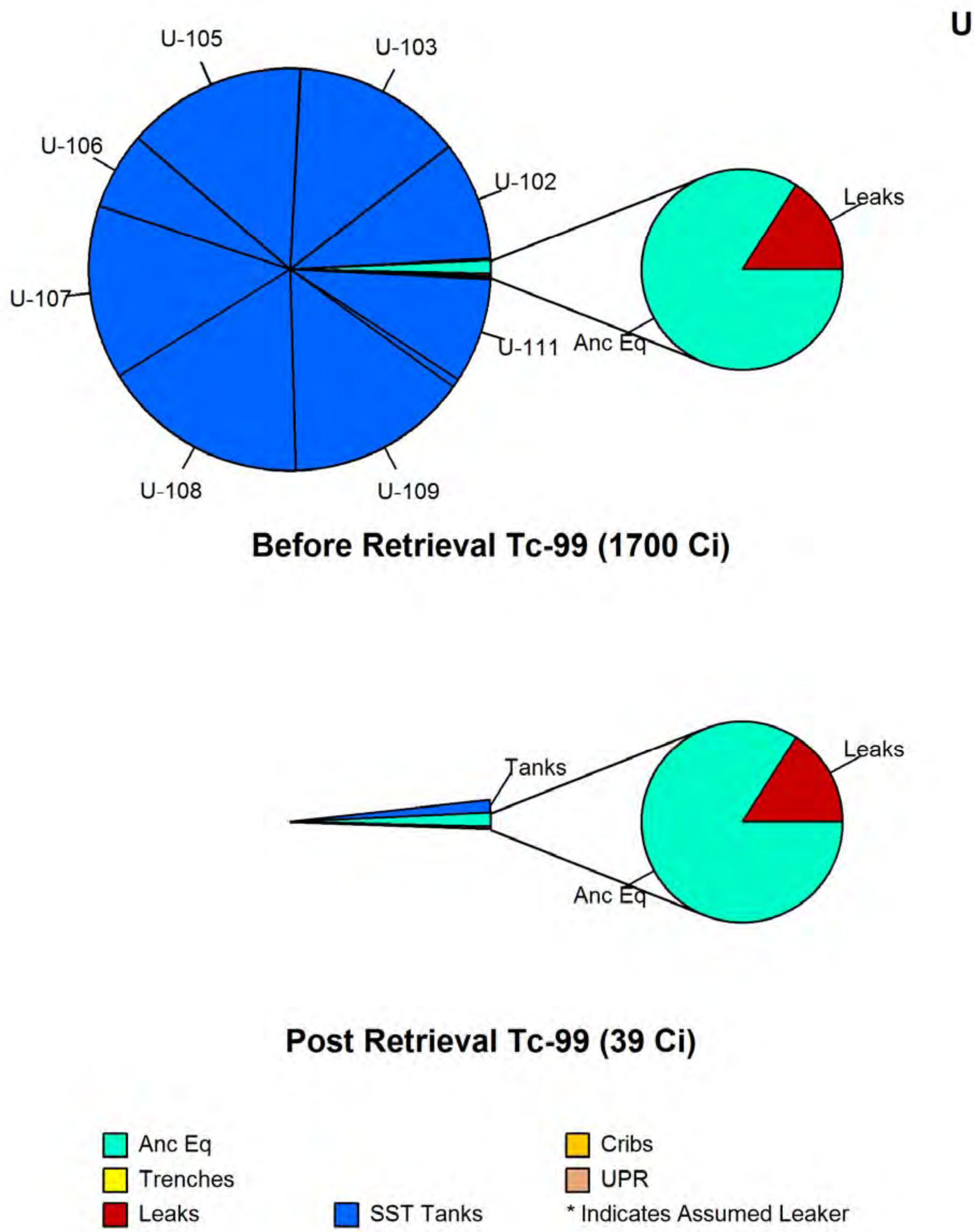

Figure E.5-3. U Tank and Waste Farms Evaluation Unit Inventory Estimates for Tc-99 Before and After 99% Retrieval

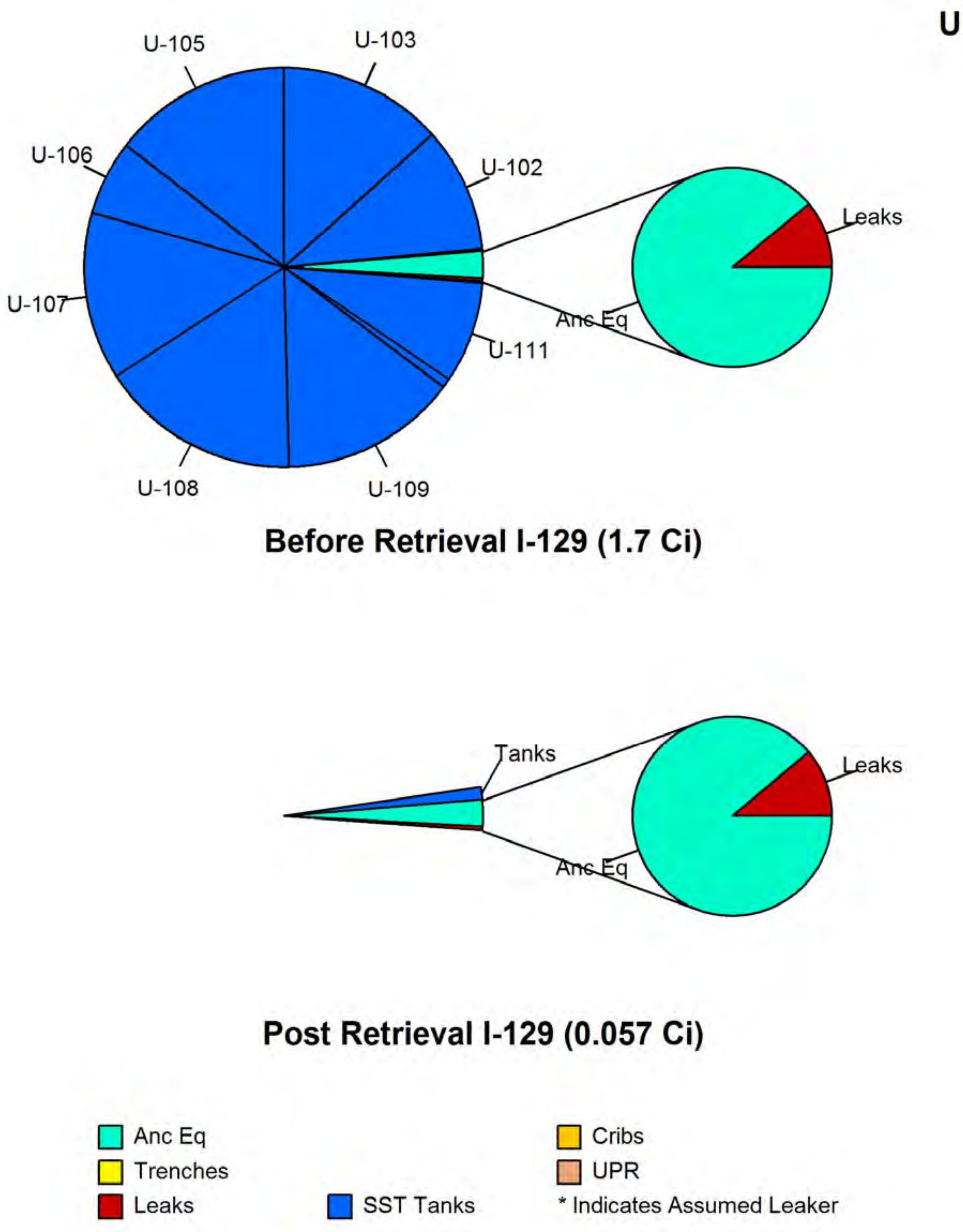

Figure E.5-4. U Tank and Waste Farms Evaluation Unit Inventory Estimates for I-129 Before and After 99% Retrieval

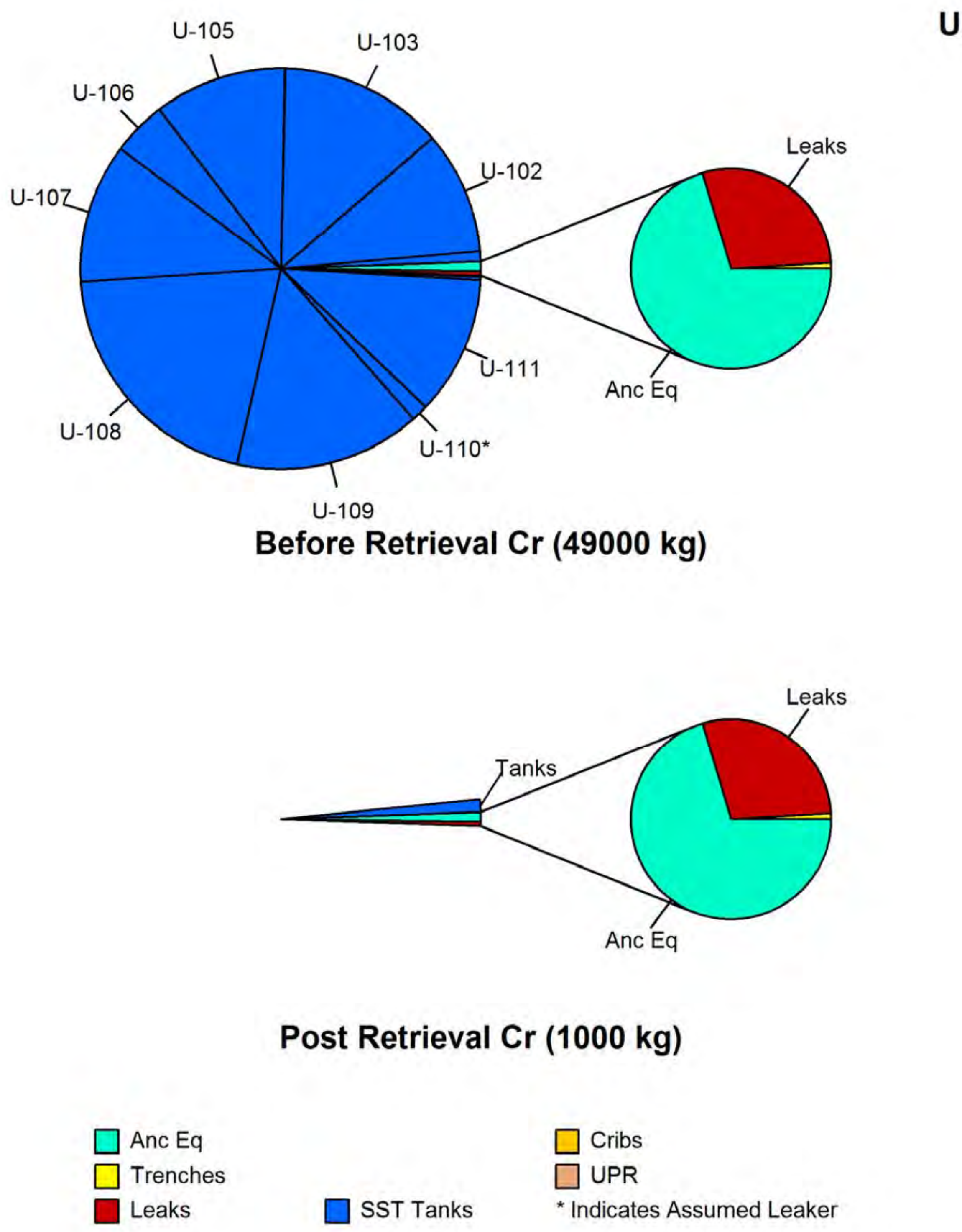

Figure E.5-5. U Tank and Waste Farms Evaluation Unit Inventory Estimates for Chromium Before and After 99% Retrieval

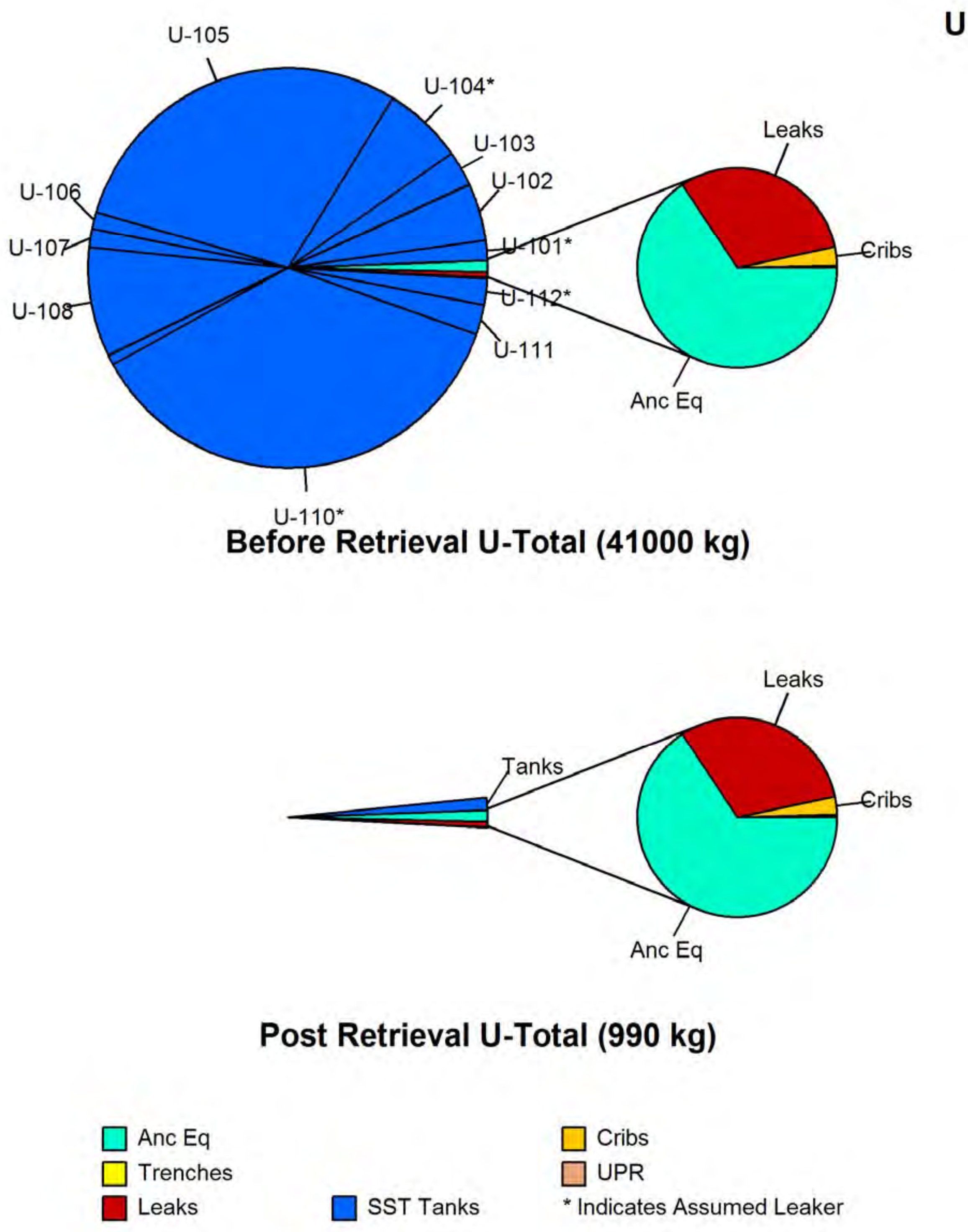

Figure E.5-6. U Tank and Waste Farms Evaluation Unit Inventory Estimates for U(tot) Before and After 99% Retrieval

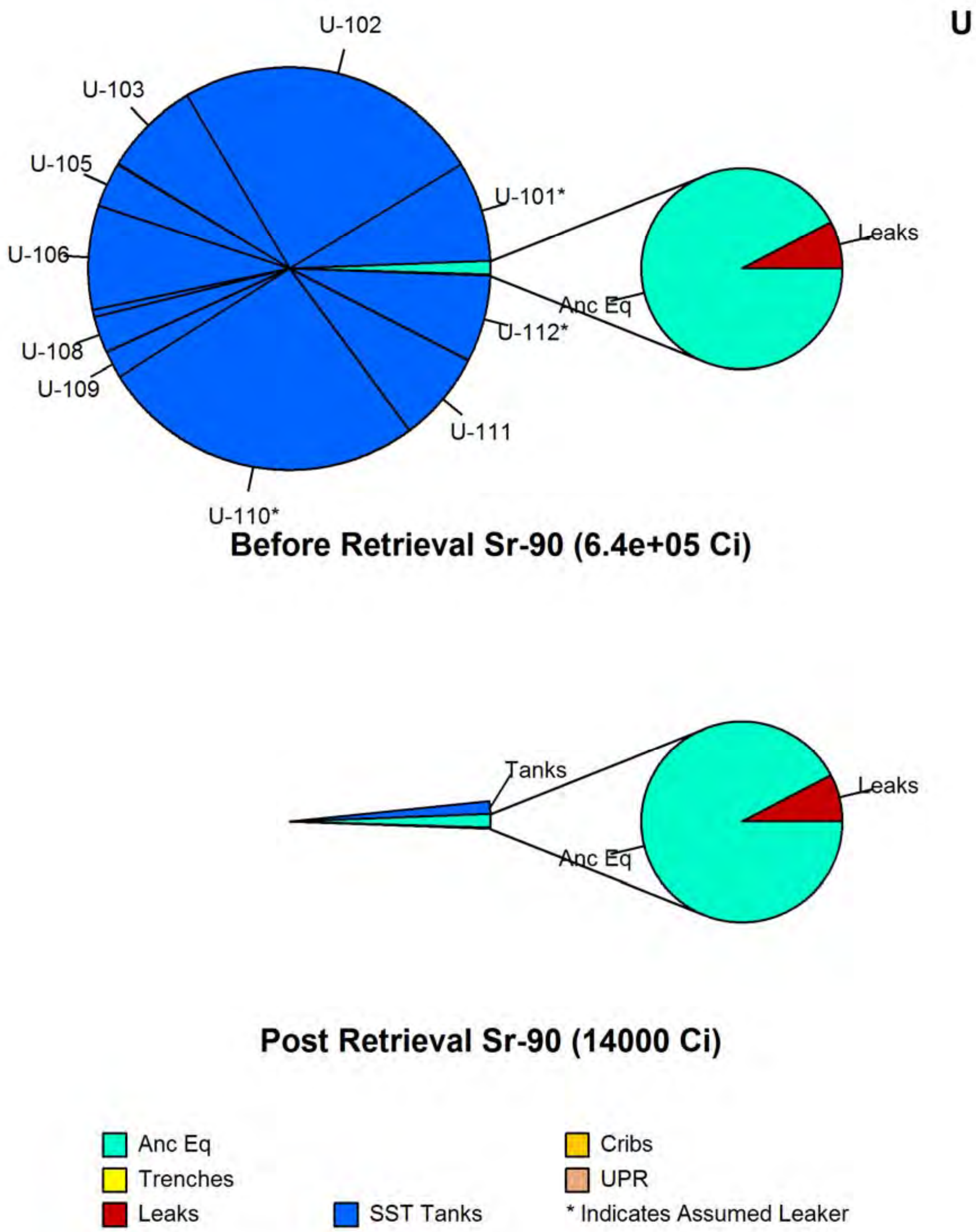

Figure E.5-7. U Tank and Waste Farms Evaluation Unit Inventory Estimates for Sr-90 Before and After 99% Retrieval

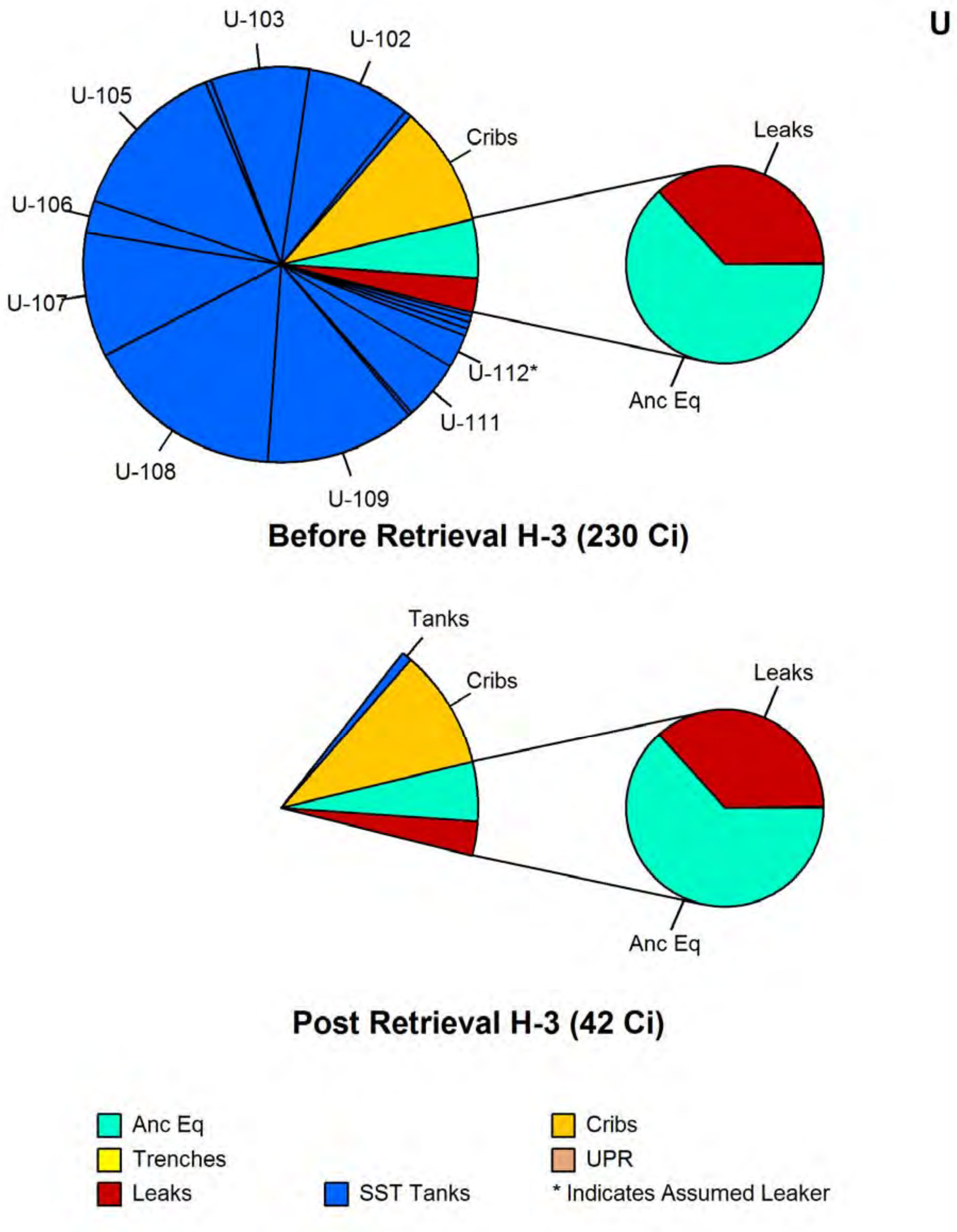

Figure E.5-8. U Tank and Waste Farms Evaluation Unit Inventory Estimates for Tritium (H-3) Before and After 99% Retrieval

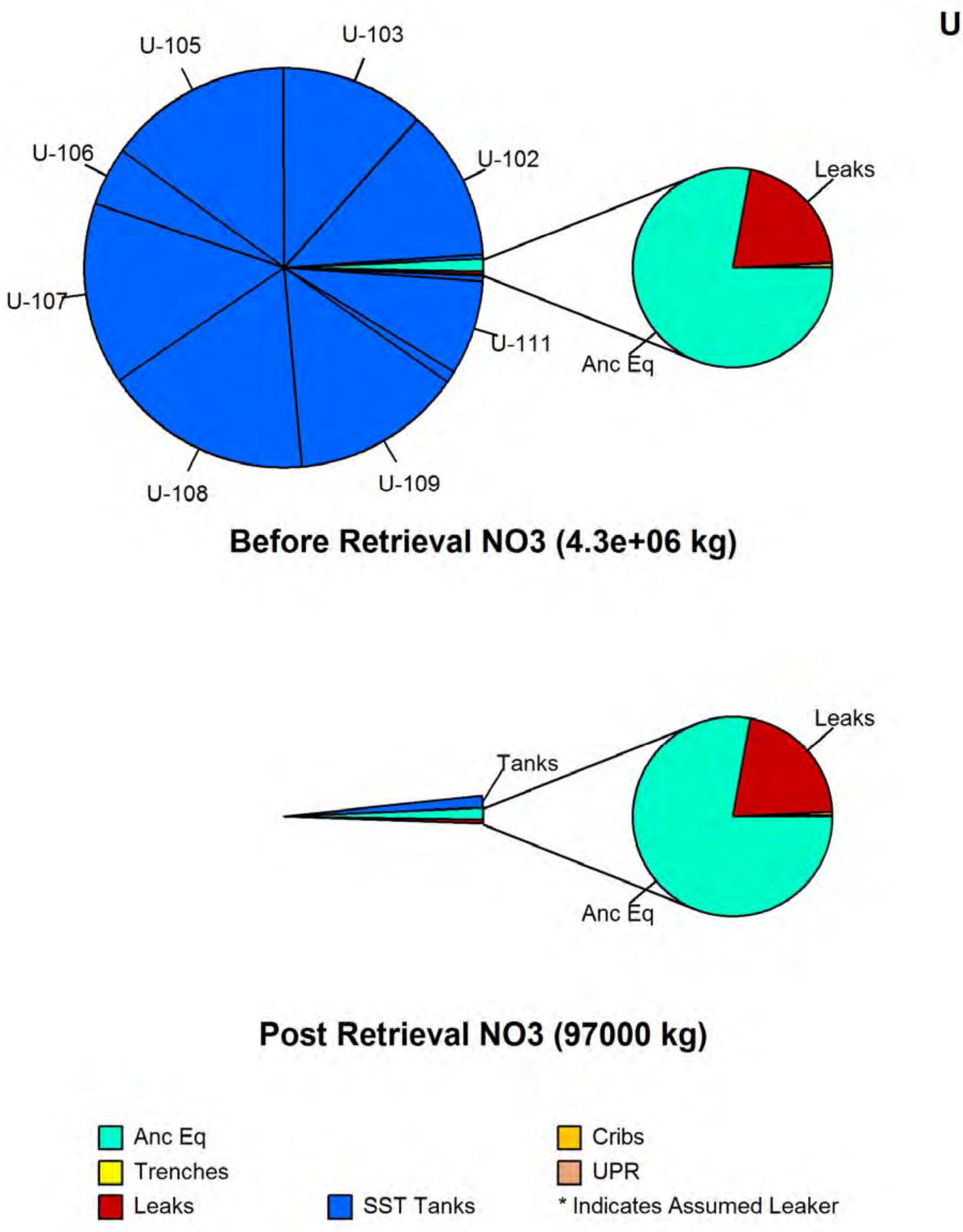

Figure E.5-9. U Tank and Waste Farms Evaluation Unit Inventory Estimates for Nitrate (NO3) Before and After 99% Retrieval

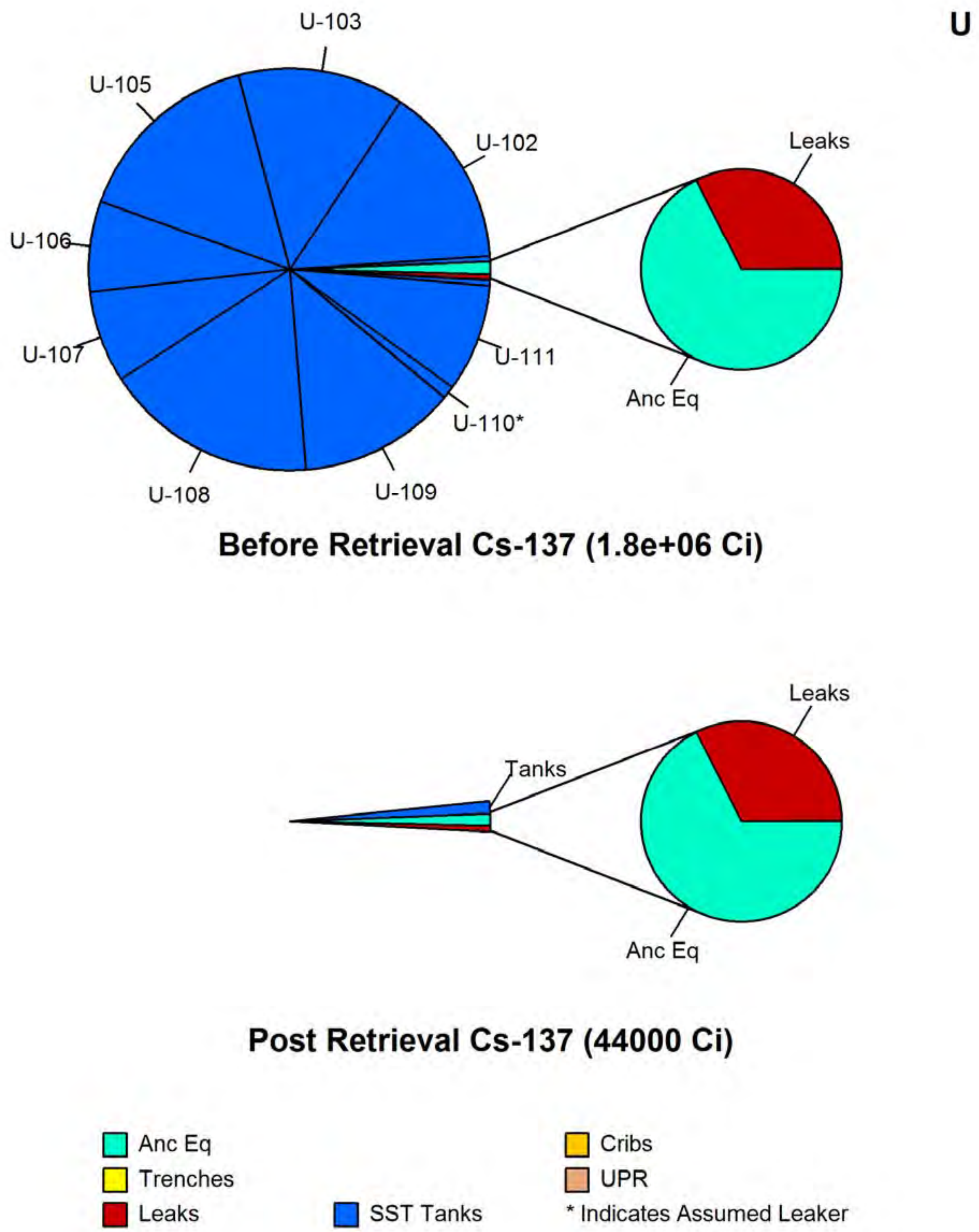

Figure E.5-10. U Tank and Waste Farms Evaluation Unit Inventory Estimates for Cs-137 Before and After 99% Retrieval

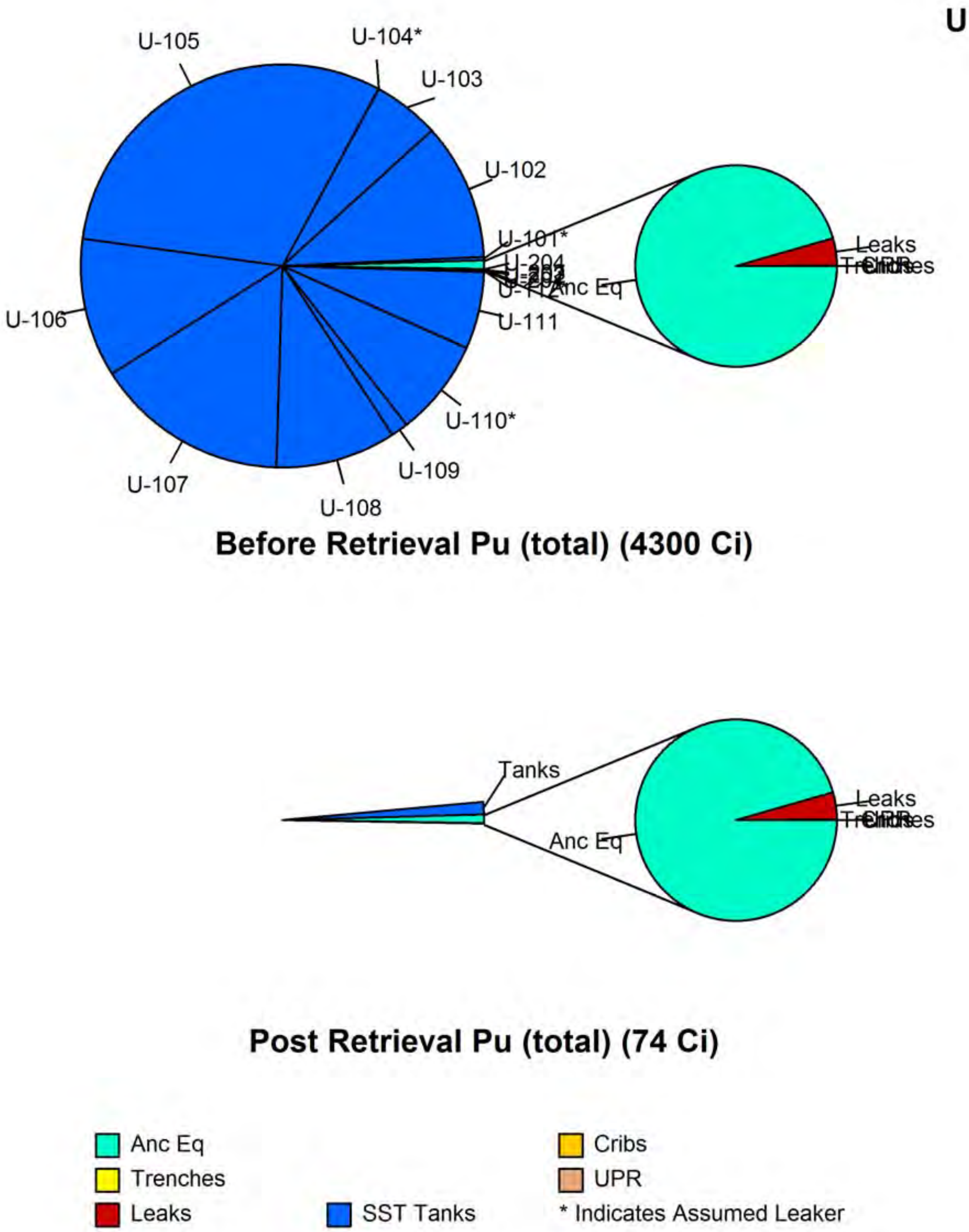

Figure E.5-11. U Tank and Waste Farms Evaluation Unit Inventory Estimates for Plutonium (total) Before and After 99% Retrieval

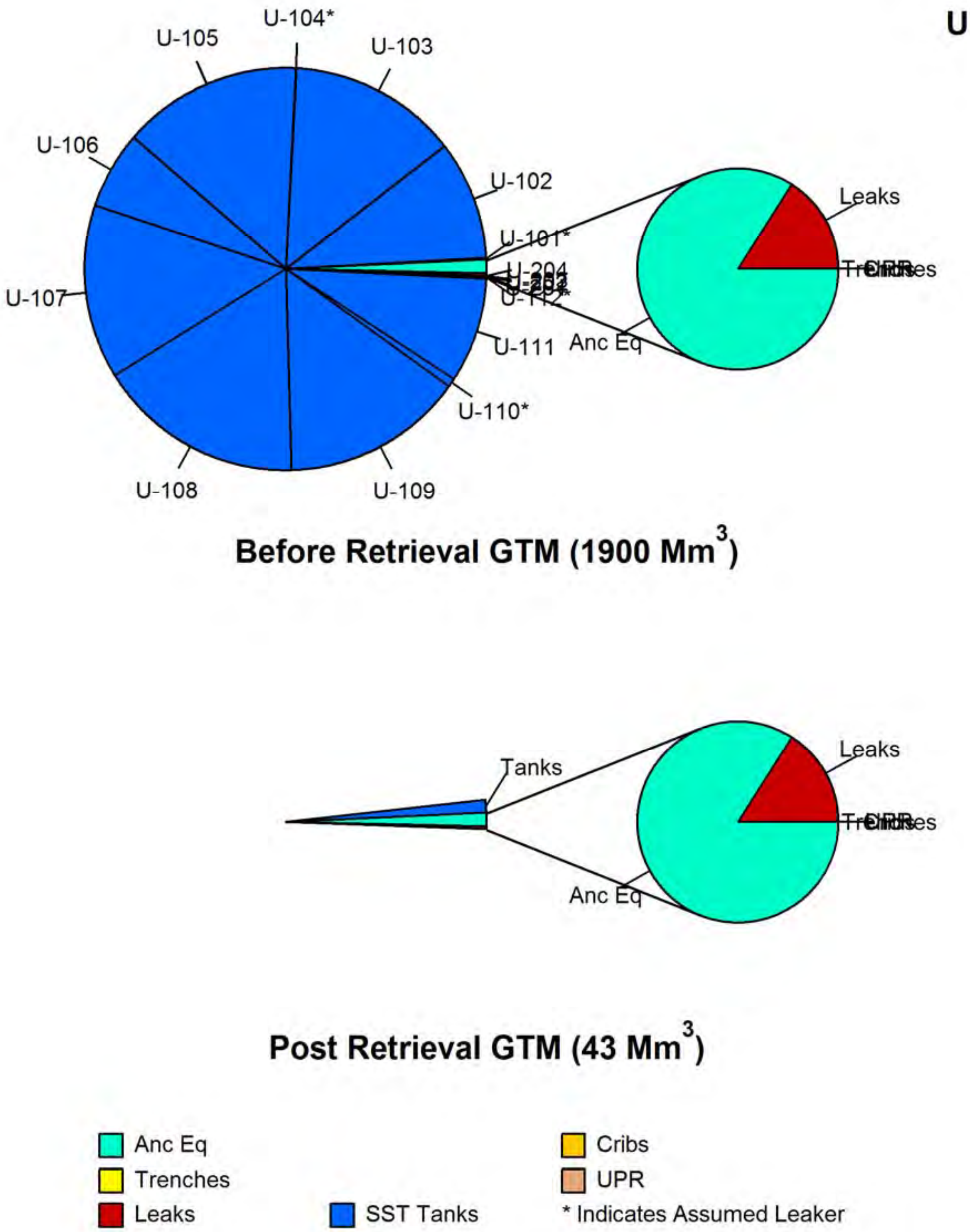

Figure E.5-12. U Tank and Waste Farms Evaluation Unit Maximum Groundwater Threat Metric (GTM) of I-129 and Tc-99 Estimates Before and After 99% Retrieval

5.6. POTENTIAL RISK/IMPACT PATHWAYS AND EVENTS

CURRENT CONCEPTUAL MODEL

A common safety analysis was performed for all the single- and double-shell tanks including pathways and barriers (safety scenarios that dominate risk, safety systems and controls, barriers to release, failure mechanisms, pathways and receptors, time frames for exposure). See Section 1.6 in Appendix E.1 for details.

POPULATIONS AND RESOURCES CURRENTLY AT RISK OR POTENTIALLY IMPACTED

Facility Worker, Co-located Person, and Public

A common analysis was performed for the Facility Worker, Co-located Person, and Public. See Section 1.6 (Appendix E.1) for details.

Groundwater

The groundwater plumes (nitrate, Tc-99, and chromium) considered associated with the U Tank and Waste Farms EU and liquid waste disposal facilities are described in Section 5.5 and further details including ratings are provided in Appendix G.6 for the CP-GW-2 EU (200-UP-1 GW OU).

As shown in Table E.5-7 (Section 5.5), the vadose zone (VZ) GTM values for the Group A and B primary contaminants translate into ratings of ND for uranium and Sr-90 (which has an inventory that would translate to a *High* rating but appears relatively immobile in the area as described in Section 5.5) and *Low* for uranium, C-14, Tc-99, chromium (total and hexavalent), and I-129 for the U Tank and Waste Farms EU. Thus the overall rating for potential groundwater impact from vadose zone sources is *Low*.

Columbia River

As described in Section 5.5, no plumes associated with the U Tank and Waste Farms EU currently intersect the Columbia River above benthic or riparian standards, which corresponds to *Not Discernible* ratings. The large dilution effect of the Columbia River results in a rating of *Not Discernible* for the free-flowing ecology.

Additional information concerning potential threats to the Columbia River from U Tank Farm and liquid waste disposal facilities is provided in Appendix G.6 for the CP-GW-2 EU.

Ecological Resources

- The fenced portion of the U Tank Farm consists of graveled surfaces and tank farm infrastructure (>60%). Level 2 and level 3 habitat resources remain at the perimeters of the EU outside the fenced area (~18% each).
- Wildlife observations made during the October survey within the habitat along the borders of the EU included coyote tracks, small mammal burrows, and harvester ant hills, which were also observed in previous surveys along with northern pocket gopher sign, side-blotched lizards, and 6 migratory bird species.
- Approximately 3.5 acres of level 3 habitat exist within the U Tank and Waste Farms EU; total loss of this habitat within the EU would result in a change of approximately 2% at the landscape level evaluated for this unit.
- The remaining level 2 and level 3 habitats within the EU are fragmented and isolated from habitat surrounding the 200 West Area.

- Individual species occurrences of Piper's daisy lie just outside the perimeter of the EU, but would not be expected to be impacted by clean up actions for U Tank Farm.
- Loss of level 2 and level 3 habitat within the U Tank and Waste Farms EU would not be expected to affect habitat connectivity outside the 200 West Area.

Cultural Resources

- There are no known recorded archaeological sites or TCPs located within the U Tank and Waste Farms EU.
- The 244UR Waste Disposal Vault a contributing property within the Manhattan Project and Cold War Era Historic District, with documentation required, is located within the U Tank and Waste Farms EU.

Archaeological sites and TCPs located within 500 meters of the EU

- The 2727WA Sodium Storage Building and the 2727W also a Sodium Storage Building contributing properties within the Manhattan Project and Cold War Era Historic District, with no documentation required are located within the vicinity of the U Tank and Waste Farms EU.
- The Hanford Site Plant Railroad, a contributing property within the Manhattan Project and Cold War Era Historic District, with documentation required is located in the vicinity of the U Tank and Waste Farms EU.

Recorded TCPs Visible from the EU

- There are two recorded TCPs associated with the Native American Precontact and Ethnographic Landscape that are visible from the U Tank and Waste Farms EU.

CLEANUP APPROACHES AND END-STATE CONCEPTUAL MODEL

Selected or Potential Cleanup Approaches

A common analysis was performed for all the single- and double-shell tanks. See Section 1.6 (Appendix E.1) for details.

Contaminant Inventory Remaining at the Conclusion of Planned Active Cleanup Period

See Section 5.5 including Table E.5-2 and Figure E.5-3 through Figure E.5-11 for the inventory information after planned 99% retrieval. Furthermore, a more general analysis was performed for all the single- and double-shell tanks. See Section 1.6 (Appendix E.1) for details.

Risks and Potential Impacts Associated with Cleanup

A common analysis was performed for all the single- and double-shell tanks for workers and the Public. See Section 1.6 (Appendix E.1) for details.

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

Facility Worker, Co-located Person, and Public

A common analysis was performed for the Facility Worker, Co-located Person, and Public. See Section 1.6 (Appendix E.1) for details.

Groundwater

As described in Section 5.5, there will be a continuing impact during this period to groundwater (as a protected resource) from mobile U Tank Farm primary contaminants currently with plumes that exceed thresholds. These impacts are described in Appendix G.6 for the CP-GW-2 EU (200-UP-1 OU).

Furthermore, there are primary (e.g., tank wastes) and secondary contaminant sources (legacy source sites) in the vadose zone that pose risk to groundwater. The vadose zone (VZ) GTM values for the Group A and B primary contaminants for the U Tank and Waste Farms EU translate to ratings of *Not Discernible* (because of the large potential impact of recharge rates) to *Low* (uncertainty). As indicated in Section 5.5, uranium or Sr-90 are unlikely to impact the groundwater in sufficient quantities to exceed the drinking water standard and thus are not considered future threats. These ratings correspond to an overall rating of *Low* for both the Active and Near-term, Post-Cleanup periods to account for uncertainties.

The 200-West Area pump-and-treat system is assumed to be operational during this evaluation period, which will be treating groundwater contamination.

It is considered unlikely that additional groundwater resources would be impacted as a result of either interim remedial actions (e.g., pump and treat) or final closure activities (that are not covered in the Ecological or Cultural Resources results).

Columbia River

As described in Section 5.5, the impacts to the Columbia River benthic, riparian, and free-flowing ecology for the Active Cleanup and Near-term, Post Cleanup periods are rated as *Not Discernible*. Additional information on groundwater plumes and potential threats associated with the U Tank Farm and liquid waste disposal facilities are described in Appendix G.6 for the CP-GW-2 EU (200-UP-1 GW OU).

It is considered unlikely that additional benthic or riparian resources would be impacted as a result of either interim remedial actions (e.g., pump and treat) or final closure activities (that are not covered in the Ecological or Cultural Resources results).

Ecological Resources

See Section 1.6 (Appendix E.1) for details.

Cultural Resources

See Section 1.6 (Appendix E.1) for details.

Additional Risks and Potential Impacts if Cleanup is Delayed

A common analysis was performed for all the single- and double-shell tanks. See Section 1.6 (Appendix E.1) for details.

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

A common analysis was performed for all the single- and double-shell tanks. See Section 1.6 (Appendix E.1) for details.

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

Table E.5-8. Summary of Populations and Resources at Risk or Potentially Impacted after Cleanup

Population or Resource		Impact Rating	Comments
Human	Facility Worker	Low	Workers will be low risk from exposure to direct radiation and waste contaminants after waste retrieval, grouting, and capping.
	Co-located Person	Low	These persons will be at low risk from exposure to direct radiation and waste contaminants after waste retrieval, grouting, and capping.
	Public	Not Discernible (ND)	The Tank Farms will be in secure and controlled areas that prevent intentional and inadvertent intruders. No complete groundwater pathway and no impact from air pathway.
Environmental	Groundwater (A&B) from vadose zone[a]	ND (Sr-90, uranium) to Low (others) **Overall**: Low	GTM values for Group A and B primary contaminants (Table E.5-7): *Low* (Sr-90, uranium, C-14, Tc-99, I-129, and total and hexavalent chromium). Sr-90 and uranium not likely to impact groundwater (Section 5.5). Sufficiently large predicted impact from changes in recharge rates to adjust ratings but were not to account for uncertainties.
	Columbia River from vadose zone[a]	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 (Section 5.5). Dilution factor of greater than 100 million between River and upwellings.
	Ecological Resources[b]	ND to Low	It will be capped, which results in less frequent monitoring, but monitoring activities can cause some disruption and disturbance to EU and buffer resources.

Population or Resource		Impact Rating	Comments
			Remediation may improve habitat through re-vegetation.
Social	Cultural Resources[b]	**Native American:** Direct: Unknown Indirect: Known **Historic Pre-Hanford:** Direct: Unknown Indirect: Unknown **Manhattan/Cold War**: Direct: None Indirect: None	Permanent indirect effects to viewshed are possible from capping. Permanent effects may be possible due to presence of contamination if capping occurs. No other expected cultural resources impacts.

a. Groundwater threat for Group A and B contaminants remaining in the vadose zone or to the Columbia River for all primary contaminants. Threats from existing plumes associated with the U Tank and Waste Farms EU are described in Section 5.5 and Appendix G.6 (CP-GW-2) for the 200-UP-1 Groundwater Operable Unit.
b. 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.

Long-Term, Post-Cleanup Status – Inventories and Risks and Potential Impact Pathways

As described in Section 5.5, the TC&WM ecological screening analysis indicate that that exposure to radioactive contaminants from peak groundwater discharge was below screening levels at the Columbia River near-shore region, indicating there should be no expected adverse effects from radionuclides. Furthermore, results of the corresponding TC&WM screening evaluation for chemicals indicated that predicted chromium and nitrate concentrations could exceed screening values (i.e., Hazard Quotient of unity) in the near-shore region. However, the predicted nitrate peak concentration was in the past and would be unlikely to exceed human or aquatic standards in the future. For chromium the long travel time from 200-West to the Columbia River likely indicates that little chromium predicted to impact the near-shore region would be from 200-West sources (including the U Tank and Waste Farms EU), which would also likely lead to insignificant impacts from the U Tank and Waste Farms EU.

For more information, see Section 1.6 (Appendix E.1).

5.7. SUPPLEMENTAL INFORMATION AND CONSIDERATIONS

A common analysis was performed for all the single- and double-shell tanks. See Section 1.7 (Appendix E.1) for details.

5.8. ATTACHMENT – U TANK AND WASTE FARMS EVALUATION UNIT WIDS REVIEW

Hanford Site-Wide Risk Review

Evaluation Unit:	U Tank Farm
ID:	CP-TF-4
Group:	Tank Farm
Operable Unit Cross-Walk:	WMA U 200-WA-1
Related EU:	CP-LS-7 CP-GW-2
Sites & Facilities:	U tank farm, ancillary structures, associated liquid waste sites, and soils contamination
Key Data Sources Docs:	RPP-13033 RPP-23405 RPP-40545 RPP-PLAN-40145 RPP-10435

Figure 1. Site Map with Evaluation Unit Boundaries and Tank Locations

Attached:

- Waste Site and Facility List
- Site Map with Evaluation Unit Boundaries and Associated Waste Sites
- Site Map with Evaluation Unit Boundaries and Associated Facilities

Prepared by: AMG, 08/29/2014
Reviewed by: GVL, 08/29/2014
Revisions: AMG, 09/10/2014

Hanford Site-Wide Risk Review
CP-TF-4 (U Tank Farm)
Waste Site and Facility List

Site Code	Name, Aliases, Description	Site Status	Site Type	Site Type Category	Operable Unit	Exclude from Evaluation
200-W-168-PL	200-W-168-PL; 216-U-3 Crib and 216-U-14 Ditch Pipelines	Inactive	Radioactive Process Sewer	Pipeline and associated valves, etc.	TBD	
200-W-179-PL	200-W-179-PL; Lines SL100, SL101, SN216/281 and DR327; Pipelines Between 241-S-152 Diversion Box and 241-U Tank Farm	Inactive	Direct Buried Tank Farm Pipeline	Pipeline and associated valves, etc.	TBD	
200-W-181-PL	200-W-181-PL; Lines V426, V427 and V428/V461; Transfer Lines Between 241-U-152 and 241-U-153 Diversion Boxes	Inactive	Direct Buried Tank Farm Pipeline	Pipeline and associated valves, etc.	TBD	
200-W-184-PL	200-W-184-PL; 241-U-152 and 241-U-153 Diversion Boxes to 241-U-301 Catch Tank; Drain Lines from 241-U-151; Line V478	Inactive	Direct Buried Tank Farm Pipeline	Pipeline and associated valves, etc.	TBD	
200-W-185-PL	200-W-185-PL; Lines V450 and V451; Transfer Lines Between 241-U-151 and 241-U-153 Diversion Boxes	Inactive	Direct Buried Tank Farm Pipeline	Pipeline and associated valves, etc.	TBD	
200-W-238	200-W-238; Large Diameter French Drain North of 241-U	Inactive	French Drain	Crib - Subsurface Liquid Disposal Site	TBD	
200-W-4	200-W-4; U-Farm Landfill	Inactive	Burial Ground	Burial Ground	Not Applic	
200-W-67	200-W-67; Contaminated Soil at the Corner of Cooper and 16th Street	Inactive	Unplanned Release	Unplanned Release - Surface/Near Surface	200-WA-1	
200-W-95	200-W-95; Contaminated Soil at 241-U Tank Farm; Contamination Migration Beyond the 241-U fence	Inactive	Contamination Migration	Unplanned Release - Surface/Near Surface	WMA U	
200-W-98-PL	200-W-98-PL; Encased Pipeline from 240-S-151 to 241-U-153 Diversion Box; V458, V459, and V460	Inactive	Encased Tank Farm Pipeline	Pipeline and associated valves, etc.	TBD	
216-U-13	216-U-13; 216-U-13 Cribs; Vehicle Steam Cleaning Pit	Inactive	Trench	Crib - Subsurface Liquid Disposal Site	200-WA-1	
216-U-3	216-U-3; 216-U-3 French Drain; 216-U-11	Inactive	French Drain	Crib - Subsurface Liquid Disposal Site	200-WA-1	
241-U-101	241-U-101; 241-U-TK-101	Inactive	Single-Shell Tank	Underground Storage Tank	WMA U	
241-U-102	241-U-102; 241-U-TK-102	Inactive	Single-Shell Tank	Underground Storage Tank	WMA U	
241-U-103	241-U-103; 241-U-TK-103	Inactive	Single-Shell Tank	Underground Storage Tank	WMA U	
241-U-104	241-U-104; 241-U-TK-104	Inactive	Single-Shell Tank	Underground Storage Tank	WMA U	
241-U-105	241-U-105; 241-U-TK-105	Inactive	Single-Shell Tank	Underground Storage Tank	WMA U	
241-U-106	241-U-106; 241-U-TK-106	Inactive	Single-Shell Tank	Underground Storage Tank	WMA U	
241-U-107	241-U-107; 241-U-TK-107	Inactive	Single-Shell Tank	Underground Storage Tank	WMA U	
241-U-108	241-U-108; 241-U-TK-108	Inactive	Single-Shell Tank	Underground Storage Tank	WMA U	
241-U-109	241-U-109; 241-U-TK-109	Inactive	Single-Shell Tank	Underground Storage Tank	WMA U	
241-U-110	241-U-110; 241-U-TK-110	Inactive	Single-Shell Tank	Underground Storage Tank	WMA U	
241-U-111	241-U-111; 241-U-TK-111	Inactive	Single-Shell Tank	Underground Storage Tank	WMA U	
241-U-112	241-U-112; 241-U-TK-112	Inactive	Single-Shell Tank	Underground Storage Tank	WMA U	
241-U-153	241-U-153; 241-U-153 Diversion Box	Inactive	Diversion Box	Pipeline and associated valves, etc.	WMA U	
241-U-201	241-U-201; 241-U-TK-201	Inactive	Single-Shell Tank	Underground Storage Tank	WMA U	
241-U-202	241-U-202; 241-U-TK-202	Inactive	Single-Shell Tank	Underground Storage Tank	WMA U	
241-U-203	241-U-203; 241-U-TK-203	Inactive	Single-Shell Tank	Underground Storage Tank	WMA U	
241-U-204	241-U-204; 241-U-TK-204	Inactive	Single-Shell Tank	Underground Storage Tank	WMA U	
241-U-252	241-U-252; 241-U-252 Diversion Box	Inactive	Diversion Box	Pipeline and associated valves, etc.	WMA U	
241-U-301	241-U-301; 241-U-301B; V478; 231-U-301 Catch Tank	Inactive	Catch Tank	Underground Storage Tank	WMA U	
241-U-A	241-U-A; 241-U-A Diversion Box; 241-U-A Valve Pit	Inactive	Valve Pit	Pipeline and associated valves, etc.	WMA U	
241-U-B	241-U-B; 241-U-B Diversion Box; 241-U-B Valve Pit	Inactive	Valve Pit	Pipeline and associated valves, etc.	WMA U	
241-U-C	241-U-C; 241-U-C Diversion Box; 241-U-C Valve Pit	Inactive	Valve Pit	Pipeline and associated valves, etc.	WMA U	
241-U-D	241-U-D; 241-U-D Diversion Box; 241-U-D Valve Pit	Inactive	Valve Pit	Pipeline and associated valves, etc.	WMA U	
241-UR-151	241-UR-151; 241-UR-151 Diversion Box; Drain Lines 5764 and 5765	Inactive	Diversion Box	Pipeline and associated valves, etc.	WMA U	

Note that only those waste sites with a WIDS (Waste Information Data System) Classification of "Accepted" are shown, along with non-duplicate facilities, identified via the Hanford Geographic Information System (HGIS).

Hanford Site-Wide Risk Review
CP-TF-4 (U Tank Farm)
Waste Site and Facility List

Site Code	Name, Aliases, Description	Site Status	Site Type	Site Type Category	Operable Unit	Exclude from Evaluation
241-UR-152	241-UR-152; 241-UR-152 Diversion Box; Line 5053	Inactive	Diversion Box	Pipeline and associated valves, etc.	WMA U	
241-UR-153	241-UR-153; 241-UR-153 Diversion Box; Line 5253	Inactive	Diversion Box	Pipeline and associated valves, etc.	WMA U	
241-UR-154	241-UR-154; 241-UR-154 Diversion Box; Line 5453	Inactive	Diversion Box	Pipeline and associated valves, etc.	WMA U	
244-U DCRT	244-U DCRT; 244-U Double-Contained Receiver Tank; 244-U Receiver Tank; 244-U Receiving Vault; 244-U RT; 244-U-TK/SUMP	Inactive	Receiver Tank	Underground Storage Tank	WMA U	
244-UR VAULT	244-UR VAULT; 244-UR Vault (Tanks -001 Through -004); IMUST; Inactive Miscellaneous Underground Storage Tank; Lines 5764 and 5765	Inactive	Receiving Vault	Underground Storage Tank	WMA U	
2607-WUT	2607-WUT; 2607-WUT Septic Tank and Tile Field	Inactive	Septic Tank	Septic System	TBD	X
UPR-200-W-115	UPR-200-W-115; Ground Contamination Above Transfer Line Along Cooper Street; UN-216-W-25	Inactive	Unplanned Release	Unplanned Release - Surface/Near Surface	200-IS-1	
UPR-200-W-128	UPR-200-W-128; Contamination Release Inside 241-U Tank Farm	Inactive	Unplanned Release	Unplanned Release - Surface/Near Surface	Not Applic	
UPR-200-W-132	UPR-200-W-132; 241-UR-151 Diversion Box Release; UN-200-W-132	Inactive	Unplanned Release	Unplanned Release - Surface/Near Surface	Not Applic	
UPR-200-W-154	UPR-200-W-154; 241-U-101 Leak	Inactive	Unplanned Release	Unplanned Release - Subsurface	Not Applic	
UPR-200-W-155	UPR-200-W-155; 241-U-104 Leak	Inactive	Unplanned Release	Unplanned Release - Subsurface	Not Applic	
UPR-200-W-156	UPR-200-W-156; 241-U-110 Leak	Inactive	Unplanned Release	Unplanned Release - Subsurface	Not Applic	
UPR-200-W-157	UPR-200-W-157; 241-U-112 Leak	Inactive	Unplanned Release	Unplanned Release - Subsurface	Not Applic	
UPR-200-W-24	UPR-200-W-24; Release from the 244-UR Vault; UN-200-W-24	Inactive	Unplanned Release	Unplanned Release - Surface/Near Surface	Not Applic	
UPR-200-W-71	UPR-200-W-71; Contamination Spread from 16th Street to Dayton Ave.; UN-200-W-71	Inactive	Unplanned Release	Unplanned Release - Surface/Near Surface	200-WA-1	
241U271	U FARM CONTROL HOUSE	ACTIVE	BUILDING	Infrastructure Building		X
241U701	INSTRUMENT AIR COMPRESSOR HOUSE	ACTIVE	BUILDING	Infrastructure Building		X
244U	SALT WELL RECEIVER VAULT	ACTIVE	STRUCTURE	Process Building		
244U271	244U CONTROL HOUSE	ACTIVE	BUILDING	Infrastructure Building		X
244U2904	244U FLUSH PIT	INACTIVE	BUILDING	Process Building		
2724U	RAD MONITORING AND PROTECTIVE CLOTHING BLDG	INACTIVE	BUILDING	Infrastructure Building		X
MO297	CHANGE TRAILER WEST OF 241U	ACTIVE	BUILDING	Infrastructure Building		X
MO823	CHANGE TRAILER AT U TANK FARM/16TH AND CAMDEN	ACTIVE	BUILDING	Infrastructure Building		X

Note that only those waste sites with a WIDS (Waste Information Data System) Classification of "Accepted" are shown, along with non-duplicate facilities, identified via the Hanford Geographic Information System (HGIS).

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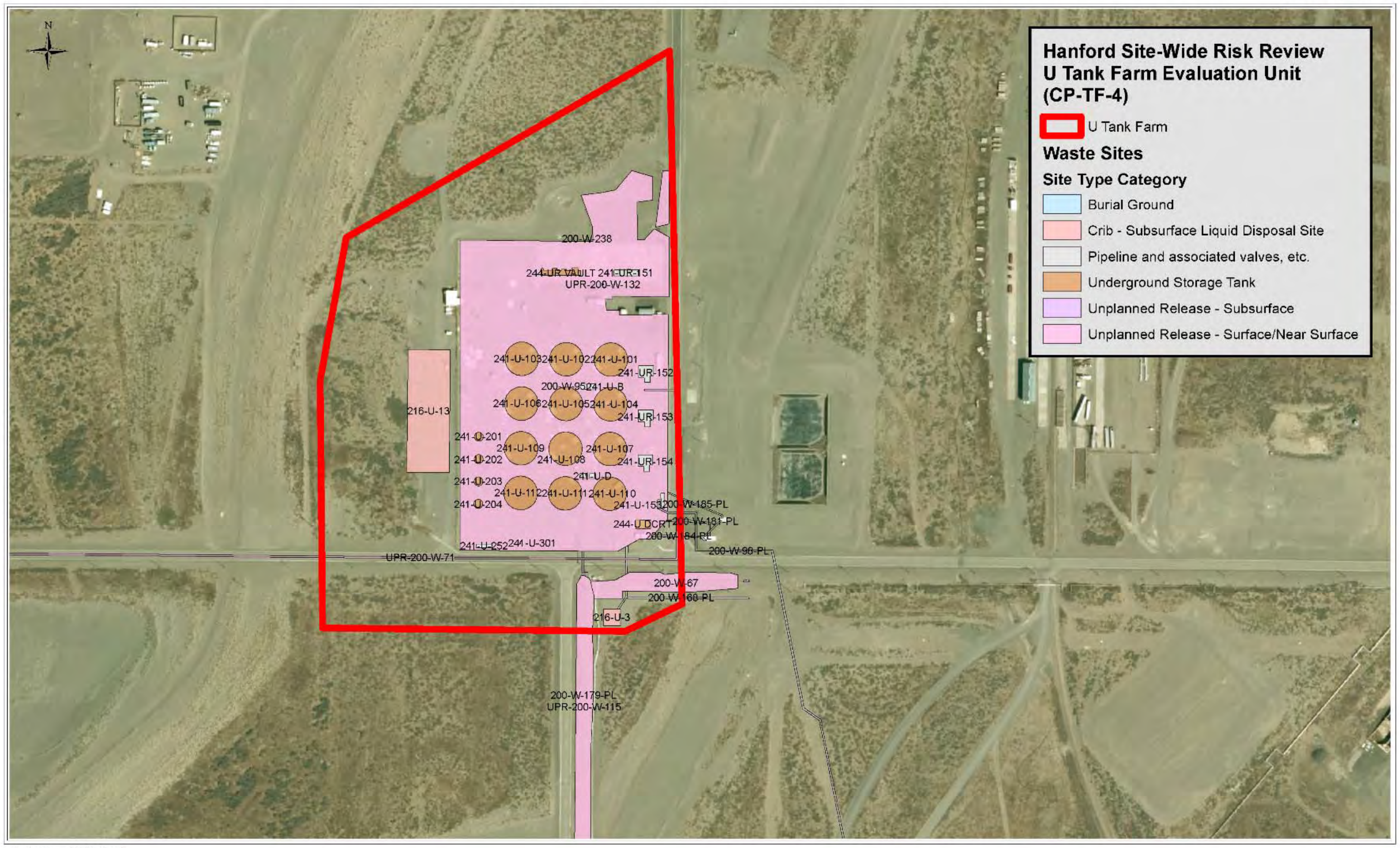
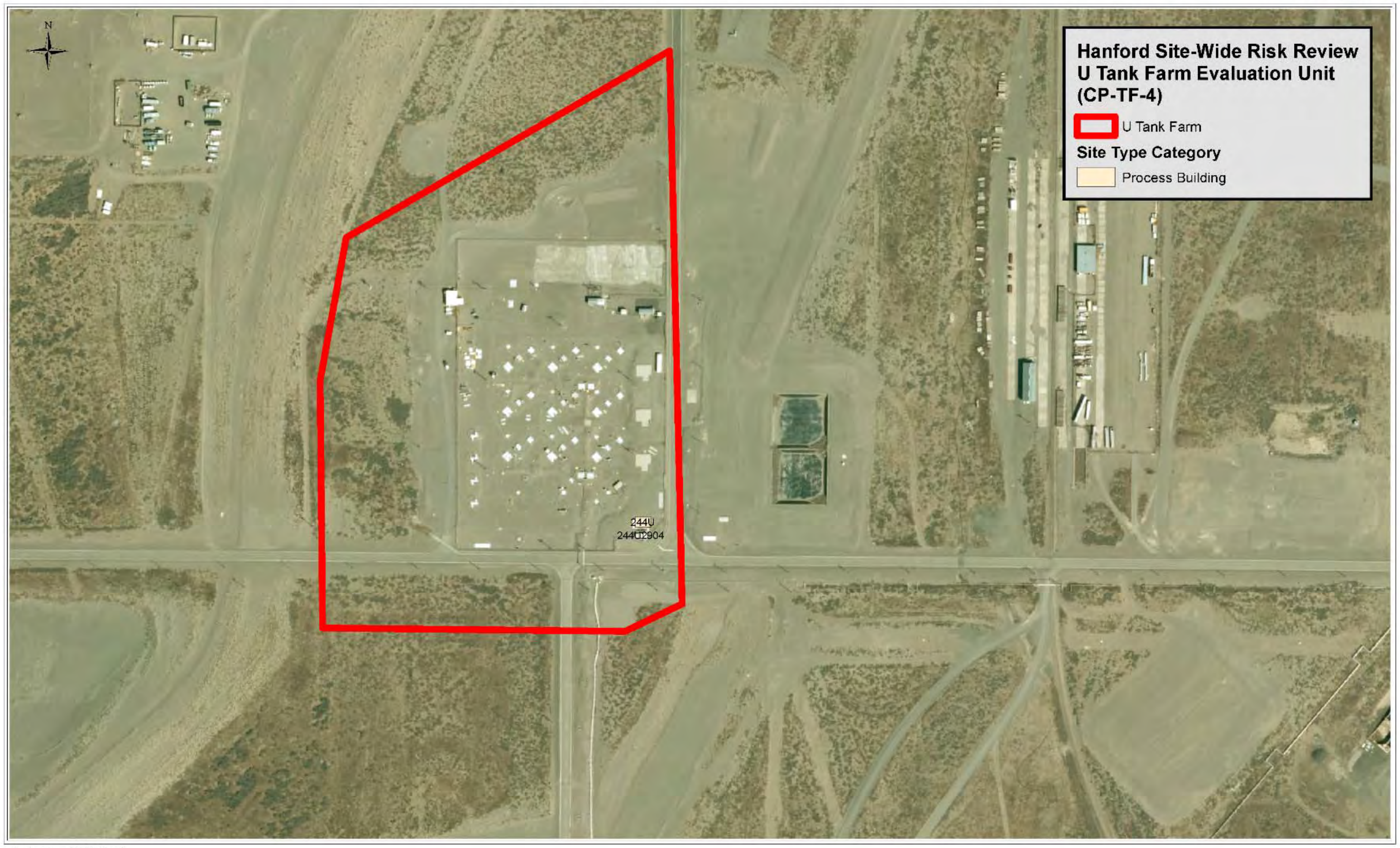


1 inch = 300 feet

DRAFT



1 inch = 300 feet

APPENDIX E.6

Tank Waste and Farms

CP-TF-5 (A-AX Tank Waste and Farms)
Evaluation Unit Summary Template

Table of Contents

List of Figures

List of Tables

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PART 6. CP-TF-5 A-AX SINGLE-SHELL TANK WASTE AND FARMS (200-E)

6.1. EXECUTIVE SUMMARY

Much of the information related to the A-AX Tank and Waste Farms Evaluation Unit (EU) is organized around the corresponding Waste Management Area (namely WMA A-AX) that is regulated under the Resource Conservation and Recovery Act (RCRA) and Washington's Hazardous Waste Management Act (HWMA, RCW 70.105) and it's implementing requirements (Washington's Dangerous Waste Regulations, WAC 173-303) (PNNL-15315).

EU LOCATION:

East-Central part of 200-East on the Hanford Reservation; Central Plateau

RELATED EUS:

T Tank Waste and Farms (CP-TF-1), S-SX Tank Waste and Farms (CP-TF-2), TX-TY Tank Waste and Farms (CP-TF-3), U Tank Waste and Farms (CP-TF-4), B-BX-BY Tank Waste and Farms (CP-TF-6), C Tank Waste and Farms (CP-TF-7), 200-East DST Waste and Farms (CP-TF-8), 200-West DST Waste and Farms (CP-TF-9), 200-E Groundwater Plumes (CP-GW-1), 200-W Groundwater Plumes (CP-GW-2), and 200 Area Waste Transfer Pipeline (CP-LS-7)

PRIMARY CONTAMINANTS, CONTAMINATED MEDIA AND WASTES:

The TC&WM EIS describes tank wastes as including radioactive (tritium or H-3, C-14, Sr-90, Tc-99, I-129, Cs-137, U-233, U-234, U-235, U-238, Np-237, Pu-239, and Pu-240)[79] and non-radioactive contaminants (chromium, mercury, nitrate, lead, total uranium, and PCBs) of potential concern (DOE/EIS-0391 2012, Appendix D). The tank wastes contain saltcake, sludge, and supernatant phases. Contaminated media related to the A-AX Tank Farms include ancillary equipment and surrounding vadose zone (including cribs and trenches) down to the saturated zone (for some mobile contaminants) from past and current discharges. The 2013 Groundwater Monitoring Report (DOE/RL-2014-32, Rev. 0) lists tank wastes including H-3, I-129, nitrate, Sr-90, Tc-99, and uranium for the 200-PO-1 Operable Unit (OU).

After evaluating the contaminants associated with A-AX Tank Farm tanks, ancillary equipment, legacy sources, and contaminated vadose zone, the primary contaminants from the tank wastes that drive human health risk to groundwater associated with the A-AX Tank and Waste Farms Evaluation Unit are: Tc-99 and I-129[80]. Those primary contaminants that may drive risk from groundwater discharge to the Columbia River are nitrate and chromium; however, any potential impacts are highly uncertain[81]. Cs-137

[79] Other isotopes considered include U-232 and U-236 and Pu-238, Pu-241, and Pu-242 to be consistent with other EUs. These additional uranium and plutonium isotopes are included in the totals presented but are not used for rating because 1) uranium toxicity impacts (represented by total uranium drives corresponding risks and 2) plutonium has been found relatively immobile in the Hanford subsurface and has not been identified as a risk driver for groundwater impacts.

[80] Tc-99 has been detected in a relatively small area in the 200-PO near field region around WMA A-AX, which appears to have sources both in WMA C (200-BP) and in WMA A-AX (DOE/RL-2014-32, Rev. 0). Because of the nature of the wastes, it is assumed that WMA A-AX is also be a source for the I-129 plume, especially since some of the highest concentrations of I-129 detected were near WMA A-AX (DOE/RL-2014-32, Rev. 0).

[81] "For groundwater discharging to the Columbia River…, potential long-term impacts on aquatic and riparian receptors would be unlikely for all COPCs and receptors except for chromium and aquatic biota..." (DOE/EIS-0391

and Sr-90 are important from a safety standpoint and uranium isotopes, plutonium isotopes, and tritium are iconic constituents; these contaminants are included in the inventory summary even though they are not considered risk drivers for impacts to or from groundwater in this review. Other current plumes including tritium, nitrate, Sr-90, and uranium that are not associated with the A-AX Tank and Waste Farms EU are captured in Appendix G.5 for the CP-GW-1 EU (200-PO-1 GW OU).

BRIEF NARRATIVE DESCRIPTION:

Waste Management Area A-AX (WMA A-AX) occupies approximately 7 acres (http://phoenix.pnnl.gov/) and contains six underground single-shell tanks (SSTs) in A Tank Farm and four SSTs in AX Tank Farm in additional to ancillary equipment (e.g., diversion boxes, pumps, valves, and pipes). The A Tank Farm was constructed in 1954-55 and the AX Tank Farm in 1963-64 (PNNL-13023, p. 2.1). The SSTs in these Tank Farms were used to store mixed wastes mainly from the PUREX process[82]. After 1977, many tanks received waste listed as evaporator feed, double-shell slurry feed, non-complexed waste, complexed waste, complex concentrated waste, complexant concentrate, and Hanford Defense Residual Liquid. Some waste stored in the A-AX Tank Farms generated sufficient decay heat to cause boiling of the tank supernatant (i.e., were “self-boiling”). Resulting vapors were routed through headers to condensers (vented to the atmosphere through filters) and the condensate was either discharged to cribs or returned to the waste tank to maintain the desired liquid levels in tanks (PNNL-13023, p. 2.2).

The A Tank Farm contains six carbon steel tanks with capacities of 1 Mgal and the first two tanks (A-101 and A-102) began receiving PUREX wastes in 1956; these two tanks were not initially self-boiling because initial volumes were large. Although the A Tank Farm tanks were equipped for boiling wastes, only the A-101 through A-105 were self-boiling. Two A Tank Farm tanks (A-104 and A-105) are classified as “assumed leakers” (Weyns 2014) where both were “self boiling”. The A Tank Farms tanks were removed from service in 1980 with the exceptions of A-104 (removed in 1975) and A-105 (removed in 1963) (PNNL-13023, p. 2.8).

The AX Tank Farm contains 4 carbon steel tanks with capacities of 1 Mgal and received PUREX wastes from 1965 until 1969 (PNNL-13023, p. 2.8). Tanks AX-101 and AX-102 began receiving fractionization waste in 1969; these tanks were sluiced in 1975 to provide feed for B Plant. Tanks AX-103 and -104 received only PUREX waste until 1973; these tanks were sluiced in 1976. All AX Tank Farm tanks are classified as “sound” (Weyns 2014, p. 15). The AX Tank Farms tanks were removed from service in 1980 with the exception of AX-104 (removed in 1978) (PNNL-13023, p. 2.8).

There are various non-tank sources that received large volumes of slightly contaminated waste and other waste streams that has resulted in extensive vadose zone and groundwater contamination in the areas around the WMA A-AX as summarized in Section 6.3.

2012, p. 2–235). For the COPC (i.e., hexavalent chromium) with the highest risk indices for aquatic biota, Hazard Quotients exceeded 40 (versus a limit of 1). However, the TC&WM EIS states “… Only estimated exposures of aquatic biota to hexavalent chromium in nearshore surface water under all Tank Closure … exceeded the Hazard Quotient criterion of 1 at the Columbia River. 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 … groundwater releases to the Columbia River...” (DOE/EIS-0391 2012, Appendix P, pp. P–53-54). “The potential impact on aquatic biota in the Hanford Reach of nitrate in groundwater discharge is uncertain.” (DOE/EIS-0391 2012, Appendix P, pp. P–54).

[82] Production in the PUREX Plant came on line in January 1956 and processed approximately 72% of the reactor fuel produced at the DOE Hanford Site, where resulting wastes included high-level solvent extraction wastes (both self-boiling and not) and cladding wastes, organic wash wastes, and cell drainage (PNNL-13023, p. 2.7).

The SSTs in WMA A-AX have been interim stabilized (i.e., liquid transferred to DSTs to <50 kgal drainable interstitial liquid and <5 kgal of supernatant). The 200-PO-1 OU is being monitored to determine the impact to groundwater prior to determining the path forward for remedial action, with a final ROD expected in 2016 (DOE/RL-2014-32, Rev. 0).

SUMMARY TABLES OF RISKS AND POTENTIAL IMPACTS TO RECEPTORS

Table E.6-1 provides a summary of nuclear and industrial safety related consequences from the CP-TF-5 (A-AX Tank and Waste Farms EU) to humans and impacts to important physical Hanford Site resources. Receptors are described in Section 1.6 (Appendix E.1).

Table E.6-1. CP-TF-5 (A-AX Tank Farms) impact Rating Summary for Human Health (unmitigated basis with mitigated basis provided in parentheses (e.g., "High (Low)").

Population or Resource		Evaluation Time Period[a] Active Cleanup (to 2064) Current Condition: Maintenance & Monitoring (M&M)	Evaluation Time Period[a] Active Cleanup (to 2064) From Cleanup Actions: Retrieval & Closure
Human Health	Facility Worker[b]	***M&M***: Low-High[d] (Low-High)[d] ***Soil***: ND-High (ND-Low)	***Preferred method***: High (Low) ***Alternative***: High (Low)
Human Health	Co-located Person[b]	***M&M***: Low-Moderate (Low) ***Soil***: ND (ND)	***Preferred method***: Low-Moderate (Low) ***Alternative***: Low-Moderate (Low)
Human Health	Public[b]	***M&M***: Low (Low) ***Soil***: ND (ND)	***Preferred method***: Low (Low) ***Alternative***: Low (Low)
Environmental	Groundwater (A&B) from vadose zone[c]	Medium – Cr(tot, VI)[f] **Overall**: Medium	Medium -- Cr(tot, VI)[f] **Overall**: Medium
Environmental	Columbia River from vadose zone[c]	Benthic: Not Discernible (radionuclides) Not Discernible (chemicals) Riparian: Not Discernible (radionuclides) Not Discernible (chemicals) Free-flowing: Not Discernible (all) **Overall**: Not Discernible	Benthic: Not Discernible (radionuclides) Not Discernible (chemicals)[g] Riparian: Not Discernible (radionuclides) Not Discernible (chemicals)[g] Free-flowing: Not Discernible (all) **Overall**: Not Discernible
Environmental	Ecological Resources[e]	ND to Low	Low to Medium
Social	Cultural Resources[e]	**Native American:** Direct: Unknown Indirect: Known **Historic Pre-Hanford:** Direct: Unknown Indirect: Unknown **Manhattan/Cold War:** Direct: Known Indirect: Known	**Native American:** Direct: Unknown Indirect: Known **Historic Pre-Hanford:** Direct: Unknown Indirect: Unknown **Manhattan/Cold War:** Direct: Known Indirect: Known

a. A rating for cultural resources is not being made because cultural resources will be evaluated under Section 106 of the National Historic Preservation Act (16 USC 470, et. seq.) during the planning for remedial action.

b. Evaluated in Section 1.6 (Appendix E.1).

c. Groundwater threat for Group A and B contaminants remaining in the vadose zone or to the Columbia River for all primary contaminants. Threats from existing plumes associated with the A-AX Tank and Waste Farms EU are described in Section 6.5 and Appendix G.5 (CP-GW-1) for the 200-PO-1 Groundwater Operable Unit.

d. Industrial safety consequences range from low to high (based on the evaluation scale used) for both mitigated (with controls) and unmitigated (without controls). Mitigated radiological and toxicological consequences to facility workers are high (unmitigated) and low (mitigated).

e. 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.

f. The large amounts of Sr-90 and uranium disposed of in the A-AX Tank and Waste Farms EU would translate to *High* ratings; however, there is no current Sr-90 or uranium plume associated with A-AX Tank and Waste Farms EU sources in the 200-PO-1 OU. It would likely require more than 150 years for either Sr-90 or uranium to reach groundwater in a sufficient amount to exceed the corresponding drinking water standard over an appreciable area (Section 6.5). Thus Sr-90 and uranium are not considered risk drivers.

g. The information from Appendix P from the TC&WM EIS would suggest that hexavalent chromium would have *Medium* and *High* ratings for benthic and riparian zone impacts, respectively. However, current well data suggest that chromium is moving much more slowly than predicted in the TC&WM EIS evaluation resulting in *Not Discernible* ratings.

Support for Risk and Impact Ratings for Each Population or Resource

Human Health

The current and cleanup-related consequences related to work being conducted at the Tank Farms in the 200 Areas (Hanford Central Plateau) was evaluated in Section 1.6 (Appendix E.1).

Groundwater, Vadose Zone, and Columbia River

A-AX Tank Farm contaminants are currently impacting groundwater, and treatment is not predicted to decrease concentrations to below thresholds before active cleanup commences. Secondary sources in the vadose also threaten to continue to impact groundwater in the future. As described in the TC&WM EIS, there appeared to be large predicted impacts on peak concentrations in groundwater both during and after cleanup (but not the near-shore region of the Columbia River). However, despite these large, predicted impacts, the groundwater ratings for I-129, hexavalent chromium, and uranium are not changed for the Active Cleanup period. On the other hand, the Tc-99 and total chromium were predicted to not exceed the screening value over the TC&WM evaluation period (10,000 years), which resulted in a *Low* groundwater rating in the Near-term, Post-Cleanup period to account for uncertainty as described in Section 6.5.

Ecological Resources

Current

High quality habitat (22% level 3) exists in EU, and 27% level 3 and 4 in buffer suggests potential for disturbance even though truck traffic is low. Trucks can bring in seeds of exotic species, changing species composition. Has some nice Sage Brush habitat on EU.

Risks and Potential Impacts from Selected or Potential Cleanup Approaches
Remediation may result in some destruction of level 3 habitat in EU (with sage brush habitat); intense activity will result in loss of resources to EU and potentially buffer area (with 27% level 3 and 4 resources).

Cultural Resources

Current
Manhattan Project/Cold War significant resources have already been mitigated. Area is very disturbed and there are no known recorded archaeological resources within the EU. Traditional cultural places are visible from EU.

Risks and Potential Impacts from Selected or Potential Cleanup Approaches
Because area has not been investigated either on the surface or subsurface, archaeological investigations may need to occur within pockets of undisturbed land if any prior to remediation. Potential for intact archaeological material to be present is very low.

Considerations for Timing of the Cleanup Actions

See Section 1.1 (Appendix E.1).

Near-Term, Post-Cleanup Risks and Potential Impacts

See Section 1.1 (Appendix E.1).

6.2. ADMINISTRATIVE INFORMATION

OU AND/OR TSDF DESIGNATION(S):

The A-AX Tank and Waste Farms Evaluation Unit (EU), denoted *CP-TF-5 – A-AX Tank Farms*, consists of 10 waste tanks, ancillary structures, associated liquid waste sites, and soils contamination; much of this EU is contained within Waste Management Area A-AX (WMA A-AX). WMA A-AX is regulated under the Resource Conservation and Recovery Act (RCRA) as modified in 40 CFR Part 265, Subpart F and Washington State's Hazardous Waste Management Act (HWMA, RCW 70.105 and its implementing requirements in the Washington State dangerous waste regulations [WAC 173-303-400]) (PNNL-15315).

COMMON NAME(S) FOR EU:

There is no common name for the A-AX Tank and Waste Farms EU because the EU is comprised of elements from other waste management units including Waste Management Area A-AX (WMA A-AX) that includes the 241-A (or A) and 241-AX (or AX) Tank Farms.

The A Tank Farm contains six waste tanks (A-101 through A-106); these tanks often are designated as 241-A-101 through 241-A-106. The AX Tank Farm contains four waste tanks (AX-101 through AX-104); these tanks often are designated as 241-AX-101 through 241-AX-104. Other components in the EU are listed below in the *Primary EU Source Components* section.

KEY WORDS:

A Tank Farm, AX Tank Farm, 241-A Tank Farm, 241-AX Tank Farm, waste tanks, tank farm, Waste Management Area A-AX, WMA A-AX

REGULATORY STATUS

Regulatory Basis

DOE is the responsible agency for the closure of all single-shell tank (SST) waste management areas (WMAs) through post closure, in close coordination with other closure and cleanup activities of the Hanford Central Plateau. Washington State has a program that is authorized under RCRA and implemented through the HWMA and its associated regulations; Ecology is the lead regulatory agency responsible for the closure of the SST system. Please refer to Section 1.2 (Appendix E.1) for more information.

Applicable Regulatory Documentation

The relationship among the tank waste retrieval work plans (TWRWP) and the overall single-shell tank (SST) waste retrieval and closure process is described in Appendix I of the Hanford Federal Facility Agreement and Consent Order (HFFACO), along with requirements for the content of TWRWPs. WMA A-AX was placed in assessment monitoring (40 CFR 265.93[d][4]) based on elevated specific conductance measurements (PNNL-15315, p. iii). A groundwater quality assessment plan was developed (PNNL-15315) describing the monitoring activities used in deciding whether WMA A-AX has affected groundwater.

Applicable Consent Decree or TPA Milestones

Federal Facility Agreement and Consent Order, 1989 and amended through June 16, 2014: Milestone M-045-00; Lead Agency Ecology: *Complete the closure of all Single Shell Tank Farms by 01/31/2043*

RISK REVIEW EVALUATION INFORMATION

Completed: Revised August 25, 2015

Evaluated by: K. G. Brown

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

6.3. 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 (of which the A-AX Tank and Waste Farms EU is a part) 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: The legacy source sites associated with the A-AX Tank and Waste Farms EU are described in Attachment Section 6.8. There are various non-tank sources that received large volumes of slightly contaminated waste and other waste streams that has resulted in extensive vadose zone and groundwater contamination in the areas around the WMA A-AX. Source include surface spills associated with leaks from transfer lines, diversion boxes, catch tanks, and vaults as well as cribs, trenches, and french drains (1,600 gallons to 304 Mgal of volume effluents) (PNNL-13023, p. 3.4-3.5). Two of the SSTs in WMA A-AX are declared "assumed leakers" with leaks estimates ranging from 500-2,500 gallons to 10,000-270,000 gallons (Weyns 2014, pp. 18-21). The most significant leak was when the bottom of Tank A-105 ruptured (releasing 10,000-270,000 gallons) from a steam explosion.

High-Level Waste Tanks and Ancillary Equipment: The 10 waste tanks in the A-AX Tank and Waste Farms EU are:

- (241-)A-101 (241-A-TK-101)
- (241-)A-102 (241-A-TK-102)
- (241-)A-103 (241-A-TK-103)
- (241-)A-104 (241-A-TK-104)
- (241-)A-105 (241-A-TK-105)
- (241-)A-106 (241-A-TK-106)
- (241-)AX-101 (241-AX-TK-101)
- (241-)AX-102 (241-AX-TK-102)
- (241-)AX-103 (241-AX-TK-103)
- (241-)AX-104 (241-AX-TK-104)

The ancillary equipment included in the A-AX Tank and Waste Farms EU is listed in the Attachment in Section 6.8 and primarily consists of pipelines, diversion boxes, and catch tanks.

Groundwater Plumes:

The A-AX Tank and Waste Farms EU is in the 200-PO-1 Operable Unit (OU). The current 200-PO-1 OU plumes that exceed water quality standards (in this case, drinking water standards) are tritium, I-129, nitrate, Sr-90, Tc-99, and uranium; however, only the Tc-99 and I-129 plumes are associated with A-AX Tank and Waste Farms EU sources[83] (DOE/RL-2014-32, Rev. 0). The 200-PO-1 OU is being monitored to determine the impact to groundwater prior to determining the path forward for remedial action.

See Appendix G.5 for the CP-GW-1 EU for additional details.

Operating Facilities: Because of the prohibition on waste additions to the Hanford SSTs,[84] the A-AX Tank and Waste Farms EU components are not considered Operating Facilities for this review. See Section 1.4 (Appendix E.1) for details.

D&D of Inactive Facilities: Not Applicable.

LOCATION AND LAYOUT MAPS

A series of maps are used to illustrate the location of the components within the CP-TF-5 EU and the A-AX Tank and Waste Farms EU relative to the Hanford Site. Figure E.2-1 shows the relationship between the 200-E (200 East) Area (where the A-AX Tank Farms and Waste management Area A-AX are located) and the Hanford Site. Figure E.6-1 illustrates the A-AX Tank and Waste Farms EU boundary. Figure E.6-2

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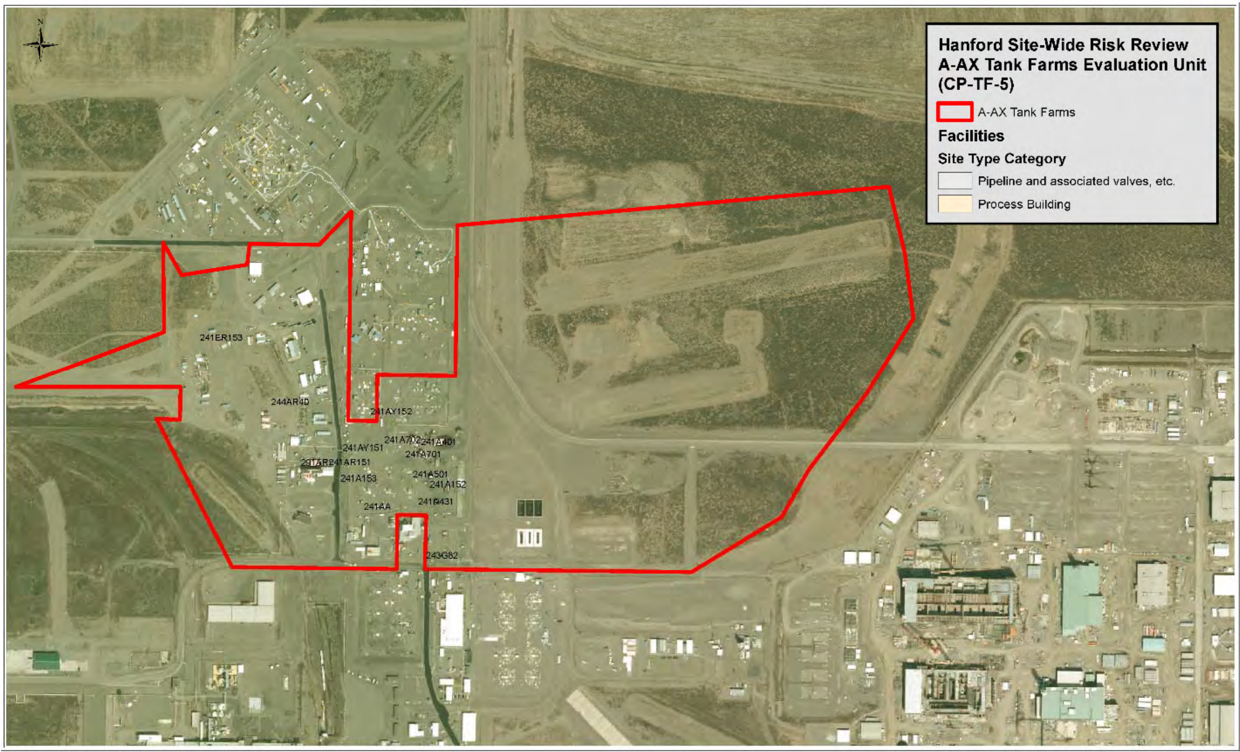
[83] Tc-99 has been detected in a relatively small area in the 200-PO near field region around WMA A-AX, which appears to have sources both in WMA C (200-BP) and in WMA A-AX (DOE/RL-2014-32, Rev. 0). Because of the nature of the wastes, it is assumed that WMA A-AX is also be a source for the I-129 plume, especially since some of the highest concentrations of I-129 detected were near WMA A-AX (DOE/RL-2014-32, Rev. 0).
[84] Berman presentation on July 29, 2009, titled "Hanford Single-Shell Tank Integrity Program." Available at www.em.doe.gov.

shows a detailed view of the waste tanks, ancillary equipment, and legacy source units in the A-AX Tank and Waste Farms EU.

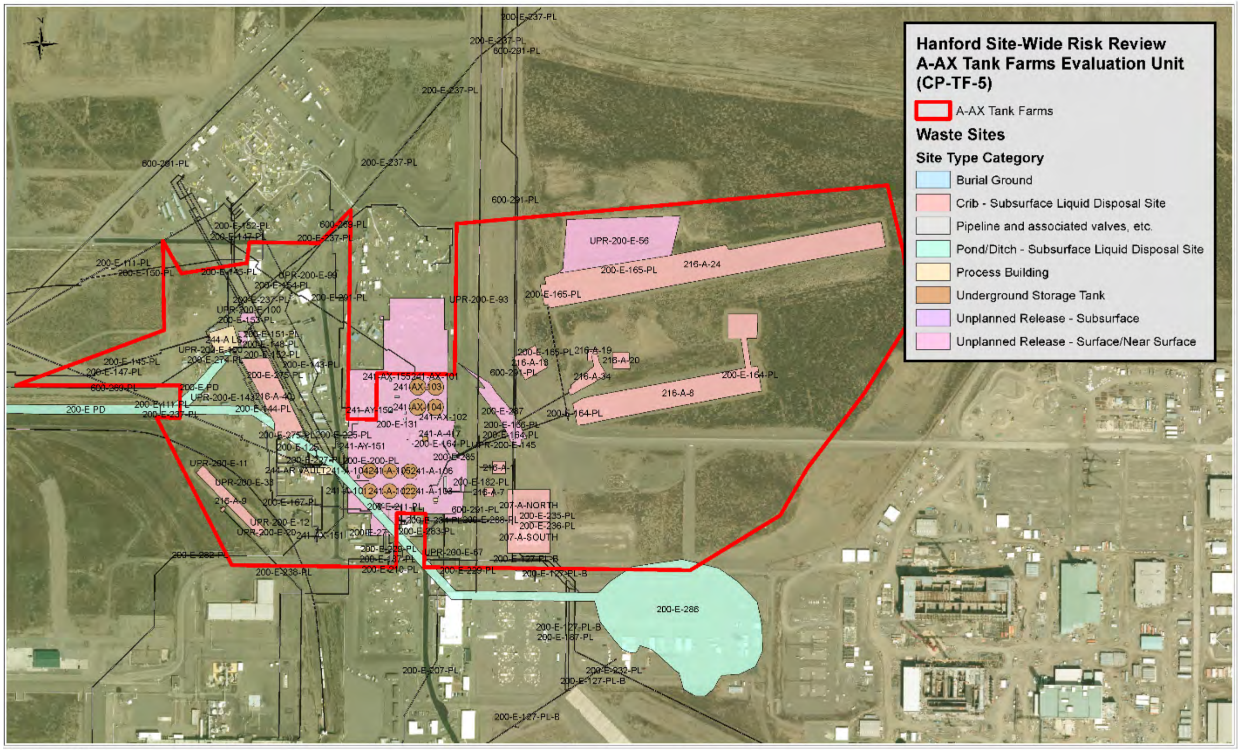
DRAFT



1 inch = 600 feet

Figure E.6-1. Polygon representing the boundary of the A-AX Tank and Waste Farms Evaluation Unit (Attachment Section 6.8).

DRAFT



1 inch = 600 feet

Figure E.6-2. Hanford A-AX Tank and Waste Farms Evaluation Unit including tanks, legacy source units, and ancillary equipment (Attachment Section 6.8).

6.4. UNIT DESCRIPTION AND HISTORY

EU Former / Current Uses

Waste Management Area A-AX (WMA A-AX) occupies approximately 7 acres (http://phoenix.pnnl.gov/) and contains 6 underground single-shell tanks (SSTs) in A Tank Farm and 4 SSTs in AX Tank Farm in additional to ancillary equipment (e.g., diversion boxes, pumps, valves, and pipes). The A Tank Farm was constructed in 1954-55 and the AX Tank Farm in 1963-64 (PNNL-13023, p. 2.1). The SSTs in these Tank Farms were used to store mixed wastes mainly from the PUREX process[85]. After 1977, many tanks received wastes including evaporator feed, double-shell slurry feed, non-complexed waste, complexed waste, complex concentrated waste, complexant concentrate, and Hanford Defense Residual Liquid. Some waste stored in the A-AX Tank Farms generated sufficient decay heat to cause boiling of the tank supernatant (i.e., were "self-boiling").

The AX Tank Farm contains 4 carbon steel tanks with capacities of 1 Mgal and received PUREX wastes from 1965 until 1969 (PNNL-13023, p. 2.8). Tanks AX-101 and AX-102 began receiving fractionization waste in 1969; these tanks were sluiced in 1975 to provide feed for B Plant. Tanks AX-103 and AX-104

[85] Production in the PUREX Plant came on line in January 1956 and processed approximately 72% of the reactor fuel produced at the DOE Hanford Site, where resulting wastes included high-level solvent extraction wastes (both self-boiling and not) and cladding wastes, organic wash wastes, and cell drainage (PNNL-13023, p. 2.7).

received only PUREX waste until 1973; these tanks were sluiced in 1976. All AX Tank Farm tanks are classified as "sound" (Weyns 2014, p. 15). The AX Tank Farms tanks were removed from service in 1980 with the exception of AX-104 (removed in 1978) (PNNL-13023, p. 2.8). The SSTs in WMA A-AX have been interim stabilized (i.e., liquid transferred to DSTs to <50 kgal drainable interstitial liquid and <5 kgal of supernatant). The A-AX Tank Farm tanks are currently awaiting retrieval and closure.

LEGACY SOURCE SITES

Vapors from the "self-boiling" tanks were routed through headers to condensers (vented to the atmosphere through filters) and the condensate was either discharged to cribs or returned to the waste tank to maintain the desired liquid levels in tanks (PNNL-13023, p. 2.2).

Various non-tank sources received large volumes of contaminated waste and other waste streams resulted in extensive vadose zone and groundwater contamination in the areas around the WMA A-AX. These sources include (PNNL-13023, p. 3.4-3.5):

- Surface spills associated with leaks from transfer lines, diversion boxes, catch tanks, and vaults.
- Liquid disposal facilities including cribs, trenches, and french drains were used to discharge from 1,600 gallons to 304 Mgal of volume effluents, including condensate and condenser cooling water, depleted uranium waste, cell and stack drainage waste, and tributyl phosphate (TBP)-kerosene organic waste from PUREX.
- Two of the SSTs in WMA A-AX are declared "assumed leakers" with leaks estimates ranging from 500-2,500 gallons (A-104 in 1975) to 10,000-270,000 gallons (A-105 in 1963) that do not include leaks from transfer lines, other ancillary equipment, surface spills or overflow amounts (Weyns 2014, pp. 18-21). The most significant leak was when the bottom of Tank A-105 ruptured (releasing 10,000-270,000 gallons) resulting from a steam explosion.

The 200-PO-1 OU is being monitored to determine the impact to groundwater prior to determining the path forward for remedial action (DOE/RL-2014-32, Rev. 0).

HIGH-LEVEL WASTE TANKS

See Section 6.3 for details.

GROUNDWATER PLUMES

The 200-PO-1 OU groundwater plumes (Tc-99 and I-129) considered to be associated with the A-AX Tank Farm and co-located liquid waste disposal facilities are described in detail in Section 6.5 with additional information in the Appendix G.5 for the CP-GW-1 EU (200-PO-1 OU).

D&D OF INACTIVE FACILITIES – NOT APPLICABLE

OPERATING FACILITIES – NOT APPLICABLE

Because of the prohibition on waste additions to the Hanford SSTs,[86] the A-AX Tank and Waste Farms EU components are not considered Operating Facilities for this Review.

[86] Berman presentation on July 29, 2009, titled "Hanford Single-Shell Tank Integrity Program." Available at www.em.doe.gov.

ECOLOGICAL RESOURCES SETTING

Landscape Evaluation and Resource Classification:

Approximately 75% of the A-AX Tank and Waste Farms EU has been previously disturbed, or consists of graveled surfaces, buildings, industrial areas and tank farm infrastructure (levels 0 and 1 from (Appendix J, Table 2, p. J-111)). Several large fragments of level 3 habitat remain within the eastern side of the EU (Appendix J, Figure 2, p. J-111).

The amount of each biological resource category was examined in a circular buffer area radiating 1,386 m from the center of the EU (equivalent to 1,490.5 acres). Approximately 26% of the total combined area (EU and associated adjacent landscape) is classified as level 3 or greater habitat. Areas classified as level 4 resources lie outside the 200 East Area fence and were not reviewed as part of this survey.

Field Survey:

Field measurements and visual surveys were conducted in October 2014 in two habitat areas: one resource level 2 area (visual survey) and one resource level 3 area (two transects) (Appendix J, Table 1, p. J-110). The field data confirmed the resource levels shown in (Appendix J, Figure 2, p. J-111). Previous ECAP survey data taken in 2010 noted an occurrence of Piper's daisy in the level 2 habitat in the southwest corner of the EU.

Wildlife observations within the level 3 habitat areas on the east side of the EU included harvester ant hills, small mammal burrows, coyote (*Canis latrans*) tracks, and an unidentified lizard. Previous ECAP survey data collected in 2010 for polygons within the EU also noted white-crowned sparrow (*Zonotrichia leucophrys*), western meadowlark (*Sturnella neglecta*), and house finch (*Carpodacus mexicanus*), as well as northern pocket gopher mounds (*Thomomys talpoides*).

CULTURAL RESOURCES SETTING

Cultural resources known to be located within the A-AX Tank and Waste Farms EU are limited to the Hanford Site Plant Railroad and the 2707AR Sludge Vault Change both contributing properties within the Manhattan Project/Cold War Era Landscape with documentation required and the 244 AR Vault Facility and Canyon and 242BA (242-A Boiler Annex) contributing properties within the Manhattan Project and Cold War Era Historic District with no documentation required. All documentation has been addressed as described in the *Hanford Site Manhattan Project and Cold War Era Historic District Treatment Plan* (DOE RL-97-56). There are no known archaeological sites, or TCPs known to be recorded within the A-AX Tank and Waste Farms EU. Portions of the A-AX Tank Farms Evaluation Unit have been inventoried for archaeological resources. No archaeological sites were located by these surveys. There is a possibility that intact archaeological material is present in the areas that have not been inventoried for archaeological resources (both on the surface and in the subsurface), particularly where pockets of undisturbed soil deposits exist within the A-AX Tank and Waste Farms EU.

Several National Register-eligible properties associated with the Manhattan Project/Cold War Era Landscape both with documentation required (241 AW Underground Liquid Tank Farm) and no documentation required (271 CR Service and Office Building) are located within 500 meters of the A-AX Tank and Waste Farms EU. Also see the list of Manhattan Project/Cold War Era buildings located within the PUREX Evaluation Unit which is located in adjacent to the A-AX Tank and Waste Farms EU. All have been documented as described in the *Hanford Site Manhattan Project and Cold War Era Historic District Treatment Plan* (DOE/RL-97-56).

Historic maps indicate that there is no evidence of historic-era settlement in or near the A-AX Tank and Waste Farms EU. The eastern most portion of the A-AX Tank and Waste Farms EU where Holocene deposits overlap with areas that have only surface disturbance present a moderate potential for the presence of intact archaeological resources associated with all three landscapes to be present subsurface within these areas within A-AX Tank and Waste Farms EU. Geomorphology throughout the rest of the A-AX Tank and Waste Farms EU and extensive ground disturbance suggest a low potential for the presence of intact archaeological resources be present subsurface within these areas within the A-AX Tank and Waste Farms EU. Where pockets of undisturbed soil may exist, it may be appropriate to conduct surface and subsurface archaeological investigations in these areas prior to initiating a remediation activity. 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 associated with these landscapes (e.g. East Benton Historical Society, the Franklin County Historical Society, Prosser Cemetery Association, the Reach and B-Reactor Museum) may need to occur. Indirect effects are always possible when TCPs are known to be located in the general vicinity. Consultation with Hanford Tribes may also 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.

6.5. WASTE AND CONTAMINATION INVENTORY

Table E.6-2 provides inventory estimates of the various source components associated with the A-AX Tank and Waste Farms EU including tank wastes and ancillary equipment, legacy sources including leaks, cribs, trenches, unplanned releases (UPRs), vadose zone sources, saturated zone (plume) estimates, treatment amounts, and remaining vadose zone estimates (i.e., the difference of the vadose zone estimates and the saturated zone and treatment estimates)[87]. This information is further summarized in Figure E.6-3 through Figure E.6-11 before and after planned 99% retrieval[88].

For example, the major sources for Tc-99 and I-129 before retrieval are the A-AX Tank Farm tanks and ancillary equipment. The maximum groundwater threat metric (GTM) (Figure E.6-12)[89] is dominated by the A-AX Tank Farm wastes before retrieval and by ancillary equipment after planned retrieval; this also applies to Tc-99 and I-129. The tritium inventory, both pre- and post-retrieval, is dominated by past discharges to cribs. For chromium, cribs and trenches and the A-AX Tank Farm tanks are major sources before retrieval. After retrieval, cribs and trenches dominate the source of this PC. For nitrate, ancillary equipment and past discharges to cribs and trenches dominate after planned retrieval. Current and post-retrieval uranium inventories are dominated by past discharges to trenches and cribs. For Sr-90 and Cs-137, the post-retrieval inventory is dominated by ancillary equipment. The post-retrieval plutonium isotope inventories are dominated by past discharges to cribs and ancillary equipment.

CONTAMINATION WITHIN PRIMARY EU SOURCE COMPONENTS

Legacy Source Sites

The estimated A-AX Tank Farm inventory for the Legacy / Vadose Zone Source Sites (i.e., cribs, trenches, and soil contaminated by tank leaks and unplanned releases) is summarized in Table E.6-2 and further

[87] The basis for the saturated and vadose zone estimates are provided in Chapter 6 of the Methodology Report (CRESP 2015) and examples are provided in the demonstration section for the 200-UP-1 Operable Unit. These estimates tend to have very high associated uncertainties.

[88] According to the Tri-Party Agreement (Ecology, EPA, and DOE, 1998), retrieval limits for residual wastes are 360 ft^3 and 30 ft^3 for 100-Series and 200-Series tanks, respectively, corresponding to the 99% waste retrieval goal as defined in TPA Milestone M-45-00.

[89] Maximum of the GTMs for Tc-99 and I-129 only.

described in Figure E.6-3 through Figure E.6-11 before and after planned 99% retrieval (which will have no impact on current legacy source site inventories). These values constitute estimates of the initial amounts of contaminants discharged to the vadose zone that are then used to estimate the remaining inventory in the vadose zone as described below (i.e., by difference using the process described in Chapter 6 of the Methodology Report (CRESP 2015)). These estimates necessarily have large associated uncertainties.

Waste Tanks and Ancillary Equipment

The estimated total inventory for all the A-AX Tank Farm High Level Waste Tanks and Ancillary Equipment is provided in Table E.6-2 for both the 90% and planned 99% retrieval scenarios. The tank-by-tank inventories are provided in Table E.6-3 through Table E.6-6. Safety-related information (i.e., hydrogen generation rates and times to the lower flammability limit are also provided in Table E.6-3. The inventories for the various contaminant in the A-AX Tank Farm tanks vary over several orders of magnitude as does the GTM. This information is further summarized in Figure E.6-3 through Figure E.6-11 before and after planned 99% retrieval and for the maximum GTM in Figure E.6-12.

Vadose Zone Contamination

The estimated inventories for the vadose zone, saturated zone, and treatment amounts are found in Table E.6-2. These inventories represent the vadose zone contamination *outside* the tanks and ancillary equipment (i.e., that generally available for transport through the environment). These are used to estimate the inventory remaining in the vadose zone using the process described in Chapter 6 of the Methodology Report (CRESP 2015). The focus in this section will be on the Group A and B contaminants in the vadose zone due to their mobility and persistence and potential threats to groundwater. To summarize:

- *Tc-99, I-129* – There are existing Tc-99 and I-129 plumes in the groundwater that are associated with A-AX Tank and Waste Farms EU sources (DOE/RL-2014-32, Rev. 0). The vadose zone inventory is dominated by ancillary equipment.
- *Sr-90* – There is a small existing Sr-90 plume; however, this plume does not appear to be associated with A-AX Tank and Waste Farms EU sources (DOE/RL-2014-32, Rev. 0). The vadose zone inventory is dominated by ancillary equipment. The TC&WM EIS groundwater transport analysis (Appendix O, DOE/EIS-0391 2012) indicates that Sr-90, despite there already being a small plume, is not expected to reach the A Barrier[90], which is interpreted here to indicate that Sr-90 is not very mobile in the vadose zone near the A-AX Tank and Waste Farms EU relative to it decay. Furthermore, the average water travel time through the vadose zone for a recharge rate of 100 mm/yr is 63 years for the 200-East Area (Table N-52, DOE/EIS-0391 2012) and thus the resulting average Sr-90 travel time accounting for retardation would be more than 300 years (i.e., 63 yr × 4.6 or 10+ half-lives leaving less than 0.10%) to move through the vadose zone[91]. It would likely require more time to reach groundwater in a sufficient amount to exceed the drinking water standard over an appreciable area. Thus a Sr-90 plume is not expected in the next 150 years due to retardation in the vadose zone or after due to radioactive decay (+99.9%

[90] The 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). The A Barrier is the closest to the A-AX Tank and Waste Farms EU. Despite including sources other than those for the A-AX Tank and Waste Farms EU, the analysis in the TC&WM EIS was considered reasonable to assess the rate of movement of contaminants to groundwater through the vadose zone.

[91] The minimum best-estimate K_d for Sr-90 for WMA C (proximate to A-AX) is 1 mL/g (PNNL-17154, p. 3.43), which translates to a retardation factor of ~4.6.

reduction in Sr-90 inventory). Thus Sr-90 is not considered a significant threat to the Hanford groundwater.

- *Uranium* – There is a small existing uranium plume that is not associated with A-AX Tank and Waste Farms EU sources. The vadose zone inventory is dominated by past discharges to cribs and trenches. Thus much of the uranium originally discharged into the vadose would have to travel through the vadose zone until potentially impacting groundwater. The TC&WM EIS groundwater transport analysis (Appendix O, DOE/EIS-0391 2012) indicates that uranium is also not expected to reach the A Barrier. Furthermore, the average water travel time through the vadose zone for a recharge rate of 100 mm/yr is 63 years for the 200-East Area (Table N-52, DOE/EIS-0391 2012), or the uranium travel time might be more than 100 years (i.e., 63 yr × 4.6) for an appreciable amount of uranium to move through the vadose zone[92]. It would likely require almost 300 years (from the original discharge) to reach groundwater in a sufficient amount to exceed the drinking water standard over an appreciable area. Thus an appreciable uranium plume would not be expected in the next 150 years but perhaps during the 1,000-year period after cleanup. Thus total uranium is not considered a significant threat to the Hanford groundwater during the Active Cleanup or Near-term, Post Cleanup periods.
- *Chromium* – There is currently no chromium plume. The vadose zone inventory is dominated by past discharges to cribs and trenches.

Using the process outlined in Chapter 6 of the Methodology Report (CRESP 2015), the vadose zone inventories in Table E.6-2 are estimated and used to calculate Groundwater Threat Metric (GTM) values for the Group A and B contaminants remaining in the vadose zone as illustrated in Table E.6-7. Note that the vadose zone (VZ) ratings range from ND for uranium and Sr-90[93] to *Low* for C-14 and Tc-99 to *Medium* for chromium (total and hexavalent).

Groundwater Plumes

In general groundwater plumes are evaluated in separate EUs; however, those portions of groundwater plumes that can be associated with the TF EU (i.e., a plume with sources associated with the TF EU) will be evaluated to provide a better idea of the saturated zone versus remaining vadose zone threats to groundwater. The estimated inventory for the saturated zone contamination is provided in Table E.6-2 where Photoshop was used to estimate the fraction of the plumes considered associated with the A-AX Tank and Waste Farms EU (Attachment 6-4 in the Methodology Report (CRESP 2015)[94]). This information is also used to estimate amounts treated and remaining in the vadose zone. For the groundwater plumes described in the 200-PO-1 OU (DOE/RL-2014-32, Rev. 0), apportionment of plumes and ratings to the A-AX Tank and Waste Farms EU is as follows:

- *I-129* – There are plumes in the OU; the single plume near the A-AX Tank and Waste Farms EU is considered associated with the EU, and the area of this plume is 5% of the area (CRESP 2015). However, a negative remaining vadose zone inventory was estimated for I-129; thus no rating

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[92] The minimum best-estimate K_d for uranium for WMA C (proximate to WMA A-AX) is 1 mL/g (PNNL-17154, p. 3.43), which translates to a retardation factor of ~4.6.

[93] The remaining vadose zone inventories for uranium and Sr-90 would translate to *Medium* ratings. However, no appreciable Sr-90 or uranium plume would be expected in the next 150 years due to transport considerations; however, uranium may impact groundwater after the 150-year period. Thus *Low* ratings are applied to the period after Active Cleanup is completed to account for uncertainties.

[94] From the graphic map files provided by PNNL, the PhotoShop Magic Wand Tool was used to select areas representing plumes and then the "Record Measurements" Tool was used to provide relative areal extents. A Custom Measurement Scale was set to that of the map.

was made. It is considered likely that the remaining vadose zone inventory (and GTM) might be on the same order of magnitude as that for Tc-99; however, this represents a data gap.

- *H-3, Nitrate, Sr*-90 and uranium – There are current plumes in the OU, but none are considered associated with A-AX Tank and Waste Farms EU sources. Any portions of the plumes that may have resulted from A-AX Tank and Waste Farms EU sources are considered insignificant.
- *Tc-99* – There are plumes in the OU; the plume near the A-AX Tank and Waste Farms EU is considered associated with the EU, and the area of this plume is 26% of the area of the plumes (CRESP 2015).

The groundwater plumes (e.g., I-129 and Tc-99) associated with the A-AX Tank Farm and co-located liquid waste disposal facilities are described in detail in the Appendix G.5 for the CP-GW-1 EU (200-PO-1 GW OU). Note that I-129 (*Very High*), nitrate (*Medium*), and H-3 (*Medium*) are the risk drivers for the 200-PO-1 GW OU; however, only the I-129 has EU sources associated with these plumes and the remaining I-129 in the vadose is indeterminate and the contribution to the existing plume is small. Thus the remaining vadose zone sources would drive the risks associated with this TF EU.

<u>Impact of Recharge Rate and Radioactive Decay on Groundwater Ratings</u>
The TC&WM EIS screening groundwater transport analysis (Appendix O, DOE/EIS-0391 2012) indicates that there may be large impacts resulting from emplacing the engineered surface barrier (and resulting reduction of infiltrating water) on the predicted peak groundwater concentrations at the A Barrier[95]. To summarize, the screening groundwater results including sources in addition to those for the A-AX Tank and Waste Farms EU (Appendix O, DOE/EIS-0391 2012) include[96]:

- Tc-99 peak concentration is 41,700 pCi/L (CY 2121) for the No Action Alternative versus 774 pCi/L (CY 2102) for Landfill Closure where the threshold value is 900 pCi/L.
- I-129 peak concentration is 38.5 pCi/L (CY 2123) for the No Action Alternative versus 1.5 pCi/L (CY 2104) for Landfill Closure where the threshold value is 1 pCi/L.
- Chromium peak concentration is 323 µg/L (CY 3710) for the No Action Alternative versus 81 µg/L (CY 2168) for Landfill Closure where the threshold value is 100 µg/L (total) or 48 µg/L (hexavalent).
- No values are reported at the A Barrier for uranium and Sr-90 for either scenario, which indicates that peak fluxes that were less than 1×10^{-8} Ci/yr for Sr-90 or 1×10^{-8} g/yr for uranium (Appendix O, DOE/EIS-0391 2012, p. O-2).

Despite the large impacts on the predicted peak concentrations, peak values for I-129 and hexavalent chromium were predicted to exceed thresholds at the A Barrier within 150-200 years and thus the saturated and vadose ratings will not be altered even though the impacts may be large. The peak total chromium value is below the standard; thus there would be no plume after cleanup. A rating of *Low* is applied to the total chromium during the Near-term, Post-Cleanup period to address uncertainty. The peak predicted concentration for Tc-99 does not exceed the threshold during the TC&WM EIS evaluation

[95] The 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). The A Barrier is the closest to the A-AX Tank and Waste Farms EU. Despite including sources other than those for the A-AX Tank and Waste Farms EU, the analysis in the TC&WM EIS was considered a reasonable source of information to assess the impact of the engineered surface barrier emplacement.
[96] Analyses specific to each Tank Farm or Central Plateau EU are not available; thus the aggregate screening analysis provided in the TC&WM EIS was used as an indication.

period (10,000 years); thus the Tc-99 saturated zone rating for the Near-term, Post-Cleanup period is also *Low* to address uncertainty.

Based on the TC&WM EIS results, it is assumed that uranium would not reach the groundwater in sufficient quantity to exceed the standard during the Active Cleanup and Near-term Post-Cleanup periods (i.e., any effects would be local); this is based on uranium not reaching the A Barrier during the evaluation period (10,000 years). Thus the uranium is evaluation would result in a *Not Discernible* rating for both the Current and Active Cleanup periods; however, a *Low* rating will be used for the Near-term Post-Cleanup period to address uncertainty.

For Sr-90, the times required for the remaining vadose zone inventory to decay to values that would result in *Medium* and *Low* ratings are 36 and 131 years, respectively. Furthermore, the TC&WM EIS screening analysis described above indicate that it is unlikely that sufficient Sr-90 would reach the groundwater to exceed the drinking water standard in the next 150 years. Thus the Sr-90 ratings would be ND for both the Current and Active Cleanup periods; however, a *Low* rating will be used for the Near-term Post-Cleanup period to address uncertainty.

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.

Benthic and Riparian Zone – Current Impacts

Based on the information in the 2013 Hanford Annual Groundwater Report (DOE/RL-2014-32, Rev. 0) and PHOENIX (http://phoenix.pnnl.gov/), only the tritium (Group C) plume from the 200-PO-1 OU currently intersects the Columbia River at concentrations exceeding the appropriate water quality standard (WQS). Using the framework process (Figure 6-11, Chapter 6, Methodology Report (CRESP 2015)), since this plume is not associated with the A-AX Tank and Waste Farms EU (DOE/RL-2014-32, Rev. 0), a *Not Discernible* rating for the current impact of tritium on the Columbia River is ascribed.

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 and the fact that no source associated with the A-AX Tank and Waste Farms EU would likely impact the Columbia River (within these evaluation periods) (Appendix O, DOE/EIS-0391 2012); a *Not Discernible* rating for H-3 would also apply to these evaluation periods.

Because other 200-PO-1 OU plumes (Tc-99 and I-129) associated with the A-AX Tank and Waste Farms EU originate from 200-East, it is possible that a current plume might reach the Columbia River in the next 150 years since these contaminants are assumed to move unretarded and the *water* travel time is ~10-30 years from 200-East to the Columbia River (Gephart 2003; PNNL-6415 Rev. 18). Following the framework process (Figure 6-11, Chapter 6, Methodology Report (CRESP 2015)), the ratio, R1, of the peak predicted concentration (Table O-8, Appendix O, DOE/EIS-0391 2012, p. O-59) incorporating source in addition to those from the A-AX Tank and Waste Farms EU to the BCG for each radioactive A-AX Tank and Waste Farms EU contaminant with a current plume (I-129 and Tc-99[97]) is significantly less than one,

[97] Sr-90 and uranium have current plumes but neither is associated with the A-AX Tank and Waste Farms EU nor is expected to reach the Columbia River in the next 10,000 years.

which leads to a *Not Discernible* rating for both the Active Cleanup and Near-term, Post-Cleanup impacts of I-129 and Tc-99 (current radioactive plumes) on the Columbia River.

Benthic and Riparian Zone – Active Cleanup and Near-term, Post Cleanup for Vadose Zone Contaminants

The TC&WM EIS results of the screening evaluation at the near-shore region under the No Action Alternative (DOE/EIS-0391 2012, Appendix O) indicate that, although not a current 200-PO-1 plume, the chromium concentration could exceed thresholds for chromium (48 or 100 µg/L) and the benchmark threshold[98] (as well as the ambient water quality criterion of 10 µg/L) for hexavalent chromium. The predicted concentrations are likely overestimated since all discharge is assumed to occur in a 40-m near-shore region; furthermore, recent well data indicate that chromium (and other contaminants) from 200-East is moving much more slowly than predicted in the TC&WM EIS[99].

Following the procedure outlined in Chapter 6 of the Methodology Report, the ratio (R1) of the maximum concentration (expected in the next 150 years) for chromium (assumed to be hexavalent) of 232 µg/L[100] to the AWQC (10 µg/L for hexavalent chromium) exceeds the threshold value of 5. Furthermore, a chromium plume (from sources in addition to those from the A-AX Tank and Waste Farms EU) is predicted to intersect the Columbia River along a 40-m near-shore zone (DOE/EIS-0391 2012, Appendix P, p. P-53)[101]. Using the matrix in Table 6-5 (Chapter 6, Methodology Report (CRESP 2015)) for the benthic zone using the ratio of R1 for R2 (since the 95% UCL is not available) and a 40-m river reach, the hexavalent chromium would translate to a (benthic) rating of *Medium* during the Active Cleanup and Near-term, Post-Cleanup periods. However, since well data suggest that chromium is not moving toward the Columbia River at the predicted rate, a rating of *Not Discernible* is ascribed for the benthic ecology.

Using the ratio R1 (instead of R2 since an estimate of R2 is unavailable) and assuming an approximate 0.023 ha riparian zone area per river reach (m) or 0.9 ha[102], the hexavalent chromium values translate (Table 6-6, Chapter 6, Methodology Report) into a (riparian) rating of *High* (for the Active Cleanup and Near-term, Post-Cleanup periods). However, since well data suggest that chromium is not moving toward the Columbia River at the predicted rate, a rating of *Not Discernible* is ascribed for the riparian zone.

Benthic and Riparian Zone – Long-term

An ecological screening analysis was performed in the TC&WM EIS (DOE/EIS-0391 2012, Appendix P) to evaluate potential long-term impacts of radioactive and chemical contaminants (*under a No Action Alternative for sources including but not limited to those from the A-AX Tank and Waste Farms EU*) discharged with groundwater on aquatic and riparian receptors at the nearshore region of the Columbia

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[98] The benchmark value used for chromium (hexavalent) in the TC&WM EIS was the sensitive-species-test-effect concentration that affects 20 percent of a test population (EC_{20}) despite the fact that the less toxic trivalent form of chromium is more like to be present in oxygenated, aquatic environs (DOE/EIS-0391 2012, Appendix P, pp. P-52 to P-53).

[99] Note that TC&WM EIS predictions indicate possible impacts from chromium to the benthic and riparian zones within the next decade; however, actual well measurements for chromium and other contaminants show no likely impacts in the foreseeable future from 200-West or 200-East sources, including the next 150 years.

[100] DOE/EIS-0391 2012, Appendix O, p. O-60 for maximum concentrations related to cribs and trenches including the period before CY 2050.

[101] The intersection between the current tritium plume originating from the 200-East Area and the Columbia River is approximately 4,600 m (Chapter 6, Methodology) or more than two orders of magnitude higher.

[102] The maximum ratio of the riparian zone area estimated by PNNL to the shoreline impact (River Reach) along the River Corridor for hexavalent chromium was 0.023 ha per m of river reach (Chapter 6, Methodology Report).

River. The screening results 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).

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 chromium and nitrate would have expected Hazard Quotients exceeding one for aquatic and riparian receptors over the evaluation period (10,000 years) in the TC&WM EIS. 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 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 A-AX Tank and Waste Farms 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). For the long-term evaluation period (>150 years), the peak concentration for chromium (assumed to be hexavalent from all sources including the A-AX Tank and Waste Farms EU) is 84 µg/L[103] would translate to some additional risk to benthic and riparian receptors (i.e., exceeds the screening threshold). This is consistent with the statements in the TC&WM EIS[104]:

> “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 Section 2.5, 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 Alternative 2B (*Tank Closure Alternative 2B: Expanded WTP Vitrification; Landfill Closure*) gives an idea of the impact on chromium (i.e., the only contaminant with ratings above Not Discernible) in the nearshore region if surface barriers are emplaced (i.e., Landfill Closure). The maximum predicted chromium concentration for the Landfill Closure Alternatives is 228 µg /L (DOE/EIS-0391 2012, Appendix O, p. O-67 for cribs and trenches) versus a value of 232 µg/L for the No Action Alternative. Thus ratings for the benthic and riparian zone would not change based on surface barrier

[103] DOE/EIS-0391 2012, Appendix O, p. O-59 for maximum concentrations for all sources after CY 2050.

[104] 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)

installation and changes in recharge rates. This is not due to ineffectiveness of the barrier but instead due to large amounts of contaminant already in the groundwater and possible impacts from sources outside the A-AX Tank and Waste Farms EU.

Facilities for D&D – Not Applicable

Operating Facilities – Not Applicable

Because of the prohibition on waste additions to the Hanford SSTs,[105] the A-AX Tank and Waste Farms EU components are not considered Operating Facilities for this Review.

[105] Berman presentation on July 29, 2009, titled "Hanford Single-Shell Tank Integrity Program." Available at www.em.doe.gov.

Table E.6-2. Summary Table of Infrastructure and Subsurface Contamination Inventory for the A-AX Tank and Waste Farms Evaluation Unit (CP-TF-5) [a][b]

Contaminated Media	Primary Contaminants	Total Amount. of Each Contaminant Before Retrieval	90% Retrieval Scenario	99% Retrieval Scenario
Infrastructure (Tanks and Ancillary Equipment)				
Tank Waste	Waste (kGal)	1384	138.4	13.84
	Sludge (kGal)	144	14.4	1.44
	Saltcake (kGal)	1233	123.3	12.33
	Supernatant (kGal)	7	0.7	0.07
Tank Waste (rad)	Am-241 (Ci)	12000	1200	120
	C-14 (Ci)	23	2.3	0.23
	Co-60 (Ci)	550	55	5.5
	Cs-137 (Ci)	1300000	130000	13000
	Eu-152 (Ci)	230	23	2.3
	Eu-154 (Ci)	9900	990	99
	H-3 (Ci)	62	6.2	0.62
	I-129 (Ci)	0.75	0.075	0.0075
	Ni-59 (Ci)	88	8.8	0.88
	Ni-63 (Ci)	8000	800	80
	Pu (total) (Ci)	9600	960	96
	Sr-90 (Ci)	8100000	810000	81000
	Tc-99 (Ci)	1100	110	11
	U (total) (Ci)	37	3.7	0.37
Tank Waste (non-rad)	Cr (kg)	23000	2300	230
	Hg (kg)	370	37	3.7
	NO3 (kg)	990000	99000	9900
	Pb (kg)	5800	580	58
	U (total) (kg)	15000	1500	150

Contaminated Media	Primary Contaminants	Total Amount. of Each Contaminant Before Retrieval	90% Retrieval Scenario	99% Retrieval Scenario
Ancillary Equipment (rad)	C-14 (Ci)	1.4	1.4	1.4
	Cs-137 (Ci)	17000	17000	17000
	H-3 (Ci)	4.2	4.2	4.2
	I-129 (Ci)	0.013	0.013	0.013
	Pu (total) (Ci)	40	40	40
	Sr-90 (Ci)	88000	88000	88000
	Tc-99 (Ci)	10	10	10
	U (total) (Ci)	0.31	0.31	0.31
Ancillary Equipment (non-rad)	Cr (kg)	220	220	220
	Hg (kg)	1.8	1.8	1.8
	NO3 (kg)	20000	20000	20000
	Pb (kg)	47	47	47
	U (total) (kg)	110	110	110
Vadose Zone Source (Leaks and Intentional Discharges into Cribs and Trenches)				
Leaks (rad)	C-14 (Ci)	0.12	0.12	0.12
	Cs-137 (Ci)	4800	4800	4800
	H-3 (Ci)	0.086	0.086	0.086
	I-129 (Ci)	0.0015	0.0015	0.0015
	Pu (total) (Ci)	0.76	0.76	0.76
	Sr-90 (Ci)	280	280	280
	Tc-99 (Ci)	1.3	1.3	1.3
	U (total) (Ci)	0.0052	0.0052	0.0052
Leaks (non-rad)	Cr (kg)	8.8	8.8	8.8
	Hg (kg)	0.0018	0.0018	0.0018
	NO3 (kg)	540	540	540
	Pb (kg)	0.53	0.53	0.53
	U (total) (kg)	4.7	4.7	4.7

Contaminated Media	Primary Contaminants	Total Amount. of Each Contaminant Before Retrieval	90% Retrieval Scenario	99% Retrieval Scenario
Cribs (rad)	Am-241 (Ci)	1.1	1.1	1.1
	C-14 (Ci)	7.7	7.7	7.7
	Co-60 (Ci)	0.022	0.022	0.022
	Cs-137 (Ci)	5800	5800	5800
	Eu-152 (Ci)	0.0078	0.0078	0.0078
	Eu-154 (Ci)	0.62	0.62	0.62
	H-3 (Ci)	34000	34000	34000
	I-129 (Ci)	0.0013	0.0013	0.0013
	Ni-59 (Ci)	0.0013	0.0013	0.0013
	Ni-63 (Ci)	0.12	0.12	0.12
	Pu (total) (Ci)	1500	1500	1500
	Sr-90 (Ci)	27	27	27
	Tc-99 (Ci)	0.13	0.13	0.13
	U (total) (Ci)	15	15	15
Cribs (non-rad)	Cr (kg)	880	880	880
	Hg (kg)	6.3	6.3	6.3
	NO3 (kg)	25000	25000	25000
	Pb (kg)	160	160	160
	TBP (kg)	310000	310000	310000
	U (total) (kg)	3000	3000	3000
Trenches (rad)	Am-241 (Ci)	0.00027	0.00027	0.00027
	C-14 (Ci)	0.0034	0.0034	0.0034
	H-3 (Ci)	2.3	2.3	2.3
	Pu (total) (Ci)	0.00057	0.00057	0.00057
	Sr-90 (Ci)	0.00042	0.00042	0.00042
	U (total) (Ci)	30	30	30
Trenches (non-rad)	Cr (kg)	720	720	720

Contaminated Media	**Primary Contaminants**	**Total Amount. of Each Contaminant Before Retrieval**	**90% Retrieval Scenario**	**99% Retrieval Scenario**
	Hg (kg)	29	29	29
	NO3 (kg)	18000	18000	18000
	Pb (kg)	40	40	40
	U (total) (kg)	45000	45000	45000
UPR (rad)	Am-241 (Ci)	6.80E-07	6.80E-07	6.80E-07
	C-14 (Ci)	2.00E-07	2.00E-07	2.00E-07
	Co-60 (Ci)	1.90E-06	1.90E-06	1.90E-06
	Cs-137 (Ci)	0.03	0.03	0.03
	Eu-152 (Ci)	1.10E-07	1.10E-07	1.10E-07
	Eu-154 (Ci)	8.30E-06	8.30E-06	8.30E-06
	H-3 (Ci)	0.19	0.19	0.19
	I-129 (Ci)	3.90E-09	3.90E-09	3.90E-09
	Ni-59 (Ci)	5.60E-08	5.60E-08	5.60E-08
	Ni-63 (Ci)	5.30E-06	5.30E-06	5.30E-06
	Pu (total) (Ci)	1.40E-06	1.40E-06	1.40E-06
	Sr-90 (Ci)	0.00025	0.00025	0.00025
	Tc-99 (Ci)	0.00084	0.00084	0.00084
	U (total) (Ci)	0.0037	0.0037	0.0037
UPR (non-rad)	Cr (kg)	0.00077	0.00077	0.00077
	Hg (kg)	2.30E-05	2.30E-05	2.30E-05
	NO3 (kg)	95	95	95
	Pb (kg)	4.70E-06	4.70E-06	4.70E-06
	U (total) (kg)	5.4	5.4	5.4
Vadose Zone (from Vadose Zone Sources)				
VZ Remaining (rad)	Am-241 (Ci)	1.1	1.1	1.1
	C-14 (Ci)	7.9	7.9	7.9
	Co-60 (Ci)	0.022	0.022	0.022

Contaminated Media	**Primary Contaminants**	**Total Amount. of Each Contaminant Before Retrieval**	**90% Retrieval Scenario**	**99% Retrieval Scenario**
	Cs-137 (Ci)	11000	11000	11000
	Eu-152 (Ci)	0.0078	0.0078	0.0078
	Eu-154 (Ci)	0.62	0.62	0.62
	H-3 (Ci)	34000	34000	34000
	I-129 (Ci)	0(c)	0(c)	0(c)
	Ni-59 (Ci)	0.0013	0.0013	0.0013
	Ni-63 (Ci)	0.12	0.12	0.12
	Pu (total) (Ci)	1500	1500	1500
	Sr-90 (Ci)	310	310	310
	Tc-99 (Ci)	1.3	1.3	1.3
	U (total) (Ci)	46	46	46
VZ Remaining (non-rad)	Cr (kg)	1600(d)	1600(d)	1600(d)
	Cr-VI (kg)	1600(d)	1600(d)	1600(d)
	Hg (kg)	35	35	35
	NO3 (kg)	43000	43000	43000
	Pb (kg)	200	200	200
	TBP (kg)	310000	310000	310000
	U (total) (kg)	48000	48000	48000
Saturated Zone (from Vadose Zone Sources)				
SZ Inventory (rad)	I-129 (Ci)	0.066	0.066	0.066
	Tc-99 (Ci)	0.1	0.1	0.1

a. Tanks (SST and DST): Best Basis Inventory (BBI) March 2014; Ancillary Equipment (Anc Eq): Tank Farm Closure & Waste Management (TC&WM) Environmental Impact Statement (DOE/EIS-0391) Appendix D; Unplanned Releases (UPRs): Soil Inventory Model (SIM) Rev 1 (RPP-26744, Rev 0); Ponds: Soil Inventory Model (SIM) Rev 1 (RPP-26744, Rev 0); Cribs: Soil Inventory Model (SIM) Rev 1 (RPP-26744, Rev 0); Trenches: Soil Inventory Model (SIM) Rev 1 (RPP-26744, Rev 0) and Tank Farm Closure & Waste Management (TC&WM) Environmental Impact Statement (DOE/EIS-0391) Appendix S; Leaks: Tank Farm Closure & Waste Management (TC&WM) Environmental Impact Statement (DOE/EIS-0391) Appendix D; MUSTs: Soil Inventory Model (SIM) Rev 1 (RPP-26744, Rev 0) and Tank Farm Closure & Waste Management (TC&WM) Environmental Impact Statement (DOE/EIS-0391) Appendix S.

b. All primary contaminant inventories are reported to 2 significant figures. The source document should be consulted for greater precision data.

c. Small negative value obtained by difference.

d. Differences in inventories for Cr vs Cr-IV are due to differing Water Quality Standards (WQS) and thus plume extents: 100 mg/L for total chromium vs 48 mg/L for chromium (IV). The difference may not be distinguishable within the number of significant digits (2) displayed.

Table E.6-3. Current Bulk Inventory and Steady State Flammability Results (by Tank) for the A-AX Tank Farms (CP-TF-5)

Tank ID	Tank Type	Capacity (kGal)[a]	Sludge (kGal)[a]	Saltcake (kGal)[a]	Supernatant (kGal)[a]	HGR(c) (ft3/d)[b]	Days to 25% LFL Barometric[c]	Days to 25% LFL Zero Ventilation[d]
A-101	SST	1000	3	317	0	1.4	NA	722
A-102	SST	1000	0	37	3	0.51	NA	>1826
A-103	SST	1000	2	372	4	2.3	NA	475
A-104	SST	1000	28	0	0	0.32	NA	>1826
A-105	SST	1000	37	0	0	0.33	NA	>1826
A-106	SST	1000	50	29	0	2.1	NA	693
AX-101	SST	1000	3	355	0	1.7	NA	NA
AX-102	SST	1000	6	24	0	0.74	NA	NA
AX-103	SST	1000	8	99	0	1.1	NA	NA
AX-104	SST	1000	7	0	0	1	NA	NA

a. Volumes from the Waste Tank Summary Report coinciding with the BBI (Rodgers 2014).

b. Hydrogen generation rate (ft^3/d) (RPP-5926 Rev. 15). Note in 2001 all 24 tanks were removed from the flammable gas watch list (including T-110 in the T Tank and Waste Farms EU) (Johnson, et al. 2001, p. iii).

c. Time (in days) to 25% of the Lower Flammability Limit (LFL) under a barometric (barom) breathing scenario (RPP-5926, Rev. 15). "NA" indicates that the headspace will not reach specified flammability level.

d. Time (in days) to 25% of the LFL under a zero ventilation scenario (RPP-5926, Rev. 15).

Table E.6-4. Current Primary Contaminant Inventory (by Tank) for the A-AX Tank Farms (CP-TF-5) [(a)]

Tank ID	Decay Date	Am-241 (Ci)	C-14 (Ci)	Cl-36 (Ci)	Co-60 (Ci)	Cs-137 (Ci)	Eu-152 (Ci)	Eu-154 (Ci)	H-3 (Ci)
A-101	2001	380	6.6	NP[(b)]	25	280000	6.5	420	16
A-102	2001	250	0.25	NP	11	37000	0.21	13	1.7
A-103	2001	240	4.6	NP	8.9	260000	1.7	110	13
A-104	2001	810	0.37	NP	79	57000	7.3	940	1.4
A-105	2001	5600	0.49	NP	180	98000	100	2100	1.3
A-106	2001	590	0.52	NP	29	59000	55	3400	3.9
AX-101	2001	390	8.2	NP	26	370000	4.8	300	20
AX-102	2001	2100	0.066	NP	60	22000	17	560	1.5
AX-103	2001	720	1.7	NP	42	110000	13	1400	4.1
AX-104	2001	950	0.11	NP	87	45000	22	630	0.29

a. From Best Basis Inventory (BBI) Summary (March 24, 2014) provided in spreadsheet form by Mark Triplett. All primary contaminant inventories are reported to 2 significant figures. The source document should be consulted for greater precision data.

b. NP = Not present at significant quantities

Table E.6-5. Current Primary Contaminant Inventory [a] and Groundwater Threat Metric (by Tank) for the A-AX Tank Farms (CP-TF-5)

Tank ID	I-129 (Ci)	Ni-59 (Ci)	Ni-63 (Ci)	Pu (total) (Ci)[b]	Sr-90 (Ci)	Tc-99 (Ci)	U (total) (Ci)[c]	GTM (Mm3)[d]
A-101	0.23	14	1300	220	110000	230	3.6	250
A-102	0.022	1.5	140	860	71000	37	18	41
A-103	0.048	12	1100	590	110000	260	7.1	290
A-104	0.0073	9.8	890	1500	2100000	14	1.4	16
A-105	0.0017	13	1200	1600	2600000	28	0.0018	31
A-106	0.063	11	1000	2700	450000	150	0.8	160
AX-101	0.3	17	1500	310	200000	290	3.6	320
AX-102	0.017	1.7	160	810	210000	6.3	1.5	7
AX-103	0.068	5.1	460	260	400000	70	0.28	78
AX-104	0.00037	2.8	260	770	1900000	21	0.12	23

a. From Best Basis Inventory (BBI) Summary (March 24, 2014) provided in spreadsheet form by Mark Triplett. All primary contaminant inventories are reported to 2 significant figures. The source document should be consulted for greater precision data.

b. Sum of plutonium isotopes 238, 239, 240, 241, and 242

c. Sum of uranium isotopes 232, 233, 234, 235, 236, and 238

d. The Groundwater Threat Metric (GTM) shown for tanks is equal to the maximum of the GTM for Tc-99 and I-129.

Table E.6-6. Current Primary Contaminant Inventory (by Tank) for the A-AX Tank Farms (CP-TF-5) [(a)]

Tank ID	CCl4 (kg)	CN (kg)	Cr (kg)	Cr-VI (kg)	Hg (kg)	NO3 (kg)	Pb (kg)	TBP (kg)	TCE (kg)	U (total) (kg)
A-101	NP[(b)]	NP	6600	NP	3.4	240000	330	NP	NP	1300
A-102	NP	NP	1600	NP	0.19	25000	260	NP	NP	6400
A-103	NP	NP	2700	NP	2.6	230000	230	NP	NP	2500
A-104	NP	NP	180	NP	37	300	58	NP	NP	1700
A-105	NP	NP	640	NP	38	17000	2800	NP	NP	2.6
A-106	NP	NP	3300	NP	260	50000	670	NP	NP	520
AX-101	NP	NP	6100	NP	14	340000	200	NP	NP	1700
AX-102	NP	NP	100	NP	7.6	26000	440	NP	NP	540
AX-103	NP	NP	2100	NP	5.2	68000	390	NP	NP	190
AX-104	NP	NP	29	NP	8.3	2300	470	NP	NP	170

a. From Best Basis Inventory (BBI) Summary (March 24, 2014) provided in spreadsheet form by Mark Triplett. All primary contaminant inventories are reported to 2 significant figures. The source document should be consulted for greater precision data.

b. NP = Not present at significant quantities

Table E.6-7. Summary of the Evaluation of Threats to Groundwater as a Protected Resource from Remaining Vadose Zone (VZ) Contamination associated with the A-AX Tank and Waste Farms Evaluation Unit (CP-TF-5)

PC	Group	WQS	Porosity[(a)]	K_d (mL/g)[(a)]	ρ (kg/L)[(a)]	VZ Source M^{Source}	SZ Total M^{SZ}	Treated[(c)] M^{Treat}	VZ Remaining $M^{Tot\ (d)}$	VZ GTM (Mm^3)	VZ Rating[(e)]
C-14	A	2000 pCi/L	0.25	0	1.82	7.85E+00 Ci	---	---	7.85E+00 Ci	3.93E+00	Low
I-129	A	1 pCi/L	0.25	0.2	1.82	2.82E-03 Ci	6.59E-02 Ci	---	---[(f)]	---	---
Sr-90	B	8 pCi/L	0.25	22	1.82	3.07E+02 Ci	---	---	3.07E+02 Ci	2.38E+02	ND[g]
Tc-99	A	900 pCi/L	0.25	0	1.82	1.42E+00 Ci	9.95E-02 Ci	---	1.32E+00 Ci	1.46E+00	Low
CCl_4	A	5 µg/L	0.25	0	1.82	---	---	---	---	---	ND
Cr	B	100 µg/L	0.25	0	1.82	1.61E+03 kg	---	---	1.61E+03 kg	1.61E+01	Medium
Cr-VI	A	48 µg/L[(b)]	0.25	0	1.82	1.61E+03 kg	---	---	1.61E+03 kg	3.35E+01	Medium
TCE	B	5 µg/L	0.25	2	1.82	---	---	---	---	---	ND
U(tot)	B	30 µg/L	0.25	0.8	1.82	4.77E+04 kg	---	---	4.77E+04 kg	2.33E+02	ND[g]

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

b. "Model Toxics Control Act–Cleanup" (WAC 173-340) Method B groundwater cleanup level for hexavalent chromium. Other WQS values represent drinking water standards.

c. Treatment amounts from the 2013 Hanford Annual Groundwater Report (DOE/RL-2014-32, Rev. 0).

d. The remaining vadose zone inventory is estimated by difference (CRESP 2015) and thus has a high associated uncertainty.

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

f. Calculation produced a negative remaining vadose zone inventory for I-129; thus no rating was made, which represents a gap in the analysis. It is considered likely that the remaining vadose zone inventory (and GTM) might be on the same order of magnitude as that for Tc-99.

g. For Sr-90, the times required for the remaining vadose zone inventory to decay to values that would result in Medium and Low ratings are 36 and 131 years, respectively. However, as discussed in Section 6.5, no appreciable uranium or Sr-90 plume would be expected in the next 150 years due to transport and decay (Sr-90) considerations. Thus the *Low* rating would apply to the period *after* the Active Cleanup is complete to account for uncertainties.

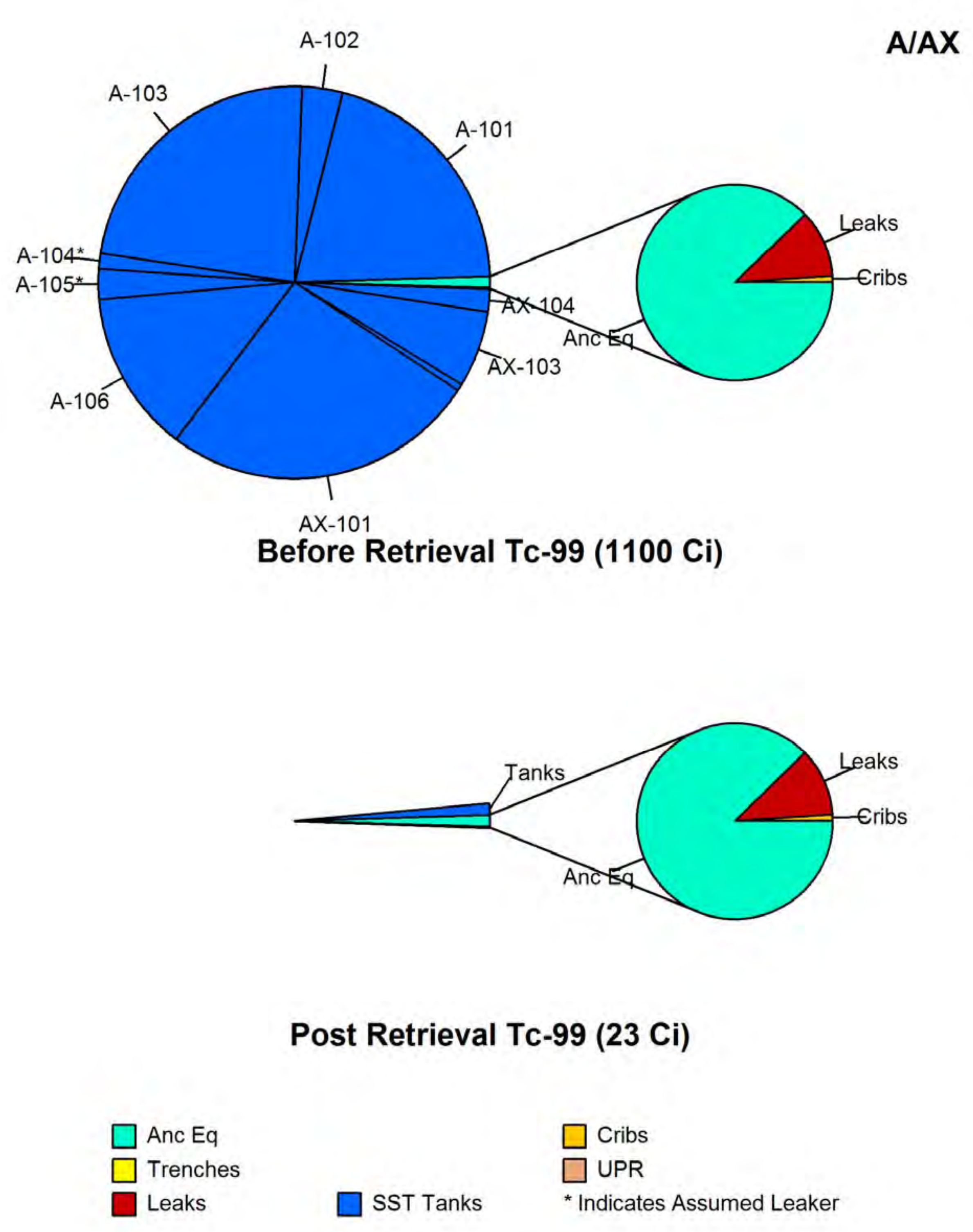

Figure E.6-3. A-AX Tank and Waste Farms Evaluation Unit Inventory Estimates for Tc-99 Before and After 99% Retrieval

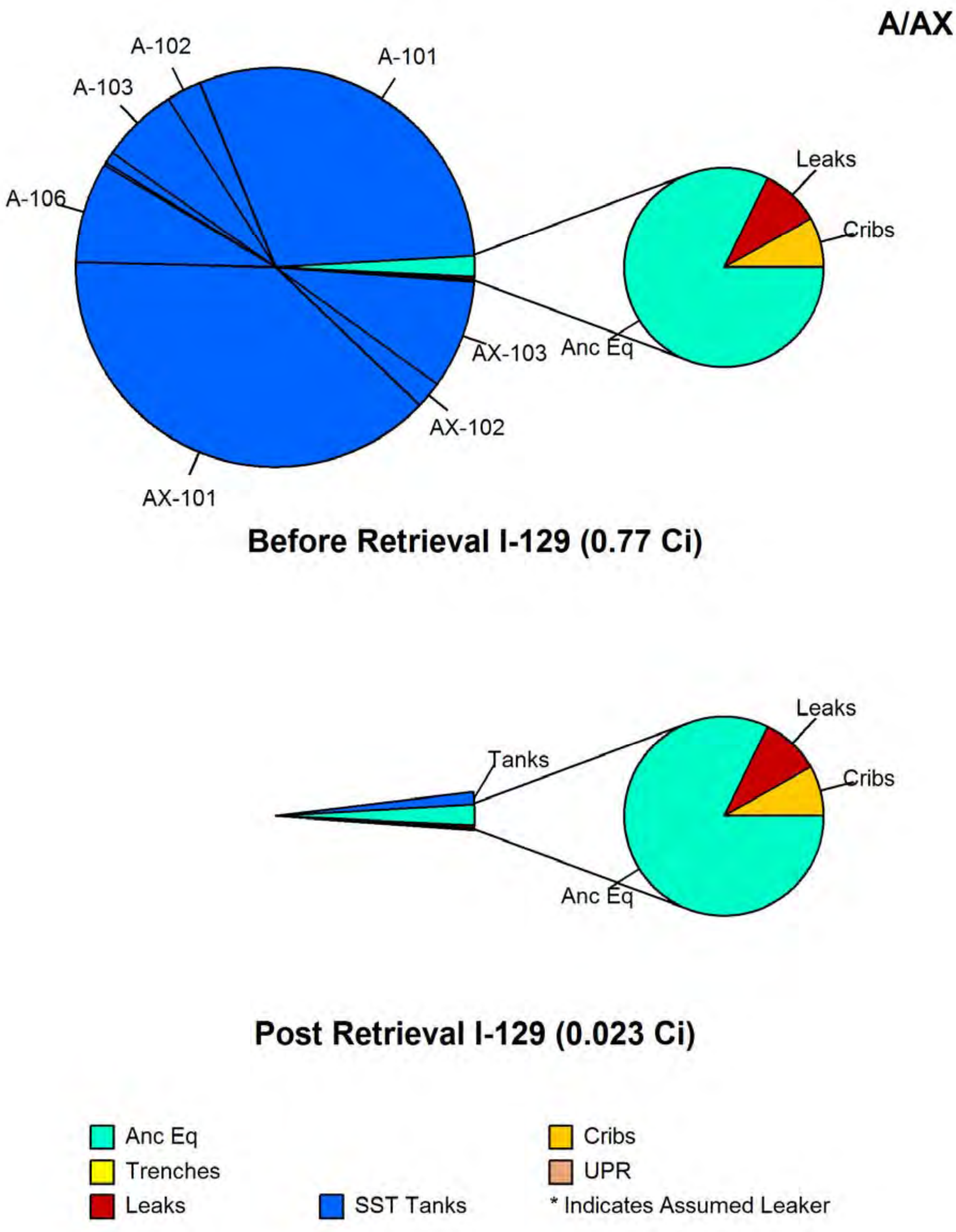

Figure E.6-4. A-AX Tank and Waste Farms Evaluation Unit Inventory Estimates for I-129 Before and After 99% Retrieval

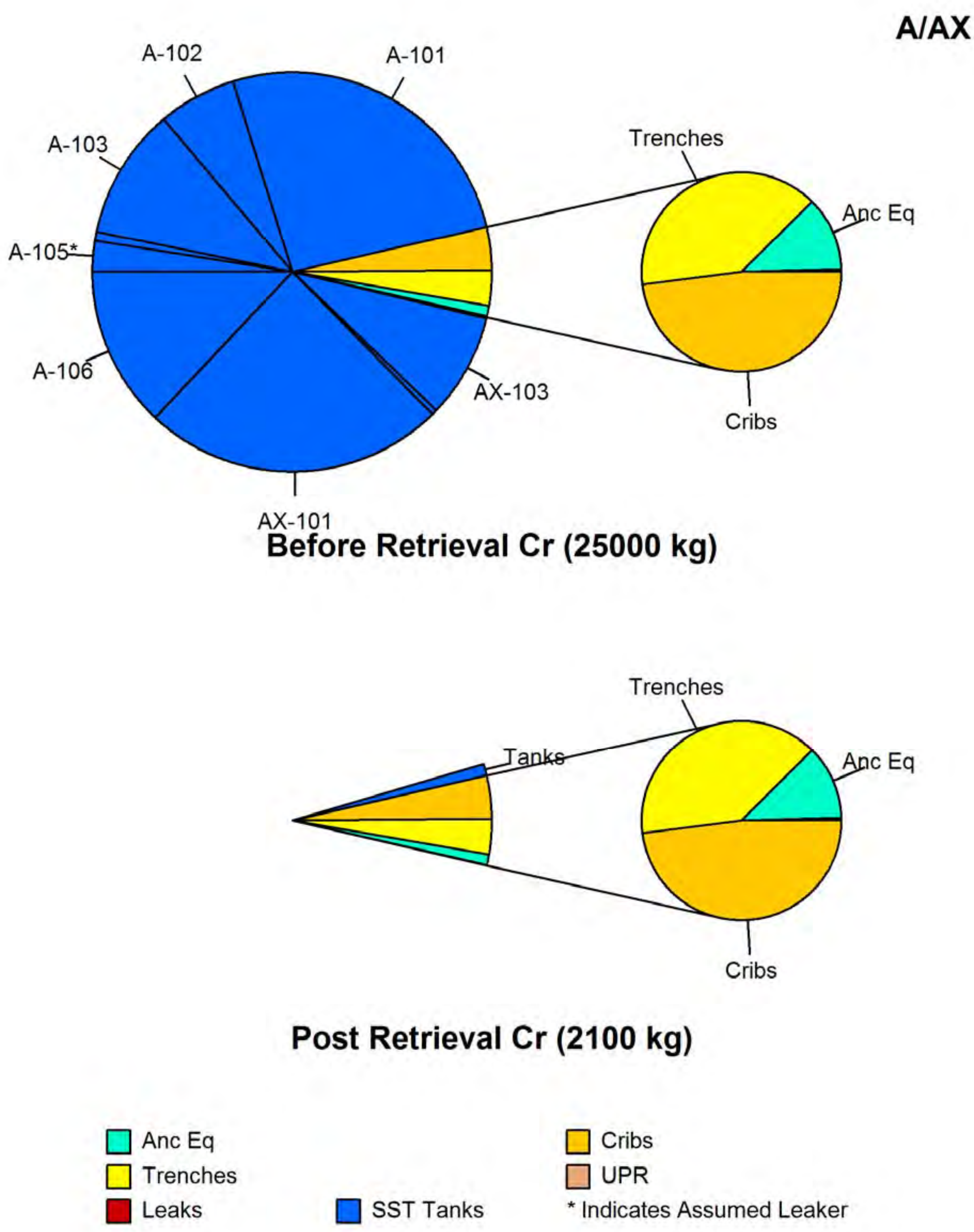

Figure E.6-5. A-AX Tank and Waste Farms Evaluation Unit Inventory Estimates for Chromium Before and After 99% Retrieval

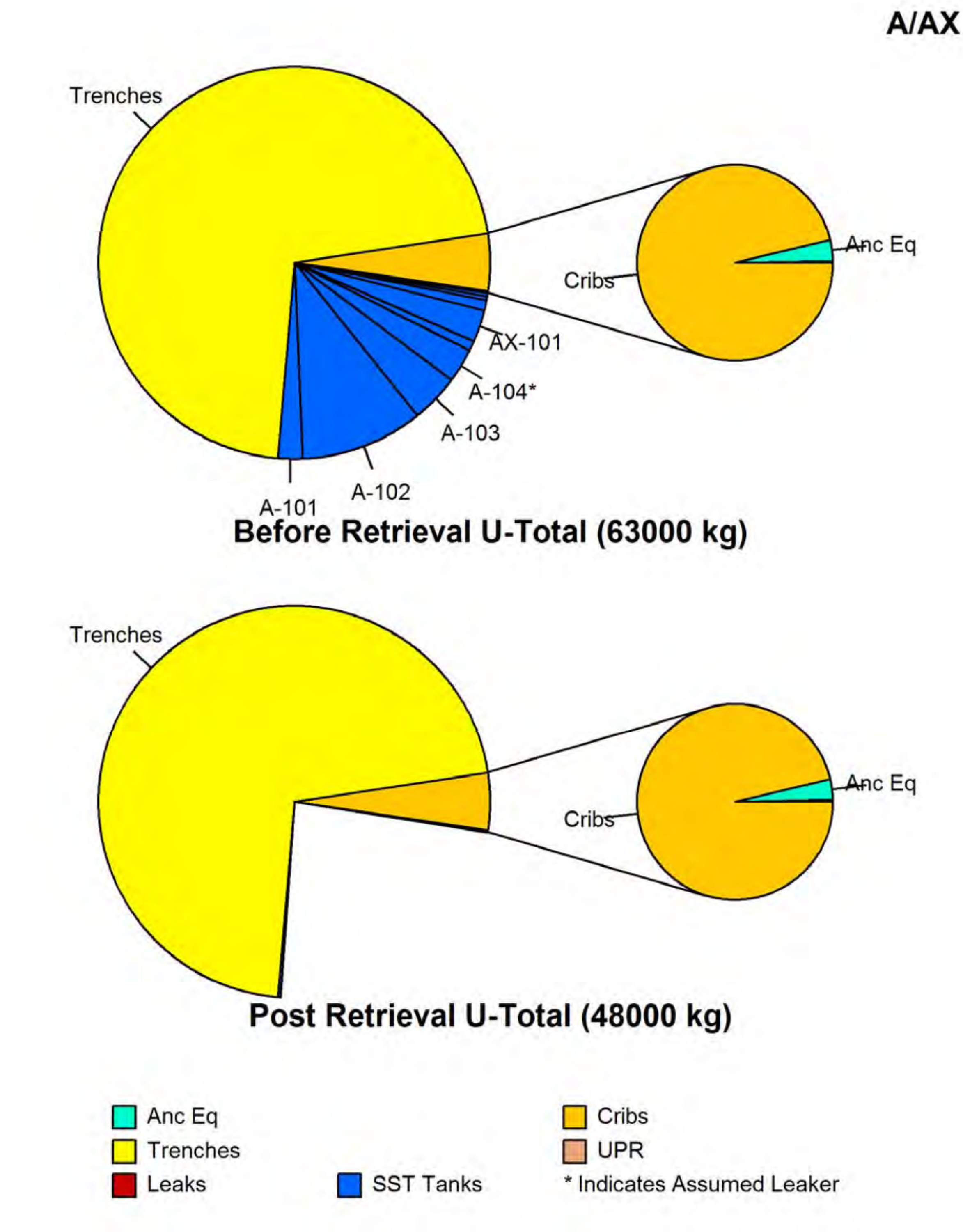

Figure E.6-6. A-AX Tank and Waste Farms Evaluation Unit Inventory Estimates for U(tot) Before and After 99% Retrieval

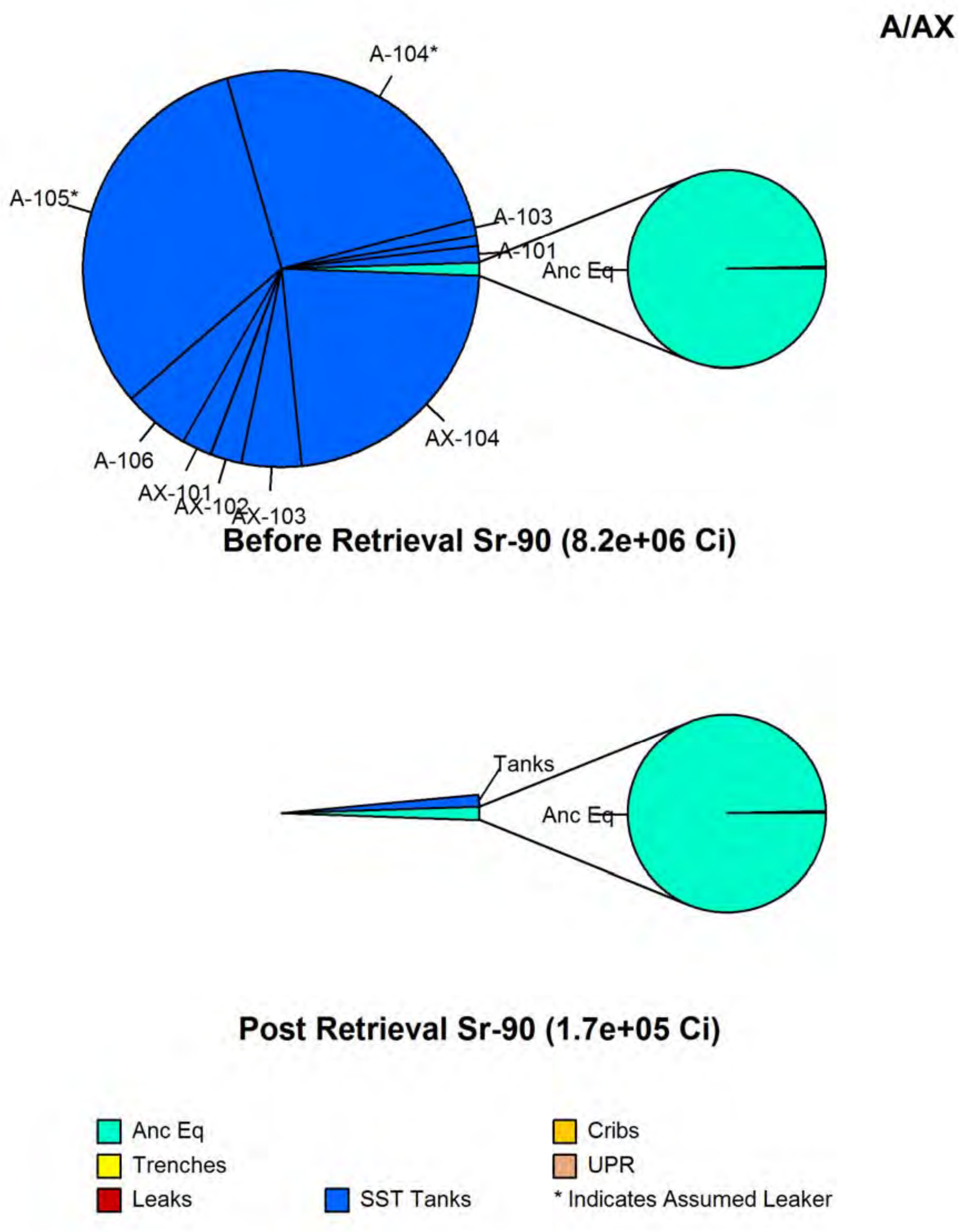

Figure E.6-7. A-AX Tank and Waste Farms Evaluation Unit Inventory Estimates for Sr-90 Before and After 99% Retrieval

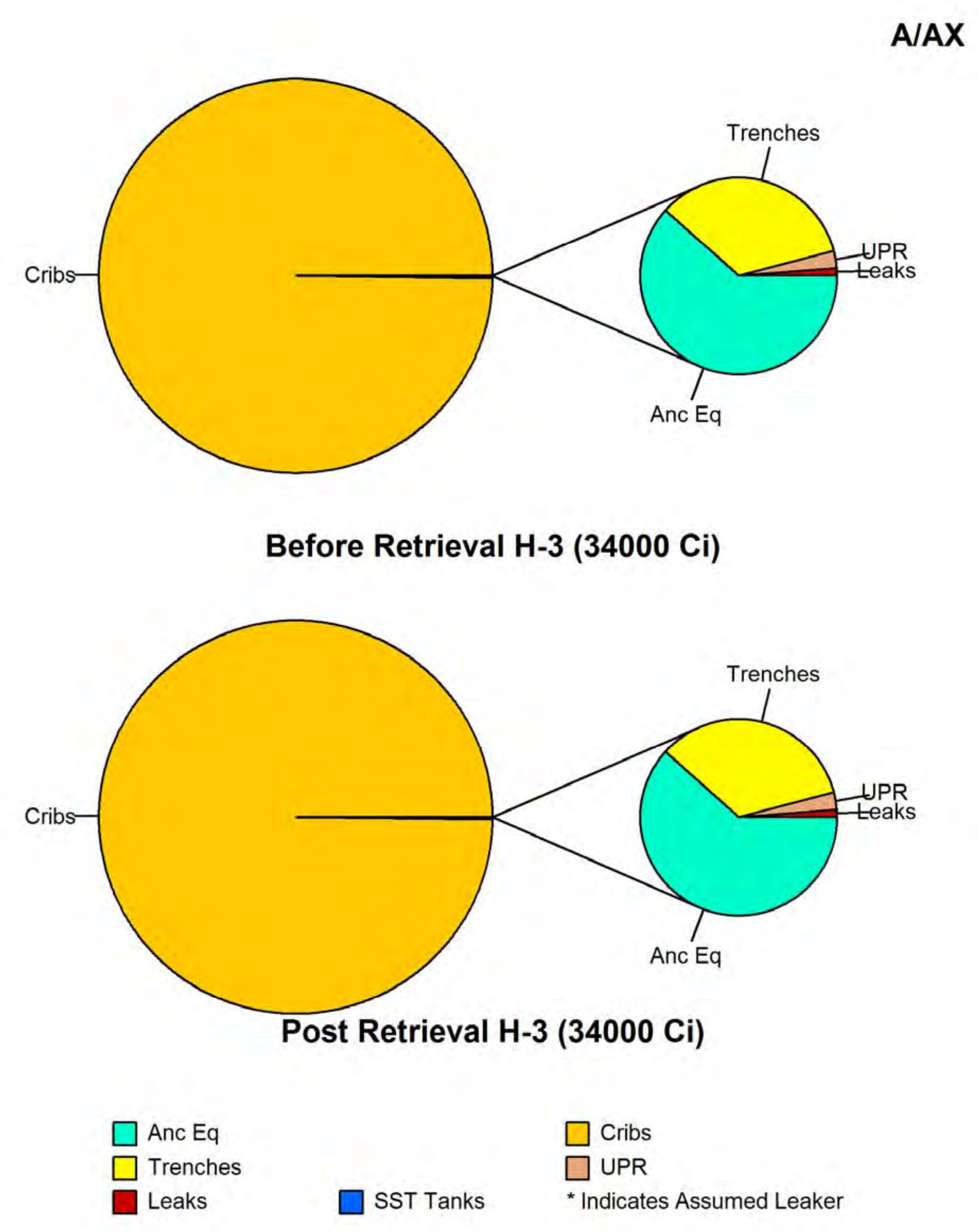

Figure E.6-8. A-AX Tank and Waste Farms Evaluation Unit Inventory Estimates for Tritium (H-3) Before and After 99% Retrieval

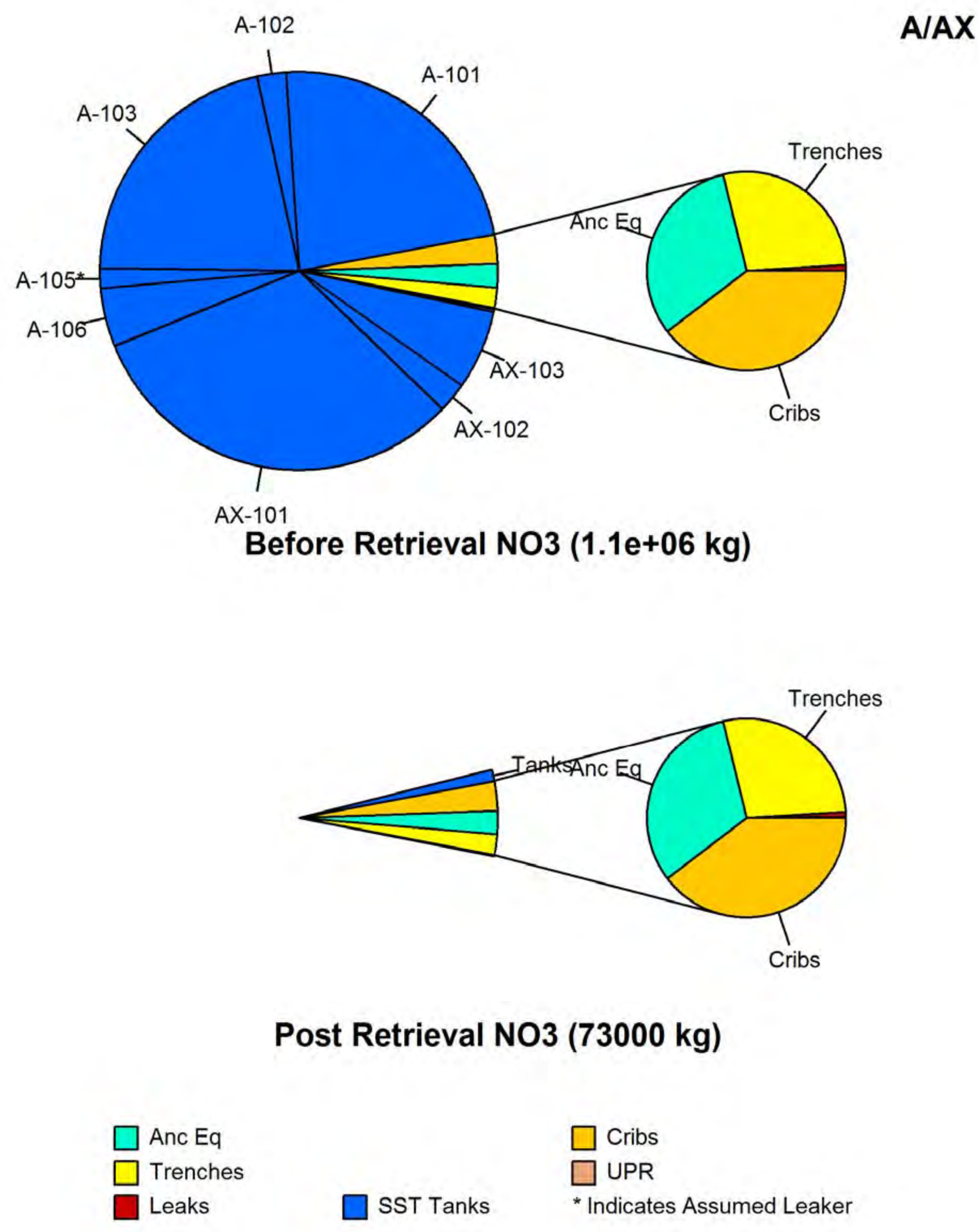

Figure E.6-9. A-AX Tank and Waste Farms Evaluation Unit Inventory Estimates for Nitrate (NO3) Before and After 99% Retrieval

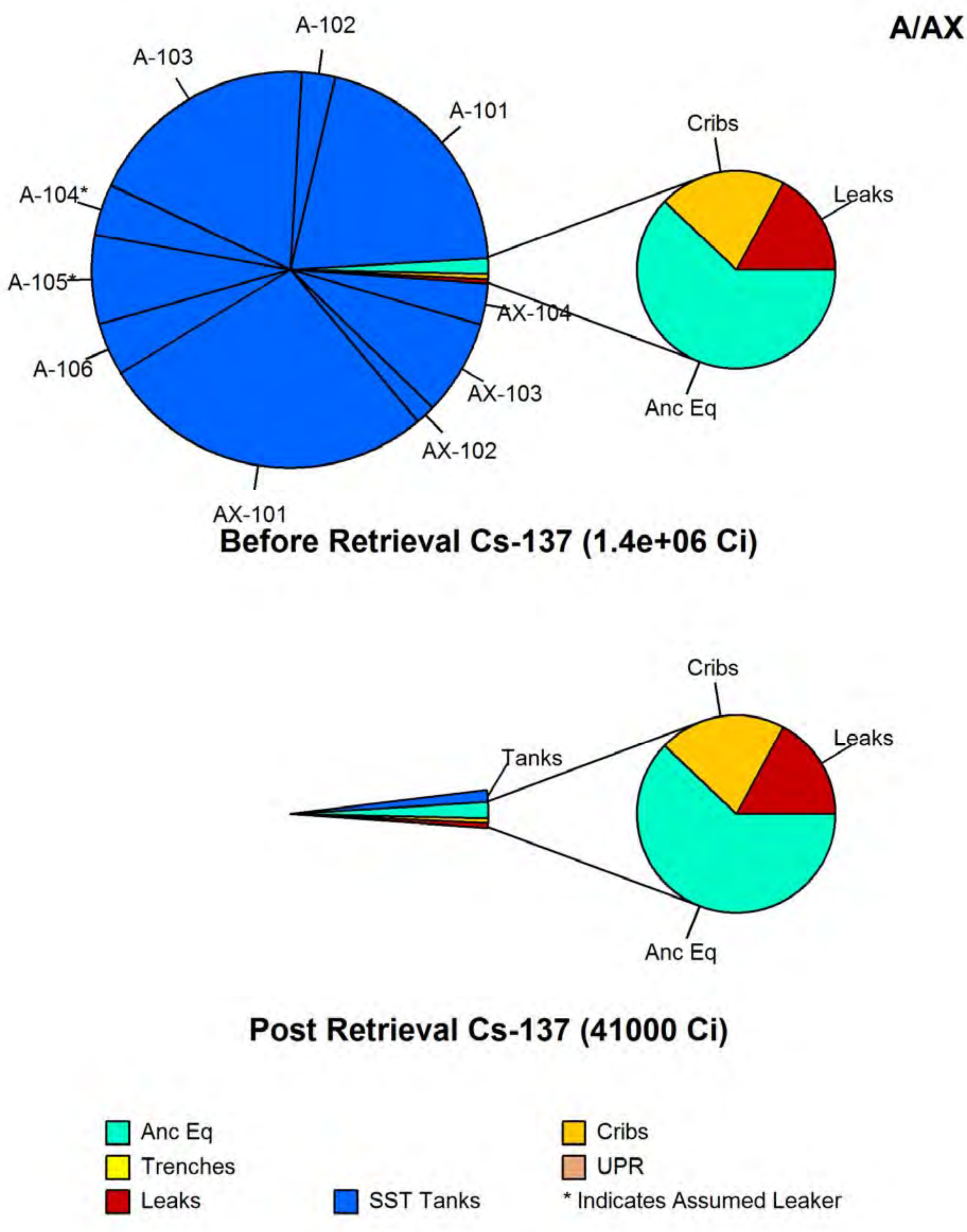

Figure E.6-10. A-AX Tank and Waste Farms Evaluation Unit Inventory Estimates for Cs-137 Before and After 99% Retrieval

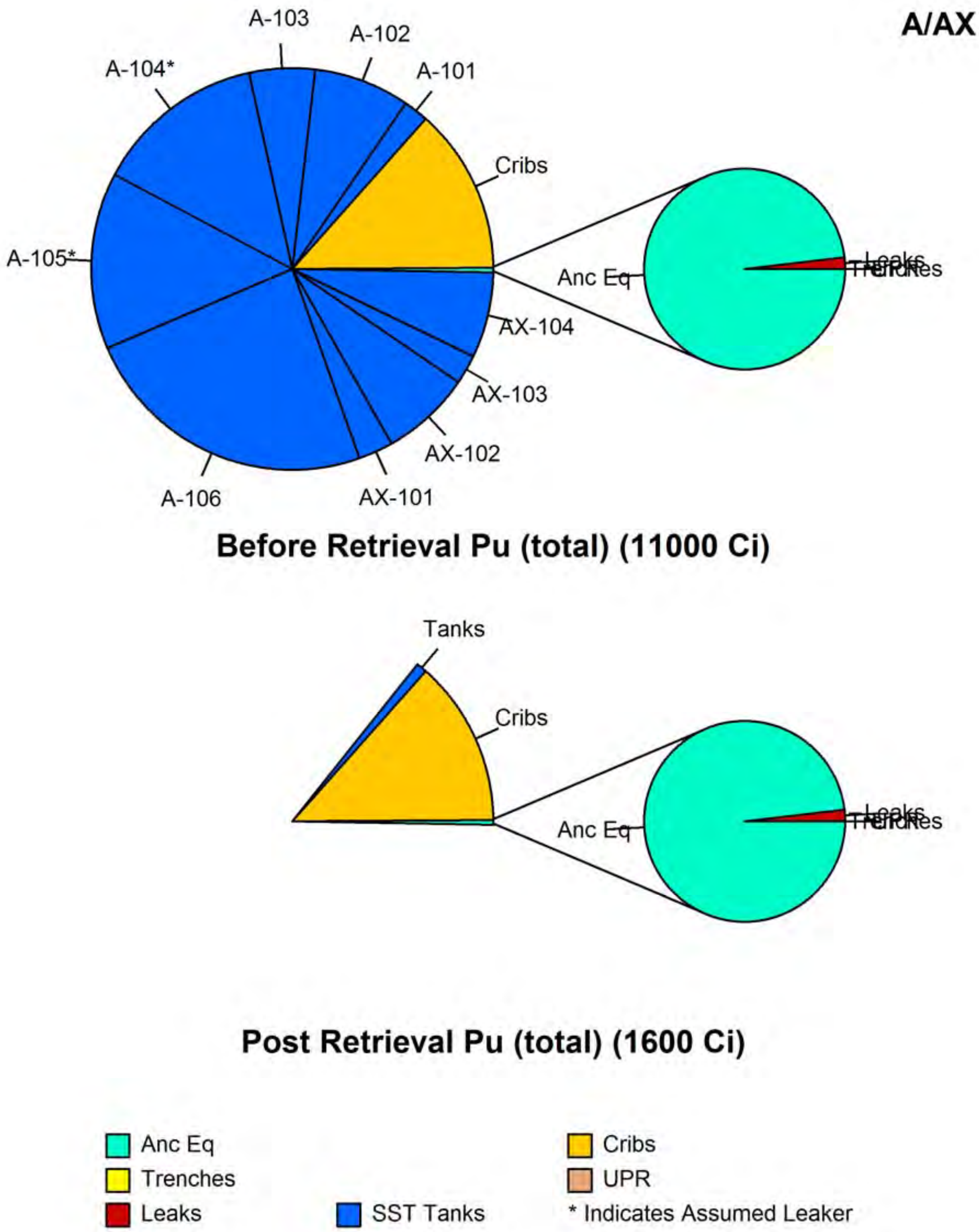

Figure E.6-11. A-AX Tank and Waste Farms Evaluation Unit Inventory Estimates for Plutonium (total) Before and After 99% Retrieval

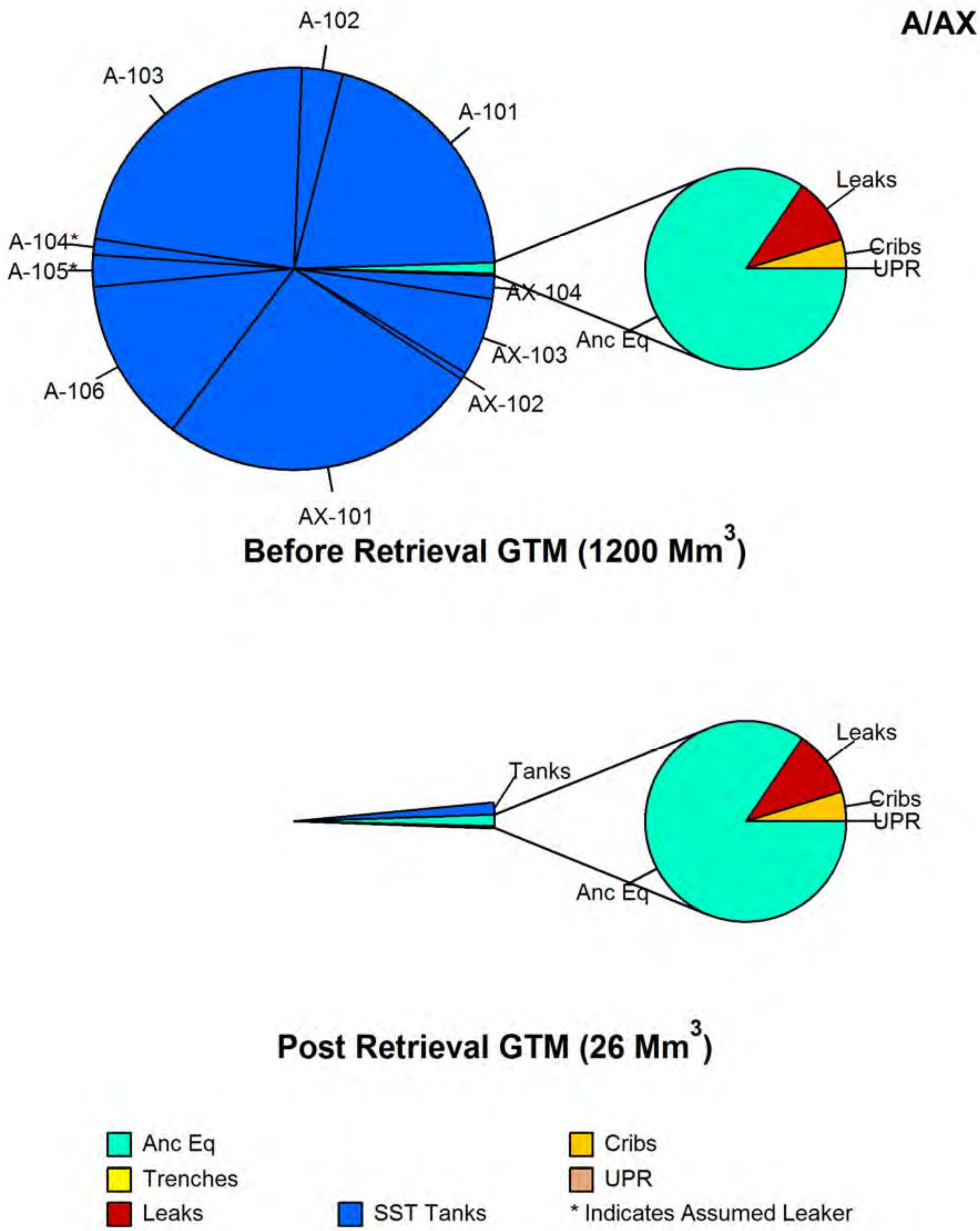

Figure E.6-12. A-AX Tank and Waste Farms Evaluation Unit Maximum Groundwater Threat Metric (GTM) of I-129 and Tc-99 Estimates Before and After 99% Retrieval

6.6. POTENTIAL RISK/IMPACT PATHWAYS AND EVENTS

CURRENT CONCEPTUAL MODEL

A common safety analysis was performed for all the single- and double-shell tanks including pathways and barriers (safety scenarios that dominate risk, safety systems and controls, barriers to release, failure mechanisms, pathways and receptors, time frames for exposure). See Section 1.6 in Appendix E.1 for details.

POPULATIONS AND RESOURCES CURRENTLY AT RISK OR POTENTIALLY IMPACTED

Facility Worker, Co-located Person, and Public

A common analysis was performed for the Facility Worker, Co-located Person, and Public. See Section 1.6 (Appendix E.1) for details.

Groundwater

The groundwater plumes (Tc-99 and I-129) associated with the A-AX Tank and Waste Farms EU and liquid waste disposal facilities are described in Section 6.5 and further details including ratings are provided in the Appendix G.5 for the CP-GW-1 EU (200-PO-1 GW OU).

As shown in Table E.6-7 (Section 6.5), the vadose zone (VZ) GTM values for the Group A and B primary contaminants translate into ratings of ND for uranium (with a *Low* rating after the Active Cleanup period as described in Section 6.5) and Sr-90 (which has an inventory that would translate to a *High* rating but appears relatively immobile in the area as described in Section 6.5), *Low* for C-14 and Tc-99, and *Medium* for chromium (total and hexavalent) for the A-AX Tank and Waste Farms EU. Thus the overall rating for groundwater impact from vadose zone sources is *Medium*.

Columbia River

As described in Section 6.5, the H-3 plume associated with the A-AX Tank and Waste Farms EU that currently intersects the Columbia River corresponds to *Not Discernible* ratings for all evaluation periods. This rating applies to all current plumes.

As described in Section 6.5, TC&WM EIS screening results indicate that peak concentrations in the nearshore region of the Columbia River were below benchmarks for wildlife receptors and benthic invertebrates and aquatic biota leading to a *Not Discernible* rating for radionuclides for both benthic and riparian receptors for all evaluation periods.

For chemicals, only nitrate and chromium (assumed hexavalent) are predicted in the TC&WM EIS to have concentrations (from sources including those other than the A-AX Tank and Waste Farms EU) that could exceed thresholds in the near-shore ecology as described in Section 6.5. However, nitrate has a *Not Discernible* rating for current conditions (since the plume is not in contact with the Columbia River) and a *Not Discernible* rating for the benthic and riparian ecology for the Active Cleanup and Near-term, Post-Cleanup periods. Hexavalent chromium has a *Not Discernible* rating for current conditions (since the plume is not in contact with the Columbia River). Hexavalent chromium would have a *Medium* rating for benthic and a *High* rating for the riparian ecology for the Active Cleanup and Near-term, Post-Cleanup periods based on the screening evaluation in the TC&WM EIS. However, well data indicate that chromium is moving much slower toward the Columbia River than predicted in the TC&WM EIS resulting in a *Not Discernible* rating for these evaluation periods.

The large dilution effect of the Columbia River results in a rating of *Not Discernible* for the free-flowing ecology for the Active Cleanup and Near-term, Post-Cleanup periods.

Additional information concerning potential threats to the Columbia River from A-AX Tank Farm and co-located liquid waste disposal facilities is provided in the Appendix G.5 for the CP-GW-1 EU (200-PO-1 GW EU).

Ecological Resources

- More than 75% of the EU consists of level 0 and level 1 habitat resources.
- Up to 27 acres of level 3 habitat may be lost if remediation actions were to result in clearing the entire EU. This would represent a loss of 1.8% of this habitat level at the landscape scale considered for this EU.
- Wildlife observations within the level 3 habitat areas on the east side of the EU included harvester ant hills, small mammal burrows, coyote tracks, and an unidentified lizard; previous surveys noted 3 migratory bird species and northern pocket gopher mounds.
- One individual occurrence of a sensitive plant species (Piper's daisy) has been previously noted within the EU boundary, but was not relocated during the October 2014 survey. Loss of individual sensitive plant occurrences is unlikely to affect population viability for this species.
- The A-AX Tank and Waste Farms EU is surrounded by additional industrial and operations areas inside the 200-East Area. Loss of level 3 resources from within the EU would not be expected to significantly impact habitat connectivity.

Cultural Resources

- The Hanford Site Plant Railroad and 2707AR Sludge Vault Change House contributing properties within the Manhattan Project and Cold War Era Historic District, with documentation required are located within the A-AX Tank and Waste Farms EU.
- The 244 AR Vault Facility and Canyon and 242BA (242-A Boiler Annex) are contributing properties within the Manhattan Project and Cold War Era Historic District with no documentation required are located within the A-AX Tank and Waste Farms EU.
- There are no archaeological sites or TCPs known to be located within the A-AX Tank Farms Evaluation Unit.

Archaeological sites and TCPs located within 500 meters of the EU

- The 241 AW Underground Liquid Tank Farm are contributing properties within the Manhattan Project and Cold War Era Historic District with documentation required are located within close proximity to the A-AX Tank and Waste Farms EU.
- The 271 CR Service and Office Building is a contributing property within the Manhattan Project and Cold War Era Historic District with no documentation required is located within close proximity to the A-AX Tank and Waste Farms EU.
- All of the Manhattan Project and Cold War era contributing properties both with documentation and no documentation requirements that are listed as being located within the PUREX Evaluation Unit are also located in close proximity to the A-AX Tank and Waste Farms EU.

Closest Recorded TCP

- There are two recorded TCPs associated with the Native American Precontact and Ethnographic Landscape that are visible from the A-AX Tank and Waste Farms EU.

CLEANUP APPROACHES AND END-STATE CONCEPTUAL MODEL

Selected or Potential Cleanup Approaches

A common analysis was performed for all the single- and double-shell tanks. See Section 1.6 (Appendix E.1) for details.

Contaminant Inventory Remaining at the Conclusion of Planned Active Cleanup Period

See Section 6.5 including Table E.6-2 and Figure E.6-3 through Figure E.6-11 for the inventory information after planned 99% retrieval. Furthermore, a more general analysis was performed for all the single- and double-shell tanks. See Section 1.6 (Appendix E.1) for details.

Risks and Potential Impacts Associated with Cleanup

A common analysis was performed for all the single- and double-shell tanks for workers and the Public. See Section 1.6 (Appendix E.1) for details.

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

Facility Worker, Co-located Person, and Public

A common analysis was performed for the Facility Worker, Co-located Person, and Public. See Section 1.6 (Appendix E.1) for details.

Groundwater

As described in Section 6.5, there will be a continuing impact during this period to groundwater (as a protected resource) from those mobile A-AX Tank Farm primary contaminants currently with plumes that exceed thresholds. These impacts are described in Appendix G.5 for the CP-GW-1 EU (200-PO-1 OU).

Furthermore, there are primary (e.g., tank wastes) and secondary contaminant sources (legacy source sites) in the vadose zone that pose risk to groundwater. The vadose zone (VZ) GTM values for the Group A and B primary contaminants for the A-AX Tank and Waste Farms EU translate to ratings of ND for uranium and Sr-90 to *Low* for C-14 and Tc-99 to *Medium* for chromium (total and hexavalent). As described in Section 6.5, impacts of decay and transport on Sr-90 and transport on uranium result in *Not Discernible* ratings for the Active Cleanup and Near-Term, Post-Cleanup periods. The overall rating is *Medium*.

The 200-PO-1 OU is being monitored to determine the impact to groundwater prior to determining the path forward for remedial action; thus groundwater will likely be treated in the future to help address groundwater contamination.

It is considered unlikely that additional groundwater resources would be impacted as a result of either interim remedial actions (e.g., pump and treat) or final closure activities (that are not covered in the Ecological or Cultural Resources results).

Columbia River

As described in Section 6.5, impacts from radiological contaminants to the Columbia River benthic and riparian ecology for the Active Cleanup and Near-term, Post Cleanup periods are rated as *Not Discernible*. The nitrate has a rating of *Not Discernible* for the benthic and riparian ecology. For the Active Cleanup and Near-term, Post Cleanup periods, chromium (assumed hexavalent) would have had benthic and riparian zone ratings of *Medium* and *High*, respectively; however, well data suggest that chromium is moving much slower than predicted in the TC&WM EIS (Appendix O, DOE/EIS-0391 2012) resulting in *Not Discernible* ratings. The large dilution effect of the Columbia River on the contamination from the seeps and groundwater upwellings produces *Not Discernible* ratings for all contaminants for the Active Cleanup and Near-term, Post Cleanup periods.

Additional information on groundwater plumes and potential threats associated with the A-AX Tank Farm and liquid waste disposal facilities are described in Appendix G.5 for the CP-GW-1 EU (200-PO-1 GW OU).

It is considered unlikely that additional benthic or riparian resources would be impacted as a result of either interim remedial actions (e.g., pump and treat) or final closure activities (that are not covered in the Ecological or Cultural Resources results).

Ecological Resources

See Section 1.6 (Appendix E.1) for details.

Cultural Resources

See Section 1.6 (Appendix E.1) for details.

Additional Risks and Potential Impacts if Cleanup is Delayed

A common analysis was performed for all the single- and double-shell tanks. See Section 1.6 (Appendix E.1) for details.

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

A common analysis was performed for all the single- and double-shell tanks. See Section 1.6 (Appendix E.1) for details.

Populations and Resources at Risk or Potentially Impacted After Cleanup Actions (from residual contaminant inventory or long-term activities)

Table E.6-8. Summary of Populations and Resources at Risk or Potentially Impacted after Cleanup

Population or Resource		Impact Rating	Comments
Human	Facility Worker	Low	Workers will be low risk from exposure to direct radiation and waste contaminants after waste retrieval, grouting, and capping.
	Co-located Person	Low	These persons will be at low risk from exposure to direct radiation and waste contaminants after waste retrieval, grouting, and capping.
	Public	Not Discernible	The Tank Farms will be in secure and controlled areas that prevent intentional and inadvertent intruders. No complete groundwater pathway and no impact from air pathway.
Environmental	Groundwater (A&B) from vadose zone[a]	Low (Sr-90, uranium, Tc-99 and total chromium) to Medium (Cr-VI) **Overall**: Medium	GTM values for Group A and B primary contaminants (Table E.6-7): Low (Sr-90, uranium, Tc-99 and total chromium) and Medium (hexavalent chromium). Ratings account for significant impacts due to recharge (total chromium, Tc-99, Sr-90, uranium) and recharge and decay (Sr-90) (Section 6.5).
	Columbia River from vadose zone[a]	Benthic: Not Discernible (radionuclides) Low (chemicals) Riparian: Not Discernible (radionuclides) Low (chemicals) Free-flowing: Not Discernible (all) **Overall**: Low	TC&WM EIS screening results used to evaluate benthic and riparian receptors (Section 6.5). Only nitrate (ND for both benthic and riparian) and hexavalent chromium (Medium for benthic and High for riparian) are predicted to have concentrations (including sources other than A-AX) that could threaten the near-shore ecology. However, well data indicate slower movement of chromium toward the river resulting in ND ratings. Dilution factor of greater than 100 million between River and upwellings.

Population or Resource		Impact Rating	Comments
	Ecological Resources[b]	ND to Low	If capped and monitored, there could be some disturbance to EU and buffer habitat, but re-vegetation may increase resource value.
Social	Cultural Resources[b]	**Native American:** Direct: Unknown Indirect: Known **Historic Pre-Hanford:** Direct: Unknown Indirect: Unknown **Manhattan/Cold War**: Direct: None Indirect: None	Permanent indirect effects to viewshed are possible from capping. Permanent effects may be possible due to presence of contamination if capping occurs. No other expected cultural resources impacts.

a. Groundwater threat for Group A and B contaminants remaining in the vadose zone or to the Columbia River for all primary contaminants. Threats from existing plumes associated with the A-AX Tank and Waste Farms EU are described in Section 6.5 and Appendix G.5 (CP-GW-1) for the 200-PO-1 Groundwater Operable Unit.
b. 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.

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

As described in Section 6.5, the TC&WM ecological screening analysis indicate that that exposure to radioactive contaminants from peak groundwater discharge was below screening levels at the Columbia River near-shore region, indicating there should be no expected adverse effects from radionuclides. Furthermore, results of the corresponding TC&WM screening evaluation for chemicals indicated that predicted chromium and nitrate concentrations could exceed screening values (i.e., Hazard Quotient of unity) in the near-shore region. The predicted nitrate peak concentration was in the past and would be unlikely to exceed human or aquatic standards in the future. On the other hand, unless treated chromium (assumed hexavalent) could over the long term impact benthic and riparian receptors (i.e., concentrations could exceed screening levels).

For more information, see Section 1.6 (Appendix E.1).

6.7. SUPPLEMENTAL INFORMATION AND CONSIDERATIONS

A common analysis was performed for all the single- and double-shell tanks. See Section 1.7 (Appendix E.1) for details.

6.8. ATTACHMENT – A-AX TANK FARMS EVALUATION UNIT WIDS REVIEW

Hanford Site-Wide Risk Review

Evaluation Unit:	A-AX Tank Farms
ID:	CP-TF-5
Group:	Tank Farm
Operable Unit Cross-Walk:	WMA A/AX 200-EA-1 200-PW-3
Related EU:	CP-LS-7 CP-TF-8 CP-GW-1
Sites & Facilities:	A-AX tank farm, ancillary structures, associated liquid waste sites, and soils contamination
Key Data Sources Docs:	RPP-13033 RPP-23405 RPP-40545 RPP-PLAN-40145 RPP-10435

Figure 1. Site Map with Evaluation Unit Boundaries and Tank Locations

Attached:

- Waste Site and Facility List
- Site Map with Evaluation Unit Boundaries and Associated Waste Sites
- Site Map with Evaluation Unit Boundaries and Associated Facilities

Prepared by: AMG, 08/29/2014
Reviewed by: GVL, 08/29/2014
Revisions: AMG, 09/10/2014

Hanford Site-Wide Risk Review
CP-TF-5 (A-AX Tank Farms)
Waste Site and Facility List

Site Code	Name, Aliases, Description	Site Status	Site Type	Site Type Category	Operable Unit	Exclude from Evaluation
200-E PD	200-E PD; 200-E Powerhouse Ditch; 200 East Powerhouse Pond	Active	Ditch	Pond/Ditch - Subsurface Liquid Disposal Site	200-EA-1	
200-E-111-PL	200-E-111-PL; 3-38 Encasement; Encased Pipeline from 241-ER-151 Diversion Box to 241-C Tank Farm and 244-AR Vault; Lines V108/V837/8618/8653/8901PAS, 809, 818, V836 and V834	Inactive	Encased Tank Farm Pipeline	Pipeline and associated valves, etc.	TBD	
200-E-125	200-E-125; Contamination Area Northwest of 244-AR Building	Inactive	Unplanned Release	Unplanned Release - Surface/Near Surface	200-EA-1	
200-E-127-PL-B	200-E-127-PL-B; Segments of Gable Mountain Pond Pipeline Located in the Inner Area	Inactive	Radioactive Process Sewer	Pipeline and associated valves, etc.	TBD	
200-E-131	200-E-131; Contaminated Soil Associated with 241-A Tank Farm Complex	Inactive	Contamination Migration	Unplanned Release - Surface/Near Surface	WMA A/AX	
200-E-143-PL	200-E-143-PL; Encased Transfer Line from 241-AX-151 Diversion Box to 241-A Tank Farms and 244-CR Vault in 241-C Tank Farm; Tank Farm Transfer Lines 4101, 4102, 4103, 4104, 4105, 4106, 4107/V033, 4017, 4018 and 8656	Inactive	Encased Tank Farm Pipeline	Pipeline and associated valves, etc.	TBD	
200-E-144-PL	200-E-144-PL; Encased Transfer Line from 241-CR-152 and 241-CR-153 to 241-AX-151; Lines 4006 and 4007 from 244-AR Vault to 241-AX-151; Tank Farm Transfer Line 4012; Transfer Line 4013 (A-4013)	Inactive	Encased Tank Farm Pipeline	Pipeline and associated valves, etc.	TBD	
200-E-145-PL	200-E-145-PL; 241-ER-152 and 241-ER-151; Interplant Transfer Line; Tank Farm Transfer Line V228; Transfer Pipeline from 241-CR-153 to 241-ER-153	Inactive	Encased Tank Farm Pipeline	Pipeline and associated valves, etc.	TBD	
200-E-147-PL	200-E-147-PL; Interplant Transfer Line; Tank Farm Transfer Line PAS-244; Transfer Line from 244-CR-TK-003 to 241-ER-153	Inactive	Direct Buried Tank Farm Pipeline	Pipeline and associated valves, etc.	TBD	
200-E-148-PL	200-E-148-PL; Direct Buried Transfer Line from 241-C-151 to 241-A-01A; Tank Farm Transfer Line V109	Inactive	Direct Buried Tank Farm Pipeline	Pipeline and associated valves, etc.	TBD	
200-E-150-PL	200-E-150-PL; Direct Buried Transfer Line from 244-CR-TK-003 to 201-C Hot Semi Works Valve Box; Tank Farm Pipeline; Tank Farm Transfer Line 8900	Inactive	Direct Buried Tank Farm Pipeline	Pipeline and associated valves, etc.	TBD	
200-E-151-PL	200-E-151-PL; Direct Buried Transfer Line from 241-C-104 to 241-A-152; Tank Farm Pipeline; Tank Farm Transfer Line V050	Inactive	Direct Buried Tank Farm Pipeline	Pipeline and associated valves, etc.	TBD	
200-E-152-PL	200-E-152-PL; Direct Buried Transfer Line from 241-C-104 to 241-A-152; Tank Farm Pipeline; Tank Farm Transfer Line V051	Inactive	Direct Buried Tank Farm Pipeline	Pipeline and associated valves, etc.	TBD	
200-E-153-PL	200-E-153-PL; Direct Buried Transfer Line from 241-C-151 to 244-AR-TK-002; Tank Farm Pipeline; Tank Farm Transfer Line V108/812	Inactive	Direct Buried Tank Farm Pipeline	Pipeline and associated valves, etc.	TBD	
200-E-154-PL	200-E-154-PL; Direct Buried Transfer Line from 241-C-151 to 241-AX-01A; Tank Farm Pipeline; Tank Farm Transfer Line V113	Inactive	Direct Buried Tank Farm Pipeline	Pipeline and associated valves, etc.	TBD	
200-E-158-PL	200-E-158-PL; 216-A-1 Pipeline; Pipeline from Sample Pit #3 to 216-A-1 Crib	Inactive	Radioactive Process Sewer	Pipeline and associated valves, etc.	TBD	
200-E-164-PL	200-E-164-PL; Pipeline Between the 216-A-8 Control Structure and the 216-A-508 Control Structure; Pipeline to 216-A-8 Crib	Inactive	Radioactive Process Sewer	Pipeline and associated valves, etc.	TBD	

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Hanford Site-Wide Risk Review
CP-TF-5 (A-AX Tank Farms)
Waste Site and Facility List

Site Code	Name, Aliases, Description	Site Status	Site Type	Site Type Category	Operable Unit	Exclude from Evaluation
200-E-165-PL	200-E-165-PL; Pipeline to 216-A-24 Crib	Inactive	Radioactive Process Sewer	Pipeline and associated valves, etc.	TBD	
200-E-166-PL	200-E-166-PL; Pipeline to 216-A-34 Ditch	Inactive	Radioactive Process Sewer	Pipeline and associated valves, etc.	TBD	
200-E-167-PL	200-E-167-PL; Lines SN-215 and SN-216; Underground Pipelines from 244-A Lift Station to 241-A-A and 241-A-B Valve Pits	Inactive	Encased Tank Farm Pipeline	Pipeline and associated valves, etc.	TBD	
200-E-182-PL	200-E-182-PL; 216-A-7 Crib Pipeline	Inactive	Radioactive Process Sewer	Pipeline and associated valves, etc.	TBD	
200-E-187-PL	200-E-187-PL; Chemical Sewer from 202-A to 216-A-29 Ditch; Lines 8819, 5802 and 5701; PUREX Chemical Sewer (CSL)	Inactive	Radioactive Process Sewer	Pipeline and associated valves, etc.	TBD	
200-E-200-PL	200-E-200-PL; Lines 801, 802, 806 and 805; Pipelines from 244-AR Vault to 241-AY-152 and 241-A-153 Diversion Boxes	Inactive	Direct Buried Tank Farm Pipeline	Pipeline and associated valves, etc.	WMA A/AX	
200-E-206-PL	200-E-206-PL; Double Pipes from 244-AR Vault to 241-AR-151 Diversion Box; Lines V716, V717 and V718/817	Inactive	Direct Buried Tank Farm Pipeline	Pipeline and associated valves, etc.	TBD	
200-E-207-PL	200-E-207-PL; Encased Transfer Line from 241-A-151 Diversion Box to 241-A-152 Diversion Box; Lines V004, V005, V006, V007 and V008	Inactive	Encased Tank Farm Pipeline	Pipeline and associated valves, etc.	TBD	
200-E-210-PL	200-E-210-PL; Encased Lines Between 241-AW Tank Farm and 242-A Evaporator Building; Lines SL-167, SL-168, SN-219, SN-220, SN-269 and SN-270	Active	Encased Tank Farm Pipeline	Pipeline and associated valves, etc.	Not Applic	
200-E-211-PL	200-E-211-PL; Lines DR334, DR335 and DR343; Transfer Lines from 241-AW to 242-A Evaporator Building	Active	Direct Buried Tank Farm Pipeline	Pipeline and associated valves, etc.	Not Applic	
200-E-225-PL	200-E-225-PL; Line V720; Transfer Line from 241-AR-151 Diversion Box to 241-AY-102 Tank	Inactive	Direct Buried Tank Farm Pipeline	Pipeline and associated valves, etc.	TBD	
200-E-227-PL	200-E-227-PL; Lines 4005/810, 4015/814 and 4019/817; Transfer Lines Between 244-AR Vault Facility and 241-AX-151 Diversion Box	Inactive	Encased Tank Farm Pipeline	Pipeline and associated valves, etc.	TBD	
200-E-229-PL	200-E-229-PL; Line SN-650; Transfer Line Between tank 241-AP-102 and 241-A-B Valve Pit	Inactive	Direct Buried Tank Farm Pipeline	Pipeline and associated valves, etc.	TBD	
200-E-232-PL	200-E-232-PL; Pipeline from 207-A Basins to 216-A-30 and 216-A-37-1 Cribs	Inactive	Radioactive Process Sewer	Pipeline and associated valves, etc.	TBD	
200-E-234-PL	200-E-234-PL; Lines 300, 501, 505, and 557; Pipelines from 242-A Evaporator Building to the 207-A Basins	Inactive	Radioactive Process Sewer	Pipeline and associated valves, etc.	TBD	
200-E-235-PL	200-E-235-PL; 207-A North Basin Distribution Lines; Lines 501,502, 503, 504, 506, and 507	Inactive	Radioactive Process Sewer	Pipeline and associated valves, etc.	Not Applic	
200-E-236-PL	200-E-236-PL; 207-A South Basin Distribution Lines; Lines 557, 558, 559, 560, 562, and 563	Inactive	Radioactive Process Sewer	Pipeline and associated valves, etc.	Not Applic	
200-E-237-PL	200-E-237-PL; 2904-E-24; Line 2904-E-1; Pipeline to 200 East Powerhouse Ditch and Pipeline from Powerhouse Ditch to 216-B-3 Ditches	Active	Process Sewer	Pipeline and associated valves, etc.	TBD	
200-E-238-PL	200-E-238-PL; Pipeline from 206-A to 216-A-9 Crib	Inactive	Radioactive Process Sewer	Pipeline and associated valves, etc.	TBD	
200-E-27	200-E-27; 242-AC; 242AC Pipefitter Shop Lead Cutting Area	Inactive	Dumping Area	Burial Ground	TBD	
200-E-274-PL	200-E-274-PL; Line 323; Pipeline from 244-A Lift Station to 216-A-40 Basin	Inactive	Radioactive Process Sewer	Pipeline and associated valves, etc.	TBD	
200-E-275-PL	200-E-275-PL; Cooling Water Pipeline to 216-A-40 Basin; Line 815	Inactive	Radioactive Process Sewer	Pipeline and associated valves, etc.	TBD	

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Hanford Site-Wide Risk Review
CP-TF-5 (A-AX Tank Farms)
Waste Site and Facility List

Site Code	Name, Aliases, Description	Site Status	Site Type	Site Type Category	Operable Unit	Exclude from Evaluation
200-E-276-PL	200-E-276-PL; 216-A-41 Crib Pipeline	Inactive	Radioactive Process Sewer	Pipeline and associated valves, etc.	TBD	
200-E-282-PL	200-E-282-PL; Lines 4001, 4002, 4003 and 4004; Process Waste Lines from 202-A to 241-AX-151 Diversion Box	Inactive	Encased Tank Farm Pipeline	Pipeline and associated valves, etc.	TBD	
200-E-283-PL	200-E-283-PL; Line 395; Pipeline from 242-A Bldg to 600-291-PL (TEDF Line)	Inactive	Radioactive Process Sewer	Pipeline and associated valves, etc.	TBD	
200-E-285	200-E-285; 216-A-8 Control Structure; 216-A-8 Sample Pit; Sample Pit #2	Inactive	Control Structure	Pipeline and associated valves, etc.	TBD	
200-E-286	200-E-286; A Swamp; A-Swamp and Ditch; Original 200 East Area Powerhouse Effluent Pond; Powerhouse Swamp	Inactive	Pond	Pond/Ditch - Subsurface Liquid Disposal Site	Not Applic	
200-E-287	200-E-287; Posted Contamination Areas on Pipe Berm east of 241-A, AN, AX, AY and AZ Tank Farms	Unknown	Contamination Migration	Unplanned Release - Surface/Near Surface	TBD	
200-E-288-PL	200-E-288-PL; PC-5000; Pipeline from 242-A Evaporator to Liquid Effluent Retention Facility	Active	Radioactive Process Sewer	Pipeline and associated valves, etc.	TBD	
200-E-291-PL	200-E-291-PL; Pipeline from 241-C-106 to 241-AY-102, SN-200, SL-100, 241-C-106 Sluice line	Inactive	Direct Buried Tank Farm Pipeline	Pipeline and associated valves, etc.	TBD	
204-AR	204-AR; 204-AR Waste Unloading Station; 204-AR-TK-1	Active	Loading Dock	Infrastructure Building	Not Applic	X
207-A-NORTH	207-A-NORTH; 207-A-NORTH Retention Basin; 207-A; 207-A North; 207-A Retention Basin	Inactive	Retention Basin	Crib - Subsurface Liquid Disposal Site	200-EA-1	
207-A-SOUTH	207-A-SOUTH; 207-A-SOUTH Retention Basin and Pump Pit; 207-A; 207-A Retention Basin; 207-A South	Inactive	Retention Basin	Crib - Subsurface Liquid Disposal Site	Not Applic	
216-A-1	216-A-1; 216-A-1 Cavern; 216-A-1 Trench	Inactive	Crib	Crib - Subsurface Liquid Disposal Site	200-EA-1	
216-A-16	216-A-16; 216-A-16 Dry Well	Inactive	French Drain	Crib - Subsurface Liquid Disposal Site	WMA A/AX	
216-A-17	216-A-17; 216-A-17 Dry Well	Inactive	French Drain	Crib - Subsurface Liquid Disposal Site	WMA A/AX	
216-A-18	216-A-18; 216-A-18 Crib; 216-A-18 Excavation; 216-A-18 Grave; 216-A-18 Sump	Inactive	Trench	Crib - Subsurface Liquid Disposal Site	200-EA-1	
216-A-19	216-A-19; 216-A-19 Crib; 216-A-19 Grave; 216-A-19 Sump; 216-A-19 Test Hole	Inactive	Trench	Crib - Subsurface Liquid Disposal Site	200-EA-1	
216-A-20	216-A-20; 216-A-20 Crib; 216-A-20 Grave; 216-A-20 Sump; 216-A-20 Test Hole	Inactive	Trench	Crib - Subsurface Liquid Disposal Site	200-EA-1	
216-A-23A	216-A-23A; 216-A-23-A French Drain	Inactive	French Drain	Crib - Subsurface Liquid Disposal Site	WMA A/AX	
216-A-23B	216-A-23B; 216-A-23-B French Drain	Inactive	French Drain	Crib - Subsurface Liquid Disposal Site	WMA A/AX	
216-A-24	216-A-24; 216-A-24 Crib	Inactive	Crib	Crib - Subsurface Liquid Disposal Site	200-PW-3	
216-A-34	216-A-34; 216-A-34 Crib; 216-A-34 Ditch	Inactive	Ditch	Crib - Subsurface Liquid Disposal Site	200-EA-1	
216-A-40	216-A-40; 216-A-40 Retention Basin; 216-A-39 Crib; 216-A-39 Trench	Inactive	Retention Basin	Crib - Subsurface Liquid Disposal Site	200-EA-1	
216-A-41	216-A-41; 216-A-41 Crib; 291-AR Stack Drain; 296-A-13 Stack Drain	Inactive	Crib	Crib - Subsurface Liquid Disposal Site	200-EA-1	
216-A-508	216-A-508; 216-A-8 Distribution Box; Control Structure for 216-A-8 Crib	Inactive	Control Structure	Crib - Subsurface Liquid Disposal Site	200-IS-1	
216-A-524	216-A-524; 216-A-524 Control Structure; 216-A 524 Weir; 216-A-24 Control Structure	Inactive	Control Structure	Crib - Subsurface Liquid Disposal Site	200-IS-1	
216-A-7	216-A-7; 216-A-7 Cavern	Inactive	Crib	Crib - Subsurface Liquid Disposal Site	200-PW-3	
216-A-8	216-A-8; 216-A-8 Crib and Overflow Pond	Inactive	Crib	Crib - Subsurface Liquid Disposal Site	200-PW-3	
216-A-9	216-A-9; 216-A-9 Crib	Inactive	Crib	Crib - Subsurface Liquid Disposal Site	200-EA-1	

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Hanford Site-Wide Risk Review
CP-TF-5 (A-AX Tank Farms)
Waste Site and Facility List

Site Code	Name, Aliases, Description	Site Status	Site Type	Site Type Category	Operable Unit	Exclude from Evaluation
241-A-101	241-A-101; 241-A-TK-101	Inactive	Single-Shell Tank	Underground Storage Tank	WMA A/AX	
241-A-102	241-A-102; 241-A-TK-102	Inactive	Single-Shell Tank	Underground Storage Tank	WMA A/AX	
241-A-103	241-A-103; 241-A-TK-103	Inactive	Single-Shell Tank	Underground Storage Tank	WMA A/AX	
241-A-104	241-A-104; 241-A-TK-104	Inactive	Single-Shell Tank	Underground Storage Tank	WMA A/AX	
241-A-105	241-A-105; 241-A-TK-105	Inactive	Single-Shell Tank	Underground Storage Tank	WMA A/AX	
241-A-106	241-A-106; 241-A-TK-106	Inactive	Single-Shell Tank	Underground Storage Tank	WMA A/AX	
241-A-152	241-A-152; 241-A-152 Diversion Box	Inactive	Diversion Box	Pipeline and associated valves, etc.	WMA A/AX	
241-A-153	241-A-153; 241-A-153 Diversion Box; 241-A-153 Transfer Station	Inactive	Diversion Box	Pipeline and associated valves, etc.	WMA A/AX	
241-A-302B	241-A-302B; 241-A-302-B Catch Tank; IMUST; Inactive Miscellaneous Underground Storage Tank; V062	Inactive	Catch Tank	Underground Storage Tank	200-IS-1	
241-A-350	241-A-350; 241-A-350 Catch Tank; 241-A-350 Drainage Lift Station	Inactive	Catch Tank	Underground Storage Tank	WMA A/AX	
241-A-417	241-A-417; 241-A-417 Condensate Tank	Inactive	Catch Tank	Underground Storage Tank	WMA A/AX	
241-A-431	241-A-431; 241-A-431 Tank Farm Ventilation Building; 241-A-431 Ventilation Building	Inactive	Process Unit/Plant	Process Building	WMA A/AX	
241-A-702-WS-1	241-A-702-WS-1; 702-A Drain Lines	Inactive	French Drain	Crib - Subsurface Liquid Disposal Site	WMA A/AX	
241-A-A	241-A-A; 241-A-A Diversion Box; 241-A-A Structural Valve Pit	Inactive	Valve Pit	Pipeline and associated valves, etc.	WMA A/AX	
241-A-B	241-A-B; 241-A-B Diversion Box; 241-A-B Structural Valve Pit	Inactive	Valve Pit	Pipeline and associated valves, etc.	WMA A/AX	
241-AR-151	241-AR-151; 241-AR-151 Diversion Box	Inactive	Diversion Box	Pipeline and associated valves, etc.	TBD	
241-AX-101	241-AX-101; 241-AX-TK-101	Inactive	Single-Shell Tank	Underground Storage Tank	WMA A/AX	
241-AX-102	241-AX-102; 241-AX-TK-102	Inactive	Single-Shell Tank	Underground Storage Tank	WMA A/AX	
241-AX-103	241-AX-103; 241-AX-TK-103	Inactive	Single-Shell Tank	Underground Storage Tank	WMA A/AX	
241-AX-104	241-AX-104; 241-AX-TK-104	Inactive	Single-Shell Tank	Underground Storage Tank	WMA A/AX	
241-AX-151	241-AX-151; 241-AX-151 Diversion Box; 241-AX-151 Diverter Station; IMUST; Inactive Miscellaneous Underground Storage Tank	Inactive	Diversion Box	Pipeline and associated valves, etc.	Not Applic	
241-AX-152CT	241-AX-152CT; 241-AX-152-CT Catch Tank	Inactive	Catch Tank	Underground Storage Tank	Not Applic	
241-AX-152DS	241-AX-152DS; 241-AX-152-DS Diverter Station; Line V713; 241-AX-152 Diverter Station	Inactive	Diversion Box	Pipeline and associated valves, etc.	WMA A/AX	
241-AX-155	241-AX-155; 241-AX-155 Diversion Box; Line V713	Inactive	Diversion Box	Pipeline and associated valves, etc.	Not Applic	
241-AX-501	241-AX-501; 241-AX-501 Condensate Valve Pit; 241-AX-501 Valve Pit	Inactive	Valve Pit	Pipeline and associated valves, etc.	WMA A/AX	
241-AX-A	241-AX-A; 241-AX-A Diversion Box; 241-AX-A Structural Valve Pit; 241-AX-A Valve Pit	Inactive	Valve Pit	Pipeline and associated valves, etc.	WMA A/AX	
241-AX-B	241-AX-B; 241-AX-B Diversion Box; 241-AX-B Structural Valve Pit; 241-AX-B Valve Pit	Inactive	Valve Pit	Pipeline and associated valves, etc.	WMA A/AX	
241-AY-151	241-AY-151; 241-AY-151 Diversion Box; 241-AY-151 Pump Out Pit	Inactive	Diversion Box	Pipeline and associated valves, etc.	Not Applic	
241-AY-152	241-AY-152; 241-AY-152 Diverter Station; 241-AY-152 Sluice Transfer Box; Line DR0074	Inactive	Diversion Box	Pipeline and associated valves, etc.	WMA A/AX	
241-ER-153	241-ER-153; 241-ER-153 Diversion Box	Inactive	Diversion Box	Pipeline and associated valves, etc.	TBD	
244-A CT	244-A CT; 244-A DCRT; 244-A Receiver Tank; 244-A RT; 244-A-TK/SMP; 244-A Catch Tank	Inactive	Catch Tank	Underground Storage Tank	TBD	

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Hanford Site-Wide Risk Review
CP-TF-5 (A-AX Tank Farms)
Waste Site and Facility List

Site Code	Name, Aliases, Description	Site Status	Site Type	Site Type Category	Operable Unit	Exclude from Evaluation
244-A LS	244-A LS; 244-AR Lift Station; 244-AR LS; SN-232, SN-233 and SN-234; 244-A Lift Station	Inactive	Control Structure	Process Building	TBD	
244-AR VAULT	244-AR Vault; 244-AR VAULT	Inactive	Receiving Vault	Process Building	TBD	
2607-E12	2607-E12; 2607-E12 Septic System	Active	Septic Tank	Septic System	200-EA-1	X
2607-E13	2607-E13; Septic Holding Tank South of 277-A	Active	Septic Tank	Septic System	TBD	X
2607-EA	2607-EA; 2607-EA Septic Tank and Drywell	Inactive	Septic Tank	Septic System	200-EA-1	X
2607-EC	2607-EC	Inactive	Septic Tank	Septic System	WMA A/AX	X
2607-ED	2607-ED	Inactive	Septic Tank	Septic System	WMA A/AX	X
2607-ES	2607-ES; Septic Tank and Dry Well North of 204-AR	Active	Septic Tank	Septic System	TBD	X
296-A-13	296-A-13; 291-AR Filter Building Stack	Inactive	Stack	Process Building	Not Applic	
600-269-PL	600-269-PL; Cross Site Transfer Line Replacement; Lines SNL-3150 and 3160; New Cross-Site Transfer Line	Active	Direct Buried Tank Farm Pipeline	Pipeline and associated valves, etc.	Not Applic	
600-291-PL	600-291-PL; TEDF Line; 200 Area Treated Effluent Disposal Facility Pipeline	Active	Process Sewer	Pipeline and associated valves, etc.	Not Applic	
UPR-200-E-10	UPR-200-E-10; Contaminated Purex Railroad Spur; UN-200-E-10	Inactive	Unplanned Release	Unplanned Release - Surface/Near Surface	200-EA-1	
UPR-200-E-100	UPR-200-E-100; Radioactive Contamination Near 244-A Lift Station; UN-200-E-100; UN-216-E-100; UN-216-E-29	Inactive	Unplanned Release	Unplanned Release - Surface/Near Surface	TBD	
UPR-200-E-11	UPR-200-E-11; Railroad Track Contamination Spread; UN-200-E-11	Inactive	Unplanned Release	Unplanned Release - Surface/Near Surface	200-OA-1	
UPR-200-E-115	UPR-200-E-115; Contamination Spread Inside 241-AX; UN-200-E-115	Inactive	Unplanned Release	Unplanned Release - Surface/Near Surface	Not Applic	
UPR-200-E-119	UPR-200-E-119; Contamination Spread Inside 241-AX; UN-200-E-119	Inactive	Unplanned Release	Unplanned Release - Surface/Near Surface	Not Applic	
UPR-200-E-12	UPR-200-E-12; Contaminated Purex Railroad Spur; UN-200-E-12	Inactive	Unplanned Release	Unplanned Release - Surface/Near Surface	200-EA-1	
UPR-200-E-125	UPR-200-E-125; 241-A-104 Release; UN-200-E-125	Inactive	Unplanned Release	Unplanned Release - Surface/Near Surface	Not Applic	
UPR-200-E-126	UPR-200-E-126; 241-A-105 Tank Leak; UN-200-E-126	Inactive	Unplanned Release	Unplanned Release - Subsurface	Not Applic	
UPR-200-E-143	UPR-200-E-143; Contamination Adjacent to 244-A Lift Station; UN-216-E-43	Inactive	Unplanned Release	Unplanned Release - Surface/Near Surface	200-EA-1	
UPR-200-E-145	UPR-200-E-145; VCP Pipeline Leak; W049H Green Soil	Inactive	Unplanned Release	Unplanned Release - Surface/Near Surface	200-IS-1	
UPR-200-E-18	UPR-200-E-18; Contamination Release at the 216-A-8 Sampler Pit; UN-200-E-18	Inactive	Unplanned Release	Unplanned Release - Surface/Near Surface	TBD	
UPR-200-E-20	UPR-200-E-20; Contaminated Purex Railroad Spur; UN-200-E-20	Inactive	Unplanned Release	Unplanned Release - Surface/Near Surface	200-EA-1	
UPR-200-E-33	UPR-200-E-33; Contaminated Purex Railroad Tracks; UN-200-E-33	Inactive	Unplanned Release	Unplanned Release - Surface/Near Surface	200-EA-1	
UPR-200-E-42	UPR-200-E-42; 241-AX-151 Release; UN-200-E-42	Inactive	Unplanned Release	Unplanned Release - Surface/Near Surface	200-IS-1	
UPR-200-E-47	UPR-200-E-47; Contamination Spread from 241-A Tank Farm; UN-200-E-47	Inactive	Unplanned Release	Unplanned Release - Surface/Near Surface	Not Applic	
UPR-200-E-48	UPR-200-E-48; 241-A-106 Pump Pit Release; UN-200-E-48	Inactive	Unplanned Release	Unplanned Release - Surface/Near Surface	Not Applic	
UPR-200-E-56	UPR-200-E-56; 216-A-24 Crib Excavation; Excavated Contamination Adjacent to 216-A-24 Crib; UN-200-E-56; UN-216-E-33	Inactive	Unplanned Release	Unplanned Release - Surface/Near Surface	200-PW-3	

Note that only those waste sites with a WIDS (Waste Information Data System) Classification of "Accepted" are shown, along with non-duplicate facilities, identified via the Hanford Geographic Information System (HGIS).

Hanford Site-Wide Risk Review
CP-TF-5 (A-AX Tank Farms)
Waste Site and Facility List

Site Code	Name, Aliases, Description	Site Status	Site Type	Site Type Category	Operable Unit	Exclude from Evaluation
UPR-200-E-59	UPR-200-E-59; Contaminated Bird Nests and Mud at 216-A-40 and 244-AR Vault; UN-200-E-59	Inactive	Unplanned Release	Unplanned Release - Surface/Near Surface	Not Applic	
UPR-200-E-67	UPR-200-E-67; Excavation of Radioactively Contaminated Pipe Encasement (V004, V005, V006, V007,V008); UN-200-E-67; UN-216-E-67	Inactive	Unplanned Release	Unplanned Release - Surface/Near Surface	200-IS-1	
UPR-200-E-93	UPR-200-E-93; UN-216-E-21 Ground Contamination Along 200 East Area fence	Inactive	Unplanned Release	Unplanned Release - Surface/Near Surface	Not Applic	
UPR-200-E-99	UPR-200-E-99; Contamination Adjacent to 244-CR Vault; UN-200-E-99; UN-216-E-27	Inactive	Unplanned Release	Unplanned Release - Surface/Near Surface	TBD	
2237	PIPEFITTERS SHOP	ACTIVE	STRUCTURE	Infrastructure Building		X
2258	DEMO'D -- STORAGE BLDG BEHIND A-FARM COMPOUND	DEMO"D	STRUCTURE	Infrastructure Building		X
241A152	DIVERSION BOX AT A TANK FARM	INACTIVE	STRUCTURE	Pipeline and associated valves, etc.		
241A153	TRANSFER BOX AT A TANK FARM	INACTIVE	STRUCTURE	Pipeline and associated valves, etc.		
241A271	INSTRUMENT CONTROL HOUSE FOR (A) FARM	ACTIVE	BUILDING	Infrastructure Building		X
241A401	TANK FARM CONDENSER FACILITY	ACTIVE	BUILDING	Process Building		
241A417	CONDENSATATE RECEIVER AND PUMP PIT	INACTIVE	STRUCTURE	Pipeline and associated valves, etc.		
241A431	TANK FARM VENTILATION HOUSE, STANDBY	INACTIVE	BUILDING	Process Building		
241A501	CONDENSATE VALVE PIT	ACTIVE	STRUCTURE	Pipeline and associated valves, etc.		
241A701	TANK FARM COMPRESSOR HOUSE	ACTIVE	BUILDING	Process Building		
241A702	TANK FARM FAN HOUSE	ACTIVE	BUILDING	Process Building		
241AA	DIVERSION BOX AT A TANK FARM	INACTIVE	STRUCTURE	Pipeline and associated valves, etc.		
241AR151	DIVERSION BOX N OF 244AR	INACTIVE	STRUCTURE	Pipeline and associated valves, etc.		
241AX801A	TANK FARM CONTROL HOUSE NORTH	ACTIVE	BUILDING	Infrastructure Building		X
241AX801B	TANK FARM CONTROL HOUSE SOUTH	ACTIVE	BUILDING	Infrastructure Building		X
241AX801C	TANK FARM DIVERSION HOUSE, SOUTH OF A FARM	ACTIVE	BUILDING	Infrastructure Building		X
241AY151	PUMP OUT PIT	INACTIVE	STRUCTURE	Pipeline and associated valves, etc.		
241AY152	SLUICE TRANSFER BOXES	ACTIVE	STRUCTURE	Pipeline and associated valves, etc.		
241ER153	DIVERSION BOX	INACTIVE	STRUCTURE	Pipeline and associated valves, etc.		
242A-BA	242A BOILER ANNEX	ACTIVE	BUILDING	Infrastructure Building		X
242AC	CRAFT SHOP	ACTIVE	BUILDING	Infrastructure Building		X
243G82	GROUT PROCESSING FAC. PRESSURE REDUCING VALVE PIT	INACTIVE	STRUCTURE	Pipeline and associated valves, etc.		
244A	WASTE VAULT AND INSTRUMENT HOUSE	ACTIVE	BUILDING	Infrastructure Building		X
244AR40	COOLING WATER DIVERSION BOX	INACTIVE	STRUCTURE	Pipeline and associated valves, etc.		
244AR701	ENERGENCY GENERATOR BUILDING	ACTIVE	BUILDING	Infrastructure Building		X
244AR702	500 KW STANDBY GENERATOR ENCLOSURE	INACTIVE	STRUCTURE	Infrastructure Building		X
244AR712	VAULT AIR LOCK AND LOAD OUT BUILDING	ACTIVE	BUILDING	Infrastructure Building		X
244AR715	COMPRESSOR BUILDING	ACTIVE	BUILDING	Infrastructure Building		X
244AR716	SOUTH COMPRESSOR BLDG WEST OF 244AR	ACTIVE	BUILDING	Infrastructure Building		X
244AR717	NORTH COMPRESSOR BLDG NW OF 244AR	ACTIVE	BUILDING	Infrastructure Building		X
2707AR	SLUDGE VAULT CHANGE HOUSE	ACTIVE	BUILDING	Infrastructure Building		X
2707AX	CHANGE HOUSE AX FARM	INACTIVE	BUILDING	Infrastructure Building		X

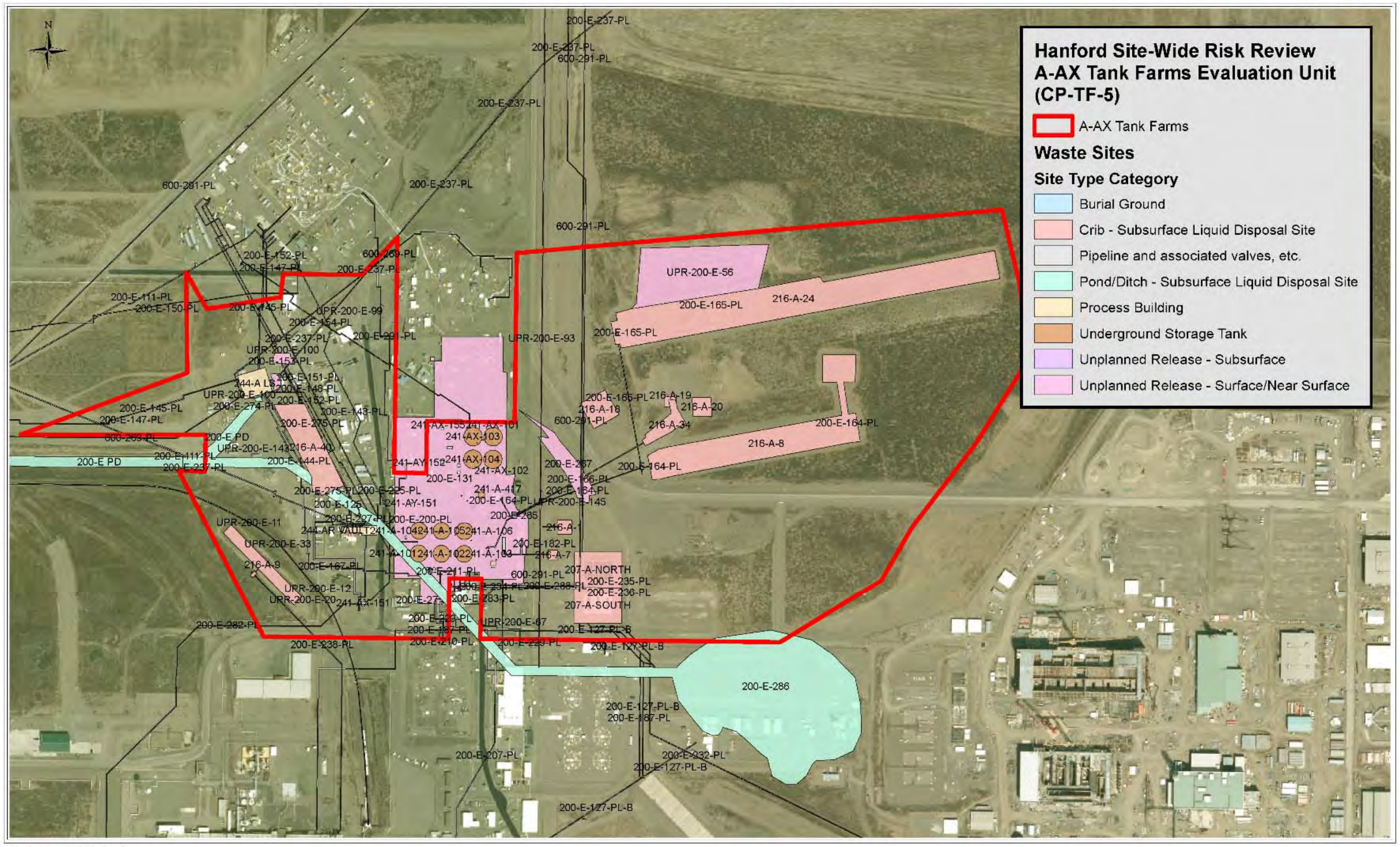
Note that only those waste sites with a WIDS (Waste Information Data System) Classification of "Accepted" are shown, along with non-duplicate facilities, identified via the Hanford Geographic Information System (HGIS).

Hanford Site-Wide Risk Review
CP-TF-5 (A-AX Tank Farms)
Waste Site and Facility List

Site Code	Name, Aliases, Description	Site Status	Site Type	Site Type Category	Operable Unit	Exclude from Evaluation
2724A	RAD MONITORING AND PROTECTIVE CLOTHING BLDG	INACTIVE	BUILDING	Infrastructure Building		X
2724AB	RAD MONITORING AND PROTECTIVE CLOTHING BLDG	INACTIVE	BUILDING	Infrastructure Building		X
2724AY	RAD MONITORING AND PROTECTIVE CLOTHING BLDG	INACTIVE	BUILDING	Infrastructure Building		X
2766	CONSTRUCTION LABORER SHOP WEST OF 244AR	ACTIVE	BUILDING	Infrastructure Building		X
2767	CONSTRUCTION CARPENTER SHOP	ACTIVE	BUILDING	Infrastructure Building		X
277A	CONSTRUCTION FAB SHOP - WEST OF 241AZ TANK FARM	ACTIVE	BUILDING	Infrastructure Building		X
2904AR	COOLING WATER SAMPLER MONITORING SYSTEM	ACTIVE	STRUCTURE	Infrastructure Building		X
291AR	EXHAUST AIR FILTER STACK BUILDING	INACTIVE	BUILDING	Process Building		
292AR	FILTER CONTAINMENT VAULT AND INSTRUMENT HOUSE	ACTIVE	STRUCTURE	Process Building		
CC2E0101	CARGO CONTAINER AT -A- TANK FARM	ACTIVE	STRUCTURE	Infrastructure Building		X
CC2E0102	CARGO CONTAINER AT -A- TANK FARM	ACTIVE	STRUCTURE	Infrastructure Building		X
CC2E0110	CARGO CONTAINER AT -A- TANK FARM	ACTIVE	STRUCTURE	Infrastructure Building		X
CC2E0111	CARGO CONTAINER AT -A- TANK FARM	ACTIVE	STRUCTURE	Infrastructure Building		X
MO272	CONSTRUCTION CRAFT LUNCHROOM SOUTH OF 277A	ACTIVE	BUILDING	Infrastructure Building		X
MO377	MOBILE OFFICE AT A TANK FARM	INACTIVE	BUILDING	Infrastructure Building		X
MO421	FIELD TRAILER AT 277A	ACTIVE	BUILDING	Infrastructure Building		X
MO503	MOBILE OFFICE AT A FARM	ACTIVE	BUILDING	Infrastructure Building		X
MO513	HPT/CHANGE TRAILER AT 241AY TANK FARM	ACTIVE	BUILDING	Infrastructure Building		X
MO527	RESTROOM TRAILER NORTH OF MO919	ACTIVE	BUILDING	Infrastructure Building		X
MO528	RESTROOM TRAILER NORTH OF MO919	ACTIVE	BUILDING	Infrastructure Building		X
MO564	CONSTRUTION OFFICE TRAILER NORTH OF 244AR	ACTIVE	BUILDING	Infrastructure Building		X
MO565	CONSTRUCTION OFFICE TRAILER NORTH OF 244AR	ACTIVE	BUILDING	Infrastructure Building		X
MO575	MOBILE OFFICE OFF OF BUFFALO WEST SIDE OF AY TANK	ACTIVE	BUILDING	Infrastructure Building		X
MO596	241C TANK FARM MOBILE OFFICE	ACTIVE	BUILDING	Infrastructure Building		X
MO597	241C TANK FARM MOBILE OFFICE	ACTIVE	BUILDING	Infrastructure Building		X
MO598	241C TANK FARM MOBILE OFFICE	ACTIVE	BUILDING	Infrastructure Building		X
MO599	241C TANK FARM MOBILE OFFICE	ACTIVE	BUILDING	Infrastructure Building		X
MO637	CONSTRUCTION MOBILE OFFICE BY 242AC SHOP	ACTIVE	BUILDING	Infrastructure Building		X
MO639	FIELD MOBILE RESTROOM AT BUFFALO AVE	ACTIVE	BUILDING	Infrastructure Building		X
MO816	CHANGE TRAILER AT 244A TANK FARM	ACTIVE	BUILDING	Infrastructure Building		X
MO890	MOBILE OFFICE SW OF 2237E	ACTIVE	BUILDING	Infrastructure Building		X
MO919	MOBILE OFFICE WEST OF 241AY EVAP SUPP	ACTIVE	BUILDING	Infrastructure Building		X
MO979	MOBILE OFFICE WEST OF 277A AT A FARM	ACTIVE	BUILDING	Infrastructure Building		X

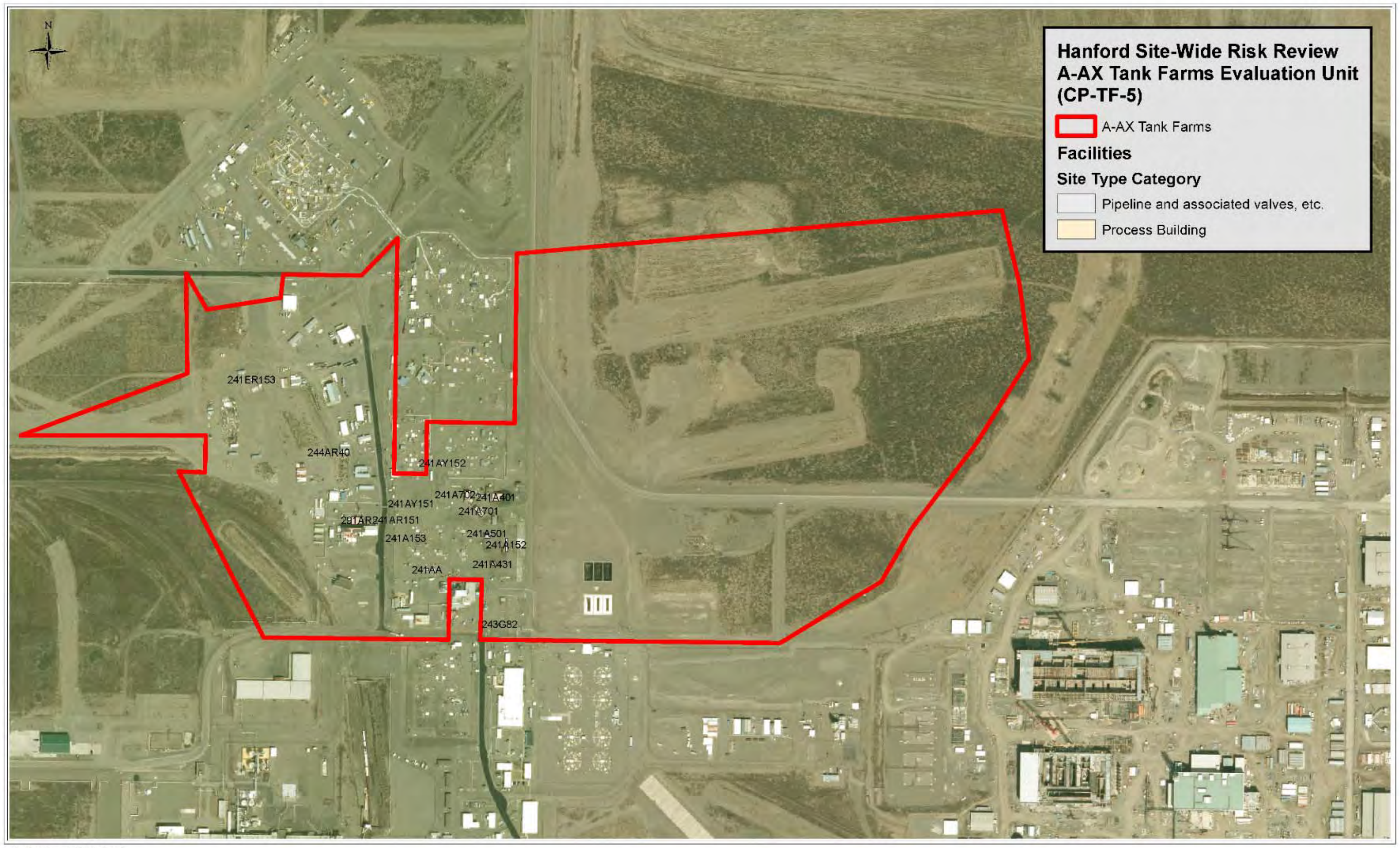
Note that only those waste sites with a WIDS (Waste Information Data System) Classification of "Accepted" are shown, along with non-duplicate facilities, identified via the Hanford Geographic Information System (HGIS).

DRAFT



1 inch = 600 feet

DRAFT



1 inch = 600 feet

APPENDIX E.7

Tank Waste and Farms

CP-TF-6 (B-BX-BY Tank Waste and Farms)
Evaluation Unit Summary Template

Table of Contents

List of Figures

List of Tables

PART 7. CP-TF-6 B-BX-BY SINGLE-SHELL TANK WASTE AND FARMS (200-E)

7.1. EXECUTIVE SUMMARY

Much of the information related to the B-BX-BY Tank and Waste Farms Evaluation Unit (EU) is organized around the corresponding Waste Management Area (namely WMA B-BX-BY) that is regulated under the Resource Conservation and Recovery Act (RCRA) and Washington's Hazardous Waste Management Act (HWMA, RCW 70.105) and it's implementing requirements (Washington's Dangerous Waste Regulations, WAC 173-303) (PNNL-13022).

EU LOCATION:

North-Central part of 200-East on the Hanford Reservation; Central Plateau

RELATED EUS:

T Tank Waste and Farms (CP-TF-1), S-SX Tank Waste and Farms (CP-TF-2), TX-TY Tank Waste and Farms (CP-TF-3), U Tank Waste and Farms (CP-TF-4), A-AX Tank Waste and Farms (CP-TF-5), C Tank Waste and Farms (CP-TF-7), 200-East DST Waste and Farms (CP-TF-8), 200-West DST Waste and Farms (CP-TF-9), 200-E Groundwater Plumes (CP-GW-1), 200-W Groundwater Plumes (CP-GW-1), and 200 Area Waste Transfer Pipeline (CP-LS-7)

PRIMARY CONTAMINANTS, CONTAMINATED MEDIA AND WASTES:

The TC&WM EIS describes tank wastes as including radioactive (tritium or H-3, C-14, Sr-90, Tc-99, I-129, Cs-137, U-233, U-234, U-235, U-238, Np-237, Pu-239, and Pu-240)[106] and non-radioactive contaminants (chromium, mercury, nitrate, lead, total uranium, and PCBs) of potential concern (DOE/EIS-0391 2012, Appendix D). The tank wastes contain saltcake, sludge, and supernatant phases. Contaminated media related to the B-BX-BY Tank Farms include ancillary equipment and surrounding vadose zone (including cribs and trenches) down to the saturated zone (for some mobile contaminants) from past and current discharges. The 2013 Groundwater Monitoring Report (DOE/RL-2014-32, Rev. 0) lists 200-BP-5 Operable Unit (OU) plumes for nitrate, I-129, Tc-99, uranium, cyanide, and H-3 associated with the B-BX-BY Tank and Waste Farms EU; the current Sr-90 plume is not associated with this EU.

After evaluating the contaminants associated with B-BX-BY Tank Farm tanks, ancillary equipment, legacy sources, and contaminated vadose zone, the primary contaminants from the tank wastes that drive human health risk to groundwater associated with the B-BX-BY Tank Farms Evaluation Unit are: Tc-99, I-129, Sr-90, H-3, chromium, uranium, cyanide, and nitrate. Those primary contaminants that may drive risk from groundwater discharge to the Columbia River are nitrate and chromium; however, any potential impacts are highly uncertain (Section 6.1). Cs-137 and Sr-90 are important from a safety standpoint and uranium isotopes, plutonium isotopes, and tritium are iconic constituents; these contaminants are included in the inventory summary even though they are not considered risk drivers

[106] Other isotopes considered include U-232 and U-236 and Pu-238, Pu-241, and Pu-242 to be consistent with other EUs. These additional uranium and plutonium isotopes are included in the totals presented but are not used for rating because 1) uranium toxicity impacts (represented by total uranium drives corresponding risks and 2) plutonium has been found relatively immobile in the Hanford subsurface and has not been identified as a risk driver for groundwater impacts.

for impacts to or from groundwater in this review. The Sr-90 plume that is not associated with the B-BX-BY Tank and Waste Farms EU is described in Appendix G.5 for the CP-GW-1 EU (200-BP-5 GW OU).

BRIEF NARRATIVE DESCRIPTION:

Waste Management Area B-BX-BY (WMA B-BX-BY) occupies approximately 20 acres (http://phoenix.pnnl.gov/) consisting of three Tank Farms, each with 12 underground single-shell tanks (SSTs) in additional to ancillary equipment (e.g., diversion boxes, pumps, valves, and pipes); the B Tank Farm also includes four smaller tanks. The tanks contain primarily salt cake from evaporator campaigns B and BY, metal waste from bismuth phosphate process, 1st / 2nd cycle decontamination from bismuth phosphate process, and lanthanum fluoride finishing waste (Remund et al. 1995). The tanks were taken out of service in 1980.

The B Tank Farm was constructed in 1943-44 (RPP-RPT-54913). The B Tank Farm includes 12 530 kgal underground waste storage tanks (B-101 through B-112) arranged in four rows of three tanks in a cascade and four smaller 55 kgal tanks. The tanks were designed for non-boiling wastes. Ten of the 16 tanks in the B Tank Farm are classified as “assumed leakers” (Weyns 2014).

The BX Tank Farm was constructed in 1946-47 to store high-level radioactive waste generated by chemical processing of irradiated uranium fuel at the chemical separation plants (RPP-RPT-47562). The BX Tank Farm contains 12 530 kgal tanks arranged in four rows of three tanks in a cascade. Five of the 12 BX Tank Farm tanks have been declared “assumed leakers” (Weyns 2014).

The BY Tank Farm was constructed in 1948-49 to store high-level radioactive waste generated from chemical processing of irradiated uranium fuel (RPP-RPT-43704). The BY Tank Farm contains 12 758 kgal underground waste storage tanks (BY-101 through BY-112) arranged in four rows of three tanks in a cascade. Five of the 12 BY Tank Farm tanks have been declared “assumed leakers” (Weyns 2014).

Twenty of the 40 SSTs in WMA B-BX-BY are classified as “assumed leakers”; leaks from these tanks total a minimum of 119,500 gallons with 70,000 gallons from BX-102 and 15,100 gallons from BY-102. Nine of the tanks have unknown leak estimates (PNNL-13022; Weyns 2014).

There are also various non-tank sources (e.g., cribs, trenches, tile fields and reverse wells) that received large volumes (7.2 to 36.8 Mgal) of contaminated waste and other waste streams resulting in extensive vadose zone and groundwater contamination in the areas around the WMA B-BX-BY (PNNL-13022).

The SSTs in WMA B-BX-BY have been interim stabilized (i.e., liquid transferred to DSTs to <50 kgal drainable interstitial liquid and <5 kgal of supernatant). The final action record of decision for 200-BP-5 OU is scheduled for 2016 (DOE/RL-2014-32, Rev. 0).

SUMMARY TABLES OF RISKS AND POTENTIAL IMPACTS TO RECEPTORS

Table E.7-1 provides a summary of nuclear and industrial safety related consequences from the CP-TF-6 (B-BX-BY Tank and Waste Farms EU) to humans and impacts to important physical Hanford Site resources. Receptors are described in Section 1.6 (Appendix E.1).

Table E.7-1. CP-TF-6 (B-BX-BY Tank Farms) impact Rating Summary for Human Health (unmitigated basis with mitigated basis provided in parentheses (e.g., "High (Low)").

Population or Resource		Evaluation Time Period[a] — Active Cleanup (to 2064) — **Current Condition:** Maintenance & Monitoring (M&M)	Evaluation Time Period[a] — Active Cleanup (to 2064) — **From Cleanup Actions:** Retrieval & Closure
Human Health	Facility Worker[b]	***M&M***: Low-High[d] (Low-High)[d] ***Soil***: ND-High (ND-Low)	***Preferred method***: High (Low) ***Alternative***: High (Low)
	Co-located Person[b]	***M&M***: Low-Moderate (Low) ***Soil***: ND (ND)	***Preferred method***: Low-Moderate (Low) ***Alternative***: Low-Moderate (Low)
	Public[b]	***M&M***: Low (Low) ***Soil***: ND (ND)	***Preferred method***: Low (Low) ***Alternative***: Low (Low)
Environmental	Groundwater (A&B) from vadose zone[c]	High -- I-129, Tc-99, Cr(tot, VI)[f] **Overall**: High	High -- I-129, Tc-99, Cr(tot, VI)[f] **Overall**: High
	Columbia River from vadose zone[c]	Benthic: Not Discernible (radionuclides) Not Discernible (chemicals) Riparian: Not Discernible (radionuclides) Not Discernible (chemicals) Free-flowing: Not Discernible (all) **Overall**: Not Discernible	Benthic: Not Discernible (radionuclides) Not Discernible (chemicals)[g] Riparian: Not Discernible (radionuclides) Not Discernible (chemicals)[g] Free-flowing: Not Discernible (all) **Overall**: Not Discernible
	Ecological Resources[e]	ND to Low	Low to Medium
Social	Cultural Resources[e]	**Native American:** Direct: Unknown Indirect: Known **Historic Pre-Hanford:** Direct: Known Indirect: Unknown **Manhattan/Cold War:** Direct: Known Indirect: Known	**Native American:** Direct: Unknown Indirect: Known **Historic Pre-Hanford:** Direct: Known Indirect: Unknown **Manhattan/Cold War:** Direct: Known Indirect: Known

a. A rating for cultural resources is not being made because cultural resources will be evaluated under Section 106 of the National Historic Preservation Act (16 USC 470, et. seq.) during the planning for remedial action.

b. Evaluated in Section 1.6 (Appendix E.1).

c. Groundwater threat for Group A and B contaminants remaining in the vadose zone or to the Columbia River for all primary contaminants. Threats from existing plumes associated with the B-BX-BY Tank and Waste Farms EU are described in Section 7.5 and Appendix G.5 (CP-GW-1) for the 200-BP-5 Groundwater Operable Unit.

d. Industrial safety consequences range from low to high (based on the evaluation scale used) for both mitigated (with controls) and unmitigated (without controls). Mitigated radiological and toxicological consequences to facility workers are high (unmitigated) and low (mitigated).

e. 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.

f. The large amount of Sr-90 disposed of in the B-BX-BY Tank and Waste Farms EU would translate to a *Very High* rating; however, there is no current Sr-90 plume associated with B-BX-BY Tank and Waste Farms EU sources in the 200-BP-5 OU. It would likely require more than 150 years for Sr-90 to reach groundwater in a sufficient amount to exceed the drinking water standard over an appreciable area (Section 7.5). Thus the Sr-90 is not considered a risk driver.

g. The information from Appendix P from the TC&WM EIS would suggest that hexavalent chromium would have *Medium* and *High* ratings for benthic and riparian zone impacts, respectively. However, current well data suggest that chromium is moving much more slowly than predicted in the TC&WM EIS evaluation resulting in *Not Discernible* ratings.

Support for Risk and Impact Ratings for Each Population or Resource

Human Health

The current and cleanup-related consequences related to work being conducted at the Tank Farms in the 200 Areas (Hanford Central Plateau) was evaluated in Section 1.6 (Appendix E.1).

Groundwater, Vadose Zone, and Columbia River

B-BX-BY Tank Farm contaminants are currently impacting groundwater and final remedial actions have not been treatment; thus there is no driver for concentrations to fall below thresholds before active cleanup commences. Secondary sources (e.g., total and hexavalent chromium) in the vadose also threaten to continue to impact groundwater in the future, including the Active Cleanup period. As described in the TC&WM EIS, there appeared to be large predicted impacts on peak concentrations in groundwater both during and after cleanup (but not the near-shore region of the Columbia River). However, despite these large, predicted impacts, the groundwater ratings for Tc-99, I-129, hexavalent chromium, and uranium would not change. The Sr-90 will decay significantly during both the Active Cleanup and Near-term, Post-Cleanup periods, however, transport considerations results in ND ratings as described in Section 7.5. Following a similar analysis, the uranium plume is predicted to decrease significantly after emplacement of a surface barrier.

Ecological Resources

Current

Little habitat in EU, but over 10% in buffer is level 3 resources. Effect ND in EU, but may be up to Low in buffer due to truck disturbance. Habitat is fragmented, which increases disturbance and increases exotic species and potentially changes in species composition of vegetation.

Risks and Potential Impacts from Selected or Potential Cleanup Approaches

Effects due to increased disturbance and potential for contaminant release, increases in exotic species, and could lose some nesting habitat, trucks could run over lizards and other wildlife during cleanup.

Cultural Resources

Current

Manhattan Project/Cold War significant resources have already been mitigated. Area is very disturbed and there are no known recorded archaeological resources within the EU. EU has not been investigated for archaeological resources (surface or subsurface). Traditional cultural places are visible from EU.

Risks and Potential Impacts from Selected or Potential Cleanup Approaches

Because area has not been investigated either on the surface or subsurface, archaeological investigations may need to occur within pockets of undisturbed land if any prior to remediation. Potential for intact archaeological material to be present is very low.

Considerations for Timing of the Cleanup Actions

See Section 1.1 (Appendix E.1).

Near-Term, Post-Cleanup Risks and Potential Impacts

See Section 1.1 (Appendix E.1).

7.2. ADMINISTRATIVE INFORMATION

OU AND/OR TSDF DESIGNATION(S):

The B-BX-BY Tank Farms Evaluation Unit (EU), denoted *CP-TF-6 – B-BX-BY Tank Farms*, consists of 20 waste tanks, ancillary structures, associated liquid waste sites, and soils contamination; much of this EU is contained within Waste Management Area B-BX-BY (WMA B-BX-BY). WMA B-BX-BY is regulated under the Resource Conservation and Recovery Act (RCRA) as modified in 40 CFR Part 265, Subpart F and Washington State's Hazardous Waste Management Act (HWMA, RCW 70.105 and its implementing requirements in the Washington State dangerous waste regulations [WAC 173-303-400]) (PNNL-13022).

COMMON NAME(S) FOR EU:

There is no common name for the B-BX-BY Tank and Waste Farms EU because the EU is comprised of elements from other waste management units including Waste Management Area B-BX-BY (WMA B-BX-BY) that includes the 241-B (or B) and 241-BX (or BX) and 241-BY (or BY) Tank Farms.

The B Tank Farm contains 16 waste tanks (B-101 through B-112 and B-201 through B-204); these tanks often are designated as 241-B-101 through 241-B-112 and 241-B-201 through 241-B-204. The BX Tank Farm contains 12 waste tanks (BX-101 through BX-112); these tanks often are designated as 241-BX-101 through 241-BX-112. The BY Tank Farm contains 12 waste tanks (BY-101 through BY-112); these tanks often are designated as 241-BY-101 through 241-BY-112. Other components in the EU are listed below in the *Primary EU Source Components* section.

KEY WORDS:

B Tank Farm, BX Tank Farm, BY Tank Farm, 241-B Tank Farm, 241-BX Tank Farm, 241-BY Tank Farm, waste tanks, tank farm, Waste Management Area B-BX-BY, WMA B-BX-BY

REGULATORY STATUS

Regulatory Basis

DOE is the responsible agency for the closure of all single-shell tank (SST) waste management areas (WMAs) through post closure, in close coordination with other closure and cleanup activities of the Hanford Central Plateau. Washington State has a program that is authorized under RCRA and implemented through the HWMA and its associated regulations; Ecology is the lead regulatory agency responsible for the closure of the SST system. Please refer to Section 1.2 (Appendix E.1) for more information.

Applicable Regulatory Documentation

The relationship among the tank waste retrieval work plans (TWRWP) and the overall single-shell tank (SST) waste retrieval and closure process is described in Appendix I of the Hanford Federal Facility Agreement and Consent Order (HFFACO), along with requirements for the content of TWRWPs. WMA A-AX was placed in assessment monitoring (40 CFR 265.93[d][4]) based on elevated specific conductance measurements (PNNL-15315, p. iii). A groundwater quality assessment plan was developed (PNNL-13022) describing the monitoring activities used in deciding whether WMA B-BX-BY has affected groundwater.

Applicable Consent Decree or TPA Milestones

Federal Facility Agreement and Consent Order, 1989 and amended through June 16, 2014: Milestone M-045-00; Lead Agency Ecology: *Complete the closure of all Single Shell Tank Farms by 01/31/2043*

RISK REVIEW EVALUATION INFORMATION

Completed: Revised August 25, 2015

Evaluated by: K. G. Brown

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

7.3. 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-West Area (of which the B-BX-BY Tank and Waste Farms EU is a part) 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: The legacy source sites associated with the B-BX-BY Tank and Waste Farms EU are described in Attachment Section 7.8. Leaks from these tanks total a minimum of 119,500 gallons with

70,000 gallons from BX-102 and 15,100 gallons from BY-102. Nine of the tanks have unknown leak estimates (PNNL-13022; Weyns 2014). There are also non-tank sources (e.g., cribs, trenches, tile fields and reverse wells) that received large volumes (7.2 to 36.8 Mgal) of contaminated waste and other waste streams that has resulted in extensive vadose zone and groundwater contamination in the areas around the WMA B-BX-BY (PNNL-13022).

High-Level Waste Tanks and Ancillary Equipment: The waste tanks in the B-BX-BY Tank and Waste Farms EU are:

- (241-)B-101 (241-B-TK-101)
- (241-)B-102 (241-B-TK-102)
- (241-)B-103 (241-B-TK-103)
- (241-)B-104 (241-B-TK-104)
- (241-)B-105 (241-B-TK-105)
- (241-)B-106 (241-B-TK-106)
- (241-)B-107 (241-B-TK-107)
- (241-)B-108 (241-B-TK-108)
- (241-)B-109 (241-B-TK-109)
- (241-)B-110 (241-B-TK-110)
- (241-)B-111 (241-B-TK-111)
- (241-)B-112 (241-B-TK-112)
- (241-)B-201 (241-B-TK-201)
- (241-)B-202 (241-B-TK-202)
- (241-)B-203 (241-B-TK-203)
- (241-)B-204 (241-B-TK-204)
- (241-)BX-101 (241-BX-TK-101)
- (241-)BX-102 (241-BX-TK-102)
- (241-)BX-103 (241-BX-TK-103)
- (241-)BX-104 (241-BX-TK-104)
- (241-)BX-105 (241-BX-TK-105)
- (241-)BX-106 (241-BX-TK-106)
- (241-)BX-107 (241-BX-TK-107)
- (241-)BX-108 (241-BX-TK-108)
- (241-)BX-109 (241-BX-TK-109)
- (241-)BX-110 (241-BX-TK-110)
- (241-)BX-111 (241-BX-TK-111)
- (241-)BX-112 (241-BX-TK-112)
- (241-)BY-101 (241-BY-TK-101)
- (241-)BY-102 (241-BY-TK-102)
- (241-)BY-103 (241-BY-TK-103)
- (241-)BY-104 (241-BY-TK-104)
- (241-)BY-105 (241-BY-TK-105)
- (241-)BY-106 (241-BY-TK-106)
- (241-)BY-107 (241-BY-TK-107)
- (241-)BY-108 (241-BY-TK-108)
- (241-)BY-109 (241-BY-TK-109)
- (241-)BY-110 (241-BY-TK-110)
- (241-)BY-111 (241-BY-TK-111)
- (241-)BY-112 (241-BY-TK-112)

The ancillary equipment included in the B-BX-BY Tank and Waste Farms EU is listed in the Attachment in Section 7.8 and primarily consists of pipelines, diversion boxes, and catch tanks.

Groundwater Plumes:

The B-BX-BY Tank and Waste Farms EU is in the 200-BP-5 Operable Unit (OU). The current 200-BP-5 OU plumes associated with B-BX-BY Tank and Waste Farms EU sources that exceed water quality standards (in this case, drinking water standards) are nitrate, I-129[107], Tc-99, uranium, cyanide, and H-3 (DOE/RL-2014-32, Rev. 0). The current Sr-90 plume in the 200-BP-5 OU is not associated with this EU. The final record of decision for the 200-BP-5 OU is scheduled for 2016.

See Appendix G.5 for the CP-GW-1 EU (200-BP-5 GW OU) for additional details.

[107] The unplanned release 241-BX-102 is listed as a potential source for I-129 in the 200-BP-5 OU (DOE/RL-2014-32, Rev. 0).

Operating Facilities: Because of the prohibition on waste additions to the Hanford SSTs,[108] the B-BX-BY Tank and Waste Farms EU components are not considered Operating Facilities for this review. See Section 1.4 (Appendix E.1) for details.

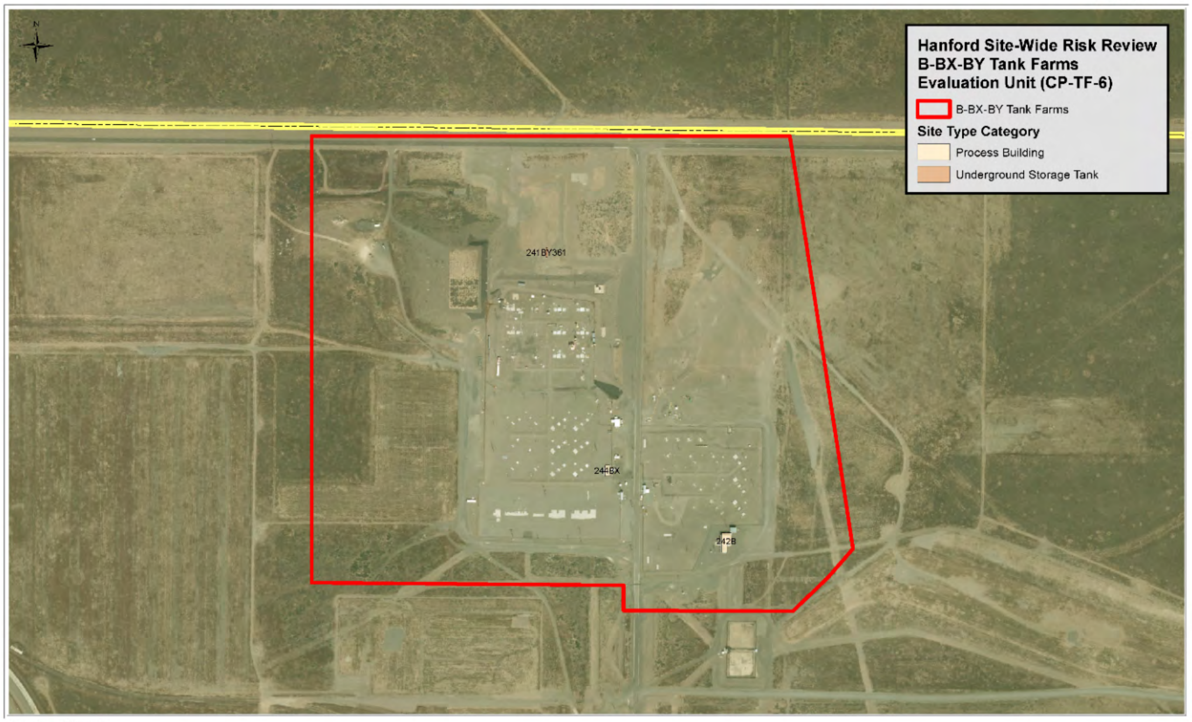
D&D of Inactive Facilities: Not Applicable.

Location and Layout Maps

A series of maps are used to illustrate the location of the components within the CP-TF-6 EU and the B-BX-BY Tank and Waste Farms EU relative to the Hanford Site. Figure E.2-1 shows the relationship between the 200-E (200 East) Area (where the B-BX-BY Tank Farms and Waste Management Area B-BX-BY are located) and the Hanford Site. Figure E.7-1 illustrates the B-BX-BY Tank and Waste Farms EU boundary. Figure E.7-2 shows a detailed view of the waste tanks, ancillary equipment, and legacy source units in the B-BX-BY Tank and Waste Farms EU.

[108] Berman presentation on July 29, 2009, titled "Hanford Single-Shell Tank Integrity Program." Available at www.em.doe.gov.

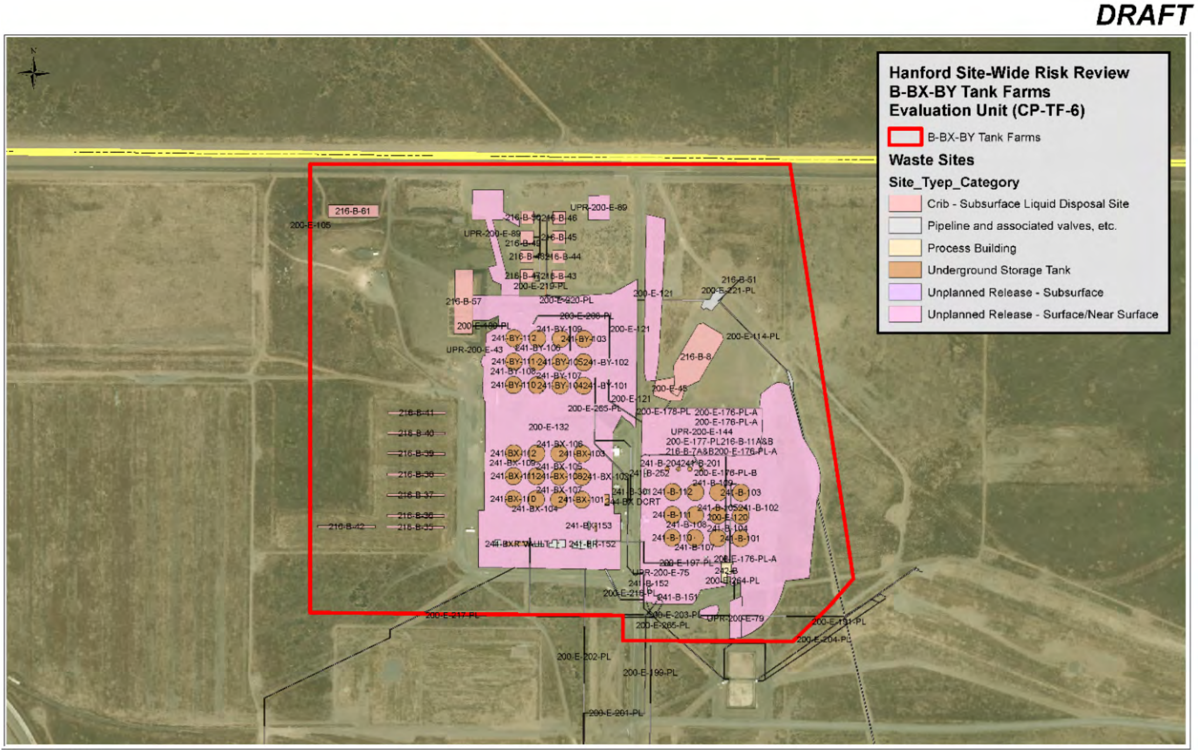
DRAFT



1 inch = 500 feet

Figure E.7-1. Polygon representing the boundary of the B-BX-BY Tank and Waste Farms Evaluation Unit (Attachment Section 7.8).

DRAFT



1 inch = 500 feet

Figure E.7-2. Hanford B-BX-BY Tank and Waste Farms Evaluation Unit including tanks, legacy source units, and ancillary equipment (Attachment Section 7.8).

7.4. UNIT DESCRIPTION AND HISTORY

EU FORMER / CURRENT USES

Waste Management Area B-BX-BY (WMA B-BX-BY) occupies approximately 20 acres (http://phoenix.pnnl.gov/) consisting of three Tank Farms, each with 12 underground single-shell tanks (SSTs) in additional to ancillary equipment (e.g., diversion boxes, pumps, valves, and pipes); the B Tank Farm also includes four smaller tanks. The tanks contain primarily salt cake from evaporator campaigns B and BY, metal waste from bismuth phosphate process, 1st / 2nd cycle decontamination from bismuth phosphate process, and lanthanum fluoride finishing waste (Remund et al. 1995).

The B Tank Farm was constructed in 1943-44 (RPP-RPT-54913) and includes 12 530 kgal underground waste storage tanks (B-101 through B-112) arranged in four rows of three tanks in a cascade and four smaller 55 kgal tanks. The tanks were designed for non-boiling wastes. The BX Tank Farm was constructed in 1946-47 to store high-level radioactive waste generated by chemical processing of irradiated uranium fuel at the chemical separation plants (RPP-RPT-47562). The BX Tank Farm contains 12 530 kgal tanks arranged in four rows of three tanks in a cascade. The BY Tank Farm was constructed in 1948-49 to store high-level radioactive waste generated from chemical processing of irradiated uranium fuel (RPP-RPT-43704). The BY Tank Farm contains 12 758 kgal underground waste storage tanks (BY-101 through BY-112) arranged in four rows of three tanks in a cascade. The tanks were taken out of service in 1980. The SSTs in WMA B-BX-BY have been interim stabilized (i.e., liquid transferred to DSTs to <50 kgal drainable interstitial liquid and <5 kgal of supernatant). The B-BX-BY Tank Farm tanks are currently awaiting retrieval and closure.

LEGACY SOURCE SITES

Twenty of the 40 SSTs in WMA B-BX-BY are classified as "assumed leakers" (Weyns 2014):

- Ten of the 16 tanks in the B Tank Farm are classified as "assumed leakers".
- Five of the 12 BX Tank Farm tanks have been declared "assumed leakers".
- Five of the 12 BY Tank Farm tanks have been declared "assumed leakers".

Leaks from these tanks total a minimum of 119,500 gallons with 70,000 gallons from BX-102 and 15,100 gallons from BY-102. Nine of the tanks have unknown leak estimates (PNNL-13022; Weyns 2014).

Various non-tank sources (e.g., cribs, trenches, tile fields and reverse wells) received large volumes (7.2 to 36.8 Mgal) of contaminated waste and other waste streams that has resulted in extensive vadose zone and groundwater contamination in the areas around the WMA B-BX-BY (PNNL-13022). These include

- liquid wastes that vary from high level metals waste to large quantities of ferrocyanide scavenged uranium recovery waste taken directly from tanks in the 241-BY Tank Farm and
- large volumes tritium-rich tank condensate generated during the in-tank solidification program.

The final action record of decision for 200-BP-5 OU is scheduled for 2016 (DOE/RL-2014-32, Rev. 0).

HIGH-LEVEL WASTE TANKS

See Section 7.3 for details.

GROUNDWATER PLUMES

The groundwater plumes (nitrate, I-129, Tc-99, uranium, cyanide, and H-3) considered to be associated with the B-BX-BY Tank Farm and co-located liquid waste disposal facilities are described in detail in Section 7.5 with additional information in Appendix G.5 for the CP-GW-1 EU (200-BP-5 GW OU).

D&D OF INACTIVE FACILITIES – NOT APPLICABLE

OPERATING FACILITIES – NOT APPLICABLE

Because of the prohibition on waste additions to the Hanford SSTs,[109] the B-BX-BY Tank and Waste Farms EU components are not considered Operating Facilities for this Review.

ECOLOGICAL RESOURCES SETTING

Landscape Evaluation and Resource Classification:

The B-BX-BY Tank and Waste Farms EU has been heavily disturbed throughout and primarily contains level 0 and 1 resources. The existing resource level map (DOE/RL-96-32 2013) also shows areas of level 2, and 3 biological resources (Appendix J, Table 3, p. J-128 and Figure 14, p. J-127). Areas of level 3 resources within the evaluation site are associated with point occurrences of sensitive species noted in previous ECAP surveys. Piper's daisy (*Erigeron piperianus*), a Washington state sensitive species, was observed in the southwest corner of the site during the July 16, 2014 survey, and has been observed near that location in past ECAP surveys. However, an occurrence of a sensitive species does not constitute a habitat "patch" as considered in this assessment, but field survey of the southwest corner of B-BX-BY EU confirmed the surrounding habitat is should be classified as level 2 resources. Climax shrubs (big sagebrush; *Artemisia tridentata*) are limited to a small patch in the center and the majority of the habitat patch is dominated by gray rabbitbrush (*Ericameria nauseosa*) (Appendix J, Figure 14, p. J-127).

The amount and proximity of biological resources to the B-BX-BY Tank and Waste Farms EU was examined within the adjacent buffer area, which extends 974 m from the geometric center of the site (equivalent to 736 acres) to encompass a circle. Approximately 43% of the adjacent buffer area is classified as level 3 or higher biological resource in the existing resource classification. The level 3 habitat within the 200-East Area represents multiple locations where Piper's daisy has been found. This species is often found in disturbed and gravelly areas on the 200-Area Plateau. The majority of the level 3 and level 4 resources are found across the paved road to the north, outside the 200-East boundary fence (Appendix J, Figure 14, p. J-127).

Field Survey:

The B-BX-BY Tank Farms evaluation site includes levels 0, 1, 2, and 3 biological resources as classified in the existing resource level map (DOE/RL-96-32 2013) (Appendix J, Table 2, p. J-126 and Figure 14, p. J-127). Most of the areas previously classified as level 3 have been degraded by activities within the EU. Several areas have been revegetated. Areas of level 3 resources within the evaluation site are associated

[109] Berman presentation on July 29, 2009, titled "Hanford Single-Shell Tank Integrity Program." Available at www.em.doe.gov.

with individual occurrences of sensitive species noted in previous ECAP surveys. Piper's daisy (*Erigeron piperianus*), a Washington state sensitive species, was observed in the southwest corner of the site during the July 2014 survey, and has been observed near that location in past ECAP surveys. Field measurements were taken in the southwest corner of B-BX-BY EU (Appendix J, Table 2, p. J-126).

Animal species (or their sign) observed during the July 2014 survey include horned lark (*Eremophila alpestris*), northern pocket gopher (*Thomomys talpoides*), coyote (*Canis latrans*), and black-tailed jackrabbit (*Lepus californicus*). The black-tailed jackrabbit sign (very old scat) was observed in the southwest corner of the evaluation site. No other sign of recent presence (e.g., runs, fresh scat, animals) was observed. The black-tailed jackrabbit is a Federal Species of Concern and Washington State Candidate species.

CULTURAL RESOURCES SETTING

Cultural resources known to be recorded within the B-BX-BY Tank and Waste Farms EU are limited to the National Register-eligible 242B Building Radioactive Particle Research Laboratory associated with the Manhattan Project/Cold War Era Landscape with no documentation required. All National-Register-eligible Manhattan Project and Cold War Era buildings been documented as described in the *Hanford Site Manhattan Project and Cold War Era Historic District Treatment Plan* (DOE/RL-97-56).

None of the B-BX-BY Tank and Waste Farms EU has been inventoried for archaeological resources and closure and remediation of the tank farms located within the B-BX-BY Tank and Waste Farms EU has been addressed in an NHPA Section 106 review. There is a possibility that intact archaeological material is present in the B-BX-BY Tank and Waste Farms EU because it has not have not been inventoried for archaeological resources (both on the surface and in the subsurface) and particularly where undisturbed soil deposits exist within the B-BX-BY Tank and Waste Farms EU to the west. Within the other extensively disturbed areas, this is unlikely. The closest recorded archaeological site, located within 500 meters of the B-BX-BY Tank and Waste Farms EU consists of two historic-era isolated finds and one historic-era site likely associated with the Pre-Hanford Early Settlers/Farming Landscape and are not considered to be National Register-eligible. Additionally, the Hanford Site Plant Railroad, a contributing property within the Manhattan Project and Cold War Era Historic District, with documentation required is located within 500 meters of the B-BX-BY Tank and Waste Farms EU. In accordance with the 1998 *Hanford Site Manhattan Project and Cold War Era Historic District Treatment Plan (*DOE/RL-97-56), all documentation requirements have been completed for these properties

Geomorphology, ground disturbance, historic maps, and the lack of cultural resources located within and in the vicinity of B-BX-BY Tank and Waste Farms EU all suggest that the potential for archaeological resources associated with all three landscapes to be present on the surface or within the subsurface within the EU is very low. Because none of the B-BX-BY Tank and Waste Farms EU has been investigated for archaeological sites and pockets of undisturbed soil may exist, it may be appropriate to conduct surface and subsurface archaeological investigations in these areas prior to initiating a remediation activity. 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 associated with these landscapes (e.g. East Benton Historical Society, the Franklin County Historical Society, Prosser Cemetery Association, the Reach and B-Reactor Museum Association) may need to occur. Indirect effects are always possible when TCPs are known to be located in the general vicinity. Consultation with Hanford Tribes may also 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.

7.5. WASTE AND CONTAMINATION INVENTORY

Table E.7-2 provides inventory estimates of the various source components associated with the B-BX-BY Tank and Waste Farms EU including tank wastes and ancillary equipment, legacy sources including leaks, cribs, trenches, unplanned releases (UPRs), vadose zone sources, saturated zone (plume) estimates, treatment amounts, and remaining vadose zone estimates (i.e., the difference of the vadose zone estimates and the saturated zone and treatment estimates)[110]. This information is further summarized in Figure E.7-3 through Figure E.7-11 before and after planned 99% retrieval[111].

For example, the major sources for Tc-99 and I-129 in the EU before retrieval are the B-BX-BY Tank Farm tanks and past discharges to cribs. The maximum groundwater threat metric (GTM) (Figure E.7-12)[112] is also dominated by the B-BX-BY Tank Farm wastes before retrieval and by past discharges to cribs after planned retrieval; this also applies to Tc-99 and I-129. The tritium and nitrate inventory, both pre- and post-retrieval, is dominated by past discharges to cribs and trenches. For chromium, the B-BX-BY Tank Farm tanks and past discharges to cribs and trenches are major sources before retrieval. After retrieval, past discharges cribs and trenches dominate the source of this PC. Current uranium inventories are dominated by tank inventories; whereas, post-retrieval sources are primarily related to past leaks. For Sr-90 and Cs-137, the post-retrieval inventory is dominated by ancillary equipment and past leaks. The post-retrieval plutonium isotope inventories are dominated by ancillary equipment and past discharges to cribs.

CONTAMINATION WITHIN PRIMARY EU SOURCE COMPONENTS

Legacy Source Sites

The estimated B-BX-BY Tank Farm inventory for the Legacy / Vadose Zone Source Sites (i.e., cribs, trenches, and soil contaminated by tank leaks and unplanned releases) is summarized in Table E.7-2 and further described in Figure E.7-3 through Figure E.7-11 before and after planned 99% retrieval (which will have no impact on the current legacy source site inventories). These values constitute estimates of the initial amounts of contaminants discharged to the vadose zone that are then used to estimate the remaining inventory in the vadose zone as described below (i.e., by difference using the process described in Chapter 6 of the Methodology Report (CRESP 2015)). These estimates necessarily have large associated uncertainties.

Waste Tanks and Ancillary Equipment

The estimated total inventory for all the B-BX-BY Tank Farm Waste Tanks and Ancillary Equipment is provided in Table E.7-2 for both the 90% and planned 99% retrieval scenarios. The tank-by-tank inventories are provided in Table E.7-3 through Table E.7-6. Safety-related information (i.e., hydrogen generation rates and times to the lower flammability limit are also provided in Table E.7-3. The inventories for the various contaminant in the B-BX-BY Tank Farm tanks vary over several orders of magnitude as does the GTM. This information is further summarized in Figure E.7-3 through Figure E.7-11 before and after planned 99% retrieval and for the maximum GTM in Figure E.7-12.

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[110] The basis for the saturated and vadose zone estimates are provided in Chapter 6 of the Methodology Report (CRESP 2015) and examples are provided in the demonstration section for the 200-UP-1 Operable Unit. These estimates tend to have very high associated uncertainties.

[111] According to the Tri-Party Agreement (Ecology, EPA, and DOE, 1998), retrieval limits for residual wastes are 360 ft^3 and 30 ft^3 for 100-Series and 200-Series tanks, respectively, corresponding to the 99% waste retrieval goal as defined in TPA Milestone M-45-00.

[112] Maximum of the GTMs for Tc-99 and I-129 only.

Vadose Zone Contamination

The estimated inventories for the vadose zone, saturated zone, and treatment amounts are found in Table E.7-2. These inventories represent the vadose zone contamination *outside* the tanks and ancillary equipment (i.e., that are generally available for transport through the environment). These inventories are used to estimate the inventory remaining in the vadose zone using the process described in Chapter 6 of the Methodology Report (CRESP 2015). The focus in this section will be on the Group A and B contaminants in the vadose zone due to their mobility and persistence and potential threats to groundwater. To summarize:

- *Tc-99, I-129* – There are already 200-BP-5 OU plumes for Tc-99 and I-129; both of these plume are associated with B-BX-BY Tank and Waste Farms EU sources (DOE/RL-2014-32, Rev. 0). However, the vadose zone inventory is dominated by past discharges to cribs.
- *Sr-90* – There is a current plume for Sr-90; however, this plume is not associated with the B-BX-BY Tank and Waste Farms EU sources. The vadose zone inventory is dominated by ancillary equipment and past leaks. Using an analysis similar to that for Sr-90 in the A-AX Tank and Waste Farms EU (Section 6.5), a Sr-90 plume related to B-BX-BY Tank and Waste Farms EU sources is not expected in the next 150 years due to retardation in the vadose zone (despite the existing plume, which is relatively small at 0.6 km^2). Sr-90 is not considered a significant threat to the Hanford groundwater. However, the times required for the remaining vadose zone Sr-90 inventory from B-BX-BY Tank and Waste Farms EU sources to decay to values that would result in *Medium* and *Low* ratings are 200+ and 300+ years, respectively, indicating that the vadose zone source is relatively substantial.
- *Chromium* – There is no current plume for chromium (either total or hexavalent). The vadose zone inventory is dominated by past discharges to cribs and trenches.
- *Uranium* – There is an existing uranium plume associated with the 241-BX-102 unplanned release. The vadose zone inventory is dominated by past leaks. The TC&WM EIS groundwater transport analysis (Appendix O, DOE/EIS-0391 2012) indicates that uranium, which already has a current plume, is predicted to exceed the drinking water standard at the B Barrier within the 10,000-year TC&WM EIS evaluation period (Appendix O, DOE/EIS-0391 2012, p. O-59)). Thus there is no basis (related to vadose zone transport results in the TC&WM EIS) to alter the rating for uranium (unlike in Section 6.5).
- *Cyanide* – There is a current cyanide (CN) plume, which is associated with a release in the 241-B Tank Farm.

Using the process outlined in Chapter 6 of the Methodology Report (CRESP 2015), the vadose zone inventories in Table E.7-2 are estimated and used to calculate Groundwater Threat Metric (GTM) values for the Group A and B contaminants remaining in the vadose zone as illustrated in Table E.7-7. Note that the vadose zone (VZ) ratings range from ND for Sr-90[113] to *Medium* for uranium to *High* for Tc-99, I-129, and chromium (total and hexavalent).

Groundwater Plumes

In general groundwater plumes are evaluated in separate EUs; however, those portions of groundwater plumes that can be associated with the TF EU (i.e., a plume with sources associated with the TF EU) will

[113] The remaining vadose zone inventory for Sr-90 would translate to *Very High* ratings; however, no appreciable Sr-90 plume would be expected in the next 150 years due to transport and decay considerations. A *Low* rating is applied to the period after Active Cleanup is completed to account for uncertainties.

be evaluated to provide a better idea of the saturated zone versus remaining vadose zone threats to groundwater. The estimated inventory for the saturated zone contamination is provided in Table E.7-2 where Photoshop was used to estimate the fraction of the plumes considered associated with the B-BX-BY Tank and Waste Farms EU (Attachment 6-4 in the Methodology Report (CRESP 2015)[114]). This information is also used to estimate amounts treated and remaining in the vadose zone. For the groundwater plumes described in the 200-BP-5 OU (DOE/RL-2014-32, Rev. 0), apportionment of plumes and ratings to the B-BX-BY Tank and Waste Farms EU would be as follows:

- *Nitrate* – There are plumes in the OU; the single plume near the B-BX-BY Tank and Waste Farms EU is associated with the EU (from the 241-BX-102 unplanned release and releases with B Tank Farm). The area of this plume is 7% of the area of the plumes (CRESP 2015).
- *I-129* – There are plumes in the OU where a potential source is the 241-BX-102 unplanned release (DOE/RL-2014-32, Rev. 0). Since the contribution of I-129 to the existing plume cannot be determined, the contribution is considered insignificant suggesting a potential gap in the analysis. The corresponding ratings would be ND.
- *Tc-99* – There are plumes in the OU; the large plume near the B-BX-BY Tank and Waste Farms EU is considered associated with the EU, and the area of this plume is 63% of the area of the plumes (CRESP 2015).
- *Uranium* – There are plumes in the OU; the large plume near the B-BX-BY Tank and Waste Farms EU is considered associated with the EU, and the area of this plume is 87% of the area of the plumes (CRESP 2015).
- *Sr*-90 – There are plumes in the OU; however, there are no major Sr-90 sources identified that are related to B-BX-BY Tank and Waste Farms EU sources (DOE/RL-2014-32, Rev. 0). Thus the contribution is considered insignificant and the ratings would be ND.
- *H-3* – There is a plume in the OU associated with large inventories disposed to the 216-B-50 and 216-B-57 Cribs in the 1960s and 1970s (i.e., associated with this EU). The area of this plume is 48% of the area of the 200-BP-5 OU tritium plumes (CRESP 2015).
- *Cyanide* – There are plumes in the 200-BP-5 OU that are associated with the B-BX-BY Tank and Waste Farms EU (including the BY Cribs) (DOE/RL-2014-32, Rev. 0). The contribution is 100% since the only plumes are associated with these sources.

The groundwater plumes associated with the B-BX-BY Tank Farm and co-located liquid waste disposal facilities are described in detail in the Appendix G.5 for the CP-GW-1 EU (200-BP-5 GW OU). Note that I-129, Tc-99, and Sr-90 (*High*) and nitrate, uranium, and tritium (*Medium*) are the risk drivers for the 200-BP-5 GW OU, which is reasonably consistent with the results for the remaining vadose zone contamination Table E.7-2. The one difference is Sr-90 where the vadose zone contamination for the B-BX-BY TF EU is rated as ND (based on transport and decay considerations) whereas the corresponding rating for the 200-BP-5 OU is *High*. Thus even if the remaining vadose zone rating for ND for Sr-90 is questioned, the groundwater threat is apparent from the 200-BP-5 OU (CP-GW-1 EU) albeit from sources outside of the B-BX-BY TF EU.

[114] From the graphic map files provided by PNNL, the PhotoShop Magic Wand Tool was used to select areas representing plumes and then the "Record Measurements" Tool was used to provide areal extents. A Custom Measurement Scale was set to that of the map.

Impact of Recharge Rate and Radioactive Decay on Groundwater Ratings

The TC&WM EIS screening groundwater transport analysis (Appendix O, DOE/EIS-0391 2012) indicates that there is little impact of emplacing the engineered surface barrier (and resulting reduction of infiltrating water) on the predicted peak groundwater concentrations (relative to thresholds) at the B Barrier[115]. This result is not ascribed to an ineffective barrier, but instead to large amounts of contaminants already present in the subsurface and possible influence from sources outside the B-BX-BY Tank and Waste Farms EU. To summarize, the screening groundwater results including sources in addition to those for the B-BX-BY Tank and Waste Farms EU (Appendix O, DOE/EIS-0391 2012) include:

- Tc-99 peak concentration is 26,500 pCi/L (CY 3957) for the No Action Alternative versus 3,570 pCi/L (CY 2056) for Landfill Closure where the threshold value is 900 pCi/L.
- I-129 peak concentration is 58.8 pCi/L (CY 3577) for the No Action Alternative versus 4.5 pCi/L (CY 2056) for Landfill Closure where the threshold value is 1 pCi/L.
- Chromium peak concentration is 864 µg/L (CY 3882) for the No Action Alternative versus 215 µg/L (CY 2050) for Landfill Closure where the threshold value is 100 µg/L (total) or 48 µg/L (hexavalent).
- Uranium peak concentration is 41 µg/L (CY 11,778) for the No Action Alternative versus 4 µg/L (CY 11,778) for Landfill Closure where the threshold value is 30 µg/L.
- No values are reported at the B Barrier for Sr-90 for either scenario, which indicates that peak fluxes (related to the sources considered) were less than 1×10^{-8} Ci/yr (Appendix O, DOE/EIS-0391 2012, p. O-2).

Despite impacts on the predicted peak concentrations, the peak values for Tc-99, I-129, and chromium exceed thresholds at the B Barrier within 150-200 years and longer for either scenario, and thus ratings will not be altered based on recharge rate scenarios.

Based on the TC&WM EIS screening results, it is assumed that uranium would not reach groundwater in sufficient quantity to exceed the standard for the Landfill scenario; therefore, the Active Cleanup rating would not be changed but the Near-term Post-Cleanup rating would be *Low* to account for uncertainties.

For Sr-90, the times required for the remaining vadose zone inventory to decay to values that would result in *Medium* and *Low* ratings are 200+ and 300+ years, respectively. Thus the Sr-90 ratings for the Active Cleanup and Near-term Post-Cleanup periods would not be changed based on decay; however, the transport and decay evaluation above results in a rating of *Not Discernible* for the Active Cleanup and Near-term Post-Cleanup periods.

Columbia River

The process illustrated in Chapter 6 of the Methodology Report 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.

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[115] The 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). The B Barrier is the closest to the B-BX-BY Tank and Waste Farms EU. Despite including sources other than those for the B-BX-BY Tank and Waste Farms EU, the analysis in the TC&WM EIS was considered the best and most consistent information to assess the impact of the engineered surface barrier emplacement.

Benthic and Riparian Zone – Current Impacts

Based on the information in the 2013 Hanford Annual Groundwater Report (DOE/RL-2014-32, Rev. 0) and PHOENIX (http://phoenix.pnnl.gov/), no plume from the 200-BP-5 OU currently intersects the Columbia River at concentrations exceeding the appropriate water quality standard (WQS). Thus current impacts from the B-BX-BY Tank and Waste Farms EU to the Columbia River benthic and riparian ecology would be rated as *Not Discernible*.

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

Because 200-BP-5 OU plumes associated with the B-BX-BY Tank and Waste Farms EU originate from 200-East, it is possible that a current plume might reach the Columbia River in the next 150 years since the *water* travel time is ~10-30 years from 200-East to the Columbia River (Gephart 2003; PNNL-6415 Rev. 18)[116]. Based on a similar analysis described for the A-AX Tank and Waste Farms EU (Section 6.5), a *Not Discernible* rating is obtained for radionuclides for the Active Cleanup and Near-term, Post-Cleanup impacts of current plumes on the Columbia River.

For nitrate (Group C chemical with a current plume related to the EU), the predicted peak concentration (16,200 µg/L in CY 2111 from Table O-8, Appendix O, DOE/EIS-0391 2012, p. O-59) is less than the drinking water standard (45,000 µg/L), which leads to a *Not Discernible*[117] rating for the Active Cleanup and Near-term, Post-Cleanup evaluation periods. However, the ratio of the predicted peak concentration (16,200 µg/L in CY 2111) to the ambient water quality criterion (AWQC) of 7,100 µg/L (DOE/RL-2010-117, Rev. 0) exceeds one during the Near-term, Post-Cleanup evaluation period, which would lead to a rating of *Low* for this period. However, well measurements indicate that nitrate and other mobile contaminants in 200-East are unlikely to reach the Columbia River in sufficient quantities to exceed the AWQC. Furthermore, the peak predictions are based on sources other than those from the B-BX-BY Tank and Waste Farms EU. Thus a *Not Discernible* rating is also ascribed to the chemical plumes associated with the B-BX-BY Tank and Waste Farms EU.

Benthic and Riparian Zone Ecology – Active Cleanup and Near-term, Post Cleanup for Vadose Zone Contaminants

Following the analysis outlined in Section 6.5 for the A-AX Tank and Waste Farms EU, the vadose zone contaminants (where hexavalent chromium is the possible risk driver) would translate to a (benthic) rating of *Not Discernible* during the Active Cleanup and Near-term, Post-Cleanup periods.

Using the TC&WM EIS screening results would lead to Medium (benthic) and High (riparian) ratings for chromium (and Not Discernible for the others); however, because well measurements indicate that chromium is moving toward the Columbia River much more slowly than assumed in the TC&WM EIS, the plumes are not likely going to reach the Columbia River within the Evaluation periods leading to *Not Discernible* ratings.

Benthic and Riparian Zone – Long-term

Following the analysis outlined in Section 6.5, there should be no expected adverse effects from radionuclides (for the sources considered in the TC&WM EIS including those for the B-BX-BY Tank and Waste Farms EU) during the TC&WM EIS evaluation period (10,000 years). Similarly, nitrate from the B-BX-BY Tank and Waste Farms EU would pose little additional long-term risk to the Columbia River

[116] Sr-90 and uranium have current plumes but neither is expected to reach the Columbia River in the next 10,000 years. The cyanide plume is also evaluated in Appendix G.5 for the CP-GW-1 EU.

[117] According to the framework (Figure 6-10, Chapter 6, Methodology Report), a rating of *Not Discernible* is warranted when the plume is not anticipated to reach the River in a concentration exceeding the drinking water standard in the time period being considered. Note that there are sources other than the B-BX-BY Tank and Waste Farms EU considered.

benthic or riparian ecology. The screening results for chromium (assumed hexavalent) would translate to some additional risk to benthic and riparian receptors (i.e., exceeds the screening threshold) although sources other than the B-BX-BY Tank and Waste Farms EU are included in the evaluation. As indicated in Section 6.5, this is consistent with the evaluation provided in the TC&WM EIS (DOE/EIS-0391 2012, Chapter 2, p. 2–235 & 2–237).

Threats to the Columbia River Free-flowing Ecology

As described in Section 2.5, 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

Similar to the evaluation in Section 6.5, the alternatives analysis in the TC&WM EIS would suggest that benthic and riparian zone ratings associated with the B-BX-BY Tank and Waste Farms EU would not change based on surface barrier installation and changes in recharge rates. This result is not due to an ineffective barrier but instead likely due to the large amounts of the contaminants already in the subsurface and possible impact from sources outside the B-BX-BY Tank and Waste Farms EU.

Facilities for D&D – Not Applicable

Operating Facilities – Not Applicable

Because of the prohibition on waste additions to the Hanford SSTs,[118] the B-BX-BY Tank and Waste Farms EU components are not considered Operating Facilities for this Review.

[118] Berman presentation on July 29, 2009, titled "Hanford Single-Shell Tank Integrity Program." Available at www.em.doe.gov.

Table E.7-2. Summary Table of Infrastructure and Subsurface Contamination Inventory for the B-BX-BY Tank and Waste Farms Evaluation Unit (CP-TF-6) [(a)(b)]

Contaminated Media	Primary Contaminants	Total Amount. of Each Contaminant Before Retrieval	90% Retrieval Scenario	99% Retrieval Scenario
Infrastructure (Tanks and Ancillary Equipment)				
Tank Waste	Waste (kGal)	7803	780.3	78.03
	Sludge (kGal)	2770	277	27.7
	Saltcake (kGal)	4997	499.7	49.97
	Supernatant (kGal)	36	3.6	0.36
Tank Waste (rad)	Am-241 (Ci)	3200	320	32
	C-14 (Ci)	94	9.4	0.94
	Co-60 (Ci)	580	58	5.8
	Cs-137 (Ci)	2300000	230000	23000
	Eu-152 (Ci)	130	13	1.3
	Eu-154 (Ci)	3000	300	30
	H-3 (Ci)	540	54	5.4
	I-129 (Ci)	2.8	0.28	0.028
	Ni-59 (Ci)	660	66	6.6
	Ni-63 (Ci)	61000	6100	610
	Pu (total) (Ci)	7100	710	71
	Sr-90 (Ci)	2400000	240000	24000
	Tc-99 (Ci)	2100	210	21
	U (total) (Ci)	270	27	2.7
Tank Waste (non-rad)	Cr (kg)	110000	11000	1100
	Hg (kg)	370	37	3.7
	NO3 (kg)	9200000	920000	92000
	Pb (kg)	18000	1800	180
	U (total) (kg)	190000	19000	1900
Ancillary Equipment (rad)	C-14 (Ci)	3.1	3.1	3.1
	Cs-137 (Ci)	18000	18000	18000
	H-3 (Ci)	7.1	7.1	7.1
	I-129 (Ci)	0.031	0.031	0.031

Contaminated Media	**Primary Contaminants**	**Total Amount. of Each Contaminant Before Retrieval**	**90% Retrieval Scenario**	**99% Retrieval Scenario**
	Pu (total) (Ci)	48	48	48
	Sr-90 (Ci)	46000	46000	46000
	Tc-99 (Ci)	18	18	18
	U (total) (Ci)	1.1	1.1	1.1
Ancillary Equipment (non-rad)	Cr (kg)	710	710	710
	Hg (kg)	5.1	5.1	5.1
	NO3 (kg)	65000	65000	65000
	U (total) (kg)	1500	1500	1500
MUST (rad)	Am-241 (Ci)	0.069	0.069	0.069
	C-14 (Ci)	0.01	0.01	0.01
	Co-60 (Ci)	0.0078	0.0078	0.0078
	Cs-137 (Ci)	1.5	1.5	1.5
	Eu-152 (Ci)	0.00061	0.00061	0.00061
	Eu-154 (Ci)	0.047	0.047	0.047
	H-3 (Ci)	0.26	0.26	0.26
	I-129 (Ci)	0.00021	0.00021	0.00021
	Ni-59 (Ci)	0.00017	0.00017	0.00017
	Ni-63 (Ci)	0.015	0.015	0.015
	Pu (total) (Ci)	0.044	0.044	0.044
	Sr-90 (Ci)	5.6	5.6	5.6
	Tc-99 (Ci)	0.16	0.16	0.16
	U (total) (Ci)	0.00088	0.00088	0.00088
MUST (non-rad)	Cr (kg)	9.3	9.3	9.3
	Hg (kg)	0.013	0.013	0.013
	NO3 (kg)	8300	8300	8300
	U (total) (kg)	1.3	1.3	1.3
Vadose Zone Source (Leaks and Intentional Discharges into Cribs and Trenches)				
Leaks (rad)	C-14 (Ci)	3.8	3.8	3.8
	Cs-137 (Ci)	32000	32000	32000
	H-3 (Ci)	29	29	29
	I-129 (Ci)	0.055	0.055	0.055
	Pu (total) (Ci)	9.5	9.5	9.5

Contaminated Media	Primary Contaminants	Total Amount. of Each Contaminant Before Retrieval	90% Retrieval Scenario	99% Retrieval Scenario
	Sr-90 (Ci)	13000	13000	13000
	Tc-99 (Ci)	29	29	29
	U (total) (Ci)	10	10	10
Leaks (non-rad)	Cr (kg)	310	310	310
	Hg (kg)	0.4	0.4	0.4
	NO3 (kg)	57000	57000	57000
	Pb (kg)	59	59	59
	U (total) (kg)	15000	15000	15000
Cribs (rad)	Am-241 (Ci)	63	63	63
	C-14 (Ci)	8.4	8.4	8.4
	Co-60 (Ci)	6.8	6.8	6.8
	Cs-137 (Ci)	2400	2400	2400
	Eu-152 (Ci)	0.61	0.61	0.61
	Eu-154 (Ci)	47	47	47
	H-3 (Ci)	550	550	550
	I-129 (Ci)	0.17	0.17	0.17
	Ni-59 (Ci)	0.25	0.25	0.25
	Ni-63 (Ci)	22	22	22
	Pu (total) (Ci)	340	340	340
	Sr-90 (Ci)	6500	6500	6500
	Tc-99 (Ci)	130	130	130
	U (total) (Ci)	2.3	2.3	2.3
Cribs (non-rad)	Cr (kg)	24000	24000	24000
	Hg (kg)	13	13	13
	NO3 (kg)	11000000	11000000	11000000
	Pb (kg)	9.7	9.7	9.7
	U (total) (kg)	1400	1400	1400
Trenches (rad)	Am-241 (Ci)	9.4	9.4	9.4
	C-14 (Ci)	1.4	1.4	1.4
	Co-60 (Ci)	4.5	4.5	4.5
	Cs-137 (Ci)	6200	6200	6200
	Eu-152 (Ci)	0.18	0.18	0.18

Contaminated Media	Primary Contaminants	Total Amount. of Each Contaminant Before Retrieval	90% Retrieval Scenario	99% Retrieval Scenario
	Eu-154 (Ci)	13	13	13
	H-3 (Ci)	91	91	91
	I-129 (Ci)	0.031	0.031	0.031
	Ni-59 (Ci)	0.36	0.36	0.36
	Ni-63 (Ci)	50	50	50
	Pu (total) (Ci)	9.6	9.6	9.6
	Sr-90 (Ci)	1200	1200	1200
	Tc-99 (Ci)	8.4	8.4	8.4
	U (total) (Ci)	0.34	0.34	0.34
Trenches (non-rad)	Cr (kg)	5000	5000	5000
	Hg (kg)	5.3	5.3	5.3
	NO3 (kg)	1700000	1700000	1700000
	U (total) (kg)	500	500	500
UPR (rad)	Am-241 (Ci)	0.27	0.27	0.27
	C-14 (Ci)	0.098	0.098	0.098
	Co-60 (Ci)	0.53	0.53	0.53
	Cs-137 (Ci)	910	910	910
	Eu-152 (Ci)	0.024	0.024	0.024
	Eu-154 (Ci)	1.8	1.8	1.8
	H-3 (Ci)	1.4	1.4	1.4
	I-129 (Ci)	0.0022	0.0022	0.0022
	Ni-59 (Ci)	0.02	0.02	0.02
	Ni-63 (Ci)	2	2	2
	Pu (total) (Ci)	0.54	0.54	0.54
	Sr-90 (Ci)	170	170	170
	Tc-99 (Ci)	3.1	3.1	3.1
	U (total) (Ci)	0.0048	0.0048	0.0048
UPR (non-rad)	Cr (kg)	82	82	82
	Hg (kg)	0.057	0.057	0.057
	NO3 (kg)	22000	22000	22000
	Pb (kg)	2.1	2.1	2.1
	U (total) (kg)	6.5	6.5	6.5

Contaminated Media	Primary Contaminants	Total Amount. of Each Contaminant Before Retrieval	90% Retrieval Scenario	99% Retrieval Scenario
Vadose Zone (from Vadose Zone Sources)				
VZ Remaining (rad)	Am-241 (Ci)	73	73	73
	C-14 (Ci)	14	14	14
	Co-60 (Ci)	12	12	12
	Cs-137 (Ci)	42000	42000	42000
	Eu-152 (Ci)	0.81	0.81	0.81
	Eu-154 (Ci)	61	61	61
	H-3 (Ci)	640	640	640
	I-129 (Ci)	0.25	0.25	0.25
	Ni-59 (Ci)	0.63	0.63	0.63
	Ni-63 (Ci)	74	74	74
	Pu (total) (Ci)	360	360	360
	Sr-90 (Ci)	21000	21000	21000
	Tc-99 (Ci)	110	110	110
	U (total) (Ci)	13	13	13
VZ Remaining (non-rad)	CN (kg)	0[c]	0[c]	0[c]
	Cr (kg)	29000[d]	29000[d]	29000[d]
	Cr-VI (kg)	29000[d]	29000[d]	29000[d]
	Hg (kg)	19	19	19
	NO3 (kg)	13000000	13000000	13000000
	Pb (kg)	71	71	71
	U (total) (kg)	17000	17000	17000
VZ Treatment (rad)	Tc-99 (Ci)	0.0089	0.0089	0.0089
VZ Treatment (non-rad)	NO3 (kg)	13	13	13
	U (total) (kg)	16	16	16
Saturated Zone (from Vadose Zone Sources)				
SZ Inventory (rad)	H-3 (Ci)	26	26	26
	Tc-99 (Ci)	63	63	63
SZ Inventory (non-rad)	CN (kg)	1300	1300	1300
	NO3 (kg)	650000	650000	650000
	U (total) (kg)	540	540	540

a. Tanks (SST and DST): Best Basis Inventory (BBI) March 2014; Ancillary Equipment (Anc Eq): Tank Farm Closure & Waste Management (TC&WM) Environmental Impact Statement (DOE/EIS-0391) Appendix D; Unplanned Releases (UPRs): Soil Inventory Model (SIM) Rev 1 (RPP-26744, Rev 0); Ponds: Soil Inventory Model (SIM) Rev 1 (RPP-26744, Rev 0); Cribs: Soil Inventory Model (SIM) Rev 1 (RPP-26744, Rev 0); Trenches: Soil Inventory Model (SIM) Rev 1 (RPP-26744, Rev 0) and Tank Farm Closure & Waste Management (TC&WM) Environmental Impact Statement (DOE/EIS-0391) Appendix S; Leaks: Tank Farm Closure & Waste Management (TC&WM) Environmental Impact Statement (DOE/EIS-0391) Appendix D; MUSTs: Soil Inventory Model (SIM) Rev 1 (RPP-26744, Rev 0) and Tank Farm Closure & Waste Management (TC&WM) Environmental Impact Statement (DOE/EIS-0391) Appendix S.

b. All primary contaminant inventories are reported to 2 significant figures. The source document should be consulted for greater precision data.

c. Small negative value obtained by difference.

d. Differences in inventories for Cr vs Cr-IV are due to differing Water Quality Standards (WQS) and thus plume extents: 100 mg/L for total chromium vs 48 mg/L for chromium (IV). The difference may not be distinguishable within the number of significant digits (2) displayed.

Table E.7-3. Current Bulk Inventory and Steady State Flammability Results (by Tank) for the B-BX-BY Tank Farms (CP-TF-6)

Tank ID	Tank Type	Capacity (kGal)[(a)]	Sludge (kGal)[(a)]	Saltcake (kGal)[(a)]	Supernatant (kGal)[(a)]	HGR(c) (ft3/d)[(b)]	Days to 25% LFL Barometric[(c)]	Days to 25% LFL Zero Ventilation[(d)]
B-101	SST	530	28	81	0	0.54	NA	1736
B-102	SST	530	0	28	4	0.33	NA	>1826
B-103	SST	530	1	55	0	0.34	NA	>1826
B-104	SST	530	309	65	0	0.51	NA	1197
B-105	SST	530	28	262	0	0.46	NA	1588
B-106	SST	530	122	0	1	0.42	NA	>1826
B-107	SST	530	86	75	0	0.4	NA	>1826
B-108	SST	530	27	65	0	0.36	NA	>1826
B-109	SST	530	50	76	0	0.37	NA	>1826
B-110	SST	530	244	0	1	0.72	NA	1032
B-111	SST	530	241	0	1	1.2	NA	588
B-112	SST	530	15	17	3	0.36	NA	>1826
B-201	SST	55	29	0	0	0.085	NA	421
B-202	SST	55	28	0	0	0.083	NA	424
B-203	SST	55	49	0	1	0.3	36	34
B-204	SST	55	48	0	2	0.29	41	37
BX-101	SST	530	48	0	0	0.37	NA	>1826
BX-102	SST	530	79	0	0	0.49	NA	>1826
BX-103	SST	530	62	0	13	1.1	NA	872
BX-104	SST	530	97	0	3	0.51	NA	>1826
BX-105	SST	530	42	25	5	0.4	NA	>1826
BX-106	SST	530	10	28	0	0.44	NA	>1826
BX-107	SST	530	347	0	0	0.57	NA	1105
BX-108	SST	530	31	0	0	0.34	NA	>1826
BX-109	SST	530	193	0	0	0.69	NA	1168
BX-110	SST	530	65	148	1	0.51	NA	1573

Tank ID	Tank Type	Capacity (kGal)[a]	Sludge (kGal)[a]	Saltcake (kGal)[a]	Supernatant (kGal)[a]	HGR(c) (ft3/d)[b]	Days to 25% LFL Barometric[c]	Days to 25% LFL Zero Ventilation[d]
BX-111	SST	530	32	156	0	0.45	NA	>1826
BX-112	SST	530	163	0	1	0.47	NA	>1826
BY-101	SST	758	37	333	0	1	NA	840
BY-102	SST	758	0	278	0	0.53	NA	>1826
BY-103	SST	758	9	405	0	0.64	NA	1244
BY-104	SST	758	46	359	0	1.3	NA	576
BY-105	SST	758	48	433	0	0.84	NA	821
BY-106	SST	758	32	398	0	1	NA	753
BY-107	SST	758	15	256	0	1.5	NA	621
BY-108	SST	758	40	182	0	0.68	NA	1510
BY-109	SST	758	24	263	0	0.54	NA	1781
BY-110	SST	758	43	323	0	4.2	379	183
BY-111	SST	758	0	402	0	0.64	NA	1256
BY-112	SST	758	2	284	0	0.58	NA	1648

a. Volumes from the Waste Tank Summary Report coinciding with the BBI (Rodgers 2014).

b. Hydrogen generation rate (ft^3/d) (RPP-5926 Rev. 15). Note in 2001 all 24 tanks were removed from the flammable gas watch list (including T-110 in the T Tank and Waste Farms EU) (Johnson, et al. 2001, p. iii).

c. Time (in days) to 25% of the Lower Flammability Limit (LFL) under a barometric (barom) breathing scenario (RPP-5926, Rev. 15). “NA” indicates that the headspace will not reach specified flammability level.

d. Time (in days) to 25% of the LFL under a zero ventilation scenario (RPP-5926, Rev. 15).

Table E.7-4. Current Primary Contaminant Inventory (by Tank) for the B-BX-BY Tank Farms (CP-TF-6) [(a)]

Tank ID	Decay Date	Am-241 (Ci)	C-14 (Ci)	Cl-36 (Ci)	Co-60 (Ci)	Cs-137 (Ci)	Eu-152 (Ci)	Eu-154 (Ci)	H-3 (Ci)
B-101	2001	1400	0.079	NP[(b)]	22	2000	13	750	0.9
B-102	2001	0.1	0.019	NP	0.0085	530	0.00078	0.048	0.21
B-103	2001	0.47	0.029	NP	0.013	820	0.0012	0.074	0.33
B-104	2001	4.8	0.21	NP	0.05	12000	0.0038	0.23	0.55
B-105	2001	1.4	0.12	NP	0.05	3900	0.0045	0.28	1.2
B-106	2001	6.3	0.071	NP	0.017	9000	0.0015	0.09	0.42
B-107	2001	4.6	0.23	NP	0.27	9900	0.0038	0.23	0.92
B-108	2001	0.11	0.2	NP	0.73	6900	0.002	0.12	0.93
B-109	2001	0.68	0.3	NP	1.2	1200	0.0024	0.15	1.3
B-110	2001	91	1.6	NP	1.9	13000	34	50	1.1
B-111	2001	98	1.9	NP	0.11	130000	39	61	1.5
B-112	2001	0.28	0.42	NP	2.4	7200	0.096	5.9	2.4
B-201	2001	4	1.90E-05	NP	0.041	17	5.20E-06	0.14	1.7
B-202	2001	8.8	2.60E-05	NP	9.50E-06	9.2	2.70E-05	0.0016	4.20E-07
B-203	2001	7.8	4.50E-05	NP	1.70E-05	1.4	4.70E-05	0.0028	7.40E-07
B-204	2001	8.4	4.10E-05	NP	1.50E-05	5.2	4.20E-05	0.0025	6.60E-07
BX-101	2001	43	0.1	NP	2.2	25000	0.082	120	0.56
BX-102	2001	1.2	0.1	NP	0.42	10000	0.0006	0.037	0.43
BX-103	2001	140	0.27	NP	1.4	18000	0.00099	0.062	6.6
BX-104	2001	330	0.14	NP	3.4	36000	0.0011	0.069	12
BX-105	2001	26	0.61	NP	4.6	31000	0.3	18	10
BX-106	2001	58	0.58	NP	4.2	17000	0.17	11	3.3
BX-107	2001	25	0.52	NP	0.096	23000	0.0054	0.33	0.46
BX-108	2001	3.2	0.035	NP	0.0085	3600	0.00079	0.049	0.25
BX-109	2001	5.9	0.069	NP	0.022	11000	0.003	0.18	1.2
BX-110	2001	6.4	3.1	NP	25	61000	1.1	65	17

Tank ID	Decay Date	Am-241 (Ci)	C-14 (Ci)	Cl-36 (Ci)	Co-60 (Ci)	Cs-137 (Ci)	Eu-152 (Ci)	Eu-154 (Ci)	H-3 (Ci)
BX-111	2001	3.5	3.1	NP	32	61000	1.4	87	18
BX-112	2001	20	0.15	NP	0.032	30000	0.0018	0.11	0.24
BY-101	2001	26	7.8	NP	88	210000	3.8	240	45
BY-102	2001	84	5.4	NP	51	100000	2.2	140	31
BY-103	2001	30	8.3	NP	87	160000	3.8	230	47
BY-104	2001	150	7.9	NP	7.9	210000	3.5	220	46
BY-105	2001	120	11	NP	6.7	140000	5	310	62
BY-106	2001	38	7.9	NP	9.8	280000	3.8	44	46
BY-107	2001	21	4.8	NP	7.2	180000	2	31	28
BY-108	2001	38	3.7	NP	33	48000	1.4	87	21
BY-109	2001	68	4.7	NP	43	84000	1.8	110	27
BY-110	2001	60	6.1	NP	8.5	170000	2.7	50	35
BY-111	2001	160	7.3	NP	77	140000	3.3	210	42
BY-112	2001	81	5.8	NP	62	110000	2.7	170	33

a. From Best Basis Inventory (BBI) Summary (March 24, 2014) provided in spreadsheet form by Mark Triplett. All primary contaminant inventories are reported to 2 significant figures. The source document should be consulted for greater precision data.

b. NP = Not present at significant quantities

Table E.7-5. Current Primary Contaminant Inventory [(a)] and Groundwater Threat Metric (by Tank) for the B-BX-BY Tank Farms (CP-TF-6)

Tank ID	I-129 (Ci)	Ni-59 (Ci)	Ni-63 (Ci)	Pu (total) (Ci)[(b)]	Sr-90 (Ci)	Tc-99 (Ci)	U (total) (Ci)[(c)]	GTM (Mm3)[(d)]
B-101	0.0011	0.54	51	1600	180000	1.8	5.3	2
B-102	0.0003	0.034	3.3	6.5	120	0.22	0.27	0.24
B-103	0.00046	0.064	6.3	66	430	0.33	1.8	0.37
B-104	0.00084	0.067	7	110	3500	19	2.6	21
B-105	0.0017	0.37	36	80	920	2.8	3.2	3.1
B-106	0.00053	0.008	0.81	23	28000	5.6	4.4	6.2
B-107	0.0092	0.47	44	54	2900	15	1.4	16
B-108	0.028	1.3	120	3.2	840	0.42	1.7	11
B-109	0.044	2.1	190	32	340	0.47	28	18
B-110	0.00088	0.17	16	170	89000	21	0.18	24
B-111	0.00046	1.3	120	170	200000	130	0.16	150
B-112	0.013	1.6	150	0.93	720	9.2	0.23	10
B-201	7.70E-10	5.00E-06	0.00041	110	220	1.70E-06	0.015	1.90E-06
B-202	0	6.80E-06	0.00057	29	360	0.69	0.034	0.76
B-203	0	1.20E-05	0.001	70	14	4.20E-06	0.0015	4.60E-06
B-204	2.90E-11	1.10E-05	0.00091	58	0.52	3.80E-06	9.30E-07	4.20E-06
BX-101	0.013	0.64	58	490	70000	10	16	11
BX-102	0.016	0.7	64	12	95000	0.12	2.6	6.4
BX-103	0.044	2	180	2000	170000	0.082	4.3	18
BX-104	0.03	0.77	70	320	110000	47	40	52
BX-105	0.021	6.5	600	92	72000	60	19	67
BX-106	0.02	3.1	280	110	66000	12	1.1	13
BX-107	0.0011	0.026	3.4	120	13000	70	2.7	78
BX-108	0.0003	0.0045	0.44	10	20000	2.6	1.7	2.9
BX-109	0.0014	0.018	1.5	14	110000	1.1	11	1.2
BX-110	0.09	18	1600	29	9600	76	3	84

Tank ID	I-129 (Ci)	Ni-59 (Ci)	Ni-63 (Ci)	Pu (total) (Ci)[b]	Sr-90 (Ci)	Tc-99 (Ci)	U (total) (Ci)[c]	GTM (Mm3)[d]
BX-111	0.091	23	2100	20	11000	71	0.38	79
BX-112	0.00035	0.0083	1.1	150	4300	16	0.57	17
BY-101	0.23	64	5800	38	130000	170	5.7	190
BY-102	0.16	37	3400	100	16000	120	5	130
BY-103	0.25	63	5800	41	27000	180	9.3	200
BY-104	0.24	58	5300	180	330000	170	18	190
BY-105	0.32	83	7600	150	130000	46	13	130
BY-106	0.17	62	5700	38	120000	170	6.9	190
BY-107	0.17	33	3000	28	68000	110	10	120
BY-108	0.12	24	2200	51	120000	80	11	89
BY-109	0.16	31	2900	96	13000	99	4.3	110
BY-110	0.21	45	4100	99	140000	130	18	150
BY-111	0.22	55	5000	190	24000	160	7.5	180
BY-112	0.17	45	4100	100	20000	130	8.6	140

a. From Best Basis Inventory (BBI) Summary (March 24, 2014) provided in spreadsheet form by Mark Triplett. All primary contaminant inventories are reported to 2 significant figures. The source document should be consulted for greater precision data.

b. Sum of plutonium isotopes 238, 239, 240, 241, and 242

c. Sum of uranium isotopes 232, 233, 234, 235, 236, and 238

d. The Groundwater Threat Metric (GTM) shown for tanks is equal to the maximum of the GTM for Tc-99 and I-129.

Table E.7-6. Current Primary Contaminant Inventory (by Tank) for the B-BX-BY Tank Farms (CP-TF-6) [(a)]

Tank ID	CCl4 (kg)	CN (kg)	Cr (kg)	Cr-VI (kg)	Hg (kg)	NO3 (kg)	Pb (kg)	TBP (kg)	TCE (kg)	U (total) (kg)
B-101	NP	NP	510	NP	21	91000	390	NP	NP	7600
B-102	NP	NP	180	NP	0.59	22000	43	NP	NP	390
B-103	NP	NP	330	NP	1.1	37000	83	NP	NP	2600
B-104	NP	NP	1000	NP	7.4	560000	1900	NP	NP	3800
B-105	NP	NP	2000	NP	6.9	180000	590	NP	NP	4700
B-106	NP	NP	260	NP	21	120000	210	NP	NP	6500
B-107	NP	NP	260	NP	2	160000	440	NP	NP	1900
B-108	NP	NP	130	NP	1.6	41000	970	NP	NP	1400
B-109	NP	NP	1500	NP	2	94000	880	NP	NP	9100
B-110	NP	NP	1000	NP	1.4	240000	670	NP	NP	260
B-111	NP	NP	1300	NP	11	95000	1800	NP	NP	230
B-112	NP	NP	430	NP	0.63	33000	170	NP	NP	57
B-201	NP	NP	490	NP	0.084	7100	41	NP	NP	22
B-202	NP	NP	360	NP	0.041	8100	87	NP	NP	43
B-203	NP	NP	690	NP	0	14000	69	NP	NP	2.2
B-204	NP	NP	720	NP	0	11000	63	NP	NP	0.0014
BX-101	NP	NP	2000	NP	39	11000	490	NP	NP	11000
BX-102	NP	NP	53	NP	7	22000	540	NP	NP	1700
BX-103	NP	NP	94	NP	2.1	15000	1100	NP	NP	1500
BX-104	NP	NP	2900	NP	8.9	30000	490	NP	NP	37000
BX-105	NP	NP	7300	NP	11	30000	480	NP	NP	7900
BX-106	NP	NP	340	NP	2.8	42000	150	NP	NP	650
BX-107	NP	NP	1800	NP	1.1	260000	120	NP	NP	4000
BX-108	NP	NP	110	NP	14	49000	110	NP	NP	2500
BX-109	NP	NP	160	NP	75	220000	740	NP	NP	17000
BX-110	NP	NP	6100	NP	0.54	440000	180	NP	NP	1200
BX-111	NP	NP	2200	NP	0.52	410000	110	NP	NP	340

Tank ID	CCl4 (kg)	CN (kg)	Cr (kg)	Cr-VI (kg)	Hg (kg)	NO3 (kg)	Pb (kg)	TBP (kg)	TCE (kg)	U (total) (kg)
BX-112	NP	NP	1200	NP	0.25	62000	130	NP	NP	840
BY-101	NP	NP	4600	NP	18	900000	610	NP	NP	7800
BY-102	NP	NP	2800	NP	0.73	180000	180	NP	NP	700
BY-103	NP	NP	6000	NP	1.2	570000	500	NP	NP	1400
BY-104	NP	NP	8700	NP	22	590000	480	NP	NP	10000
BY-105	NP	NP	1900	NP	21	1400000	430	NP	NP	9000
BY-106	NP	NP	2300	NP	14	810000	420	NP	NP	6600
BY-107	NP	NP	640	NP	7.3	330000	230	NP	NP	4500
BY-108	NP	NP	390	NP	17	230000	470	NP	NP	11000
BY-109	NP	NP	2500	NP	0.61	130000	160	NP	NP	630
BY-110	NP	NP	7500	NP	23	240000	1100	NP	NP	10000
BY-111	NP	NP	5700	NP	1.1	370000	250	NP	NP	1100
BY-112	NP	NP	33000	NP	1.5	140000	200	NP	NP	4600

a. From Best Basis Inventory (BBI) Summary (March 24, 2014) provided in spreadsheet form by Mark Triplett. All primary contaminant inventories are reported to 2 significant figures. The source document should be consulted for greater precision data.

b. NP = Not present at significant quantities

Table E.7-7. Summary of the Evaluation of Threats to Groundwater as a Protected Resource from Remaining Vadose Zone (VZ) Contamination associated with the B-BX-BY Tank and Waste Farms Evaluation Unit (CP-TF-6)

PC	Group	WQS	Porosity[a]	K_d (mL/g)[a]	ρ (kg/L)[a]	VZ Source M^{Source}	SZ Total M^{SZ}	Treated[c] M^{Treat}	VZ Remaining M^{Tot} [d]	VZ GTM (Mm^3)	VZ Rating[e]
C-14	A	2000 pCi/L	0.25	0	1.82	1.37E+01 Ci	---	---	1.37E+01 Ci	6.87E+00	Low
I-129	A	1 pCi/L	0.25	0.2	1.82	2.54E-01 Ci	---	---	2.54E-01 Ci	1.04E+02	High
Sr-90	B	8 pCi/L	0.25	22	1.82	2.11E+04 Ci	---	---	2.11E+04 Ci	1.64E+04	ND[f]
Tc-99	A	900 pCi/L	0.25	0	1.82	1.69E+02 Ci	6.26E+01 Ci	8.88E-03 Ci	1.07E+02 Ci	1.18E+02	High
CCl_4	A	5 µg/L	0.25	0	1.82	---	---	---	---	---	ND
Cr	B	100 µg/L	0.25	0	1.82	2.91E+04 kg	---	---	2.91E+04 kg	2.91E+02	High
Cr-VI	A	48 µg/L[b]	0.25	0	1.82	2.91E+04 kg	---	---	2.91E+04 kg	6.07E+02	High
TCE	B	5 µg/L	0.25	2	1.82	---	---	---	---	---	ND
U(tot)	B	30 µg/L	0.25	0.8	1.82	1.73E+04 kg	5.36E+02 kg	1.56E+01 kg	1.68E+04 kg	8.19E+01	Medium

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

b. "Model Toxics Control Act−Cleanup" (WAC 173-340) Method B groundwater cleanup level for hexavalent chromium. Other WQS values represent drinking water standards.

c. Treatment amounts from the 2013 Hanford Annual Groundwater Report (DOE/RL-2014-32, Rev. 0). The final action record of decision for the 200-BP-5 OU is scheduled for 2016 (DOE/RL-2014-32, Rev. 0, p. BP-3)

d. The remaining vadose zone inventory is estimated by difference (CRESP 2015) and thus has a high associated uncertainty.

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

f. Sr-90 will decay significantly over the Active and Near-term, Post-Cleanup periods but not enough to lower ratings. Transport analysis suggests that Sr-90 will be relatively immobile in the vadose zone in the future leading to an ND rating.

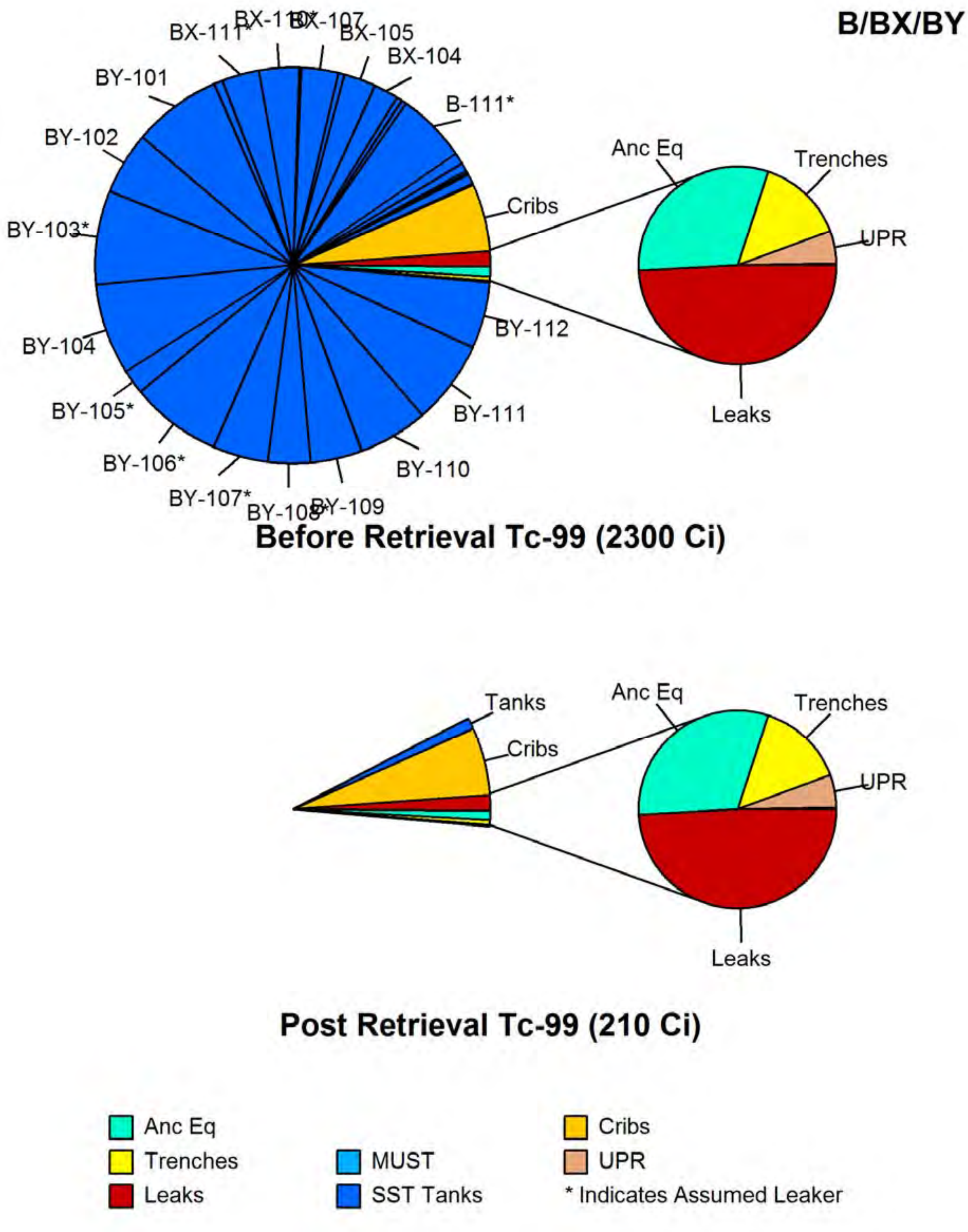

Figure E.7-3. B-BX-BY Tank and Waste Farms Evaluation Unit Inventory Estimates for Tc-99 Before and After 99% Retrieval

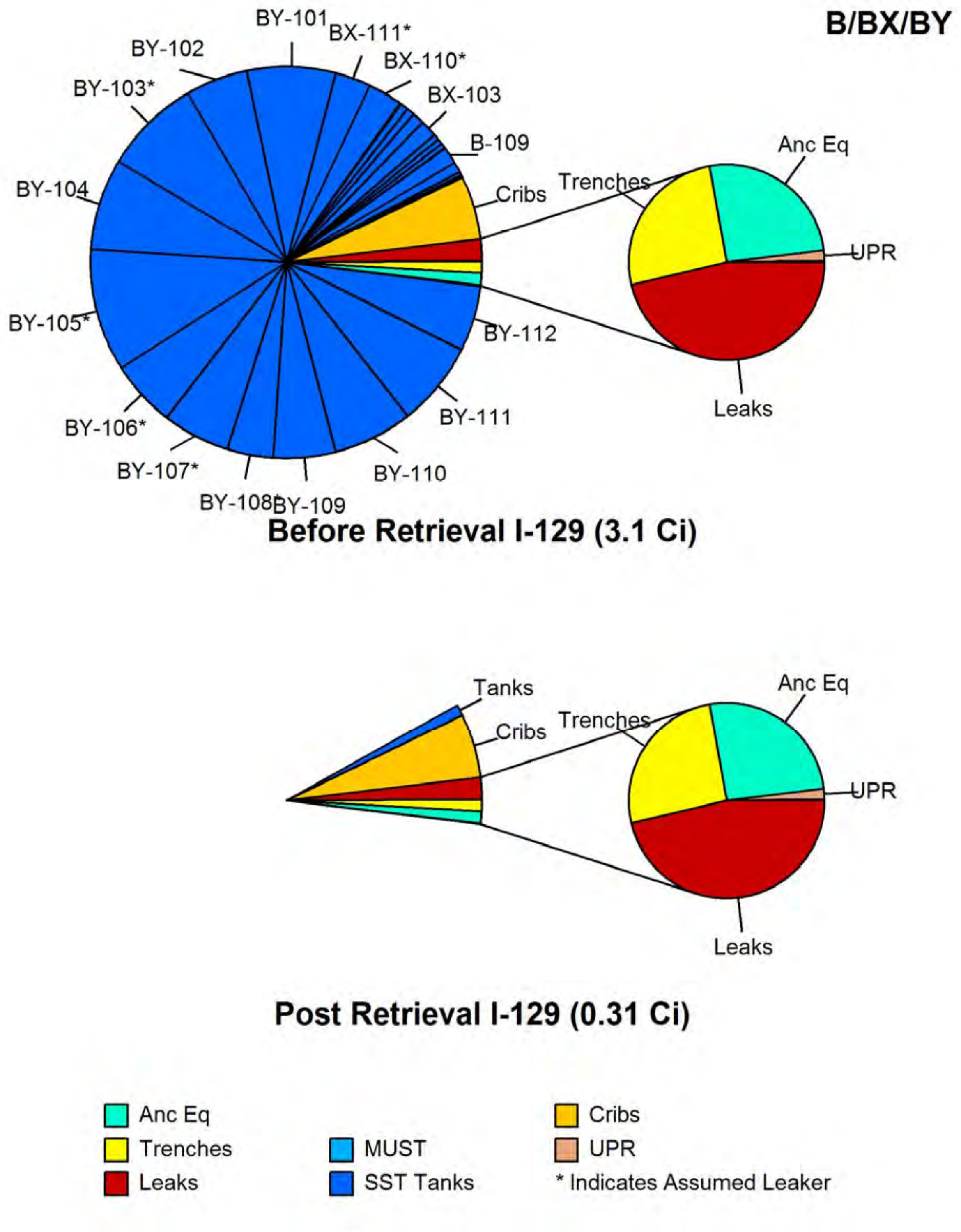

Figure E.7-4. B-BX-BY Tank and Waste Farms Evaluation Unit Inventory Estimates for I-129 Before and After 99% Retrieval

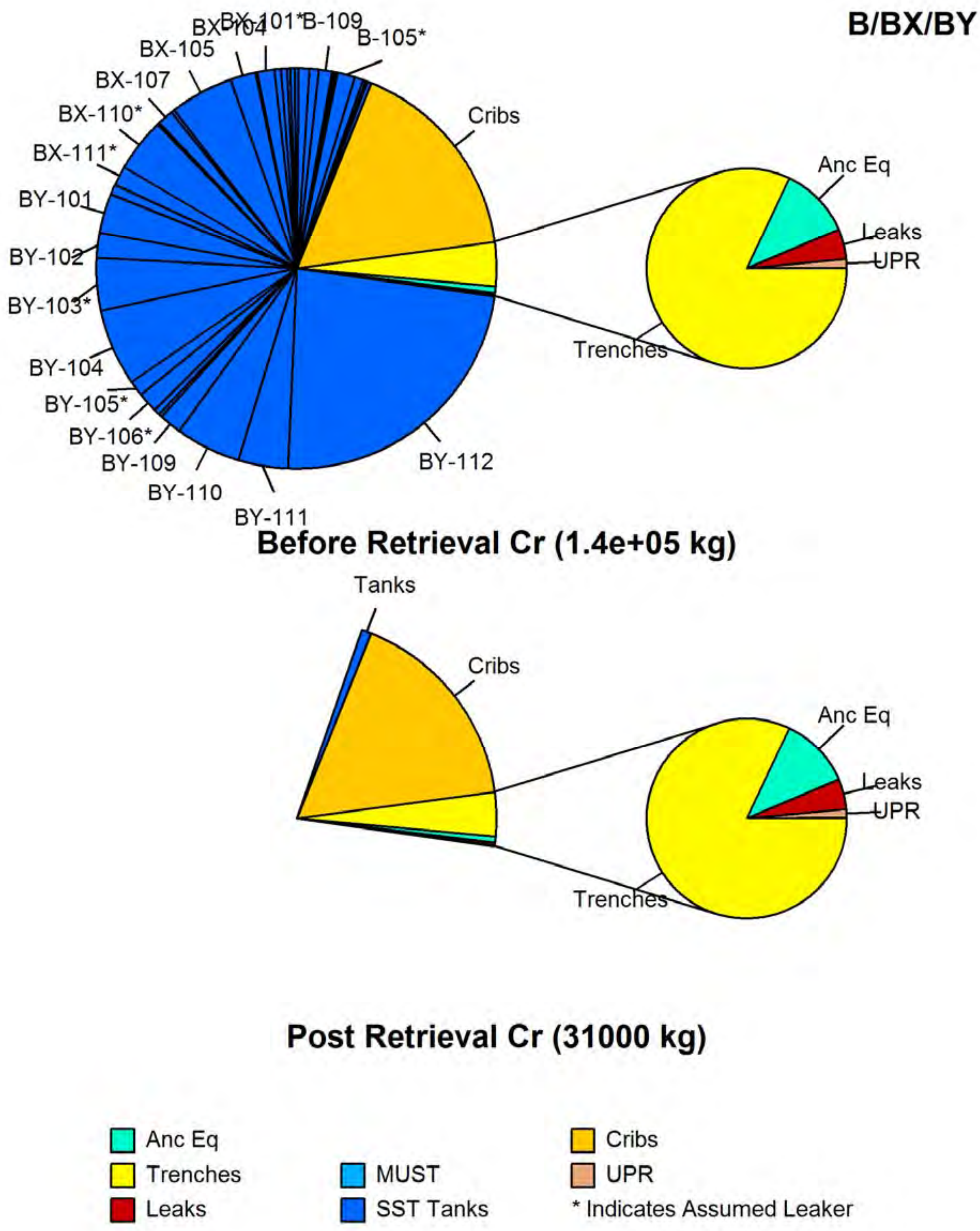

Figure E.7-5. B-BX-BY Tank and Waste Farms Evaluation Unit Inventory Estimates for Chromium Before and After 99% Retrieval

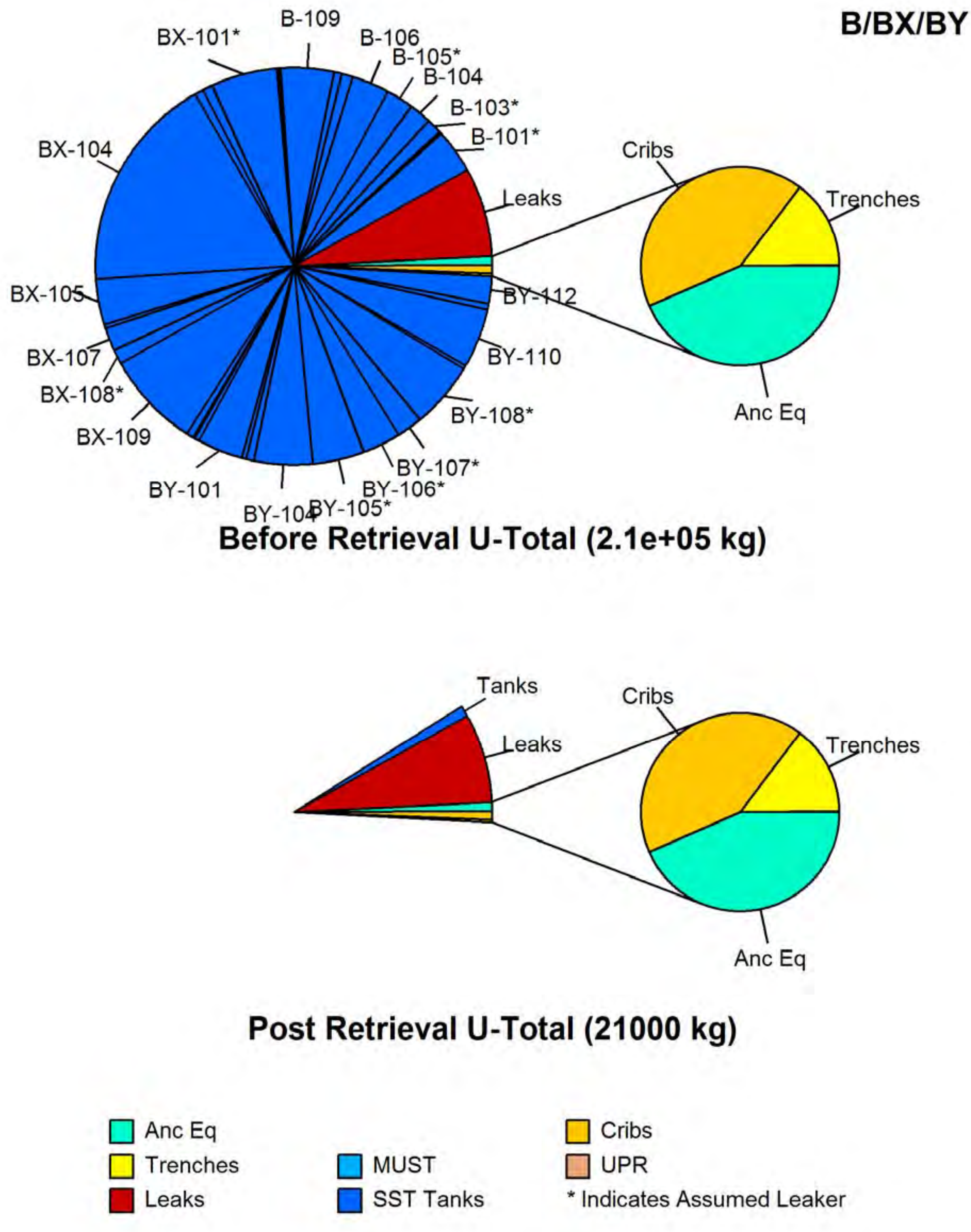

Figure E.7-6. B-BX-BY Tank and Waste Farms Evaluation Unit Inventory Estimates for U(tot) Before and After 99% Retrieval

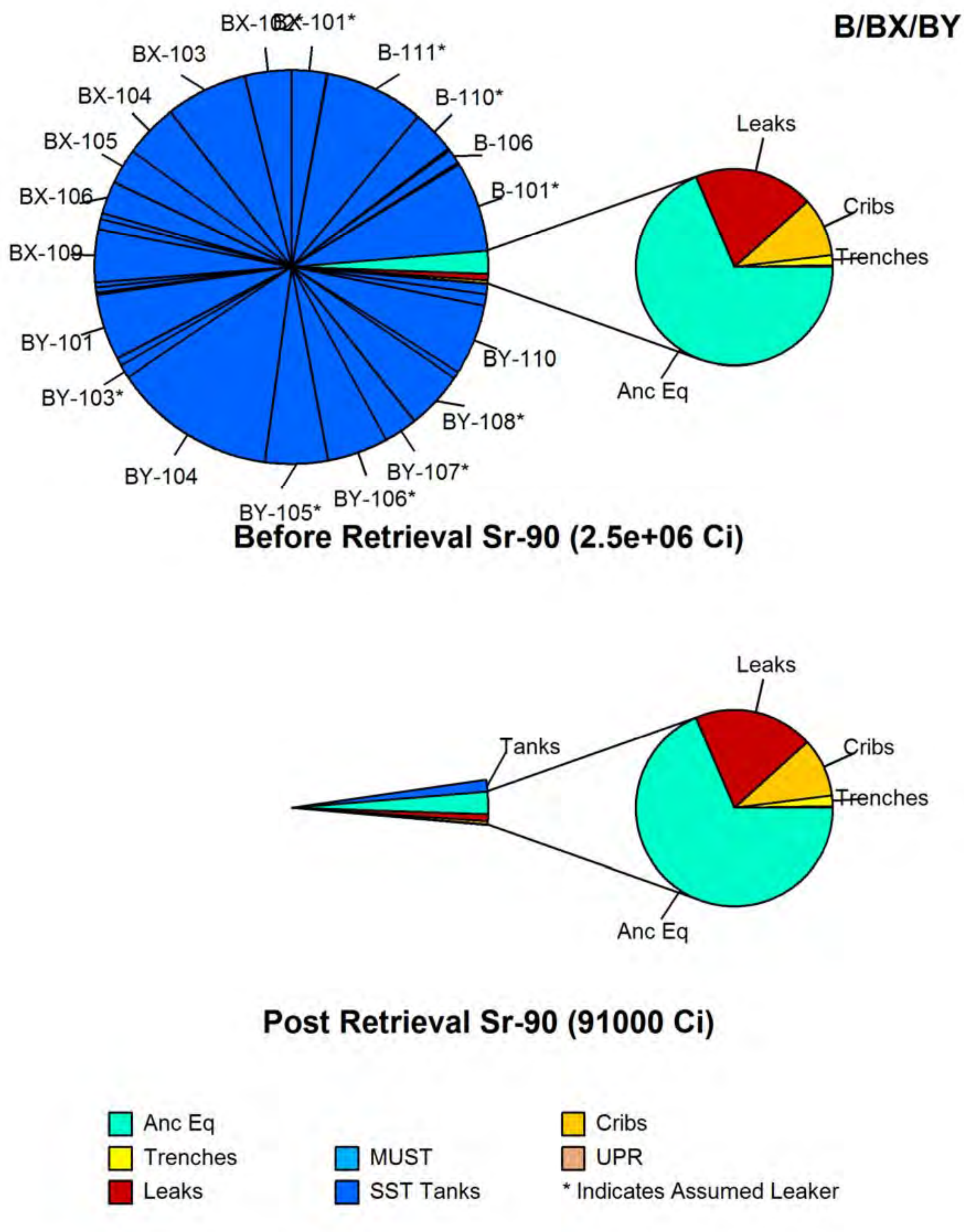

Figure E.7-7. B-BX-BY Tank and Waste Farms Evaluation Unit Inventory Estimates for Sr-90 Before and After 99% Retrieval

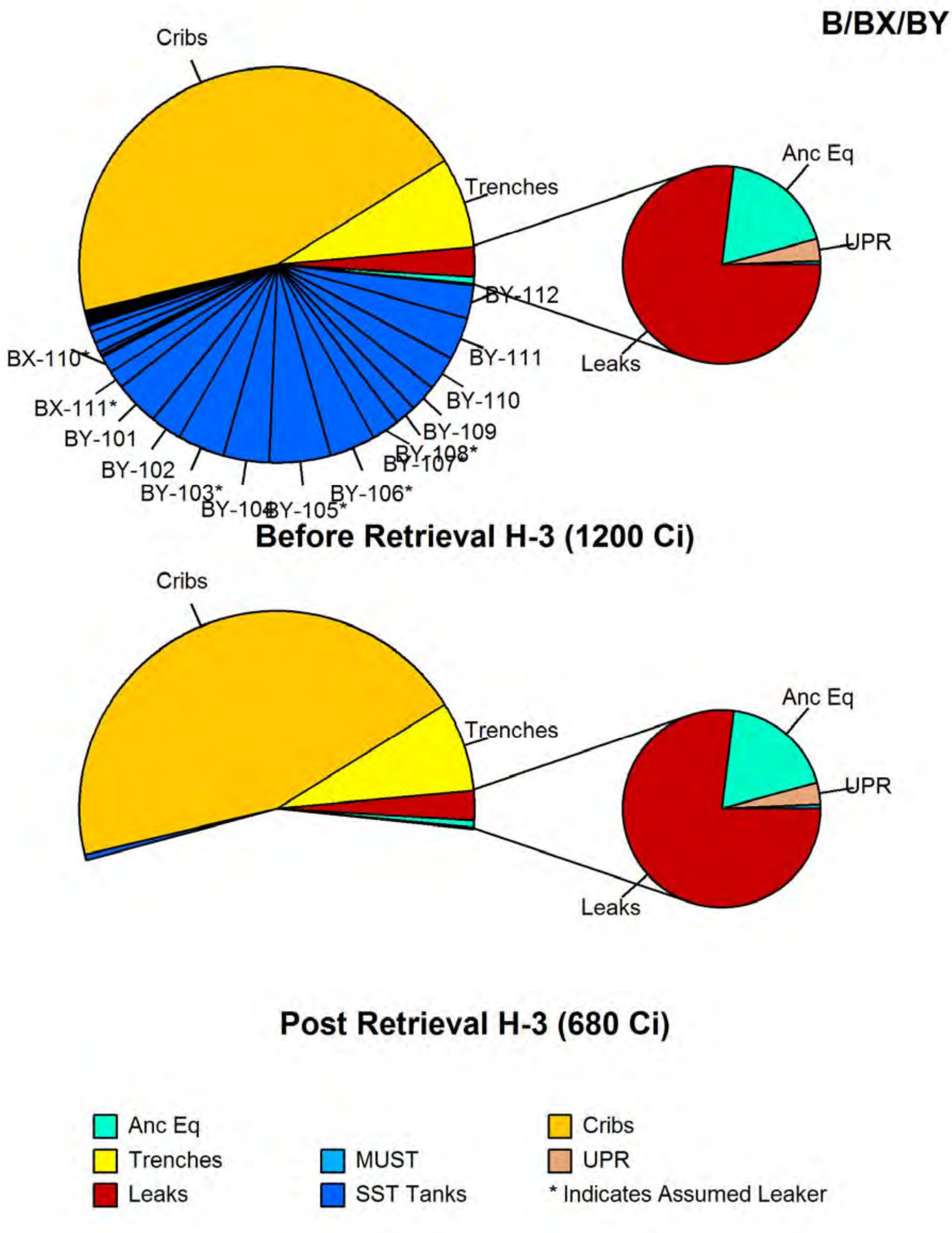

Figure E.7-8. B-BX-BY Tank and Waste Farms Evaluation Unit Inventory Estimates for Tritium (H-3) Before and After 99% Retrieval

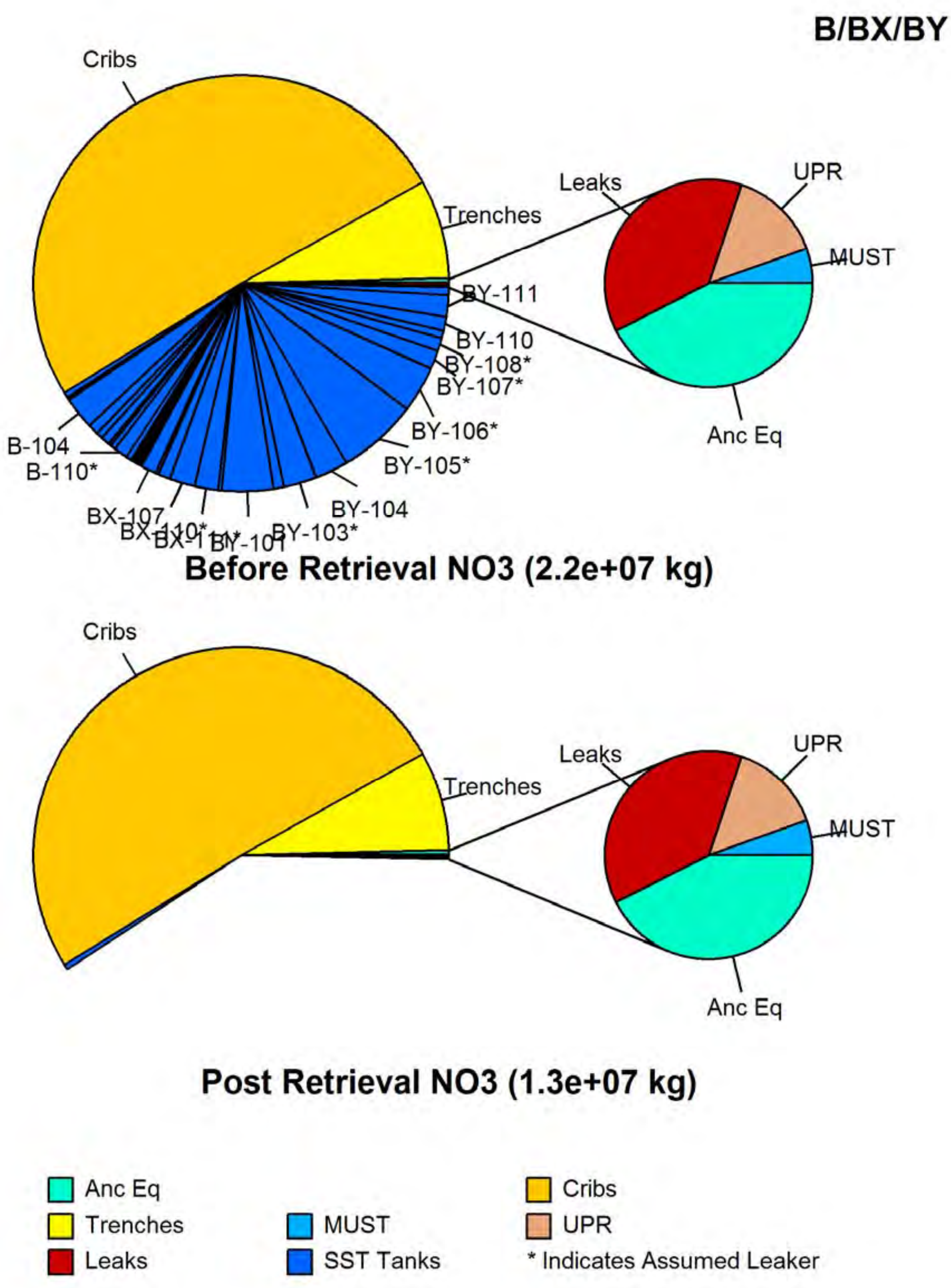

Figure E.7-9. B-BX-BY Tank and Waste Farms Evaluation Unit Inventory Estimates for Nitrate (NO3) Before and After 99% Retrieval

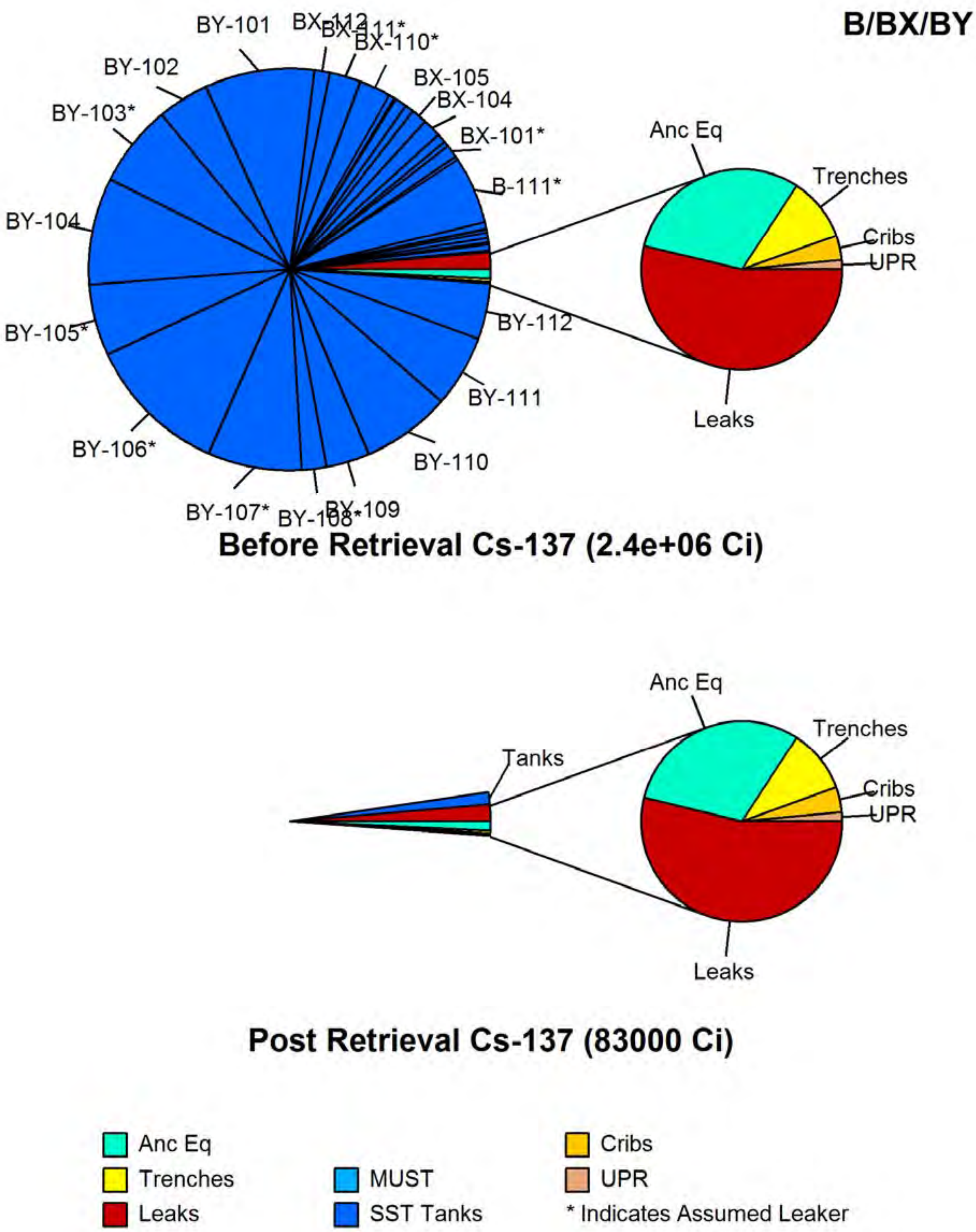

Figure E.7-10. B-BX-BY Tank and Waste Farms Evaluation Unit Inventory Estimates for Cs-137 Before and After 99% Retrieval

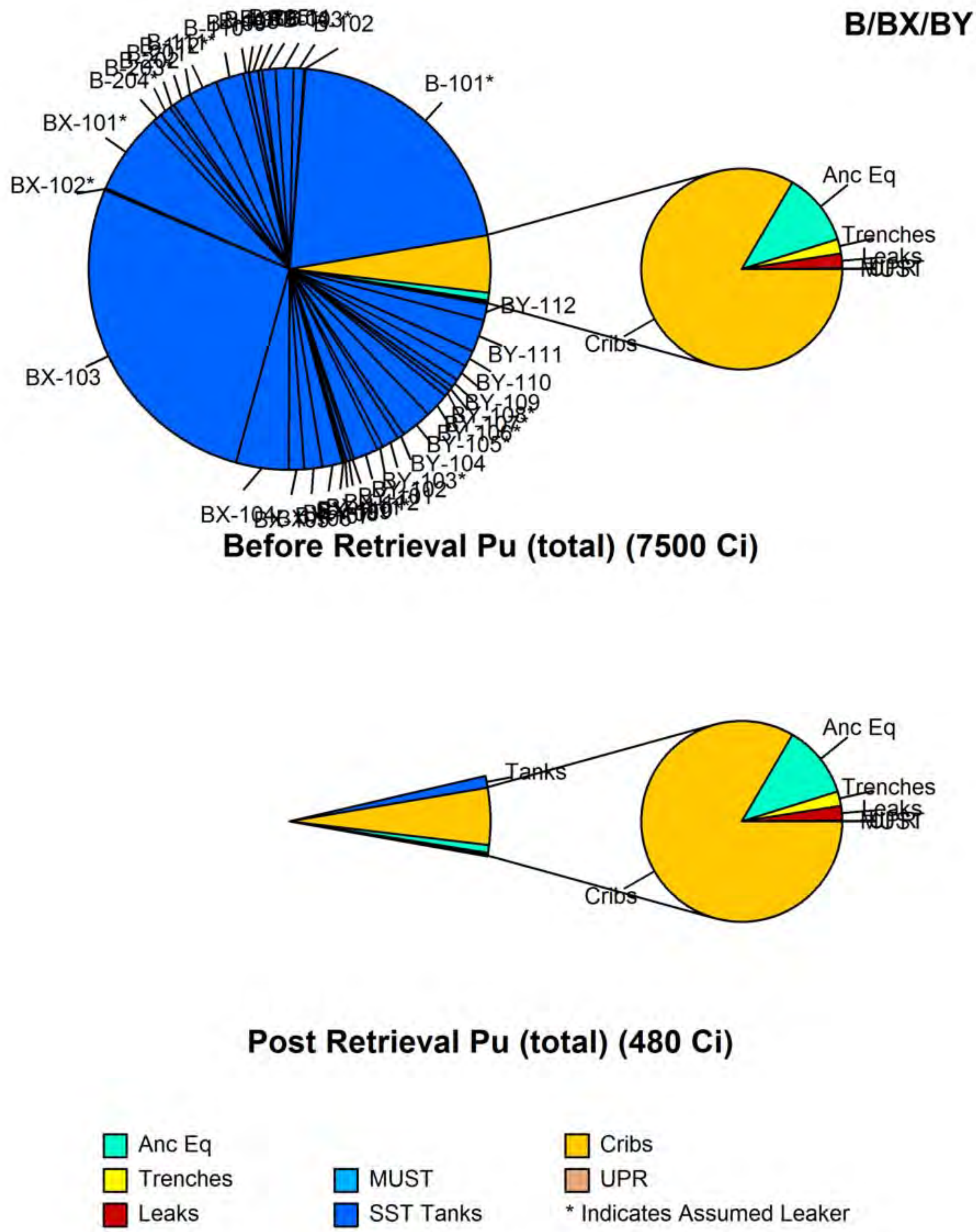

Figure E.7-11. B-BX-BY Tank and Waste Farms Evaluation Unit Inventory Estimates for Plutonium (total) Before and After 99% Retrieval

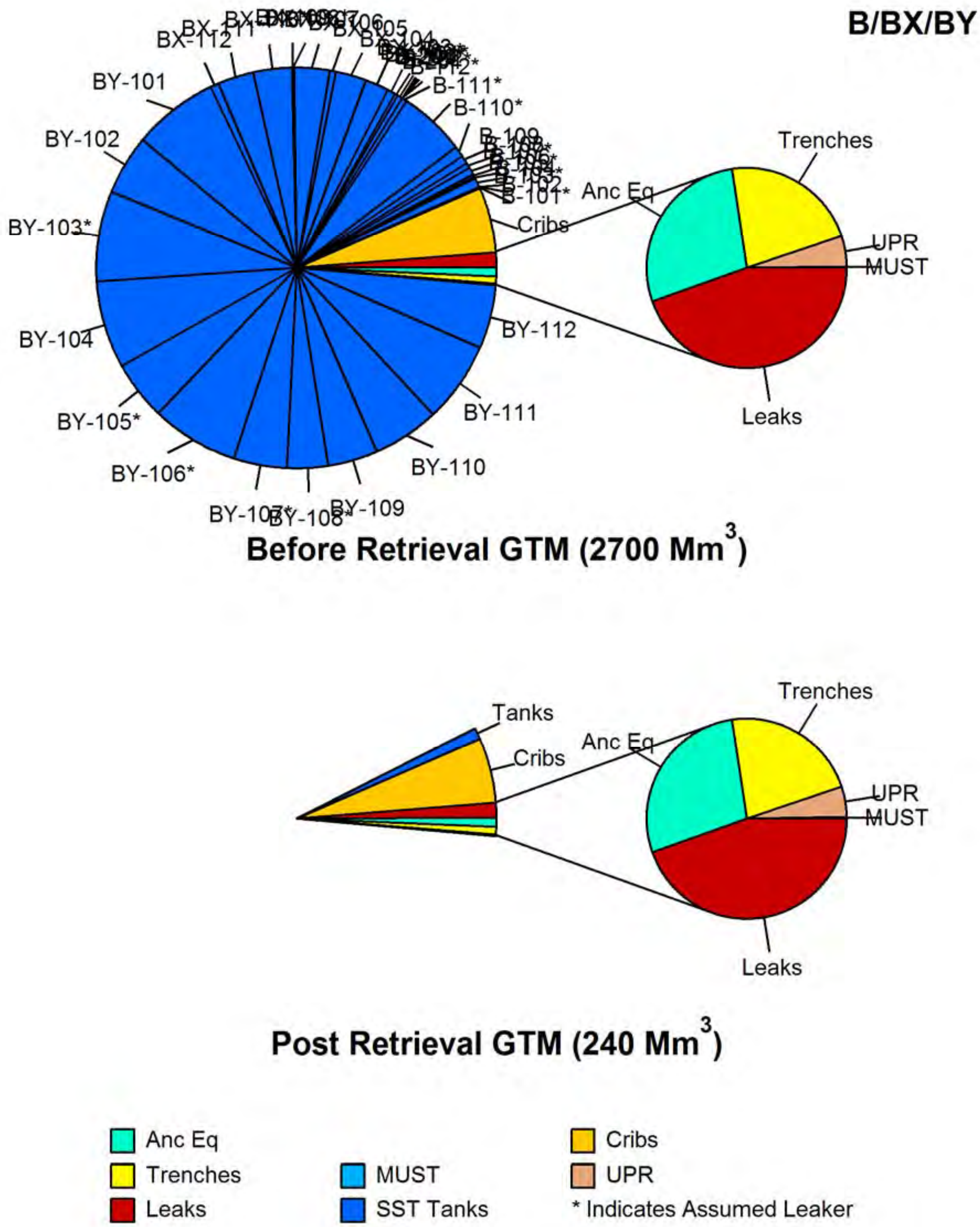

Figure E.7-12. B-BX-BY Tank and Waste Farms Evaluation Unit Maximum Groundwater Threat Metric (GTM) of I-129 and Tc-99 Estimates Before and After 99% Retrieval

7.6. POTENTIAL RISK/IMPACT PATHWAYS AND EVENTS

CURRENT CONCEPTUAL MODEL

A common safety analysis was performed for all the single- and double-shell tanks including pathways and barriers (safety scenarios that dominate risk, safety systems and controls, barriers to release, failure mechanisms, pathways and receptors, time frames for exposure). See Section 1.6 in Appendix E.1 for details.

POPULATIONS AND RESOURCES CURRENTLY AT RISK OR POTENTIALLY IMPACTED

Facility Worker, Co-located Person, and Public

A common analysis was performed for the Facility Worker, Co-located Person, and Public. See Section 1.6 (Appendix E.1) for details.

Groundwater

The current groundwater plumes (Tc-99, nitrate, and uranium) associated with the B-BX-BY Tank and Waste Farms EU and liquid waste disposal facilities are described in Section 7.5 and further details including ratings are provided in the Appendix G.5 for the CP-GW-1 EU (200-BP-5 OU).

As shown in Table E.7-7 (Section 7.5), the vadose zone (VZ) GTM values for the Group A and B primary contaminants range from ND for Sr-90 (which has an inventory that would translate to a *High* rating but appears relatively immobile in the area as described in Section 7.5) to *Low* for C-14 to *Medium* for uranium to *High* for Tc-99, I-129, and chromium (total and hexavalent). The Sr-90 will decay significantly during the Active and Near-term, Post Cleanup periods, but not sufficiently to impact future ratings; however, the transport analysis (Section 7.5) indicates that Sr-90 would not impact groundwater within the next 150 years (impacting future ratings) resulting in ND ratings. A similar transport analysis indicates that a surface barrier emplacement would result in no uranium plume; a rating of *Low* is assigned to represent uncertainty. The overall current rating for groundwater impact from vadose zone sources is *High*.

Columbia River

As described in Section 7.5, there are no plumes associated with the B-BX-BY Tank and Waste Farms EU that currently intersect the Columbia River, which corresponds to *Not Discernible* ratings for all evaluation periods.

As described in Section 7.5, TC&WM EIS screening results indicate that peak concentrations in the nearshore region of the Columbia River were below benchmarks for wildlife receptors and benthic invertebrates and aquatic biota leading to a *Not Discernible* rating for radionuclides for both benthic and riparian receptors for all evaluation periods.

For chemicals, only nitrate and chromium (assumed hexavalent) are predicted in the TC&WM EIS to have concentrations (from sources including those other than the B-BX-BY Tank and Waste Farms EU) that could exceed thresholds in the near-shore ecology as described in Section 7.5. Nitrate has a *Not Discernible* rating for current conditions (since the plume is not in contact with the Columbia River) for the benthic and riparian ecology as well as for the Active Cleanup and Near-term, Post-Cleanup periods. Hexavalent chromium, which has a *Not Discernible* rating for current conditions (since the plume is not in contact with the Columbia River), would have *Medium* and High ratings for benthic and riparian zones, respectively, based on screening TC&WM EIS are instead rated ND for these receptors and time periods because recent well data suggest that the chromium plume would move toward the Columbia River at a much slower rate than predicted.

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

Additional information concerning potential threats to the Columbia River from B-BX-BY Tank Farm and co-located liquid waste disposal facilities is provided in the Appendix G.5 for the CP-GW-1 EU (200-BP-5 GW OU).

Ecological Resources

- Animal species (or their sign) observed during July 2014 survey include horned lark, northern pocket gopher, coyote, and black-tailed jackrabbit.
- Almost 70% of the EU consists of level 0 and level 1 habitat; level 2 habitats within the EU are fragmented by roadways, buildings, and infrastructure.
- Individual occurrences of level 3 resources associated with the sensitive plant species Piper's daisy have been previously documented at the B-BX-BY evaluation site and a single occurrence of Piper's daisy was noted within the EU during the survey. However, there are no patches of level 3 or higher habitat greater than 0.5 ac within the evaluation site;
- Cleanup activities would result in no net change in the amount of level 3 or higher habitats within a 0.97 km radius;
- Loss of individual Piper's daisy (level 3 species) from within the EU would not be expected to affect population viability for this species.
- Habitats within the B-X-BY Tank Farm are highly fragmented and lie within the 200-East Area. Loss of remaining level 2 or level 3 habitat associated with remediation actions would not be expected to significantly alter habitat connectivity outside the 200 East Area.

Cultural Resources

- There are no known recorded archaeological sites or TCPs located within the EU.
- The 242B Building Radioactive Particle Research Laboratory is a contributing property within the Manhattan Project and Cold War Era Historic District, with no documentation required, that is located within the B-BX-BY Tank and Waste Farms EU. In accordance with the 1998 *Hanford Site Manhattan Project and Cold War Era Historic District Treatment Plan (*DOE/RL-97-56), all documentation requirements have been completed for these properties.

Archaeological sites and TCPs located within 500 meters of the EU

- Two isolated finds and one small site which may be associated with the Pre-Hanford Landscape are located within 500 meters of the B-BX-BY Tank and Waste Farms EU. All three are considered to be National Register ineligible.
- The Hanford Site Plant Railroad, a contributing property within the Manhattan Project and Cold War Era Historic District, with documentation required is located within 500 meters of the B-BX-BY Tank and Waste Farms EU. In accordance with the 1998 *Hanford Site Manhattan Project and Cold War Era Historic District Treatment Plan (*DOE/RL-97-56), all documentation requirements have been completed for these properties.

<u>**Closest Recorded TCP**</u>

- There are two recorded TCPs associated with the Native American Precontact and Ethnographic Landscape that are visible from the B-BX-BY Tank and Waste Farms EU.

CLEANUP APPROACHES AND END-STATE CONCEPTUAL MODEL

Selected or Potential Cleanup Approaches

A common analysis was performed for all the single- and double-shell tanks. See Section 1.6 (Appendix E.1) for details.

Contaminant Inventory Remaining at the Conclusion of Planned Active Cleanup Period

See Section 7.5 including Table E.7-2 and Figure E.7-3 through Figure E.7-11 for the inventory information after planned 99% retrieval. Furthermore, a more general analysis was performed for all the single- and double-shell tanks. See Section 1.6 (Appendix E.1) for details.

Risks and Potential Impacts Associated with Cleanup

A common analysis was performed for all the single- and double-shell tanks for workers and the Public. See Section 1.6 (Appendix E.1) for details.

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

Facility Worker, Co-located Person, and Public

A common analysis was performed for the Facility Worker, Co-located Person, and Public. See Section 1.6 (Appendix E.1) for details.

Groundwater

As described in Section 7.5, there will be a continuing impact during this period to groundwater (as a protected resource) from those mobile B-BX-BY Tank and Waste Farms EU primary contaminants currently with plumes that exceed thresholds. These impacts are described in Appendix G.5 for the CP-GW-1 EU (200-BP-5 GW OU).

Furthermore, there are primary (e.g., tank wastes) and secondary contaminant sources (legacy source sites) in the vadose zone that pose risk to groundwater. The vadose zone (VZ) GTM values for the Group A and B primary contaminants for the B-BX-BY Tank and Waste Farms EU range from ND for Sr-90 to *Low* for C-14 to *Medium* for uranium to *High* for Tc-99, I-129, and chromium (total and hexavalent). The Sr-90 will decay significantly during these periods, but not sufficiently to impact ratings; however, the transport analysis (Section 7.5) indicates that Sr-90 is not expected to impact groundwater in the next 150 years. The uranium would likely be less than the standard after emplacement of a surface barrier and thus the rating would be *Low* after the Active Cleanup period (to address uncertainty). These evaluations correspond to an overall rating of *High* for the Active Cleanup and Near-Term, Post-Cleanup periods.

The final action record of decision for the 200-BP-5 OU is scheduled for 2016 (DOE/RL-2014-32, Rev. 0, p. BP-3); thus groundwater will likely be treated in the future to help address the aforementioned groundwater contamination.

It is considered unlikely that additional groundwater resources would be impacted as a result of either interim remedial actions (e.g., pump and treat) or final closure activities (that are not covered in the Ecological or Cultural Resources results).

Columbia River

As described in Section 7.5, impacts from radiological contaminants to the Columbia River benthic and riparian ecology for the Active Cleanup and Near-term, Post Cleanup periods are rated as *Not Discernible*. Nitrate has a rating of *Not Discernible* for the benthic and riparian ecology for the Active Cleanup and Near-term, Post Cleanup periods. Chromium (assumed hexavalent) would have ratings of *Medium* and *High* for the benthic and riparian zone receptors, respectively, based on the TC&WM EIS screening analysis; however, recent well data suggests that a chromium plume from this area would move toward the Columbia River as a much slower rate than that predicted resulting in *Not Discernible* ratings for these receptors and evaluation periods. The large dilution effect of the Columbia River on the contamination from the seeps and groundwater upwellings produces *Not Discernible* ratings for all contaminants for the Active Cleanup and Near-term, Post Cleanup periods.

Additional information on groundwater plumes and potential threats associated with the B-BX-BY Tank Farm and liquid waste disposal facilities are described in Appendix G.5 for the CP-GW-1 EU (200-BP-5 GW OU).

It is considered unlikely that additional benthic or riparian resources would be impacted as a result of either interim remedial actions (e.g., pump and treat) or final closure activities (that are not covered in the Ecological or Cultural Resources results).

Ecological Resources

See Section 1.6 (Appendix E.1) for details.

Cultural Resources

See Section 1.6 (Appendix E.1) for details.

ADDITIONAL RISKS AND POTENTIAL IMPACTS IF CLEANUP IS DELAYED

A common analysis was performed for all the single- and double-shell tanks. See Section 1.6 (Appendix E.1) for details.

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

A common analysis was performed for all the single- and double-shell tanks. See Section 1.6 (Appendix E.1) for details.

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

Table E.7-8. Summary of Populations and Resources at Risk or Potentially Impacted after Cleanup

Population or Resource		Impact Rating	Comments
Human	Facility Worker	Low	Workers will be low risk from exposure to direct radiation and waste contaminants after waste retrieval, grouting, and capping.
	Co-located Person	Low	These persons will be at low risk from exposure to direct radiation and waste contaminants after waste retrieval, grouting, and capping.
	Public	Not Discernible	The Tank Farms will be in secure and controlled areas that prevent intentional and inadvertent intruders. No complete groundwater pathway and no impact from air pathway.
Environmental	Groundwater (A&B) from vadose zone[a]	ND (sr-90) to High (Tc-99, I-129, Cr-tot, Cr-VI) **Overall**: High	GTM values for Group A and B primary contaminants (Table E.7-7): ND (Sr-90), Low (uranium, C-14), and High (Tc-99, I-129, total and hexavalent chromium). Little predicted impact from changes in recharge rates and transport consideration to impact ratings for Tc-99, I-129, total and hexavalent chromium transport. Recharge rate impacts uranium rating (Medium to Low) and transport considerations result in Sr-90 rating of ND.
	Columbia River from vadose zone[a]	Benthic: Not Discernible (radionuclides) Low (chemicals) Riparian: Not Discernible (radionuclides) Low (chemicals) Free-flowing: Not Discernible (all) **Overall**: Low	TC&WM EIS screening results used to evaluate benthic and riparian receptors (Section 7.5). Only nitrate (ND for both benthic and riparian) and hexavalent chromium (Medium for benthic and High for riparian) are predicted to have concentrations (including sources other than B-BX-BY) that could threaten the near-shore ecology. However, well data indicate slower movement of chromium toward

Population or Resource		Impact Rating	Comments
			the river resulting in ND ratings. Dilution factor of greater than 100 million between River and upwelling.
	Ecological Resources[b]	ND to Low	Continued monitoring could result in some disturbance to EU, and buffer lands. Remediation may improve habitat (and increased monitoring may lead to increases in exotic species or changes in vegetation species composition).
Social	Cultural Resources[b]	**Native American:** Direct: Unknown Indirect: Known **Historic Pre-Hanford:** Direct: Known Indirect: Unknown **Manhattan/Cold War**: Direct: None Indirect: None	Permanent indirect effects to viewshed are possible from capping. Permanent effects may be possible due to presence of contamination if capping occurs. No other expected cultural resources impacts.

a. Groundwater threat for Group A and B contaminants remaining in the vadose zone or to the Columbia River for all primary contaminants. Threats from existing plumes associated with the B-BX-BY Tank and Waste Farms EU are described in Section 7.5 and Appendix G.5 (CP-GW-1) for the 200-BP-5 Groundwater Operable Unit.
b. 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.

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

As described in Section 7.5, the TC&WM ecological screening analysis indicate that that exposure to radioactive contaminants from peak groundwater discharge was below screening levels at the Columbia River near-shore region, indicating there should be no expected adverse effects from radionuclides. Furthermore, results of the corresponding TC&WM screening evaluation for chemicals indicated that predicted chromium and nitrate concentrations could exceed screening values (i.e., Hazard Quotient of unity) in the near-shore region. The predicted nitrate peak concentration was in the past and would be unlikely to exceed human or aquatic standards in the future. On the other hand, unless treated chromium (assumed hexavalent) may impact benthic and riparian receptors (i.e., concentrations could exceed screening levels). This is consistent with the evaluation in the TC&WM EIS.

For more information, see Section 1.6.

7.7. SUPPLEMENTAL INFORMATION AND CONSIDERATIONS

A common analysis was performed for all the single- and double-shell tanks. See Section 1.7 for details.

7.8. ATTACHMENT – B-BX-BY TANK FARMS EVALUATION UNIT WIDS REVIEW

Hanford Site-Wide Risk Review

Evaluation Unit:	B-BX-BY Tank Farms
ID:	CP-TF-6
Group:	Tank Farm
Operable Unit Cross-Walk:	WMA B/BX/BY 200-DV-1 200-EA-1
Related EU:	CP-LS-7 CP-GW-1
Sites & Facilities:	B-BX-BY tank farms, ancillary structures, associated liquid waste sites, and associated soils contamination.
Key Data Sources Docs:	RPP-13033 RPP-23405 RPP-40545 RPP-PLAN-40145 RPP-10435

Figure 1. Site Map with Evaluation Unit Boundaries and Tank Locations

DRAFT

Attached:

- Waste Site and Facility List
- Site Map with Evaluation Unit Boundaries and Associated Waste Sites
- Site Map with Evaluation Unit Boundaries and Associated Facilities

Prepared by: AMG, 08/29/2014
Reviewed by: GVL, 08/29/2014
Revisions: AMG, 09/10/2014

Hanford Site-Wide Risk Review
CP-TF-6 (B-BX-BY Tank Farms)
Waste Site and Facility List

Site Code	Name, Aliases, Description	Site Status	Site Type	Site Type Category	Operable Unit	Exclude from Evaluation
200-E-105	200-E-105; Soil Contamination Area on the 216-B-61 Crib	Inactive	Unplanned Release	Unplanned Release - Surface/Near Surface	Not Applic	
200-E-114-PL	200-E-114-PL; 216-BC-2805; 2805-E1, 2805-E2, 2805-E3 and 2805-E4; Pipeline from 216-BY-201 to 216-BC-201; Pipeline from 241-BY Tank Farm to 241-C Tank Farm and BC Cribs Trenches	Inactive	Radioactive Process Sewer	Pipeline and associated valves, etc.	200-BC-1	
200-E-120	200-E-120; Contaminated Soil at 241-B Tank Farm; Contamination Migration Beyond the 241-B fence	Inactive	Contamination Migration	Unplanned Release - Surface/Near Surface	WMA B/BX/B	
200-E-121	200-E-121; Soil Contamination Area East and West of Baltimore Avenue	Inactive	Unplanned Release	Unplanned Release - Surface/Near Surface	200-EA-1	
200-E-132	200-E-132; 241-BX/BY Tank Farm Contaminated Soil; Contamination Migration Beyond the 241-BX/BY fence	Inactive	Contamination Migration	Unplanned Release - Surface/Near Surface	WMA B/BX/B	
200-E-176-PL-A	200-E-176-PL-A; Pipeline from 242-B to 216-B-11-A&B, Portion of pipeline outside the 241-B fence	Inactive	Direct Buried Tank Farm Pipeline	Pipeline and associated valves, etc.	TBD	
200-E-176-PL-B	200-E-176-PL-B; Pipeline from 242-B to 216-B-11-A&B, Portion of pipeline inside the 241-B fence	Inactive	Direct Buried Tank Farm Pipeline	Pipeline and associated valves, etc.	TBD	
200-E-177-PL	200-E-177-PL; Pipeline Rerouting Waste from 216-B-8 Crib Pipeline to 216-B-11A&B Reverse Wells	Inactive	Radioactive Process Sewer	Pipeline and associated valves, etc.	TBD	
200-E-178-PL	200-E-178-PL; Pipeline from Tank 241-B-110 to 216-B-8 Crib and Tile Field	Inactive	Radioactive Process Sewer	Pipeline and associated valves, etc.	TBD	
200-E-180-PL	200-E-180-PL; 216-B-57 Crib Pipeline	Inactive	Radioactive Process Sewer	Pipeline and associated valves, etc.	TBD	
200-E-191-PL	200-E-191-PL; 216-B-63 Pipeline; Pipeline from 207-B Valve Pit to 216-B-63 Ditch	Inactive	Radioactive Process Sewer	Pipeline and associated valves, etc.	TBD	
200-E-197-PL	200-E-197-PL; Encased Pipelines Between 241-BR-152 Diversion Box and 241-B Tank Farm; Lines 9002, 9006, 9010, 9014, 9017, 9020, 9031, 9032, 9035, 9037, 9038, 9041, 9044 and 9047	Inactive	Encased Tank Farm Pipeline	Pipeline and associated valves, etc.	WMA B/BX/B	
200-E-199-PL	200-E-199-PL; Lines V204, V206, V208, V209, V211, V213, V215, and V285; Tank Farm Lines from 241-B-154 Diversion Box to 241-B Tank Farm	Inactive	Direct Buried Tank Farm Pipeline	Pipeline and associated valves, etc.	TBD	
200-E-201-PL	200-E-201-PL; Lines V315 and V319; Transfer Lines from 241-BX-155 to Diversion Boxes in 241-B Tank Farm	Inactive	Direct Buried Tank Farm Pipeline	Pipeline and associated valves, etc.	TBD	
200-E-202-PL	200-E-202-PL; Lines V315, V316, V317, V318 and V319; Transfer Lines from 241-BX-155 Diversion Box to 241-BX-153 Diversion Box	Inactive	Direct Buried Tank Farm Pipeline	Pipeline and associated valves, etc.	TBD	
200-E-203-PL	200-E-203-PL; Line 9712; Pipeline from 241-BYR-154 Diversion Box to 216-B-2-2 Ditch	Inactive	Radioactive Process Sewer	Pipeline and associated valves, etc.	TBD	
200-E-204-PL	200-E-204-PL; Pipeline to 216-B-2-1 and 216-B-2-2 Ditches	Inactive	Radioactive Process Sewer	Pipeline and associated valves, etc.	TBD	
200-E-208-PL	200-E-208-PL; Lines V304 and V305 from 241-BY Tank Farm to 241-B-252 Diversion Box	Inactive	Direct Buried Tank Farm Pipeline	Pipeline and associated valves, etc.	WMA B/BX/B	
200-E-216-PL	200-E-216-PL; Lines V235, V236, V237, V242, C251, V252, and V253; Transfer Lines Between 241-BX-153, 241-B-151 and 241-B-152 Diversion Boxes	Inactive	Direct Buried Tank Farm Pipeline	Pipeline and associated valves, etc.	WMA B/BX/B	
200-E-217-PL	200-E-217-PL; Encased Transfer Line from 241-ER-151 Diversion Box to 241-BX Tank Farm; Lines 9808, 9653, 9719 and V225	Inactive	Encased Tank Farm Pipeline	Pipeline and associated valves, etc.	TBD	
200-E-219-PL	200-E-219-PL; BY Crib Distribution Pipelines; Pipelines from 216-BY-201 Flush Tank to 216-B-43, 216-B-44, 216-B-45, 216-B-46, 216-B-47, 216-B-48, 216-B-49, and 216-B-50 Cribs	Inactive	Radioactive Process Sewer	Pipeline and associated valves, etc.	TBD	

Note that only those waste sites with a WIDS (Waste Information Data System) Classification of "Accepted" are shown, along with non-duplicate facilities, identified via the Hanford Geographic Information System (HGIS).

Hanford Site-Wide Risk Review
CP-TF-6 (B-BX-BY Tank Farms)
Waste Site and Facility List

Site Code	Name, Aliases, Description	Site Status	Site Type	Site Type Category	Operable Unit	Exclude from Evaluation
200-E-220-PL	200-E-220-PL; Pipeline from 241-BY Tank Farm to 216-BY-201 Flush Tank and Monitoring Pit	Inactive	Radioactive Process Sewer	Pipeline and associated valves, etc.	TBD	
200-E-221-PL	200-E-221-PL; BC Crib Pipeline Drain Line; Pipeline to 216-B-51 French Drain	Inactive	Radioactive Process Sewer	Pipeline and associated valves, etc.	TBD	
200-E-264-PL	200-E-264-PL; Pipeline from 242-B Evaporator Building to 207-B Retention Basin	Inactive	Radioactive Process Sewer	Pipeline and associated valves, etc.	TBD	
200-E-265-PL	200-E-265-PL; 241-BY and 241-BX Tank Farm Cooling Water Pipeline to 207-B Retention Basin	Inactive	Radioactive Process Sewer	Pipeline and associated valves, etc.	TBD	
200-E-281-PL	200-E-281-PL; Line V306; Pipeline from 241-B Tank Farm to 216-B-7A and 216-B-7B Cribs	Inactive	Radioactive Process Sewer	Pipeline and associated valves, etc.	TBD	
200-E-284	200-E-284; Septic Tank East of 241-BY-102	Inactive	Septic Tank	Septic System	TBD	X
200-E-45	200-E-45; Contaminated Pump Run-in Caisson; Health Instrument Shaft; HI Shaft	Inactive	Silo	Crib - Subsurface Liquid Disposal Site	200-DV-1	
200-E-59	200-E-59; 241-BY-ITS2 Condenser Vessel; 241-BY-ITS2-TK-1; IMUST; ITS-2	Inactive	Storage Tank	Underground Storage Tank	WMA B/BX/B	
200-E-60	200 E 60; 241 BY ITS2 Heater Flush Tank; 241 BY ITS2 TK 2; IMUST; Inactive Miscellaneous Underground Storage Tank; ITS-2	Inactive	Storage Tank	Underground Storage Tank	WMA B/BX/B	
216-B-11A&B	216-B-11A&B; 216-B-11B; 242-B-1 Crib; 216-B-11 Crib; 216-B-11A & B	Inactive	French Drain	Crib - Subsurface Liquid Disposal Site	200-DV-1	
216-B-35	216-B-35; 216-B-35 Trench; 216-BX-1 Trench; 241-BX-1 Grave	Inactive	Trench	Crib - Subsurface Liquid Disposal Site	200-DV-1	
216-B-36	216-B-36; 216-B-36 Trench; 216-BX-2 Trench; 241-BX-2 Grave	Inactive	Trench	Crib - Subsurface Liquid Disposal Site	200-DV-1	
216-B-37	216-B-37; 216-B-37 Trench; 216-BX-3 Trench; 241-BX-3 Grave	Inactive	Trench	Crib - Subsurface Liquid Disposal Site	200-DV-1	
216-B-38	216-B-38; 216-B-38 Trench; 216-BX-4 Trench; 241-BX-4 Grave	Inactive	Trench	Crib - Subsurface Liquid Disposal Site	200-DV-1	
216-B-39	216-B-39; 216-B-39 Trench; 216-BX-5 Trench; 241-BX-5 Grave	Inactive	Trench	Crib - Subsurface Liquid Disposal Site	200-DV-1	
216-B-40	216-B-40; 216-B-40 Trench; 216-BX-6 Trench; 241-BX-6 Grave; 241-BX-6 Trench	Inactive	Trench	Crib - Subsurface Liquid Disposal Site	200-DV-1	
216-B-41	216-B-41; 216-B-41 Trench; 216-BX-7 Trench; 241-BX-7 Grave	Inactive	Trench	Crib - Subsurface Liquid Disposal Site	200-DV-1	
216-B-42	216-B-42; 216-B-42 Trench; 216-BX-8 Trench; 241-BX-8 Grave	Inactive	Trench	Crib - Subsurface Liquid Disposal Site	200-DV-1	
216-B-43	216-B-43; 216-BY-1 Cavern; 216-BY-1 Crib	Inactive	Crib	Crib - Subsurface Liquid Disposal Site	200-DV-1	
216-B-44	216-B-44; 216-BY-2 Cavern; 216-BY-2 Crib	Inactive	Crib	Crib - Subsurface Liquid Disposal Site	200-DV-1	
216-B-45	216-B-45; 216-BY-3 Cavern; 216-BY-3 Crib	Inactive	Crib	Crib - Subsurface Liquid Disposal Site	200-DV-1	
216-B-46	216-B-46; 216-BY-4 Cavern; 216-BY-4 Crib	Inactive	Crib	Crib - Subsurface Liquid Disposal Site	200-DV-1	
216-B-47	216-B-47; 216-BY-5 Cavern; 216-BY-5 Crib	Inactive	Crib	Crib - Subsurface Liquid Disposal Site	200-DV-1	
216-B-48	216-B-48; 216-BY-6 Cavern; 216-BY-6 Crib	Inactive	Crib	Crib - Subsurface Liquid Disposal Site	200-DV-1	
216-B-49	216-B-49; 216-BY-7 Cavern; 216-BY-7 Crib	Inactive	Crib	Crib - Subsurface Liquid Disposal Site	200-DV-1	
216-B-50	216-B-50; 216-BY-8 Cavern; 216-BY-8 Crib	Inactive	Crib	Crib - Subsurface Liquid Disposal Site	200-DV-1	
216-B-51	216-B-51; 216-BY-9 Crib	Inactive	French Drain	Crib - Subsurface Liquid Disposal Site	200-EA-1	
216-B-57	216-B-57; 216-B-57 Enclosed Trench; Hanford Prototype Barrier; 200-BP-1 Prototype Barrier	Inactive	Crib	Crib - Subsurface Liquid Disposal Site	200-DV-1	
216-B-61	216-B-61; 216-B-61 Crib	Inactive	Crib	Crib - Subsurface Liquid Disposal Site	Not Applic	
216-B-7A&B	216-B-7A&B; 216-B-7B Sump; 241-B-1 and 2 Cribs; 241-B-201 Crib; 216-B-7 Crib; 216-B-7A & B; 216-B-7A Sump	Inactive	Crib	Crib - Subsurface Liquid Disposal Site	200-DV-1	
216-B-8	216-B-8; 216-B-8TF; 241-B-3 Crib	Inactive	Crib	Crib - Subsurface Liquid Disposal Site	200-DV-1	
216-BY-201	216-BY-201; 216-BY-47; 241-BY Flush Tank; IMUST; Inactive Miscellaneous Underground Storage Tank; Supernatant Disposal Flush Tank	Inactive	Settling Tank	Underground Storage Tank	200-EA-1	
241-B-101	241-B-101; 241-B-TK-101	Inactive	Single-Shell Tank	Underground Storage Tank	WMA B/BX/B	

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Hanford Site-Wide Risk Review
CP-TF-6 (B-BX-BY Tank Farms)
Waste Site and Facility List

Site Code	Name, Aliases, Description	Site Status	Site Type	Site Type Category	Operable Unit	Exclude from Evaluation
241-B-102	241-B-102; 241-B-TK-102	Inactive	Single-Shell Tank	Underground Storage Tank	WMA B/BX/B	
241-B-103	241-B-103; 241-B-TK-103	Inactive	Single-Shell Tank	Underground Storage Tank	WMA B/BX/B	
241-B-104	241-B-104; 241-B-TK-104	Inactive	Single-Shell Tank	Underground Storage Tank	WMA B/BX/B	
241-B-105	241-B-105; 241-B-TK-105	Inactive	Single-Shell Tank	Underground Storage Tank	WMA B/BX/B	
241-B-106	241-B-106; 241-B-TK-106	Inactive	Single-Shell Tank	Underground Storage Tank	WMA B/BX/B	
241-B-107	241-B-107; 241-B-TK-107	Inactive	Single-Shell Tank	Underground Storage Tank	WMA B/BX/B	
241-B-108	241-B-108; 241-B-TK-108	Inactive	Single-Shell Tank	Underground Storage Tank	WMA B/BX/B	
241-B-109	241-B-109; 241-B-TK-109	Inactive	Single-Shell Tank	Underground Storage Tank	WMA B/BX/B	
241-B-110	241-B-110; 241-B-TK-110	Inactive	Single-Shell Tank	Underground Storage Tank	WMA B/BX/B	
241-B-111	241-B-111; 241-B-TK-111	Inactive	Single-Shell Tank	Underground Storage Tank	WMA B/BX/B	
241-B-112	241-B-112; 241-B-TK-112	Inactive	Single-Shell Tank	Underground Storage Tank	WMA B/BX/B	
241-B-151	241-B-151; 241-B-151 Diversion Box	Inactive	Diversion Box	Pipeline and associated valves, etc.	WMA B/BX/B	
241-B-152	241-B-152; 241-B-152 Diversion Box	Inactive	Diversion Box	Pipeline and associated valves, etc.	WMA B/BX/B	
241-B-153	241-B-153; 241-B-153 Diversion Box	Inactive	Diversion Box	Pipeline and associated valves, etc.	WMA B/BX/B	
241-B-201	241-B-201; 241-B-TK-201	Inactive	Single-Shell Tank	Underground Storage Tank	WMA B/BX/B	
241-B-202	241-B-202; 241-B-TK-202	Inactive	Single-Shell Tank	Underground Storage Tank	WMA B/BX/B	
241-B-203	241-B-203; 241-B-TK-203	Inactive	Single-Shell Tank	Underground Storage Tank	WMA B/BX/B	
241-B-204	241-B-204; 241-B-TK-204	Inactive	Single-Shell Tank	Underground Storage Tank	WMA B/BX/B	
241-B-252	241-B-252; 241-B-252 Diversion Box	Inactive	Diversion Box	Pipeline and associated valves, etc.	WMA B/BX/B	
241-B-301	241-B-301; 241-B-301B; 241-B-301-B Catch Tank; Drain Lines V238 and V312; IMUST; Inactive Miscellaneous Underground Storage Tank	Inactive	Catch Tank	Underground Storage Tank	WMA B/BX/B	
241-BR-152	241-BR-152; 241-BR-152 Diversion Box	Inactive	Diversion Box	Pipeline and associated valves, etc.	WMA B/BX/B	
241-BX-101	241-BX-101; 241-BX-TK-101	Inactive	Single-Shell Tank	Underground Storage Tank	WMA B/BX/B	
241-BX-102	241-BX-102; 241-BX-TK-102	Inactive	Single-Shell Tank	Underground Storage Tank	WMA B/BX/B	
241-BX-103	241-BX-103; 241-BX-TK-103	Inactive	Single-Shell Tank	Underground Storage Tank	WMA B/BX/B	
241-BX-104	241-BX-104; 241-BX-TK-104	Inactive	Single-Shell Tank	Underground Storage Tank	WMA B/BX/B	
241-BX-105	241-BX-105; 241-BX-TK-105	Inactive	Single-Shell Tank	Underground Storage Tank	WMA B/BX/B	
241-BX-106	241-BX-106; 241-BX-TK-106	Inactive	Single-Shell Tank	Underground Storage Tank	WMA B/BX/B	
241-BX-107	241-BX-107; 241-BX-TK-107	Inactive	Single-Shell Tank	Underground Storage Tank	WMA B/BX/B	
241-BX-108	241-BX-108; 241-BX-TK-108	Inactive	Single-Shell Tank	Underground Storage Tank	WMA B/BX/B	
241-BX-109	241-BX-109; 241-BX-TK-109	Inactive	Single-Shell Tank	Underground Storage Tank	WMA B/BX/B	
241-BX-110	241-BX-110; 241-BX-TK-110	Inactive	Single-Shell Tank	Underground Storage Tank	WMA B/BX/B	
241-BX-111	241-BX-111; 241-BX-TK-111	Inactive	Single-Shell Tank	Underground Storage Tank	WMA B/BX/B	
241-BX-112	241-BX-112; 241-BX-TK-112	Inactive	Single-Shell Tank	Underground Storage Tank	WMA B/BX/B	
241-BX-153	241-BX-153; 241-BX-153 Diversion Box	Inactive	Diversion Box	Pipeline and associated valves, etc.	WMA B/BX/B	
241-BX-302A	241-BX-302A; 241-BX-302-A Catch Tank; 9053; 9253; 9453; Drain Lines V357; IMUST; Inactive Miscellaneous Underground Storage Tank	Inactive	Catch Tank	Underground Storage Tank	WMA B/BX/B	
241-BXR-151	241-BXR-151; 241-BXR-151 Diversion Box	Inactive	Diversion Box	Pipeline and associated valves, etc.	WMA B/BX/B	
241-BXR-152	241-BXR-152; 241-BXR-152 Diversion Box	Inactive	Diversion Box	Pipeline and associated valves, etc.	WMA B/BX/B	
241-BXR-153	241-BXR-153; 241-BXR-153 Diversion Box; Line 9453	Inactive	Diversion Box	Pipeline and associated valves, etc.	WMA B/BX/B	
241-BY-101	241-BY-101; 241-BY-TK-101	Inactive	Single-Shell Tank	Underground Storage Tank	WMA B/BX/B	
241-BY-102	241-BY-102; 241-BY-TK-102	Inactive	Single-Shell Tank	Underground Storage Tank	WMA B/BX/B	
241-BY-103	241-BY-103; 241-BY-TK-103	Inactive	Single-Shell Tank	Underground Storage Tank	WMA B/BX/B	
241-BY-104	241-BY-104; 241-BY-TK-104	Inactive	Single-Shell Tank	Underground Storage Tank	WMA B/BX/B	
241-BY-105	241-BY-105; 241-BY-TK-105	Inactive	Single-Shell Tank	Underground Storage Tank	WMA B/BX/B	

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Hanford Site-Wide Risk Review
CP-TF-6 (B-BX-BY Tank Farms)
Waste Site and Facility List

Site Code	Name, Aliases, Description	Site Status	Site Type	Site Type Category	Operable Unit	Exclude from Evaluation
241-BY-106	241-BY-106; 241-BY-TK-106	Inactive	Single-Shell Tank	Underground Storage Tank	WMA B/BX/B	
241-BY-107	241-BY-107; 241-BY-TK-107	Inactive	Single-Shell Tank	Underground Storage Tank	WMA B/BX/B	
241-BY-108	241-BY-108; 241-BY-TK-108	Inactive	Single-Shell Tank	Underground Storage Tank	WMA B/BX/B	
241-BY-109	241-BY-109; 241-BY-TK-109	Inactive	Single-Shell Tank	Underground Storage Tank	WMA B/BX/B	
241-BY-110	241-BY-110; 241-BY-TK-110	Inactive	Single-Shell Tank	Underground Storage Tank	WMA B/BX/B	
241-BY-111	241-BY-111; 241-BY-TK-111	Inactive	Single-Shell Tank	Underground Storage Tank	WMA B/BX/B	
241-BY-112	241-BY-112; 241-BY-TK-112	Inactive	Single-Shell Tank	Underground Storage Tank	WMA B/BX/B	
241-BYR-152	241-BYR-152; 241-BYR-152 Diversion Box	Inactive	Diversion Box	Pipeline and associated valves, etc.	WMA B/BX/B	
241-BYR-153	241-BYR-153; 241-BYR-153 Diversion Box	Inactive	Diversion Box	Pipeline and associated valves, etc.	WMA B/BX/B	
241-BYR-154	241-BYR-154; 241-BYR-154 Diversion Box	Inactive	Diversion Box	Pipeline and associated valves, etc.	WMA B/BX/B	
242-B	242-B; 242-B Evaporator	Inactive	Evaporator	Process Building	Not Applic	
242-B-151	242-B-151; 242-B Evaporator Building Diversion Box	Inactive	Diversion Box	Pipeline and associated valves, etc.	WMA B/BX/B	
244-BX DCRT	244-BX DCRT; 244-BX Double-Contained Receiver Tank; 244-BX Receiver Tank; 244-BX Receiver Vault; 244-BX RT; 244-BX-TK/SMP	Inactive	Receiver Tank	Underground Storage Tank	WMA B/BX/B	
244-BXR VAULT	244-BXR Vault; 244-BXR VAULT; IMUST; Inactive Miscellaneous Underground Storage Tank; Lines 9765 and 7453; 244-BXR Receiving Vault	Inactive	Receiving Vault	Underground Storage Tank	WMA B/BX/B	
2607-E9	2607-E9; 2607-E9 Septic System; 242B/BL Septic Tank and Drain Field	Inactive	Septic Tank	Septic System	200-EA-1	X
2607-EB	2607-EB; 241-BY-254 (ITS #2) Sanitary Septic System	Inactive	Septic Tank	Septic System	TBD	X
2607-EF	2607-EF; Septic Tank West of 241-BX Tank Farm	Inactive	Septic Tank	Septic System	TBD	X
UPR-200-E-101	UPR-200-E-101; Radioactive Spill Near 242-B Evaporator; UN-200-E-101; UN-216-E-101; UN-216-E-30	Inactive	Unplanned Release	Unplanned Release - Surface/Near Surface	200-EA-1	
UPR-200-E-105	UPR-200-E-105; Liquid Release in the 241-BY Tank Farm; UN-200-E-105	Inactive	Unplanned Release	Unplanned Release - Surface/Near Surface	Not Applic	
UPR-200-E-108	UPR-200-E-108; 241-B-102 Tank Release; UN-200-E-108	Inactive	Unplanned Release	Unplanned Release - Subsurface	Not Applic	
UPR-200-E-109	UPR-200-E-109; Release from 241-B-104; UN-200-E-109	Inactive	Unplanned Release	Unplanned Release - Subsurface	Not Applic	
UPR-200-E-110	UPR-200-E-110; 241-BY Valve Pit Release; UN-200-E-110	Inactive	Unplanned Release	Unplanned Release - Surface/Near Surface	Not Applic	
UPR-200-E-116	UPR-200-E-116; 241-BY-112 Flush Release; UN-200-E-116	Inactive	Unplanned Release	Unplanned Release - Surface/Near Surface	Not Applic	
UPR-200-E-127	UPR-200-E-127; 241-B-107 Leak; UN-200-E-127	Inactive	Unplanned Release	Unplanned Release - Subsurface	Not Applic	
UPR-200-E-128	UPR-200-E-128; 241-B-110 Leak; UN-200-E-128	Inactive	Unplanned Release	Unplanned Release - Subsurface	Not Applic	
UPR-200-E-129	UPR-200-E-129; 241-B-201 Leak; UN-200-E-129	Inactive	Unplanned Release	Unplanned Release - Subsurface	Not Applic	
UPR-200-E-130	UPR-200-E-130; 241-B-203 Leak; UN-200-E-130	Inactive	Unplanned Release	Unplanned Release - Subsurface	Not Applic	
UPR-200-E-131	UPR-200-E-131; 241-BX-102 Release; UN-200-E-131	Inactive	Unplanned Release	Unplanned Release - Subsurface	Not Applic	
UPR-200-E-132	UPR-200-E-132; 241-BX-102 Tank Leak; UN-200-E-132	Inactive	Unplanned Release	Unplanned Release - Subsurface	Not Applic	
UPR-200-E-133	UPR-200-E-133; 241-BX-108 Leak; UN-200-E-133	Inactive	Unplanned Release	Unplanned Release - Subsurface	Not Applic	
UPR-200-E-134	UPR-200-E-134; 241-BY-103 Tank Leak; UN-200-E-134	Inactive	Unplanned Release	Unplanned Release - Subsurface	Not Applic	
UPR-200-E-135	UPR-200-E-135; 241-BY-108 Tank Leak; UN-200-E-135	Inactive	Unplanned Release	Unplanned Release - Subsurface	Not Applic	
UPR-200-E-144	UPR-200-E-144; Soil Contamination North of 241-B; UN-216-E-44	Inactive	Unplanned Release	Unplanned Release - Surface/Near Surface	200-EA-1	
UPR-200-E-38	UPR-200-E-38; Release from 241-B-152; UN-200-E-38; UN-216-E-4	Inactive	Unplanned Release	Unplanned Release - Surface/Near Surface	Not Applic	
UPR-200-E-4	UPR-200-E-4; 241-B-151 Diversion Box Contamination Spread; UN-200-E-4	Inactive	Unplanned Release	Unplanned Release - Surface/Near Surface	Not Applic	
UPR-200-E-43	UPR-200-E-43; Road Contamination Near 241-BY Tank Farm; UN-200-E-43	Inactive	Unplanned Release	Unplanned Release - Surface/Near Surface	200-EA-1	

Note that only those waste sites with a WIDS (Waste Information Data System) Classification of "Accepted" are shown, along with non-duplicate facilities, identified via the Hanford Geographic Information System (HGIS).

Hanford Site-Wide Risk Review
CP-TF-6 (B-BX-BY Tank Farms)
Waste Site and Facility List

Site Code	Name, Aliases, Description	Site Status	Site Type	Site Type Category	Operable Unit	Exclude from Evaluation
UPR-200-E-5	UPR-200-E-5; 241-BX-102 Tank Overflow; UN-200-E-5	Inactive	Unplanned Release	Unplanned Release - Surface/Near Surface	Not Applic	
UPR-200-E-73	UPR-200-E-73; 241-B-151 Diversion Box Contamination; UN-200-E-73; UN-216-E-1	Inactive	Unplanned Release	Unplanned Release - Surface/Near Surface	Not Applic	
UPR-200-E-74	UPR-200-E-74; 241-B-152 Diversion Box Contamination; UN-200-E-74; UN-216-E-2	Inactive	Unplanned Release	Unplanned Release - Surface/Near Surface	Not Applic	
UPR-200-E-75	UPR-200-E-75; 241-B-153 Diversion Box Contamination; UN-200-E-75; UN-216-E-3	Inactive	Unplanned Release	Unplanned Release - Surface/Near Surface	Not Applic	
UPR-200-E-76	UPR-200-E-76; 241-B-152 Pipeline Break; UN-200-E-76; UN-216-E-4	Inactive	Unplanned Release	Unplanned Release - Surface/Near Surface	Not Applic	
UPR-200-E-79	UPR-200-E-79; 200-E-264-PL Line Break; 242-B to 207-B Line Break; UN-200-E-79; UN-216-E-7	Inactive	Unplanned Release	Unplanned Release - Surface/Near Surface	TBD	
UPR-200-E-89	UPR-200-E-89; Contamination Migration to the North, East & West of BX-BY Tank Farms; UN-200-E-89; UN-216-E-17	Inactive	Unplanned Release	Unplanned Release - Surface/Near Surface	200-EA-1	
UPR-200-E-9	UPR-200-E-9; Liquid Overflow at 216-BY-201; UN-200-E-9	Inactive	Unplanned Release	Unplanned Release - Surface/Near Surface	200-EA-1	
241B701	INSTRUMENT AIR COMPRESSOR BUILDING	INACTIVE	BUILDING	Infrastructure Building		X
241BY254	CONTROL HOUSE AND COMPRESSOR, ITS2	INACTIVE	BUILDING	Infrastructure Building		X
241BY301	CONTROL HOUSE IN-TANK SOLIDIFICATION	INACTIVE	BUILDING	Infrastructure Building		X
241BY302	COMPRESSOR HOUSE, ITS1	INACTIVE	BUILDING	Infrastructure Building		X
241BY361	FLUSH TANK -- UNDERGROUND	INACTIVE	TANK	Underground Storage Tank		
242B	RADIOACTIVE PARTICLE RESEARCH LABORATORY	INACTIVE	BUILDING	Process Building		
242BL	CASK LOADING BUILDING	INACTIVE	BUILDING	Infrastructure Building		X
244BX	SALT WELL RECEIVER VAULT	INACTIVE	BUILDING	Process Building		
244BX271	ELECTRICAL INSTRUMENT CONTROL BLDG	ACTIVE	BUILDING	Infrastructure Building		X
250800000	SIREN EAST OF BALTIMORE SOUTH OF 241B	ACTIVE	STRUCTURE	Process Building		X
2724B	RAD MONITORING AND PROTECTIVE CLOTHING BLDG	INACTIVE	BUILDING	Infrastructure Building		X
2724BX	RAD MONITORING AND PROTECTIVE CLOTHING BLDG	INACTIVE	BUILDING	Infrastructure Building		X
2724BY	RAD MONITORING AND PROTECTIVE CLOTHING BLDG	INACTIVE	BUILDING	Infrastructure Building		X
2724BYA	RAD MONITORING AND PROTECTIVE CLOTHING BLDG	INACTIVE	BUILDING	Infrastructure Building		X
MO114	CHANGE TRAILER AT 241BY	INACTIVE	BUILDING	Infrastructure Building		X
MO299	CHANGE TRL BX AND BY TANK FARM	ACTIVE	BUILDING	Infrastructure Building		X
MO824	CHANGE TRAILER AT 241BX TANK FARM	ACTIVE	BUILDING	Infrastructure Building		X
MO825	CHANGE TRAILER NORTH OF 2724B	ACTIVE	BUILDING	Infrastructure Building		X

Note that only those waste sites with a WIDS (Waste Information Data System) Classification of "Accepted" are shown, along with non-duplicate facilities, identified via the Hanford Geographic Information System (HGIS).

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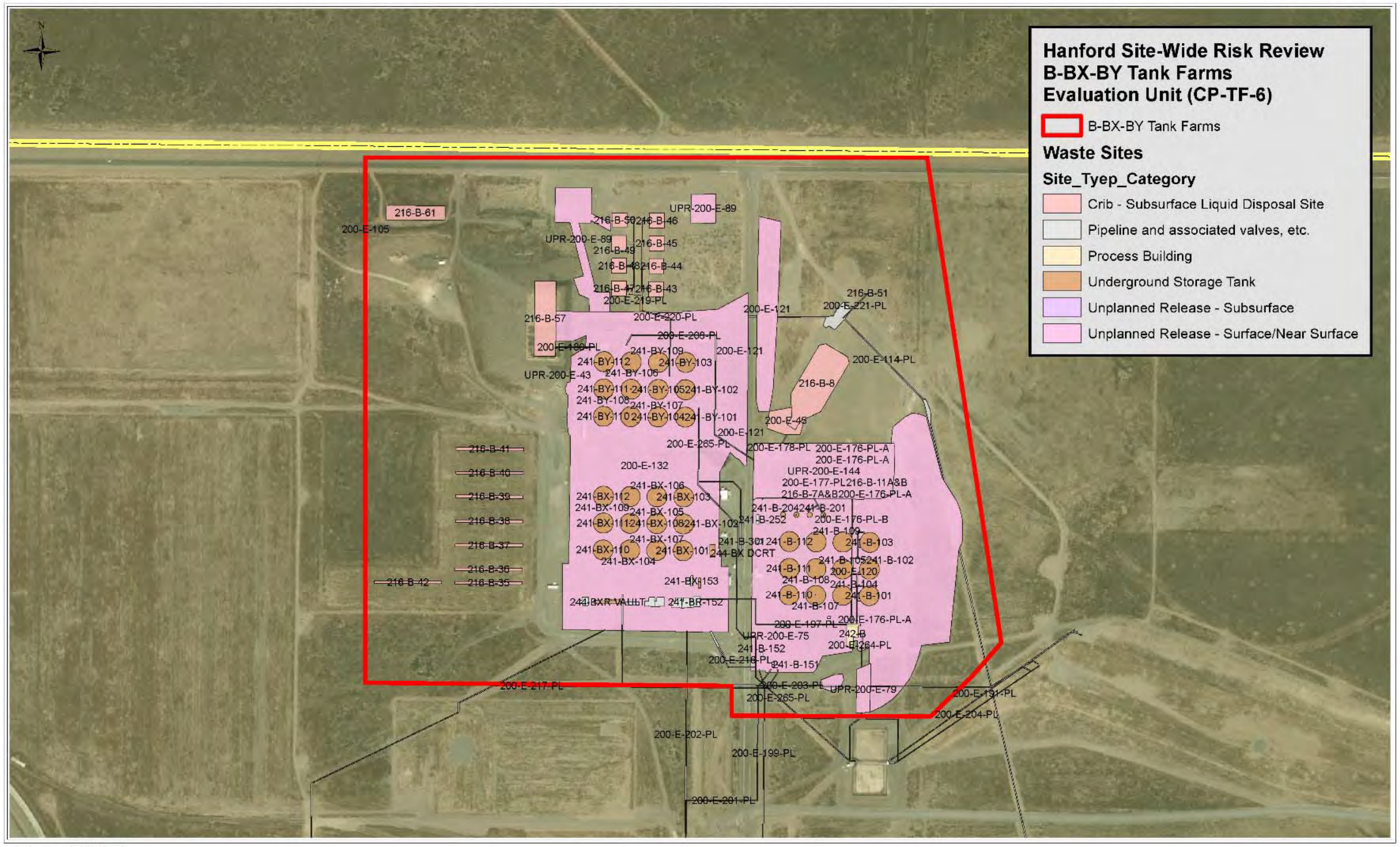

1 inch = 500 feet

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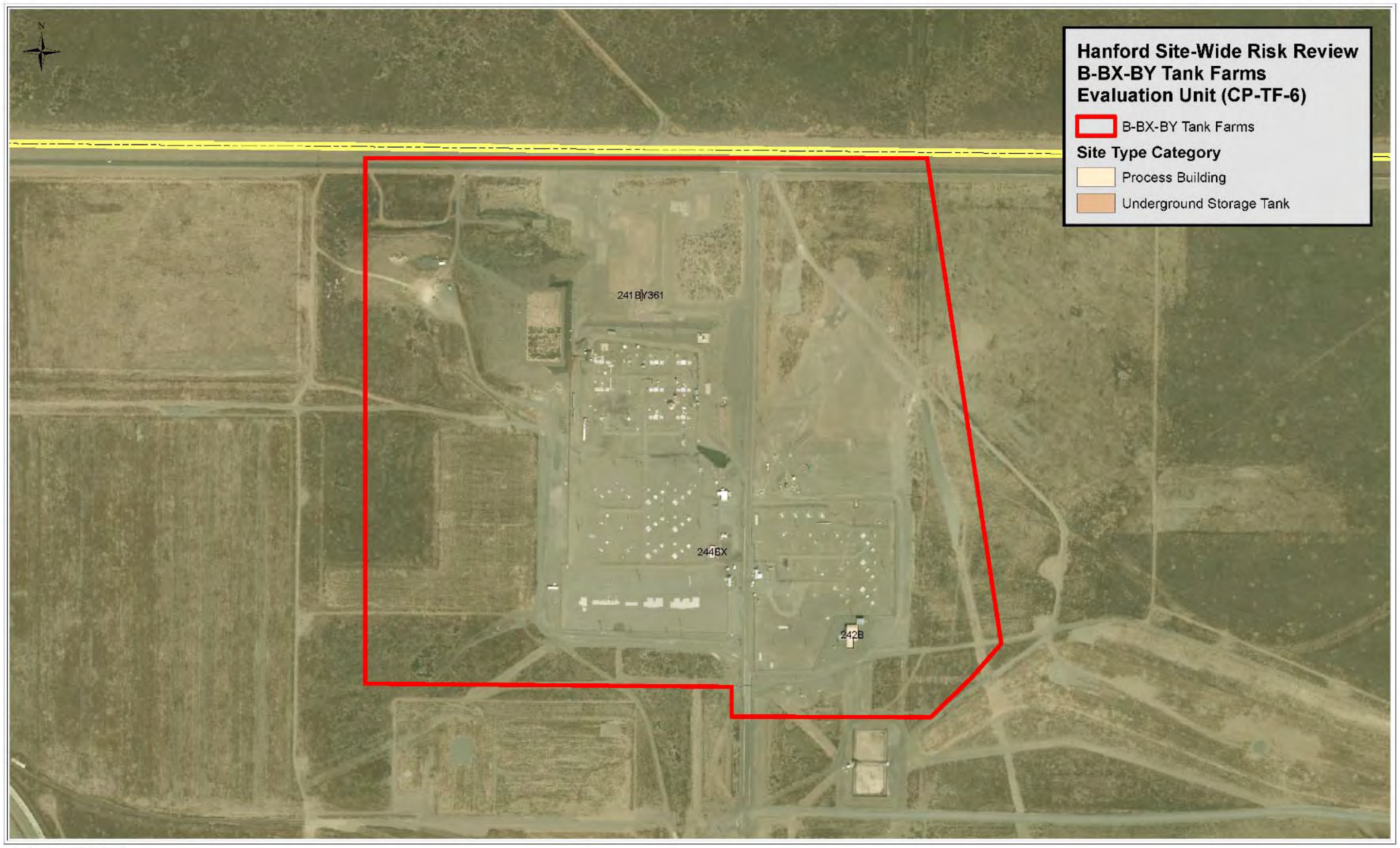

1 inch = 500 feet

APPENDIX E.8

Tank Waste and Farm

CP-TF-7 (C Tank Waste and Farm)
Evaluation Unit Summary Template

Table of Contents

List of Figures

List of Tables

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PART 8. CP-TF-7 C SINGLE-SHELL TANK WASTE AND FARM (200-E)

8.1. EXECUTIVE SUMMARY

Much of the information related to the C Tank and Waste Farms Evaluation Unit (EU) is organized around the corresponding Waste Management Area (namely WMA C) that is regulated under the Resource Conservation and Recovery Act (RCRA) and Washington's Hazardous Waste Management Act (HWMA, RCW 70.105) and its implementing requirements (Washington's Dangerous Waste Regulations, WAC 173-303) (Johnson&Chou 1999).

EU LOCATION:

East-Central part of 200-East on the Hanford Reservation; Central Plateau

RELATED EUS:

T Tank Waste and Farms (CP-TF-1), S-SX Tank Waste and Farms (CP-TF-2), TX-TY Tank Waste and Farms (CP-TF-3), U Tank Waste and Farms (CP-TF-4), A-AX Tank Waste and Farms (CP-TF-5), B-BX-BY v (CP-TF-6), 200-East DST Waste and Farms (CP-TF-8), 200-West DST Waste and Farms (CP-TF-9), 200-E Groundwater Plumes (CP-GW-1), 200-W Groundwater Plumes (CP-GW-1), and 200 Area Waste Transfer Pipeline (CP-LS-7)

PRIMARY CONTAMINANTS, CONTAMINATED MEDIA AND WASTES:

The TC&WM EIS describes tank wastes as including radioactive (tritium or H-3, C-14, Sr-90, Tc-99, I-129, Cs-137, U-233, U-234, U-235, U-238, Np-237, Pu-239, and Pu-240)[119] and non-radioactive contaminants (chromium, mercury, nitrate, lead, total uranium, and PCBs) of potential concern (DOE/EIS-0391 2012, Appendix D). The tank wastes contain saltcake, sludge, and supernatant phases. Contaminated media related to the C Tank Farm include ancillary equipment and surrounding vadose zone (including cribs and trenches) down to the saturated zone (for some mobile contaminants) from past and current discharges. The 2013 Groundwater Monitoring Report (DOE/RL-2014-32, Rev. 0) lists tank wastes including nitrate, I-129, Tc-99, uranium, Sr-90, cyanide, and H-3 for the 200-BP-5 Operable Unit (OU); the nitrate and Tc-99 plumes are associated with C Tank and Waste Farms EU sources.

After evaluating the contaminants associated with C Tank Farm tanks, ancillary equipment, legacy sources, and contaminated vadose zone, the primary contaminants from the tank wastes that drive human health risk to groundwater for the C Tank Farms Evaluation Unit are: Tc-99, I-129, Sr-90, H-3, chromium, uranium, cyanide, and nitrate. Those primary contaminants that may drive risk from groundwater discharge to the Columbia River are nitrate and chromium; however, any potential impacts are highly uncertain (Section 6.1). Cs-137 and Sr-90 are important from a safety standpoint and uranium isotopes, plutonium isotopes, and tritium are iconic constituents; these contaminants are included in the inventory summary even though they are not considered risk drivers for impacts to or from groundwater in this review. The other 200-BP-5 OU plumes (i.e., I-129, uranium, Sr-90, cyanide, and

[119] Other isotopes considered include U-232 and U-236 and Pu-238, Pu-241, and Pu-242 to be consistent with other EUs. These additional uranium and plutonium isotopes are included in the totals presented but are not used for rating because 1) uranium toxicity impacts (represented by total uranium drives corresponding risks and 2) plutonium has been found relatively immobile in the Hanford subsurface and has not been identified as a risk driver for groundwater impacts.

tritium) that are not associated with C Tank and Waste Farms EU sources are described in Appendix G.5 for the CP-GW-1 EU (200-BP-5 GW OU).

BRIEF NARRATIVE DESCRIPTION:

Waste Management Area C (WMA C) occupies approximately 8.5 acres (http://phoenix.pnnl.gov/) with 16 underground single-shell tanks (SSTs) in additional to ancillary equipment (e.g., diversion boxes, pumps, valves, and pipes). The tanks contain primarily 1st cycle decontamination from bismuth phosphate process, aluminum cladding Purex wastes, metal waste from bismuth phosphate process, and ferrocyanide sludge (Remund et al. 1995). The C Tank Farm tanks were taken out of service between 1970 and 1980 (Horton & Narbutovskih 2001).

The C Tank Farm was constructed in 1943-44 (Horton & Narbutovskih 2001, p. 2.2) and includes 12 530 kgal underground waste storage tanks (C-101 through C-112) and four smaller 55 kgal tanks (C-201 through C-204). The C Tank Farm tanks were designed for non-boiling wastes. Six of the 16 tanks in the C Tank Farm are classified as “assumed leakers” (Weyns 2014). Leaks from these tanks are estimated at 29,250 gallons and range from 350 gallons (C-204 in 1988) to 20,000 gallons (C-101 in 1980).

There are also various non-tank sources that received large volumes of contaminated waste and other waste streams that has resulted in vadose zone and groundwater contamination in the areas around the WMA C including fourteen documented unplanned releases including surface spills and leaks from transfer lines, diversion boxes, catch tanks, and vaults (Horton & Narbutovskih 2001).

The SSTs in WMA C were previously interim stabilized (i.e., liquid transferred to DSTs to <50 kgal drainable interstitial liquid and <5 kgal of supernatant). Tank waste retrieval is in progress in the C Tank Farm (Weyns 2014):

- Retrieval has been completed in nine of the C Tank Farm tanks (C-103, C-104, C-106, C-110, C-112, and C-201 through C-204).
- Retrieval has been completed to various limits of technology in four tanks (C-101, C-107, C-108, and C-109).
- Retrieval is in progress in the remaining tanks (C-102, C-105, C-111)

SUMMARY TABLES OF RISKS AND POTENTIAL IMPACTS TO RECEPTORS

Table E.8-1 provides a summary of nuclear and industrial safety related consequences from the CP-TF-7 (C Tank and Waste Farms EU) to humans and impacts to important physical Hanford Site resources. Receptors are described in Section 1.6 (Appendix E.1).

Table E.8-1. CP-TF-7 (C Tank Farm) impact Rating Summary for Human Health (unmitigated basis with mitigated basis provided in parentheses (e.g., "High (Low)").

Population or Resource		Evaluation Time Period[a] Active Cleanup (to 2064) **Current Condition:** Maintenance & Monitoring (M&M)	Evaluation Time Period[a] Active Cleanup (to 2064) **From Cleanup Actions:** Retrieval & Closure
Human Health	Facility Worker[b]	***M&M***: Low-High[d] (Low-High)[d] ***Soil***: ND-High (ND-Low)	***Preferred method***: High (Low) ***Alternative***: High (Low)
Human Health	Co-located Person[b]	***M&M***: Low-Moderate (Low) ***Soil***: ND (ND)	***Preferred method***: Low-Moderate (Low) ***Alternative***: Low-Moderate (Low)
Human Health	Public[b]	***M&M***: Low (Low) ***Soil***: ND (ND)	***Preferred method***: Low (Low) ***Alternative***: Low (Low)
Environmental	Groundwater (A&B) from vadose zone[c]	Medium -- I-129[f] **Overall**: Medium	Medium -- I-129[f] **Overall**: Medium
Environmental	Columbia River from vadose zone[c]	Benthic: Not Discernible (radionuclides) Not Discernible (chemicals) Riparian: Not Discernible (radionuclides) Not Discernible (chemicals) Free-flowing: Not Discernible (all) **Overall**: Not Discernible	Benthic: Not Discernible (radionuclides) Not Discernible (chemicals)[g] Riparian: Not Discernible (radionuclides) Not Discernible (chemicals)[g] Free-flowing: Not Discernible (all) **Overall**: Not Discernible
Environmental	Ecological Resources[e]	ND	ND to Medium
Social	Cultural Resources[e]	**Native American:** Direct: Known Indirect: Known **Historic Pre-Hanford:** Direct: Known Indirect: Unknown **Manhattan/Cold War:** Direct: Known Indirect: Known	**Native American:** Direct: Known Indirect: Known **Historic Pre-Hanford:** Direct: Known Indirect: Unknown **Manhattan/Cold War:** Direct: Known Indirect: Known

a. A rating for cultural resources is not being made because cultural resources will be evaluated under Section 106 of the National Historic Preservation Act (16 USC 470, et. seq.) during the planning for remedial action.

b. Evaluated in Section 1.6 (Appendix E.1).

c. Groundwater threat for Group A and B contaminants remaining in the vadose zone or to the Columbia River for all primary contaminants. Threats from existing plumes associated with the C Tank and Waste Farms EU are described in Section 8.5 and Appendix G.5 (CP-GW-1) for the 200-BP-5 Groundwater Operable Unit.

d. Industrial safety consequences range from low to high (based on the evaluation scale used) for both mitigated (with controls) and unmitigated (without controls). Mitigated radiological and toxicological consequences to facility workers are high (unmitigated) and low (mitigated).

e. 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.

f. The inventory of Sr-90 in the vadose zone would translate to a *High* rating. However, transport considerations based on the screening evaluations in the TC&WM EIS indicate that Sr-90 is unlikely to impact groundwater in the future (Section 8.5).

g. The information from Appendix P from the TC&WM EIS would suggest that hexavalent chromium would have *Medium* and *High* ratings for benthic and riparian zone impacts, respectively. However, current well data suggest that chromium is moving much more slowly than predicted in the TC&WM EIS evaluation resulting in *Not Discernible* ratings.

SUPPORT FOR RISK AND IMPACT RATINGS FOR EACH POPULATION OR RESOURCE

Human Health

The current and cleanup-related consequences related to work being conducted at the Tank Farms in the 200 Areas (Hanford Central Plateau) was evaluated in Section 1.6 (Appendix E.1).

Groundwater, Vadose Zone, and Columbia River

C Tank Farm contaminants are currently impacting groundwater, and treatment is not predicted to decrease concentrations to below thresholds before active cleanup commences. Secondary sources (e.g., total and hexavalent chromium) in the vadose also threaten to continue to impact groundwater in the future, including the Active Cleanup period. As described in the TC&WM EIS (and summarized in Section 8.5), there are significant impacts on peak concentrations in groundwater (with an impact on ratings as described in Section 8.5) but not the near-shore region of the Columbia River during or after cleanup. Thus the values for these receptors are the same as those shown in Table E.8-8.

Ecological Resources

Current
No resources on site, but about 15% level 3 resources on buffer. If no trucks, ND effects currently.

Risks and Potential Impacts from Selected or Potential Cleanup Approaches
No resources on EU, but about 15% level 3 resources on buffer area. Remediation could result in truck disturbance, increases in exotic species, and changes in species composition in buffer.

Cultural Resources

Current
Manhattan Project/Cold War significant resources have already been mitigated. Area is very disturbed and there are no known recorded archaeological resources within the EU. Traditional cultural places are visible from EU.

Risks and Potential Impacts from Selected or Potential Cleanup Approaches

Because area has not been investigated either on the surface or subsurface, archaeological investigations may need to occur within pockets of undisturbed land if any prior to remediation. Potential for intact archaeological material to be present is very low.

Considerations for Timing of the Cleanup Actions

See Section 1.1 (Appendix E.1).

Near-Term, Post-Cleanup Risks and Potential Impacts

See Section 1.1 (Appendix E.1).

8.2. ADMINISTRATIVE INFORMATION

OU AND/OR TSDF DESIGNATION(S):

The C Tank and Waste Farms Evaluation Unit (EU), denoted *CP-TF-7 – C Tank Farm*, consists of 16 waste tanks, ancillary structures, associated liquid waste sites, and soils contamination; much of this EU is contained within Waste Management Area C (WMA C). WMA C is regulated under the Resource Conservation and Recovery Act (RCRA) as modified in 40 CFR Part 265, Subpart F and Washington State's Hazardous Waste Management Act (HWMA, RCW 70.105 and its implementing requirements in the Washington State dangerous waste regulations [WAC 173-303-400]).

COMMON NAME(S) FOR EU:

There is no common name for the C Tank and Waste Farms EU because the EU is comprised of elements from other waste management units including Waste Management Area C (WMA C) that includes the 241-C (or C) Tank Farm.

The C Tank Farm contains 16 waste tanks (C-101 through C-112 and C-201 through C-204); these tanks often are designated as 241-C-101 through 241-C-112 and 241-C-201 through 241-C-204. Other components in the EU are listed below in the *Primary EU Source Components* section.

KEY WORDS:

C Tank Farm, 241-C Tank Farm, waste tanks, tank farm, Waste Management Area C, WMA C

REGULATORY STATUS

Regulatory Basis

DOE is the responsible agency for the closure of all single-shell tank (SST) waste management areas (WMAs) through post closure, in close coordination with other closure and cleanup activities of the Hanford Central Plateau. Washington State has a program that is authorized under RCRA and implemented through the HWMA and its associated regulations; Ecology is the lead regulatory agency responsible for the closure of the SST system. Please refer to Section 1.2 (Appendix E.1) for more information.

Applicable Regulatory Documentation

The relationship among the tank waste retrieval work plans (TWRWP) and the overall single-shell tank (SST) waste retrieval and closure process is described in Appendix I of the Hanford Federal Facility

Agreement and Consent Order (HFFACO), along with requirements for the content of TWRWPs. WMA C was placed in assessment monitoring (40 CFR 265.93[d][4]) based on elevated specific conductance measurements (DOE/RL-2009-77, p. iii). A groundwater quality assessment plan was developed (DOE/RL-2009-77, p. iii) describing the monitoring activities used in deciding whether WMA C has affected groundwater.

Applicable Consent Decree or TPA Milestones

Federal Facility Agreement and Consent Order, 1989 and amended through June 16, 2014: Milestone M-045-00; Lead Agency Ecology: *Complete the closure of all Single Shell Tank Farms by 01/31/2043*

RISK REVIEW EVALUATION INFORMATION

Completed: Revised August 25, 2015

Evaluated by: K. G. Brown

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

8.3. 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-West Area (of which the C Tank and Waste Farms EU is a part) 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: The legacy source sites associated with the C Tank and Waste Farms EU are described in Attachment Section 8.8. To summarize, there are various non-tank sources that received large volumes of contaminated waste and other waste streams that has resulted in vadose zone and groundwater contamination in the areas around the WMA C including fourteen documented unplanned releases including surface spills and leaks from transfer lines, diversion boxes, catch tanks, and vaults (Horton & Narbutovskih 2001). Six of the 16 tanks in the C Tank Farm are classified as “assumed leakers” with total leaks estimated at 29,250 gallons and ranging from 350 gallons (C-204 in 1988) to 20,000 gallons (C-101 in 1980) (Weyns 2014).

High-Level Waste Tanks and Ancillary Equipment: The waste tanks in the C Tank and Waste Farms EU are:

- (241-)C-101 (241-C-TK-101)
- (241-)C-102 (241-C-TK-102)
- (241-)C-103 (241-C-TK-103)
- (241-)C-104 (241-C-TK-104)
- (241-)C-109 (241-C-TK-109)
- (241-)C-110 (241-C-TK-110)
- (241-)C-111 (241-C-TK-111)
- (241-)C-112 (241-C-TK-112)

- (241-)C-105 (241-C-TK-105)
- (241-)C-106 (241-C-TK-106)
- (241-)C-107 (241-C-TK-107)
- (241-)C-108 (241-C-TK-108)
- (241-)C-201 (241-C-TK-201)
- (241-)C-202 (241-C-TK-202)
- (241-)C-203 (241-C-TK-203)
- (241-)C-204 (241-C-TK-204)

The ancillary equipment included in the C Tank and Waste Farms EU is listed in the Attachment in Section 8.8 and primarily consists of pipelines, diversion boxes, and catch tanks.

Groundwater Plumes:

The C Tank and Waste Farms EU is in the 200-BP-5 Operable Unit (OU). The current 200-BP-5 OU plumes that exceed water quality standards (in this case, drinking water standards) are nitrate, I-129, Tc-99, uranium, Sr-90, cyanide, and H-3 (DOE/RL-2014-32, Rev. 0). The nitrate and Tc-99 plumes are associated with C Tank and Waste Farms EU sources (DOE/RL-2014-32, Rev. 0); however, the contributions are likely minor (Section 8.5). The final record of decision for the 200-BP-5 OU is scheduled for 2016.

See Appendix G.5 for the CP-GW-1 EU for additional details.

Operating Facilities: Because of the prohibition on waste additions to the Hanford SSTs,[120] the C Tank and Waste Farms EU components are not considered Operating Facilities for this review. See Section 1.4 (Appendix E.1) for details.

D&D of Inactive Facilities: Not Applicable.

Location and Layout Maps

A series of maps are used to illustrate the location of the components within the CP-TF-5 EU and the C Tank and Waste Farms EU relative to the Hanford Site. Figure E.2-1 shows the relationship between the 200-E (200 East) Area (where the C Tank Farm and Waste Management Area C are located) and the Hanford Site. Figure E.8-1 illustrates the C Tank and Waste Farms EU boundary. Figure E.8-2 shows a detailed view of the waste tanks, ancillary equipment, and legacy source units in the C Tank and Waste Farms EU.

[120] Berman presentation on July 29, 2009, titled "Hanford Single-Shell Tank Integrity Program." Available at www.em.doe.gov.

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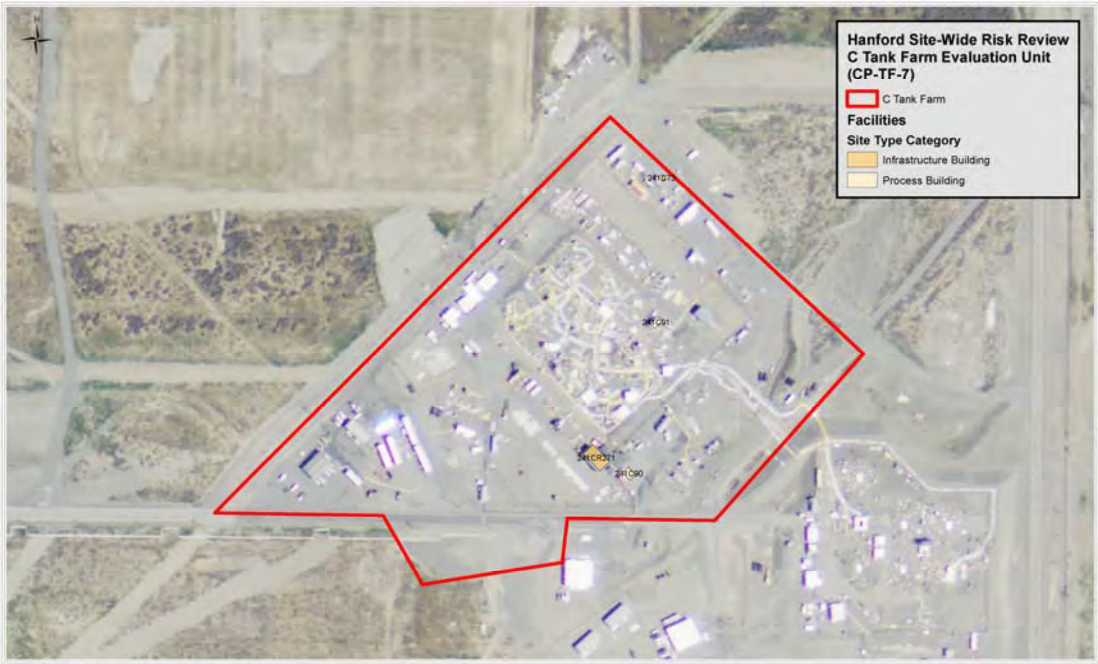

1 inch = 250 feet

Figure E.8-1. Polygon representing the boundary of the C Tank and Waste Farms Evaluation Unit (Attachment Section 8.8).

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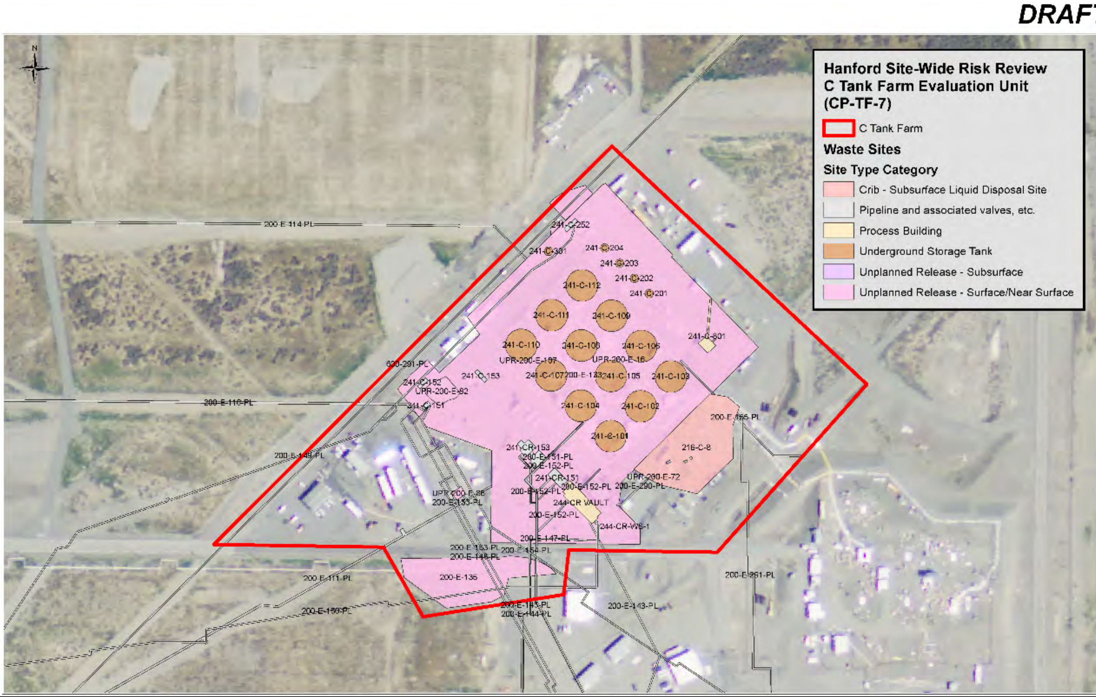

1 inch = 250 feet

Figure E.8-2. Hanford C Tank and Waste Farms Evaluation Unit including tanks, legacy source units, and ancillary equipment (Attachment Section 8.8).

8.4. UNIT DESCRIPTION AND HISTORY

EU Former / Current Uses

Waste Management Area C (WMA C) occupies approximately 8.5 acres (estimated using http://phoenix.pnnl.gov/) with 16 underground single-shell tanks (SSTs) in additional to ancillary equipment (e.g., diversion boxes, pumps, valves, and pipes). The tanks contain primarily 1st cycle decontamination from bismuth phosphate process, aluminum cladding Purex wastes, metal waste from bismuth phosphate process, and ferrocyanide sludge (Remund et al. 1995).

The C Tank Farm was constructed in 1943-44 (Horton & Narbutovskih 2001, p. 2.2) and includes 12 530 kgal underground waste storage tanks (C-101 through C-112) and four smaller 55 kgal tanks (C-201 through C-204). The C Tank Farm tanks were designed for non-boiling wastes. The C Tank Farm tanks were taken out of service between 1970 and 1980 (Horton & Narbutovskih 2001). The SSTs in WMA C were previously interim stabilized (i.e., liquid transferred to DSTs to <50 kgal drainable interstitial liquid and <5 kgal of supernatant). Tank waste retrieval is in progress in the C Tank Farm (Weyns 2014):

- Retrieval has been completed in nine of the C Tank Farm tanks (C-103, C-104, C-106, C-110, C-112, and C-201 through C-204).
- Retrieval has been completed to various limits of technology in four tanks (C-101, C-107, C-108, and C-109).
- Retrieval is in progress in the remaining tanks (C-102, C-105, C-111).

Legacy Source Sites

Six of the 16 tanks in the C Tank Farm are classified as “assumed leakers” (Weyns 2014). Total leaks from these tanks are estimated at 29,250 gallons and range from 350 gallons (C-204 in 1988) to 20,000 gallons (C-101 in 1980).

Various non-tank sources received large volumes of contaminated waste and other waste streams that has resulted in vadose zone and groundwater contamination in the areas around the WMA C including fourteen documented unplanned releases including surface spills and leaks from transfer lines, diversion boxes, catch tanks, and vaults (Horton & Narbutovskih 2001). The final action record of decision for 200-BP-5 OU is scheduled for 2016 (DOE/RL-2014-32, Rev. 0).

High-Level Waste Tanks

See Section 8.3 for details.

Groundwater Plumes

The groundwater plumes (Tc-99 and nitrate) considered to be associated with the C Tank Farm and co-located liquid waste disposal facilities are described in detail in Section 8.5 with additional information in the Appendix G.5 for the CP-GW-1 EU (200-BP-5 GW OU).

D&D of Inactive Facilities – Not Applicable

Operating Facilities – Not Applicable

Because of the prohibition on waste additions to the Hanford SSTs,[121] the C Tank and Waste Farms EU components are not considered Operating Facilities for this Review.

Ecological Resources Setting

Landscape Evaluation and Resource Classification:

The EU for C Tank Farm consists of level 0 habitat except for a very small area (0.1 acre) of level 2 habitat. The amount and proximity of biological resources to the C Tank and Waste Farms EU was examined within the adjacent landscape buffer area radiating 483 m from the geometric center of the EU (equivalent to 181 acres). No level 3 or greater habitat occurs within the EU. If remediation actions result in the loss of level 2 habitat within the EU, this change would only represent a 0.1% difference in available level 2 habitat resources at the landscape level. A little more than 15% of the combined total area (EU plus adjacent landscape buffer area) consists of level 3 or greater habitats. Some of the level 3 resources in the combined total area are individual occurrences of sensitive plant species (likely Piper's daisy, *Erigeron piperianus*).

Field Survey:

Visual survey and vehicle reconnaissance of the C Tank and Waste Farms EU confirmed that the area is primarily level 0 habitat (Appendix J, Figure 17, p. J-138) with disturbed and graveled surfaces as shown in (Appendix J, Figure 18, p. J-139). Because the site is primarily industrial, no field measurements of vegetation were recorded. No wildlife were observed within the EU during the October survey. Previous ECAP surveys in 2010 noted the presence of mountain cottontail (*Sylvilagus nuttallii*) in the area.

Cultural Resources Setting

Cultural resources known to be located within the C Tank and Waste Farms EU are limited to the 271-CR Service and Office Building a contributing property within the Manhattan Project/Cold War Era Landscape with no documentation required. All documentation has been addressed as described in the *Hanford Site Manhattan Project and Cold War Era Historic District Treatment Plan* (DOE/RL-97-56). There are no known archaeological sites, or TCPs known to be recorded within the C Tank and Waste Farms EU. None of the C Tank and Waste Farms EU has been inventoried for archaeological resources. Closure and remediation of the tank farms located within the C Tank and Waste Farms EU has been addressed in an NHPA Section 106 review. Given the extensive ground disturbance within the C Tank and Waste Farms EU, it is unlikely but there is a possibility that intact archaeological material is present in the C Tank and Waste Farms EU because it has not have not been inventoried for archaeological resources (both on the surface and in the subsurface) and particularly if undisturbed soil deposits exist within the C Tank and Waste Farms EU.

Two National Register-eligible properties associated with the Manhattan Project/Cold War Era Landscape with documentation required (Hanford Site Plant Railroad and the 2707AR Sludge Vault Change House) are located within 500 meters of the C Tank and Waste Farms EU. Both have been documented as described in the *Hanford Site Manhattan Project and Cold War Era Historic District Treatment Plan* (DOE/RL-97-56). Additionally one isolated find associated with the Native American

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[121] Berman presentation on July 29, 2009, titled "Hanford Single-Shell Tank Integrity Program." Available at www.em.doe.gov.

Precontact and Ethnographic Landscape has been located within 500 meters of the C Tank and Waste Farms EU. This isolated find is not considered to be eligible for the National Register of Historic Places.

Historic maps indicate that there is no evidence of historic settlement in or near the C Tank and Waste Farms EU. Geomorphology and extensive ground disturbance further indicates a low potential for the presence of intact archaeological resources associated with all three landscapes to be present subsurface within the C Tank and Waste Farms EU. Because none of the C Tank and Waste Farms EU has been investigated for archaeological sites and it is possible but unlikely that pockets of undisturbed soil exist, it may be appropriate to conduct surface and subsurface archaeological investigations in these areas prior to initiating a remediation activity. 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 associated with these landscapes (e.g. East Benton Historical Society, the Franklin County Historical Society, Prosser Cemetery Association, the Reach, and B-Reactor Museum Association) may need to occur. Indirect effects are always possible when TCPs are known to be located in the general vicinity. Consultation with Hanford Tribes may also 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.

8.5. WASTE AND CONTAMINATION INVENTORY

Table E.8-2 provides inventory estimates of the various source components associated with the C Tank and Waste Farms EU including tank wastes and ancillary equipment, legacy sources including leaks, cribs, trenches, unplanned releases (UPRs), vadose zone sources, saturated zone (plume) estimates, treatment amounts, and remaining vadose zone estimates (i.e., the difference of the vadose zone estimates and the saturated zone and treatment estimates)[122]. This information is further summarized in Figure E.8-3 through Figure E.8-11 before and after planned 99% retrieval[123].

For example, the major sources for Tc-99 in the EU before retrieval are the C Tank Farm tanks, past leaks, unplanned releases, and ancillary equipment where past leaks, unplanned releases, and ancillary equipment dominate post-retrieval inventories. The major sources for I-129 before retrieval are the C Tank Farm tanks, unplanned releases, and ancillary equipment where unplanned releases and ancillary equipment dominate post-retrieval inventories. The maximum groundwater threat metric (GTM) (Figure E.8-12)[124] is dominated by the C Tank Farm wastes before retrieval and by unplanned releases, leaks, and ancillary equipment after planned retrieval. The tritium inventory is dominated by unplanned releases after planned retrieval is complete. The nitrate, chromium, and Cs-137 vadose zone inventories are dominated by ancillary equipment, unplanned releases, and leaks. Post-retrieval vadose zone sources for uranium, Sr-90, and plutonium isotopes are largely from ancillary equipment.

[122] The basis for the saturated and vadose zone estimates are provided in Chapter 6 of the Methodology Report (CRESP 2015) and examples are provided in the demonstration section for the 200-UP-1 Operable Unit. These estimates tend to have very high associated uncertainties.

[123] According to the Tri-Party Agreement (Ecology, EPA, and DOE, 1998), retrieval limits for residual wastes are 360 ft^3 and 30 ft^3 for 100-Series and 200-Series tanks, respectively, corresponding to the 99% waste retrieval goal as defined in TPA Milestone M-45-00.

[124] Maximum of the GTMs for Tc-99 and I-129 only.

CONTAMINATION WITHIN PRIMARY EU SOURCE COMPONENTS

Legacy Source Sites

The estimated C Tank Farm inventory for the Legacy / Vadose Zone Source Sites (i.e., cribs, trenches, and soil contaminated by tank leaks and unplanned releases) is summarized in Table E.8-2 and further described in Figure E.8-3 through Figure E.8-11 before and after planned 99% retrieval (which will have no impact on the legacy source site inventories). These values constitute estimates of the initial amounts of contaminants discharged to the vadose zone that are then used to estimate the remaining inventory in the vadose zone as described below (i.e., by difference using the process described in Chapter 6 of the Methodology Report (CRESP 2015)). These estimates necessarily have large associated uncertainties.

Waste Tanks and Ancillary Equipment

The estimated total inventory for all the C Tank Farm Waste Tanks and Ancillary Equipment is provided in Table E.8-2 for both the 90% and planned 99% retrieval scenarios. The tank-by-tank inventories are provided in Table E.7-3 through Table E.7-6. Safety-related information (i.e., hydrogen generation rates and times to the lower flammability limit are also provided. The inventories for the various contaminant in the B-BX-BY Tank Farm tanks vary over several orders of magnitude as does the GTM. This information is further summarized in Figure E.8-3 through Figure E.8-11 before and after planned 99% retrieval and for the maximum GTM in Figure E.8-12.

Vadose Zone Contamination

The estimated inventories for the vadose zone, saturated zone, and treatment amounts are found in Table E.8-2. These inventories represent the vadose zone contamination *outside* the tanks and ancillary equipment (i.e., that generally available for transport through the environment). These are used to estimate the inventory remaining in the vadose zone using the process described in Chapter 6 of the Methodology Report. The focus in this section will be on the Group A and B contaminants in the vadose zone due to their mobility and persistence and potential threats to groundwater. To summarize:

- *Tc-99* – There is a current plume for Tc-99 that is associated with C Tank and Waste Farms EU sources (DOE/RL-2014-32, Rev. 0). The vadose zone inventory is dominated by past leaks, unplanned releases, and ancillary equipment.
- *I-129* – There is a current plume for I-129 that is not associated with C Tank and Waste Farms EU sources. The vadose zone inventory is dominated by unplanned releases and ancillary equipment.
- *Sr-90, uranium* – There are current plumes for Sr-90 and uranium that are not associated with C Tank and Waste Farms EU sources. The vadose zone inventory is dominated by ancillary equipment. Based on analyses similar to those in Section 6.5 (using the A Barrier[125]), the Sr-90 and uranium are not considered likely to reach the groundwater in sufficient quantities to impact this resource in the next 150 years. For Sr-90, the times required for the remaining vadose zone inventory to decay to values that would result in *Medium* and *Low* ratings are 60 and 150 years, respectively. Thus the Sr-90 rating for the Near-term Post-Cleanup period would be *Medium* (with no change to the Active period rating); however, transport considerations

[125] The 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). The A Barrier is the closest to the C Tank and Waste Farms EU. Despite including sources other than those for the C Tank and Waste Farms EU, the analysis in the TC&WM EIS was considered reasonable to assess the travel time of these constituents in the subsurface.

indicate that the Sr-90 would not likely impact groundwater in the future. Thus uranium and Sr-90 are not considered significant threats to the Hanford groundwater.

- *Chromium* – There is not a current plume for chromium. The vadose zone inventory is dominated by ancillary equipment, unplanned releases, and leaks.

Using the process outlined in Chapter 6 of the Methodology Report (CRESP 2015), the vadose zone inventories in Table E.8-2 are estimated and used to calculate Groundwater Threat Metric (GTM) values for the Group A and B contaminants remaining in the vadose zone as illustrated in Table E.8-7. Note that the vadose zone (VZ) ratings range from ND for uranium and Sr-90[126] to *Low* for Tc-99 and chromium (total and hexavalent) to *Medium* for I-129.

Groundwater Plumes

In general groundwater plumes are evaluated in separate EUs; however, those portions of groundwater plumes that can be associated with the TF EU (i.e., a plume with sources associated with the TF EU) will be evaluated to provide a better idea of the saturated zone versus remaining vadose zone threats to groundwater. The estimated inventory for the saturated zone contamination is provided in Table E.8-2 where Photoshop was used to estimate the fraction of the plumes considered associated with the C Tank and Waste Farms EU (Attachment 6-4 in the Methodology Report (CRESP 2015)[127]). This information is also used to estimate amounts treated and remaining in the vadose zone. For the groundwater plumes described in the 200-BP-5 OU (DOE/RL-2014-32, Rev. 0), apportionment of plumes and ratings to the C Tank and Waste Farms EU is as follows:

- *Nitrate* – There are plumes in the OU; the single small plume near the C Tank and Waste Farms EU is considered associated with the EU, and the area of this plume is less than 1% of the area of the plumes (CRESP 2015).
- *I-129* – There are plumes in the OU; however, there are no major I-129 sources were identified related to the C Tank and Waste Farms EU (DOE/RL-2014-32, Rev. 0). Thus the contribution is considered insignificant.
- *Tc-99* – There are plumes in the OU; the plume near the C Tank and Waste Farms EU is considered associated with the EU, and the area of this plume is 5% of the area of the plumes (CRESP 2015).
- *Uranium* – There are plumes in the OU; however, there are no sources related to the C Tank and Waste Farms EU, and thus the plume is considered insignificant.
- *Sr*-90 – There are plumes in the OU; however, there are no major Sr-90 sources identified related to the C Tank and Waste Farms EU (DOE/RL-2014-32, Rev. 0). Thus the contribution is considered insignificant.

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[126] The remaining vadose zone inventories for uranium and Sr-90 would translate to *Low* and *Medium* ratings, respectively. However, no appreciable Sr-90 or uranium plume from C TF EU sources would be expected in the next 150 years due to transport considerations; however, uranium may impact groundwater after the 150-year period. Thus *Low* ratings are applied to the period after Active Cleanup is completed to account for uncertainties.
[127] From the graphic map files provided by PNNL, the PhotoShop Magic Wand Tool was used to select areas representing plumes and then the "Record Measurements" Tool was used to provide areal extents. A Custom Measurement Scale was set to that of the map.

- *H-3* – There are plumes in the OU; however, there are no major H-3 sources identified related to the C Tank and Waste Farms EU (DOE/RL-2014-32, Rev. 0). Thus the contribution is considered insignificant.
- *Cyanide* – There are plumes in the OU; however, there are no major cyanide sources identified related to the C Tank and Waste Farms EU (DOE/RL-2014-32, Rev. 0). Thus the contribution is considered insignificant.

The groundwater plumes (e.g., nitrate and Tc-99) associated with the C Tank Farm and co-located liquid waste disposal facilities are also described in detail in the Appendix G.5 for the CP-GW-1 EU (200-BP-5 GW OU). Note that I-129, Tc-99, and Sr-90 (*High*) and nitrate, uranium, and tritium (*Medium*) are the risk drivers for the 200-BP-5 GW OU. However, the nitrate and Tc-99 plumes associated with the B-BX-BY TF EU are relatively small (less than 5% of the total plume areas for each); therefore, the risk associated with this TF EU is driven largely by vadose zone sources (Table E.8-7).

<u>Impact of Recharge Rate and Radioactive Decay on Groundwater Ratings</u>
The TC&WM EIS screening groundwater transport analysis (Appendix O, DOE/EIS-0391 2012) can be used to gauge the possible impact of emplacing the engineered surface barrier (and resulting reduction of infiltrating water) on the predicted peak groundwater concentrations. Since an analysis is not provided for the C Barrier, that for the A Barrier (Section 6.5)[128], which is proximate to the C Tank and Waste Farms EU is used here. Despite the large impacts on the predicted peak concentrations, the peak values for I-129 and hexavalent chromium may exceed thresholds at the A Barrier within 150-200 years (including sources other than those from the C Tank and Waste Farms EU) and thus ratings will not be modified even though the impacts may be large. The peak predicted concentration for Tc-99 does not exceed the threshold during the TC&WM EIS evaluation period (10,000 years); thus the Tc-99 saturated zone rating for the Near-term, Post-Cleanup period is considered *Not Discernible*.

Based on the TC&WM EIS screening results, it is assumed that uranium would not reach groundwater in sufficient quantity to exceed the standard during the Active Cleanup and Near-term Post-Cleanup periods. Thus the uranium is evaluation would result in *Not Discernible* ratings for the Active Cleanup period but would be *Low* for the Near-term Post-Cleanup period to address uncertainty.

For Sr-90, the times required for the remaining vadose zone inventory to decay to values that would result in *Medium* and *Low* ratings are 60 and 150 years, respectively. Thus the Sr-90 ratings for the Active Cleanup and Near-term Post-Cleanup periods would be *High* and *Medium*, respectively, based on decay considerations. However, transport considerations based on the TC&WM EIS screening evaluations indicate that Sr-90 is unlikely to impact groundwater in the future, which leads to a *Not Discernible* rating for the Active Cleanup period and a Low rating for the Near-term Post-Cleanup period to again address uncertainty.

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

[128] The 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). The A Barrier is the closest to the C Tank and Waste Farms EU. Despite including sources other than those for the C Tank and Waste Farms EU, the analysis in the TC&WM EIS was considered a reasonable source of information to assess the impact of the engineered surface barrier emplacement.

impact area is used to define ratings. Thus a common evaluation for the benthic and riparian zone is performed here.

Benthic and Riparian Zone – Current Impacts
Based on the information in the 2013 Hanford Annual Groundwater Report (DOE/RL-2014-32, Rev. 0) and PHOENIX (http://phoenix.pnnl.gov/), no plume from the 200-BP-5 OU currently intersects the Columbia River at concentrations exceeding the appropriate water quality standard (WQS). Thus current impacts from the C Tank and Waste Farms EU to the Columbia River benthic and riparian ecology would be rated as *Not Discernible*.

Benthic and Riparian Zone – Active Cleanup and Near-term, Post Cleanup for Current Plumes
Because 200-BP-5 OU plumes (nitrate and Tc-99) associated with the C Tank and Waste Farms EU originate from 200-East, it is possible that a current plume might reach the Columbia River in the next 150 years since the *water* travel time is ~10-30 years from 200-East to the Columbia River (Gephart 2003; PNNL-6415 Rev. 18). Based on a similar analysis described for the A-AX Tank and Waste Farms EU (Section 6.5), a *Not Discernible* rating is obtained for Tc-99 for the Near-term, Post-Cleanup impacts on the Columbia River[129]. For nitrate, a *Not Discernible* rating is obtained for the Active Cleanup and Near-term, Post-Cleanup periods.

Benthic Ecology – Active Cleanup and Near-term, Post Cleanup for Vadose Zone Contaminants
Following the analysis outlined in Section 6.5 for the A-AX Tank and Waste Farms EU, the vadose zone contaminants (where hexavalent chromium is the possible risk driver) would translate to a (benthic) rating of *Not Discernible* during the Active Cleanup and Near-term, Post-Cleanup periods.

Using the TC&WM EIS screening results would lead to Medium (benthic) and High (riparian) ratings for chromium (and Not Discernible for the others); however, because well measurements indicate that chromium is moving toward the Columbia River much more slowly than assumed in the TC&WM EIS, the plumes are not likely going to reach the Columbia River within the Evaluation periods leading to *Not Discernible* ratings.

Benthic and Riparian Zone – Long-term
Following the analysis outlined in Section 6.5, there should be no expected adverse effects from radionuclides during the TC&WM EIS evaluation period (10,000 years). Similarly, nitrate from the C Tank and Waste Farms EU would pose little additional long-term risk to the Columbia River benthic or riparian ecology. The screening results for chromium (assumed hexavalent) would translate to some additional risk to benthic and riparian receptors (i.e., exceeds the screening threshold) although sources other than the C Tank and Waste Farms EU are included in the evaluation. As indicated in Section 6.5, this is consistent with the evaluation provided in the TC&WM EIS (DOE/EIS-0391 2012, Chapter 2, p. 2-235 & 2-237).

Potential Impact of Recharge Rate on Threats to the Columbia River
Similar to the evaluation in Section 6.5, the alternatives analysis in the TC&WM EIS would suggest that benthic and riparian zone ratings associated with the C Tank and Waste Farms EU would not change based on surface barrier installation and changes in recharge rates. This is not due to an ineffective barrier but instead likely due to the large amounts of the contaminants already in the subsurface and possible impact from sources outside the C Tank and Waste Farms EU.

[129] Sr-90 and uranium have current plumes but neither is neither associated with the C TF EU nor expected to reach the Columbia River in the next 10,000 years (DOE/EIS-0391 2012). The cyanide plume, which is also not associated with the C TF EU, is evaluated in Appendix G.5 for the CP-GW-1 EU.

Threats to the Columbia River Free-flowing Ecology

As described in Section 2.5, 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.

Facilities for D&D – Not Applicable

Operating Facilities – Not Applicable

Because of the prohibition on waste additions to the Hanford SSTs,[130] the C Tank and Waste Farms EU components are not considered Operating Facilities for this Review.

[130] Berman presentation on July 29, 2009, titled "Hanford Single-Shell Tank Integrity Program." Available at www.em.doe.gov.

Table E.8-2. Summary Table of Infrastructure and Subsurface Contamination Inventory for the C Tank and Waste Farms Evaluation Unit (CP-TF-7) [(a)(b)]

Contaminated Media	Primary Contaminants	Total Amount. of Each Contaminant Before Retrieval	90% Retrieval Scenario	99% Retrieval Scenario
Infrastructure (Tanks and Ancillary Equipment)				
Tank Waste	Waste (kGal)	540	54	5.4
	Sludge (kGal)	524	52.4	5.24
	Saltcake (kGal)	2	0.2	0.02
	Supernatant (kGal)	14	1.4	0.14
Tank Waste (rad)	Am-241 (Ci)	2300	230	23
	C-14 (Ci)	2.8	0.28	0.028
	Co-60 (Ci)	100	10	1
	Cs-137 (Ci)	160000	16000	1600
	Eu-152 (Ci)	3.9	0.39	0.039
	Eu-154 (Ci)	110	11	1.1
	H-3 (Ci)	120	12	1.2
	I-129 (Ci)	0.44	0.044	0.0044
	Ni-59 (Ci)	27	2.7	0.27
	Ni-63 (Ci)	1600	160	16
	Pu (total) (Ci)	11000	1100	110
	Sr-90 (Ci)	1100000	110000	11000
	Tc-99 (Ci)	100	10	1
	U (total) (Ci)	140	14	1.4
Tank Waste (non-rad)	Cr (kg)	1300	130	13
	Hg (kg)	73	7.3	0.73
	NO3 (kg)	120000	12000	1200
	Pb (kg)	3800	380	38
	U (total) (kg)	33000	3300	330
Ancillary Equipment (rad)	C-14 (Ci)	0.22	0.22	0.22
	Cs-137 (Ci)	14000	14000	14000
	H-3 (Ci)	1.6	1.6	1.6
	I-129 (Ci)	0.014	0.014	0.014

Contaminated Media	Primary Contaminants	Total Amount. of Each Contaminant Before Retrieval	90% Retrieval Scenario	99% Retrieval Scenario
	Pu (total) (Ci)	300	300	300
	Sr-90 (Ci)	130000	130000	130000
	Tc-99 (Ci)	5	5	5
	U (total) (Ci)	7	7	7
Ancillary Equipment (non-rad)	Cr (kg)	79	79	79
	Hg (kg)	5.5	5.5	5.5
	NO3 (kg)	9300	9300	9300
	Pb (kg)	330	330	330
	U (total) (kg)	1600	1600	1600
Vadose Zone Source (Leaks and Intentional Discharges into Cribs and Trenches)				
Leaks (rad)	C-14 (Ci)	0.15	0.15	0.15
	Cs-137 (Ci)	18000	18000	18000
	H-3 (Ci)	1.2	1.2	1.2
	I-129 (Ci)	0.0026	0.0026	0.0026
	Pu (total) (Ci)	0.59	0.59	0.59
	Sr-90 (Ci)	260	260	260
	Tc-99 (Ci)	6.6	6.6	6.6
	U (total) (Ci)	0.0054	0.0054	0.0054
Leaks (non-rad)	Cr (kg)	42	42	42
	Hg (kg)	0.021	0.021	0.021
	NO3 (kg)	4800	4800	4800
	Pb (kg)	6.9	6.9	6.9
	U (total) (kg)	2.9	2.9	2.9
Cribs (rad)	Cs-137 (Ci)	3.00E-05	3.00E-05	3.00E-05
	Pu (total) (Ci)	1.60E-06	1.60E-06	1.60E-06
	Sr-90 (Ci)	0.00025	0.00025	0.00025
	U (total) (Ci)	2.60E-09	2.60E-09	2.60E-09
Cribs (non-rad)	Hg (kg)	8.50E-05	8.50E-05	8.50E-05
	NO3 (kg)	0.0091	0.0091	0.0091
	Pb (kg)	0.00015	0.00015	0.00015
	U (total) (kg)	3.70E-06	3.70E-06	3.70E-06
UPR (rad)	Am-241 (Ci)	1.3	1.3	1.3

Contaminated Media	Primary Contaminants	Total Amount. of Each Contaminant Before Retrieval	90% Retrieval Scenario	99% Retrieval Scenario
	C-14 (Ci)	0.31	0.31	0.31
	Co-60 (Ci)	4.3	4.3	4.3
	Cs-137 (Ci)	20000	20000	20000
	Eu-152 (Ci)	0.083	0.083	0.083
	Eu-154 (Ci)	6.4	6.4	6.4
	H-3 (Ci)	24	24	24
	I-129 (Ci)	0.027	0.027	0.027
	Ni-59 (Ci)	1.1	1.1	1.1
	Ni-63 (Ci)	110	110	110
	Pu (total) (Ci)	3.1	3.1	3.1
	Sr-90 (Ci)	270	270	270
	Tc-99 (Ci)	6.4	6.4	6.4
	U (total) (Ci)	0.017	0.017	0.017
UPR (non-rad)	Cr (kg)	98	98	98
	Hg (kg)	0.025	0.025	0.025
	NO3 (kg)	7800	7800	7800
	Pb (kg)	25	25	25
	U (total) (kg)	6.6	6.6	6.6
Vadose Zone (from Vadose Zone Sources)				
VZ Remaining (rad)	Am-241 (Ci)	1.3	1.3	1.3
	C-14 (Ci)	0.46	0.46	0.46
	Co-60 (Ci)	4.3	4.3	4.3
	Cs-137 (Ci)	38000	38000	38000
	Eu-152 (Ci)	0.083	0.083	0.083
	Eu-154 (Ci)	6.4	6.4	6.4
	H-3 (Ci)	25	25	25
	I-129 (Ci)	0.03	0.03	0.03
	Ni-59 (Ci)	1.1	1.1	1.1
	Ni-63 (Ci)	110	110	110
	Pu (total) (Ci)	3.7	3.7	3.7
	Sr-90 (Ci)	530	530	530
	Tc-99 (Ci)	8.4	8.4	8.4

Contaminated Media	Primary Contaminants	Total Amount. of Each Contaminant Before Retrieval	90% Retrieval Scenario	99% Retrieval Scenario
	U (total) (Ci)	0.022	0.022	0.022
VZ Remaining (non-rad)	CN (kg)	0[(c)]	0[(c)]	0[(c)]
	Cr (kg)	140[(d)]	140[(d)]	140[(d)]
	Cr-VI (kg)	140[(d)]	140[(d)]	140[(d)]
	Hg (kg)	0.046	0.046	0.046
	NO3 (kg)	0[(c)]	0[(c)]	0[(c)]
	Pb (kg)	31	31	31
	U (total) (kg)	9.5	9.5	9.5
VZ Treatment (rad)	Tc-99 (Ci)	0.00065	0.00065	0.00065
VZ Treatment (non-rad)	NO3 (kg)	0.95	0.95	0.95
Saturated Zone (from Vadose Zone Sources)				
SZ Inventory (rad)	Tc-99 (Ci)	4.6	4.6	4.6
SZ Inventory (non-rad)	CN (kg)	1300	1300	1300
	NO3 (kg)	49000	49000	49000

a. Tanks (SST and DST): Best Basis Inventory (BBI) March 2014; Ancillary Equipment (Anc Eq): Tank Farm Closure & Waste Management (TC&WM) Environmental Impact Statement (DOE/EIS-0391) Appendix D; Unplanned Releases (UPRs): Soil Inventory Model (SIM) Rev 1 (RPP-26744, Rev 0); Ponds: Soil Inventory Model (SIM) Rev 1 (RPP-26744, Rev 0); Cribs: Soil Inventory Model (SIM) Rev 1 (RPP-26744, Rev 0); Trenches: Soil Inventory Model (SIM) Rev 1 (RPP-26744, Rev 0) and Tank Farm Closure & Waste Management (TC&WM) Environmental Impact Statement (DOE/EIS-0391) Appendix S; Leaks: Tank Farm Closure & Waste Management (TC&WM) Environmental Impact Statement (DOE/EIS-0391) Appendix D; MUSTs: Soil Inventory Model (SIM) Rev 1 (RPP-26744, Rev 0) and Tank Farm Closure & Waste Management (TC&WM) Environmental Impact Statement (DOE/EIS-0391) Appendix S.

b. All primary contaminant inventories are reported to 2 significant figures. The source document should be consulted for greater precision data.

c. Small negative value obtained by difference.

d. Differences in inventories for Cr vs Cr-IV are due to differing Water Quality Standards (WQS) and thus plume extents: 100 mg/L for total chromium vs 48 mg/L for chromium (IV). The difference may not be distinguishable within the number of significant digits (2) displayed.

Table E.8-3. Current Bulk Inventory and Steady State Flammability Results (by Tank) for the C Tank Farm (CP-TF-7)

Tank ID	Tank Type	Capacity (kGal)[a]	Sludge (kGal)[a]	Saltcake (kGal)[a]	Supernatant (kGal)[a]	HGR(c) (ft3/d)[b]	Days to 25% LFL Barometric[c]	Days to 25% LFL Zero Ventilation[d]
C-101	SST	530	4	0	1	0.32	NA	>1826
C-102	SST	530	316	0	3	0.76	NA	856
C-103	SST	530	2	0	0	0.8	NA	1341
C-104	SST	530	1	0	1	0.31	NA	>1826
C-105	SST	530	132	0	8	1	NA	895
C-106	SST	530	3	0	0	1.3	NA	764
C-107	SST	530	16	0	0	1	NA	924
C-108	SST	530	3	0	0	0.78	NA	1370
C-109	SST	530	2	0	0	0.31	NA	>1826
C-110	SST	530	0	2	0	0.31	NA	>1826
C-111	SST	530	32	0	1	1	NA	921
C-112	SST	530	13	0	0	0.64	NA	1579
C-201	SST	55	0	0	0	0.063	NA	1155
C-202	SST	55	0	0	0	0.064	NA	1136
C-203	SST	55	0	0	0	0.061	NA	1182
C-204	SST	55	0	0	0	0.061	NA	1195

a. Volumes from the Waste Tank Summary Report coinciding with the BBI (Rodgers 2014).

b. Hydrogen generation rate (ft^3/d) (RPP-5926 Rev. 15). Note in 2001 all 24 tanks were removed from the flammable gas watch list (including T-110 in the T Tank and Waste Farms EU) (Johnson, et al. 2001, p. iii).

c. Time (in days) to 25% of the Lower Flammability Limit (LFL) under a barometric (barom) breathing scenario (RPP-5926, Rev. 15). "NA" indicates that the headspace will not reach specified flammability level.

d. Time (in days) to 25% of the LFL under a zero ventilation scenario (RPP-5926, Rev. 15).

Table E.8-4. Current Primary Contaminant Inventory (by Tank) for the C Tank Farm (CP-TF-7) [(a)]

Tank ID	Decay Date	Am-241 (Ci)	C-14 (Ci)	Cl-36 (Ci)	Co-60 (Ci)	Cs-137 (Ci)	Eu-152 (Ci)	Eu-154 (Ci)	H-3 (Ci)
C-101	2001	10	0.0028	NP[(b)]	0.00086	480	0.00012	0.0073	0.048
C-102	2001	1100	1.4	NP	56	24000	0.012	19	29
C-103	2001	4.9	0.007	NP	0.089	800	0.000048	3.7	0.0078
C-104	2001	4.9	0.0018	NP	1.3	470	0.037	2.4	0.01
C-105	2001	300	0.51	NP	34	70000	0.0022	0.13	83
C-106	2001	65	0.0082	NP	11	1300	3.7	59	0.0082
C-107	2001	700	0.04	NP	0.0084	5700	0.0005	0.028	0.053
C-108	2001	0.78	0.0067	NP	0.0029	92	0.00016	0.0097	0.031
C-109	2001	0.32	0.00066	NP	0.0021	49	0.00012	0.0071	0.0059
C-110	2001	0.022	0.005	NP	0.00074	33	0.000042	0.0025	0.0069
C-111	2001	85	0.1	NP	0.5	9400	0.099	6.3	5.1
C-112	2001	85	0.66	NP	0.31	44000	0.018	22	0.89
C-201	2001	2.5	0.00077	NP	0.012	9.2	0.0039	0.25	0.00031
C-202	2001	1.2	0.0002	NP	0.012	8.2	0.004	0.25	0.00032
C-203	2001	0.032	0.00017	NP	0.01	12	0.0032	0.04	0.00026
C-204	2001	0.0032	0.00019	NP	0.009	5.4	0.003	0.15	0.00022

a. From Best Basis Inventory (BBI) Summary (March 24, 2014) provided in spreadsheet form by Mark Triplett. All primary contaminant inventories are reported to 2 significant figures. The source document should be consulted for greater precision data.

b. NP = Not present at significant quantities

Table E.8-5. Current Primary Contaminant Inventory[a] and Groundwater Threat Metric (by Tank) for the C Tank Farm (CP-TF-7)

Tank ID	I-129 (Ci)	Ni-59 (Ci)	Ni-63 (Ci)	Pu (total) (Ci)[b]	Sr-90 (Ci)	Tc-99 (Ci)	U (total) (Ci)[c]	GTM (Mm3)[d]
C-101	0.000056	0.00072	0.06	23	4400	0.043	0.35	0.048
C-102	0.23	8.6	790	8900	25000	0.89	130	94
C-103	0.003	0.11	20	11	9100	0.045	0.037	1.2
C-104	0.00028	0.049	62	16	3700	0.17	1.8	0.19
C-105	0.093	4.6	410	990	400000	81	5.2	90
C-106	0.00063	11	71	56	60000	0.16	0.0043	0.26
C-107	0.076	0.0022	0.3	310	60000	4	0.8	31
C-108	0.000031	0.00076	2.5	0.72	1400	0.04	0.061	0.044
C-109	0.000023	0.00055	0.82	1.2	2700	0.0075	0.017	0.0092
C-110	0.00005	0.0002	0.027	0.59	340	0.058	0.0018	0.064
C-111	0.014	1.4	120	180	410000	2.2	1.6	5.7
C-112	0.02	1.5	130	37	98000	13	4.9	14
C-201	0.00000046	0.0041	0.9	35	230	0.0026	0.075	0.0029
C-202	0.0000074	0.0042	0.22	31	440	0.0025	0.07	0.003
C-203	0.000015	0.0034	0.06	1.1	210	0.0023	0.23	0.006
C-204	0.00000036	0.0032	0.016	0.022	140	0.0032	0.17	0.0035

a. From Best Basis Inventory (BBI) Summary (March 24, 2014) provided in spreadsheet form by Mark Triplett. All primary contaminant inventories are reported to 2 significant figures. The source document should be consulted for greater precision data.

b. Sum of plutonium isotopes 238, 239, 240, 241, and 242

c. Sum of uranium isotopes 232, 233, 234, 235, 236, and 238

d. The Groundwater Threat Metric (GTM) shown for tanks is equal to the maximum of the GTM for Tc-99 and I-129.

Table E.8-6. Current Primary Contaminant Inventory (by Tank) for the C Tank Farm (CP-TF-7) [(a)]

Tank ID	CCl4 (kg)	CN (kg)	Cr (kg)	Cr-VI (kg)	Hg (kg)	NO3 (kg)	Pb (kg)	TBP (kg)	TCE (kg)	U (total) (kg)
C-101	NP[(b)]	NP	7.2	NP	3	8200	21	NP	NP	520
C-102	NP	NP	640	NP	6	65000	1600	NP	NP	16000
C-103	NP	NP	2.4	NP	1.1	0.87	8.5	NP	NP	49
C-104	NP	NP	1.7	NP	0.77	5.3	3.7	NP	NP	750
C-105	NP	NP	390	NP	5.2	8100	360	NP	NP	7600
C-106	NP	NP	3.8	NP	1.9	35	26	NP	NP	2.7
C-107	NP	NP	100	NP	7	6700	680	NP	NP	1200
C-108	NP	NP	0.51	NP	0.017	7.5	14	NP	NP	98
C-109	NP	NP	0.15	NP	0.016	3.9	4.6	NP	NP	24
C-110	NP	NP	3.5	NP	0.006	99	3.3	NP	NP	2.6
C-111	NP	NP	73	NP	47	15000	770	NP	NP	2400
C-112	NP	NP	93	NP	0.52	17000	280	NP	NP	4500
C-201	NP	NP	12	NP	0.11	1.4	6.3	NP	NP	110
C-202	NP	NP	9.1	NP	0.29	1.3	5.8	NP	NP	99
C-203	NP	NP	2.6	NP	0.0022	3.8	3.1	NP	NP	330
C-204	NP	NP	1.4	NP	0.15	0.022	1	NP	NP	240

a. From Best Basis Inventory (BBI) Summary (March 24, 2014) provided in spreadsheet form by Mark Triplett. All primary contaminant inventories are reported to 2 significant figures. The source document should be consulted for greater precision data.

b. NP = Not present at significant quantities

Table E.8-7. Summary of the Evaluation of Threats to Groundwater as a Protected Resource from Remaining Vadose Zone (VZ) Contamination associated with the C Tank and Waste Farms Evaluation Unit (CP-TF-7)

PC	Group	WQS	Porosity[(a)]	K_d (mL/g)[(a)]	ρ (kg/L)[(a)]	VZ Source M^{Source}	SZ Total M^{SZ}	Treated[(c)] M^{Treat}	VZ Remaining $M^{Tot\ (d)}$	VZ GTM (Mm^3)	VZ Rating[(e)]
C-14	A	2000 pCi/L	0.25	0	1.82	4.61E-01 Ci	---	---	4.61E-01 Ci	2.30E-01	Low
I-129	A	1 pCi/L	0.25	0.2	1.82	2.99E-02 Ci	---	---	2.99E-02 Ci	1.22E+01	Medium
Sr-90	B	8 pCi/L	0.25	22	1.82	5.29E+02 Ci	---	---	5.29E+02 Ci	4.11E+02	ND[(f)]
Tc-99	A	900 pCi/L	0.25	0	1.82	1.30E+01 Ci	4.61E+00 Ci	6.54E-04 Ci	8.36E+00 Ci	9.29E+00	Low
CCl4	A	5 µg/L	0.25	0	1.82	---	---	---	---	---	ND
Cr	B	100 µg/L	0.25	0	1.82	1.40E+02 kg	---	---	1.40E+02 kg	1.40E+00	Low
Cr-VI	A	48 µg/L[(b)]	0.25	0	1.82	1.40E+02 kg	---	---	1.40E+02 kg	2.91E+00	Low
TCE	B	5 µg/L	0.25	2	1.82	---	---	---	---	---	ND
U(tot)	B	30 µg/L	0.25	0.8	1.82	9.52E+00 kg	---	---	9.52E+00 kg	4.65E-02	ND[(f)]

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

b. "Model Toxics Control Act−Cleanup" (WAC 173-340) Method B groundwater cleanup level for hexavalent chromium. Other WQS values represent drinking water standards.

c. Treatment amounts from the 2013 Hanford Annual Groundwater Report (DOE/RL-2014-32, Rev. 0).

d. The remaining vadose zone inventory is estimated by difference (CRESP 2015) and thus has a high associated uncertainty.

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

f. As discussed in Section 6.5, no appreciable uranium or Sr-90 plume would be expected in the next 150 years due to transport and decay (Sr-90) considerations. Thus the *Low* rating would apply to the period *after* the Active Cleanup is complete to account for uncertainties.

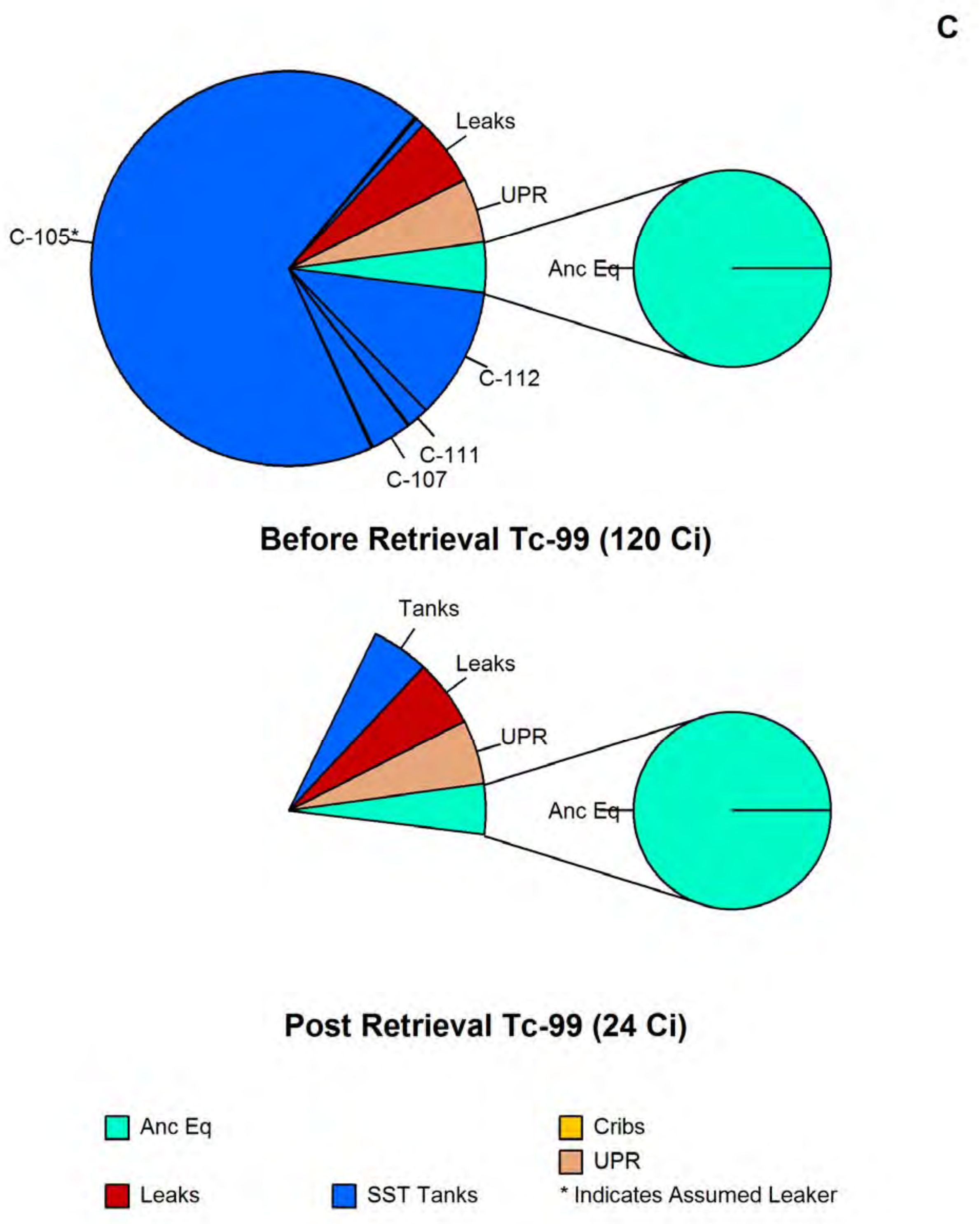


Figure E.8-3. C Tank and Waste Farms Evaluation Unit Inventory Estimates for Tc-99 Before and After 99% Retrieval

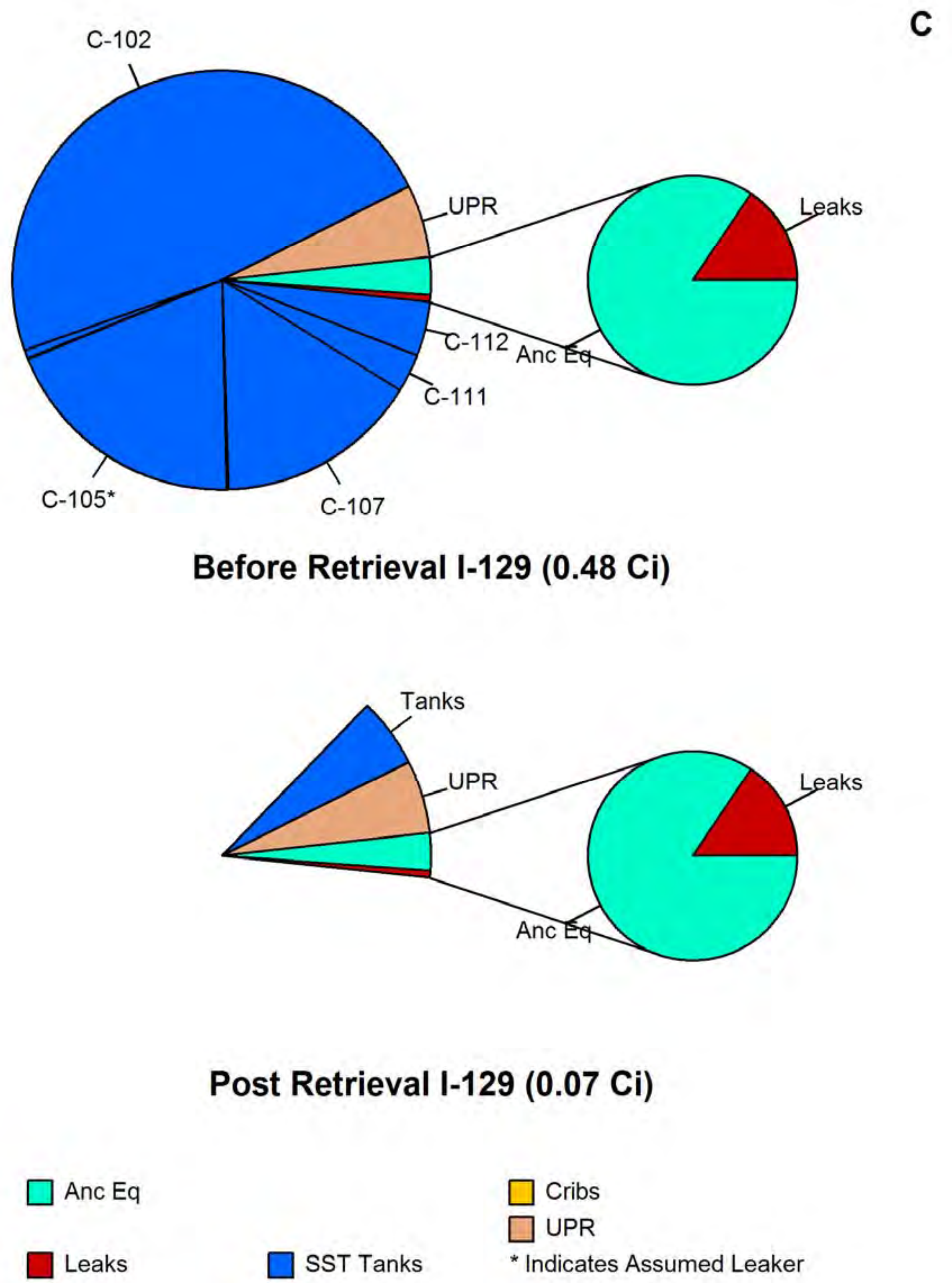


Figure E.8-4. C Tank and Waste Farms Evaluation Unit Inventory Estimates for I-129 Before and After 99% Retrieval

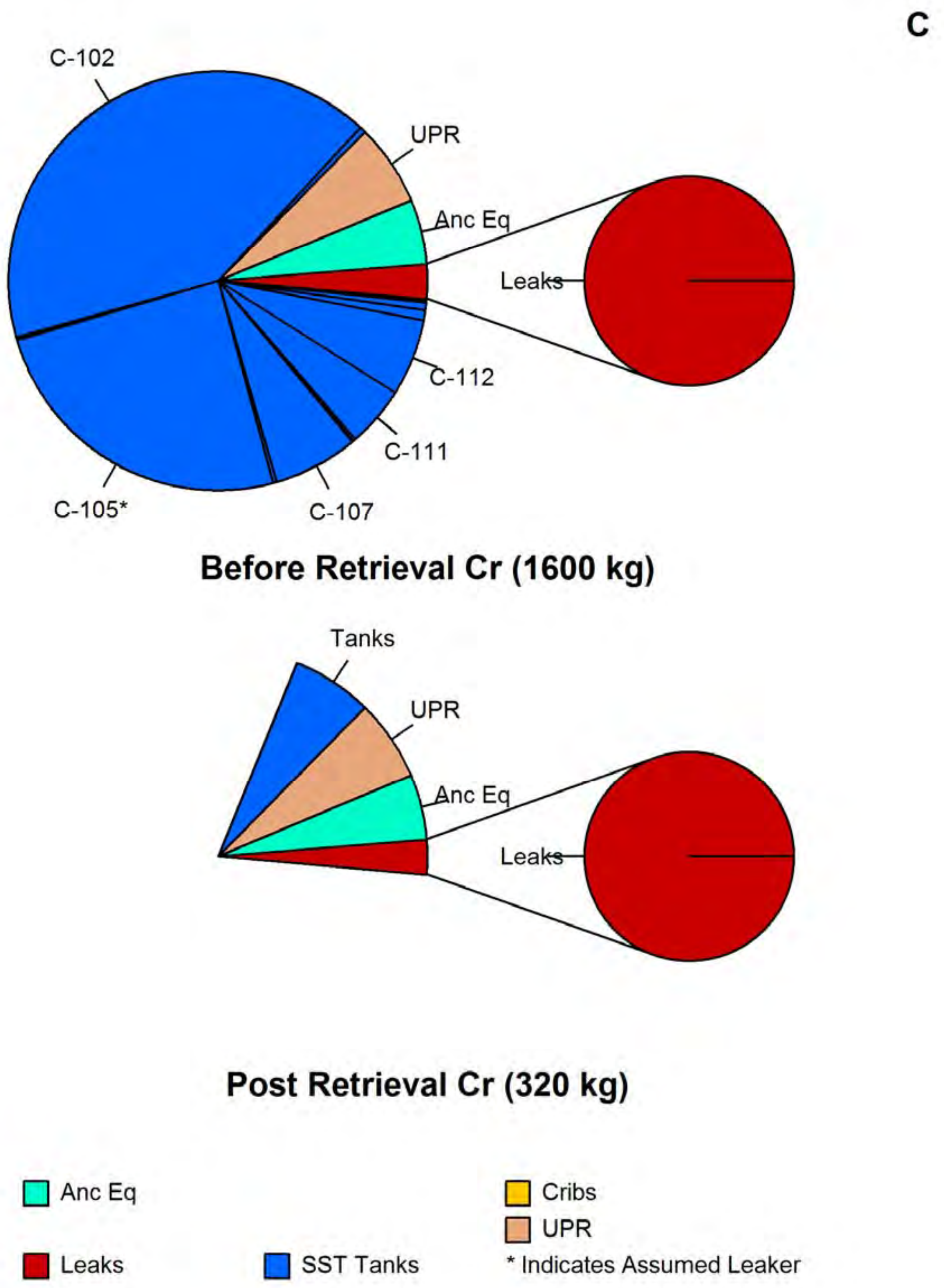


Figure E.8-5. C Tank and Waste Farms Evaluation Unit Inventory Estimates for Chromium Before and After 99% Retrieval

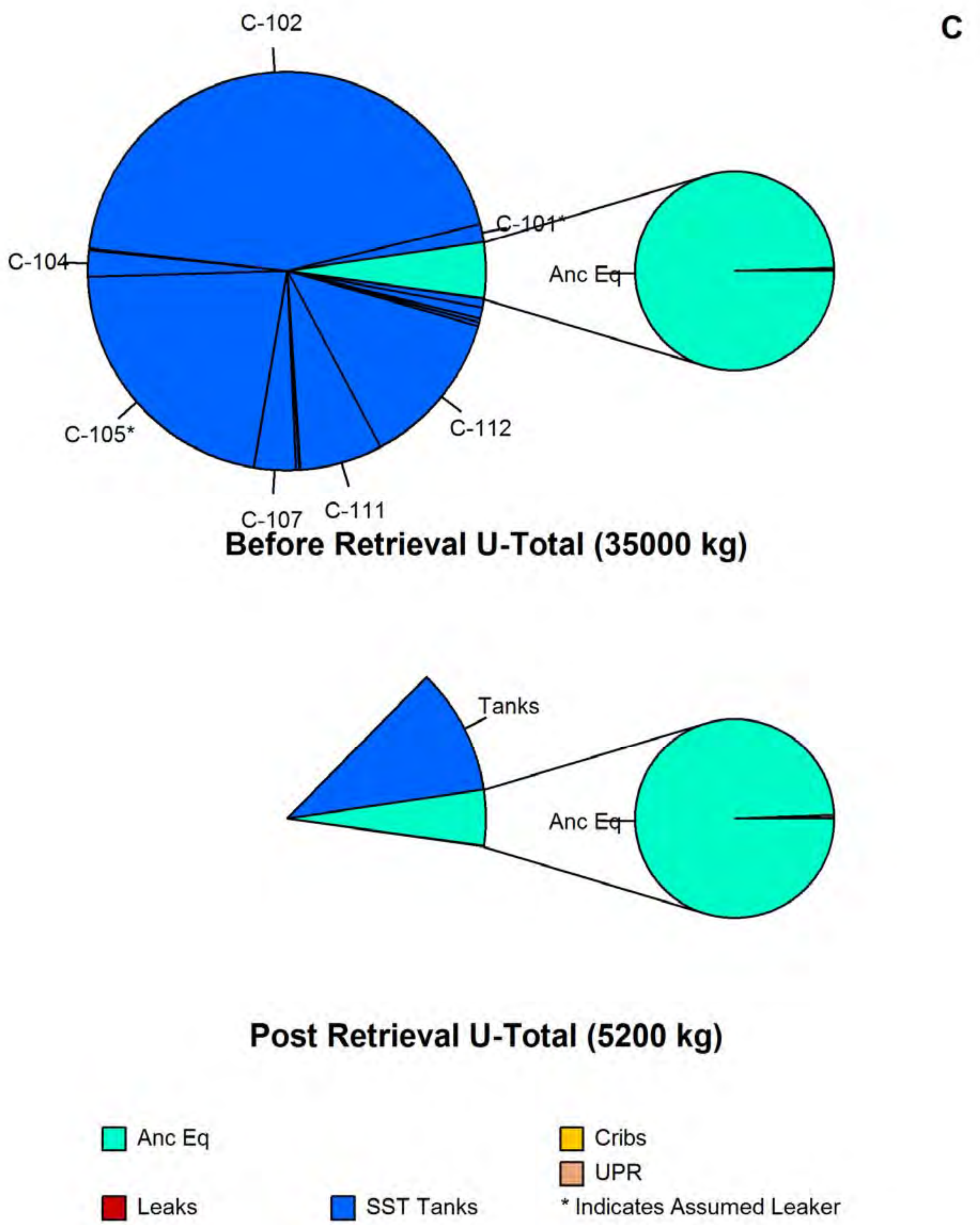


Figure E.8-6. C Tank and Waste Farms Evaluation Unit Inventory Estimates for U(tot) Before and After 99% Retrieval

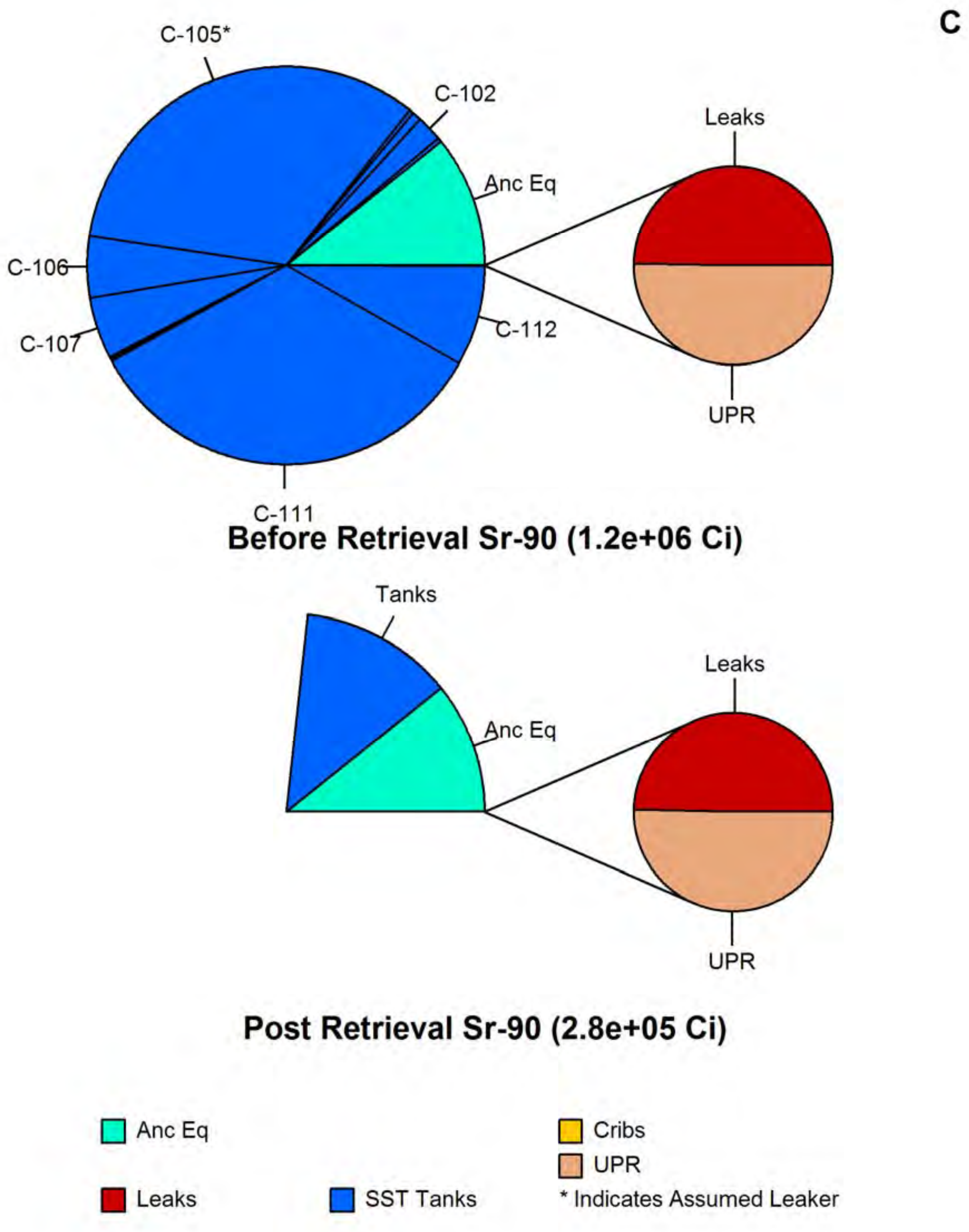


Figure E.8-7. C Tank and Waste Farms Evaluation Unit Inventory Estimates for Sr-90 Before and After 99% Retrieval

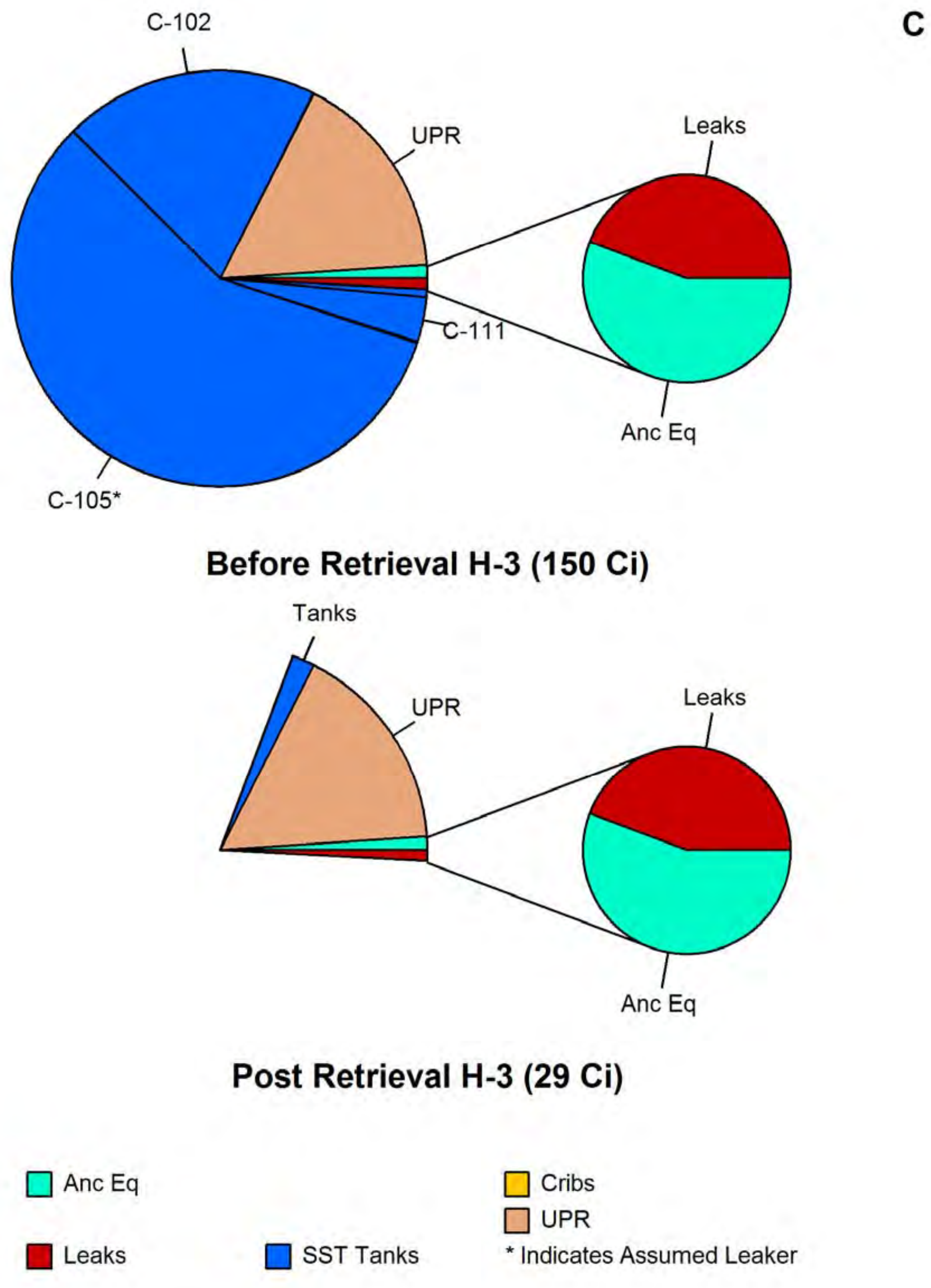


Figure E.8-8. C Tank and Waste Farms Evaluation Unit Inventory Estimates for Tritium (H-3) Before and After 99% Retrieval

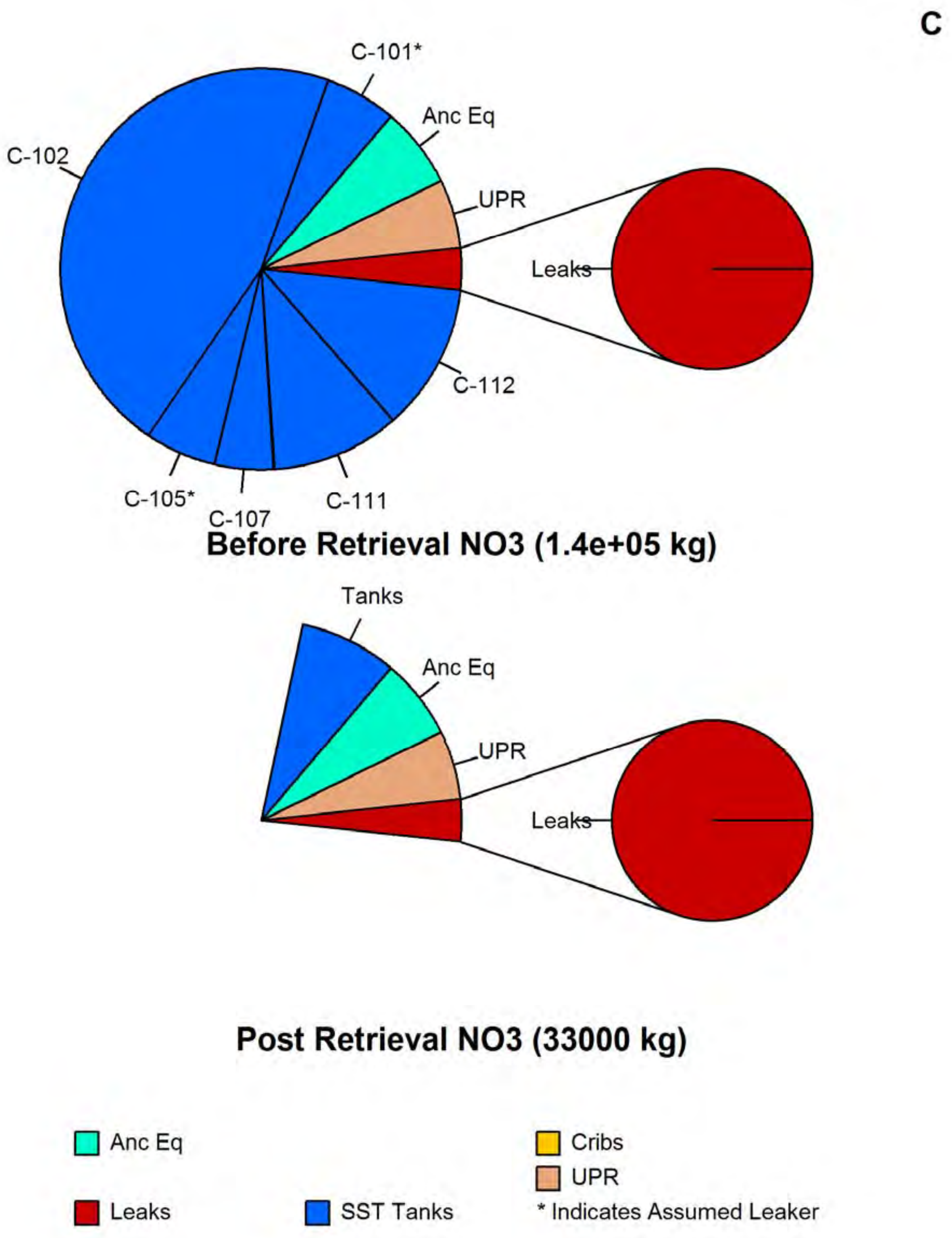


Figure E.8-9. C Tank and Waste Farms Evaluation Unit Inventory Estimates for Nitrate (NO3) Before and After 99% Retrieval

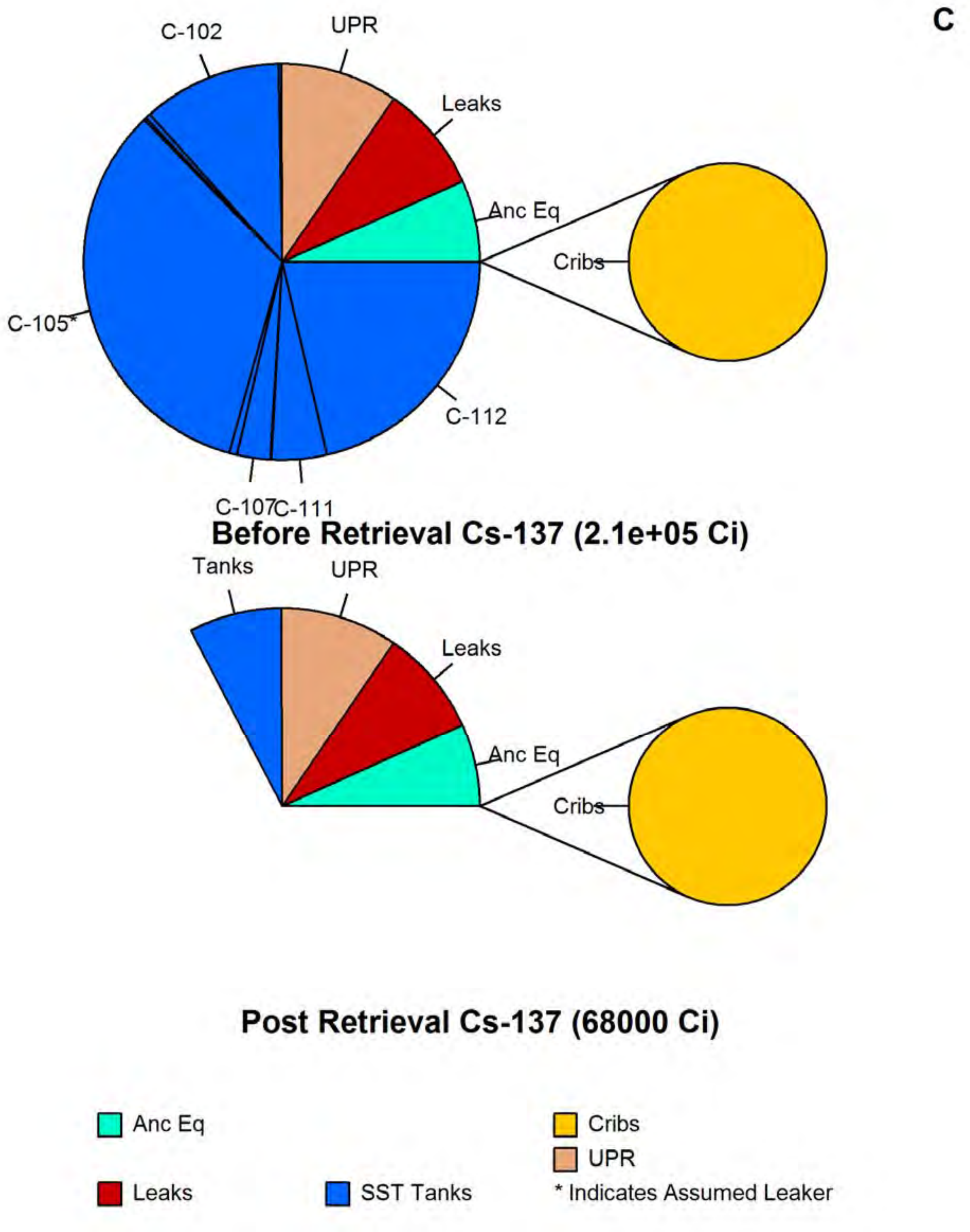


Figure E.8-10. C Tank and Waste Farms Evaluation Unit Inventory Estimates for Cs-137 Before and After 99% Retrieval

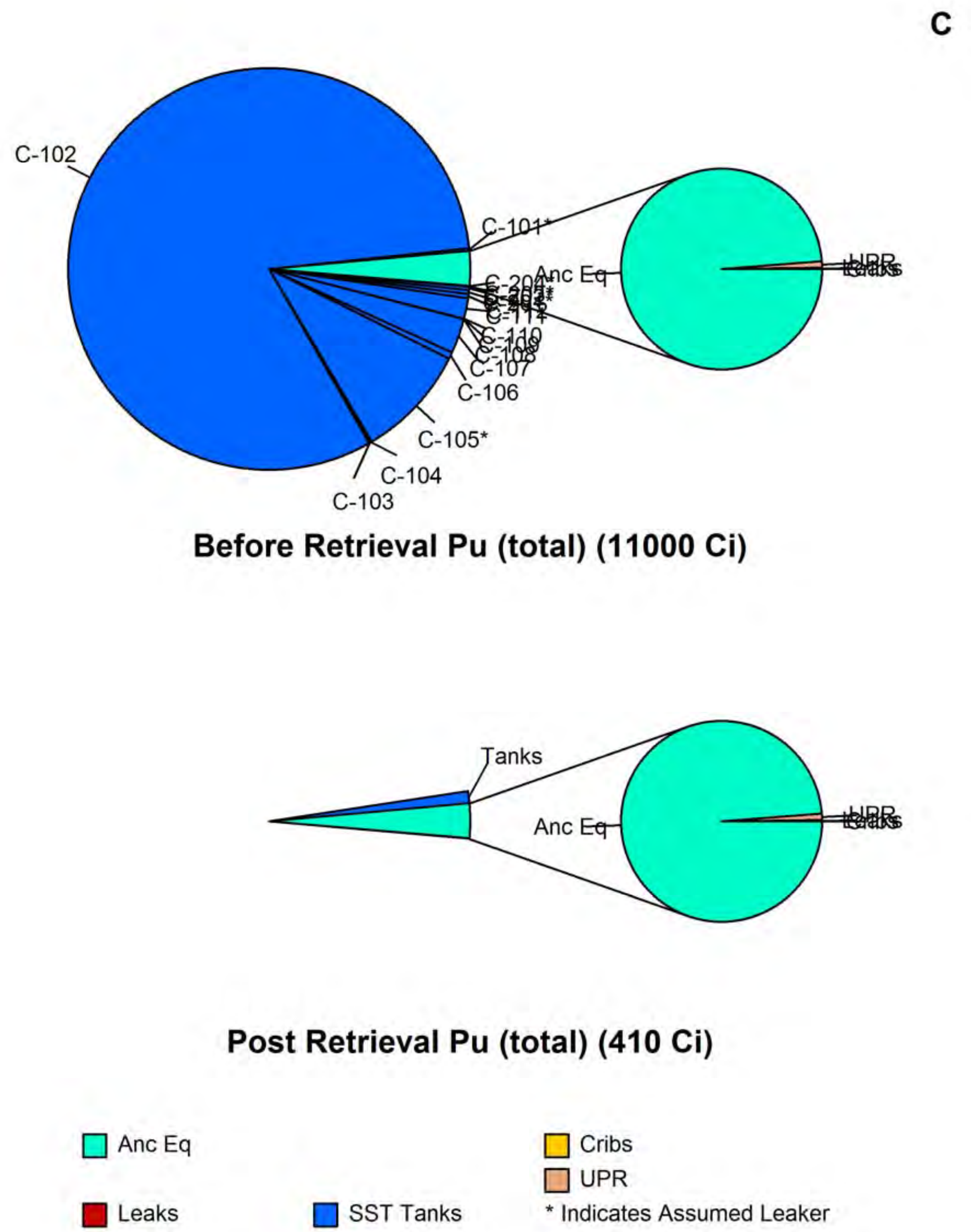


Figure E.8-11. C Tank and Waste Farms Evaluation Unit Inventory Estimates for Plutonium (total) Before and After 99% Retrieval

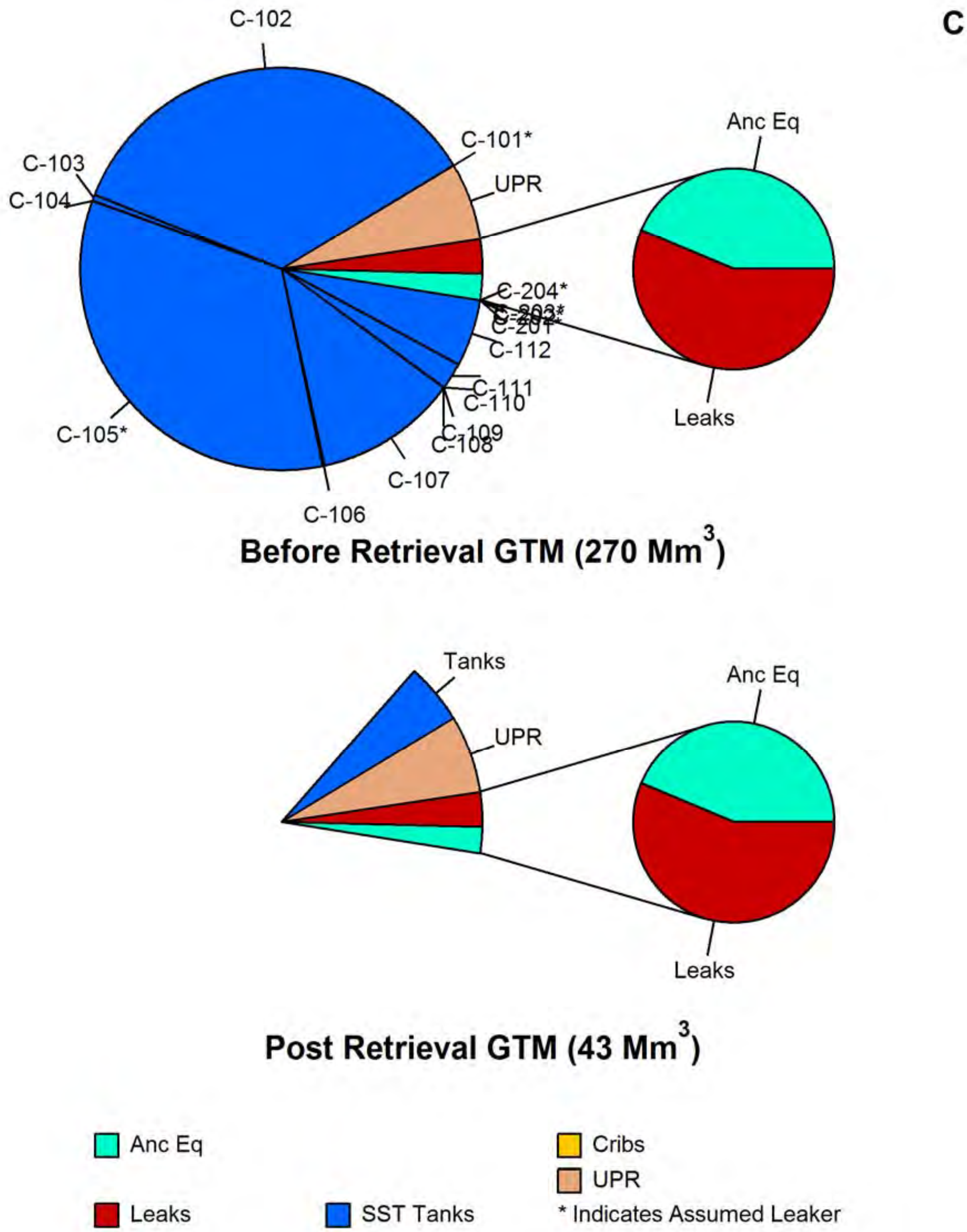


Figure E.8-12. C Tank and Waste Farms Evaluation Unit Maximum Groundwater Threat Metric (GTM) of I-129 and Tc-99 Estimates Before and After 99% Retrieval

8.6. POTENTIAL RISK/IMPACT PATHWAYS AND EVENTS

CURRENT CONCEPTUAL MODEL

A common safety analysis was performed for all the single- and double-shell tanks including pathways and barriers (safety scenarios that dominate risk, safety systems and controls, barriers to release, failure mechanisms, pathways and receptors, time frames for exposure). See Section 1.6 in Appendix E.1 for details.

POPULATIONS AND RESOURCES CURRENTLY AT RISK OR POTENTIALLY IMPACTED

Facility Worker, Co-located Person, and Public

A common analysis was performed for the Facility Worker, Co-located Person, and Public. See Section 1.6 (Appendix E.1) for details.

Groundwater

The current groundwater plumes (Tc-99 and nitrate) associated with the C Tank and Waste Farms EU and liquid waste disposal facilities are described in Section 8.5 and further details including ratings are provided in the Appendix G.5 for the CP-GW-1 EU (200-BP-5 GW OU).

As shown in Table E.8-7 (Section 8.5), the vadose zone (VZ) GTM values for the Group A and B primary contaminants range from ND for Sr-90 (which has an inventory that would translate to a *High* rating but appears relatively immobile in the area as described in Section 8.5) and uranium, *Low* for C-14, Tc-99, and chromium (total and hexavalent) to *Medium* for I-129. The Sr-90 will decay significantly during the Active and Near-term, Post Cleanup periods that would result in a *Medium* rating during the Near-term, Post-Cleanup period. However, transport considerations indicate the Sr-90 is unlikely to impact groundwater in the future (i.e., next 10,000 years). Thus the overall current rating for groundwater impact from vadose zone sources is *Medium*.

Columbia River

As described in Section 8.5, there are no plumes associated with the C Tank and Waste Farms EU that currently intersect the Columbia River, which corresponds to *Not Discernible* ratings for all evaluation periods.

As described in Section 8.5, TC&WM EIS screening results indicate that peak concentrations in the nearshore region of the Columbia River were below benchmarks for wildlife receptors and benthic invertebrates and aquatic biota leading to a *Not Discernible* rating for radionuclides for both benthic and riparian receptors for all evaluation periods.

For chemicals, only nitrate and chromium (assumed hexavalent) are predicted in the TC&WM EIS to have concentrations (from sources including those other than the C Tank and Waste Farms EU) that could exceed thresholds in the near-shore ecology as described in Section 8.5. Nitrate has a *Not Discernible* rating for current conditions (since the plume is not in contact with the Columbia River) and would have *Low* ratings for the benthic and riparian ecology for the Active Cleanup and Near-term, Post-Cleanup periods. Hexavalent chromium has a *Not Discernible* rating for current conditions (since the plume is not in contact with the Columbia River) and would have *Medium* and *High* ratings for benthic and riparian receptors for the Active Cleanup and Near-term, Post-Cleanup periods based on the TC&WM EIS screening results. However, well data indicate that chromium and nitrate are moving much slower toward the Columbia River than predicted in the TC&WM EIS resulting in a *Not Discernible* rating for these evaluation periods.

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

Additional information concerning potential threats to the Columbia River from C Tank Farm and co-located liquid waste disposal facilities is provided in the Appendix G.5 for the CP-GW-1 EU (200-BP-5 GW OU).

Ecological Resources

- The EU for C Tank Farm consists almost entirely of level 0 resources, and remediation actions will not have any negative effects on habitat resources within the EU.
- The EU is contiguous with the A-AX Tank Farm and 200-East Double Shell Tanks, but does adjoin small patches of level 2 and level 3 habitat to the west. However, disturbance to habitats within the EU would not have any effect on habitat connectivity.
- No wildlife were observed in the vicinity during the October survey.
- Individual occurrences of sensitive plant species are located within the landscape buffer area, but would be unlikely to be affected by any remediation action within the evaluation unit.

Cultural Resources

- The 271-CR Service and Office Building, contributing property within the Manhattan Project/Cold War Era Historic District with no documentation required is located within the C Tank and Waste Farms EU.
- There are no archaeological sites or TCPs known to be located or recorded within the C Tank and Waste Farms EU.

Archaeological sites and TCPs located within 500 meters of the EU

- An isolated find associated with the Native American Precontact and Ethnographic Landscape consisting has been located within close proximity to the C Tank and Waste Farms Evaluation Unit.
- The Hanford Site Plant Railroad and 2707AR Sludge Vault Change House are contributing properties within the Manhattan Project and Cold War Era Historic District with documentation required are located within close proximity to the C Tank and Waste Farms Evaluation Unit.

Recorded TCPs Visible from the EU

There are two recorded TCPs associated with the Native American Precontact and Ethnographic Landscape that are visible from the C Tank and Waste Farms EU.

CLEANUP APPROACHES AND END-STATE CONCEPTUAL MODEL

Selected or Potential Cleanup Approaches

A common analysis was performed for all the single- and double-shell tanks. See Section 1.6 (Appendix E.1) for details.

Contaminant Inventory Remaining at the Conclusion of Planned Active Cleanup Period

See Section 8.5 including Table E.8-2 and Figure E.8-3 through Figure E.8-11 for the inventory information after planned 99% retrieval. Furthermore, a more general analysis was performed for all the single- and double-shell tanks. See Section 1.6 for details.

Risks and Potential Impacts Associated with Cleanup

A common analysis was performed for all the single- and double-shell tanks for workers and the Public. See Section 1.6 (Appendix E.1) for details.

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

Facility Worker, Co-located Person, and Public

A common analysis was performed for the Facility Worker, Co-located Person, and Public. See Section 1.6 (Appendix E.1) for details.

Groundwater

As described in Section 8.5, there will be a continuing impact during this period to groundwater (as a protected resource) from those mobile C Tank and Waste Farms EU primary contaminants currently with plumes that exceed thresholds. These impacts are described in Appendix G.5 for the CP-GW-1 EU (200-BP-5 GW OU).

Furthermore, there are primary (e.g., tank wastes) and secondary contaminant sources (legacy source sites) in the vadose zone that pose risk to groundwater. For the Active Cleanup and Near-Term, Post-Cleanup periods, the vadose zone (VZ) GTM values for the Group A and B primary contaminants for the C Tank and Waste Farms EU range from *Not Discernible* for uranium and Sr-90 to *Low* for C-14, Tc-99, and chromium (total and hexavalent) to *Medium* for I-129. As described in Section 8.5, transport considerations based on the screening evaluations in the TC&WM EIS indicate that uranium and Sr-90 are not likely to impact groundwater in the next 150 years. Thus the overall rating for the Active Cleanup and Near-Term, Post-Cleanup periods is *Medium*.

The final action record of decision for the 200-BP-5 OU is scheduled for 2016 (DOE/RL-2014-32, Rev. 0, p. BP-3); thus groundwater will likely be treated in the future to help address groundwater contamination.

It is considered unlikely that additional groundwater resources would be impacted as a result of either interim remedial actions (e.g., pump and treat) or final closure activities (that are not covered in the Ecological or Cultural Resources results).

Columbia River

As described in Section 8.5, impacts from radiological contaminants to the Columbia River benthic and riparian ecology for the Active Cleanup and Near-term, Post Cleanup periods are rated as *Not Discernible*. The nitrate has a rating of *Not Discernible* for the benthic and riparian ecology. For the Active Cleanup and Near-term, Post Cleanup periods, chromium (assumed hexavalent) would have had benthic and riparian zone ratings of *Medium* and *High*, respectively; however, well data suggest that chromium is moving much slower than predicted in the TC&WM EIS (Appendix O, DOE/EIS-0391 2012) resulting in *Not Discernible* ratings. The large dilution effect of the Columbia River on the contamination from the seeps and groundwater upwellings produces *Not Discernible* ratings for all contaminants for the Active Cleanup and Near-term, Post Cleanup periods.

It is considered unlikely that additional benthic or riparian resources would be impacted as a result of either interim remedial actions (e.g., pump and treat) or final closure activities (that are not covered in the Ecological or Cultural Resources results). Additional information on groundwater plumes and potential threats associated with the C Tank Farm and liquid waste disposal facilities are described in Section 8.5 and Appendix G.5 for the CP-GW-1 EU (200-BP-5 GW OU).

Ecological Resources

Personnel, car, and pick-up truck traffic through non-target and remediated areas will likely no longer cause an effect on the ecological resources, unless heavy traffic caused ruts. If alien/exotic species became established during remediation, their presence could continue to affect the ecological resources. Permanent effects remain in the area of site with barrier or cap. Permanent effects remain in area surrounding cap or containment, depending upon traffic and current activities. 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 community.

Cultural Resources

Personnel, car and truck traffic on paved roads will likely have no direct effects on the cultural resources assuming the resources were not disturbed during remediation. If the remedial action included construction of buildings, cap or other type of containment then there are permanent effects in the area of the site. If archaeological resources or TCPs were directly or indirectly damaged or altered during construction of buildings or cap, cumulative effects include continued erosion and adverse effects to both archaeological site and TCP. If contamination is left behind and controlled by a barrier or other containment, then permanent effects to the cultural resources may occur in the area. If archaeological resources or TCPs were directly or indirectly damaged or altered during contamination, then cumulative effects include permanent adverse effects to both archaeological site and TCP.

ADDITIONAL RISKS AND POTENTIAL IMPACTS IF CLEANUP IS DELAYED

A common analysis was performed for all the single- and double-shell tanks. See Section 1.6 (Appendix E.1) for details.

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

A common analysis was performed for all the single- and double-shell tanks. See Section 1.6 (Appendix E.1) for details.

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

Table E.8-8. Summary of Populations and Resources at Risk or Potentially Impacted after Cleanup

Population or Resource		Impact Rating	Comments
Human	Facility Worker	Low	Workers will be low risk from exposure to direct radiation and waste contaminants after waste retrieval, grouting, and capping.
	Co-located Person	Low	These persons will be at low risk from exposure to direct radiation and waste contaminants after waste retrieval, grouting, and capping.
	Public	Not Discernible	The Tank Farms will be in secure and controlled areas that prevent intentional and inadvertent intruders. No complete groundwater pathway and no impact from air pathway.
Environmental	Groundwater (A&B) from vadose zone[a]	Low (Sr-90, uranium, C-14, Tc-99, total and hexavalent chromium) to Medium (I-129) **Overall**: Medium	GTM values for Group A and B primary contaminants (Table E.8-7) as modified: Low (uranium, Sr-90, C-14, Tc-99, chromium (total and hexavalent), and Medium for I-129. Sr-90 will decay significantly, and transport considerations described in Section 8.5 indicate that the impact from uranium and Sr-90 to groundwater will be Low to address uncertainty. Insufficient predicted impact from changes in recharge rates to modify ratings.
	Columbia River from vadose zone[a]	Benthic: Not Discernible (radionuclides) Not Discernible (chemicals) Riparian: Not Discernible (radionuclides) Not Discernible (chemicals) Free-flowing: Not Discernible (all) **Overall**: Not Discernible	TC&WM EIS screening results used to evaluate benthic and riparian receptors (Section 8.5). Only nitrate (ND for both benthic and riparian) and hexavalent chromium (Medium for benthic and High for riparian) are predicted to have concentrations (including sources other than the C Tank and Waste Farms EU) that could threaten the near-shore ecology. However, well data indicate slower movement of

Population or Resource		Impact Rating	Comments
			chromium toward the river resulting in an ND rating. Dilution factor of greater than 100 million between River and upwellings.
	Ecological Resources[b]	ND to Low	Likely monitoring of caps, with potential for disruption due to monitoring. Re-vegetation could result in higher quality habitat on EU.
Social	Cultural Resources[b]	**Native American:** Direct: Known Indirect: Known **Historic Pre-Hanford:** Direct: Known Indirect: Unknown **Manhattan/Cold War**: Direct: None Indirect: None	Permanent indirect effects to viewshed are possible from capping. Permanent effects may be possible due to presence of contamination if capping occurs. No other expected cultural resources impacts.

a. Groundwater threat for Group A and B contaminants remaining in the vadose zone or to the Columbia River for all primary contaminants. Threats from existing plumes associated with the C Tank and Waste Farms EU are described in Section 8.5 and Appendix G.5 (CP-GW-1) for the 200-BP-5 Groundwater Operable Unit.
b. 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.

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

As described in Section 8.5, the TC&WM ecological screening analysis indicate that that exposure to radioactive contaminants from peak groundwater discharge was below screening levels at the Columbia River near-shore region, indicating there should be no expected adverse effects from radionuclides. Furthermore, results of the corresponding TC&WM screening evaluation for chemicals indicated that predicted chromium and nitrate concentrations could exceed screening values (i.e., Hazard Quotient of unity) in the near-shore region. The predicted nitrate peak concentration was in the past and would be unlikely to exceed human or aquatic standards in the future. On the other hand, unless treated chromium (assumed hexavalent) could possibly impact benthic and riparian receptors (i.e., concentrations would exceed screening levels) after the Near-term, Post-Cleanup period.

For more information, see Section 1.6 (Appendix E.1).

8.7. SUPPLEMENTAL INFORMATION AND CONSIDERATIONS

A common analysis was performed for all the single- and double-shell tanks. See Section 1.7 (Appendix E.1) for details.

8.8. ATTACHMENT – C TANK AND WASTE FARMS EVALUATION UNIT WIDS REVIEW

Hanford Site-Wide Risk Review

Evaluation Unit:	C Tank Farm
ID:	CP-TF-7
Group:	Tank Farm
Operable Unit Cross-Walk:	WMA C
Related EU:	CP-LS-7 CP-GW-1
Sites & Facilities:	C tank farm, ancillary structures, associated liquid waste sites, and soils contamination
Key Data Sources Docs:	RPP-13033 RPP-23405 RPP-40545 RPP-PLAN-40145 RPP-10435

Figure 1. Site Map with Evaluation Unit Boundaries and Tank Locations

Attached:

- Waste Site and Facility List
- Site Map with Evaluation Unit Boundaries and Associated Waste Sites
- Site Map with Evaluation Unit Boundaries and Associated Facilities

Prepared by: AMG, 08/29/2014
Reviewed by: GVL, 08/29/2014
Revisions: AMG, 09/10/2014

Hanford Site-Wide Risk Review
CP-TF-7 (C Tank Farm)
Waste Site and Facility List

Site Code	Name, Aliases, Description	Site Status	Site Type	Site Type Category	Operable Unit	Exclude from Evaluation
200-E-111-PL	200-E-111-PL; 3-38 Encasement; Encased Pipeline from 241-ER-151 Diversion Box to 241-C Tank Farm and 244-AR Vault; Lines V108/V837/8618/8653/8901PAS, 809, 818, V836 and V834	Inactive	Encased Tank Farm Pipeline	Pipeline and associated valves, etc.	TBD	
200-E-114-PL	200-E-114-PL; 216-BC-2805; 2805-E1, 2805-E2, 2805-E3 and 2805-E4; Pipeline from 216-BY-201 to 216-BC-201; Pipeline from 241-BY Tank Farm to 241-C Tank Farm and BC Cribs Trenches	Inactive	Radioactive Process Sewer	Pipeline and associated valves, etc.	200-BC-1	
200-E-116-PL	200-E-116-PL; Direct Buried Pipelines V111/V210/V130, 8902, and V122; Pipelines from 241-B-154 Diversion Box to 241-C-151 and 241-C-152 Diversion Boxes	Inactive	Direct Buried Tank Farm Pipeline	Pipeline and associated valves, etc.	TBD	
200-E-133	200-E-133; Contaminated Soil at 241-C Tank Farm; Contamination Migration Beyond the fence at C Farm	Inactive	Contamination Migration	Unplanned Release - Surface/Near Surface	WMA C	
200-E-135	200-E-135; Contamination Area South of 241-C Tank Farm	Inactive	Unplanned Release	Unplanned Release - Surface/Near Surface	TBD	
200-E-143-PL	200-E-143-PL; Encased Transfer Line from 241-AX-151 Diversion Box to 241-A Tank Farms and 244-CR Vault in 241-C Tank Farm; Tank Farm Transfer Lines 4101, 4102, 4103, 4104, 4105, 4106, 4107/V033, 4017, 4018 and 8656	Inactive	Encased Tank Farm Pipeline	Pipeline and associated valves, etc.	TBD	
200-E-144-PL	200-E-144-PL; Encased Transfer Line from 241-CR-152 and 241-CR-153 to 241-AX-151; Lines 4006 and 4007 from 244-AR Vault to 241-AX-151; Tank Farm Transfer Line 4012; Transfer Line 4013 (A-4013)	Inactive	Encased Tank Farm Pipeline	Pipeline and associated valves, etc.	TBD	
200-E-145-PL	200-E-145-PL; 241-ER-152 and 241-ER-151; Interplant Transfer Line; Tank Farm Transfer Line V228; Transfer Pipeline from 241-CR-153 to 241-ER-153	Inactive	Encased Tank Farm Pipeline	Pipeline and associated valves, etc.	TBD	
200-E-147-PL	200-E-147-PL; Interplant Transfer Line; Tank Farm Transfer Line PAS-244; Transfer Line from 244-CR-TK-003 to 241-ER-153	Inactive	Direct Buried Tank Farm Pipeline	Pipeline and associated valves, etc.	TBD	
200-E-148-PL	200-E-148-PL; Direct Buried Transfer Line from 241-C-151 to 241-A-01A; Tank Farm Transfer Line V109	Inactive	Direct Buried Tank Farm Pipeline	Pipeline and associated valves, etc.	TBD	
200-E-149-PL	200-E-149-PL; Direct Buried Transfer Line from 241-C-252 to 201-C Hot Semi Works; Tank Farm Pipeline; Tank Farm Transfer Line V175	Inactive	Direct Buried Tank Farm Pipeline	Pipeline and associated valves, etc.	TBD	
200-E-150-PL	200-E-150-PL; Direct Buried Transfer Line from 244-CR-TK-003 to 201-C Hot Semi Works Valve Box; Tank Farm Pipeline; Tank Farm Transfer Line 8900	Inactive	Direct Buried Tank Farm Pipeline	Pipeline and associated valves, etc.	TBD	
200-E-151-PL	200-E-151-PL; Direct Buried Transfer Line from 241-C-104 to 241-A-152; Tank Farm Pipeline; Tank Farm Transfer Line V050	Inactive	Direct Buried Tank Farm Pipeline	Pipeline and associated valves, etc.	TBD	

Note that only those waste sites with a WIDS (Waste Information Data System) Classification of "Accepted" are shown, along with non-duplicate facilities, identified via the Hanford Geographic Information System (HGIS).

Hanford Site-Wide Risk Review
CP-TF-7 (C Tank Farm)
Waste Site and Facility List

Site Code	Name, Aliases, Description	Site Status	Site Type	Site Type Category	Operable Unit	Exclude from Evaluation
200-E-152-PL	200-E-152-PL; Direct Buried Transfer Line from 241-C-104 to 241-A-152; Tank Farm Pipeline; Tank Farm Transfer Line V051	Inactive	Direct Buried Tank Farm Pipeline	Pipeline and associated valves, etc.	TBD	
200-E-153-PL	200-E-153-PL; Direct Buried Transfer Line from 241-C-151 to 244-AR-TK-002; Tank Farm Pipeline; Tank Farm Transfer Line V108/812	Inactive	Direct Buried Tank Farm Pipeline	Pipeline and associated valves, etc.	TBD	
200-E-154-PL	200-E-154-PL; Direct Buried Transfer Line from 241-C-151 to 241-AX-01A; Tank Farm Pipeline; Tank Farm Transfer Line V113	Inactive	Direct Buried Tank Farm Pipeline	Pipeline and associated valves, etc.	TBD	
200-E-155-PL	200-E-155-PL; Pipeline from 241-C Fence to Radioactive Process Sewer Line 2904-CR-1	Inactive	Radioactive Process Sewer	Pipeline and associated valves, etc.	TBD	
200-E-290-PL	200-E-290-PL; Pipeline from 271-CR to 216-C-8 French Drain	Inactive	Radioactive Process Sewer	Pipeline and associated valves, etc.	TBD	
200-E-291-PL	200-E-291-PL; Pipeline from 241-C-106 to 241-AY-102, SN-200, SL-100, 241-C-106 Sluice line	Inactive	Direct Buried Tank Farm Pipeline	Pipeline and associated valves, etc.	TBD	
216-C-8	216-C-8; 216-C-8 Crib; 216-C-8 French Drain; 271-CR Crib	Inactive	French Drain	Crib - Subsurface Liquid Disposal Site	WMA C	
241-C-101	241-C-101; 241-C-TK-101	Inactive	Single-Shell Tank	Underground Storage Tank	WMA C	
241-C-102	241-C-102; 241-C-TK-102	Inactive	Single-Shell Tank	Underground Storage Tank	WMA C	
241-C-103	241-C-103; 241-C-TK-103	Inactive	Single-Shell Tank	Underground Storage Tank	WMA C	
241-C-104	241-C-104; 241-C-TK-104	Inactive	Single-Shell Tank	Underground Storage Tank	WMA C	
241-C-105	241-C-105; 241-C-TK-105	Inactive	Single-Shell Tank	Underground Storage Tank	WMA C	
241-C-106	241-C-106; 241-C-TK-106	Inactive	Single-Shell Tank	Underground Storage Tank	WMA C	
241-C-107	241-C-107; 241-C-TK-107	Inactive	Single-Shell Tank	Underground Storage Tank	WMA C	
241-C-108	241-C-108; 241-C-TK-108	Inactive	Single-Shell Tank	Underground Storage Tank	WMA C	
241-C-109	241-C-109; 241-C-TK-109	Inactive	Single-Shell Tank	Underground Storage Tank	WMA C	
241-C-110	241-C-110; 241-C-TK-110	Inactive	Single-Shell Tank	Underground Storage Tank	WMA C	
241-C-111	241-C-111; 241-C-TK-111	Inactive	Single-Shell Tank	Underground Storage Tank	WMA C	
241-C-112	241-C-112; 241-C-TK-112	Inactive	Single-Shell Tank	Underground Storage Tank	WMA C	
241-C-151	241-C-151; 241-C-151 Diversion Box	Inactive	Diversion Box	Pipeline and associated valves, etc.	WMA C	
241-C-152	241-C-152; 241-C-152 Diversion Box	Inactive	Diversion Box	Pipeline and associated valves, etc.	WMA C	
241-C-153	241-C-153; 241-C-153 Diversion Box	Inactive	Diversion Box	Pipeline and associated valves, etc.	WMA C	
241-C-201	241-C-201; 241-C-TK-201	Inactive	Single-Shell Tank	Underground Storage Tank	WMA C	
241-C-202	241-C-202; 241-C-TK-202	Inactive	Single-Shell Tank	Underground Storage Tank	WMA C	
241-C-203	241-C-203; 241-C-TK-203	Inactive	Single-Shell Tank	Underground Storage Tank	WMA C	
241-C-204	241-C-204; 241-C-TK-204	Inactive	Single-Shell Tank	Underground Storage Tank	WMA C	
241-C-252	241-C-252; 241-C-252 Diversion Box	Inactive	Diversion Box	Pipeline and associated valves, etc.	WMA C	
241-C-301	241-C-301; 241-C-301C; 241-C-301-C Catch Tank; IMUST; Inactive Miscellaneous Underground Storage Tank; Lines V114 and V155	Inactive	Catch Tank	Underground Storage Tank	WMA C	
241-C-801	241-C-801; 241-C-801 Cesium Loadout Facility	Inactive	Process Unit/Plant	Process Building	WMA C	
241-CR-151	241-CR-151; 241-CR-151 Diversion Box	Inactive	Diversion Box	Pipeline and associated valves, etc.	WMA C	
241-CR-152	241-CR-152; 241-CR-152 Diversion Box; Line 8253	Inactive	Diversion Box	Pipeline and associated valves, etc.	WMA C	
241-CR-153	241-CR-153; 241-CR-153 Diversion Box; Line 8307	Inactive	Diversion Box	Pipeline and associated valves, etc.	WMA C	

Note that only those waste sites with a WIDS (Waste Information Data System) Classification of "Accepted" are shown, along with non-duplicate facilities, identified via the Hanford Geographic Information System (HGIS).

Hanford Site-Wide Risk Review
CP-TF-7 (C Tank Farm)
Waste Site and Facility List

Site Code	Name, Aliases, Description	Site Status	Site Type	Site Type Category	Operable Unit	Exclude from Evaluation
244-CR VAULT	244-CR Vault; 244-CR VAULT; Line 8765	Inactive	Receiving Vault	Process Building	WMA C	
244-CR-WS-1	244-CR-WS-1; 244-CR French Drain	Inactive	French Drain	Crib - Subsurface Liquid Disposal Site	WMA C	
2607-EG	2607-EG	Inactive	Septic Tank	Septic System	WMA C	X
600-291-PL	600-291-PL; TEDF Line; 200 Area Treated Effluent Disposal Facility Pipeline	Active	Process Sewer	Pipeline and associated valves, etc.	Not Applic	
UPR-200-E-107	UPR-200-E-107; Contamination Spread in 241-C Tank Farm; UN-200-E-107	Inactive	Unplanned Release	Unplanned Release - Surface/Near Surface	Not Applic	
UPR-200-E-118	UPR-200-E-118; Airborne Release from 241-C-107; UN-200-E-118	Inactive	Unplanned Release	Unplanned Release - Surface/Near Surface	Not Applic	
UPR-200-E-136	UPR-200-E-136; 241-C-101 Tank Leak; UN-200-E-136	Inactive	Unplanned Release	Unplanned Release - Subsurface	Not Applic	
UPR-200-E-137	UPR-200-E-137; 241-C-203 Leak; UN-200-E-137	Inactive	Unplanned Release	Unplanned Release - Subsurface	Not Applic	
UPR-200-E-16	UPR-200-E-16; 241-C Overground Transfer Line Leak; UN-200-E-16	Inactive	Unplanned Release	Unplanned Release - Subsurface	Not Applic	
UPR-200-E-27	UPR-200-E-27; 244-CR Contamination Spread; UN-200-E-27	Inactive	Unplanned Release	Unplanned Release - Surface/Near Surface	Not Applic	
UPR-200-E-68	UPR-200-E-68; Radioactive Contamination Spread; UN-200-E-68; UN-216-E-68	Inactive	Unplanned Release	Unplanned Release - Surface/Near Surface	Not Applic	
UPR-200-E-72	UPR-200-E-72; Radioactive Contamination from Uncovered Buried Waste; UN-200-E-72	Inactive	Unplanned Release	Unplanned Release - Surface/Near Surface	WMA C	
UPR-200-E-81	UPR-200-E-81; 241-CR-151 Line Break; UN-200-E-81; UN-216-E-9	Inactive	Unplanned Release	Unplanned Release - Surface/Near Surface	Not Applic	
UPR-200-E-82	UPR-200-E-82; V122; 241-C-152 Line Break; B Plant Ion Exchange Feed Line Leak; UN-200-E-82; UN-216-E-10	Inactive	Unplanned Release	Unplanned Release - Surface/Near Surface	Not Applic	
UPR-200-E-86	UPR-200-E-86; 241-C Tank Farm Line (V812) Break Southwest Corner; UN-200-E-86; UN-216-E-14	Inactive	Unplanned Release	Unplanned Release - Surface/Near Surface	Not Applic	
241C73	C FARM SERVICE BUILDING	ACTIVE	BUILDING	Infrastructure Building		
241C90	AIR COMPRESSOR FACILITY	ACTIVE	STRUCTURE	Process Building		
241C91	241C106 PROCESS BUILDING	ACTIVE	BUILDING	Process Building		
241CR271	WASTE DISPOSAL CONTROL HOUSE 241C TANK FARM	ACTIVE	BUILDING	Infrastructure Building		
271CR	SERVICE AND OFFICE BUILDING	ACTIVE	BUILDING	Infrastructure Building		X
2724CA	RAD MONITORING AND PROTECTIVE CLOTHING BLDG	INACTIVE	BUILDING	Infrastructure Building		X
291CR	244CR VAULT VENTILATION SYSTEM	INACTIVE	STRUCTURE	Process Building		
CT0001	CONTRACTOR TRL EAST SIDE OF C TANK FARM	ACTIVE	BUILDING	Infrastructure Building		X
HO6403534	CONTROL TRAILER NE OF 241-C TANK FARM	ACTIVE	BUILDING	Infrastructure Building		X
MO117	FACILITY EQUIPMENT/CONTROL TRAILER	ACTIVE	BUILDING	Infrastructure Building		X
MO211	MOBILE OFFICE NORTHEAST OF C FARM	ACTIVE	BUILDING	Infrastructure Building		X
MO512	HPT/CHANGE TRL ON NW SIDE OF 241C TANK FARM	ACTIVE	BUILDING	Infrastructure Building		X

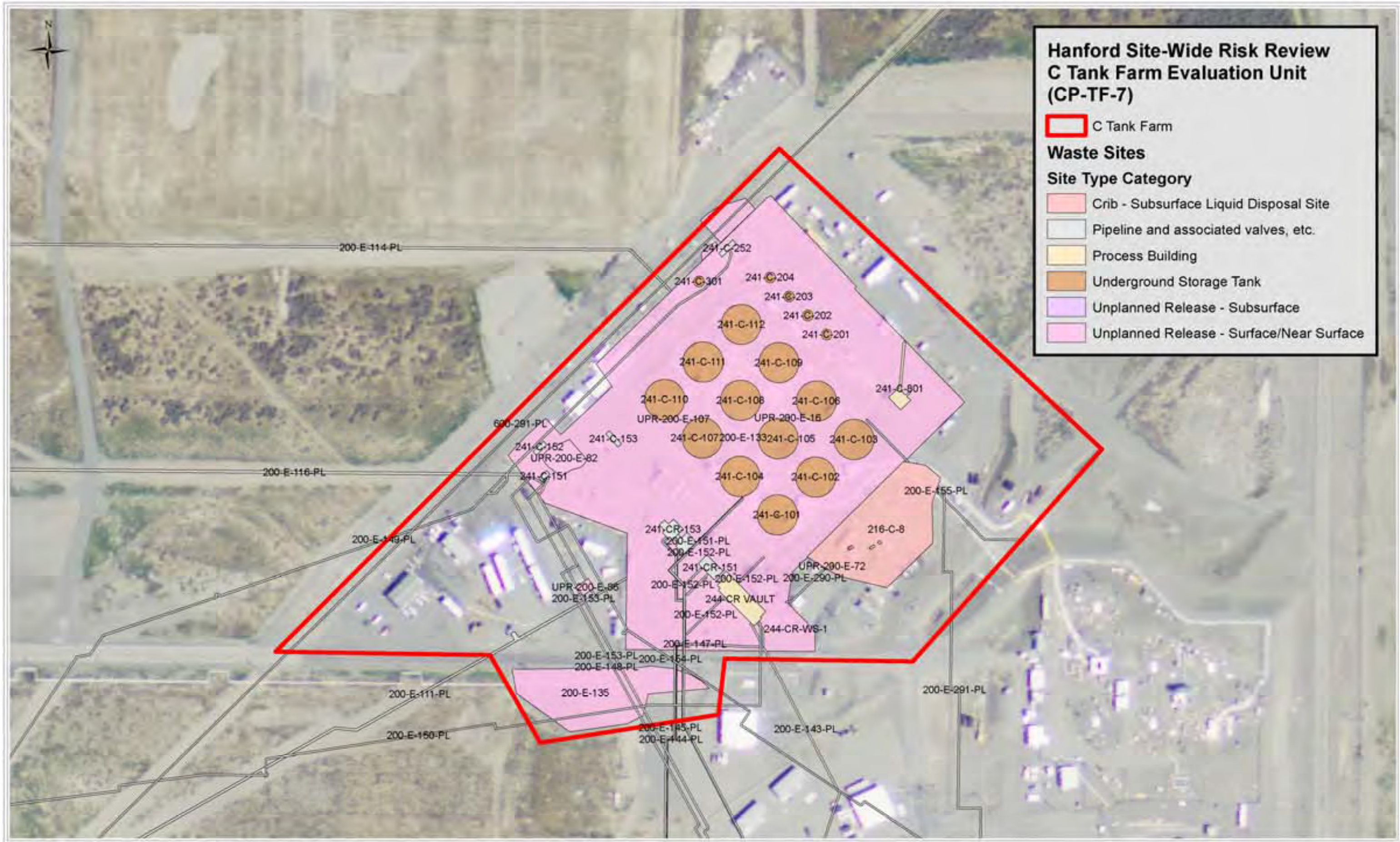
Note that only those waste sites with a WIDS (Waste Information Data System) Classification of "Accepted" are shown, along with non-duplicate facilities, identified via the Hanford Geographic Information System (HGIS).

Hanford Site-Wide Risk Review
CP-TF-7 (C Tank Farm)
Waste Site and Facility List

Site Code	Name, Aliases, Description	Site Status	Site Type	Site Type Category	Operable Unit	Exclude from Evaluation
MO522	CHANGEROOM TRAILER SE OF C-FARM N OF 241CR	ACTIVE	BUILDING	Infrastructure Building		X
MO523	RESPIRATOR TRAILER - SOUTHWEST OF C-FARM	ACTIVE	BUILDING	Infrastructure Building		X
MO524	LUNCHROOM TRAILER - SOUTHWEST OF C-FARM	ACTIVE	BUILDING	Infrastructure Building		X
MO525	MOBILE OFFICE - SOUTHWEST OF C-FARM	ACTIVE	BUILDING	Infrastructure Building		X
MO529	C FARM SLUICING CONTROL MOBILE	ACTIVE	BUILDING	Infrastructure Building		X
MO531	MOBILE OFFICE - SOUTHWEST OF C-FARM	ACTIVE	BUILDING	Infrastructure Building		X
MO567	MOBILE OFFICE NE OF 241C TANK FARM	ACTIVE	BUILDING	Infrastructure Building		X
MO579	MARS CONTROL TRAILER AT C FARM	ACTIVE	BUILDING	Infrastructure Building		X
MO822	CHANGE TRAILER AT 241C TANK FARM	ACTIVE	BUILDING	Infrastructure Building		X
MO826	CHANGE TRAILER AT 241C TANK FARM	ACTIVE	BUILDING	Infrastructure Building		X

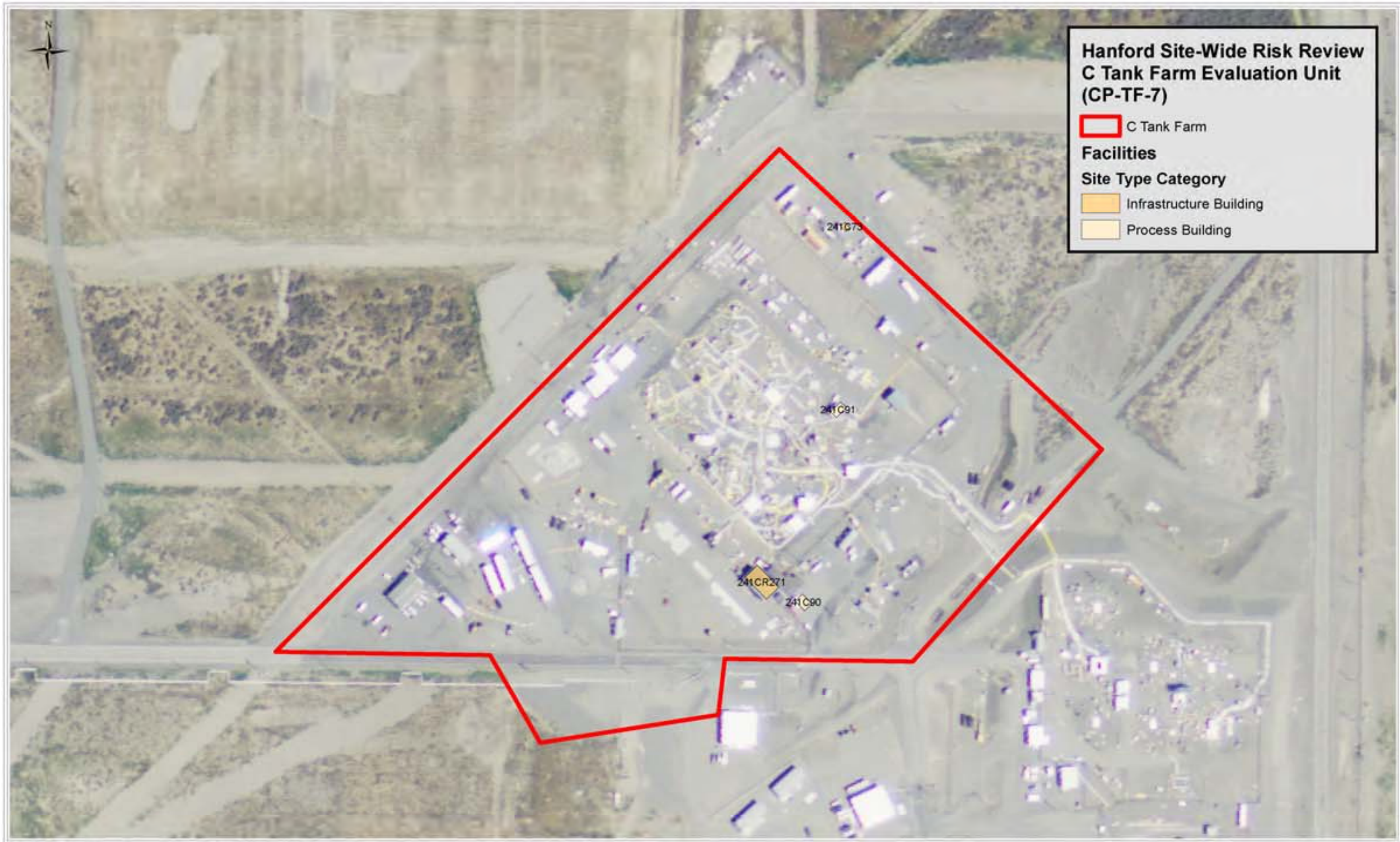
Note that only those waste sites with a WIDS (Waste Information Data System) Classification of "Accepted" are shown, along with non-duplicate facilities, identified via the Hanford Geographic Information System (HGIS).

DRAFT



1 inch = 250 feet

DRAFT



1 inch = 250 feet

APPENDIX E.9

Tank Waste and Farms

CP-TF-8 (AN-AP-AW-AY-AZ Double-shell Tank Waste and Farms)

Evaluation Unit Summary Template

Table of Contents

List of Figures

List of Tables

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PART 9. CP-TF-8 AN-AP-AW-AY-AZ DOUBLE-SHELL TANK WASTE AND FARMS (200-E)

9.1. EXECUTIVE SUMMARY

EU LOCATION:

200 East Tank Farm

RELATED EUS:

S-SX Tank Waste and Farms (CP-TF-2), TX-TY Tank Waste and Farms (CP-TF-3), U Tank Waste and Farms (CP-TF-4), A-AX Tank Waste and Farms (CP-TF-5), B-BX-BY Tank Waste and Farms (CP-TF-6), C Tank Waste and Farms (CP-TF-7), 200-West DST Waste and Farms (CP-TF-9), 200-E Groundwater Plumes (CP-GW-1), and 200 Area Waste Transfer Pipeline (CP-LS-7)

PRIMARY CONTAMINANTS, CONTAMINATED MEDIA AND WASTES:

The TC&WM EIS describes tank wastes as including radioactive (tritium or H-3, C-14, Sr-90, Tc-99, I-129, Cs-137, U-233, U-234, U-235, U-238, Np-237, Pu-239, and Pu-240)[131] and non-radioactive contaminants (chromium, mercury, nitrate, lead, total uranium, and PCBs) of potential concern (DOE/EIS-0391 2012, Appendix D). The tank wastes contain saltcake, sludge, and supernatant phases.

BRIEF NARRATIVE DESCRIPTION:

To provide additional storage capacity, 28 double-shell tanks were built in six tank farms between 1968 and 1986. Five of these tank farms are located in the 200 East Area, and one is located in the 200 West Area.

SUMMARY TABLES OF RISKS AND POTENTIAL IMPACTS TO RECEPTORS

Table E.9-1 provides a summary of nuclear and industrial safety related consequences from the CP-TF-8 (200-East DST Farm EU) to humans and impacts to important physical Hanford Site resources. Receptors are described in Section 1.6 (Appendix E.1).

[131] Other isotopes considered include U-232 and U-236 and Pu-238, Pu-241, and Pu-242 to be consistent with other EUs. These additional uranium and plutonium isotopes are included in the totals presented but are not used for rating because 1) uranium toxicity impacts (represented by total uranium drives corresponding risks and 2) plutonium has been found relatively immobile in the Hanford subsurface and has not been identified as a risk driver for groundwater impacts.

Table E.9-1. CP-TF-8 (200-East DST Farm) impact Rating Summary for Human Health (unmitigated basis with mitigated basis provided in parentheses (e.g., "High (Low)")

Population or Resource		Evaluation Time Period[a] Active Cleanup (to 2064) Current Condition: Maintenance & Monitoring (M&M)	Evaluation Time Period[a] Active Cleanup (to 2064) From Cleanup Actions: Retrieval & Closure
Human Health	Facility Worker[b]	***M&M***: Low-High[d] (Low-High)[d] ***Soil***: ND-High (ND-Low)	***Preferred method***: High (Low) ***Alternative***: High (Low)
Human Health	Co-located Person[b]	***M&M***: Low-Moderate (Low) ***Soil***: ND (ND)	***Preferred method***: Low-Moderate (Low) ***Alternative***: Low-Moderate (Low)
Human Health	Public[b]	***M&M***: Low (Low) ***Soil***: ND (ND)	***Preferred method***: Low (Low) ***Alternative***: Low (Low)
Environmental	Groundwater (A&B) from vadose zone[c]	Low – Multiple (e.g., Tc-99)[f] **Overall**: Low	Low – Multiple (e.g., Tc-99)[f] **Overall**: Low
Environmental	Columbia River from vadose zone[c]	Benthic: Not Discernible (radionuclides) Not Discernible (chemicals) Riparian: Not Discernible (radionuclides) Not Discernible (chemicals) Free-flowing: Not Discernible (all) **Overall**: Not Discernible[f]	Benthic: Not Discernible (radionuclides) Not Discernible (chemicals) Riparian: Not Discernible (radionuclides) Not Discernible (chemicals) Free-flowing: Not Discernible (all) **Overall**: Not Discernible[f]
Environmental	Ecological Resources[e]	ND	ND to Medium
Social	Cultural Resources[e]	**Native American:** Direct: Unknown Indirect: Known **Historic Pre-Hanford:** Direct: Unknown Indirect: Unknown **Manhattan/Cold War:** Direct: Known Indirect: Known	**Native American:** Direct: Unknown Indirect: Known **Historic Pre-Hanford:** Direct: Unknown Indirect: Unknown **Manhattan/Cold War:** Direct: Known Indirect: Known

a. A rating for cultural resources is not being made because cultural resources will be evaluated under Section 106 of the National Historic Preservation Act (16 USC 470, et. seq.) during the planning for remedial action.

b. Evaluated in Section 1.6.

c. Groundwater threat for Group A and B contaminants remaining in the vadose zone or to the Columbia River for all primary contaminants. Threats from existing plumes associated with the 200 East DST Tank and Waste Farms EU are described in Section 9.5 and Appendix G.5 (CP-GW-1) for the 200-PO-1 and 200-BP-5 Groundwater Operable Units.

d. Industrial safety consequences range from low to high (based on the evaluation scale used) for both mitigated (with controls) and unmitigated (without controls). Mitigated radiological and toxicological consequences to facility workers are high (unmitigated) and low (mitigated).

e. 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.

f. Small legacy site(s) are associated with the 200-East DSTs where the threat to groundwater is from the inventory in the 216-A-39 crib. Note the ratings are not related to the waste in the DSTs (or the Tank AY-102 leak into the annulus). This small amount of contamination would not be able to support a plume (only from this EU) that could impact the Columbia River.

Support for Risk and Impact Ratings for Each Population or Resource

Human Health

The current and cleanup-related consequences related to work being conducted at the Tank Farms in the 200 Areas (Hanford Central Plateau) was evaluated in Section 1.6 (Appendix E.1).

Groundwater, Vadose Zone, and Columbia River

Contaminants from the Hanford double-shell Tank Farms are not currently impacting groundwater nor are the secondary sources; future impacts to groundwater or the Columbia River are not expected (e.g., the small amounts of vadose zone contaminants could not alone support plumes to the Columbia River). There are very small legacy sources (216-A-39 crib, unplanned releases, etc.) associated with this EU. The contaminants in the legacy source sites are considered unlikely to ever impact the Columbia River ecology (benthic, riparian, or free-flowing).

Ecological Resources

Current

No resources on site, but about 5% level 3 resources on buffer. If no trucks, ND effects currently.

Risks and Potential Impacts from Selected or Potential Cleanup Approaches

No resources on EU, but about 5% level 3 resources on buffer. Remediation could result in truck disturbance, increases in exotic species, changes in species composition in buffer, and contamination of sensitive species.

Cultural Resources

Current

Manhattan Project/Cold War significant resources have already been mitigated. Area is very disturbed and there are no known recorded archaeological resources within the EU. Traditional cultural places are visible from EU.

Risks and Potential Impacts from Selected or Potential Cleanup Approaches

Because area has not been investigated either on the surface or subsurface, archaeological investigations may need to occur within pockets of undisturbed land if any prior to remediation. Potential for intact archaeological material to be present is very low.

Considerations for Timing of the Cleanup Actions

There is potential for additional tank degradation and further leaks and contaminant transport through the vadose and saturated zones if Tank Farm closure activities are significantly delayed. For example, in 2012 DOE found that waste from one double-shell tank in the 200-East DST Farm EU (AY-102) had leaked from the primary shell into the annulus (but not the environment), and that 12 other DSTs "have construction flaws similar to those that contributed to the leak in AY-102" (GAO 2014). There is also potential risk from direct radiation and tank waste contaminants to workers (and ecological receptors) from routine Tank Farm operations. However, there would be no additional risk to facility workers, co-located persons, or the public if cleanup is delayed.

Near-Term, Post-Cleanup Risks and Potential Impacts

The assumed tank closure alternative includes 99 percent retrieval of waste from the double-shell tanks (DSTs) and treatment elsewhere onsite; operations and necessary maintenance, waste transfers and associated operations, and upgrades to existing tanks or construction of waste receipt facilities. DST closure operations is assumed to include filling the tanks and ancillary equipment with grout to immobilize residual waste contaminants. Disposal of contaminated equipment and soil would occur on site. Decisions on the extent of soil removal and/or treatment would be made on a tank farm or waste management area basis through the RCRA closure permitting process. The tanks would be stabilized with grout, and an engineered modified RCRA Subtitle C barrier put in place followed by post-closure care.

Thus workers and the public would be isolated from the residual contamination in the tanks by both grout and soil cover. Tank waste contamination already in the vadose and saturated zones would experience reduced infiltrating water (the primary driver for the release and transport of contaminants) because of the surface barrier.

Likely monitoring of caps, with potential for disruption due to monitoring. Re-vegetation could result in higher quality habitat on EU, but could be some residual contamination to sensitive resources.

Permanent indirect effects to viewshed are possible from capping. Permanent effects may be possible due to presence of contamination if capping occurs. No other expected cultural resources impacts.

9.2. ADMINISTRATIVE INFORMATION

OU and/or TSDF Designation(s):

The 200-East DST Tank and Waste Farms Evaluation Unit (EU), denoted *CP-TF-8*, consists of 25 waste tanks and ancillary structures.

Common name(s) for EU:

There is no common name for the 200-East DST EU because the EU is comprised of elements from a set of double-shell Tank Farms. Other components in the EU (including associated legacy waste sites) are listed below in the *Primary EU Source Components* section.

The only legacy source site with a non-zero inventory is the 216-A-39 crib.

KEY WORDS:

Double-shell Tank Farm, 241-AN Tank Farm, 241-AP Tank Farm, 241-AW Tank Farm, 241-AY Tank Farm, 241-AZ Tank Farm, waste tanks, tank farm

REGULATORY STATUS

Regulatory Basis

The 200 Areas of the Hanford Site have been placed by EPA on the National Priorities List (NPL). The completion of remediation of the 200 Areas overall will eventually be finalized via CERCLA decisions made by the EPA, and permitting decisions made by Ecology.

DOE is the responsible agency for the closure of all Tank Farms through post closure, in close coordination with other closure and cleanup activities of the Hanford Central Plateau. Washington State has a program that is authorized under RCRA and implemented through the HWMA and its associated regulations. Please refer to Section 1.2 (Appendix E.1) for more information.

Applicable Regulatory Documentation

Please refer to Section 1.2 (Appendix E.1).

Applicable Consent Decree or TPA Milestones

Not applicable.

RISK REVIEW EVALUATION INFORMATION

Completed: Revised August 25, 2015

Evaluated by: K. Jones and K. G. Brown

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

9.3. 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: The legacy source sites associated with the 200-East DST Farm EU are described in Attachment Section 9.8. They are very small quantity sources including the 216-A-39 crib and various unplanned releases. Only the 216-A-39 cribs has a non-zero inventory; the other inventories are unknown and considered insignificant for this Review.

High-Level Waste Tanks and Ancillary Equipment: The 25 double-shell waste tanks in the 241-AN (-101 through -107 tanks), 241-AP (-101 through -108), 241-AW (-101 through -106), 241-AY (-101 and -102), and 241-AZ (-101 and -102). The ancillary equipment included in the200-East DST Farm EU is listed in Attachment Section 9.8 and consists primarily of pipelines, diversion boxes, and catch tanks.

Groundwater Plumes:

There are no groundwater plumes associated with the 200-East DSTs.

Operating Facilities: The DSTs will be used to process the wastes in the SSTs. Because of concerns with risks resulting from SSTs, the tank waste retrieval process currently planned at Hanford consists of two general phases: 1) retrieving wastes from SSTs to double-shell tanks (that are RCRA-compliant) for staging and subsequent tank closure and 2) mixing of the retrieved and staged SST waste for delivery to treatment facilities at the WTP. Thus the DSTs are considered an Operating Facility for this Review.

D&D of Inactive Facilities: Not Applicable.

LOCATION AND LAYOUT MAPS

A series of maps are used to illustrate the location of the components within the CP-TF-8 EU and the 200-East DST Farm EU relative to the Hanford Site. Figure E.2-1 shows the relationship between the 200-E (200 East) Area (where the 200-East DST Farm EU is located) and the Hanford Site. Figure E.9-1 illustrates the 200-East DST Farm EU boundary. Figure E.9-2 shows a detailed view of the waste tanks, ancillary equipment, and legacy source units in the 200-East DST Farm EU.

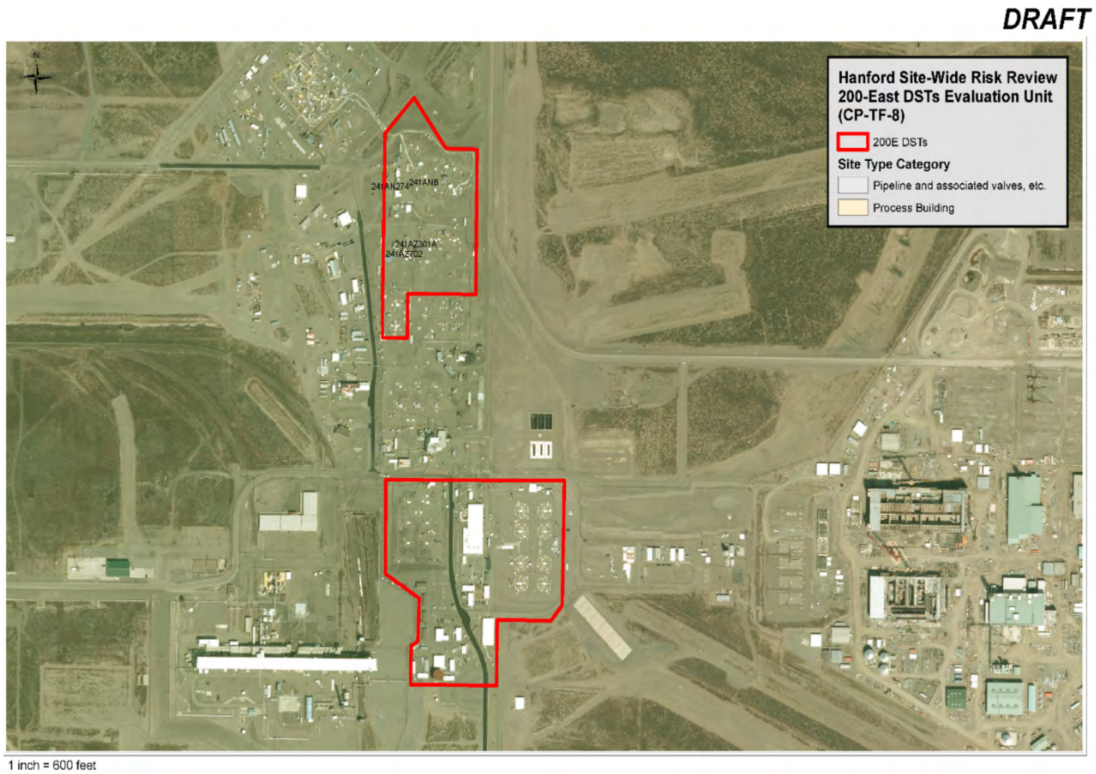

Figure E.9-1. Polygon representing the boundary of the 200-East DST Farm Evaluation Unit (Attachment Section 9.8).

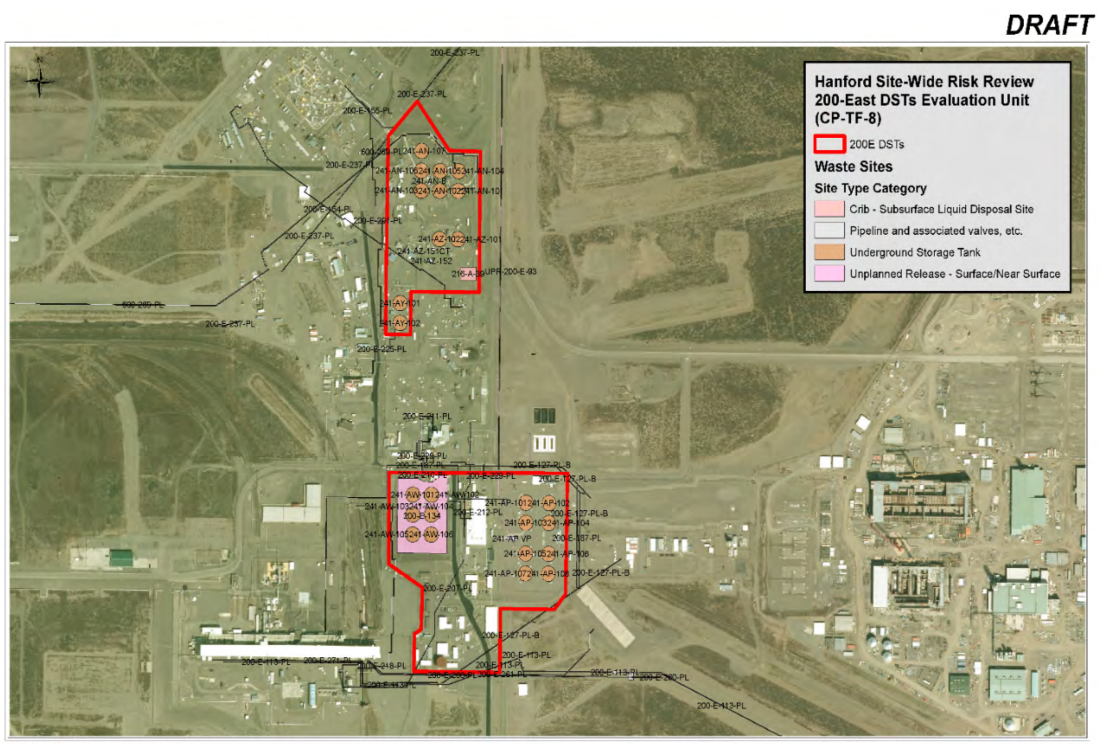

Figure E.9-2. Hanford 200-East DST Farm Evaluation Unit including tanks, legacy source units, and ancillary equipment (Attachment Section 9.8).

9.4. UNIT DESCRIPTION AND HISTORY

EU Former / Current Uses

The Double-Shell Tank (DST) System began operations between April 1971 and October 1986. The DST System is used for receipt and the storage of liquid mixed waste generated on the Hanford Facility. Liquid mixed waste is transferred through buried double-encased transfer lines from SSTs to designated underground DSTs. Note that hose-in-hose temporary transfer lines are used for SST to DST transfers only. Transfers from tanker trucks use a single wall hose with plastic sleeving as the secondary containment and is under continuous surveillance (WA7890008967 Pt III).

Legacy Source Sites

There is a crib (216-A-39) with an inventory and three unplanned release sites (with unknown inventories) in the CP-TF-8 EU (Attachment Section 9.8). The contribution from these sites is small.

High-Level Waste Tanks

See Section 9.3 for details.

Groundwater Plumes – Not Applicable

D&D of Inactive Facilities – Not Applicable

Operating Facilities – Not Applicable

The CP-TF-8 DSTs in the EU can be considered Operating Facilities for this Review since they will be used to process the single-shell tank waste.

Ecological Resources Setting

Landscape Evaluation and Resource Classification:

The amount and proximity of the biological resources to the EUs were examined within the adjacent landscape buffer areas radiating approximately 386 m (northern polygon) and 420 m (southern polygon) from the geometric centers of the EU (equivalent to 228.6 acres combined). The major portion—that is, nearly 90%—of the 200-East Double Shell Tanks EU and adjacent landscape buffer is comprised of level 0 and level 1 habitat resources (Appendix J, Table 2, p. J-57 and Figure 8, p. J-58). Small patches of level 2 habitat are located close to, but not contiguous with the northern and southern extents of the two EU polygons. A small patch (approximately 2 to 3 acres of level 3 habitat is located to the east of the two polygons (300 to 700 feet away from EU boundaries), and individual occurrences of level 3 plant species, Piper's daisy (*Erigeron piperianus*) are located to the south.

Field Survey:

Field surveys conducted in October 2014 confirmed that the majority of the 200-East Double Shell Tanks EU consists of buildings, parking areas, graveled surfaces, and infrastructure related to the tanks. No vegetation measurements were taken and no field data sheets are included. The table in Appendix J (Appendix J, Table 2, p. J-57) documents the surface conditions of the EU. No wildlife was observed within the EU during the October 2014 survey; however, PNNL ECAP surveys conducted in 2009 noted the following wildlife on/near the buildings: house finch (*Carpodacus mexicanus*), Brewer's blackbird (*Euphagus byanocephalus*), black-billed magpie (*Pica pica*), and western kingbird (*Tyrannus verticalis*).

CULTURAL RESOURCES SETTING

Underground Liquid Waste Tanks Farm, a contributing property within the Manhattan Project/Cold War Era Landscape with no documentation required. All documentation has been addressed as described in the *Hanford Site Manhattan Project and Cold War Era Historic District Treatment Plan* (DOE/RL-97-56). There are no known archaeological sites, or TCPs known to be recorded within the 200-East DSTs EU. None of the 200-East DSTs EU has been inventoried for archaeological resources with the exception of a very small portion. No archeological resources were located by this inventory in the 200-East DSTs EU. There is a possibility, but unlikely given the extensive disturbance in the 200-East DSTs EU, that intact archaeological material is present in the areas that have not been inventoried for archaeological resources (both on the surface and in the subsurface), particularly if undisturbed soil deposits exist within the 200-East DSTs EU. Closure and remediation of the tank farms located within the 200-East DSTs EU has been addressed in an NHPA Section 106 review completed.

Several National Register-eligible properties associated with the Manhattan Project/Cold War Era Landscape both with documentation required (Hanford Site Plant Railroad and the 2707AR Sludge Vault Change House) and no documentation required (244 AR Vault Facility and Canyon and 242BA 242-A Boiler Annex)are located within 500 meters of the 200-East DSTs EU. Also see the list of Manhattan Project/Cold War Era buildings located within the PUREX Evaluation Unit which is located in adjacent to the 200-East DSTs EU. All have been documented as described in the *Hanford Site Manhattan Project and Cold War Era Historic District Treatment Plan* (DOE/RL-97-56).

Historic maps indicate that there is no evidence of historic settlement in or near the 200-East DSTs EU. Geomorphology throughout most of the 200-East DSTs EU (with the exception of the eastern portion of the southern-most area of the 200-East DSTs EU) and extensive ground disturbance further suggest a low potential for intact archaeological resources associated with all three landscapes to be present subsurface within the 200-East DSTs EU. Pockets of undisturbed soil may exist, it may be appropriate to conduct surface and subsurface archaeological investigations in these areas prior to initiating a remediation activity. 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 associated with these landscapes (e.g. East Benton Historical Society, the Franklin County Historical Society, Prosser Cemetery Association, the Reach, and B-Reactor Museum Association) may need to occur. Indirect effects are always possible when TCPs are known to be located in the general vicinity. Consultation with Hanford Tribes may also 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.

9.5. WASTE AND CONTAMINATION INVENTORY

Table E.9-2 provides inventory estimates of the various source components associated with the 200-East DST Farm EU (CP-TF-8); these are primarily tank wastes and ancillary equipment. The legacy sources (primarily discharges to cribs) are very small relative to the DST and other SST legacy inventory in the vadose zone as shown in Figure E.9-3 through Figure E.9-11. Thus the primary focus should be on the tank waste and ancillary equipment for the EU.

The major sources for before assumed retrieval are the 200-East DSTs. A 99% retrieval as used for the Hanford SSTs (CP-TF-1 through CP-TF-7) is also assumed for the 200-East DST Farm EUs. The tank residuals represent the largest source after assumed 99% retrieval for the contaminants with the remaining contribution from ancillary equipment. The current maximum groundwater threat metric (GTM) (Figure E.9-12)[132] is dominated by the Tc-99 and I-129 in the 200-East DST Farms wastes before retrieval and by residual waste after assumed 99% retrieval.

CONTAMINATION WITHIN PRIMARY EU SOURCE COMPONENTS

Legacy Source Sites

The estimated 200-East DST Farm inventory for the Legacy / Vadose Zone Source Sites (in this case, a small inventory in a crib) is summarized in Table E.9-2 and further described in Figure E.9-3 through Figure E.9-11 before and after planned 99% retrieval (which will have no impact on the legacy source site inventories). These legacy source inventories are relatively small.

Waste Tanks and Ancillary Equipment

The estimated total inventory for the 200-East DST Farm waste tanks and Ancillary Equipment is provided in Table E.9-2 for both assumed 90% and 99% retrieval scenarios. The tank-by-tank inventories are provided in Table E.9-3 through Table E.9-6. Safety-related information (i.e., hydrogen generation rates and times to the lower flammability limit are also provided. The inventories for the various contaminant in the 200-East DST Farm tanks vary over several orders of magnitude as does the GTM. This information is further summarized in Figure E.9-3 through Figure E.9-11 before and after assumed 99% retrieval and for the maximum GTM (I-129 and Tc-99) in Figure E.9-12.

Vadose Zone Contamination

The estimated inventories for the vadose zone are found in Table E.9-2. These inventories represent the vadose zone contamination *outside* the tanks and ancillary equipment (i.e., that are generally available for transport through the environment); however, as shown in Figure E.9-3 through Figure E.9-11, these values are relatively small. These values are used to estimate the inventory remaining in the vadose zone using the process described in Chapter 6 of the Methodology Report (CRESP 2015). The focus in this section will be on the Group A and B contaminants in the vadose zone due to their mobility and persistence and potential threats to groundwater. Using the process outlined in Chapter 6 of the Methodology Report (CRESP 2015), the vadose zone inventories in Table E.9-2 are estimated and used to calculate Groundwater Threat Metric (GTM) values for the Group A and B contaminants remaining in the vadose zone as illustrated in Table E.9-7. The ratings associated with potential vadose zone threats related to the 200-East DST Farm EU are *Low* for all primary contaminants (with non-zero inventories) except for Sr-90 and uranium for all evaluation periods[133].

Groundwater Plumes

There are no plumes associated with 200-East DST Farm EU sources (Table E.9-2) nor are any expected in the foreseeable future.

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[132] Maximum of the GTMs for Tc-99 and I-129 only.

[133] As indicated in Section 6.5 (A-AX TF EU) and Section 7.5 (B-BX-BY TF EU), Sr-90 and uranium are likely relatively immobile in the Active Cleanup and Near-term, Post-Cleanup periods, which leads to ND ratings. The ratings after the Near-term, Post-Cleanup period are *Low* to address uncertainties.

Columbia River – Benthic, Riparian, and Free-flowing Ecology – All Evaluation Periods

The process illustrated in Chapter 6 of the Methodology Report (CRESP 2015) is used to evaluate potential impacts to the Columbia River. Since there are no plumes associated with the 200-East DST Farm EU (Table E.9-2) nor are any expected in the foreseeable future (i.e., not sufficient source from this one EU to support plumes to the Columbia River), the potential for impacts to the Columbia River benthic, riparian, or free-flowing ecology is not credible based on current information. Thus the ratings associated with potential threats from 200-East DST Farm EU to Columbia River benthic, riparian, or free-flowing receptors are defined to be *Not Discernible* for all contaminants and all evaluation periods.

Facilities for D&D – Not Applicable

Operating Facilities

The CP-TF-8 DSTs in the EU can be considered Operating Facilities for this Review since they will be used to process the single-shell tank waste. The inventory associated with these facilities is thus that shown for the Waste Tanks and Ancillary Equipment above.

Table E.9-2. Summary Table of Infrastructure and Subsurface Contamination Inventory for the AN/AP/AW/AY/AZ Tank and Waste Farms EU (CP-TF-8) [(a)(b)]

Contaminated Media	Primary Contaminants	Total Amount. of Each Contaminant Before Retrieval	90% Retrieval Scenario	99% Retrieval Scenario
Infrastructure (Tanks and Ancillary Equipment)				
Tank Waste	Waste (kGal)	24494	2449.4	244.94
	Sludge (kGal)	1924	192.4	19.24
	Saltcake (kGal)	3175	317.5	31.75
	Supernatant (kGal)	19395	1939.5	193.95
Tank Waste (rad)	Am-241 (Ci)	92000	9200	920
	C-14 (Ci)	180	18	1.8
	Co-60 (Ci)	2100	210	21
	Cs-137 (Ci)	26000000	2600000	260000
	Eu-152 (Ci)	390	39	3.9
	Eu-154 (Ci)	31000	3100	310
	H-3 (Ci)	790	79	7.9
	I-129 (Ci)	16	1.6	0.16
	Ni-59 (Ci)	310	31	3.1
	Ni-63 (Ci)	26000	2600	260
	Pu (total) (Ci)	61000	6100	610
	Sr-90 (Ci)	21000000	2100000	210000
	Tc-99 (Ci)	14000	1400	140
	U (total) (Ci)	480	48	4.8
Tank Waste (non-rad)	Cr (kg)	68000	6800	680
	Hg (kg)	400	40	4
	NO3 (kg)	13000000	1300000	130000
	Pb (kg)	29000	2900	290
	U (total) (kg)	150000	15000	1500
Ancillary Equipment (rad)	C-14 (Ci)	1.7	1.7	1.7
	Cs-137 (Ci)	89000	89000	89000
	H-3 (Ci)	6.5	6.5	6.5
	I-129 (Ci)	0.052	0.052	0.052

Contaminated Media	Primary Contaminants	Total Amount. of Each Contaminant Before Retrieval	90% Retrieval Scenario	99% Retrieval Scenario
	Pu (total) (Ci)	41	41	41
	Sr-90 (Ci)	71000	71000	71000
	Tc-99 (Ci)	39	39	39
	U (total) (Ci)	0.23	0.23	0.23
Ancillary Equipment (non-rad)	Cr (kg)	210	210	210
	Hg (kg)	0.86	0.86	0.86
	NO3 (kg)	57000	57000	57000
	Pb (kg)	52	52	52
	U (total) (kg)	210	210	210
Vadose Zone Source (Leaks and Intentional Discharges into Cribs and Trenches)				
Cribs (rad)	Am-241 (Ci)	0.00013	0.00013	0.00013
	C-14 (Ci)	6.00E-05	6.00E-05	6.00E-05
	Co-60 (Ci)	0.00048	0.00048	0.00048
	Cs-137 (Ci)	15	15	15
	Eu-152 (Ci)	2.00E-05	2.00E-05	2.00E-05
	Eu-154 (Ci)	0.0016	0.0016	0.0016
	H-3 (Ci)	0.00024	0.00024	0.00024
	I-129 (Ci)	2.00E-07	2.00E-07	2.00E-07
	Ni-59 (Ci)	2.70E-05	2.70E-05	2.70E-05
	Ni-63 (Ci)	0.0026	0.0026	0.0026
	Pu (total) (Ci)	0.00035	0.00035	0.00035
	Sr-90 (Ci)	0.05	0.05	0.05
	Tc-99 (Ci)	0.0034	0.0034	0.0034
	U (total) (Ci)	4.30E-07	4.30E-07	4.30E-07
Cribs (non-rad)	Cr (kg)	0.0085	0.0085	0.0085
	Hg (kg)	6.50E-06	6.50E-06	6.50E-06
	NO3 (kg)	0.15	0.15	0.15
	Pb (kg)	0.003	0.003	0.003
	U (total) (kg)	0.00062	0.00062	0.00062
Vadose Zone (from Vadose Zone Sources)				
VZ Remaining (rad)	Am-241 (Ci)	0.00013	0.00013	0.00013
	C-14 (Ci)	6.00E-05	6.00E-05	6.00E-05

Contaminated Media	Primary Contaminants	Total Amount. of Each Contaminant Before Retrieval	90% Retrieval Scenario	99% Retrieval Scenario
	Co-60 (Ci)	0.00048	0.00048	0.00048
	Cs-137 (Ci)	15	15	15
	Eu-152 (Ci)	2.00E-05	2.00E-05	2.00E-05
	Eu-154 (Ci)	0.0016	0.0016	0.0016
	H-3 (Ci)	0.00024	0.00024	0.00024
	I-129 (Ci)	2.00E-07	2.00E-07	2.00E-07
	Ni-59 (Ci)	2.70E-05	2.70E-05	2.70E-05
	Ni-63 (Ci)	0.0026	0.0026	0.0026
	Pu (total) (Ci)	0.00035	0.00035	0.00035
	Sr-90 (Ci)	0.05	0.05	0.05
	Tc-99 (Ci)	0.0034	0.0034	0.0034
	U (total) (Ci)	4.30E-07	4.30E-07	4.30E-07
VZ Remaining (non-rad)	Cr (kg)	0.0085[c]	0.0085[c]	0.0085[c]
	Cr-VI (kg)	0.0085[c]	0.0085[c]	0.0085[c]
	Hg (kg)	6.50E-06	6.50E-06	6.50E-06
	NO3 (kg)	0.15	0.15	0.15
	Pb (kg)	0.003	0.003	0.003
	U (total) (kg)	0.00062	0.00062	0.00062
Saturated Zone (from Vadose Zone Sources)				

a. Tanks (SST and DST): Best Basis Inventory (BBI) March 2014; Ancillary Equipment (Anc Eq): Tank Farm Closure & Waste Management (TC&WM) Environmental Impact Statement (DOE/EIS-0391) Appendix D; Unplanned Releases (UPRs): Soil Inventory Model (SIM) Rev 1 (RPP-26744, Rev 0); Ponds: Soil Inventory Model (SIM) Rev 1 (RPP-26744, Rev 0); Cribs: Soil Inventory Model (SIM) Rev 1 (RPP-26744, Rev 0); Trenches: Soil Inventory Model (SIM) Rev 1 (RPP-26744, Rev 0) and Tank Farm Closure & Waste Management (TC&WM) Environmental Impact Statement (DOE/EIS-0391) Appendix S; Leaks: Tank Farm Closure & Waste Management (TC&WM) Environmental Impact Statement (DOE/EIS-0391) Appendix D; MUSTs: Soil Inventory Model (SIM) Rev 1 (RPP-26744, Rev 0) and Tank Farm Closure & Waste Management (TC&WM) Environmental Impact Statement (DOE/EIS-0391) Appendix S.

b. All primary contaminant inventories are reported to 2 significant figures. The source document should be consulted for greater precision data.

c. Differences in inventories for Cr vs Cr-IV are due to differing Water Quality Standards (WQS) and thus plume extents: 100 mg/L for total chromium vs 48 mg/L for chromium (IV). Some differences may not be apparent due to the number of significant figures (2) used.

Table E.9-3. Current Bulk Inventory and Steady State Flammability Results (by Tank) for the AN-AP-AW-AY-AZ Double-Shell Tank Farms (CP-TF-8)

Tank ID	Tank Type	Capacity (kGal)[(a)]	Sludge (kGal)[(a)]	Saltcake (kGal)[(a)]	Supernatant (kGal)[(a)]	HGR(c) (ft3/d)[(b)]	Days to 25% LFL Barometric[(c)]	Days to 25% LFL Zero Ventilation[(d)]
AN-101	DST	1160	399	31	320	17	45	40
AN-102	DST	1160	0	154	914	32	12	11
AN-103	DST	1160	0	486	477	24	21	20
AN-104	DST	1160	0	443	609	29	13	13
AN-105	DST	1160	0	536	591	28	11	11
AN-106	DST	1160	407	25	236	24	34	31
AN-107	DST	1160	0	241	836	32	11	11
AP-101	DST	1257	0	33	1201	17	11	11
AP-102	DST	1160	28	0	1111	15	21	20
AP-103	DST	1257	0	52	1183	16	11	11
AP-104	DST	1160	0	100	646	13	91	75
AP-105	DST	1257	0	105	1140	15	11	11
AP-106	DST	1160	0	0	1129	13	24	23
AP-107	DST	1160	0	0	439	11	126	96
AP-108	DST	1257	0	112	1128	16	11	11
AW-101	DST	1160	0	396	737	26	12	12
AW-102	DST	1160	52	0	912	17	38	35
AW-103	DST	1160	280	40	760	12	32	30
AW-104	DST	1160	97	157	801	14	28	27
AW-105	DST	1160	248	0	153	11	144	106
AW-106	DST	1160	0	264	872	22	14	14
AY-101	DST	1018	105	0	894	15	36	33
AY-102	DST	1018	151	0	645	93	7.1	7

Tank ID	Tank Type	Capacity (kGal)[a]	Sludge (kGal)[a]	Saltcake (kGal)[a]	Supernatant (kGal)[a]	HGR(c) (ft3/d)[b]	Days to 25% LFL Barometric[c]	Days to 25% LFL Zero Ventilation[d]
AZ-101	DST	1018	52	0	775	54	12	11
AZ-102	DST	1018	105	0	886	47	9.9	9.7

a. Volumes from the Waste Tank Summary Report coinciding with the BBI (Rodgers 2014).

b. Hydrogen generation rate (ft^3/d) (RPP-5926 Rev. 15). Note in 2001 all 24 tanks were removed from the flammable gas watch list (including T-110 in the T Tank and Waste Farms EU) (Johnson, et al. 2001, p. iii).

c. Time (in days) to 25% of the Lower Flammability Limit (LFL) under a barometric (barom) breathing scenario (RPP-5926, Rev. 15). “NA” indicates that the headspace will not reach specified flammability level.

d. Time (in days) to 25% of the LFL under a zero ventilation scenario (RPP-5926, Rev. 15).

Table E.9-4. Current Primary Contaminant Inventory (by Tank) for the AN-AP-AW-AY-AZ Double-Shell Tank Farms (CP-TF-8) [(a)]

Tank ID	Decay Date	Am-241 (Ci)	C-14 (Ci)	Cl-36 (Ci)	Co-60 (Ci)	Cs-137 (Ci)	Eu-152 (Ci)	Eu-154 (Ci)	H-3 (Ci)
AN-101	2001	4800	5.9	NP[(b)]	130	420000	12	710	74
AN-102	2001	840	2.9	NP	41	1300000	1.6	320	1.7
AN-103	2001	21	15	NP	14	1600000	2.5	120	5.8
AN-104	2001	48	11	NP	12	1700000	2.1	88	15
AN-105	2001	53	14	NP	18	1300000	2.5	140	3.4
AN-106	2001	8400	2.2	NP	230	350000	24	2600	29
AN-107	2001	3100	7.2	NP	160	1200000	1.7	2200	7.7
AP-101	2001	5.9	7.5	NP	20	1100000	6.8	70	4.3
AP-102	2001	7.2	12	NP	9.8	930000	4	98	39
AP-103	2001	33	26	NP	24	990000	5.7	53	91
AP-104	2001	3.1	3.4	NP	6.6	180000	1	8.4	4.2
AP-105	2001	7.9	6.8	NP	20	1400000	5.3	140	6.2
AP-106	2001	2.6	4.2	NP	7.6	690000	4.7	450	54
AP-107	2001	0.49	2	NP	5.3	540000	2.8	25	10
AP-108	2001	8.3	11	NP	11	890000	8.5	52	45
AW-101	2001	110	11	NP	19	1400000	2.3	130	23
AW-102	2001	570	4.3	NP	15	960000	4.8	50	49
AW-103	2001	180	2.4	NP	25	350000	2	42	5.2
AW-104	2001	100	4.8	NP	12	880000	3	76	4.7
AW-105	2001	700	3.2	NP	18	39000	0.064	6.3	180
AW-106	2001	49	13	NP	17	820000	2	97	13
AY-101	2001	15000	2.3	NP	340	150000	83	4900	38
AY-102	2001	5000	0.92	NP	47	610000	52	4700	12
AZ-101	2001	24000	6	NP	440	4900000	85	7500	38
AZ-102	2001	28000	2.2	NP	450	1400000	75	6300	39

a. From Best Basis Inventory (BBI) Summary (March 24, 2014) provided in spreadsheet form by Mark Triplett. All primary contaminant inventories are reported to 2 significant figures. The source document should be consulted for greater precision data.

b. NP = Not present at significant quantities

Table E.9-5. Current Primary Contaminant Inventory [a] and Groundwater Threat Metric (by Tank) for the AN-AP-AW-AY-AZ Double-Shell Tank Farms (CP-TF-8)

Tank ID	I-129 (Ci)	Ni-59 (Ci)	Ni-63 (Ci)	Pu (total) (Ci)[b]	Sr-90 (Ci)	Tc-99 (Ci)	U (total) (Ci)[c]	GTM (Mm3)[d]
AN-101	0.86	15	1300	14000	810000	200	380	350
AN-102	0.58	4.7	420	270	310000	580	1.4	640
AN-103	1.2	14	1200	22	5700	680	0.18	760
AN-104	0.69	9.8	880	37	65000	790	0.64	880
AN-105	0.85	13	1100	34	26000	1100	0.38	1200
AN-106	0.86	29	2300	6900	3900000	140	21	350
AN-107	0.6	75	5200	1000	450000	430	0.97	480
AP-101	0.79	4.5	400	13	5900	760	0.21	840
AP-102	1.3	1.5	140	3.1	1700	700	0.19	780
AP-103	1.4	3.9	350	39	13000	960	0.26	1100
AP-104	0.19	3	270	11	2800	160	0.4	170
AP-105	0.88	4.4	400	20	20000	950	0.24	1100
AP-106	0.33	4.3	380	0.72	4600	370	0.065	410
AP-107	0.085	0.83	74	3.3	2700	180	0.02	200
AP-108	1.1	5.5	440	6.1	4300	720	0.23	800
AW-101	0.67	9.7	880	510	75000	820	3.8	910
AW-102	0.29	3.3	300	270	160000	320	4.5	360
AW-103	0.27	3.3	130	2900	12000	400	15	440
AW-104	0.86	4	370	5000	5300	760	8.9	840
AW-105	0.064	0.068	6.2	5300	55000	9.3	18	26
AW-106	0.78	10	940	890	40000	590	3.7	660
AY-101	0.14	33	3000	4000	2100000	58	3	64
AY-102	0.49	25	2200	4200	4200000	180	1.7	200
AZ-101	0.39	21	2000	8100	4800000	1200	1.6	1400
AZ-102	0.16	11	1000	7800	3600000	400	6.2	450

a. From Best Basis Inventory (BBI) Summary (March 24, 2014) provided in spreadsheet form by Mark Triplett. All primary contaminant inventories are reported to 2 significant figures. The source document should be consulted for greater precision data.

b. Sum of plutonium isotopes 238, 239, 240, 241, and 242

c. Sum of uranium isotopes 232, 233, 234, 235, 236, and 238

d. The Groundwater Threat Metric (GTM) shown for tanks is equal to the maximum of the GTM for Tc-99 and I-129.

Table E.9-6. Current Primary Contaminant Inventory (by Tank) for the AN-AP-AW-AY-AZ Double-Shell Tank Farms (CP-TF-8) [(a)]

Tank ID	CCl4 (kg)	CN (kg)	Cr (kg)	Cr-VI (kg)	Hg (kg)	NO3 (kg)	Pb (kg)	TBP (kg)	TCE (kg)	U (total) (kg)
AN-101	NP[(b)]	NP	2400	NP	80	210000	3300	NP	NP	54000
AN-102	NP	NP	2100	NP	0.45	880000	740	NP	NP	960
AN-103	NP	NP	2600	NP	1.6	660000	430	NP	NP	130
AN-104	NP	NP	4600	NP	1.2	730000	170	NP	NP	460
AN-105	NP	NP	7300	NP	1.9	690000	260	NP	NP	270
AN-106	NP	NP	2800	NP	120	210000	13000	NP	NP	24000
AN-107	NP	NP	1400	NP	0.65	780000	1700	NP	NP	680
AP-101	NP	NP	3700	NP	0.038	1000000	130	NP	NP	130
AP-102	NP	NP	2700	NP	0.0018	730000	280	NP	NP	60
AP-103	NP	NP	3200	NP	0.25	850000	180	NP	NP	210
AP-104	NP	NP	1200	NP	3.1	240000	60	NP	NP	280
AP-105	NP	NP	2300	NP	0.3	860000	140	NP	NP	160
AP-106	NP	NP	3000	NP	0	300000	17	NP	NP	23
AP-107	NP	NP	990	NP	0.014	190000	22	NP	NP	12
AP-108	NP	NP	3600	NP	0.003	910000	150	NP	NP	140
AW-101	NP	NP	1200	NP	1.7	820000	690	NP	NP	2700
AW-102	NP	NP	2000	NP	7.6	360000	1300	NP	NP	6500
AW-103	NP	NP	5000	NP	0.22	370000	44	NP	NP	14000
AW-104	NP	NP	3500	NP	0.4	450000	240	NP	NP	9800
AW-105	NP	NP	1200	NP	0	49000	120	NP	NP	20000
AW-106	NP	NP	2300	NP	1.6	650000	210	NP	NP	2700
AY-101	NP	NP	2000	NP	19	110000	730	NP	NP	490
AY-102	NP	NP	2000	NP	160	350000	4300	NP	NP	2000
AZ-101	NP	NP	2700	NP	1.1	190000	150	NP	NP	1700
AZ-102	NP	NP	2400	NP	5	250000	800	NP	NP	7100

a. From Best Basis Inventory (BBI) Summary (March 24, 2014) provided in spreadsheet form by Mark Triplett. All primary contaminant inventories are reported to 2 significant figures. The source document should be consulted for greater precision data.

b. NP = Not present at significant quantities

Table E.9-7. Summary of the Evaluation of Threats to Groundwater as a Protected Resource from Remaining Vadose Zone (VZ) Contamination associated with the AN-AP-AW-AY-AZ Double-Shell Tank Farms (CP-TF-8)

PC	Group	WQS	Porosity[(a)]	K_d (mL/g)[(a)]	ρ (kg/L)[(a)]	VZ Source M^{Source}	SZ Total M^{SZ}	Treated[(c)] M^{Treat}	VZ Remaining M^{Tot}	VZ GTM (Mm^3)	VZ Rating[(d)]
C-14	A	2000 pCi/L	0.25	0	1.82	5.96E-05 Ci	---	---	5.96E-05 Ci	2.98E-05	Low
I-129	A	1 pCi/L	0.25	0.2	1.82	2.04E-07 Ci	---	---	2.04E-07 Ci	8.30E-05	Low
Sr-90	B	8 pCi/L	0.25	22	1.82	4.96E-02 Ci	---	---	4.96E-02 Ci	3.85E-02	ND[(e)]
Tc-99	A	900 pCi/L	0.25	0	1.82	3.39E-03 Ci	---	---	3.39E-03 Ci	3.77E-03	Low
CCl_4	A	5 µg/L	0.25	0	1.82	---	---	---	---	---	ND
Cr	B	100 µg/L	0.25	0	1.82	8.47E-03 kg	---	---	8.47E-03 kg	8.47E-05	Low
Cr-VI	A	48 µg/L[(b)]	0.25	0	1.82	8.47E-03 kg	---	---	8.47E-03 kg	1.76E-04	Low
TCE	B	5 µg/L	0.25	2	1.82	---	---	---	---	---	ND
U(tot)	B	30 µg/L	0.25	0.8	1.82	6.21E-04 kg	---	---	6.21E-04 kg	3.03E-06	ND[(e)]

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

b. "Model Toxics Control Act−Cleanup" (WAC 173-340) Method B groundwater cleanup level for hexavalent chromium. Other WQS values are corresponding drinking water standards.

c. Treatment amounts from the 2013 Hanford Annual Groundwater Report (DOE/RL-2014-32, Rev. 0).

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

e. Sr-90 will decay significantly during the Active Cleanup and Near-term, Post-Cleanup periods and transport considerations (Section 9.5) indicate that Sr-90 and uranium will likely be relatively immobile in the subsurface leading to ND ratings through the Near-term, Post-Cleanup period. A *Low* rating will be ascribed after this period to address uncertainty.

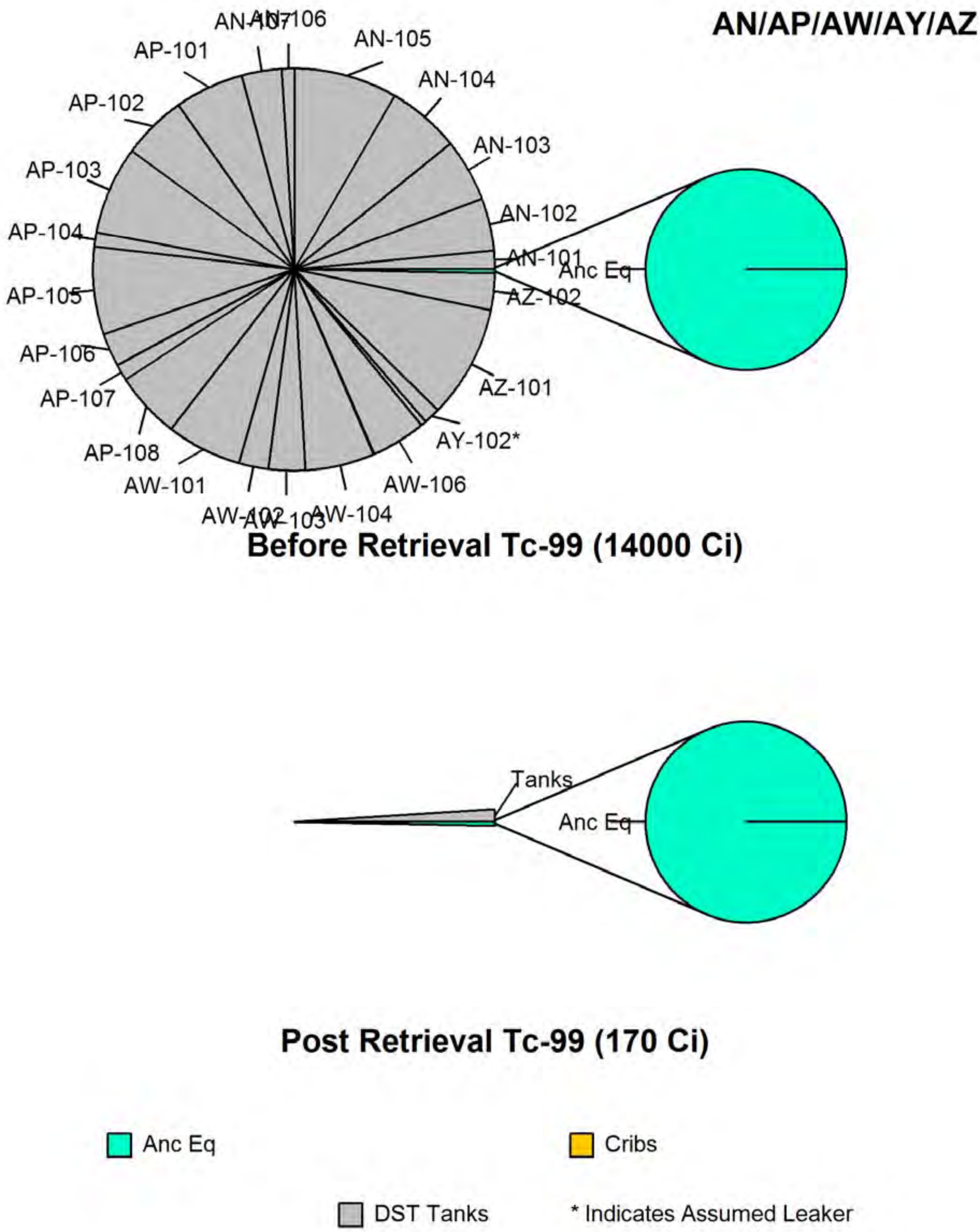


Figure E.9-3. AN-AP-AW-AY-AZ Tank and Waste Farms Evaluation Unit Inventory Estimates for Tc-99 Before and After 99% Retrieval

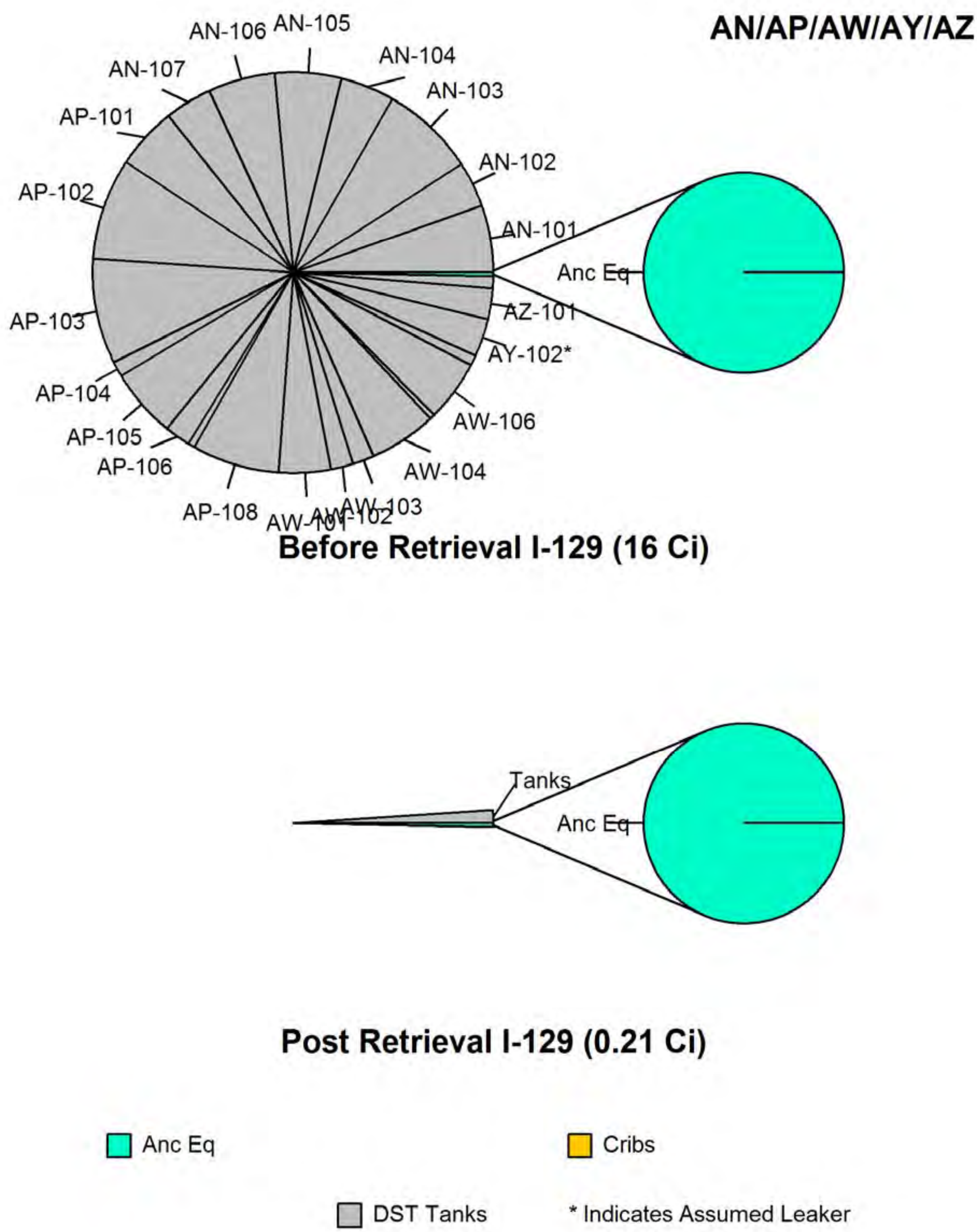


Figure E.9-4. AN-AP-AW-AY-AZ Tank and Waste Farms Evaluation Unit Inventory Estimates for I-129 Before and After 99% Retrieval

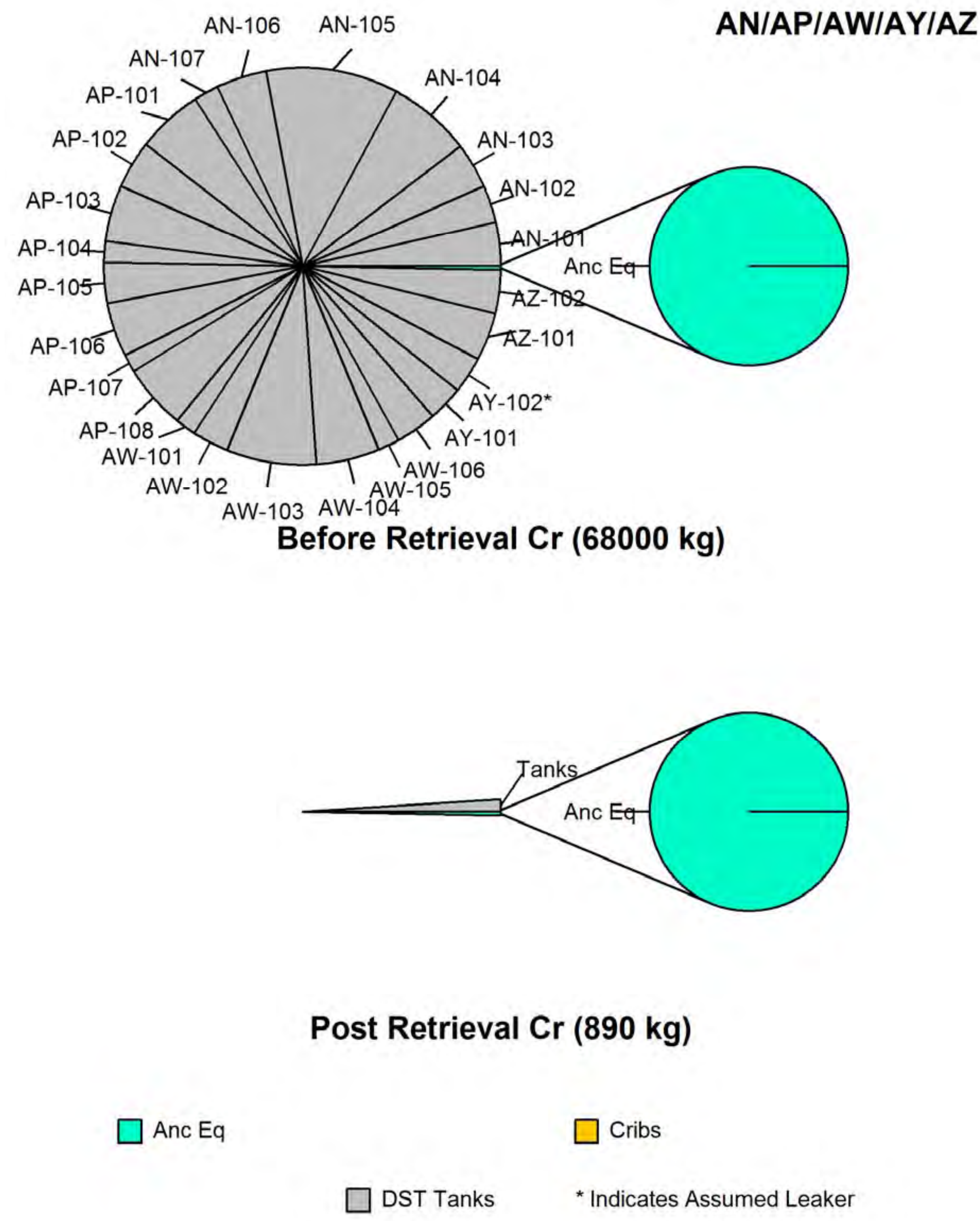


Figure E.9-5. AN-AP-AW-AY-AZ Tank and Waste Farms Evaluation Unit Inventory Estimates for Chromium Before and After 99% Retrieval

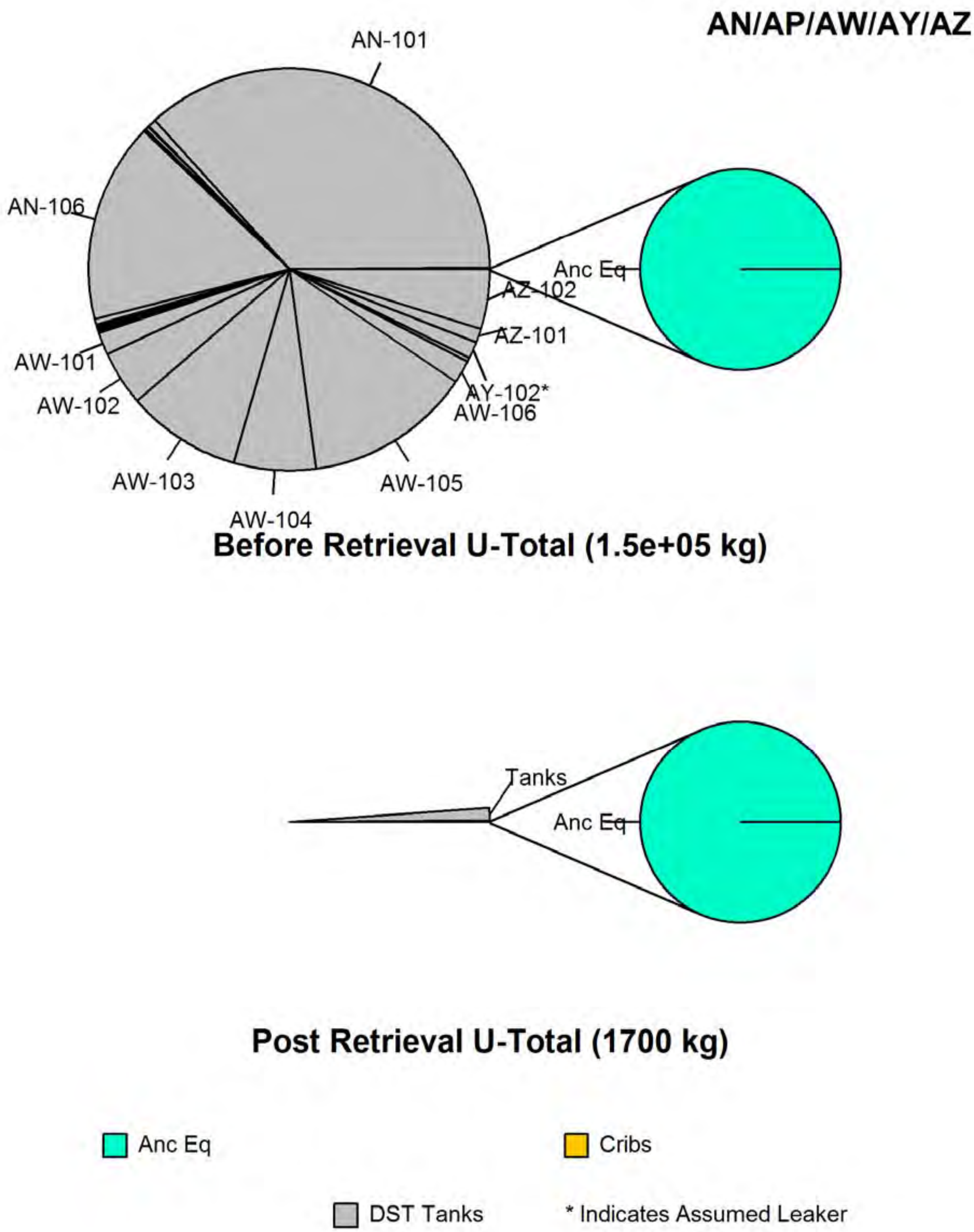


Figure E.9-6. AN-AP-AW-AY-AZ Tank and Waste Farms Evaluation Unit Inventory Estimates for U(tot) Before and After 99% Retrieval

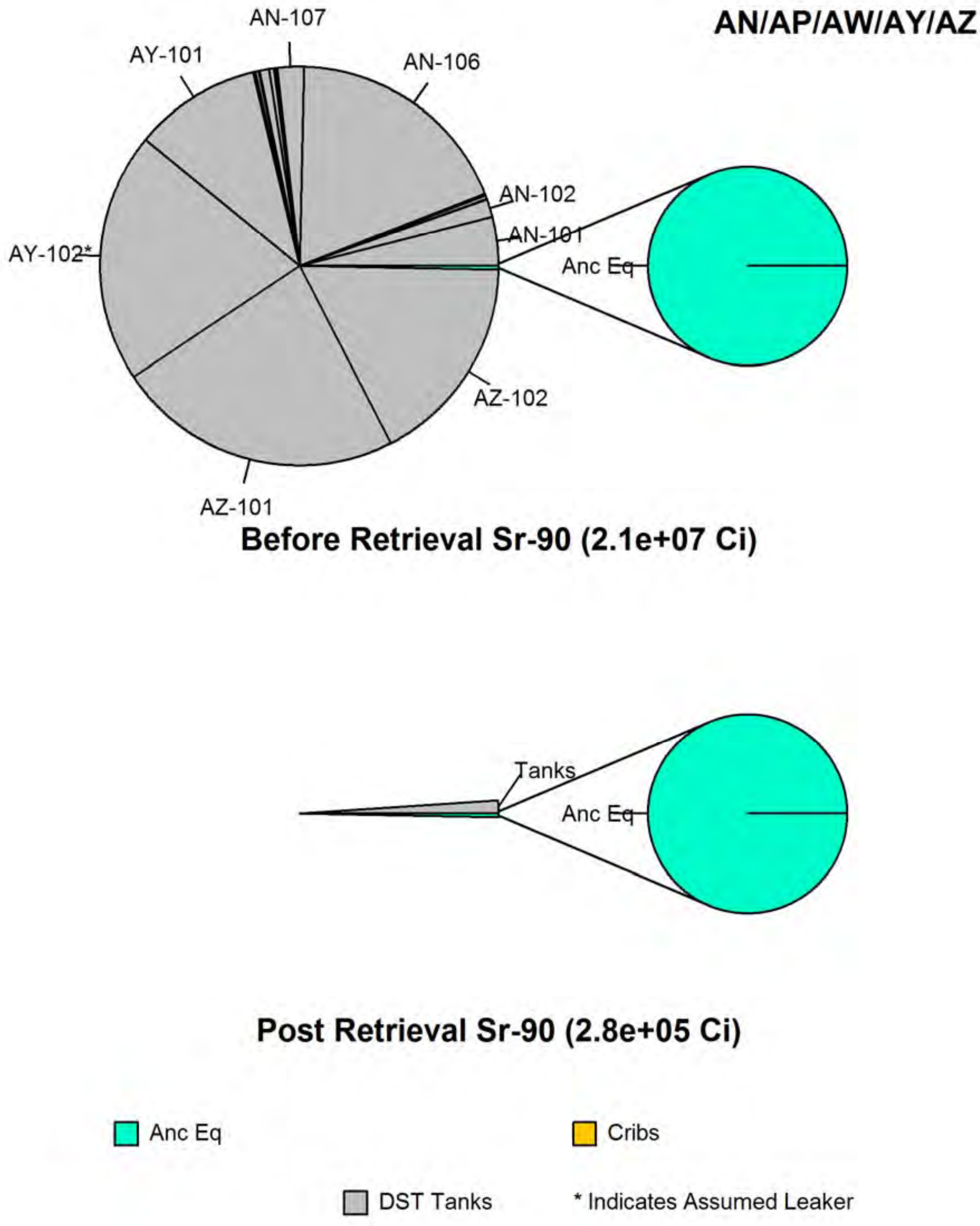


Figure E.9-7. AN-AP-AW-AY-AZ Tank and Waste Farms Evaluation Unit Inventory Estimates for Sr-90 Before and After 99% Retrieval

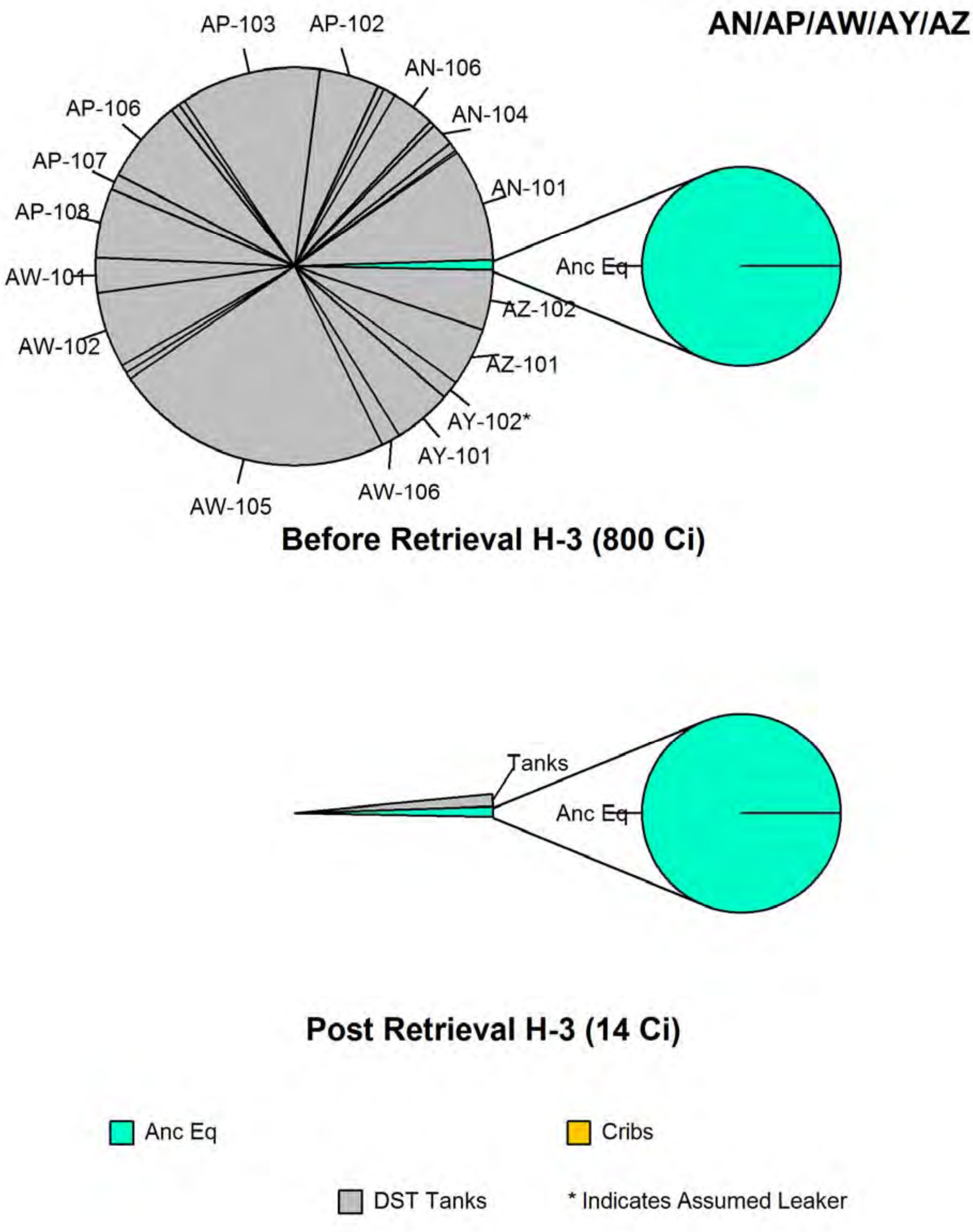


Figure E.9-8. AN-AP-AW-AY-AZ Tank and Waste Farms Evaluation Unit Inventory Estimates for Tritium (H-3) Before and After 99% Retrieval

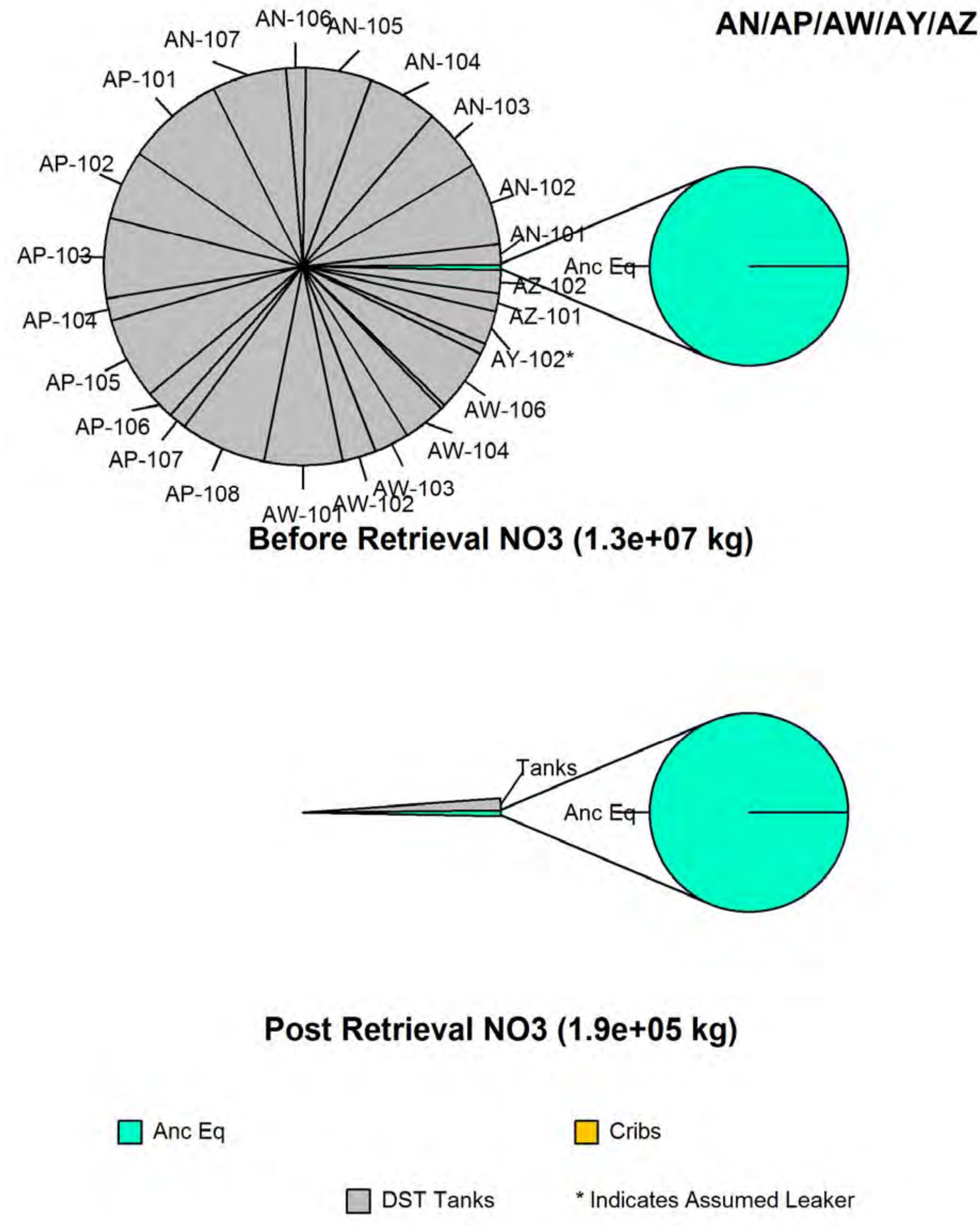


Figure E.9-9. AN-AP-AW-AY-AZ Tank and Waste Farms Evaluation Unit Inventory Estimates for Nitrate (NO3) Before and After 99% Retrieval

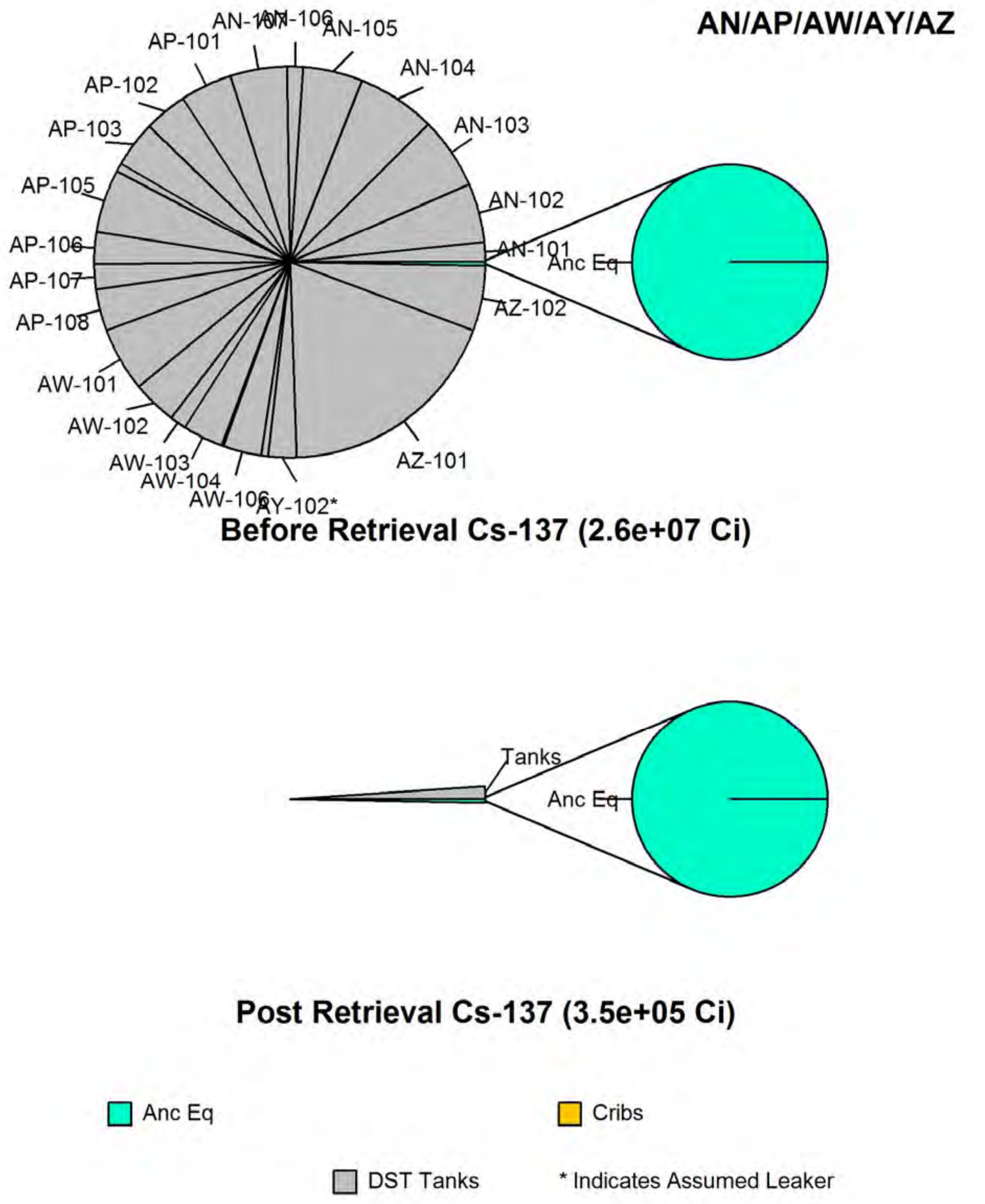


Figure E.9-10. AN-AP-AW-AY-AZ Tank and Waste Farms Evaluation Unit Inventory Estimates for Cs-137 Before and After 99% Retrieval

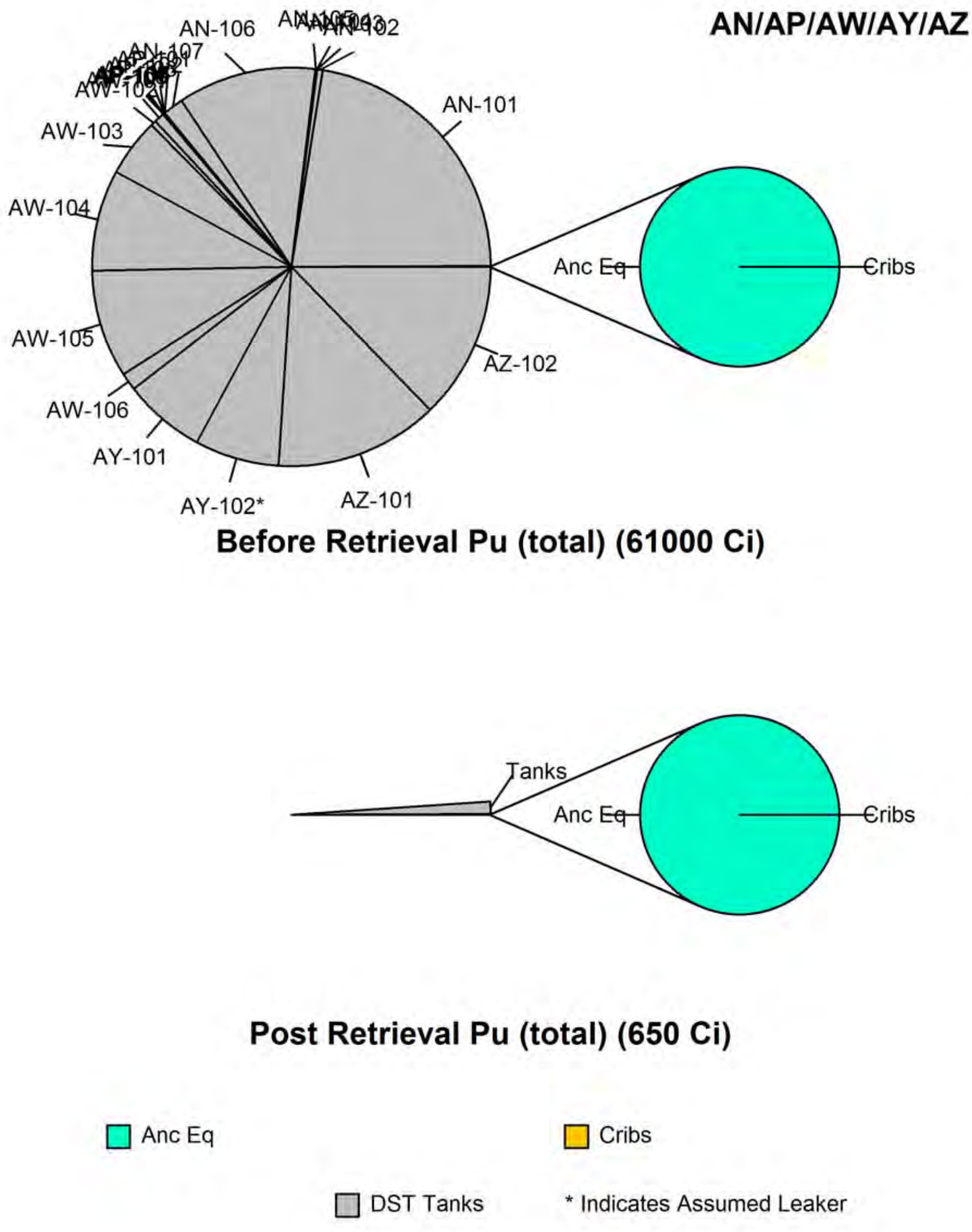


Figure E.9-11. AN-AP-AW-AY-AZ Tank and Waste Farms Evaluation Unit Inventory Estimates for Plutonium (total) Before and After 99% Retrieval

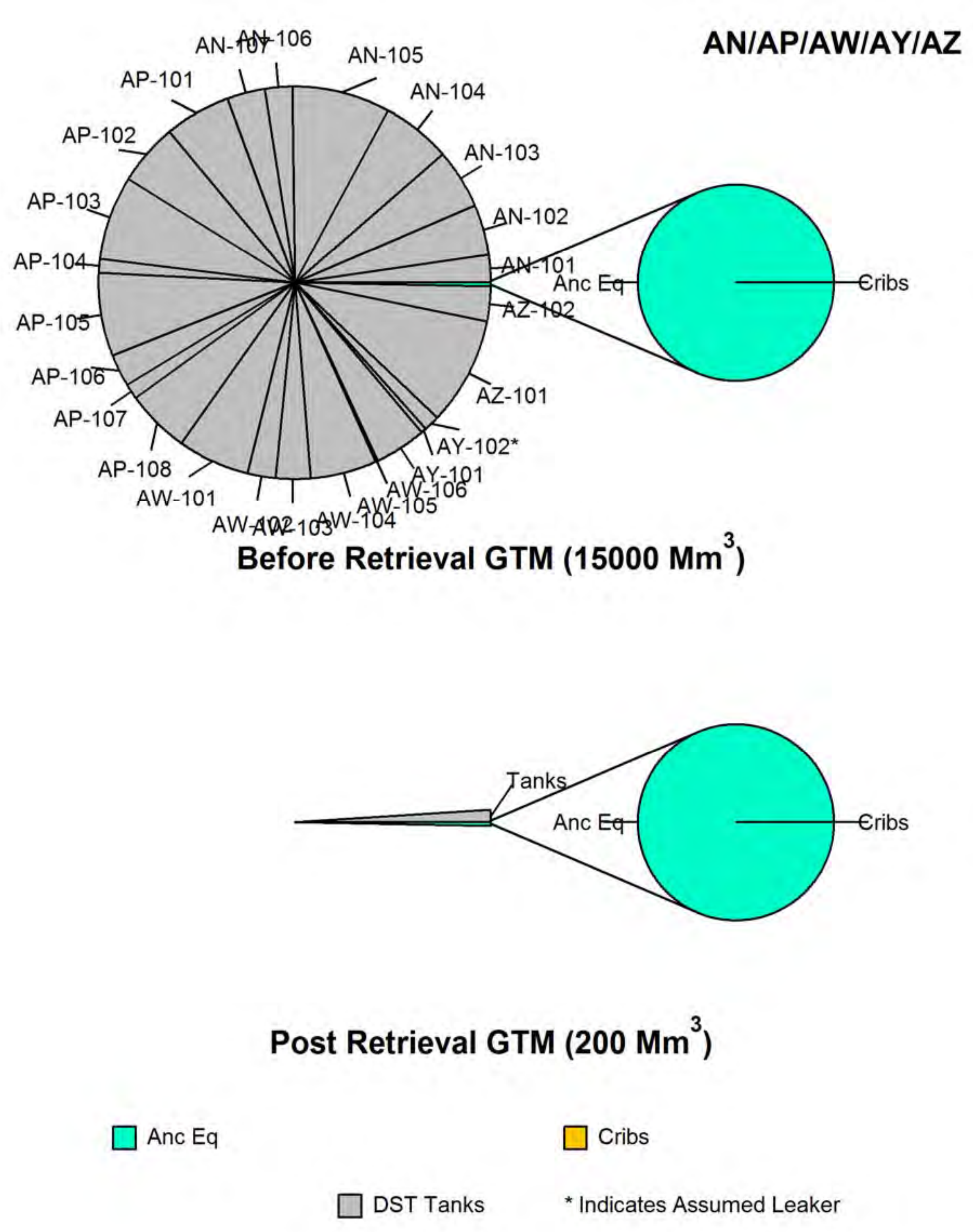


Figure E.9-12. AN-AP-AW-AY-AZ Tank and Waste Farms Evaluation Unit Maximum Groundwater Threat Metric (GTM) of I-129 and Tc-99 Estimates Before and After 99% Retrieval

9.6. POTENTIAL RISK/IMPACT PATHWAYS AND EVENTS

CURRENT CONCEPTUAL MODEL

A common safety analysis was performed for all the single- and double-shell tanks including pathways and barriers (safety scenarios that dominate risk, safety systems and controls, barriers to release, failure mechanisms, pathways and receptors, time frames for exposure). See Section 1.6 in Appendix E.1 for details.

POPULATIONS AND RESOURCES CURRENTLY AT RISK OR POTENTIALLY IMPACTED

Facility Worker, Co-located Person, and Public

A common analysis was performed for the Facility Worker, Co-located Person, and Public. See Section 1.6 (Appendix E.1) for details.

Groundwater

There are no plumes associated with the 200-East DST Farm EU (Table E.9-2) nor are any expected in the foreseeable future (Section 9.5).

As shown in Table E.9-2 (Section 9.5), the vadose zone (VZ) GTM values for the Group A and B primary contaminants range are *Low* for all primary contaminants with non-zero inventories except for Sr-90 and Tc-99 (that have ND ratiings). The Sr-90 will decay significantly during the Active and Near-term, Post Cleanup period and transport considerations suggest that Sr-90 or uranium plumes would not be expected. The overall current rating for groundwater impact from vadose zone sources is *Low*.

Columbia River

Since there are no plumes associated with the 200-East DST Farm EU Table E.9-2) nor are any expected in the foreseeable future, the potential for impacts to the Columbia River benthic, riparian, or free-flowing ecology is not credible based on current information. Thus the ratings associated with potential threats from 200-East DST Farm EU to Columbia River benthic, riparian, or free-flowing receptors are defined to be *Not Discernible* for all contaminants and all evaluation periods.

Ecological Resources

- The EU is level 0 habitat, and no level 3 or greater resources exist within the 200-East Double Shell Tank EU boundaries.
- No wildlife were observed using the disturbed habitats within the EU boundaries.
- Because the area is an industrial site, and is contiguous with adjacent tank farms and other industrial areas—no significant change in habitat connectivity would be expected to result from remediation actions taken within the EU.

Cultural Resources

- The 241 AW Underground Liquid Waste Tanks Farm, a contributing property within the Manhattan Project and Cold War Era Historic District, with documentation required, is located within the 200-East DSTs EU.
- There are no archaeological sites or TCPs known to be located within the 200-East DSTs EU.

Archaeological sites and TCPs located within 500 meters of the EU

- An isolated find associated with the Native American Precontact and Ethnographic Landscape has been located within close proximity to the 200-East DSTs EU.
- The Hanford Site Plant Railroad and the 2707AR Sludge Vault Change House a contributing property within the Manhattan Project and Cold War Era Historic District with documentation required is located within close proximity to the 200-East DSTs EU.
- The 244 AR Vault Facility and Canyon and 242BA 242-A Boiler Annex are contributing properties within the Manhattan Project and Cold War Era Historic District with no documentation required are located within close proximity to the 200-East DSTs EU.
- All of the Manhattan Project/Cold War Era buildings located within the PUREX Evaluation Unit are also located in close proximity to the 200-East DSTs EU.

Closest Recorded TCP

- There are two recorded TCPs associated with the Native American Precontact and Ethnographic Landscape that are visible from 200-East DSTs EU.

CLEANUP APPROACHES AND END-STATE CONCEPTUAL MODEL

Selected or Potential Cleanup Approaches

A common analysis was performed for all the single- and double-shell tanks. See Section 1.6 (Appendix E.1) for details.

Contaminant Inventory Remaining at the Conclusion of Planned Active Cleanup Period

See Section 9.5 including Table E.9-2 and Figure E.9-3 through Figure E.9-11 for the inventory information after planned 99% retrieval. Furthermore, a more general analysis was performed for all the single- and double-shell tanks. See Section 1.6 (Appendix E.1) for details.

Risks and Potential Impacts Associated with Cleanup

A general analysis was performed for all the single- and double-shell tanks for workers and the Public. See Section 1.6 (Appendix E.1) for details.

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

Facility Worker, Co-located Person, and Public

A common analysis was performed for the Facility Worker, Co-located Person, and Public. See Section 1.6 (Appendix E.1) for details.

Groundwater

There are no current or anticipated plumes or impacts to groundwater from sources associated with the 200-East DST Farm EU.

Furthermore, there are primary (e.g., tank wastes) and secondary contaminant sources (legacy source sites) in the vadose zone that may pose a very small risk to groundwater. For the Active Cleanup and Near-Term, Post-Cleanup periods, the vadose zone (VZ) GTM values for the Group A and B primary contaminants for the 200-East DST Farm EU would be *Low* (including Sr-90 and uranium) since neither decay nor transport considerations would change the overall rating. Thus the overall rating for the Active Cleanup and Near-Term, Post-Cleanup periods is *Low*.

It is considered unlikely that additional groundwater resources would be impacted as a result of assumed final closure activities (that are not covered in the Ecological or Cultural Resources results).

Columbia River

There are no current or anticipated plumes or impacts to the Columbia River from the 200-East DST Farm EU.

It is considered unlikely that additional benthic or riparian resources would be impacted as a result of assumed final closure activities (that are not covered in the Ecological or Cultural Resources results).

Ecological Resources

No ecological resources are in this EU, and thus there are no effects.

Cultural Resources

See Section 1.6 (Appendix E.1) for details.

Additional Risks and Potential Impacts if Cleanup is Delayed

A common analysis was performed for all the single- and double-shell tanks. See Section 1.6 (Appendix E.1) for details.

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

A common analysis was performed for all the single- and double-shell tanks. See Section 1.6 (Appendix E.1) for details.

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

Table E.9-8. Summary of Populations and Resources at Risk or Potentially Impacted after Cleanup

Population or Resource		Impact Rating	Comments
Human	Facility Worker	Low	Workers will be low risk from exposure to direct radiation and waste contaminants after waste retrieval, grouting, and capping.
	Co-located Person	Low	These persons will be at low risk from exposure to direct radiation and waste contaminants after waste retrieval, grouting, and capping.
	Public	Not Discernible (ND)	The Tank Farms will be in secure and controlled areas that prevent intentional and inadvertent intruders. No complete groundwater pathway and no impact from air pathway.
Environmental	Groundwater (A&B) from vadose zone[a]	Low (all PCs) **Overall**: Low	GTM values for Group A and B primary contaminants (Table E.9-2) as modified: *Low* for all PCs, including Sr-90 and uranium to address uncertainty. No current plumes or expected significant transport from vadose zone to groundwater.
	Columbia River from vadose zone[a]	Benthic: Not Discernible (all) Riparian: Not Discernible (all) Free-flowing: Not Discernible (all) **Overall**: Not Discernible	No current plumes or expected significant transport from vadose zone to groundwater and thus no credible impact to the Columbia River ecology over the foreseeable future.
	Ecological Resources[b]	ND to Low	Likely monitoring of caps, with potential for disruption due to monitoring. Re-vegetation could result in higher quality habitat on EU, but could be some residual contamination to sensitive resources.
Social	Cultural Resources[b]	**Native American:** Direct: Unknown Indirect: Known **Historic Pre-Hanford:** Direct: Unknown	Permanent indirect effects to viewshed are possible from capping. Permanent effects may be possible due to presence of contamination if capping occurs.

Population or Resource		Impact Rating	Comments
		Indirect: Unknown **Manhattan/Cold War**: Direct: None Indirect: None	No other expected cultural resources impacts.

a. Groundwater threat for Group A and B contaminants remaining in the vadose zone or to the Columbia River for all primary contaminants.
b. 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.

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

There are no current plumes or expected significant transport from vadose zone to groundwater and thus no credible impact to groundwater or the Columbia River ecology over the foreseeable future.

9.7. SUPPLEMENTAL INFORMATION AND CONSIDERATIONS

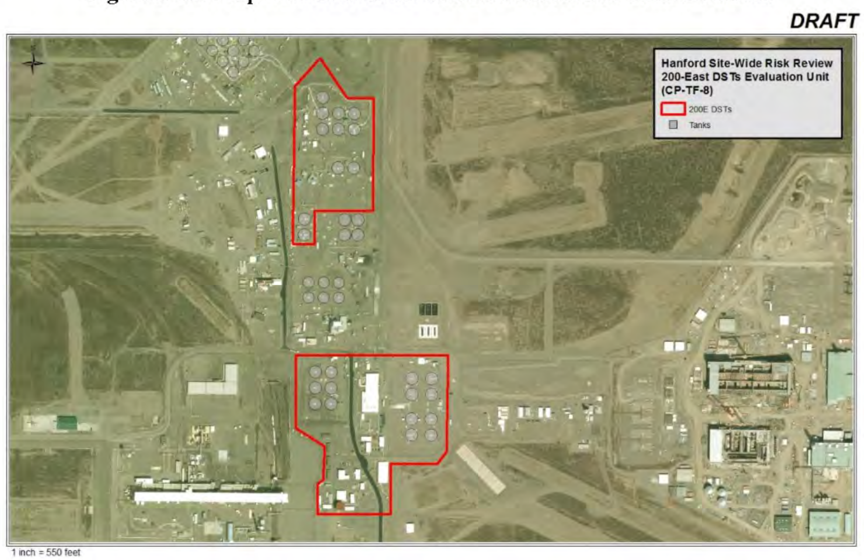
A common analysis was performed for all the single- and double-shell tanks. See Section 1.7 (Appendix E.1) for details.

9.8. ATTACHMENT – AN-AP-AW-AY-AZ TANK FARMS EVALUATION UNIT WIDS REVIEW

Hanford Site-Wide Risk Review

Evaluation Unit:	200-East DSTs
ID:	CP-TF-8
Group:	Tank Farm
Operable Unit Cross-Walk:	NA
Related EU:	CP-LS-7 CP-TF-5
Sites & Facilities:	AN, AP, AW, AY, AZ tank farms, ancillary structures, associated liquid waste sites, and soils contamination
Key Data Sources Docs:	NA

Figure 1. Site Map with Evaluation Unit Boundaries and Tank Locations



Attached:

- Waste Site and Facility List
- Site Map with Evaluation Unit Boundaries and Associated Waste Sites
- Site Map with Evaluation Unit Boundaries and Associated Facilities

Hanford Site-Wide Risk Review
CP-TF-8 (200-East DSTs)
Waste Site and Facility List

Site Code	Name	Site Status	Site Type	Site Type Category	Operable Unit	Exclude from Evaluation
200-E-113-PL	200-E-113-PL; 216-A-42C Valve Box; Line 8824; Pipeline from PUREX to 216-A-6 and 216-A-30 Crib	Inactive	Process Sewer	Pipeline and associated valves, etc.	TBD	
200-E-127-PL-B	200-E-127-PL-B; Segments of Gable Mountain Pond Pipeline Located in the Inner Area	Inactive	Radioactive Process Sewer	Pipeline and associated valves, etc.	TBD	
200-E-134	200-E-134; Potentially Contaminated Soil in 241-AW Tank Farm	Inactive	Unplanned Release	Unplanned Release - Surface/Near Surface	Not Applic	
200-E-154-PL	200-E-154-PL; Direct Buried Transfer Line from 241-C-151 to 241-AX-01A; Tank Farm Pipeline; Tank Farm Transfer Line V113	Inactive	Direct Buried Tank Farm Pipeline	Pipeline and associated valves, etc.	TBD	
200-E-155-PL	200-E-155-PL; Pipeline from 241-C Fence to Radioactive Process Sewer Line 2904-CR-1	Inactive	Radioactive Process Sewer	Pipeline and associated valves, etc.	TBD	
200-E-187-PL	200-E-187-PL; Chemical Sewer from 202-A to 216-A-29 Ditch; Lines 8819, 5802 and 5701; PUREX Chemical Sewer (CSL)	Inactive	Radioactive Process Sewer	Pipeline and associated valves, etc.	TBD	
200-E-207-PL	200-E-207-PL; Encased Transfer Line from 241-A-151 Diversion Box to 241-A-152 Diversion Box; Lines V004, V005, V006, V007 and V008	Inactive	Encased Tank Farm Pipeline	Pipeline and associated valves, etc.	TBD	
200-E-210-PL	200-E-210-PL; Encased Lines Between 241-AW Tank Farm and 242-A Evaporator Building; Lines SL-167, SL-168, SN-219, SN-220, SN-269 and SN-270	Active	Encased Tank Farm Pipeline	Pipeline and associated valves, etc.	Not Applic	
200-E-211-PL	200-E-211-PL; Lines DR334, DR335 and DR343; Transfer Lines from 241-AW to 242-A Evaporator Building	Active	Direct Buried Tank Farm Pipeline	Pipeline and associated valves, etc.	Not Applic	
200-E-212-PL	200-E-212-PL; Lines SL-509, SL-510, SN-609 and SN-610; Transfer Lines Between 241-AW Tank Farm and 241-AP Tank Farm	Active	Direct Buried Tank Farm Pipeline	Pipeline and associated valves, etc.	Not Applic	
200-E-218-PL	200-E-218-PL; Lines V021; Transfer Lines Between 241-A-151 Diversion Box and 241-AW Tank Farm; V022; V023	Inactive	Direct Buried Tank Farm Pipeline	Pipeline and associated valves, etc.	TBD	
200-E-225-PL	200-E-225-PL; Line V720; Transfer Line from 241-AR-151 Diversion Box to 241-AY-102 Tank	Inactive	Direct Buried Tank Farm Pipeline	Pipeline and associated valves, etc.	TBD	
200-E-229-PL	200-E-229-PL; Line SN-650; Transfer Line Between tank 241-AP-102 and 241-A-B Valve Pit	Inactive	Direct Buried Tank Farm Pipeline	Pipeline and associated valves, etc.	TBD	
200-E-237-PL	200-E-237-PL; 2904-E-24; Line 2904-E-1; Pipeline to 200 East Powerhouse Ditch and Pipeline from Powerhouse Ditch to 216-B-3 Ditches	Active	Process Sewer	Pipeline and associated valves, etc.	TBD	
200-E-260-PL	200-E-260-PL; Line 8824A; Steam Condensate By-Pass Line from PUREX to 216-A-30	Inactive	Radioactive Process Sewer	Pipeline and associated valves, etc.	TBD	
200-E-261-PL	200-E-261-PL; Effluent Recycle Line from 216-A-42 Basin to PUREX	Inactive	Radioactive Process Sewer	Pipeline and associated valves, etc.	TBD	
200-E-271-PL	200-E-271-PL; Line 8823; PUREX Cooling Water Header Pipeline	Inactive	Radioactive Process Sewer	Pipeline and associated valves, etc.	TBD	
200-E-291-PL	200-E-291-PL; Pipeline from 241-C-106 to 241-AY-102, SN-200, SL-100, 241-C-106 Sluice line	Inactive	Direct Buried Tank Farm Pipeline	Pipeline and associated valves, etc.	TBD	
216-A-39	216-A-39; 216-A-39 Crib; 216-A-39 Trench	Inactive	Crib	Crib - Subsurface Liquid Disposal Site	Not Applic	

Note that only those waste sites with a WIDS (Waste Information Data System) Classification of "Accepted" are shown, along with non-duplicate facilities, identified via the Hanford Geographic Information System (HGIS).

Hanford Site-Wide Risk Review
CP-TF-8 (200-East DSTs)
Waste Site and Facility List

Site Code	Name	Site Status	Site Type	Site Type Category	Operable Unit	Exclude from Evaluation
241-AN-101	241-AN-101; 241-AN-TK-101	Active	Double-Shell Tank	Underground Storage Tank	Not Applic	
241-AN-102	241-AN-102; 241-AN-TK-102	Active	Double-Shell Tank	Underground Storage Tank	Not Applic	
241-AN-103	241-AN-103; 241-AN-TK-103	Active	Double-Shell Tank	Underground Storage Tank	Not Applic	
241-AN-104	241-AN-104; 241-AN-TK-104	Active	Double-Shell Tank	Underground Storage Tank	Not Applic	
241-AN-105	241-AN-105; 241-AN-TK-105	Active	Double-Shell Tank	Underground Storage Tank	Not Applic	
241-AN-106	241-AN-106; 241-AN-TK-106	Active	Double-Shell Tank	Underground Storage Tank	Not Applic	
241-AN-107	241-AN-107; 241-AN-TK-107	Active	Double-Shell Tank	Underground Storage Tank	Not Applic	
241-AN-A	241-AN-A; 241-AN-A Diversion Box	Active	Valve Pit	Pipeline and associated valves, etc.	Not Applic	
241-AN-B	241-AN-B; 241-AN-B Diversion Box	Active	Valve Pit	Pipeline and associated valves, etc.	Not Applic	
241-AP VP	241-AP VP; 241-AP Valve Pit	Active	Valve Pit	Pipeline and associated valves, etc.	Not Applic	
241-AP-101	241-AP-101; 241-AP-TK-101	Active	Double-Shell Tank	Underground Storage Tank	Not Applic	
241-AP-102	241-AP-102; 241-AP-TK-102	Active	Double-Shell Tank	Underground Storage Tank	Not Applic	
241-AP-103	241-AP-103; 241-AP-TK-103	Active	Double-Shell Tank	Underground Storage Tank	Not Applic	
241-AP-104	241-AP-104; 241-AP-TK-104	Active	Double-Shell Tank	Underground Storage Tank	Not Applic	
241-AP-105	241-AP-105; 241-AP-TK-105	Active	Double-Shell Tank	Underground Storage Tank	Not Applic	
241-AP-106	241-AP-106; 241-AP-TK-106	Active	Double-Shell Tank	Underground Storage Tank	Not Applic	
241-AP-107	241-AP-107; 241-AP-TK-107	Active	Double-Shell Tank	Underground Storage Tank	Not Applic	
241-AP-108	241-AP-108; 241-AP-TK-108	Active	Double-Shell Tank	Underground Storage Tank	Not Applic	
241-AW-101	241-AW-101; 241-AW-TK-101	Active	Double-Shell Tank	Underground Storage Tank	Not Applic	
241-AW-102	241-AW-102; 241-AW-TK-102	Active	Double-Shell Tank	Underground Storage Tank	Not Applic	
241-AW-103	241-AW-103; 241-AW-TK-103	Active	Double-Shell Tank	Underground Storage Tank	Not Applic	
241-AW-104	241-AW-104; 241-AW-TK-104	Active	Double-Shell Tank	Underground Storage Tank	Not Applic	
241-AW-105	241-AW-105; 241-AW-TK-105	Active	Double-Shell Tank	Underground Storage Tank	Not Applic	
241-AW-106	241-AW-106; 241-AW-TK-106	Active	Double-Shell Tank	Underground Storage Tank	Not Applic	
241-AW-A	241-AW-A; 241-AW-A Diversion Box; 241-AW-A Valve Pit	Active	Valve Pit	Pipeline and associated valves, etc.	Not Applic	
241-AW-B	241-AW-B; 241-AW-B Diversion Box; 241-AW-B Valve Pit	Active	Valve Pit	Pipeline and associated valves, etc.	Not Applic	
241-AY-101	241-AY-101; 241-AY-TK-101	Active	Double-Shell Tank	Underground Storage Tank	Not Applic	
241-AY-102	241-AY-102; 241-AY-TK-102	Active	Double-Shell Tank	Underground Storage Tank	Not Applic	
241-AZ-101	241-AZ-101; 241-AZ-TK-101	Active	Double-Shell Tank	Underground Storage Tank	Not Applic	
241-AZ-102	241-AZ-102; 241-AZ-TK-102	Active	Double-Shell Tank	Underground Storage Tank	Not Applic	
241-AZ-151CT	241-AZ-151CT; 241-AZ-151 Catch Tank	Inactive	Catch Tank	Underground Storage Tank	Not Applic	
241-AZ-151DS	241-AZ-151DS; 241-AZ-151-DS Diverter Station; 241-AZ-151 Diverter Station	Inactive	Diversion Box	Pipeline and associated valves, etc.	Not Applic	
241-AZ-152	241-AZ-152; 241-AZ-152 Diversion Box; 241-AZ-152 Sluice Transfer Box	Inactive	Diversion Box	Pipeline and associated valves, etc.	Not Applic	
2607-EJ	2607-EJ; 2607-EJ Septic System	Inactive	Septic Tank	Septic System	Not Applic	X
600-269-PL	600-269-PL; Cross Site Transfer Line Replacement; Lines SNL-3150 and 3160; New Cross-Site Transfer Line	Active	Direct Buried Tank Farm Pipeline	Pipeline and associated valves, etc.	Not Applic	
UPR-200-E-19	UPR-200-E-19; Contamination Release at 216-A-6 Sampler; UN-200-E-19	Inactive	Unplanned Release	Unplanned Release - Surface/Near Surface	200-EA-1	
UPR-200-E-93	UPR-200-E-93; UN-216-E-21 Ground Contamination Along 200 East Area fence	Inactive	Unplanned Release	Unplanned Release - Surface/Near Surface	Not Applic	

Note that only those waste sites with a WIDS (Waste Information Data System) Classification of "Accepted" are shown, along with non-duplicate facilities, identified via the Hanford Geographic Information System (HGIS).

Hanford Site-Wide Risk Review
CP-TF-8 (200-East DSTs)
Waste Site and Facility List

Site Code	Name	Site Status	Site Type	Site Type Category	Operable Unit	Exclude from Evaluation
250600	TELECOMMUNICATIONS	ACTIVE	BUILDING	Infrastructure Building		X
220A	PROPORTIONAL SAMPLER PIT	INACTIVE	STRUCTURE	Infrastructure Building		X
241A201	EMERGENCY COOLING WATER STORAGE TANKS SE OF PUREX	INACTIVE	TANK	Infrastructure Building		X
241AN271	INSTRUMENT CONTROL HOUSE	ACTIVE	BUILDING	Infrastructure Building		X
241AN273	COMPRESSOR BUILDING	ACTIVE	BUILDING	Infrastructure Building		X
241AN274	MIXER PUMP AND CAUSTIC ADDITION CONTROL BLDG	ACTIVE	BUILDING	Process Building		
241AN801	WATER SERVICE BUILDING	ACTIVE	BUILDING	Infrastructure Building		X
241ANB	VALVE VAULT	ACTIVE	STRUCTURE	Pipeline and associated valves, etc.		
241AP271	TANK FARM INSTRUMENT BUILDING	ACTIVE	BUILDING	Infrastructure Building		X
241AP273	COMPRESSOR BUILDING	ACTIVE	BUILDING	Infrastructure Building		X
241AP801	WATER SERVICE BUILDING	ACTIVE	STRUCTURE	Infrastructure Building		X
241AW271	TANK FARM CONTROL HOUSE	ACTIVE	BUILDING	Infrastructure Building		X
241AW273	COMPRESSOR BUILDING	ACTIVE	BUILDING	Infrastructure Building		X
241AW801	WATER SERVICE BUILDING	ACTIVE	BUILDING	Infrastructure Building		X
241AY801A	TANK FARM INSTRUMENT HOUSE	ACTIVE	BUILDING	Infrastructure Building		X
241AZ152	SLUICE TRANSFER BOX	ACTIVE	STRUCTURE	Pipeline and associated valves, etc.		X
241AZ156	MIXER PUMP SPEED CONTROL HOUSE	ACTIVE	BUILDING	Infrastructure Building		X
241AZ271	CHANGE HOUSE / CONTROL BUILDING	ACTIVE	BUILDING	Infrastructure Building		X
241AZ301A	241AZ CHEMICAL ADDITIONAL BLDG	ACTIVE	BUILDING	Process Building		
241AZ701	DIESEL GENERATOR BUILDING	ACTIVE	BUILDING	Infrastructure Building		X
241AZ702	WASTE TANK VENTILATION BUILDING	ACTIVE	BUILDING	Process Building		
241AZ801A	INSTRUMENT BUILDING	ACTIVE	BUILDING	Infrastructure Building		X
2715AW	TANK FARM STORAGE / STAGING FACILITY	ACTIVE	BUILDING	Infrastructure Building		X
2724AZ	RAD MONITORING AND PROTECTIVE CLOTHING BLDG	INACTIVE	BUILDING	Infrastructure Building		X
272AW	TANK FARM OPERATIONS SUPPORT FACILITY	ACTIVE	BUILDING	Infrastructure Building		X
272EA	SWP CHANGE SHELTER NE CORNER OF 272AW	ACTIVE	BUILDING	Infrastructure Building		X
274AW	OFFICE BUILDING	ACTIVE	BUILDING	Infrastructure Building		X
278AW	TANK FARM MASK STATION	ACTIVE	BUILDING	Infrastructure Building		X
295AD	SWL SAMPLE STATION	INACTIVE	BUILDING	Infrastructure Building		X
CT0058	REMOVED FROM SITE -- SHOWER TRAILER EAST OF 272AW	REMOVED	BUILDING	Infrastructure Building		X
MO144	MOBILE OFFICE SOUTH OF 2715AW	ACTIVE	BUILDING	Infrastructure Building		X
MO149	MOBILE OFFICE SOUTH OF 2715AW	ACTIVE	BUILDING	Infrastructure Building		X
MO150	MOBILE OFFICE SOUTH OF 2715AW	ACTIVE	BUILDING	Infrastructure Building		X
MO151	MOBILE OFFICE SOUTH OF 2715AW	ACTIVE	BUILDING	Infrastructure Building		X
MO156	SHOWER/LOCKER TRAILER SOUTH OF 278AW	ACTIVE	BUILDING	Infrastructure Building		X
MO157	SHOWER/LOCKER TRAILER SOUTH OF 278AW	ACTIVE	BUILDING	Infrastructure Building		X
MO2240	MO2240 SOUTH OF AW FARM	ACTIVE	BUILDING	Infrastructure Building		X

Note that only those waste sites with a WIDS (Waste Information Data System) Classification of "Accepted" are shown, along with non-duplicate facilities, identified via the Hanford Geographic Information System (HGIS).

Hanford Site-Wide Risk Review
CP-TF-8 (200-East DSTs)
Waste Site and Facility List

Site Code	Name	Site Status	Site Type	Site Type Category	Operable Unit	Exclude from Evaluation
MO2241	MO2241 SOUTH OF AW FARM	ACTIVE	BUILDING	Infrastructure Building		X
MO2242	MO2242 SOUTH OF AW FARM	ACTIVE	BUILDING	Infrastructure Building		X
MO2243	MO2243 SOUTH OF AW FARM	ACTIVE	BUILDING	Infrastructure Building		X
MO2244	DECON FIELD TRAILER EAST OF BUFFALO AVE AT 241AZ70	ACTIVE	BUILDING	Infrastructure Building		X
MO2350	RESTROOM TRAILER SW OF 2715AW	ACTIVE	BUILDING	Infrastructure Building		X
MO266	MOBILE OFFICE AT 272AW TANK FARMS	ACTIVE	BUILDING	Infrastructure Building		X
MO267	MOBILE OFFICE AT 272AW TANK FARMS	ACTIVE	BUILDING	Infrastructure Building		X
MO268	MOBILE OFFICE AT 272AW TANK FARMS	ACTIVE	BUILDING	Infrastructure Building		X
MO439	CHANGE TRAILER AT AY TANK FARM	ACTIVE	BUILDING	Infrastructure Building		X
MO497	MOBILE OFFICE NORTH OF 241AN	ACTIVE	BUILDING	Infrastructure Building		X
MO511	CONFRENCE TRAILER SE OF 272AW	ACTIVE	BUILDING	Infrastructure Building		X
MO513	HPT/CHANGE TRAILER AT 241AY TANK FARM	ACTIVE	BUILDING	Infrastructure Building		X
MO533	TANK OPERATIONS SUPPORT MOBILE SE OF 272AW	ACTIVE	BUILDING	Infrastructure Building		X
MO577	MOBILE OFFICE NORTH OF 244AR712	ACTIVE	BUILDING	Infrastructure Building		X
MO578	MOBILE OFFICE NORTH OF 244AR712	ACTIVE	BUILDING	Infrastructure Building		X
MO815	CHANGE TRAILER AT 241AP TANK FARM	ACTIVE	BUILDING	Infrastructure Building		X
MO818	CHANGE TRAILER AT 241AW TANK FARM	ACTIVE	BUILDING	Infrastructure Building		X
MO820	CHANGE TRAILER AT AN TANK FARM	ACTIVE	BUILDING	Infrastructure Building		X

Note that only those waste sites with a WIDS (Waste Information Data System) Classification of "Accepted" are shown, along with non-duplicate facilities, identified via the Hanford Geographic Information System (HGIS).

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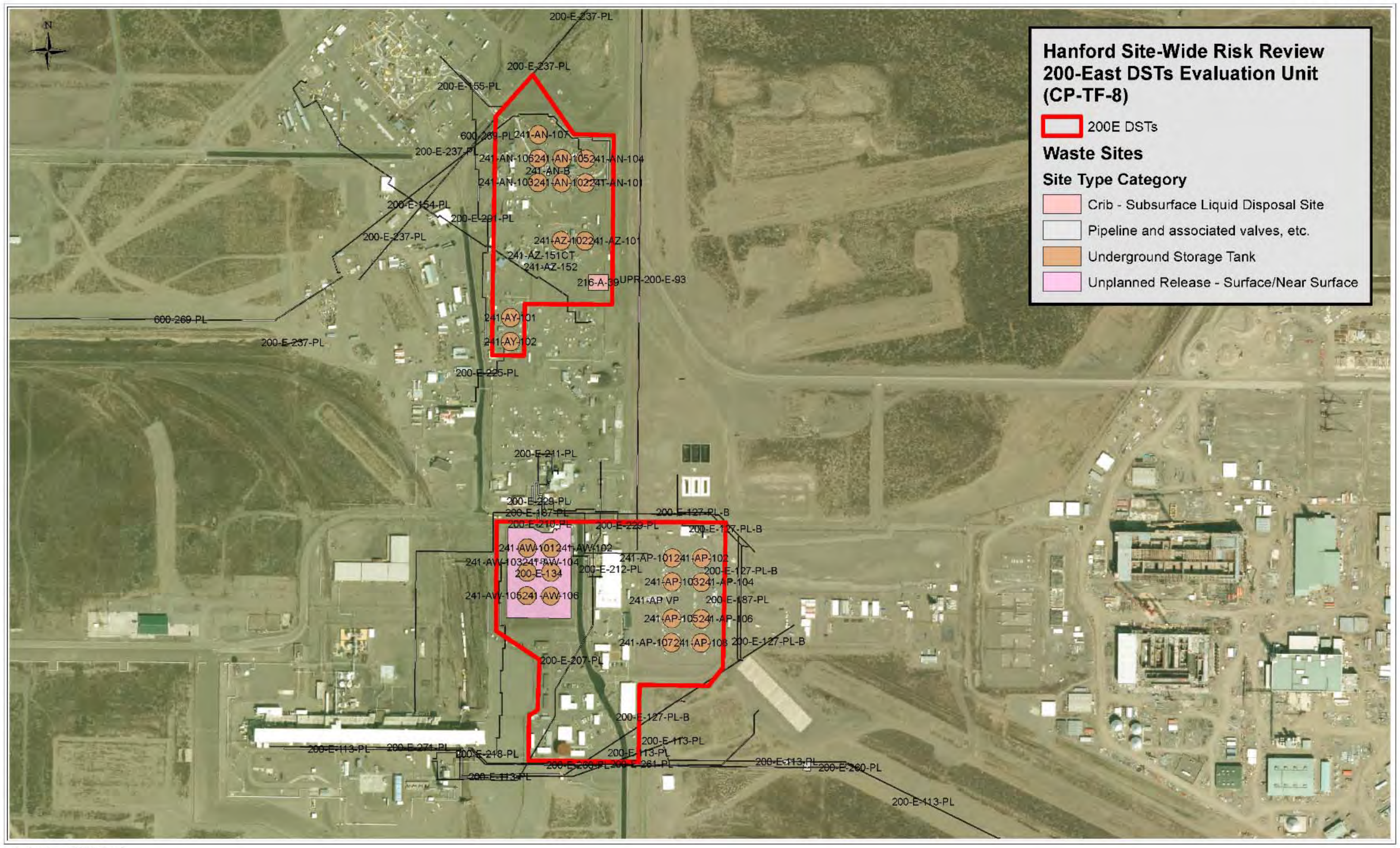

1 inch = 600 feet

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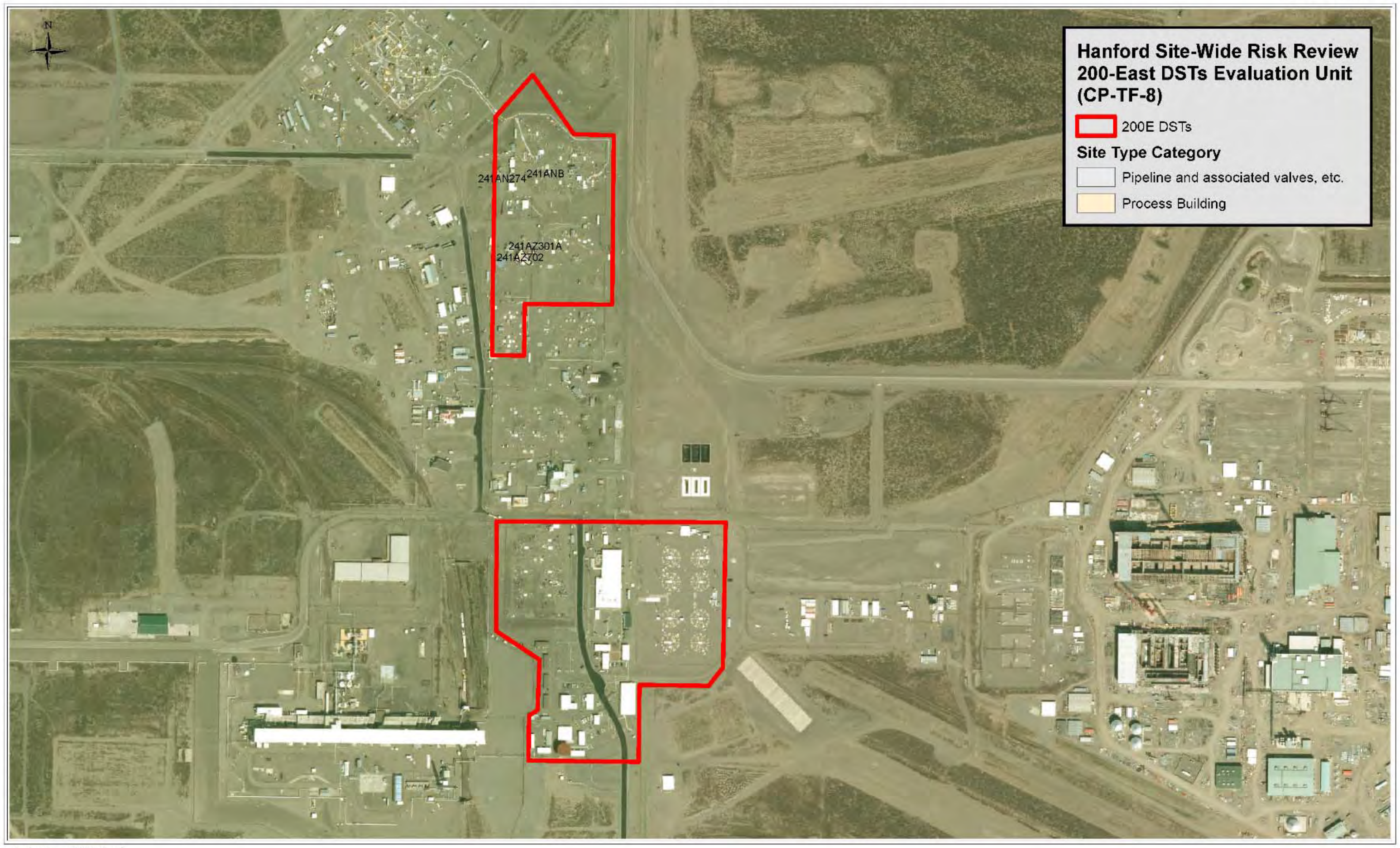

1 inch = 600 feet

APPENDIX E.10

Tank Waste and Farm

CP-TF-9 (SY Double-shell Tank Waste and Farm) Evaluation Unit Summary Template

Table of Contents

List of Figures

List of Tables

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PART 10. CP-TF-9 SY DOUBLE-SHELL TANK WASTE AND FARM (200-W)

10.1. EXECUTIVE SUMMARY

EU LOCATION:

200 West Tank Farm

RELATED EUS:

S-SX Tank Farm (CP-TF-2), TX-TY Tank Farms (CP-TF-3), U Tank Farm (CP-TF-4), A-AX Tank Farms (CP-TF-5), B-BX-BY Tank Farms (CP-TF-6), C Tank Farm (CP-TF-7), 200-East DSTs (CP-TF-9), 200-W Groundwater (CP-GW-2), and 200 Area HLW Transfer Pipeline (CP-LS-7)

PRIMARY CONTAMINANTS, CONTAMINATED MEDIA AND WASTES:

The TC&WM EIS describes tank wastes as including radioactive (tritium or H-3, C-14, Sr-90, Tc-99, I-129, Cs-137, U-233, U-234, U-235, U-238, Np-237, Pu-239, and Pu-240)[134] and non-radioactive contaminants (chromium, mercury, nitrate, lead, total uranium, and PCBs) of potential concern (DOE/EIS-0391 2012, Appendix D). The tank wastes contain saltcake, sludge, and supernatant phases.

BRIEF NARRATIVE DESCRIPTION:

To provide additional storage capacity, 28 double-shell tanks were built in six tank farms between 1968 and 1986. Five of these tank farms are located in the 200 East Area, and one (241-SY) is located in the 200 West Area.

SUMMARY TABLES OF RISKS AND POTENTIAL IMPACTS TO RECEPTORS

Table E.10-1 provides a summary of nuclear and industrial safety related consequences from the CP-TF-9 (200-West DST Farm EU) to humans and impacts to important physical Hanford Site resources. Receptors are described in Section 1.6 (Appendix E.1).

[134] Other isotopes considered include U-232 and U-236 and Pu-238, Pu-241, and Pu-242 to be consistent with other EUs. These additional uranium and plutonium isotopes are included in the totals presented but are not used for rating because 1) uranium toxicity impacts (represented by total uranium drives corresponding risks and 2) plutonium has been found relatively immobile in the Hanford subsurface and has not been identified as a risk driver for groundwater impacts.

Table E.10-1. CP-TF-9 (200-West DST Farm) impact Rating Summary for Human Health (unmitigated basis with mitigated basis provided in parentheses (e.g., "High (Low)").

Population or Resource		Evaluation Time Period[a] — Active Cleanup (to 2064): **Current Condition:** Maintenance & Monitoring (M&M)	Evaluation Time Period[a] — Active Cleanup (to 2064): **From Cleanup Actions**[:] Retrieval & Closure
Human Health	Facility Worker[b]	***M&M***: Low-High[d] (Low-High)[d] ***Soil***: ND-High (ND-Low)	***Preferred method***: High (Low) ***Alternative***: High (Low)
	Co-located Person[b]	***M&M***: Low-Moderate (Low) ***Soil***: ND (ND)	***Preferred method***: Low-Moderate (Low) ***Alternative***: Low-Moderate (Low)
	Public[b]	***M&M***: Low (Low) ***Soil***: ND (ND)	***Preferred method***: Low (Low) ***Alternative***: Low (Low)
Environmental	Groundwater (A&B) from vadose zone[c]	Not Discernible[f] **Overall**: Not Discernible	Not Discernible[f] **Overall**: Not Discernible
	Columbia River from vadose zone[c]	Benthic: Not Discernible (radionuclides) Not Discernible (chemicals) Riparian: Not Discernible (radionuclides) Not Discernible (chemicals) Free-flowing: Not Discernible (all) **Overall**: Not Discernible[f]	Benthic: Not Discernible (radionuclides) Not Discernible (chemicals) Riparian: Not Discernible (radionuclides) Not Discernible (chemicals) Free-flowing: Not Discernible (all) **Overall**: Not Discernible[f]
	Ecological Resources[e]	ND	ND to Medium
Social	Cultural Resources[e]	**Native American:** Direct: Unknown Indirect: Known **Historic Pre-Hanford:** Direct: Unknown Indirect: Unknown **Manhattan/Cold War:** Direct: Known Indirect: Known	**Native American:** Direct: Unknown Indirect: Known **Historic Pre-Hanford:** Direct: Unknown Indirect: Unknown **Manhattan/Cold War:** Direct: Known Indirect: Known

a. A rating for cultural resources is not being made because cultural resources will be evaluated under Section 106 of the National Historic Preservation Act (16 USC 470, et. seq.) during the planning for remedial action.

b. Evaluated in Section 1.6 (Appendix E.1).

c. Groundwater threat for Group A and B contaminants remaining in the vadose zone or to the Columbia River for all primary contaminants. However, there is no vadose zone contamination associated with this EU (and none expected in the future) and thus there is no risk and an ND rating.
d. Industrial safety consequences range from low to high (based on the evaluation scale used) for both mitigated (with controls) and unmitigated (without controls). Mitigated radiological and toxicological consequences to facility workers are high (unmitigated) and low (mitigated).
e. 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.
f. There are no legacy source sites associated with the 200-West DST Farm EU or anticipated in the future; therefore, ratings are ND.

Support for Risk and Impact Ratings for Each Population or Resource

Human Health

The current and cleanup-related consequences related to work being conducted at the Tank Farms in the 200 Areas (Hanford Central Plateau) was evaluated in Section 1.6 (Appendix E.1).

Groundwater, Vadose Zone, and Columbia River

Contaminants from the Hanford double-shell Tank Farms are not currently impacting groundwater nor are there secondary sources considered likely for future impacts to groundwater or the Columbia River.

Ecological Resources

Current
No resources on site, but about 15% level 3 resources on buffer. If not trucks, ND effects currently.

Risks and Potential Impacts from Selected or Potential Cleanup Approaches
No resources on EU, but about 7% level 3 resources on buffer. Remediation could result in truck disturbance, increases in exotic species, changes in species composition in buffer, and contamination of sensitive species.

Cultural Resources

Current
Manhattan Project/Cold War significant resources have already been mitigated. Area is very disturbed and there are no known recorded archaeological resources within the EU. Traditional cultural places are visible from EU.

Risks and Potential Impacts from Selected or Potential Cleanup Approaches
Because area has not been investigated either on the surface or subsurface, archaeological investigations may need to occur within pockets of undisturbed land if any prior to remediation. Potential for intact archaeological material to be present is very low.

Considerations for Timing of the Cleanup Actions

See Section 9.1 (Appendix E.9).

Near-Term, Post-Cleanup Risks and Potential Impacts

See Section 9.1 (Appendix E.9).

10.2. ADMINISTRATIVE INFORMATION

OU and/or TSDF Designation(s):

The 200-West DST Tank and Waste Farms Evaluation Unit (EU), denoted *CP-TF-9*, consists of 3 waste tanks and ancillary structures.

Common name(s) for EU:

There is no common name for the 200-West DST EU because the EU is comprised of various elements from a double-shell Tank Farm. Other components in the EU (including any associated legacy waste sites) are listed below in the *Primary EU Source Components* section.

Key Words:

Double-shell Tank Farm, 241-SY Tank Farm, waste tanks, tank farm

Regulatory Status

Regulatory Basis

The 200 Areas of the Hanford Site have been placed by EPA on the National Priorities List (NPL). The completion of remediation of the 200 Areas overall will eventually be finalized via CERCLA decisions made by the EPA, and permitting decisions made by Ecology.

DOE is the responsible agency for the closure of all Tank Farms through post closure, in close coordination with other closure and cleanup activities of the Hanford Central Plateau. Washington State has a program that is authorized under RCRA and implemented through the HWMA and its associated regulations. Please refer to Section 1.2 (Appendix E.1) for more information.

Applicable Regulatory Documentation

Please refer to Section 1.2 (Appendix E.1).

Applicable Consent Decree or TPA Milestones

Not applicable.

Risk Review Evaluation Information

Completed: Revised August 25, 2015

Evaluated by: K. Jones and K. G. Brown

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

10.3. SUMMARY DESCRIPTION

Current land use

DOE Hanford Site for industrial use. All current land-use activities in the 200-West 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-West 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: There are two unplanned release sites in the CP-TF-9 EU (Attachment Section 10.8); however, the contributions from these sites are insignificant and not considered here.

High-Level Waste Tanks and Ancillary Equipment: The 3 double-shell waste tanks in the 241-SY (-101 through -103 tanks). The ancillary equipment included in the 200-East Tank and Waste Farms EU is listed in Attachment Section 10.8 and consists primarily of pipelines, diversion boxes, and catch tanks.

Groundwater Plumes:

There are no groundwater plumes associated with the 200-West DSTs.

Operating Facilities: The DSTs are considered an Operating Facility for this Review. See Section 9.3 (Appendix E.9) for additional information.

D&D of Inactive Facilities: Not Applicable.

Location and Layout Maps

A series of maps are used to illustrate the location of the components within the CP-TF-9 EU and the 200-West DST Farm EU relative to the Hanford Site. Figure E.2-1 (Appendix E.2) shows the relationship between the 200-W (200 West) Area (where the 200-West DST Farm EU is located) and the Hanford Site. Figure E.10-1 illustrates the 200-West DST Farm EU boundary. Figure E.10-2 shows a detailed view of the waste tanks, ancillary equipment, and legacy source units in the 200-West DST Farm EU.

Figure E.10-1. Polygon representing the boundary of the 200-West DST Farm Evaluation Unit (Attachment Section 10.8).

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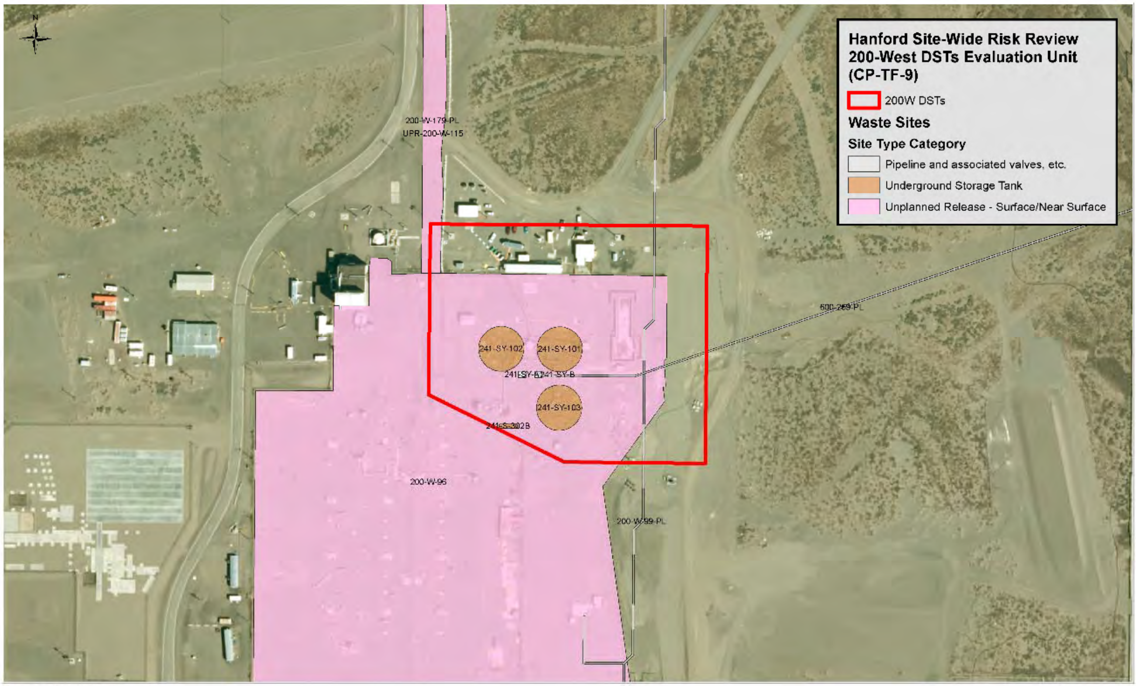


1 inch = 200 feet

Figure E.10-2. Hanford 200-West DST Farm Evaluation Unit including tanks, legacy source units, and ancillary equipment (Attachment Section 10.8).

10.4. UNIT DESCRIPTION AND HISTORY

EU Former / Current Uses

See Section 9.4 (Appendix E.9).

Legacy Source Sites

Not applicable. There are two unplanned release sites in the CP-TF-9 EU (Attachment Section 10.8); however, the contributions from these sites are insignificant (i.e., no inventories vailable) and not considered here.

High-Level Waste Tanks

See Section 10.3 for details.

Groundwater Plumes

Not applicable.

D&D of Inactive Facilities – Not Applicable

Operating Facilities – Not Applicable

The CP-TF-9 DSTs in the EU can be considered Operating Facilities for this Review since they will be used to process the single-shell tank waste.

Ecological Resources Setting

Landscape Evaluation and Resource Classification:

The amount of each category of biological resources at and near the 200-West Double Shell Tanks EU was examined within a circular area radiating 204 m from the geometric center of the unit (equivalent to 32.2 acres). The entire EU (4.7 ac) is comprised of level 0 biological resources (Appendix J, Table 2, p. J-57). The major portion (18.6 ac, 67.6%) of the adjacent landscape buffer is made up of level 0 and 1 resources, with the remainder comprised of several small patches of level 2 (6.9 ac, 25.1%) located north and east of the EU and a single patch of level 3 (1.9 ac, 6.9%) located north of the EU (Appendix J, Table 2, p. J-57 and Figure 8, p. J-58). Overall, only six percent of the total combined area currently consists of higher quality (level 3 or above) biological resources based on habitat.

Field Survey:

PNNL biologists conducted a reconnaissance and visual survey of the 200-West Double Shell Tanks EU in October 2014. This field survey confirmed that nearly the entire EU consists of graveled surfaces, buildings, parking areas, and infrastructure related to the tanks. Only sparse vegetation, consisting of alien grasses and forbs, occurs along roadside margins outside the tank farm fence. No vegetation measurements were taken and no field data sheets are included. The table in Appendix J (Appendix J, Table 2, p. J-57) documents the surface conditions of the EU.

No wildlife were observed within the EU during the October reconnaissance, however, PNNL ECAP surveys conducted in 2009 noted the following birds: an American kestrel (*Falco sparverius*) apparently nesting in a light pole or nearby building, Say's phoebe (*Sayornis saya*), barn swallow (*Hirundo rustica*), and white-crowned sparrow (*Zonotrichia leucophrys*).

Cultural Resources Setting

There are no known archaeological sites, buildings or TCPs known to be recorded within the 200-West DSTs EU. None of the 200-West DSTs EU has been inventoried for archaeological resources. Given the extensive disturbance within the 200 West DSTs EU, it is unlikely, but there is a possibility that intact archaeological material is present in the areas that have not been inventoried for archaeological resources (both on the surface and in the subsurface), particularly if undisturbed soil deposits exist within the 200-West DSTs EU. Closure and remediation of the tank farms located within the 200-West DSTs has been addressed in an NHPA Section 106 review.

Two National Register-eligible properties associated with the Manhattan Project/Cold War Era Landscape (Hanford Site Plant Railroad with documentation required and the 242S Evaporator Facility with no documentation required) are located within 500 meters of the 200-West DST EU. Both have been documented as described in the *Hanford Site Manhattan Project and Cold War Era Historic District Treatment Plan* (DOE/RL-97-56).

Historic maps indicate that there is no evidence of historic-era settlement in or near the 200-West DST EU. Geomorphology and extensive ground disturbance further indicates a low potential for the presence of intact archaeological resources associated with all three landscape to be present subsurface within the 200-West DST EU. Pockets of undisturbed soil may exist, it may be appropriate to conduct surface and subsurface archaeological investigations in these areas prior to initiating a remediation activity. 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 associated with these landscapes (e.g. East Benton Historical Society, the Franklin County Historical Society, Prosser Cemetery Association, the Reach and B-Reactor Museum Association) may need to occur. Indirect effects are always possible when TCPs are known to be located in the general vicinity. Consultation with Hanford Tribes may also 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.

10.5. WASTE AND CONTAMINATION INVENTORY

Table E.10-2 provides inventory estimates of the various source components associated with the 200-West DST Farm EU (CP-TF-9) that are primarily tank wastes and ancillary equipment. There are no significant legacy sources associated with the 200-West DST Farm EU. Thus the focus will be on the tank waste and ancillary equipment for the EU.

The major sources for before assumed retrieval are the 200-West DSTs. A 99% retrieval as used for the Hanford SSTs (CP-TF-1 through CP-TF-7) is also assumed for the 200-West DST Farm EUs. The tank residuals represent the largest source after assumed 99% retrieval for the contaminants with the remaining contribution from ancillary equipment as shown in Figure E.10-3 through Figure E.10-11. The current maximum groundwater threat metric (GTM) (Figure E.10-12)[135] is dominated by the Tc-99 and I-129 in the 200-West DST Farms wastes before retrieval and by residual waste after assumed 99% retrieval.

CONTAMINATION WITHIN PRIMARY EU SOURCE COMPONENTS

Legacy Source Sites

There are no significant legacy sources associated with the 200-West DST Farm (Table E.10-2).

Waste Tanks and Ancillary Equipment

The estimated total inventory for the 200-West DST Farm waste tanks and Ancillary Equipment is provided in Table E.10-2 for both as assumed 90% and 99% retrieval scenarios. The tank-by-tank inventories are provided in Table E.10-3 through Table E.10-6. Safety-related information (i.e., hydrogen generation rates and times to the lower flammability limit are also provided in Table E.10-3. The inventories for the various contaminant in the 200-East DST Farm tanks vary over several orders of magnitude as does the GTM. This information is further summarized in Figure E.10-3 through Figure E.10-11 before and after assumed 99% retrieval and for the maximum GTM in Figure E.10-12.

Vadose Zone Contamination

There are no vadose zone, saturated zone, and treatment amounts associated with the 200-West DST Farm EU (Table E.10-2). Thus the ratings associated with potential vadose zone threats related to the 200-West DST Farm EU are *Not Discernible* for all contaminants and all evaluation periods.

[135] Maximum of the GTMs for Tc-99 and I-129 only.

Groundwater Plumes

There are no plumes associated with 200-West DST Farm EU sources (Table E.10-2) nor are any expected in the foreseeable future.

Columbia River – Benthic, Riparian, and Free-flowing Ecology – All Evaluation Periods

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. With this in mind, a common evaluation for the ecological receptors is performed here.

Since there are no plumes associated with the 200-West DST Farm EU (Table E.10-2) nor are any expected in the foreseeable future, the potential for impacts to the Columbia River benthic, riparian, or free-flowing ecology is not credible based on current information. Thus the ratings associated with potential threats from 200-West DST Farm EU to Columbia River benthic, riparian, or free-flowing receptors are *Not Discernible* for all contaminants and all evaluation periods.

Facilities for D&D – Not Applicable

Operating Facilities

The CP-TF-9 DSTs in the EU can be considered Operating Facilities for this Review since they will be used to process the single-shell tank waste. The inventory associated with these facilities is thus that shown in Table E.10-2 for the Waste Tanks and Ancillary Equipment.

Table E.10-2. Summary Table of Infrastructure and Subsurface Contamination Inventory for the SY Tank and Waste Farms EU (CP-TF-9) [(a)(b)]

Contaminated Media	Primary Contaminants	Total Amount. of Each Contaminant Before Retrieval	90% Retrieval Scenario	99% Retrieval Scenario
Infrastructure (Tanks and Ancillary Equipment)				
Tank Waste	Waste (kGal)	2413	241.3	24.13
	Sludge (kGal)	199	19.9	1.99
	Saltcake (kGal)	611	61.1	6.11
	Supernatant (kGal)	1603	160.3	16.03
Tank Waste (rad)	Am-241 (Ci)	23000	2300	230
	C-14 (Ci)	14	1.4	0.14
	Co-60 (Ci)	34	3.4	0.34
	Cs-137 (Ci)	1400000	140000	14000
	Eu-152 (Ci)	24	2.4	0.24
	Eu-154 (Ci)	1400	140	14
	H-3 (Ci)	27	2.7	0.27
	I-129 (Ci)	1.5	0.15	0.015
	Ni-59 (Ci)	9.3	0.93	0.093
	Ni-63 (Ci)	840	84	8.4
	Pu (total) (Ci)	16000	1600	160
	Sr-90 (Ci)	320000	32000	3200
	Tc-99 (Ci)	1600	160	16
	U (total) (Ci)	8.7	0.87	0.087
Tank Waste (non-rad)	Cr (kg)	61000	6100	610
	Hg (kg)	11	1.1	0.11
	NO3 (kg)	990000	99000	9900
	Pb (kg)	1700	170	17
	U (total) (kg)	6000	600	60
Ancillary Equipment (rad)	C-14 (Ci)	0.14	0.14	0.14
	Cs-137 (Ci)	9200	9200	9200
	H-3 (Ci)	3.9	3.9	3.9
	I-129 (Ci)	0.0095	0.0095	0.0095
	Pu (total) (Ci)	17	17	17

Contaminated Media	**Primary Contaminants**	**Total Amount. of Each Contaminant Before Retrieval**	**90% Retrieval Scenario**	**99% Retrieval Scenario**
	Sr-90 (Ci)	780	780	780
	Tc-99 (Ci)	8.8	8.8	8.8
	U (total) (Ci)	0.016	0.016	0.016
Ancillary Equipment (non-rad)	Cr (kg)	170	170	170
	Hg (kg)	0.032	0.032	0.032
	NO3 (kg)	8900	8900	8900
	Pb (kg)	5.6	5.6	5.6
	U (total) (kg)	8.5	8.5	8.5
Vadose Zone Source (Leaks and Intentional Discharges into Cribs and Trenches)				
Vadose Zone (from Vadose Zone Sources)				
Saturated Zone (from Vadose Zone Sources)				

a. Tanks (SST and DST): Best Basis Inventory (BBI) March 2014; Ancillary Equipment (Anc Eq): Tank Farm Closure & Waste Management (TC&WM) Environmental Impact Statement (DOE/EIS-0391) Appendix D; Unplanned Releases (UPRs): Soil Inventory Model (SIM) Rev 1 (RPP-26744, Rev 0); Ponds: Soil Inventory Model (SIM) Rev 1 (RPP-26744, Rev 0); Cribs: Soil Inventory Model (SIM) Rev 1 (RPP-26744, Rev 0); Trenches: Soil Inventory Model (SIM) Rev 1 (RPP-26744, Rev 0) and Tank Farm Closure & Waste Management (TC&WM) Environmental Impact Statement (DOE/EIS-0391) Appendix S; Leaks: Tank Farm Closure & Waste Management (TC&WM) Environmental Impact Statement (DOE/EIS-0391) Appendix D; MUSTs: Soil Inventory Model (SIM) Rev 1 (RPP-26744, Rev 0) and Tank Farm Closure & Waste Management (TC&WM) Environmental Impact Statement (DOE/EIS-0391) Appendix S.

b. All primary contaminant inventories are reported to 2 significant figures. The source document should be consulted for greater precision data.

Table E.10-3. Current Bulk Inventory and Steady State Flammability Results (by Tank) for the SY Tank Farm (CP-TF-9)

Tank ID	Tank Type	Capacity (kGal)[(a)]	Sludge (kGal)[(a)]	Saltcake (kGal)[(a)]	Supernatant (kGal)[(a)]	HGR(c) (ft3/d)[(b)]	Days to 25% LFL Barometric[(c)]	Days to 25% LFL Zero Ventilation[(d)]
SY-101	DST	1160	0	255	865	11	30	28
SY-102	DST	1160	199	0	360	12	98	79
SY-103	DST	1160	0	356	378	18	44	40

a. Volumes from the Waste Tank Summary Report coinciding with the BBI (Rodgers 2014).

b. Hydrogen generation rate (ft^3/d) (RPP-5926 Rev. 15). Note in 2001 all 24 tanks were removed from the flammable gas watch list (including T-110 in the T Tank and Waste Farms EU) (Johnson, et al. 2001, p. iii).

c. Time (in days) to 25% of the Lower Flammability Limit (LFL) under a barometric (barom) breathing scenario (RPP-5926, Rev. 15). "NA" indicates that the headspace will not reach specified flammability level.

d. Time (in days) to 25% of the LFL under a zero ventilation scenario (RPP-5926, Rev. 15).

Table E.10-4. Current Primary Contaminant Inventory (by Tank) for the SY Tank Farm (CP-TF-9) [(a)]

Tank ID	Decay Date	Am-241 (Ci)	C-14 (Ci)	Cl-36 (Ci)	Co-60 (Ci)	Cs-137 (Ci)	Eu-152 (Ci)	Eu-154 (Ci)	H-3 (Ci)
SY-101	2001	710	8.2	NP[(b)]	11	270000	8.8	410	24
SY-102	2001	21000	1.8	NP	5.7	150000	9.3	340	1.2
SY-103	2001	1300	3.9	NP	18	970000	5.5	660	1.5

a. From Best Basis Inventory (BBI) Summary (March 24, 2014) provided in spreadsheet form by Mark Triplett. All primary contaminant inventories are reported to 2 significant figures. The source document should be consulted for greater precision data.

b. NP = Not present at significant quantities

Table E.10-5. Current Primary Contaminant Inventory [(a)] and Groundwater Threat Metric (by Tank) for the SY Tank Farm (CP-TF-9)

Tank ID	I-129 (Ci)	Ni-59 (Ci)	Ni-63 (Ci)	Pu (total) (Ci)[(b)]	Sr-90 (Ci)	Tc-99 (Ci)	U (total) (Ci)[(c)]	GTM (Mm3)[(d)]
SY-101	0.3	4.4	400	160	75000	300	1.3	330
SY-102	0.14	1.9	170	16000	190000	240	5.4	270
SY-103	1	2.9	270	290	64000	1000	2.1	1100

a. From Best Basis Inventory (BBI) Summary (March 24, 2014) provided in spreadsheet form by Mark Triplett. All primary contaminant inventories are reported to 2 significant figures. The source document should be consulted for greater precision data.

b. Sum of plutonium isotopes 238, 239, 240, 241, and 242

c. Sum of uranium isotopes 232, 233, 234, 235, 236, and 238

d. The Groundwater Threat Metric (GTM) shown for tanks is equal to the maximum of the GTM for Tc-99 and I-129.

Table E.10-6. Current Primary Contaminant Inventory (by Tank) for the SY Tank Farm (CP-TF-9) [(a)]

Tank ID	CCl4 (kg)	CN (kg)	Cr (kg)	Cr-VI (kg)	Hg (kg)	NO3 (kg)	Pb (kg)	TBP (kg)	TCE (kg)	U (total) (kg)
SY-101	NP[(b)]	NP	26000	NP	0.54	300000	440	NP	NP	570
SY-102	NP	NP	21000	NP	8	180000	700	NP	NP	4000
SY-103	NP	NP	15000	NP	2.6	500000	520	NP	NP	1400

a. From Best Basis Inventory (BBI) Summary (March 24, 2014) provided in spreadsheet form by Mark Triplett. All primary contaminant inventories are reported to 2 significant figures. The source document should be consulted for greater precision data.

b. NP = Not present at significant quantities

Table E.10-7. Summary of the Evaluation of Threats to Groundwater as a Protected Resource from Remaining Vadose Zone (VZ) Contamination associated with the SY Tank Farm (CP-TF-9). Despite no significant vadose zone sources, this information is provided for consistency with the other TF EUs.

PC	Group	WQS	Porosity[(a)]	K_d (mL/g)[(a)]	ρ (kg/L)[(a)]	VZ Source M^{Source}	SZ Total M^{SZ}	Treated[(c)] M^{Treat}	VZ Remaining M^{Tot}	VZ GTM (Mm^3)	VZ Rating[(d)]
C-14	A	2000 pCi/L	0.23	0	1.84	---	---	---	---	---	ND
I-129	A	1 pCi/L	0.23	0.2	1.84	---	---	---	---	---	ND
Sr-90	B	8 pCi/L	0.23	22	1.84	---	---	---	---	---	ND
Tc-99	A	900 pCi/L	0.23	0	1.84	---	---	---	---	---	ND
CCl_4	A	5 µg/L	0.23	0	1.84	---	---	---	---	---	ND
Cr	B	100 µg/L	0.23	0	1.84	---	---	---	---	---	ND
Cr-VI	A	48 µg/L[(b)]	0.23	0	1.84	---	---	---	---	---	ND
TCE	B	5 µg/L	0.23	2	1.84	---	---	---	---	---	ND
U(tot)	B	30 µg/L	0.23	0.8	1.84	---	---	---	---	---	ND

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

b. “Model Toxics Control Act–Cleanup” (WAC 173-340) Method B groundwater cleanup level for hexavalent chromium. The other WQS values are drinking water standards.

c. Treatment amounts from the 2013 Hanford Annual Groundwater Report (DOE/RL-2014-32, Rev. 0).

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

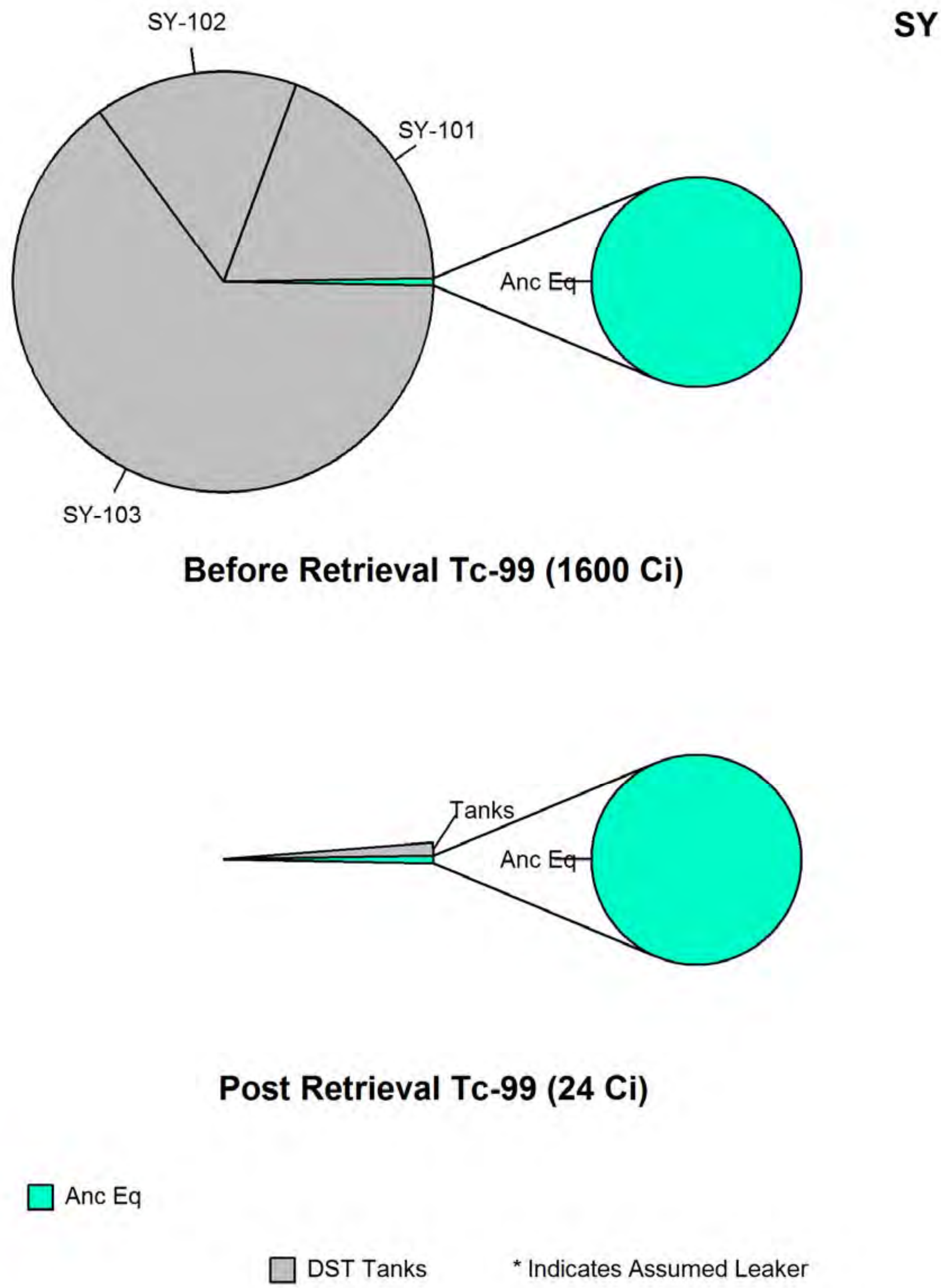


Figure E.10-3. SY Tank and Waste Farms Evaluation Unit Inventory Estimates for Tc-99 Before and After 99% Retrieval

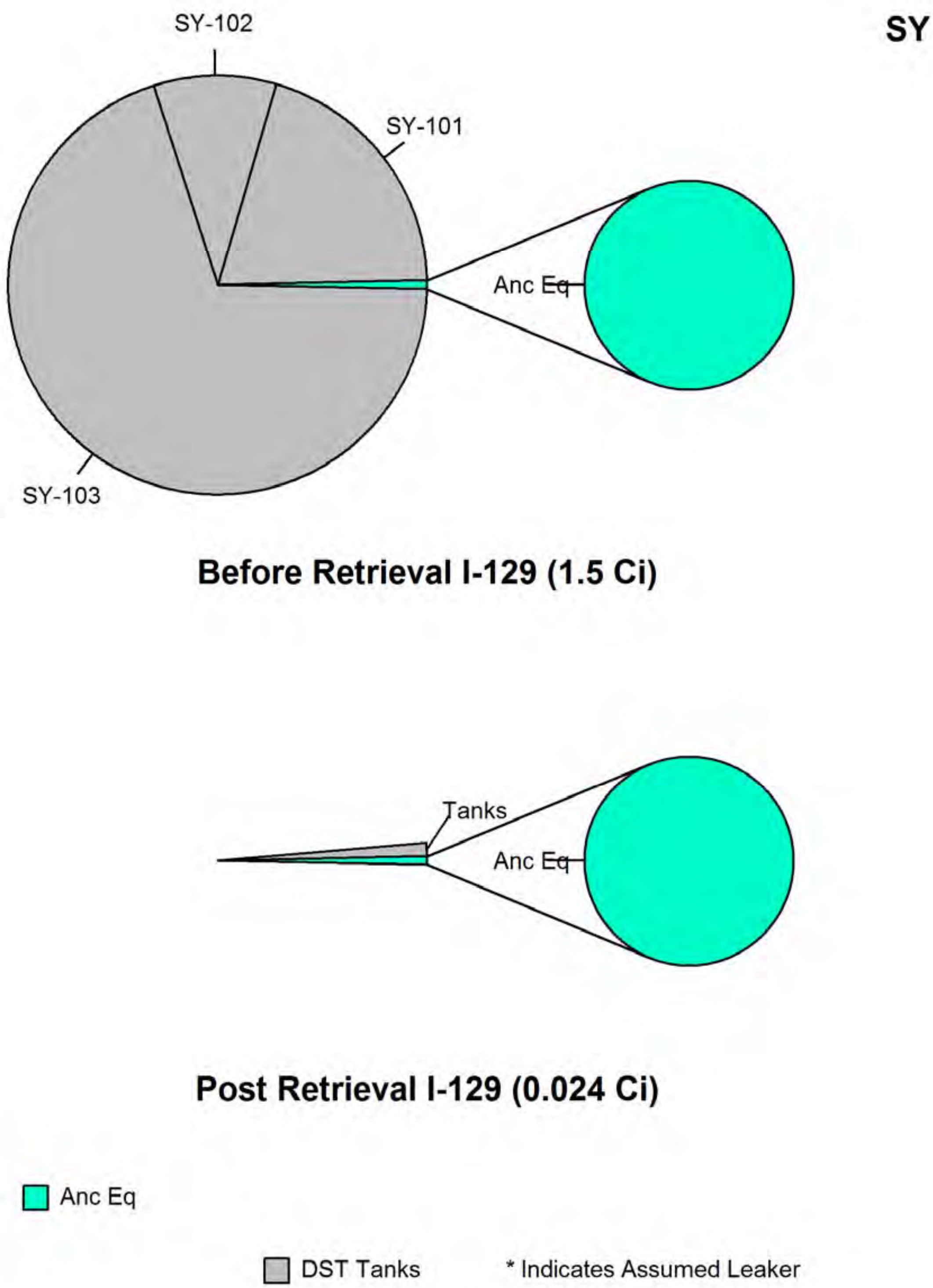


Figure E.10-4. SY Tank and Waste Farms Evaluation Unit Inventory Estimates for I-129 Before and After 99% Retrieval

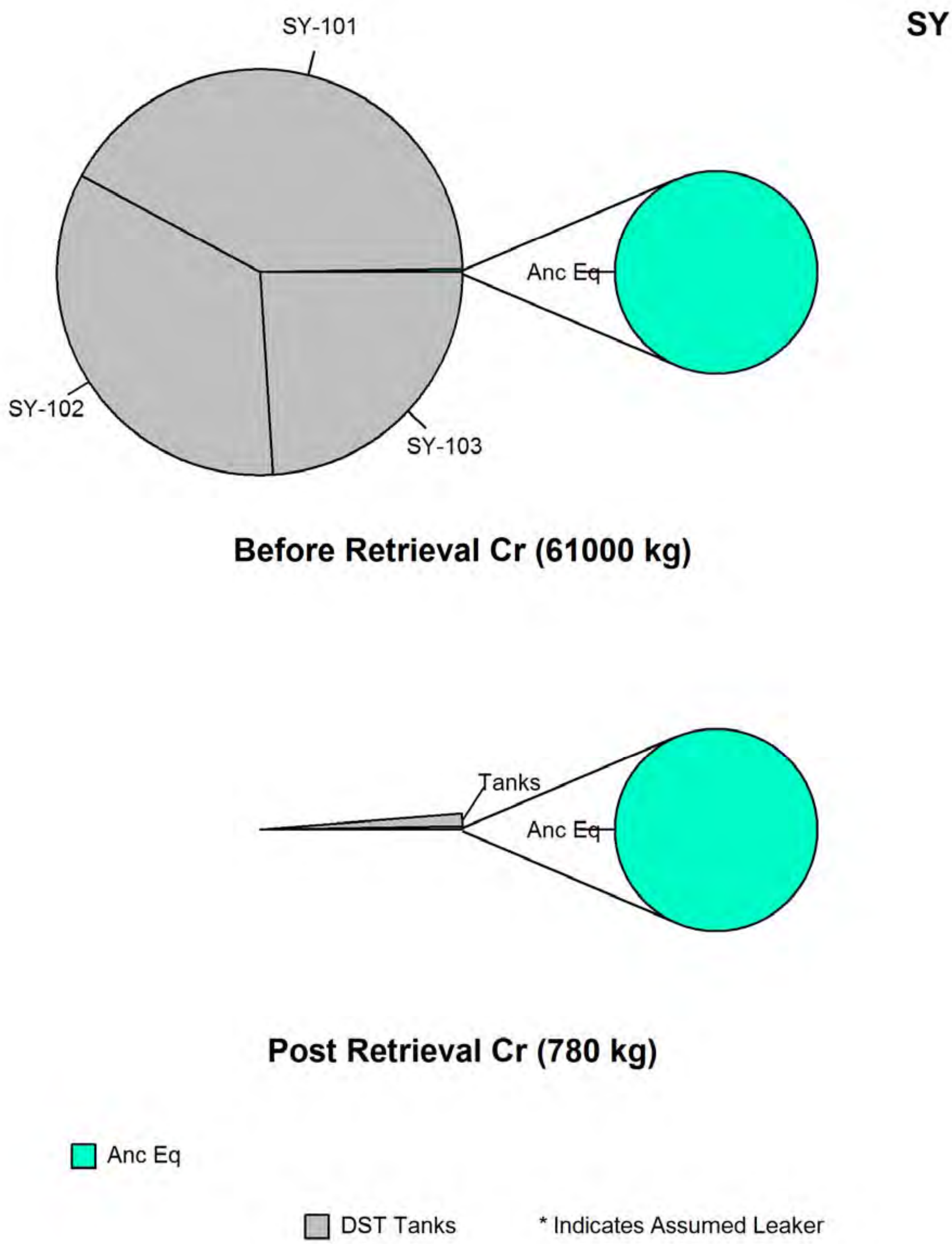


Figure E.10-5. SY Tank and Waste Farms Evaluation Unit Inventory Estimates for Chromium Before and After 99% Retrieval

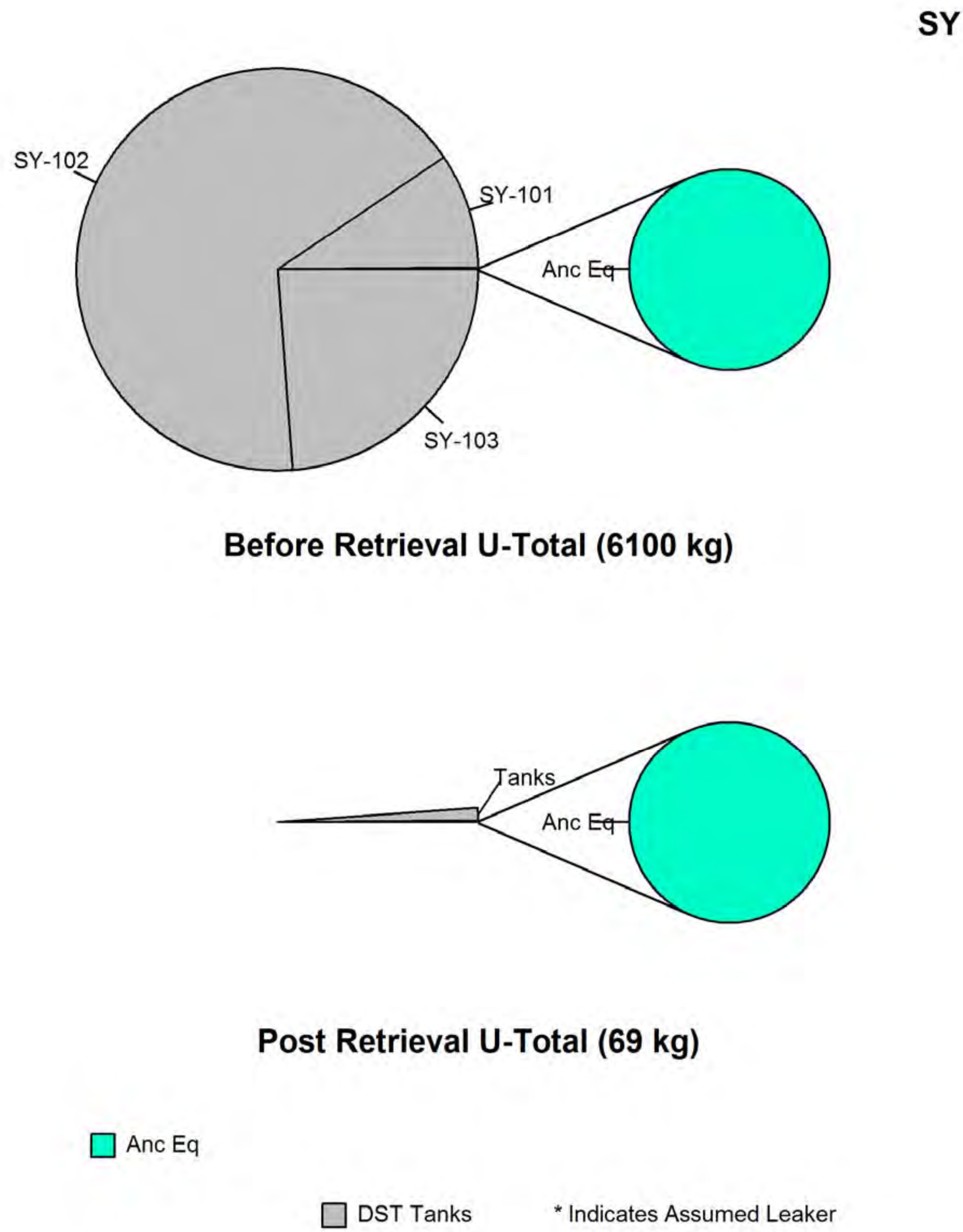


Figure E.10-6. SY Tank and Waste Farms Evaluation Unit Inventory Estimates for U(tot) Before and After 99% Retrieval

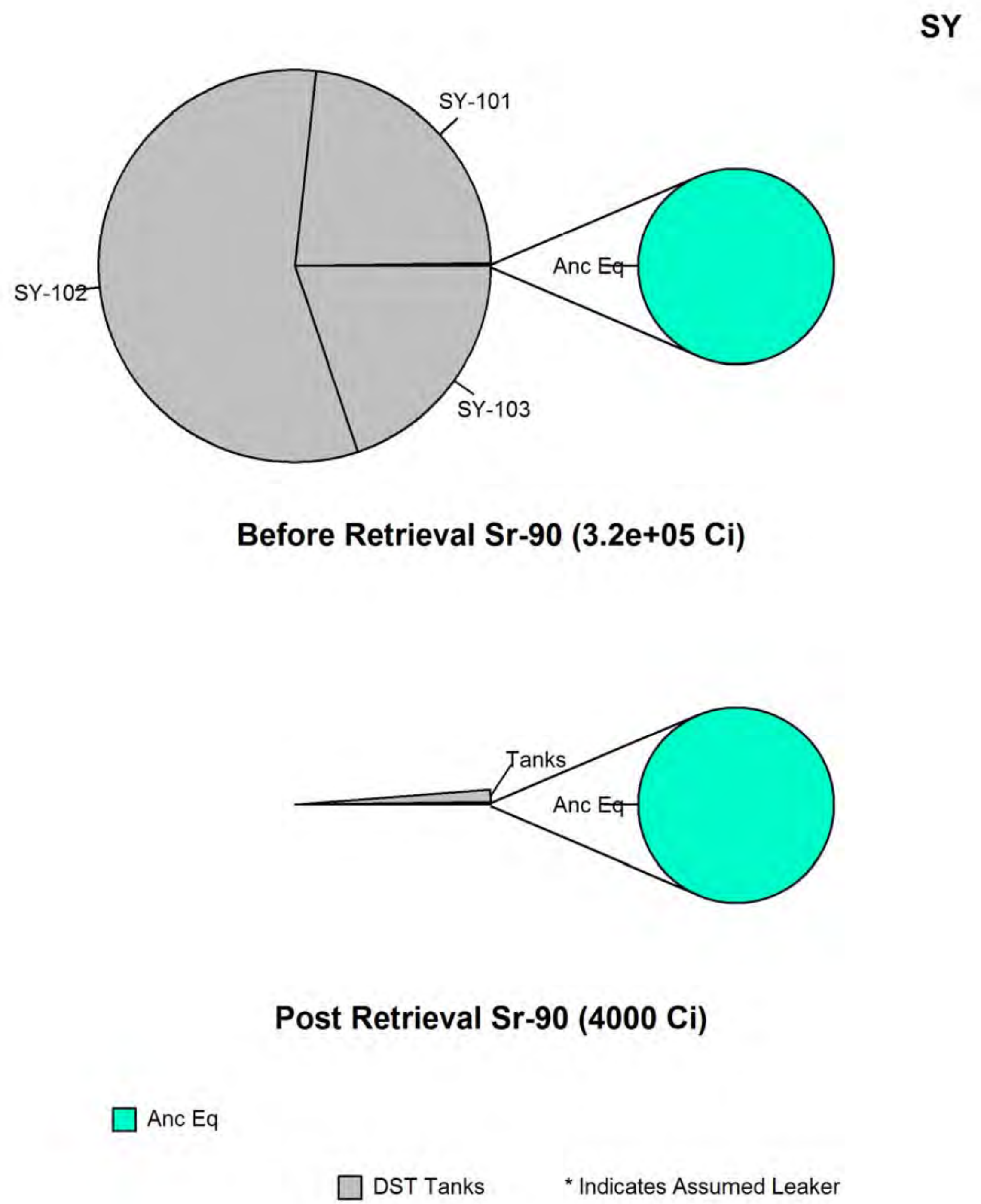


Figure E.10-7. SY Tank and Waste Farms Evaluation Unit Inventory Estimates for Sr-90 Before and After 99% Retrieval

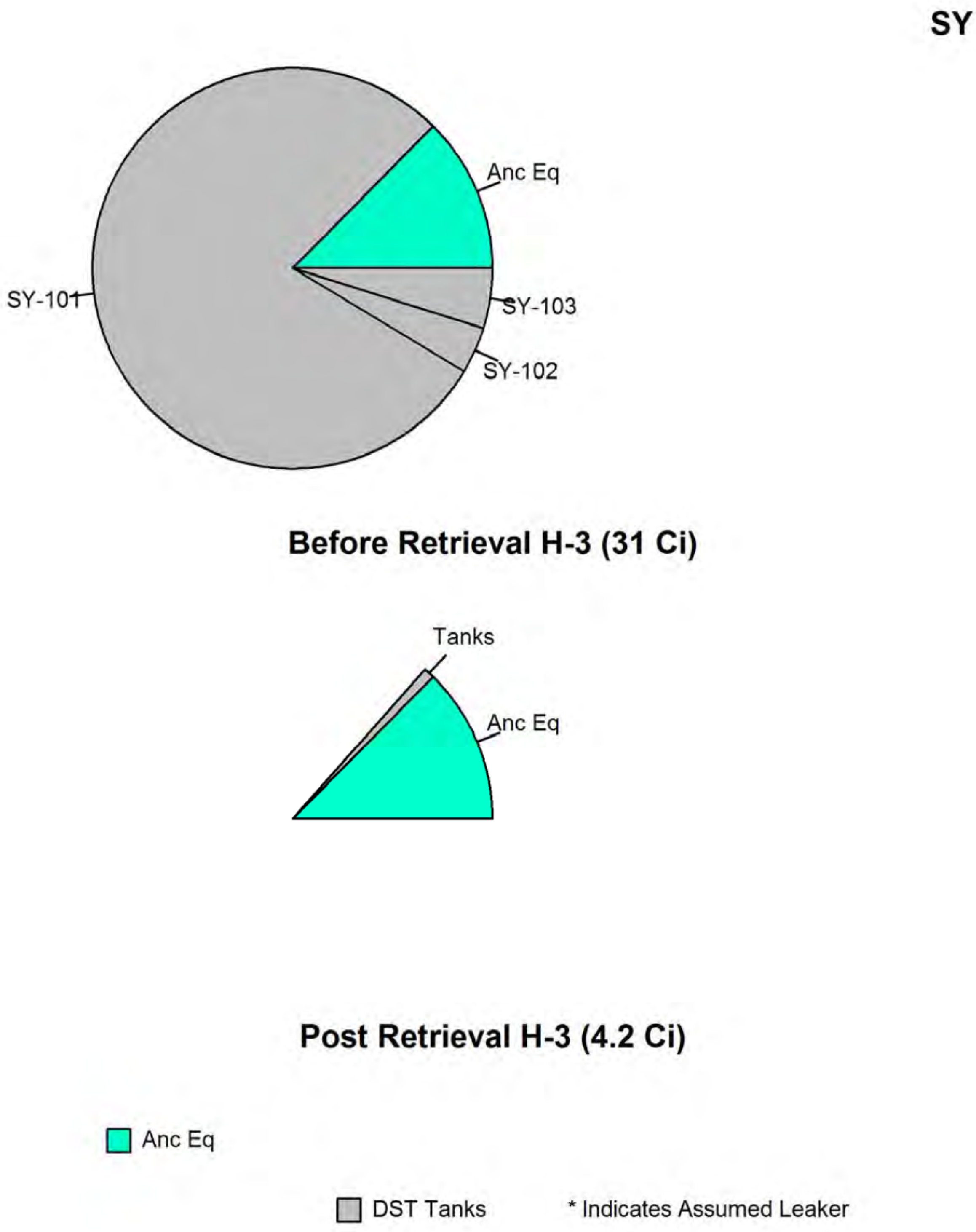


Figure E.10-8. SY Tank and Waste Farms Evaluation Unit Inventory Estimates for Tritium (H-3) Before and After 99% Retrieval

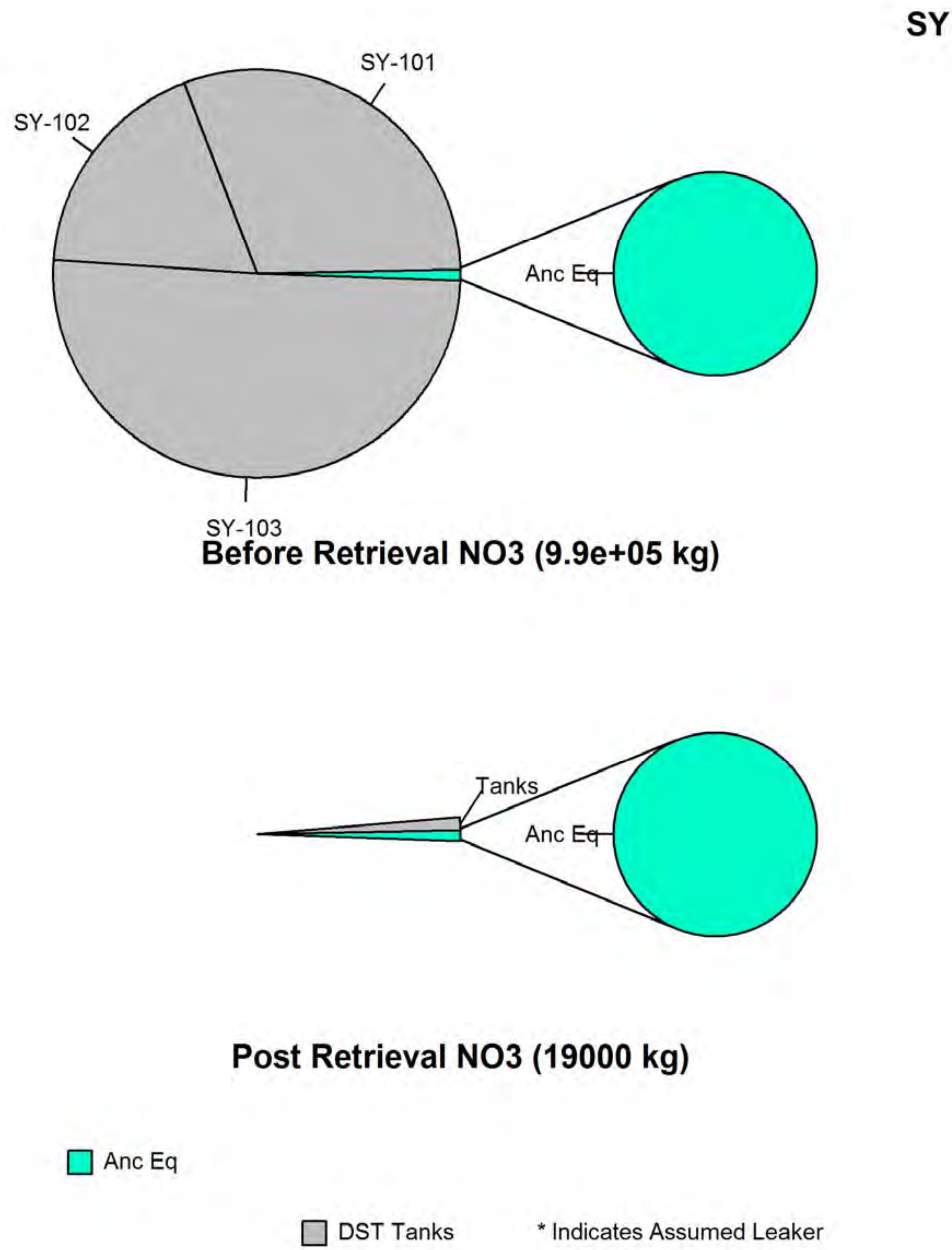


Figure E.10-9. SY Tank and Waste Farms Evaluation Unit Inventory Estimates for Nitrate (NO3) Before and After 99% Retrieval

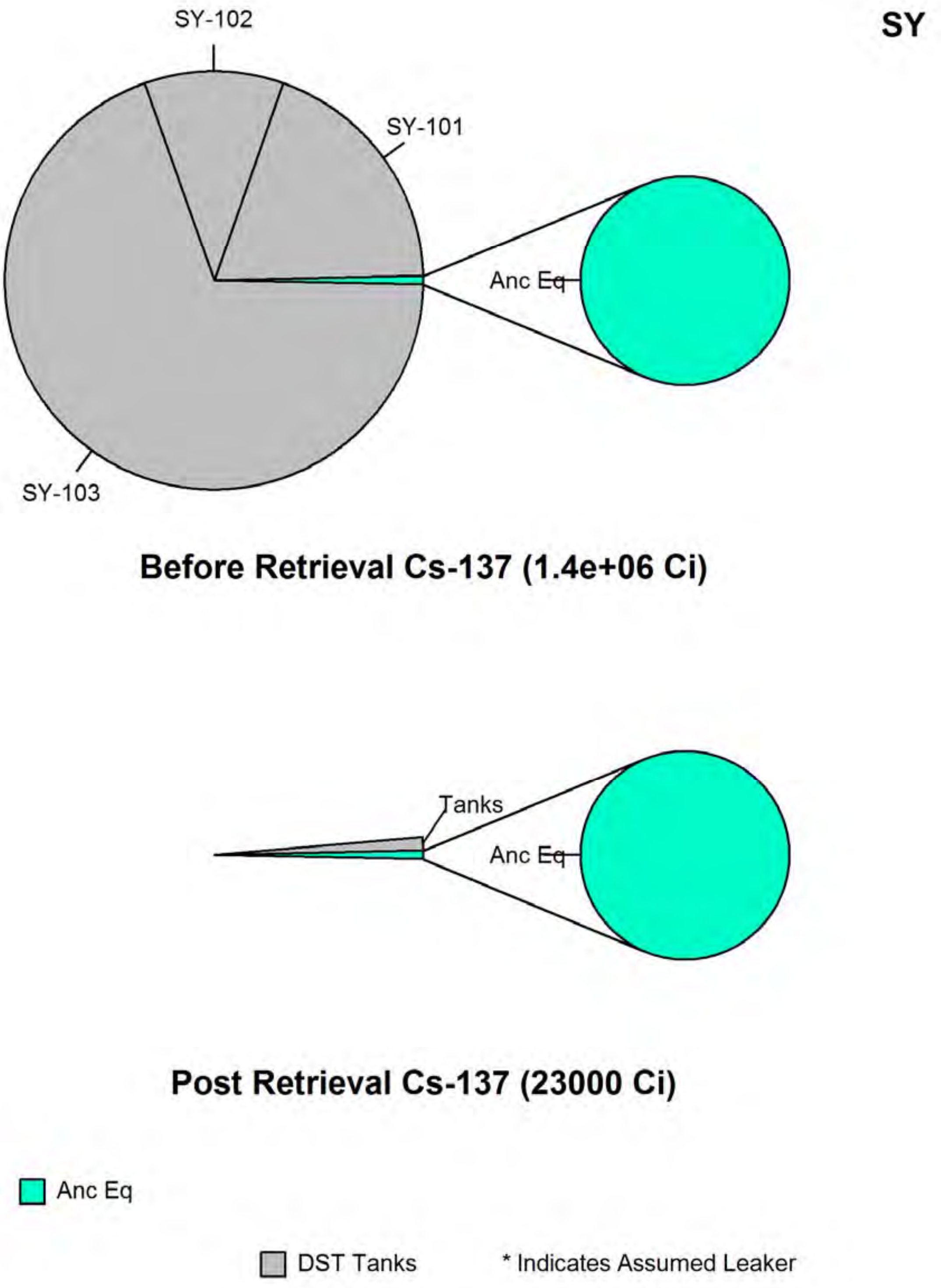


Figure E.10-10. SY Tank and Waste Farms Evaluation Unit Inventory Estimates for Cs-137 Before and After 99% Retrieval

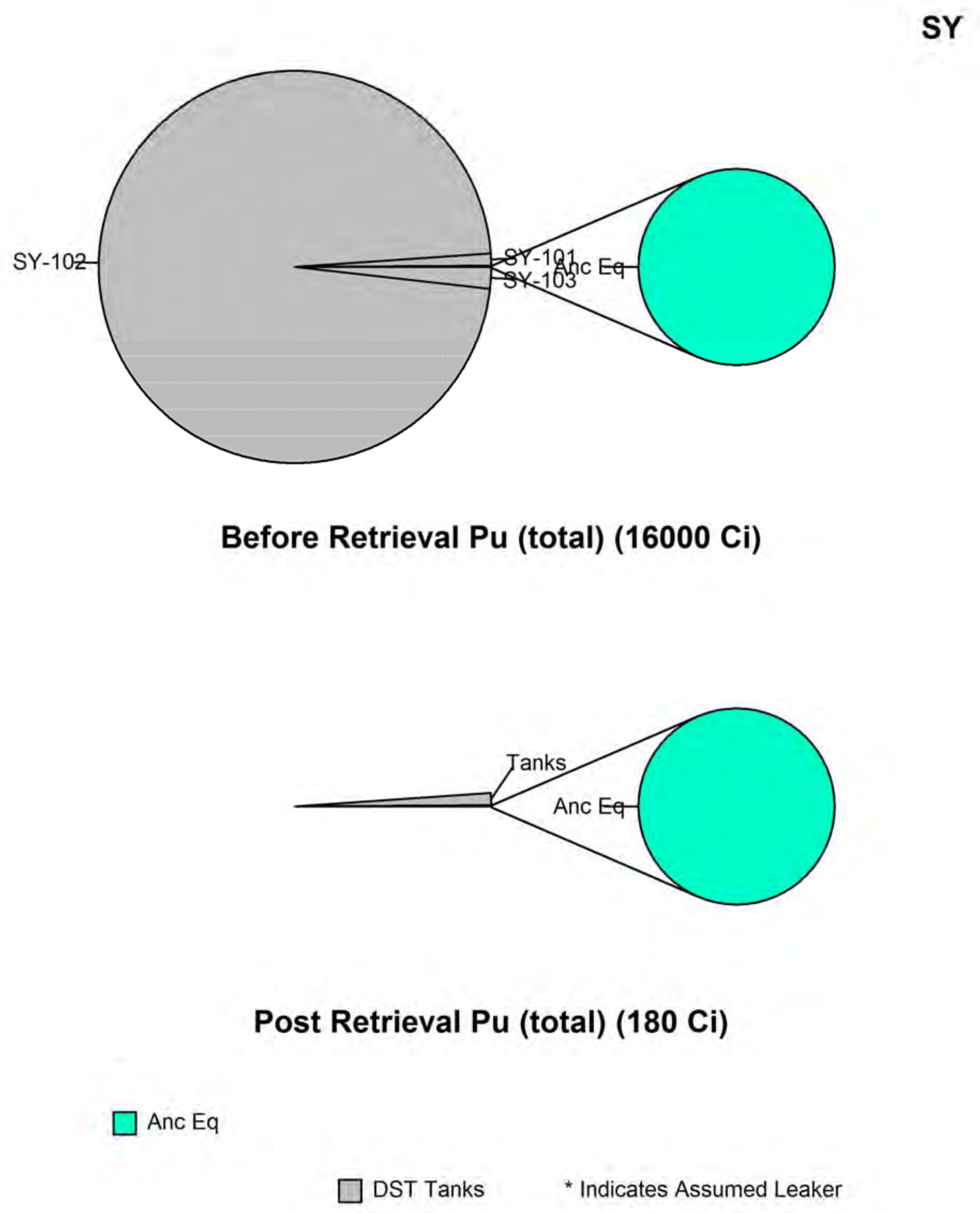


Figure E.10-11. SY Tank and Waste Farms Evaluation Unit Inventory Estimates for Plutonium (total) Before and After 99% Retrieval

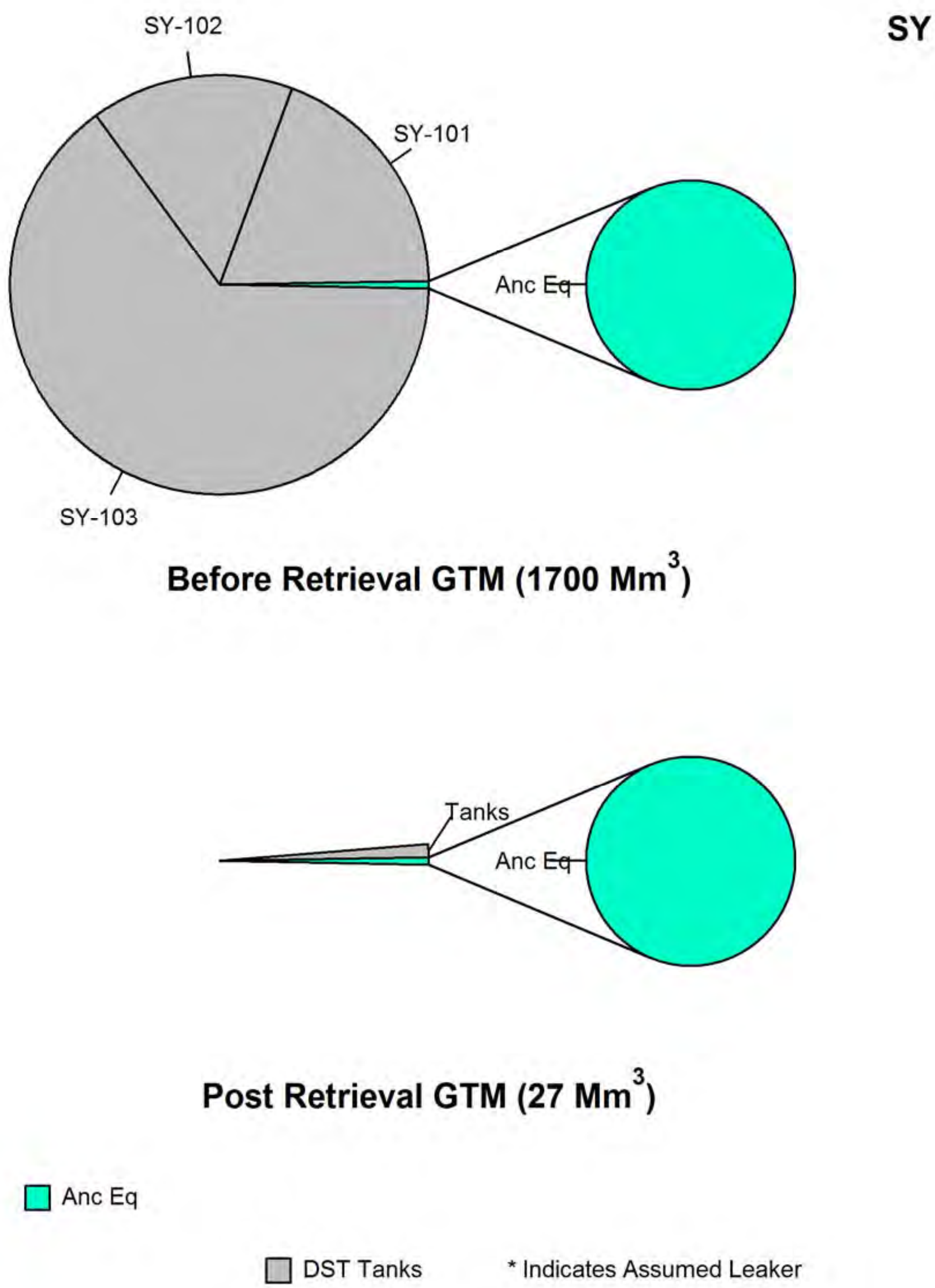


Figure E.10-12. SY Tank and Waste Farms Evaluation Unit Maximum Groundwater Threat Metric (GTM) of I-129 and Tc-99 Estimates Before and After 99% Retrieval

10.6. POTENTIAL RISK/IMPACT PATHWAYS AND EVENTS

CURRENT CONCEPTUAL MODEL

A common safety analysis was performed for all the single- and double-shell tanks including pathways and barriers (safety scenarios that dominate risk, safety systems and controls, barriers to release, failure mechanisms, pathways and receptors, time frames for exposure). See Section 1.6 in Appendix E.1 for details.

POPULATIONS AND RESOURCES CURRENTLY AT RISK OR POTENTIALLY IMPACTED

Facility Worker, Co-located Person, and Public

A common analysis was performed for the Facility Worker, Co-located Person, and Public. See Section 1.6 (Appendix E.1) for details.

Groundwater

There are no plumes associated with the 200-West DST Farm EU (Table E.10-2 and Table E.10-7) nor are any expected in the foreseeable future. Thus the ratings for all primary contaminants and all time periods is *Not Discernible*.

Columbia River

Since there are no plumes associated with the 200-West DST Farm EU (Table E.10-2) nor are any expected in the foreseeable future, the potential for impacts to the Columbia River benthic, riparian, or free-flowing ecology is not credible based on current information. Thus the ratings associated with potential threats from 200-West DST Farm EU to Columbia River benthic, riparian, or free-flowing receptors are defined to be *Not Discernible* for all contaminants and all evaluation periods.

Ecological Resources

- The EU for the 200-West DSTs consists entirely of level 0 habitat resources.
- No wildlife or signs were observed during the October survey of the EU.
- Remediation actions undertaken within the 200-West DSTs EU boundary would result in no net change in biological resources within a 2.1 km radius.
- Because the area is an industrial site, and is contiguous with adjacent tank farms and other industrial areas—no significant change in habitat connectivity would be expected if habitat resources within the EU are lost.

Cultural Resources

- There are no cultural resources known to be located within the 200-West DST.

Archaeological sites and TCPs located within 500 meters of the EU

- The 242S Evaporator Facility a contributing property within the Manhattan Project and Cold War Era Historic District, with no documentation required is located adjacent to the 200-West DST Evaluation Unit.
- The Hanford Site Plant Railroad, a contributing property within the Manhattan Project and Cold War Era Historic District, with documentation required is located in the vicinity of the 200-West DST Evaluation Unit.

<u>**Closest Recorded TCP**</u>

- There are two recorded TCPs associated with the Native American Precontact and Ethnographic Landscape that are visible from 200-West DSTs EU.

CLEANUP APPROACHES AND END-STATE CONCEPTUAL MODEL

Selected or Potential Cleanup Approaches

A common analysis was performed for all the single- and double-shell tanks. See Section 1.6 (Appendix E.1) for details.

Contaminant Inventory Remaining at the Conclusion of Planned Active Cleanup Period

See Section 10.5 including Table E.10-2 and Figure E.10-3 through Figure E.10-11 for the inventory information after planned 99% retrieval. Furthermore, a more general analysis was performed for all the single- and double-shell tanks. See Section 1.6 (Appendix E.1) for details.

Risks and Potential Impacts Associated with Cleanup

A common analysis was performed for all the single- and double-shell tanks for workers and the Public. See Section 1.6 (Appendix E.1) for details.

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

Facility Worker, Co-located Person, and Public

A common analysis was performed for the Facility Worker, Co-located Person, and Public. See Section 1.6 (Appendix E.1) for details.

Groundwater

There are no current or anticipated plumes or impacts to groundwater from the 200-West DST Farms.

It is considered unlikely that additional groundwater resources would be impacted as a result of assumed final closure activities (that are not covered in the Ecological or Cultural Resources results).

Columbia River

There are no current or anticipated plumes or impacts to the Columbia River from the 200-West DST Farms.

It is considered unlikely that additional benthic or riparian resources would be impacted as a result of assumed final closure activities (that are not covered in the Ecological or Cultural Resources results).

Ecological Resources

No ecological resources are in this EU, and thus there are no effects.

Cultural Resources

See Section 1.6 (Appendix E.1) for details.

ADDITIONAL RISKS AND POTENTIAL IMPACTS IF CLEANUP IS DELAYED

A common analysis was performed for all the single- and double-shell tanks. See Section 1.6 (Appendix E.1) for details.

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

A common analysis was performed for all the single- and double-shell tanks. See Section 1.6 (Appendix E.1) for details.

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

Table E.10-8. Summary of Populations and Resources at Risk or Potentially Impacted after Cleanup

Population or Resource		Impact Rating	Comments
Human	Facility Worker	Low	Workers will be low risk from exposure to direct radiation and waste contaminants after waste retrieval, grouting, and capping.
	Co-located Person	Low	These persons will be at low risk from exposure to direct radiation and waste contaminants after waste retrieval, grouting, and capping.
	Public	Not Discernible (ND)	The Tank Farms will be in secure and controlled areas that prevent intentional and inadvertent intruders. No complete groundwater pathway and no impact from air pathway.
Environmental	Groundwater (A&B) from vadose zone[a]	Not Discernible **Overall**: Not Discernible	No current plumes or expected significant transport from vadose zone to groundwater. No significant legacy source sites in the EU.
	Columbia River from vadose zone[a]	Benthic: Not Discernible (all) Riparian: Not Discernible (all) Free-flowing: Not Discernible (all) **Overall**: Not Discernible	No current plumes or expected significant transport from vadose zone to groundwater and thus no credible impact to the Columbia River ecology over the foreseeable future.
	Ecological Resources[b]	ND to Low	Likely monitoring of caps, little disturbance, but potential for disruption due to monitoring, and some contamination of receptors. Re-vegetation could result in higher quality habitat on EU.
Social	Cultural Resources[b]	**Native American:** Direct: Unknown Indirect: Known **Historic Pre-Hanford:**	Permanent indirect effects to viewshed are possible from capping. Permanent effects may be possible due to presence of

Population or Resource		Impact Rating	Comments
		Direct: Unknown Indirect: Unknown **Manhattan/Cold War**: Direct: None Indirect: None	contamination if capping occurs. No other expected cultural resources impacts.

a. Groundwater threat for Group A and B contaminants remaining in the vadose zone or to the Columbia River for all primary contaminants. Threats from existing plumes associated with the 200 West DST Tank and Waste Farms EU are described in Section 10.5 and Appendix G.6 (CP-GW-2) for the 200-UP-1 and 200-ZP-1 Groundwater Operable Units. However, there is no vadose zone contamination associated with this EU (and none expected in the future) and thus there is no risk and an ND rating.
b. 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.

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

There are no current plumes or expected significant transport from vadose zone to groundwater and thus no credible impact to groundwater or the Columbia River ecology over the foreseeable future.

10.7. SUPPLEMENTAL INFORMATION AND CONSIDERATIONS

A common analysis was performed for all the single- and double-shell tanks. See Section 1.7 (Appendix E.1) for details.

10.8. ATTACHMENT – SY TANK AND WASTE FARMS EVALUATION UNIT WIDS REVIEW

Hanford Site-Wide Risk Review

Evaluation Unit:	200-West DSTs
ID:	CP-TF-9
Group:	Tank Farm
Operable Unit Cross-Walk:	WMA S/SX
Related EU:	CP-LS-7 CP-TF-2
Sites & Facilities:	SY tank farm, ancillary structures, associated liquid waste sites, and soils contamination
Key Data Sources Docs:	NA

Figure 1. Site Map with Evaluation Unit Boundaries and Tank Locations

DRAFT

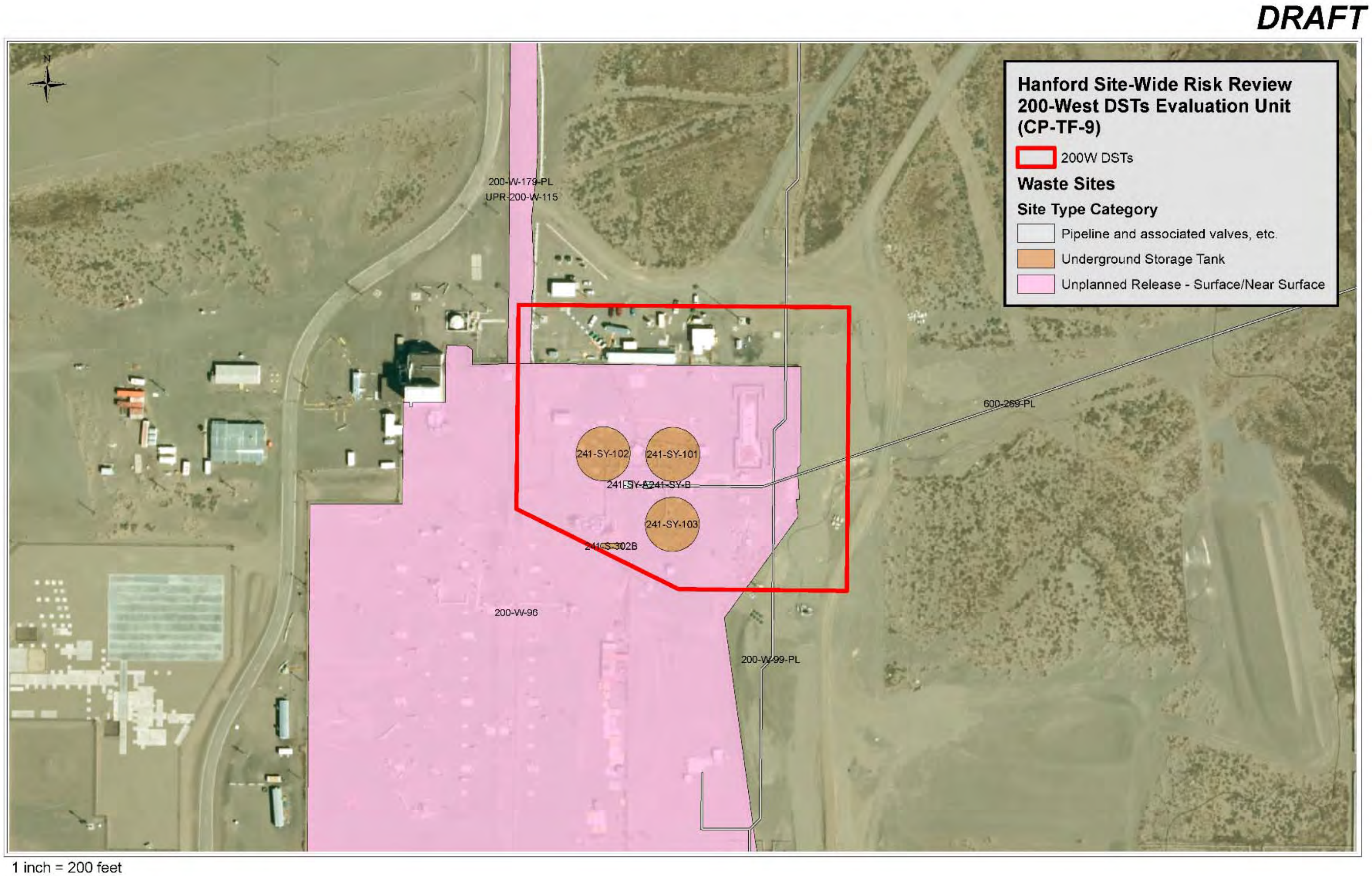
Attached:

- Waste Site and Facility List
- Site Map with Evaluation Unit Boundaries and Associated Waste Sites

Hanford Site-Wide Risk Review
CP-TF-9 (200-West DSTs)
Waste Site and Facility List

Site Code	Name, Aliases, Description	Site Status	Site Type	Site Type Category	Operable Unit	Exclude from Evaluation
200-W-179-PL	200-W-179-PL; Lines SL100, SL101, SN216/281 and DR327; Pipelines Between 241-S-152 Diversion Box and 241-U Tank Farm	Inactive	Direct Buried Tank Farm Pipeline	Pipeline and associated valves, etc.	TBD	
200-W-96	200-W-96; Contaminated Soil at 241-S/SX/SY Tank Farm	Inactive	Unplanned Release	Unplanned Release - Surface/Near Surface	WMA S/SX	
200-W-99-PL	200-W-99-PL; Encased Pipeline from 241-U-151 to 241-S-151 Diversion Boxes; Lines V455 and V456	Inactive	Encased Tank Farm Pipeline	Pipeline and associated valves, etc.	TBD	
241-S-302B	241-S-302B; 241-S-302-B Catch Tank; IMUST; Inactive Miscellaneous Underground Storage Tank	Inactive	Catch Tank	Underground Storage Tank	Not Applic	
241-SY-101	241-SY-101; 241-SY-TK-101	Active	Double-Shell Tank	Underground Storage Tank	Not Applic	
241-SY-102	241-SY-102; 241-SY-TK-102	Active	Double-Shell Tank	Underground Storage Tank	Not Applic	
241-SY-103	241-SY-103; 241-SY-TK-103	Active	Double-Shell Tank	Underground Storage Tank	Not Applic	
241-SY-A	241-SY-A; 241-SY-A Diversion Box; 241-SY-A Valve Pit	Active	Valve Pit	Pipeline and associated valves, etc.	Not Applic	
241-SY-B	241-SY-B; 241-SY-B Diversion Box; 241-SY-B Valve Pit	Active	Valve Pit	Pipeline and associated valves, etc.	Not Applic	
600-269-PL	600-269-PL; Cross Site Transfer Line Replacement; Lines SNL-3150 and 3160; New Cross-Site Transfer Line	Active	Direct Buried Tank Farm Pipeline	Pipeline and associated valves, etc.	Not Applic	
UPR-200-W-115	UPR-200-W-115; Ground Contamination Above Transfer Line Along Cooper Street; UN-216-W-25	Inactive	Unplanned Release	Unplanned Release - Surface/Near Surface	200-IS-1	
241SY271	INSTRUMENT AND ELECTICAL CONTROL HOUSE	ACTIVE	BUILDING	Infrastructure Building		X
241SY272	ELECTRICAL BUILDING	ACTIVE	BUILDING	Infrastructure Building		X
241SY274	GAS MONITORING SHELTER (GMS-1)	ACTIVE	BUILDING	Infrastructure Building		X
241SY275	GAS MONITORING SHELTER (GMS-2)	ACTIVE	BUILDING	Infrastructure Building		X
2724SY	RAD MONITORING AND PROTECTIVE CLOTHING BLDG	INACTIVE	BUILDING	Infrastructure Building		X
MO2173	MOBILE OFFICE NORTH OF SY FARM	ACTIVE	BUILDING	Infrastructure Building		X
MO296	CHANGE TRAILER BY 241SY NEAR EVAPORATOR	INACTIVE	BUILDING	Infrastructure Building		X
MO450	STORAGE MOBILE NORTH OF 241SY TANK FARM	ACTIVE	BUILDING	Infrastructure Building		X
MO655	POWER OPERATION CENTER FOR SY TANK FARM	ACTIVE	BUILDING	Infrastructure Building		X

Note that only those waste sites with a WIDS (Waste Information Data System) Classification of "Accepted" are shown, along with non-duplicate facilities, identified via the Hanford Geographic Information System (HGIS).


DRAFT
Hanford Site-Wide Risk Review
200-West DSTs Evaluation Unit
(CP-TF-9)
200W DSTs
Waste Sites
Site Type Category
Pipeline and associated valves, etc.
Underground Storage Tank
Unplanned Release - Surface/Near Surface
200-W-179-PL
UPR-200-W-115
241-SY-102
241-SY-101
241-SY-103
241-SY-B
241-S-302B
200-W-96
200-W-99-PL
600-269-PL
1 inch = 200 feet

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APPENDIX F.1

DEACTIVATION, DECOMMISIONING, DECONTAMINATION, AND DEMOLITION OF FACILITIES (D4) EVALUATION UNITS

DEACTIVATION, DECOMMISIONING, DECONTAMINATION, AND DEMOLITION OF INACTIVE FACILITIES

Deactivation is usually the first disposition activity undertaken following operational shutdown and transition of a facility. The deactivation mission is to place a facility in a safe shutdown condition that is economical to monitor and maintain until the eventual decommissioning of the facility. Facilities may be held for an extended period in safe shutdown while awaiting decommissioning. During decommissioning, the facility is taken to its ultimate end state through decontamination and/or dismantlement to demolition or entombment. After decommissioning is complete, the facility or surrounding area may require DOE control to protect the public and the environment or for environmental remediation.

Evaluation units (EUs) composed of a set of inactive facilities undergoing deactivation and decommissioning (D&D) have been identified based on major processing complexes or facilities with a common history of operations and geographic proximity. The EUs for facilities undergoing D&D are organized around the three principal operational functions and design attributes: reactors, canyon "chemical separations plants," and plutonium production and supporting facilities (including radioactive material storage, waste processing, and laboratory facilities). In addition, contaminated soils as a result of facility operations or unplanned releases underneath or in the immediate vicinity of the facility (such as Building 324) may be included within the specified EU.

The reactor EUs include eight of the nine plutonium production reactors (B Reactor, C Reactor, D Reactor, DR Reactor, F Reactor, H Reactor, K-East Reactor, K-West Reactor, and N Reactor) built on the Hanford Site from 1943 through 1965. The last operating reactor, the N Reactor, was shut down in 1988. B Reactor, the world's first nuclear reactor, is being preserved as a National Historic Landmark and is not included as an EU. The deactivation of these reactors includes cocooning (encasing the reactor in a concrete shell) followed by construction of a safe-storage enclosure around the reactor building. Once modified in this way, the reactors are to be left in place until radioactive decay reduces the radioactivity of the reactor core. Once safer radiation levels are achieved, final decommissioning will be undertaken.

The Fast Flux Test Facility (FFTF), formerly an operating 400-megawatt (thermal) liquid-metal (sodium)-cooled nuclear research and test reactor, is currently undergoing entombment. The above-grade FFTF Reactor Containment Building and its adjacent support buildings/facilities/ structures are being dismantled and removed to grade. Below-grade structures, the reactor vessel, piping, and other components will remain in place along with demolition waste consolidated in below-grade spaces. The below-grade structures will be filled with grout to immobilize remaining radioactive and hazardous constituents. An engineered barrier will be constructed over the filled area, followed by post-closure care and institutional controls.

The canyon "chemical separations plants" EUs include the B Plant, REDOX (S Plant), U Plant, and PUREX (A Plant) facilities at Hanford. These facilities have been shut down and are undergoing decommissioning. T Plant is the only canyon facility at Hanford that remains in operation. Currently, the mission of T Plant is to support decontamination; headspace sampling; and repackaging, remediation, and verification of containerized waste as noted in the Operating Facilities discussion. All of these chemical separations plants look similar to one another. They are hundreds of feet long, and most stand about 80 feet high and 70 feet wide. The facilities are currently in the D&D process, with U Plant serving as the pilot case. Final disposition plans are to pump cement-like grout into the interior to fill much of the canyon, thereby locking any contamination in place. This step has been completed for U-Plant. Next, facility demolition will be done in such a way that walls are partially collapsed. Finally, an engineered barrier will be constructed over the filled area, institutional controls will be put in place, and the site will receive post-closure care.

Plutonium production and supporting facilities include the Plutonium Finishing Plant complex, 324 Building, and 100 KW Basin. These facilities are undergoing D&D, with the final endpoint options ranging from slab on grade and entombment of underground portions to complete demolition and removal.

Operational facilities such as the Waste Encapsulation and Storage Facility (adjacent to B Plant) used for underwater storage of strontium and cesium capsules and the Solid Waste Operations Complex facilities will ultimately undergo D&D. For these facilities, the current operation is being considered in the operating facility EU portion of the risk review.

APPENDIX F.2

BUILDING 324 (RC-DD-1, RIVER CORRIDOR)
EVALUATION UNIT SUMMARY TEMPLATE

Table of Contents

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PART I. EXECUTIVE SUMMARY

EU LOCATION

300 Industrial Area

RELATED EUS

Other D&D Projects

PRIMARY CONTAMINANTS, CONTAMINATED MEDIA AND WASTES

As a result of residues and internal facility spills during the conduct of past activities, the Building 324 facility contained areas with significant fixed and dispersible mixed waste contamination. Decontamination began in 1996 shortly after its closure and continued to 2009-10 when a leak in the B-Cell floor was discovered. In 1996, both the HLV and LLV tanks were emptied and the HLV tanks were flushed to satisfy Tri-Party Agreement milestone M-89-01. The scope of these cleanout activities was to collect and containerize the dispersible materials and decommission and containerize all excess equipment from the B-Cell, and it was during this period that the floor leak was discovered. The 324 Building currently contains significant quantities of residual holdup inside structures, systems and components (SSCs). The contamination primarily is associated with "hot-cell" activities that involved experiments conducted in a controlled environment with highly radioactive materials. In some cases, the material is in a dispersible form and is susceptible to release in the event of a natural disaster or potential accidents. Systems, equipment, and building structures require routine surveillance and preventive measures to ensure that the safety envelope between the managed contaminants and the public, the workers, and the environment is maintained. In addition, the facility contains limited inventories of chemicals and waste from past and present building operations. A recent accident analysis (WCH-140-07 [OUO Document]) estimated that 23,000 curies of ^{90}Sr and 42,000 curies of ^{137}Cs are primarily located in the building's A and B Cells and the HLV & LLV tanks.

In 2009, a breach in the B-Cell liner was discovered during grout removal in the trench and sump. Research determined that a spill of approximately 510 Liters of a highly radioactive waste stream (approximately 1.3 million curies) containing ^{137}Cs and ^{90}Sr occurred in the B-Cell in October 1986. High radiation levels at the failed liner locations led to concerns that contamination had spread to the soil beneath the cell and D4 activities on the building were suspended.

In 2010, eight closed casings (Geoprobes) were installed beneath B-Cell which indicated contamination of up to 8,900 Rad/hour in the soil. Modelling by PNNL[1] estimated that the contamination from the spill had migrated to as much as 4 meters below B-Cell based on assumptions that continuing amounts of water would have seeped through the hole until it was plugged up in 1992, thus driving the contaminates lower into the soil. In October 2014 nine new geoprobes were inserted by WCH below the B-Cell floor that enabled the measurement of exposure rates along the full length of each probe. These exposure rates were then converted to activity rates (Curies) at one foot increments. The

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[1] Pacific Northwest National Laboratory 2012, *Numerical Modeling of ^{90}Sr and ^{137}Cs Transport from a Spill in the B-Cell of the 324 Building, Hanford Site 300 Area,* PNNL-21214, under contract to U.S. Department of Energy, March 2012

modeling[2] of this data indicates that a contaminant plume containing an estimated 224,100 curies of ^{137}Cs and ^{90}Sr extends down to the cobble layer 4 feet below the B-Cell footings and spreads out horizontally with increasing depth. A maximum reading of 11,700 Rad/hr was recorded by one of the probes. This more recent analysis indicates that the contamination has migrated down from the building footings and also horizontally to about 4 feet outside the boundaries of the building foundation. The strongest readings are in an approximate one foot wide column that begins at the expansion joints and reaches the coble layer four feet below the footings. Lower readings are recorded as the plume expands horizontally with depth and there is minimal contamination in a 9 x 12 ft. area under the center of the B-Cell floor. Two hydraulic hammer unit penetrometers that were inserted at an angle into the cobble layer showed that the level of contamination below the cobble layer is negligible compared to the level of contamination immediately below B Cell.

BRIEF NARRATIVE DESCRIPTION

The 324 Chemical and Materials Engineering Laboratory is a Hazard Category 2 nonreactor nuclear facility operated by Washington Closure Hanford (WCH). It was constructed in 1965 as a dual purpose facility that contained both radiochemical and radiometallurgical hot cells and laboratories. Research operations ceased in 1996 and cleanout/stabilization activities began.

Planned demolition activities were suspended in 2010, and current work at the facility has been limited since June 2012 to reestablishing maintenance stopped or minimized when demolition was eminent. The goal is to maintain the facility in a safe condition until the material under B-Cell can be placed in a condition that supports the building's demolition. Corrective maintenance on fire systems and ventilation has been a focus.

Multiple methods for removal, stabilization, treatment, packaging, and disposal of the contaminated material beneath the B-Cell were evaluated by Washington Closure Hanford (WCH-503, Rev 0) in 2011. Two alternatives graded better than the rest, using its pre-established grading criteria. They would stabilize the contamination in place by injecting a grout or polymer into and/or under the waste matrix to prevent its migration to groundwater and leave the contamination in-situ with an engineered cap over the site. The majority of the 324 Building would be demolished and transported to ERDF for disposal; however the B-Cell foundation would remain and used as part of an engineered cap over the area. However, DOE believes that this method is inconsistent with the remove, treat and dispose (RTD) requirements of the *Interim Action Record of Decision for the 300-FF-2 Operable Unit, Hanford Site* (EPA 2001) and CERCLA documentation for the 300 Area.

A group of similar methods that involve excavation of the contaminated soils through the opening created in the B-Cell floor have been deemed consistent with the Final ROD and are the DOE's choice to address this issue. The soils would be extracted up through the floor, mixed with grout and transferred to the C and D hot cells. This process involved technical uncertainty which DOE is seeking to resolve through a $19 million contract with AREVA to design, construct and operate a pilot project designed as "proof of concept" for the remote retrieval of high activity radioactive soils beneath the building 324. The results of this prototype will not be known before September 2015. After the contaminated soils have been removed, the outer shell of the building would be demolished and the hot cells would be cut into monoliths and transported to ERDF for disposal.

[2] Washington Closure Hanford 2015, *Characterization of the Soil Contamination Under 324 B-Cell*, Calculation Sheet Project 618-10FR, Job No. 14655, Calc. No. 0300X-CA-N0140, Rev. 2, February 18, 2015.

A new study was conducted by WCH in October 2014 and findings of the data analysis were issued in February 2015. As noted above, this study produced very different results from the 2011-12 analysis of the soil contamination in terms of how deep the ^{137}Cs and ^{90}Sr contaminates may have migrated, and more importantly the new information relating to their having migrated horizontally to as much as 4 feet outside the B-Cell foundation footprint. These results raise large uncertainties that will need to be considered before proceeding with the currently chosen method of excavation through the B-Cell floor. This recent study was undertaken nearly four years after the analysis of remediation alternatives for the contaminated soil (WCH-503) and two years after execution of the Final ROD for the Hanford 300 Area that required the application of remove, treat, dispose (RTD) processes such as the current plan to excavate the contaminated soils through the floor of the B-Cell. This soil remediation method may prove to not be technically feasible and sufficiently safe because of the extensive horizontal migration of the ^{137}Cs and ^{90}Sr to outside the B-Cell foundation structure, and other alternatives such as in-situ treatment may require further reconsideration.

We have assumed that once a final determination is made on the method to be used for remediation of the contaminated soils, that work to complete the stabilization and deactivation of the 324 Building interior will resume. The hazards and risk ratings for these activities are indicated under "From Cleanup Actions - Building" in Table 1 below.

Summary Tables of Risks and Potential Impacts to Receptors

Table 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 324 Building or immediate areas around the outside of the building; a Co-located Person (CP) is an individual located 100 meters from Building 324; and Public is an individual located at the closest point on the Hanford Site boundary not subject to DOE access control, which in this instance is the west bank of the Columbia River approximately 305 m (1,000 ft) east of the facility. The nuclear related risks to humans are based on unmitigated (unprotected or controlled conditions) dose exposures expressed in a range of from Non-Discernable (ND) to Very High. The estimated mitigated exposure that takes engineered and administrative controls and protections into consideration, is shown in parenthesis.

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 Non-Discernable (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: No risk ratings are provided for Cultural Resources. The Table 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.

Table 1. Risk Rating Summary (for Human Health, unmitigated nuclear safety basis indicated, mitigated basis indicated in parenthesis (e.g., "Very High" (Low)).

Population or Resource		Evaluation Time Period Active Cleanup (to 2064) **Current Condition:** Security & Maintenance	 **From Cleanup Actions:** Building and Soils
Human Health	Facility Worker	***S&M***: High (Low) ***Soils***: ND	***Building***: High (Low) ***Soils***: High** (Low)
Human Health	Co-located Person	***S&M***: High (Low) ***Soils***: ND	***Building***: High (Low) ***Soils***: Unknown**
Human Health	Public	***S&M***: High (Low) ***Soils***: ND	***Building***: High (Low) ***Soils***: Unknown**
Environmental	Groundwater	Low	Low
Environmental	Columbia River	ND	ND
Environmental	Ecological Resources*	ND	ND
Social	Cultural Resources*	**Native American:** Direct: Known Indirect: Unknown **Historic Pre-Hanford:** Direct: Known Indirect: Unknown **Manhattan/Cold War:** Direct: Known Indirect: None	**Native American:** Direct: Known Indirect: Unknown **Historic Pre-Hanford:** Direct: Known Indirect: Unknown **Manhattan/Cold War:** Direct: Known Indirect: None

*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.

** Ratings are for the currently approved remediation option.

SUPPORT FOR RISK AND IMPACT RATINGS FOR EACH POPULATION OR RESOURCE

Human Health

__Current__

Building and Facility: The only current activities consist primarily of surveillance of the facility and preventative and corrective maintenance of selected equipment. During this period, Building 324 could be impacted by the following natural phenomenon hazard:

<u>Seismic Event</u>: A peak ground acceleration of 0.2 g seismic event would likely lead to a building collapse. The source term from the earthquake consists primarily of the contamination in the hot cells. Portions of surface contaminants in the B-Cell (i.e., some plutonium residue, 90Sr, and 137Cs) are resuspended by the impact and are released to the environment. However, except for the released gases, the fallen debris within the hot cells and the building will impede the flow of contaminants from the cells, reducing the total particulate releases significantly. Impact to the Public is rated similar to that of a Co-located Person because of the relatively short distance (1,000 ft) to the river bank and because of more conservative accepted dose consequences. The Worker has a High Risk rating because of the potential of a building collapse.

Unmitigated Risk: Facility Worker – High; CP – Medium; Public – Medium

Mitigation: The potential for the concurrent loss of all exhaust ventilation and the accident is highly unlikely. Risk to the worker is minimized by the construction of the building to UBC standard, surveillance and maintenance programs, and the emergency preparedness program.

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

Contaminated Soils: Workers, CP and the Public are not directly exposed to the contaminated soil because it is located below grade beneath a concrete slab and portions of the building. And because the contamination remains underground, there is not a dispersion pathway for the material to reach the atmosphere that would impact workers, the public or ecological economic resources. Migration of the contaminants through the soil into groundwater requires a driving force such as a large source of water to push the contamination lower. A potential accident scenario that would provide a large amount of water is the rupture of the pressurized water pipe serving the building's fire suppression system. External sections of the water pipe are located in close proximity to the outside B Cell-Building 324 wall, and thus in close proximity to the contaminated soils under B Cell, and could rupture if activated in response to a fire because of their age.

This event has not been analyzed in a DSA, but DOE site management are aware of its possibility. The resulting impact to the Columbia River would depend on the amount of water released and reaching the contaminated soils.

Unmitigated Risk: Columbia River – Low

This risk could be mitigated through immediate replacement of "at risk" sections of water pipe. The risk will also be removed when the contaminated soils are either removed or stabilized through in-situ treatment during cleanup.

Mitigated Risk: Columbia River – ND

<u>Risks and Potential Impacts from Selected or Potential Cleanup Approaches</u>

Building and Facility: Stabilization & Deactivation work on the 324 Building that is expected to resume when a final soil remediation solution is approved and sufficient multi-year funding is committed, could be impacted by the following accident and natural phenomenon hazards (WCH-140-07):

<u>Waste Handling Accident</u>: As part of the S&D activities, radioactive materials are transferred remotely within and between hot cells. In the accident scenario, an open top RGC is filled with B-Cell dispersible material and is in transit to the airlock for dose profiling. A failure of one of the two lifting points on a full RGC or a crane malfunction during transport to the airlock causes a portion of RGC content to spill onto the airlock floor. The spill releases contamination to the airlock atmosphere. The B-Cell door will be open during the transfer and one or more of the other cell doors could be open.

Unmitigated Risk: Facility Worker – High; CP – High; Public – High

Mitigation: Performing operations with the potential for dispersal of significant quantities of contamination are infrequent. The building's design safety factors of HEPA filters, exhaust fans and exhaust of air out through the building's 150 foot high stack will significantly reduce the dose of an airborne release. The potential for the concurrent loss of all exhaust ventilation and an accident is highly unlikely.

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

<u>*Hydrogen Deflagration*</u>: Water used in cleaning the B-Cell leaked into one or more of the LLV or HLV tanks. Hydrogen is generated by radiolysis from radioactivity in the tank, accumulates to flammable concentrations, and ignites causing a hydrogen deflagration.

Unmitigated Risk: Facility Worker – High; CP – Medium; Public – High

Mitigation: The duration of continuing operations following a loss of all exhaust ventilation is brief in the unlikely event of loss of all exhaust ventilation. The potential for the concurrent loss of all exhaust ventilation and an accident is highly unlikely.

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

<u>*Drop of a Steel-Waste Disposal Box in the Truck Lock:*</u> Casks and containers are loaded and unloaded in the 324 Building truck lock. The Steel-Waste Disposal Box is assumed to drop because of a handling accident and release material following the impact. The impact is assumed to induce a fire, which heats all the waste in the SWDB. Impact to the Public is classified higher than Co-located Person because of more conservative accepted dose consequence.

Unmitigated Risk: Facility Worker – High; CP – Low; Public – Medium

Mitigation: The SWDB contains an RODC, which is a welded steel overpack container with a bolted lid, and an RGC, which is an open top box. The radioactive material is located within these three containers. If the fans are not running, the release from the SWDB drop and fire could leak out the truck lock door or through the roof if the fire damages the roof. If the fans are running, the pressure differential will be such that the airflow in the truck lock is into the building and that it exits through the150-ft stack.

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

<u>*Waste-Handling Accident in the Cask-Handling Area:*</u> Activities in the hot cells consist of collecting and removing loose holdup material, and large pieces of equipment, and loading them into steel-waste disposal boxes weighing 22 tons. The postulated scenario is mishandling of an SWDB containing the maximum radioactive content, resulting in a drop from the maximum lift height (approximately 12 ft), and breach of cover blocks and/or the floor and crushing tank 105 and one or more of the other HLV tanks. Impact to the Public is classified higher than Co-located Person because of more conservative accepted dose consequence.

Unmitigated Risk: Facility Worker –High; CP – Low; Public – Medium

Mitigation: The 150-ft stack, filters and the ductwork connecting the building to the stack are credited to reduce the radioactive dose, and the stacks will provide atmospheric diffusion.

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

<u>*Industrial Safety:*</u> Fire within the cells and other areas of the building represent one of the most frequent industrial hazards to S&D workers, followed by accidents while working with cranes,

compressed air & gas cylinders and waste containers. These hazards can also be initiators and contributors to larger unmitigated accident consequences and releases of radioactive or toxic chemical materials. Industrial accidents would not have impact outside Building 324 (hence no risk to CW or Public).

Unmitigated Risk: Facility Worker – High

Mitigation: The DOE and contractor Safety Management programs that include work control, fire protection, training, occupational safety and industrial hygiene, emergency preparedness, and management and organization have proven to be effective in reducing industrial accidents at the Hanford site to well below that in private industry.

Mitigated Risk: Facility Worker – Low

Building and Contaminated Soils

As noted above, there is the potential for several high risk radiological and industrial related accidents during remediation and deactivation inside Building 324. There are additional risks and potential impacts associated with the extraction of the contaminated soil up through the B-Cell floor, mixing it with grout and transferring it to the C and D hot cells. Upon completion, the outer shell of the building would be demolished, and the hot cells would be cut into monoliths and transported to ERDF for disposal.

This soil remediation method was scored by Washington Closure Hanford (WCH-503) as having a greater potential for workers to be exposed to radiological contamination and dose rates than two in-situ alternatives described below, because of the possible need to enter B-Cell for maintenance and/or repair of equipment. In addition, the sealing of C and D cells may expose workers to radioactive material in the form of dust and debris. The risk associated with the Waste Handling Accidents identified above would also appear to be directly relevant and applicable to this method. In addition, the potential of a peak ground acceleration of 0.2 g seismic event would still exist and thus likely lead to a building collapse during a period when highly contaminated soils are being brought into the building through an open floor in B-Cell.

Two other alternatives which involve injecting a grout or polymer into and/or under the waste matrix scored higher in WCH's analysis. With these methods, the majority of the building would be demolished and transported to ERDF for disposal; however the B-Cell foundation would remain and used as part of an engineered cap over the area. This alternative method leaves the contaminated soils in-situ and capped, thus preventing exposure to workers, ground water and the atmosphere. Although this method is not consistent with the remove, treat and dispose (RTD) requirements of the *Interim Action Record of Decision for the 300-FF-2 Operable Unit, Hanford Site* (EPA 2001) and CERCLA documentation for the 300 Area, it may prove to be a viable option if the currently chosen method proves to be not technically feasible or sufficiently safe to carry out.

Based on available information and analysis of risks in WCH-503, we estimated the following ratings on the currently preferred remediation plan to the Facility Worker. The information available does not provide a sound basis for determining potential unmitigated risks to the Co-located Person or Public:

Unmitigated Risk Removal of Soils: Facility Worker – High

Mitigation: With regard to accidents while remotely excavating the soils and bringing them into B Cell, the building's design safety factors of HEPA filters, exhaust fans and exhaust of air out through the building's 150 foot high stack will significantly reduce the dose of an airborne release within the cells and building. The potential for the concurrent loss of all exhaust ventilation and an accident is highly unlikely.

Mitigated Risk Removal of Soils: Facility Worker – Low

Final Building Demolition

The authors were unable to locate a DSA or similar risk analysis associated with the demolition or dismantlement of a DOE building with large hot-cells having shared common walls constructed of 1.2-meter-thick, high-density concrete or 1.4-meter-thick, concrete walls, such as those making up Building 324. However, the Final Hazard Categorization of Building 327 (WCH-232, Rev. 0) provides a description and risk analysis of the planned D4 of a building having multiple hot cells. The major difference though is that Building 327's hot cells were smaller stand-alone units, often shop-fabricated from cast iron and thus could be removed individually. The final D4 tasks included structurally reinforcing the exterior of each cell so that they could be filled with grout or foam and then preparing them for lifting and transfer out of the building. The cells were separated from the building foundation using cutting techniques such as diamond wire cutting, and the cell monoliths were lifted with a crane through the building roof or moved through the roll-up door, and transported to ERDF for final disposition.

The Building 324 hot cells are much larger in size and interconnected by common thick concrete walls. But the common cell walls presumably could be cut by a similar diamond wire process and the cells separated for removal and the monoliths transported to ERDF for final disposition. Unfortunately, the Building 327 Final Hazard Categorization does not provide a basis for adequately evaluating Worker, CP and public risks to other radiation exposures or industrial accidents involved in the final demolition or dismantlement of Building 324 beyond those already identified in the review of cleanup risks above.

Groundwater

Migration of the contaminants through the soil into groundwater requires a driving force (source of water to mobilize the contamination). This driver is not present at this time. The Sr-90 is not expected to move in the subsurface over the next 150 years leading to a rating of ND. The rupture of the pressurized water pipe serving the building's fire suppression system is a potential accident scenario that could provide necessary water infiltration for movement. Therefore, a *Low* rating is applied for the current status and Active Cleanup area completed to account for uncertainties.

Columbia River

Migration of the contaminants through the soil into groundwater requires a driving force (source of water to mobilize the contamination). This leads to a rating of ND.

Ecological Resources

Current

There are currently no ecological resources on EU or buffer area.

Risks and Potential Impacts from Selected or Potential Cleanup Approaches

Any ecological risk depends upon the quality and quantity of re-vegetation following remediation; there could be a risk from invasion of exotic species.

Cultural Resources

Current

Ratings for cultural resources are not being made because cultural resources will be evaluated under Section 106 of the National Historic Preservation Act (16 USC 470, et. seq.) during the planning for remedial action. The resulting Section 106 process will engage all stakeholders, including Native

American Tribes, concerning the Native American, Historic Pre-Hanford, and Manhattan Project/Cold War landscapes. This process will identify all cultural resources and evaluate their eligibility for the National Register of Historic Places, any direct and indirect effects from remediation, as well as the need for any mitigation actions. CRESP has consulted with the Native American Tribes having historical ties to Hanford and they consider the entire Hanford Site to be culturally and historically important.

There are very disturbed, but close to important cultural resources (close proximity to river); Manhattan era significant facility has already been mitigated. There are no known recorded archaeological sites or TCPs located within the 324 Building EU; there are five archaeological sites located within 500 meters of the 324 Building EU. There are no ecological resources at Building 324 or the buffer area

Risks and Potential Impacts from Selected or Potential Cleanup Approaches
There are no expectations for impacts to known cultural resources.

Considerations for timing of the cleanup actions

There is no risk to the Facility Worker, CP or Public if cleanup of the soils or building is delayed up to a few years. There is no known physical deterioration occurring in Building 324 or its several hot cells, and recent measures were taken to improve the condition of its exterior and to prevent rain from reaching soils covering the recent excavation. Studies indicate that the contaminants are not moving from their current location in the soils and thus not threatening groundwater, although additional groundwater monitoring is recommended to ensure that contaminants have not migrated toward the River. There are potential benefits to near-term measures that prevent infiltration to the soils (e.g., covers or in-situ grouting) and allow time for an order of magnitude decrease in radiation levels due to natural decay (ca. 90 years) or allowing natural attenuation to achieve long-term environmental safety. The building, however contains a considerable amount of radiological contaminants and long-term delays would likely require improvements to the roof and other parts of the exterior structure.

Near-Term, Post-Cleanup Risks and Potential Impacts

Both soil remediation alternatives will remove or fully stabilize the contaminated soils, and Building 324 will either entirely or mostly be demolished, and then transported to ERDF. The second alternative would leave a soil monolith and engineered cap in the Industrial 300 Area to allow the ^{90}Sr and ^{137}Cs to reach safer radiation exposure levels before removal and final building demolition, and thus represents a potential impact on ecological resources during its removal. Long-term surveillance and maintenance of the 300-296 site would be required until the contaminated soils and engineered cap are removed.

Any ecological risk depends upon the quality and quantity of re-vegetation following remediation. There could be a risk from invasion of exotic species.

There are no expectations for impacts to known cultural resources.

PART II. ADMINISTRATIVE INFORMATION

OU and/or TSDF Designation(s)

300-FF-2

Common name(s) for EU

300-296 and Building 324

KEY WORDS

D&D, Hot Cells, Soils

REGULATORY STATUS

Regulatory basis: Removal of the 324 Building, and the hot cells would be performed under the CERCLA Action Memorandum #2 for the 300 Area Facilities. In addition, closure of the TSD units in the 324 Building would be performed under the RCRA Closure Plan.

Removal of contaminated soils under the B-Cell are subject to the remedy specified in the Final ROD[3]: "Principal threat wastes exist in three waste sites in 300-FF-2. Soil in waste site 300-296 below the 324 building, vertical pipe units at the 618-10 and 618-11 burial ground waste sites and caissons at 618-11 contain principal threat waste. Under the selected remedy for 300-FF-2, all principal threat waste will be treated where practicable to reduce the toxicity, mobility, contamination or radiation exposure, including some that will be treated in-situ prior to removing the waste for disposal. Treatment will be with grout or an alternative method approved by EPA during remedial design. The selected remedy for 300-FF-2 requires all waste that is removed for disposal to be treated as necessary to meet the waste acceptance criteria of the disposal facility. Such treatment also reduces the toxicity and mobility of radionuclides and chemical hazardous substances."

"Because the selected and amended remedies will result in hazardous substances, pollutants or contaminants remaining on-site above levels that allow for unlimited use and unrestricted exposure, a statutory review will be conducted within five years after initiation of remedial action to ensure that the remedies are, or will be, protective of human health and the environment. Five-year reviews will be conducted after the initiation of remedial action and continue until hazardous substances no longer remain present above levels that allow for unlimited use and unrestricted exposure."

Applicable regulatory documentation

Remedial Investigation/Feasibility Study for the 300-FF-1, 300-FF-2, and 300-FF-5 Operable Units, February 2013.

Record of Decision for 300-FF-2 and 300-FF-5, and Record of Decision Amendment for 300-FF-1 Area 300 Final ROD and RI/FS; U.S. Environmental Protection Agency, Region 10; U.S. Department of Energy, Richland Operations Office; November 2013.

Applicable Consent Decree or TPA milestones: Federal Facility Agreement and Consent Order, 1989 and amended through June 16, 2014: Milestone M-094-00; Lead Agency EPA: Complete disposition of all 300 Area surplus facilities identified in the removal action work plan(s) for the 300 Area facilities including the 324 Building and its ancillary buildings and structures, by September 30, 2018.

RISK REVIEW EVALUATION INFORMATION

Completed: Revised June 22, 2015

Evaluated by: H. Mayer

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

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[3] U.S. Environmental Protection Agency, Region 10, U.S. Department of Energy, Richland Operations Office 2013, *Hanford Site 300 Area, Record of Decision for 300-FF-2 and 300-FF-5, and Record of Decision Amendment for 300-FF-1*, November 2013, p. iii and iv.

PART III. SUMMARY DESCRIPTION

CURRENT LAND USE

DOE Hanford industrial site area

DESIGNATED FUTURE LAND USE

Industrial (300 Area Final ROD)

PRIMARY EU SOURCE COMPONENTS

Legacy Source Sites

Not Applicable

High-Level Waste Tanks and Ancillary Equipment

Not Applicable

Groundwater Plumes

Not Applicable

Operating Facilities

Not Applicable

D&D of Inactive Facilities

Significant amounts of ^{90}Sr and ^{137}Cs are in B-Cell and in the soils directly beneath B-Cell of Building 324. Migration of the material through the soil into groundwater requires a driving force (source of water to push the contamination).

LOCATION AND LAYOUT MAPS

Building 324 is located approximately 300 meters from the Columbia River.

Figure 1. Building 324

EU Designation: RC-DD-1 (Building 324)

Figure 2. Building 324 Evaluation Unit

PART IV. UNIT DESCRIPTION AND HISTORY

EU Former/Current Use(s)

The 324 Chemical and Materials Engineering Laboratory was constructed in 1965 as a dual purpose facility that contained both radiochemical and radiometallurgical hot cells and laboratories in the 300 Area of the Hanford Site. It was operated by Pacific Northwest National Laboratory (PNNL) until 1996, when the facility was transferred to B&W Hanford Company (BWHC) for interim operation and eventual stabilization and deactivation (S&D) in preparation for building demolition. PNNL continued limited operations in the 324 Building until October 1998. Responsibility for the building S&D was assumed by Fluor Hanford (FH) in September 1999 and continued until August 2005. Responsibility was assumed by Washington Closure Hanford (WCH) in August 2005. In 2009, a breach in the B-Cell liner was discovered during grout removal in the trench and sump. This changed condition lead to suspension of planned demolition activities until safety basis documentation could be revised and options for soil remediation and building use/demolition could be developed. Current work at the facility has been limited since June 2012 to reestablishing maintenance stopped or minimized when demolition was eminent, pending resolution of the soil remediation issues and eventual demolition of the 324 Building.

Legacy Source Sites

Not Applicable

High-Level Waste Tanks

Not Applicable

Groundwater Plumes

The general verbally expressed consensus of WCH and EPA is that currently there is no short-term threat of the Cs-137 and Sr-90 contaminants migrating to groundwater levels.

D&D of Inactive Facilities

The 324 Chemical and Materials Engineering Laboratory was constructed in 1965 as a dual purpose facility that contained both radiochemical and radiometallurgical hot cells and laboratories. It conducted diverse studies on the chemical and physical processing of high-activity radioactive materials, characterization of physical and chemical properties of irradiated materials, and non-radioactive process development. It is a substantial concrete and steel structure, and has a partial basement and first, second, and partial third floors. The foundation structure is poured-in-place reinforced concrete. The superstructure is insulated fluted steel industrial panel supported on a structural steel frame. The parapeted roof (original sections constructed in 1963) has a slightly sloped steel deck covered with concrete with gravel-finished built-up roofing. The structure and systems for the building were designed to the UBC and the Hanford Plant SDC in existence at the time of their design (SDC-4.1) and therefore were designed to resist the extreme weather and earthquakes specified in these documents.

The building contains two groups of heavily shielded cells with operating and service galleries and two vaults equipped with tanks for retaining radioactive liquid. In addition, the building houses two engineering development laboratories; used for non-radioactive activities. The cells were equipped with cranes, remote manipulators, viewing windows, various types of test equipment, POG systems, and various services including air, water, steam, and electrical power. The cells and vaults are designed to shield the workers from direct radiation and, with the ventilation system and its HEPA filters, to confine any radioactive particulate materials.

The radiometallurgical portion of the laboratory, known as the Radiometallurgy and Materials Testing Laboratories, included three large hot cells known as the Shielded Materials Facility and were located in

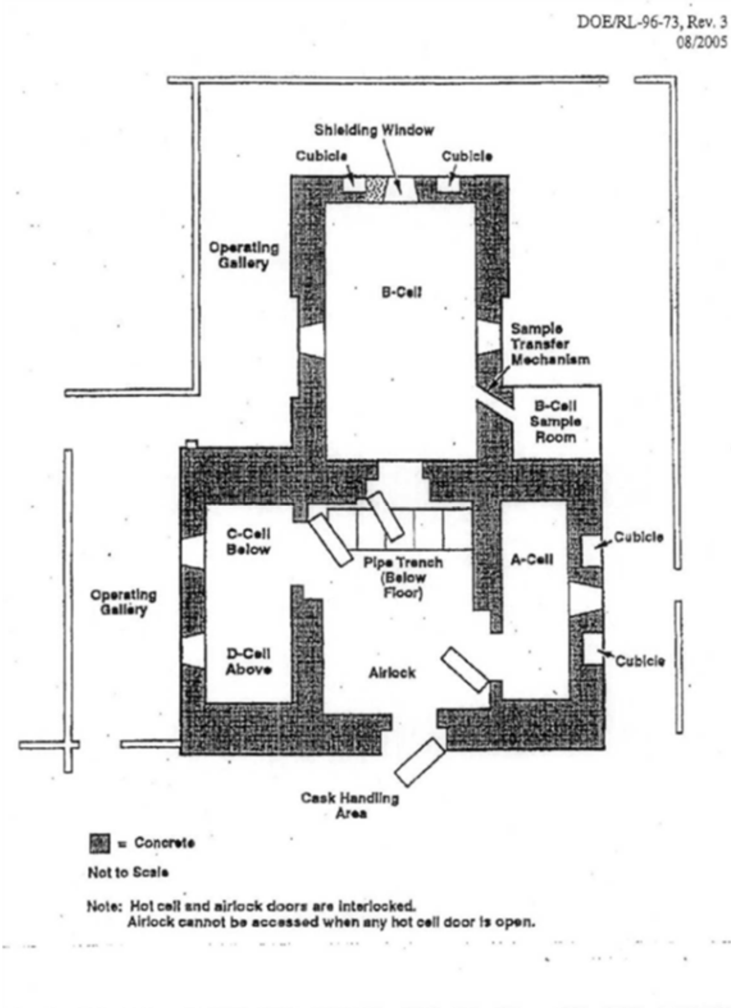

Figure 3. Building 324 Schematic

the southeast section of the building. The radiochemical portion, located on the north side, had four large hot cells (A, B, C, and D-Cells) and an Air Lock Cell. The cells and airlock are joined to form a T-shaped structure. D-Cell is located above the C-Cell on the south side. C-CeII/D-Cell, the airlock, and the A-Cell form the top of the T-shape. B-Cell connects to the airlock to form the bottom of the T-shape. The walls are constructed of 1.2-meter-thick, high-density concrete or 1.4-meter-thick, normal-density concrete.

The radiometallurgical portion of the laboratory, known as the Radiometallurgy and Materials Testing Laboratories, included three large hot cells known as the Shielded Materials Facility and were located in the southeast section of the building. The radiochemical portion, located on the north side, had four large hot cells (A, B, C, and D-Cells) and an Air Lock Cell. The cells and airlock are joined to form a T-shaped structure. D-Cell is located above the C-Cell on the south side. C-CeII/D-Cell, the airlock, and the A-Cell form the top of the T-shape. B-Cell connects to the airlock to form the bottom of the T-shape. The walls are constructed of 1.2-meter-thick, high-density concrete or 1.4-meter-thick, normal-density concrete.

Cell operations normally were conducted from the operating gallery using through-the-wall, master-slave manipulators; remotely operated in-cell bridge cranes; a periscope; and electromechanical manipulators. Operations were aided by direct viewing through lead-glass windows that previously contained oil between the glass panes for transparency. The facility handled a large variety of irradiated materials, test assemblies and samples, and segregated radioisotopes. Radioactive/fissionable materials in varying forms and geometry also were handled.

The B-Cell is the largest building component at 22 ft wide by 25 ft long by 30.5 ft high. It is 10 ft below grade and extends 20.5 ft above ground level. The floor and the walls (up to 27 ft high) are lined with stainless steel. The cell is surrounded on three sides by operating galleries on the first and second floors and on two sides by an operating gallery at the basement level. Shielding walls at the three operating faces are 4-5 ft thick concrete with oil-filled lead glass viewing windows.

To protect against releases of radioactive material from the hot cells to the environment, integral metal liners with sumps (i.e., without drains) were installed in the cells and tank vaults. Confinement of radioactive particulate matter within the shielded cells is provided by a directed airflow through a high-efficiency particulate air (HEPA) filtered ventilation system.

Other support facilities within the 324 Building included the high-level and low-level vault areas, each containing four stainless tanks. These tanks were used as temporary holding tanks for feed solutions, feedstock tanks for process solutions, or collection tanks for effluents from project activities. In 1996, both the High Level Vault and Low Level Vault tanks were emptied and the HLV tanks were flushed to satisfy Tri-Party Agreement milestone M-89-01.

Research operations ceased in 1996 and cleanout/stabilization activities began. In 2009, a breach in the B-Cell liner was discovered during grout removal in the trench and sump. High radiation levels at the failed liner location led to concerns that contamination may have spread to the soil beneath the cell. It was determined that in October 1986, a spill of approximately 510 Liters of a highly radioactive waste stream containing cesium (^{137}Cs) and strontium (^{90}Sr) occurred in the B-Cell. Unknown quantities of water were used immediately after the spill, and at various other times following the spill, to wash items contained in the B-Cell (MW Perrott, WCH, private communication, January 2011). Wastes being removed from B-Cell were also grouted and in the course of the grouting activities, sufficient grout was spilled on the floor of the B-Cell to completely fill the sump with solidified grout. Although unintentional, this spilling of grout is thought to have effectively stopped any further release of waste through the B-Cell sump, at some undetermined time prior to 1992.

Deactivation and decontamination work on the building was slowed and then suspended in 2012 while the spill and resulting soil contamination was being researched. A study was completed by WCH in December 2011 that recommended remote excavation of the soils through the floor of B Cell, mixing with grout and transferring to the C and D Cells for permanent storage. In 2012-2013 work was conducted on the interior of Building 324 to restore it to safe operational condition in order to be carry out these proposed activities. Areva was awarded a $19 million contract in January 2014 to design and test a system for remotely removing the soils using a full-scale mockup of B-Cell and associated hot cells by September 2015.

A new study was conducted by WCH in October 2014 and findings of the data analysis were issued in February 2015. As noted earlier, this study produced very different results from the 2011-12 analysis of the soil contamination in terms of how deep the ^{137}Cs and ^{90}Sr contaminates may have migrated, and more importantly that they have migrated horizontally to as much as 4 feet outside the B-Cell foundation footprint (but within the overall building footprint). These results raise large uncertainties that will need to be considered before proceeding with the currently chosen method of excavation through the B-Cell floor. This recent study was undertaken nearly four years after the analysis of remediation alternatives for the contaminated soil (WCH-503) and two years after execution of the Final ROD for the Hanford 300 Area that required the application of remove, treat, dispose (RTD) processes such as the current plan to excavate the contaminated soils through the floor of the B-Cell. This soil remediation method may prove to not be technically feasible and sufficiently safe because of the extensive horizontal migration of the^{137}Cs and ^{90}Sr to outside the B-Cell foundation structure, and other alternatives such as in-situ treatment may require further consideration.

Pending final determination of these major issues, the current mission of the 324 Building contractor is to maintain the building in a safe condition until the material under B-Cell can be placed in a condition that supports the building's demolition. Corrective maintenance on fire systems and ventilation has been a focus.

OPERATING FACILITIES

Not Applicable

ECOLOGICAL RESOURCES SETTING

Landscape Evaluation and Resource Classification

The amount of each category of biological resources was evaluated at two scales: 1) within the 324 Building EU and 2) within a circular area radiating 231 m from the geometric center of the unit (equivalent to 41.5 acres). The EU and buffer area north, south, and east of the unit were previously classified as level 3 because it is within 0.25 miles of the Columbia River. These areas were reclassified for this assessment to level 0 to reflect current habitat conditions.

Field Survey

Reconnaissance and visual survey of the 324 Building EU indicated the unit consists entirely of non-vegetated areas, paved, concrete, and compacted gravel areas (i.e., level 0 resources), and no field measurements of vegetation abundance were collected during the July 2014 survey. Some weedy species such as cheatgrass and Russian thistle were sparsely established around the road edges and parking lot boundaries. No wildlife were observed within the EU. Previous ECAP building survey data indicated that the starling (*Sturnus vulgaris*), which is not protected by the Migratory Bird Treaty Act (MBTA), was the only bird species observed nesting on the building as recently as 2009.

CULTURAL RESOURCES SETTING

Most of the 324 Building EU has been inventoried for cultural resources with negative findings. Demolition and remediation activities within the 324 Building EU have been addressed in an NHPA Section 106 cultural resources review. There are no cultural resources (archaeological, buildings or TCPs) known to be located within the 324 Building EU. It is very unlikely that intact archaeological material is present in the areas that have not been inventoried for archaeological resources (both on the surface and in the subsurface) given the extensive disturbance present within the 324 Building EU.

There are several cultural resources associated with all three landscapes located within 500 meters of the 324 building EU. These include the following:

- The following buildings are all contributing properties within the Manhattan Project/Cold War Era Landscape with documentation required and are within 500 meters of the 324 building EU. In accordance with the 1998 *Hanford Site Manhattan Project and Cold War Era Historic District Treatment Plan (*DOE/RL-97-56), all documentation requirements have been completed for these properties.

340A	WASTE RETENTION BUILDING
382	PUMP HOUSE BUILDING
320	PHYSICAL SCIENCES LABORATORY
309	SP-100 GES TEST FACILITY
308A	FUELS DEVELOMENT LABORATORY
340	WASTE NEUTRALIZATION FACILITY
340B	WASTE LOADOUT BUILDING
326	MATERIALS SCIENCES LABORATORY
329	CHEMICAL SCIENCES LABORATORY
3760	3760 OFFICE BUILDING

3709A	300 AREA FIRE STATION
3790	Badging Office
308	FUELS DEVELOPMENT LABORATORY
325A	CESIUM RECOVERY FACILITY PART OF 325
325	RADIOCHEMICAL PROCESSING LABORATORY (RPL)
318	RADIOLOGICAL CALIBRATIONS LABORATORY
3614A	RIVER MONITORING STATION

- The following buildings are all contributing properties within the Manhattan Project/Cold War Era Landscape with no documentation required and are within 500 meters of the 324 building EU. In accordance with the 1998 *Hanford Site Manhattan Project and Cold War Era Historic District Treatment Plan (*DOE/RL-97-56), all documentation requirements have been completed for these properties.

331	LIFE SCIENCES LABORATORY
324	CHEMICAL ENGINEERING BUILDING
339A	COMPUTER FACILITY
350	PLANT OPERATIONS AND MAINTENANCE FACILITY
3707F	RADIATION MONITORING BUILDING
3714	SOILS LABORATORY
3730	GAMMA IRRADIATION FACILITY
3766	OFFICE BUILDING

- There are five archaeological sites located within 500 meters of the 324 Building EU. These include one isolated find, three National Register-eligible sites, and a state-Registered archaeological district associated with the Native American Precontact and Ethnographic Landscape and one isolated find associated with the Pre-Hanford Early Settlers and Farming Landscape.

Historic maps indicate that historic land use was occurring within the Pre-Hanford Early Settlers/Farming and the Manhattan Project and Cold War era.   Geomorphology indicators suggests potential for the presence of archaeological resources associated with the Native American Precontact and Ethnographic landscape to be present depending on the location of these soils within the 324 Building EU. However because of the extensive disturbance within the 324 Building EU, it is unlikely any archaeological material remains intact. It is always possible for pockets of undisturbed deposits to exist and archaeological monitoring may be appropriate as well as surface and subsurface archaeological investigations in these areas prior to initiating a remediation activity. 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) may need to occur. Consultation with Hanford Tribes may also 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

As a result of residues and internal facility spills during the conduct of past activities, the facility contained areas with significant fixed and dispersible mixed waste contamination. Decontamination began in 1996 shortly after its closure and continued to 2009-10 when the B-Cell leak was discovered. In 1996, both the HLV and LLV tanks were emptied and the HLV tanks were flushed to satisfy Tri-Party Agreement milestone M-89-01. The scope of these cleanout activities was to collect and containerize the dispersible materials and decommission and containerize all excess equipment from the B-Cell, and it was during this period that the floor leak was discovered. A recent analysis indicates that an estimated 23,000 curies of ^{90}Sr and 42,000 curies of ^{137}Cs are primarily located in the building's A and B Cells and the vault HLV & LLV tank area.

A spill of approximately 510 Liters of a highly radioactive waste stream containing about 883,000 curies of ^{137}Cs and 388,000 curies of ^{90}Sr occurred in the B-Cell of the 324 Building in October 1986. It was likely from a glass-waste repository testing program associated with the Federal Republic of Germany (FRG). Unknown quantities of water were used immediately after the leak and at later times to wash the floor of the B-Cell. This added water would have transported ^{137}Cs and ^{90}Sr deeper into the underlying soils. Assuming the benefit of radioactive decay since the 1986 spill to 2014, we estimated that there are 198,000 curies of ^{90}Sr and 464,000 curies of ^{137}Cs[4] remaining in the soils below the B-Cell.

Two studies have been conducted to determine the location and amounts of ^{137}Cs and ^{90}Sr in the soils below the B-Cell. In 2010, eight closed-end horizontal access pipes (Geoprobes) were inserted in a fan-shaped pattern beneath B-Cell. They indicated radiological contamination up to 8,900 Rad/hour was present. One- and three-dimensional flow and transport modeling were performed by PNNL (PNNL-21214[5]) to evaluate the possible extent of migration of ^{137}Cs and ^{90}Sr that leaked from the B-Cell into the subsurface soils. They yielded differing results in terms of the predicted depths to peak concentrations and the maximum depths of penetration of the contaminants. The 1-D model suggests that peak concentrations of ^{90}Sr may be located 1–3 m below the foundation, but ^{90}Sr contamination may extend 4–11 m below the foundation, depending on the assumed water release rate. In contrast, the 3-D Kd-based model results suggest that both ^{137}Cs and ^{90}Sr peak concentrations may be located 1–2 m below the foundation, and nearly all of the contamination may be contained within the upper 3 m of the sediment profile.

In 2014, nine penetrometers geoprobes ranging in length from 60 ft to 100 ft were driven horizontally beneath the B-Cell and exposure rates along the penetrometers were measured using field exposure rate instruments of various ranges. The activity associated with each penetrometer was determined by using the exposure rate measurements along the length of the housing and exposure rate to activity conversion factors. The highest reading was 11,700 RAD/hr. The results from the individual penetrometers were modeled to generate an approximation of a three dimensional contamination plume that contained three zones of activity (high, medium and low) which follow the path of the expansion joint in the floor of the cell. The strongest readings were in an approximate one foot wide column that begins at the expansion joints and reaches the coble layer four feet below the footings.

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[4] Decayed values were computed using half-lives of 28.7 yrs for ^{90}SR and 30.17 yrs for ^{137}Cs over 28 years from 1986 to 2014.

[5] *Numerical Modeling of ^{90}Sr and ^{137}Cs Transport from a Spill in the B-Cell of the 324 Building, Hanford Site 300 Area,* PNNL-21214

Lower readings were recorded as the plume expands horizontally with depth. The plume extends approximately 4 feet outside the entire B-Cell foundation structure and there is minimal to no contamination in a large area under the center of the B-Cell floor (see Figure 4. Activity Profile Beneath B-Cell). The concentrations of activity in each zone were based on averages from the individual Geoprobe results. The sum of the zone volumes times the zone concentrations yielded an estimated total activity in a vadose zone plume[6] of 155,700 Ci of ^{137}Cs and 68,420 Ci of ^{90}Sr in the area up to 4 ft. beneath the B-Cell foundation. Two hydraulic hammer unit penetrometers that were inserted at an angle into the cobble layer showed that the level of contamination below the cobble layer is negligible compared to the level of contamination immediately below B Cell.

These results varies considerably from the PNNL modeling that was done with different type Geoprobes and contaminant migration assumptions which indicated that the ^{137}Cs and ^{90}Sr peak concentrations could be anywhere from 1-2 meters to as much as 4-11 meters below the B-Cell foundation.

The general verbally expressed consensus of WCH and EPA is that currently there is no short-term threat of the contaminants migrating to groundwater levels.

Red – High Activity

Yellow - Medium

Blue - Low

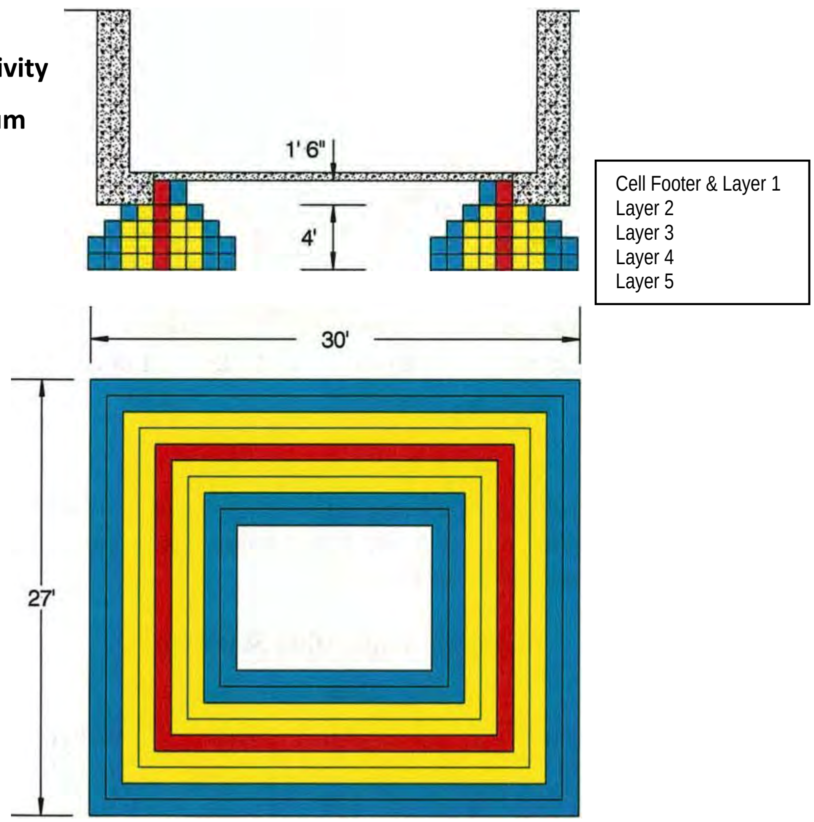

Figure 4. Activity Profile Beneath B-Cell

Inventory

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[6] Washington Closure Hanford 2011, *Characterization of the Soil Contamination Under 324 B-Cell*, Calculation Sheet Project 618-10FR, Job No. 14655, Calc. No. 0300X-CA-N0140, Rev. 2, February 18, 2015.

Table 2. Contaminant Inventory

Nuclide	Location	WIDS	Curies
Cs-137	Building	300-19 & 25	42,000
Cs-137	Soils	300-296*	464,069
Cs-137	Soils	300-296**	155,700
Sr-90	Building	300-19 & 25	23,000
Sr-90	Soils	300-296*	197,725
Sr-90	Soils	300-296**	68,400
Am-241	Building	300-19 & 25	56.7
Pu-239-240	Building	300-19 & 25	7.8

(*)Estimated decayed amount of original spill material in 2014

(**) Contained in vadose area plume area from footings to cobble layer (4 ft depth)

CONTAMINATION WITHIN PRIMARY EU SOURCE COMPONENTS

Legacy Source Sites

Not Applicable

High Level Waste Tanks and Ancillary Equipment

Two shielded underground vaults (HLV and LLV) in the 324 Building are equipped with tanks for temporary storage of liquids. Each vault contains four stainless tanks. These tanks had been used as temporary holding tanks for feed solutions, feedstock tanks for process solutions, or collection tanks for effluents from project activities. The HLV and LLV tanks had also been used to store mixed waste solutions. In 1996, both the HLV and LLV tanks were emptied and the HLV tanks were flushed to satisfy Tri-Party Agreement milestone M-89-01.

Detailed inventories are provided in Table 3, Table 4, Table 5. All values are to 2 significant figures. The source document should be consulted for greater precision data. The sum for each primary contaminant is shown in the first row. Table 6 provides a summary of the evaluation of threats to groundwater as a protected resource from saturated zone and remaining vadose zone contamination associated with the evaluation unit.

Vadose Zone Contamination

See above

Groundwater Plumes

Contaminant migration has been limited to the shallow soils directly below the 324 building as a result of water discharges through the B-cell that has been sealed after discovery of the initial release. Infiltration of water is prevented by the building’s reinforced concrete structure and floor. The general verbally expressed consensus of WCH and EPA is that currently there is no short-term threat of the contaminants migrating to groundwater levels. The primary threat of water infiltration is from rupture of the pressurized water pipe serving the building’s fire suppression system; measures to mitigate this risk should be considered.

Facilities for D&D

See above

EU Designation: RC-DD-1 (Building 324)

Operating Facilities

Not Applicable

EU Designation: RC-DD-1 (Building 324)

Table 3. Inventory of Primary Contaminants [(a)]

WIDS	Description	Decay Date	Ref[(b)]	Am-241 (Ci)	C-14 (Ci)	Cl-36 (Ci)	Co-60 (Ci)	Cs-137 (Ci)	Eu-152 (Ci)	Eu-154 (Ci)	H-3 (Ci)	I-129 (Ci)
All	Sum			57	NP	NP	NP	510000	NP	NP	NP	NP
300-19	Process Building	Unknown	EIS-S	57	NP	NP	NP	42000	NP	NP	NP	NP
300-25	Process Building	Unknown	EIS-S	NP	NP	NP	NP	NP	NP	NP	NP	NP
316-3[(c)]	Trenches	Unknown	EIS-S	NP	NP	NP	NP	NP	NP	NP	NP	NP
300-296	UPR	2014		NP	NP	NP	NP	460000	NP	NP	NP	NP

a. NP = Not present at significant quantities for indicated EU
b. EIS-S = DOE/EIS-0391 2012
c. Contaminated sediments excavated and removed in 1963; trench backfilled in 1965; removal, treatment, and disposal planned. (DOE/EIS-0391 2012, Appendix S)

Table 4. Inventory of Primary Contaminants (cont)[(a)]

WIDS	Description	Decay Date	Ref[(b)]	Ni-59 (Ci)	Ni-63 (Ci)	Pu (total) (Ci)	Sr-90 (Ci)	Tc-99 (Ci)	U (total) (Ci)
All	Sum			NP	NP	7.8	220000	NP	NP
300-19	Process Building	Unknown	EIS-S	NP	NP	7.8	NP	NP	NP
300-25	Process Building	Unknown	EIS-S	NP	NP	NP	23000	NP	NP
316-3	Trenches	Unknown	EIS-S	NP	NP	NP	NP	NP	NP
300-296	UPR	2014		NP	NP	NP	200000	NP	NP

a. NP = Not present at significant quantities for indicated EU
b. EIS-S = DOE/EIS-0391 2012
c. Contaminated sediments excavated and removed in 1963; trench backfilled in 1965; removal, treatment, and disposal planned. (DOE/EIS-0391 2012, Appendix S)

Table 5. Inventory of Primary Contaminants (cont)[(a)]

WIDS	Descrip-tion	Ref[(b)]	CCl4 (kg)	CN (kg)	Cr (kg)	Cr-VI (kg)	Hg (kg)	NO3 (kg)	Pb (kg)	TBP (kg)	TCE (kg)	U (total) (kg)
All	Sum		NP	NP	NP	NP	10	NP	NP	NP	NP	NP
300-19	Process Building	EIS-S	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP
300-25	Process Building	EIS-S	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP
316-3	Trenches	EIS-S	NP	NP	NP	NP	10	NP	NP	NP	NP	NP
300-296	UPR		NP	NP	NP	NP	NP	NP	NP	NP	NP	NP

a. NP = Not present at significant quantities for indicated EU
b. EIS-S = DOE/EIS-0391 2012
c. Contaminated sediments excavated and removed in 1963; trench backfilled in 1965; removal, treatment, and disposal planned. (DOE/EIS-0391 2012, Appendix S)

Table 6. Summary of the Evaluation of Threats to Groundwater as a Protected Resource from Saturated Zone (SZ) and Remaining Vadose Zone (VZ) Contamination associated with the Evaluation Unit

PC	Group	WQS	Porosity[a]	K_d (mL/g)[a]	ρ (kg/L)[a]	VZ Source M^{Source}	SZ Total M^{SZ}	Treated[c] M^{Treat}	VZ Remaining M^{Tot}	VZ GTM (Mm^3)	VZ Rating[d]
C-14	A	2000 pCi/L	0.18	0	1.84	---	---	---	---	---	ND
I-129	A	1 pCi/L	0.18	0.2	1.84	---	---	---	---	---	ND
Sr-90	B	8 pCi/L	0.18	22	1.84	1.98E+05 Ci	---	---	1.98E+05 Ci	1.09E+05	Low[e]
Tc-99	A	900 pCi/L	0.18	0	1.84	---	---	---	---	---	ND
CCl4	A	5 µg/L	0.18	0	1.84	---	---	---	---	---	ND
Cr	B	100 µg/L	0.18	0	1.84	---	---	---	---	---	ND
Cr-VI	A	10 µg/L[b]	0.18	0	1.84	---	---	---	---	---	ND
TCE	B	5 µg/L	0.18	2	1.84	---	---	---	---	---	ND
U(tot)	B	30 µg/L	0.18	0.8	1.84	---	---	---	---	---	ND

a. Parameters obtained from the analysis provided in Attachment 6-1 to Methodology Report.

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

c. Treatment amounts from the 2013 Hanford Annual Groundwater Report (DOE/RL-2014-32, Rev. 0).

d. Groundwater Threat Metric rating based on Table 6-3, Methodology Report.

e. There is no driving force for Sr-90 to move in the subsurface over the next 150 years unless the current cover provided by the building structure (concrete floor and foundation) is removed or another source of water was introduced. The rupture of the pressurized water pipe serving the building’s fire suppression system could provide necessary water infiltration for movement. Thus the *Low* rating would apply for the current status and Active Cleanup period to account for uncertainties.

PART VI. POTENTIAL RISK/IMPACT PATHWAYS AND EVENTS

CURRENT CONCEPTUAL MODEL

Narrative description of pathways and barriers to receptors and conditions/events that can lead to completed pathways

Pathways and Barriers: (1. description of institutional, natural and engineered barriers (including material characteristics) that currently mitigate or prevent risk or impacts, 2. Time scale from loss of each barrier to realization of risk or impacts)

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

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

Large amounts of radioactive material have been removed from the building, but as much as 65,000 curies of ^{137}Cs and ^{90}Sr dispersible activity remains, especially in A-Cell, B-Cell, and vault tank areas. Additionally, as noted earlier, soil under B-Cell is highly contaminated from ^{137}Cs-^{90}Sr solution that leaked through the hot cell liner in 1986. The contaminated soil represents the largest quantity of radioactive material associated with the 324 Facility. There is some uncertainty in the exact quantities and locations, so conservative bounding assumptions were used in the most current DSA prepared by the contractor Washington Closure Hanford.

A 1995 PNNL study indicates the structural design of the REC and SMF cannot withstand an earthquake having a peak ground acceleration greater than 0.139 g. This seismic capacity is insufficient to withstand an earthquake with a peak ground acceleration of 0.2 g required for a Hanford Hazard Category 2 facility. The study concludes that structural damage would result in a loss of confinement of radiological materials in the hot cells. The resulting shock/vibration would suspend radioactive and hazardous materials and the seismic loading would breach the structural integrity of the building, resulting in an uncontrolled release to the environment.

A fire in B-Cell is a high consequence event because of the potential for radiological release of dispersible ^{137}Cs and ^{90}Sr still remaining. However, flammable and combustible liquids (e.g., ethanol, hydraulic fluid, lubricants) are not present in the hot cells in bulk quantities. Lubricants are present in equipment such as overhead cranes. The combustible loading in the REC consist of mixed combustibles on the floors, wire insulation, and plastic sleeves on the manipulators. The largest combustible inventory in the hot cells is the oil that fills the cell windows. The structure of the window has barriers to prevent leakage of oil into the cell. The inside surface of the windows would have to be breached by heat from a fire or by mechanical damage to provide a means for the window oil to become involved in a cell fire. Without involving the oil from the windows, the combustible loading maintained in the B-Cell is not sufficient to result in a significant radiological release.

What are the active safety class and safety significant systems and controls?

The building's ventilation, HEPA filtration and 150 foot exhaust stack provide active safety systems to minimize the consequences of radioactive and chemical contaminates releases to the air inside and outside the hot cells.

What are the passive safety class and safety significant systems and controls?

A seismic event that exceeds the structural design may still be sufficient to enable workers to escape/evacuate Building 324 or areas being worked on before complete or critical area collapse, given the immense size and configuration of the building and cells. Cell operating procedures restrict quantity and use of flammable liquids and combustible materials inside the cells. Washington Closure Hanford and DOE sites training and emergency preparedness, and training and experience of Hanford Fire Department provide passive safety class and safety significant systems and controls.

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?

Building 324 is a substantial concrete and steel structure, with a poured-in-place reinforced concrete foundation structure. The superstructure is insulated fluted steel industrial panel supported on a structural steel frame. The parapeted roof has a slightly sloped steel deck covered with concrete with gravel-finished built-up roofing. The hot cell walls are constructed of 1.2-meter-thick, high-density concrete or 1.4-meter-thick, normal-density concrete. There is no known evidence of deterioration. Confinement of radioactive particulate matter within the shielded cells is provided by a directed airflow through a high-efficiency particulate air (HEPA) filtered ventilation system. Thus, there is minimal to no risk or a release or dispersion of contaminants to the outside. In general, several barriers in the 324 Building preclude the release of radioactive or other hazardous materials, consistent with the DOE-Hanford defense-in-depth concept.

Workers within the building currently involved in S&M activities wear protective equipment and monitoring devices that have proven to be effective barriers to exposure in recent years on the basis of the contractor's and the site's safety record.

Contaminates under B-Cell do not represent a risk to workers or the public in their current configuration. Workers are not directly exposed to the material because it is located below grade beneath a concrete slab and portions of the 324 Building. And because the contamination remains underground, there is not a dispersion pathway for the material to reach the atmosphere. Migration of the material through the soil into groundwater requires a driving force, such as a large source of water.

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

A strong seismic event that causes the catastrophic collapse of the building would release some radioactive contaminants inside the building and/or to the environment, but the robustness of the cells and building configuration will reduce the potential impacts.

In its current state, the greatest risk to the contaminates in the soils is an event such as the rupture of the buildings fire protection water line that would release a sufficient amount of water on the ground closest to the B-Cell that would cause the ^{137}Cs and ^{90}Sr to migrate into groundwater.

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

Should a significant release of water to the contaminated soil area occur, the contaminants could eventually make their way to the Columbia River. Although the level of contamination at the point of entry into the groundwater would likely represent a violation of State and/or Federal clean water standards, it is believed that its eventual mixing with the large Columbia River would cause it to dissipate and not cause any risk to the public. However, there may be high levels of ^{137}Cs and ^{90}Sr in the hyporheic transition zone that might impact aquatic organisms that reside in this zone e.g., salmon eggs.

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

It is unknown and dependent on the amount of liquid being sufficient to cause considerable migration of the contaminants.

Are there current on-going releases to the environment or receptors?

Not at this time

POPULATIONS AND RESOURCES CURRENTLY AT RISK OR POTENTIALLY IMPACTED

Facility Worker

S&D Workers inside the building may be exposed to residual radioactive and chemical contaminants, but are protected by special equipment. Workers outside Building 324 are not directly exposed to the contaminated soils because they are located below grade beneath a concrete slab and portions of the building. And because the contamination remains underground, there is not a dispersion pathway for the material to reach the atmosphere.

Co-Located Person (CP)

CPs are not directly exposed to the contaminated soils because they are located 100 meters away from the building, and the soils are below grade beneath a concrete slab and portions of the building. And because the contamination remains underground, there is not a dispersion pathway for the material to reach the atmosphere. There is a low risk of exposure through dispersal of radioactive materials from an accident at the building site.

Public

The contamination remains underground or within the hot cells, there is not a dispersion pathway for the material to reach the atmosphere and travel outside the site boundary.

Groundwater

Migration of the contaminants through the soil into groundwater requires a driving force (source of water to mobilize the contamination). This driver is not present at this time. The Sr-90 is not expected to move in the subsurface over the next 150 years leading to a rating of ND.

The rupture of the pressurized water pipe serving the building's fire suppression system is a potential accident scenario that could provide necessary water infiltration for movement.

Columbia River

Migration of the contaminants through the soil into groundwater requires a driving force (source of water to mobilize the contamination). This leads to a rating of ND.

Ecological Resources

- The EU consists entirely of level 0 resources.
- No species listed by the US Fish and Wildlife Service or listed by Washington State as species of conservation concern were observed within or in the vicinity of the EU.
- No level 3 or higher habitat resources exist within a 231 m radius of the unit.
- Because the EU lies within and adjacent to a highly disturbed industrial area, the cleanup activities associated with the 324 building would not be expected to impact habitat connectivity.

Cultural Resources

- There are no known recorded archaeological sites or TCPs located within the 324 Building EU.

- The 324 Building is a contributing property within the Manhattan Project/Cold War era Landscape with documentation required is located within the 324 Building EU. In accordance with the 1998 *Hanford Site Manhattan Project and Cold War Era Historic District Treatment Plan (*DOE/RL-97-56), all documentation requirements have been completed for this property.

Archaeological sites, buildings and TCPs located within 500 meters of the EU

- The numerous buildings within 500 m of the EU that are all contributing properties within the Manhattan Project/Cold War Era Landscape with documentation required and are within 500 meters of the 324 building EU. In accordance with the 1998 *Hanford Site Manhattan Project and Cold War Era Historic District Treatment Plan (*DOE/RL-97-56), all documentation requirements have been completed for these properties.
- The numerous buildings within 500 m of the EU that are all contributing properties within the Manhattan Project/Cold War Era Landscape with no documentation required and are within 500 meters of the 324 building EU. In accordance with the 1998 *Hanford Site Manhattan Project and Cold War Era Historic District Treatment Plan (*DOE/RL-97-56), all documentation requirements have been completed for these properties.
- There are five archaeological sites located within 500 meters of the 324 Building EU. These include one isolated find, three National Register-eligible sites, and a state-Registered archaeological district associated with the Native American Precontact and Ethnographic Landscape and one isolated find associated with the Pre-Hanford Early Settlers and Farming Landscape.

Recorded TCPs Visible from the EU

- There are no known recorded TCPs known to be visible from the 324 Building EU or within the immediate vicinity.

CLEANUP APPROACHES AND END-STATE CONCEPTUAL MODEL

Selected or Potential Cleanup Approaches

In December 2011, WCH[7] reviewed and considered about one hundred means and methods for waste removal, stabilization, treatment, packaging, and disposal of the contaminated soil beneath Building 324, and narrowed them down to fourteen remediation alternatives that were evaluated against regulatory, protection of human health, proven technology and other screening criteria. A total of 15 attributes were used in the scoring, with each being assigned a weight of 1-4 in terms of its relative importance to achieving the remediation objective and then a risk priority score of 1-8 to represent the likelihood and consequence of an accident or negative event. The higher weight and risk score the better the alternative. The maximum total score for any remedial alternative was 280.

Of the fourteen, the four that had strong scores (166-204) and were consistent with the Final ROD involved those that extract the contaminated soil up through the B-Cell floor, utilize the existing facility's ventilation system to move it with grout to the C and D Cells, and take advantage of the existing Radiochemical Engineering Complex hot cell structure for containment and shielding. The two alternatives that graded highest (239 and 240) on these same criteria were procedures that would stabilize the contamination in place and leave the contamination in situ with a cap over the site to allow

[7] Remediation Alternatives Evaluation for Contaminated Soil Beneath the 324 Building, WCH-503, Rev. 0, December 2011

for radiation decay and safer removal and final remediation at a later date. Each of the soil remediation strategies will require a different D&D strategy for the building and hot cells.

Work to stabilize and deactivate Building 324 has been limited since 2012 so as to adequately review these and other alternatives. AREVA was awarded a $19 million contract in January 2014 to design, construct and operate a pilot project designed as “proof of concept” for the remote retrieval of high activity radioactive soils beneath building 324 by September 2015. This method will significantly increase the level of ^{137}Cs and ^{90}Sr within the building’s B, C and D Cells, and will necessitate that the outer building shell be demolished and that the three hot cells each be removed in whole or part as monoliths and transported to ERDF for permanent disposal. The early estimate was for the soil mitigation work to be completed about Fall 2016, but possible changes to funding availability in FY 2016 have put this next step on hold, as well as the follow-on demolition of the building and removal and transport of the hot cells to ERDF. Removal of the 324 Building, and the hot cells would be performed under the CERCLA Action Memorandum #2 for the 300 Area Facilities. In addition, closure of the TSD units in the 324 Building would be performed under the RCRA Closure Plan.

Two alternatives graded higher than the currently chosen soil remediation method with regard to the Attributes of Radiation Safety, Air Impacts, Contamination Control, Ability to Construct and Operate, and Availability of Equipment/Services, and equal or similar scores to the chosen method for Attributes such as Industrial and Occupational Safety, Administrative Feasibility, and Proven Technology/Process. They are:

- *Grout Injection into Waste Matrix After Building Removal, Leaving Bottom of B Cell in Place, Install Geo-Membrane Cap*. With the structure in place and an operational building ventilation system, a drill rig will be placed into B Cell and holes will be drilled to provide access to soil beneath B Cell. Contaminated soil will be stabilized by pumping a high-strength grout into the underlying soil. Following stabilization and demolition of the majority of the Building, the stabilized monolith (consisting of the bottom of B Cell and the contaminated soil) will be left in place and an engineered cap will be constructed over the newly formed monolith to prevent infiltration of water.
- *Inject Polymer and/or Grout Layer Under Contamination, Leaving Bottom of B Cell in Place, Install Geo-Membrane Cap*. With the structure in place and an operational building ventilation system, the bottom of B Cell will be filled with grout material to stabilize contamination. Following the demolition of the 324 Building including the upper portion of B Cell, a horizontal barrier system will be installed under the monolith. The barrier system will consist of a cone-shaped barrier constructed of a polymer and/or grout layer beneath the bottom of contamination. An engineered cap will be constructed over the B Cell area.

Long-term surveillance and maintenance of the 300-296 site would be required in both these instances until the contaminated soils and engineered cap are removed. However, leaving contamination in place was deemed by WCH to be inconsistent with the Final 300 Area ROD and CERCLA documentation for the 300 Area. In addition, regulators (U.S. Department of Energy, Richland Operations, and U.S. Environmental Protection Agency) have indicated that they believe in situ alternatives are not acceptable and would be unfavorable with respect to qualitative consideration of “modifying criteria. These alternative processes would thus require revisions to the CERCLA documents and Final 300 Area ROD.

However, a new study was conducted by WCH in October 2014 and findings of the data analysis were issued in February 2015. As noted earlier, this study produced very different results from the 2011-12 analysis of the soil contamination in terms of how deep the ^{137}Cs and ^{90}Sr contaminates may have migrated, and more importantly that they have migrated horizontally to as much as 4 feet outside the B-Cell foundation footprint. These results raise large uncertainties that will need to be considered before proceeding with the currently chosen method of excavation through the B-Cell floor. This recent study was undertaken nearly four years after the analysis of remediation alternatives for the contaminated soil (WCH-503) and two years after execution of the Final ROD for the Hanford 300 Area that required the application of remove, treat, dispose (RTD) processes such as the current plan to excavate the contaminated soils through the floor of the B-Cell. That soil remediation method may prove to not be technically feasible and sufficiently safe because of the extensive horizontal migration of the ^{137}Cs and ^{90}Sr to outside the B-Cell foundation structure, and other alternatives such as in-situ treatment may require further consideration.

Building 324 is being currently maintained in a safe S&M mode pending completion and evaluation of the AREVA pilot project results and inclusion of the new 2014-15 data.

Contaminant Inventory Remaining at the Conclusion of Planned Active Cleanup Period

Both cleanup alternatives will remove or fully stabilize the contaminated soils, and Building 324 will either entirely or mostly be demolished, and then transported to ERDF. The alternative approach would leave a soil monolith and engineered cap in the industrial 300 Area for 100+ years, whereas the DOE's preferred method would remove all contaminates and the building by 2020.

Risks and Potential Impacts Associated with Cleanup

Both cleanup alternatives will put cleanup workers at risk. The DOE preferred method of soil remediation was determined to have a greater potential for workers to be exposed to radiological contamination and dose rates if they are required to enter B-Cell for maintenance and/or repair of equipment. In addition, the sealing of C and D cells may expose workers to radioactive material in the form of dust and debris.

In addition, studies indicate that Building 324 could not withstand an earthquake with a peak ground acceleration greater than 0.139 g (Hanford HC-2 facilities require minimum of 0.2 g horizontal acceleration capacity). Facility worker consequences could be higher due to possible building collapse during worker preparation of the radiology contaminated interior, and even more so as the very highly contaminated soils currently located beneath B-Cell are excavated and brought into and permanently stored in the B, C and D Cells, as proposed under the preferred DOE soil cleanup methodology.

The alternative method would require an engineered cap over the contaminated soil area, but the area is proposed to remain restricted to industrial uses. About 15-16 facilities will remain in operational use, including Buildings 318, 325, 331 and 350 which PNNL modified in 2009-10 ($34 million in 325 alone) and will continue to use.

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

Facility Worker

See above

Co-located Person

Low risk from accident on building site that would cause sufficient aerial release of contaminates to reach Co-located Person.

Public

Low risk from accident on building site that would cause sufficient aerial release of contaminates to reach Public

Groundwater

Migration of the contaminants through the soil into groundwater requires a driving force (source of water to mobilize the contamination). This driver is not present at this time. The Sr-90 is not expected to move in the subsurface over the next 150 years leading to a rating of ND. The rupture of the pressurized water pipe serving the building's fire suppression system is a potential accident scenario that could provide necessary water infiltration for movement. Thus, a rating of Low is assigned.

Columbia River

Migration of the contaminants through the soil into groundwater requires a driving force (source of water to mobilize the contamination). This leads to a rating of ND.

Ecological Resources

No ecological resources are in this EU, and thus there are no effects

Cultural Resources

Personnel, car, and truck traffic on paved roads as well as use of heavy equipment will not have any direct impact on archaeological resources because there is no disturbance to soil/ground or alteration to the landscape. Assuming heavy equipment locations 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 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 paved roads located on TCP, direct effects include visual, auditory and vibrational alterations to landscape/setting. Heavy equipment 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. Revegetation activities may cause direct effects to TCPs include physical alteration to or restoration of TCP depending on how the area is recontoured and what plants are selected for revegetation.

Indirect effects from personnel, car, and truck traffic on paved roads as well as use of heavy equipment 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. Existing road causes no alteration to 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. 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.

Additional Risks and Potential Impacts if Cleanup is Delayed

There is no risk to the Facility Worker, CP or Public if cleanup of the soils or building is delayed. There is no known physical deterioration occurring in Building 324 or its several hot cells, and recent measures were taken to improve the condition of its interior and to prevent rain from reaching soils covering the recent excavation. Studies indicate that the contaminants are not moving from their current location in the soils and thus not threatening groundwater, although additional groundwater monitoring is recommended to ensure that contaminants do not migrate toward the River and provide early indication of any change. There are potential benefits to near-term measures that prevent infiltration to the soils (e.g., covers or in-situ grouting) and allow time for an order of magnitude decrease in radiation levels due to natural decay (ca. 90 years) or allowing natural attenuation to achieve long-term environmental safety.

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

Both cleanup alternatives will remove or fully stabilize the contaminated soils, and Building 324 will either entirely or mostly be demolished, and then transported to ERDF. The currently proposed methodology would remove the Cs and Sr, but it is unclear if an attempt will be made to remove 100% of the contaminants or if a portion will be allowed to remain and decay. This work would be completed by 2020. The alternative approach would encapsulate these contaminants in a presumably safe soil monolith, and the Building 324 foundation and engineered cap would protect it from water infiltration for 50-100 years. The engineered cap, including sub-surface B-Cell walls and other Bldg. 324 foundation would be then be removed and transported to ERDF along with the soil monolith.

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

Table 7. Populations and Resources at Risk

Population or Resource		Risk/Impact Rating	Comments
Human	Facility Worker	ND	No workers will be present.
	Co-located Person	ND	None
	Public	ND	None
Environmental	Groundwater	Low	Migration of the contaminants through the soil into groundwater requires a driving force (source of water to mobilize the contamination). This driver is not present at this time. The Sr-90 is not expected to move in the subsurface over the next 150 years leading to a rating of ND. However, the *Low* rating would apply after the Active Cleanup is completed to account for uncertainties. The rupture of the pressurized water pipe serving the building's fire suppression system is a potential accident scenario that

			could provide necessary water infiltration for movement.
	Columbia River	ND	Migration of the contaminants through the soil into groundwater requires a driving force (source of water to mobilize the contamination). This leads to a rating of ND.
	Ecological Resources*	ND-Low	Any risk depends upon the quality and quantity of re-vegetation following remediation. Could be a risk from invasion of exotic species.
Social	Cultural Resources*	**Native American:** Direct: Unknown Indirect: Known **Historic Pre-Hanford:** Direct: Known Indirect: None **Manhattan/Cold War**: Direct: None Indirect: None	No expectations for impacts to known cultural resources.

*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.

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

The currently proposed methodology would remove the Cs and Sr, but it is unclear if an attempt will be made to remove 100% of the contaminants or if a portion will be allowed to remain and decay. This work would be completed by 2020. The alternative approach would encapsulate these contaminants in a presumably safe soil monolith, and the Building 324 foundation and engineered cap would protect it from water infiltration for 100 years. The engineered cap, including sub-surface B-Cell walls and other Bldg. 324 foundation would be then be removed and transported to ERDF along with the soil monolith.

PART VII. SUPPLEMENTAL INFORMATION AND CONSIDERATIONS

The Final Hanford 300 Area ROD contains the following under Declaration of the Record of Decision; 4.0 Description of the selected remedies and ROD Amendment: (page iii)

"Principal threat wastes exist in three waste sites in 300-FF-2. Soil in waste site 300-296 below the 324 building, vertical pipe units at the 618-10 and 618-11 burial ground waste sites and caissons at 618-11 contain principal threat waste. Under the selected remedy for 300-FF-2, all principal threat waste will be treated where practicable to reduce the toxicity, mobility, contamination or radiation exposure, including some that will be treated in-situ prior to removing the waste for disposal. Treatment will be with grout or an alternative method approved by EPA during remedial design." This would appear to permit implementation and use of the alternative soil remediation option which involves injecting a grout or polymer into and/or under the waste matrix beneath Building 324. The majority of the building would be demolished and transported to ERDF for disposal; however the B-Cell foundation would remain and used as part of an engineered cap over the area. The monolith contaminants would be removed in 50-100 years and transported to ERDF.

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APPENDIX F.3

K-EAST and WEST REACTORS
(RC-DD-2, RIVER CORRIDOR)
EVALUATION UNIT SUMMARY TEMPLATE

Table of Contents

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PART I. EXECUTIVE SUMMARY

EU LOCATION

100-K Area

RELATED EUS

RC-LS-2 and RC-GW-3

PRIMARY CONTAMINANTS, CONTAMINATED MEDIA AND WASTES:

The K-East Reactor Building is currently managed as below Hazard Category (HC) 3 for limited deactivation and decommissioning activities under DD-49580, *Final Hazard Categorization for Interim Safe Storage of 105-KE Reactor Building* and at K-West for authorized surveillance and maintenance activities under KBC-39764*, Final Hazard Categorization for Surveillance, Maintenance and Various D4 Activities for the 105-KW Reactor*. The 105-KW Basin is currently managed as an HC-2 facility, with only sludge and potentially a small amount of fuel. The sludge is stored in the Sludge Containerization System and in Integrated Water Treatment System equipment (e.g., settler tubes). The KW fuel storage basin is addressed is a separate EU risk analysis document.

In general, the primary radiological contaminants within each of the reactor buildings are:

- Tritium (H-3)
- Carbon-14
- Cobalt-60
- Cesium-137
- Uranium isotopes
- Strontium-90
- Europium-152 & 154
- Nickel-59 & 63
- Chlorine-36
- Plutonium isotopes
- Technetium-99

Cobalt-60 and Cesium-137 are of importance because they contribute to the dose received by decommissioning workers, and Carbon-14 and Uranium-238 are important because of their long half-life and contribution to long-term individual and public doses.

Chromium is the primary groundwater contaminant underlying the 100-K Area, and remediation is being conducted under the Interim Action Record of Decision for the 100-KR-4 Operable Units.

There are radiological contaminants that may require removal located at the base of the north K-East Reactor building wall related to cooling water that leaked through the construction joint between the basin and the reactor building (designated as inactive waste site UPR-100-K-1). During operation of the fuel storage basin, a leak developed in the bottom of the fuel discharge chute that allowed contaminated water to leak into the soil. It is assumed that contaminated water leaked from the entire 55-foot length of the discharge chute joint. Contaminated soils have been excavated and removed to 15 feet below ground level, but further remediation may be required.

BRIEF NARRATIVE DESCRIPTION:

The K Reactors were a third-generation-design plutonium production reactor, and the largest built at Hanford. Construction of the KW Reactor began in 1952, with the initial start-up of the reactor occurring on January 4, 1955. The final shutdown of the reactor occurred on February 1, 1970. Construction of the KE Reactor began in 1953, with the initial start-up of the reactor occurring on April 17, 1955. The final shutdown of the reactor occurred on January 28, 1971.

During final shutdown of the two reactor buildings, extensive procedures were performed to safely shut down the entire facility and contain contamination within the reactor block. They are deactivated facilities and there are no active processes in operation. The KE Reactor Building achieved Cold & Dark status (electrical and mechanical systems air-gapped to eliminate potential external energy sources) in February 2010. Work will proceed to put the building into interim safe storage (ISS) until approximately Year 2068, followed by deferred demolition of the building and transporting of the reactor cores to ERDF for final disposition. ISS consists of demolishing part of the reactor building, constructing a foundation around and safe storage enclosure (SSE) over the reactor block ("cocooning" the reactor building), and providing long-term monitoring. As of November 2013 the following tasks had been completed on the KE Reactor: Demolishing portions of the reactor building outside the shield walls including fuel storage basins; Removing loose equipment and debris within the shield walls; and Removing or fixing loose contamination in areas within the shield walls. Still to be done are constructing the SSE over the existing structure and installing a remote monitoring system inside the SSE. Pending resumption of SSE construction, interim S&M will be conducted to ensure the reactor building condition remains as described in the current Hazard Analysis.

The K-West Reactor site is currently undergoing routine S&M activities and limited pre-demolition activities pending removal of the sludge in the K-West Fuel Basin and demolition of the basin.

DOE is currently following a remediation path of safe storage followed by deferred one-piece removal of the reactor as documented the Record of Decision[1] and applied to the other Hanford surplus reactors. A CERCLA EE/CA process was used to evaluate safe storage options including cocooning. However in July 2010, it decided to broaden its decommissioning approach by retaining the immediate one-piece removal alternative that was deemed equally favorable based solely on the evaluation of environmental impacts. A Supplemental EIS Analysis (DOE/EIS-0119F-SA-01) addressed a proposed action to pursue accelerated dismantlement, removal, and disposal of all eight surplus reactor facilities on the Hanford Site, with an initial focus on the K-East Reactor as a demonstration of capabilities to accelerate the dismantlement, removal and disposal of the remaining seven surplus production reactors. The implementation of these activities would be conducted as a CERCLA non-time critical removal action. In April 2011 DOE advised the Hanford Advisory Board that it was no longer pursuing this option and was proceeding with construction of safe storage enclosures for both reactor buildings.

A tritium plume was created in the vadose zone beneath the KE Reactor about 1993 from the leakage of shielding water at the construction joint in the pickup chute structure that connected the fuel storage basin to the KE Reactor building.

Hexavalent chromium is the primary groundwater contaminant underlying the 100-K Area (100-KR-4 OU). Remediation of the chromium is being conducted under the Interim Action Record of Decision (1996) for the 100-KR-4 Operable Unit. The first pump-and-treat system was constructed in 1997 to address the largest K area chromium plume that was located beneath the 116-K-2 trench. Over time it

[1] (58 FR 48509)

was determined that other areas required remediation and two P&T systems (KW-2007 and KX-2009) were added to substantially expand the remedial treatment capacity.

SUMMARY TABLES OF RISKS AND POTENTIAL IMPACTS TO RECEPTORS

Table F.3-1 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 K-East Reactor facility; a Co-located Person (CP) is an individual located 100 meters from the facility; and Public is an individual located at the closest point on the Hanford Site boundary not subject to DOE access control, which in this instance is the west bank of the Columbia River. The nuclear related risks to humans are based on unmitigated (unprotected or controlled conditions) dose exposures expressed in a range of from Non-Discernable (ND) to Very High. The estimated mitigated exposure that takes engineered and administrative controls and protections into consideration, is shown in parenthesis.

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 Non-Discernable (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: No risk ratings are provided for Cultural Resources. The Table 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.

Table F.3-1. Risk Rating Summary (for Human Health, unmitigated nuclear safety basis indicated, mitigated basis indicated in parenthesis (e.g., "High" (Low)).

Population or Resource		Evaluation Time Periods	
		Active Cleanup (to 2064)	
		Current Condition: S&M	From Cleanup Actions (Construct SSE)
Human	Facility Worker	Low (Low)	Low (Low)
	Co-located Person	Low (Low)	Low (Low
	Public	Low (Low)	Low (Low
Environmental	Groundwater	ND	ND
	Columbia River	ND	ND
	Ecological Resources*	ND	ND
Social	Cultural Resources*	**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

*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.

SUPPORT FOR RISK AND IMPACT RATINGS FOR EACH POPULATION OR RESOURCE

Human Health

__Current__

An April 2013 Hazard Analysis (DD-49581) prepared by the contractor CHPRC identified two primary hazardous radiological scenarios:

Seismic Event: An evaluation of the ability of the graphite stacks of the 105-KE and 105-KW Reactors to withstand an earthquake of Zone 2 intensity (i.e., horizontal acceleration of 0.1 g) was performed in 1953. It was concluded that the graphite stack of the 105-KE and 105-KW Reactors could withstand a Zone 2 earthquake with negligible damage even if considerable distortion of the stack occurred via graphite growth. The arrangement of the graphite stack, cast iron thermal shield, and concrete biological shield limits the movement of the graphite and cast iron to central bowing (from front to rear) during an earthquake. The evaluation also determined that an accompanying 0.41 g vertical acceleration (assuming a 0.1 g horizontal acceleration) would be necessary for slippage to occur at the cast iron-graphite interface at the top of the stack. Finally, the evaluation concluded that the likelihood of the stack ever being vibrated at its resonant frequency is not likely to occur. Similar opinions on the seismic stability of the Hanford Reactors were made in BHI-01172[2] and specifically with K-West in KBC-39764 Rev 1[3] [OUO doc] and K-East in DD-49580[4]

Unmitigated and Mitigated Risk: Facility Worker – ND; CP – ND; Public – ND

Fuel Fire Engulfing Fixed Contamination on K-East Reactor Building Exterior: The Hazard Analysis postulates that a fuel fire occurring S&M, well drilling activities, or during SSE construction could ignite the Polymeric Barrier System (PBS) fixative on the lower north exterior wall. It concluded that the PBS would be consumed by the fire and some fixed contamination released. The analysis concluded that a fire engulfing this area would be considered a below-HC-3 event. Thus, only low consequences are estimated.

Unmitigated and Mitigated Risk: Facility Worker – Low; CP – Low; Public – Low

Industrial Safety: Pending resumption of K-East SSE construction, interim S&M is the only worker activity, and no industrial accident scenarios were identified as presenting anything other than a Low risk to the S&M Worker.

Unmitigated and Mitigated Risk: Facility Worker – Low; CP – ND; Public – ND

Risks and Potential Impacts from Selected or Potential Cleanup Approaches

No information is available regarding the decontamination and demolition of parts of the K-West reactor building and ancillary buildings that will be required after the fuel basin has been removed and in preparation of constructing an SSE. None of the radiological hazards specific to the proposed Safe Storage Enclosure (SSE) Construction at K-East were determined to have greater than Low consequences for the Co-located Person or Offsite Public. No scenarios were identified as presenting significant hazards to the Facility Worker and none of the hazardous events were assigned. No unmitigated dose exposures were calculated or provided in the Hazard Analysis.

The Hazard Analysis identified several potential industrial safety accidents at K-East involving use of a crane to lift and move construction materials and workers up to 2-3 stories above the ground when constructing the proposed Safe Storage Enclosure (SSE) unit. No scenarios were identified as presenting significant hazards to the Facility Worker.

It should be noted that this stage of cleanup is only to build SSE structures to enclose the two reactor buildings. The current plan is to dismantle the SSEs and reactor buildings about 2068, and no information is available regarding those potential risks.

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[2] Bechtel Hanford, Inc., *Surplus Reactor Auditable Safety Analysis, BHI-01172, Rev. 3.,* for U.S. Department of Energy, Richland Operations Office. August 19, 2004

[3] CH2MHill Plateau Remediation Company, *Final Hazard Categorization for Surveillance, Maintenance and Various D4 Activities for the I05-KW Reactor, KBC-39764, Rev. 1*, prepared for U.S. Department of Energy, Assistant Secretary for Environmental Management, May 28, 2010

[4] CH2MHill Plateau Remediation Company, *Final Hazard Categorization for Interim Safe Storage of 105-KE Reactor Building*, DD-49580, Revision 1, EDC#: ECR-13-000396, for U.S. Department of Energy, Assistant Secretary for Environmental Management, November 12, 2013

Groundwater

The bulk of the inventory for this EU is contained in the reactor cores inside the buildings and is not expected to impact either the groundwater or the Columbia River.

It is noted that Sr-90 has been measured in the groundwater above the DWS and has a shoreline impact. Thus, it is possible for a very small amount to move through the groundwater to the Columbia River. However, there is insufficient Sr-90 inventory exterior to the building to support a plume relative to decay. This leads to an ND rating.

Columbia River

No groundwater plume is expected from this EU. Thus, there is no impact on the Columbia River, leading to a ND rating.

Ecological Resources

Current

There are currently no ecological resources on EU, and only 1 acre of level 3 on buffer area.

Risks and Potential Impacts from Selected or Potential Cleanup Approaches

There are no ecological resources are in this EU, and thus no effects.

Cultural Resources

Current

Manhattan Project/Cold War significant resources have already been mitigated. Area within the EU is heavily disturbed, but the entire area is extremely culturally sensitive based on prehistoric, ethno-historic, and historic land use in the area. 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

Due to highly sensitive cultural resources in vicinity of the EU, consultation is needed. Archaeological investigations or monitoring may also need to occur. Direct and indirect effects are likely to archaeological sites and traditional cultural places in vicinity of the EU.

Considerations for timing of the cleanup actions

An Environmental Impact Statement (EIS) Supplemental Analysis (DOE/EIS-0119F-SA-01) prepared in July 2010 addresses a proposed action to pursue accelerated dismantlement, removal, and disposal of all eight surplus reactor facilities on the Hanford Site, with an initial focus on the K-East Reactor as a demonstration of capabilities to accelerate the disposition of the other reactors. This alternative was felt to be the same as DOE's "safe storage followed by deferred dismantlement" alternative described in the Final EIS except that it accelerates the safe storage period from 75 years as currently being pursued to about 20 years. DOE is no longer pursuing this alternative.

The existing soil grading exposes the exterior of the K-East Reactor Building to a depth of approximately 16 to 21 ft below grade on three sides. The floor of the basin excavation pit on the north side is covered with approximately 2 ft of clean overburden for radiation shielding and to reduce contamination levels when backfill is resumed. A structural stability analysis was performed, and concluded that this configuration has adequate structural stability until the SSE construction resumes (currently scheduled for 2016). A delay beyond 2016 may require temporary filling of these areas to retain structural stability of the exposed building.

Near-Term, Post-Cleanup Risks and Potential Impacts

This stage of cleanup is only to build an SSE structure to enclose each of the reactor buildings. The current plan is to dismantle the SSEs and reactor buildings about 2068, and no information is available regarding those potential risks.

Any risk to Ecological Resources depends upon the quality and quantity of re-vegetation following remediation. There could be a risk from invasion of exotic species.

Permanent direct and indirect Cultural Resource effects are possible due to high sensitivity of area.

PART II. ADMINISTRATIVE INFORMATION

OU and/or TSDF Designation(s)

105-KE and 105-KW

Common name(s) for EU

K-East and K-West Reactors

Key Words

D&D, Reactors

Regulatory Status

Regulatory basis: CERCLA

Applicable regulatory documentation:

Applicable Consent Decree or TPA milestones: DOE/RL-2005-26,Rev. 1, Removal Action Work Plan for 105-KE/KW Reactor Facilities and Ancillary Facilities. TPA Milestone M-093-27 Complete 105-KE & 105-KW Reactor ISS in Accordance with the Removal Action Plan - 12/31/2019

Risk Review Evaluation Information

Completed (revised): June 23, 2015

Evaluated by: H. Mayer

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

PART III. SUMMARY DESCRIPTION

Current land use

Industrial

Designated future land use

Conservation, Unrestricted

PRIMARY EU SOURCE COMPONENTS

Legacy Source Sites

Not Applicable

High-Level Waste Tanks and Ancillary Equipment

Not Applicable

Groundwater Plumes

Hexavalent chromium is the primary groundwater contaminant underlying the 100-K Area (100-KR-4 OU). Remediation of the chromium is being conducted under the Interim Action Record of Decision (1996) for the 100-KR-4 Operable Unit. The first pump-and-treat system was constructed in 1997 to address the largest K area chromium plume that was located beneath the 116-K-2 trench. Over time it was determined that other areas required remediation and two P&T systems (KW-2007 and KX-2009) were added to substantially expand the remedial treatment capacity.

A tritium plume was created in the vadose zone beneath the K-East Reactor about 1993 from the leakage of shielding water at the construction joint in the pickup chute structure that connected the fuel storage basin to the reactor building.

D&D of Inactive Facilities

The K Reactor buildings are concrete and structural steel multistory structures (original dimensions[5] approximately 275 ft by 213 ft by 107 ft). The construction includes reinforced concrete and transite siding and reinforced concrete or corrugated transite paneled roofs with built-up asphalt and gravel surfacing. The buildings originally contained a reactor block; inner and outer horizontal control rod (HCR) rooms; a front-face work area; fans and ducts for ventilation and recirculating inert gas systems; water cooling systems; and supporting offices, shops, and laboratories. The K-East fuel storage basin has been removed and areas outside the reactor block shield walls have been demolished in preparation for SSE construction. These actions cannot be taken at K-West until the sludge is removed from the fuel basin.

The reactor core of each building is estimated to currently contain approximately 18,000 Ci of radionuclides (see Table F.3-4 for Worst Case Estimate of Reactor Core).

In addition, about 187 tons of lead (in 1993[6]) is believed to exist in surface coatings (i.e., lead-based paint), plumbing, and as radiological shielding (e.g., lead shot, brick, sheet and cast-lead forms) inside some of the 100-K Area facilities. About 926 cu. yds of asbestos-containing material (ACM) is located in and around the facilities and may exist as vessel or piping insulation, floor tiles, transite wall coverings or panels, sheetrock, electrical wire insulation, and ducting. PCBs are identified as potential contaminants in the 100-K Area facilities and PCB-contaminated waste will likely be generated.

During final shutdown of the two K Reactor Buildings, extensive procedures were performed to safely shut down the entire facility and contain contamination within the reactor block. The activities performed included installing process tube caps, purging the cover gas lines, closing drain valves, discharging fuel and verifying that the fuel was discharged from each process tube, and draining process water lines. The 3X balls from the reactor were vacuumed from the hoppers, placed in metal drums,

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[5] CH2MHill Plateau Remediation Company, *Final Hazard Categorization for Interim Safe Storage of 105-KE Reactor Building*, DD-49580, Revision 1, EDC#: ECR-13-000396

[6] Referenced in: Bechtel Hanford, Inc., *Surplus Reactor Auditable Safety Analysis, BHI-01172, Rev. 3.,* for U.S. Department of Energy, Richland Operations Office. August 19, 2004

treated with desiccant, and stored in the inner rod room during the reactor's deactivation. They have since been removed from the facility.

Operating Facilities

Not Applicable

Location and Layout Maps

Figure F.3-1. K East and West Reactors along the Columbia River (as of July 2013)

Figure F.3-2. KE/KW Reactor Evaluation Unit Map

PART IV. UNIT DESCRIPTION AND HISTORY

EU Former/Current Use(s)

Legacy Source Sites

Not Applicable

High-Level Waste Tanks

Not Applicable

Groundwater Plumes

Sodium dichromate was added to the reactor cooling water at the K-East Headhouse to minimize corrosion of the cooling pipes in the reactor cores, and through various spills, leaks and other discharges hexavalent chromium became the primary groundwater contaminant underlying the 100-K Area (100-KR-4 OU). Remediation of the chromium is being conducted under the Interim Action Record of Decision (1996) for the 100-KR-4 Operable Unit. The first pump-and-treat system was constructed in 1997 to address the largest K area chromium plume that was located beneath the 116-K-2 trench. Over time it was determined that other areas required remediation and two P&T systems (KW-2007 and KX-2009) were added to substantially expand the remedial treatment capacity.

D&D of Inactive Facilities

The K Reactors were a third-generation-design plutonium production reactor. Construction of the KW Reactor began in 1952, with the initial start-up of the reactor occurring on January 4, 1955. The final shutdown of the reactor occurred on February 1, 1970. Construction of the KE Reactor began in 1953, with the initial start-up of the reactor occurring on April 17, 1955. The final shutdown of the reactor occurred on January 28, 1971. The K Reactors are generally comparable to the older reactors in design however, they differ as follows:

1. The biological shields are constructed of concrete rather than the steel Masonite laminate used for the older reactors,
2. Their graphite stacks are one and one half times larger than those of the older reactors, and
3. They have approximately 61 % more process tubes.

Additional noteworthy differences include the following: (1) the concrete foundations contain tunnels for the retrieval of the boron-steel balls used for the ball 3x system (a shutdown safety system); (2) the outer rod rooms have reinforced-concrete walls 1 to 3 ft thick; (3) the supply and exhaust fan areas are located on opposite ends of the building instead of both being located on the same end; (4) the valve pits are below grade, directly under the front-face work area; and (5) the mechanical rooms and miscellaneous above-grade support rooms were built with transite wall panels and roofs.

The reactor buildings are concrete and structural steel multistory structures (original dimensions approximately 275 ft by 213 ft by 107 ft). The construction includes reinforced concrete and transite siding and reinforced concrete or corrugated transite paneled roofs with built-up asphalt and gravel surfacing. The buildings originally contained a reactor block; inner and outer horizontal control rod (HCR) rooms; a front-face work area; fans and ducts for ventilation and recirculating inert gas systems; water cooling systems; and supporting offices, shops, and laboratories.

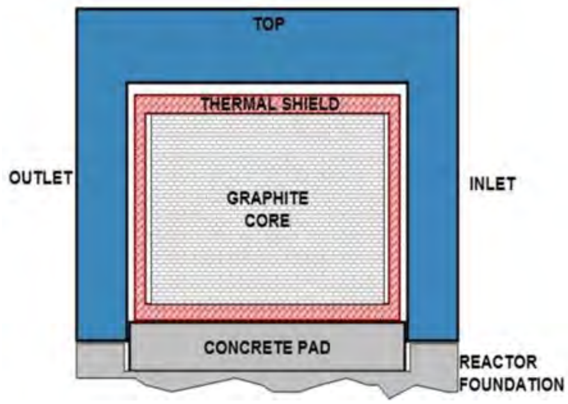

Figure F.3-3. Schematic Reactor Cross-Section

The reactor block is located near the center of the building, and consists of a graphite moderator stack (41 ft wide by 41 ft high by 33.5 ft deep) encased in a cast iron thermal shield (10 in. thick) and a biological shield consisting of high-density aggregate concrete (45 to 83 in. thick). The entire block rests on a massive concrete foundation. The reactor block, including the foundation, weighs approximately 12,100 tons. A cast iron thermal shield surrounding the graphite stack isolates the biological shield from the core.

Today, both Reactor Buildings are in a deactivated facility and there are no active processes in operation. The K-East Reactor Building achieved Cold & Dark status (electrical and mechanical systems air-gapped to eliminate potential external energy sources) in February 2010. The K-West Basin is currently managed as an HC-2 facility pending removal of sludge materials, and the Reactor is currently undergoing routine S&M activities.

The Fuel Storage Basins (FSBs) at K Reactors were cleaned of debris and deactivated after final reactor shutdown. However, the basins were modified and reactivated to provide storage space for irradiated fuel prior to Spent Nuclear Fuel (SNF) processing. In 1980, irradiated N-Reactor fuel was placed, for what was intended to be short duration storage, under water in the pools previously used for temporary storage of irradiated fuel from the K-East/K-West Reactor production complex. Over time, debris, silt, sand, and material from operations resulted in the formation of sludge that accumulated in the bottom of these basins. In addition, the extended storage of the irradiated fuel resulted in corrosion of the fuel cladding and the storage canisters, especially in the K-East Basin, where the fuel was exposed directly to the storage water. The SNF in the KE-FSB was moved to the KW-FSB in 2004, and since then the KE-FSB and the portion of discharge chute outboard of the construction joint on the north side of the reactor building have been demolished.

During demolition of the K-East chute, it was determined that a large amount of radionuclides had passed through openings between the chute and the reactor building, run down the north side exterior wall and into the soils below. The exterior wall was found to be contaminated and a fixative was applied (recently painted purple). The soils were excavated to 15 ft. below grade and removed. Two feet of fill was applied, and it is unclear as to whether additional remediation of the exterior wall and/or soils below 15 ft. will be required.

During final shutdown of the K Reactor Buildings, extensive procedures were performed to safely shut down the entire facility and contain contamination within the reactor block. Several permanent decommissioning alternatives for the Hanford production reactors were evaluated by the site and the selected alternative for the K Reactor Buildings was interim safe storage until approximately Year 2068, followed by deferred demolition of the building. Interim safe storage consists of demolishing part of the reactor building, constructing a safe storage enclosure (SSE) over the reactor block, and providing long-term monitoring. Interim safe storage generally consists of the following tasks (those with asterisk had been completed at K-East as of November 2013):

- Demolishing portions of the reactor building outside the shield walls (*)
- Removing loose equipment and debris within the shield walls (*)
- Removing or fixing loose contamination in areas within the shield walls (*)
- Annual inspections for interim S&M pending resumption of SSE construction
- Fill in areas around three sides of building to near ground level and construct foundation for SSE
- Constructing the SSE over the existing structure
- Installing a remote monitoring system inside the SSE
- Inspections every 5 years for the duration of ISS

Most of the equipment not permanently anchored, hazardous and combustible materials and other miscellaneous debris have been removed from the K-East building. Penetrations were covered or isolated to prevent water and biological intrusion. Below-grade openings in the basement, the water tunnels, exhaust air duct, and other penetrations were isolated by filling the openings with concrete. Ground-level and above-ground openings were covered with steel plate or siding panels. 105-KE originally had 20 horizontal control rods (HCRs). Thirteen have been removed. Three of the remaining seven rods have been determined to potentially be an experimental version with Inconel cladding instead of aluminum.

The existing soil grading exposes the exterior of the reactor building to a depth of approximately 16 ft to 21 ft below grade. The floor of the basin excavation pit is covered with approximately 2 ft of clean overburden for radiation shielding and to reduce contamination levels when backfill is resumed. A structural stability analysis was performed, and concluded that this configuration has adequate structural stability until the SSE construction resumes (currently scheduled for 2016). To facilitate construction of the SSE foundation, the excavation areas will be backfilled to grade level on all sides of the reactor building.

Figure F.3-4. K East Reactor Building (Personal photo, Eastern Side, June 2014)

The SSE will be a structurally independent building supported on a newly poured concrete foundation outboard of the existing K reactor building structure. No structural connection will be made to the existing building, and all roofing, siding, and structural steel will be left in place. The SSE will consist of a steel framework covered by sheet metal paneling (see Figures F.3-5 and F.3-6). This construction approach is expected to expose workers to fewer industrial, radiological, and waste management hazards while enclosing this reactor. A single entry door on the west side will normally be welded shut, but will provide access for the 5-year inspections. The SSE construction will enable potential use of the existing 30 ft by 30 ft rollup door in the reactor building south wall. This differs from previous reactor building ISS, where the building was sealed but a separate SSE was not constructed. Louvers installed on the entry door facilitate ventilation when preparing for the five-year inspections. Dedicated lighting will be provided along the inspection route.

Interim safe storage is expected to last until approximately 2068. The reactor block, including the thermal and biological shields, is of robust constructions and has shown little degradation after 50 years. Because the SSE will protect the reactor block from the elements, it is reasonable to expect that the reactor will remain structurally sound for the duration of ISS. The current configuration requires surveillance at least annually. Following construction of the SSE, the building will be inspected at five year intervals until final demolition. Surveillance and maintenance activities involve periodic walk downs to identify and correct any unfavorable condition affecting structure integrity, storage stability, or potential dispersal of contamination.

Figure F.3-5. Structured Steel Frame

Figure F.3- 6. Interim Safe Storage Enclosure

OPERATING FACILITIES

Not Applicable

ECOLOGICAL RESOURCES SETTING

Landscape Evaluation and Resource Classification:

The amount and proximity of biological resources to the two reactors in the EU was examined within two adjacent landscape buffer areas; each landscape buffer area is defined by a circle radiating approximately 146 m from the geometric center of each reactor (equivalent to 27.8 acres for the two buffer zones combined). Most of the EU the adjacent landscape buffer areas consist of level 0 biological resources—94.2% of the combined total area. The adjacent landscape buffer area includes a small area designated as resource level 4. The level 4 area is a species resource and is considered a level 4 resource because it intersects a designated buffer zone for a bald eagle (*Haliaeetus leucocephalus*) roosting area at the river's edge close to the northwest corner of the 100-K Area.

Field Survey:

The 100-K East and West Reactors EU and adjacent habitat were evaluated by vehicle and pedestrian surveys in October 2014. The EU consists entirely of built structures and graveled and concrete surfaces and no field measurements of vegetation were made. Some sparse Russian thistle (Salsola tragus) was noted around the periphery of parking areas and graveled slopes. No wildlife was observed at the reactors during the October survey. Data collected during an ECAP survey of 100-K Area buildings notes various bird species using the reactors buildings at that time. Much of the infrastructure around the reactors has been removed since that survey was completed, and the available nesting/perching areas that were used by birds likely no longer exist.

CULTURAL RESOURCES SETTING

Cultural resources documented within the K Area Reactors EU include five Manhattan Project/Cold War Era Landscape resources (4 with individual documentation required, 1 with no individual documentation required). In accordance with the 1998 *Hanford Site Manhattan Project and Cold War Era Historic*

*District Treatment Plan (*DOE/RL-97-56), all documentation requirements have been completed for properties contributing to the Manhattan Project and Cold War era historic district. No other archaeological resources or TCPs are known to be recorded within the EU.

A small portion of the K Area Reactors EU has been inventoried for archaeological resources. Remediation of waste sites within the K Area Waste Sites Evaluation Unit has been addressed by a NHPA Section 106 review. There are 10 archaeological sites within 500 meters of the EU: 4 archaeological sites (3 eligible and 1 unevaluated) represent the Native American Pre-contact and Ethnographic landscape; 1 archaeological site (eligible) represents the Pre-Hanford Early Settlers/Farming landscape, 3 archaeological sites (1 eligible, 1 not eligible, and 1 unevaluated); and 2 isolates (2 not eligible) represent the Manhattan Project/Cold War era landscape.

The geomorphologic composition of the EU, historic map, and modern aerial imagery all suggest low potential for subsurface intact archaeological resources in EU. 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) may need to occur. Consultation with Hanford Tribes may also 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

CONTAMINATION WITHIN PRIMARY EU SOURCE COMPONENTS

Legacy Source Sites

Not Applicable

High Level Waste Tanks and Ancillary Equipment

Not Applicable

Vadose Zone Contamination

Not Applicable

Groundwater Plumes

Facilities for D&D

The radiological materials in the K Reactor Buildings are located within the reactor blocks. See Table F.3-2 for estimates of the radiological inventory in the KE Reactor decayed to September 2009. The KW Reactor inventory (also decayed to 2009) is very similar[7].

[7] CH2MHill Plateau Remediation Company, *Final Hazard Categorization for Surveillance, Maintenance and Various D4 Activities for the I05-KW Reactor, KBC-39764, Rev. 1*, prepared for U.S. Department of Energy, Assistant Secretary for Environmental Management, May 28, 2010 [OUO Document]

Table F.3-2. 105-KE Reactor Building Radiological Inventory Estimates[8]

Nuclide	Total (Ci)	Nuclide	Total (Ci)
^{3}H	7,532	^{154}Eu	3.0
^{14}C	6,979	^{241}Pu	2.3
^{63}Ni	2,450	^{94}Nb	1.7
^{60}Co	764.5	^{235m}U	1.0
^{36}Cl	54.0	^{239}Pu	1.0
^{59}Ni	22.0	^{241}Am	0.4
^{137}Cs	17.1	^{93}Mo	0.3
^{137m}Ba	16.1	^{240}Pu	0.3
^{41}Ca	16.0	^{133}Ba	0.2
^{152}Eu	11.9	^{238}Pu	0.1
^{93}Zr	11.0	^{108m}Ag	0.04
^{93m}Nb	7.1	^{99}Tc	0.03
^{90}Sr	5.8	^{108}Ag	0.003
^{90}Y	5.8		

In addition, there is a fixed contamination area on the lower part of the north exterior wall of the K-East Reactor Building of approximately 864 sq. ft. and has been covered with Polymeric Barrier System (PBS) fixative. The contamination extends from the original ground level down to approximately 16 ft below grade and will be covered when the basin excavation pit is backfilled for SSE construction. It is postulated that, when the discharge chute was removed as authorized under KBC-39834, the excavator bucket transferred contamination from the contaminated soil below to the chipped surface of the remaining grout monolith (the chute was removed by chipping with an excavator). The area of concern was limited to the cut off portion of the discharge chute. An estimate of the highest levels of contamination on the exterior wall was developed by CH2MHill based on the assumption that it came from a transfer of soil.

Table F.3-3. Building Exterior Contamination

Nuclide	Total Ci
137Cs	0.752
90Sr	0.335
239/240Pu	0.033
241Am	0.033

As indicated above, the soils below this chute area were found to be contaminated, which could have been caused by the excavator equipment during removal of the discharge chute (the chute was removed by chipping with an excavator), and/or leakages occurred through spaces between the chute and connecting building wall. The soils were excavated to 15 ft below grade and removed. Two feet of

[8] CH2MHill Plateau Remediation Company, *Final Hazard Categorization for Interim Safe Storage of 105-KE Reactor Building*, DD-49580, Revision 1, EDC#: ECR-13-000396, for U.S. Department of Energy, Assistant Secretary for Environmental Management, November 12, 2013.

fill was applied, and it is unclear at this time as to whether additional remediation of the exterior wall and/or soils below 15 ft. will be required.

Detailed inventories are provided in Table F.3-2, Table F.3-3, and Table F.3-4. All values are to 2 significant figures. The source document should be consulted for greater precision data. The sum for each primary contaminant is shown in the first row. Table F.3-7 provides a summary of the evaluation of threats to groundwater as a protected resource from saturated zone and remaining vadose zone contamination associated with the evaluation unit.

Operating Facilities

Not Applicable

Table F.3-4. Inventory of Primary Contaminants[(a)]

WIDS	Description	Decay Date	Ref	Am-241 (Ci)	C-14 (Ci)	Cl-36 (Ci)	Co-60 (Ci)	Cs-137 (Ci)	Eu-152 (Ci)	Eu-154 (Ci)	H-3 (Ci)	I-129 (Ci)
All	Sum			0.84	14000	110	1500	35	24	5.9	15000	NP
	Building Exterior	2009	Foot-note 8	0.033	NP	NP	NP	0.75	NP	NP	NP	NP
105KE	Process Building	2009	Foot-note 8	0.4	7000	54	760	17	12	3	7500	NP
105KW	Process Building	2009	See text	0.4	7000	54	760	17	12	3	7500	NP

a. NP = Not present at significant quantities for indicated EU

Table F.3-5. Inventory of Primary Contaminants (cont)[(a)]

WIDS	Description	Decay Date	Ref	Ni-59 (Ci)	Ni-63 (Ci)	Pu (total) (Ci)	Sr-90 (Ci)	Tc-99 (Ci)	U (total) (Ci)
All	Sum			44	4900	7.4	12	0.066	2
	Building Exterior	2009	Foot-note 8	NP	NP	0.033	0.34	NP	NP
105KE	Process Building	2009	Foot-note 8	22	2500	3.7	5.7	0.033	1
105KW	Process Building	2009	See text	22	2500	3.7	5.7	0.033	1

a. NP = Not present at significant quantities for indicated EU

Table F.3-6. Inventory of Primary Contaminants (cont)[(a)]

WIDS	Descrip-tion	Ref[(b)]	CCl4 (kg)	CN (kg)	Cr (kg)	Cr-VI (kg)	Hg (kg)	NO3 (kg)	Pb (kg)	TBP (kg)	TCE (kg)	U (total) (kg)
All	Sum		NP	NP	NP	NP	NP	NP	NP	NP	NP	NP
	Building Exterior	Foot-note 8	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP
105KE	Process Building	Foot-note 8	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP
105KW	Process Building	See text	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP

a. NP = Not present at significant quantities for indicated EU

Table F.3-7. Summary of the Evaluation of Threats to Groundwater as a Protected Resource from Saturated Zone (SZ) and Remaining Vadose Zone (VZ) Contamination associated with the Evaluation Unit

PC	Group	WQS	Porosity[a]	K_d (mL/g)[a]	ρ (kg/L)[a]	VZ Source M^{Source}	SZ Total M^{SZ}	Treated[c] M^{Treat}	VZ Remaining M^{Tot}	VZ GTM (Mm³)	VZ Rating[d]
C-14	A	2000 pCi/L	0.18	0	1.84	---	---	---	---	---	ND
I-129	A	1 pCi/L	0.18	0.2	1.84	---	---	---	---	---	ND
Sr-90	B	8 pCi/L	0.18	22	1.84	3.35E-01 Ci	---	---	3.35E-01 Ci	1.85E-01	ND[e]
Tc-99	A	900 pCi/L	0.18	0	1.84	---	---	---	---	---	ND
CCl4	A	5 µg/L	0.18	0	1.84	---	---	---	---	---	ND
Cr	B	100 µg/L	0.18	0	1.84	---	---	---	---	---	ND
Cr-VI	A	10 µg/L[(b)]	0.18	0	1.84	---	---	---	---	---	ND
TCE	B	5 µg/L	0.18	2	1.84	---	---	---	---	---	ND
U(tot)	B	30 µg/L	0.18	0.8	1.84	---	---	---	---	---	ND

a. Parameters obtained from the analysis provided in Attachment 6-1 to Methodology Report.

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

c. Treatment amounts from the 2013 Hanford Annual Groundwater Report (DOE/RL-2014-32, Rev. 0).

d. Groundwater Threat Metric rating based on Table 6-3, Methodology Report.

e. There is insufficient Sr-90 inventory to support a plume relative to decay. However, it is noted that Sr-90 has been measured in the groundwater above the DWS and has a shoreline impact. Thus, it is possible for a very small amount to move through the groundwater to the Columbia River.

PART VI. POTENTIAL RISK/IMPACT PATHWAYS AND EVENTS

CURRENT CONCEPTUAL MODEL

Narrative description of pathways and barriers to receptors and conditions/events that can lead to completed pathways

Pathways and Barriers: (1. description of institutional, natural and engineered barriers (including material characteristics) that currently mitigate or prevent risk or impacts, 2. Time scale from loss of each barrier to realization of risk or impacts)

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?*

The Hazards Analysis DD-49581 prepared by CHPRC on K-East identified two primary hazardous scenarios:

- Seismic event impacting reactor building (evaluated because most radiological material is not dispersible based on form and distribution; a reduced ARF x RF applies for the dispersible remainder; and an FHC is needed to reduce the HC to below HC-3).
- Fuel fire engulfing fixed contamination on K-East Reactor Building exterior (combustible fixative causes an increase in ARF x RF that must be addressed with an FHC).

An evaluation of the ability of the graphite stacks of the 105-KE and 105-KW Reactors to withstand an earthquake of Zone 2 intensity (i.e., horizontal acceleration of 0.1 g) was performed in 1953. It was concluded that the graphite stack of the 105-KE and 105-KW Reactors could withstand a Zone 2 earthquake with negligible damage even if considerable distortion of the stack occurred via graphite growth. The arrangement of the graphite stack, cast iron thermal shield, and concrete biological shield limits the movement of the graphite and cast iron to central bowing (from front to rear) during an earthquake. The evaluation also determined that an accompanying 0.41 g vertical acceleration (assuming a 0.1 g horizontal acceleration) would be necessary for slippage to occur at the cast iron-graphite interface at the top of the stack. Finally, the evaluation concluded that the likelihood of the stack ever being vibrated at its resonant frequency is not likely to occur. Similar opinions on the seismic stability of the Hanford Reactors were made in BHI-01172 and specifically with K-West in KBC-39764 Rev 1 [OUO doc] and K-East in DD-49580.

The Hazard Analysis postulates that a fuel fire at K-East occurring during SSE construction, S&M, or well drilling activities could ignite the Polymeric Barrier System (PBS) fixative covering the FCA on the lower north exterior wall. It concluded that the PBS would be consumed by the fire and some fixed contamination is released. The analysis concluded that a fire engulfing the FCA would be considered a below-HC-3 event. Thus, only low consequences are estimated.

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

The K-East Reactor Building is currently managed as below Hazard Category 3 for limited deactivation and decommissioning activities under DD-49580, *Final Hazard Categorization for Interim Safe Storage of 105-KE Reactor Building* and at K-West for authorized surveillance and maintenance activities under KBC-39764*, Final Hazard Categorization for Surveillance, Maintenance and Various D4 Activities for the 105-KW Reactor*. The 105-KW Basin is currently managed as an HC-2 facility, with only sludge and potentially a small amount of fuel. The sludge is stored in the Sludge Containerization System and in Integrated Water Treatment System equipment (e.g., settler tubes). The KW fuel storage basin is addressed is a separate EU risk analysis document. All hazards specific to Interim Security & Maintenance (current activities) and the proposed Safe Storage Enclosure Construction and Interim Safe Storage S&M at K-West have been determined by CHPRC to be Risk Bin III or lower, which require protection by Safety Management Programs, or Risk Bin IV which does not require controls. No scenarios were identified as presenting significant hazards to the facility worker. No hazardous events were identified that require the designation of safety significant controls to protect the Facility Worker from prompt death, serious injury, or the uncontrolled release of chemical or radiological materials.

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

The low relative risk of S&M activities is primarily maintained by passive barriers (e.g., the thermal and biological shields surrounding the reactor core) and contractor/DOE work control processes and safety management programs.

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?*

The reactor buildings are concrete and structural steel multistory structures (approximately 275 ft by 213 ft by 107 ft). The construction includes reinforced concrete and transite siding and reinforced concrete or corrugated transite paneled roofs with built-up asphalt and gravel surfacing. The reactor block is located near the center of the building. Most of the equipment not permanently anchored, hazardous and combustible materials and other miscellaneous debris have been removed from the building. Penetrations were covered or isolated to prevent water and biological intrusion. Below-grade openings in the basement, the water tunnels, exhaust air duct, and other penetrations were isolated by filling the openings with concrete. Ground-level and above-ground openings were covered with steel plate or siding panels. 105-KE originally had 20 horizontal control rods (HCRs). Thirteen have been removed. Three of the remaining seven rods have been determined to potentially be an experimental version with Inconel cladding instead of aluminum.

The fixed contamination area on the lower part of the north exterior wall of the K-East Reactor Building covers approximately 864 sq. ft. and has been covered with Polymeric Barrier System (PBS) fixative.

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

Hazard Analysis DD-49581 identified two primary hazardous scenarios at K-East:

- Seismic event impacting reactor building (evaluated because most radiological material is not dispersible based on form and distribution; a reduced ARF x RF applies for the dispersible remainder; and an FHC is needed to reduce the HC to below HC-3).
- Fuel fire engulfing fixed contamination on reactor building exterior (combustible fixative causes an increase in ARF x RF that must be addressed with an FHC).

However, an evaluation has been made of the seismic stability for the K Reactors (0100X-CA-C0027, Seismic Stability Evaluation of 100K Reactor Blocks - “KE” and “KW”). The stability calculation verified that the reactor block structure has adequate strength and foundation base anchorage to withstand the overturning and sliding effects caused by seismic force. The stability calculations concluded that the insignificantly small deflections of the block ensure that any potential for dislodging the top biological shield is nonexistent. Hence, the reactor block is a rigid structure and is stable against both the horizontal and vertical seismic forces defined for existing Performance Category 3 structures.

The Hazards Analysis concluded that the PBS on the external wall of K-East would be consumed by the fire with some fixed contamination is released. The analysis concluded that a fire engulfing the FCA would be considered a below-HC-3 event. The analysis did not consider the possibility of a massive flood caused by a seismic event destroying one or more upstream Columbia River dams.

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

The primary pathway would be an airborne release of radioactive materials, however both potential incidents would have a low probability of occurrence or impact.

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

Neither event is expected to cause human exposure or impacts to resources.

8. *Are there current on-going releases to the environment or receptors?*

None

POPULATIONS AND RESOURCES CURRENTLY AT RISK OR POTENTIALLY IMPACTED

Facility Worker

All hazards specific to Interim Security & Maintenance (current activities) at K-East have been determined to be Risk Bin III or lower, which require protection by Safety Management Programs, or Risk Bin IV which does not require controls. No scenarios were identified as presenting significant hazards to the facility worker. The hazard analysis team utilized a checklist / key word / what-if process to identify and then evaluate specific hazards. None of the hazardous events were assigned greater than Low consequences for the Offsite Public or Collocated Worker. Correspondingly, there were no hazardous events assigned to Risk Bins I or II. No hazardous events were identified that require the designation of safety significant controls to protect the Facility Worker from prompt death, serious injury, or the uncontrolled release of chemical or radiological materials.

Similar DSA or Hazard Analysis findings were not available for K-West S&M activities.

Co-located Person

See Facility Workers above

Public

See Facility Workers above

Groundwater

Hexavalent chromium is the primary groundwater contaminant underlying the 100-K Area (100-KR-4 OU). Remediation of the chromium is being conducted under the Interim Action Record of Decision for the 100-KR-4 Operable Units. However, no contaminants in this EU are associated with a groundwater plume.

The bulk of the inventory for this EU is contained in the reactor cores inside the buildings and is not expected to impact either the groundwater or the Columbia River.

It is noted that Sr-90 has been measured in the groundwater above the DWS and has a shoreline impact. Thus, it is possible for a very small amount to move through the groundwater to the Columbia River. However, there is insufficient Sr-90 inventory exterior to the building to support a plume relative to decay. This leads to an ND rating.

Columbia River

No groundwater plume is expected from this EU. Thus, there is no impact on the Columbia River, leading to a ND rating.

Ecological Resources

- Deconstruction and decommissioning of the KE/KW reactors would not be expected to result in loss of any additional habitat at the EU. All habitat resources are level 0.
- Previous surveys noted nesting birds associated with the reactor buildings; however it is not evident that the infrastructure and building features that supported nesting are still in existence.
- Remediation actions taken for this EU are not expected to impact habitat connectivity within the adjacent landscape.
- A portion of the adjacent landscape buffer area for the 100-K west reactor is relatively near (within 400 meters) an active bald eagle roost site. Noise and construction activities associated with deconstruction and decommissioning could potentially influence eagle use of the roost.

Cultural Resources

- There are no known TCPs within the EU.
- No archaeological resources have been documented in the EU.
- Five Manhattan Project/Cold War Era resources are located within the Evaluation Unit (4 with individual documentation required, 1 with no individual documentation required). Mitigation for contributing buildings/structures has been completed as per the *Hanford Site Manhattan Project and Cold War Era Historic District Treatment Plan* (DOE/RL-97-56) and building demolition is ongoing.

Name	Description
105KE	Reactor Building
105KW	Reactor Building and Process Water Tunnels
107KW	Effluent Water Retention Basin
116KW	Reactor Exhaust Stack
119KW	Exhaust Air Sampling Building

Archaeological sites and TCPs located within 500 meters of the EU

- There are no documented TCPs located within 500 meters of the EU.
- Ten additional cultural resources have been documented within 500-meters of the EU. These resources include archaeological sites and isolates representing the Native American Pre-contact and Ethnographic, Pre-Hanford Early Settlers/Farming and Manhattan Project/Cold War era cultural landscapes.
    - Four archaeological sites (3 eligible and 1 unevaluated) represent the Native American Pre-contact and Ethnographic landscape.
    - One archaeological site (eligible) represents the Pre-Hanford Early Settlers/Farming landscape.
    - Three archaeological sites (1 eligible, 1 not eligible and 1 unevaluated) and 2 isolates (2 not eligible) represent the Manhattan Project/Cold War era landscape.

Closest Recorded TCP

- Known TCPs exist in the vicinity of the EU.

CLEANUP APPROACHES AND END-STATE CONCEPTUAL MODEL

Selected or Potential Cleanup Approaches

A safe storage enclosure (SSE) will be constructed over the two reactor buildings. It will be a structurally independent building supported on a newly poured concrete foundation outboard of the existing K-Reactor Building structures. No structural connection will be made to the existing building, and all roofing, siding, and structural steel will be left in place. The SSE will consist of a steel framework covered by sheet metal paneling (see Figures F.3-4 and F.3-5). This construction approach is expected to expose workers to fewer industrial, radiological, and waste management hazards while enclosing this reactor. Reroofing the reactor, as has been done at previous reactors, might have required extensive wall and ceiling bracing from inside the reactor, where workers would face potential radiation exposure.

A single entry door on the west side will normally be welded shut, but will provide access for the 5-year inspections. The SSE construction will enable potential use of the existing 30 ft by 30 ft rollup door in the reactor building south wall. This differs from previous reactor building ISS, where the building was sealed but a separate SSE was not constructed. Louvers installed on the entry door facilitate ventilation when preparing for the five-year inspections. Dedicated lighting will be provided along the inspection route.

This interim safe storage (ISS) is expected to remain until approximately 2068. The reactor block, including the thermal and biological shields, is of robust construction, and according to a CHPRC analysis it has shown little degradation after 50 years. Because the SSE will protect the reactor block from the elements, it is reasonable to expect that the reactor will remain structurally sound for the duration of ISS. The current configuration requires surveillance at least annually. Following construction of the SSE, the building will be inspected at five year intervals until final demolition. Surveillance and maintenance activities involve periodic walk downs to identify and correct any unfavorable condition affecting structure integrity, storage stability, or potential dispersal of contamination. Pending resumption of SSE construction, interim S&M will be conducted to ensure the reactor building condition remains as described in the April 2013 Hazard Analysis.

In or about 2068, DOE has proposed to demolish the SSE and the remaining reactor shell around the reactor block, followed by a one-piece removal of the reactor block that would be transported to ERDF for permanent disposal. The reactor block includes the graphite core, the thermal and biological shields, and the concrete base. Contaminated structural surfaces would also be removed, packaged, and also transported to the ERDF for disposal. Noncontaminated material and equipment could be released for salvage, in compliance with applicable policies and procedures, or disposed of in place or in an ordinary landfill. The site would be backfilled, graded, seeded and released for other DOE use. Dismantlement of the KE reactor would take about 3 years.

Contaminant Inventory Remaining at the Conclusion of Planned Active Cleanup Period

The reactor block will still be intact in 2068 and thus contain the current contaminant inventory. But the passage of nearly 100 years since the reactor was operational will allow adequate time for the decay of short and intermediate-half-life radionuclides, such as cobalt-60 (5.27 year half-life) and Tritium (12 yr. half- life), thus reducing the potential occupational dose rate to workers at that time.

Risks and Potential Impacts Associated with Cleanup

All hazards specific to the proposed Safe Storage Enclosure Construction and Interim Safe Storage S&M at K-East were determined to be Risk Bin III or lower, which require protection by Safety Management Programs, or Risk Bin IV which does not require controls. No scenarios were identified as presenting significant hazards to the facility worker. The hazard analysis team utilized a checklist / key word / what-if process to identify and then evaluate specific hazards. None of the hazardous events were assigned greater than Low consequences for the Offsite Public or Collocated Worker. Correspondingly, there were no hazardous events assigned to Risk Bins I or II. No hazardous events were identified that require the designation of safety significant controls to protect the Facility Worker from prompt death, serious injury, or the uncontrolled release of chemical or radiological materials.

In or about 2068, DOE has proposed to demolish the two SSE structures and the remaining reactor shells around the reactor blocks, followed by a one-piece removal of the reactor block that would be transported to ERDF for permanent disposal. The Supplemental EIS[9] estimated that the occupational radiation dose for completing this process at all eight reactors would aggregate 51 person-rems, or an average of less than 7 rems. Possibly a greater risk may be an accident in transporting the reactor block and other materials to ERDF, since it was estimated that 140 truck trips would be involved.

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

Facility Worker

See above

Co-located Person

See above

Public

See above

Groundwater

The bulk of the inventory for this EU is contained in the reactor cores inside the buildings and is not expected to impact either the groundwater or the Columbia River.

It is noted that Sr-90 has been measured in the groundwater above the DWS and has a shoreline impact. Thus, it is possible for a very small amount to move through the groundwater to the Columbia River. However, there is insufficient Sr-90 inventory exterior to the building to support a plume relative to decay. This leads to an ND rating.

Columbia River

No groundwater plume is expected from this EU. Thus, there is no impact on the Columbia River, leading to a ND rating.

Ecological Resources

No ecological resources are in this EU, and thus there are no effects.

Cultural Resources

Personnel, car, and truck traffic on paved roads as well as use of heavy equipment will not have any direct impact on archaeological resources because there is no disturbance to soil/ground or alteration to the landscape. Assuming heavy equipment locations 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 locations and staging areas have not been cleared, this could result in artifact breakage and

[9]U.S. Department of Energy, *Decommissioning of Eight Surplus Production Reactors at the Hanford Site, Richland, Washington, Supplemental Analysis*, DOE/EIS-0119F-SA-01, July 2010.

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 paved roads located on TCP, direct effects include visual, auditory and vibrational alterations to landscape/setting. Heavy equipment 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. Revegetation activities may cause direct effects to TCPs include 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, car, and truck traffic on paved roads as well as use of heavy equipment 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. Existing road causes no alteration to 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. 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

The existing soil grading exposes the exterior of the K-East Reactor Building to a depth of approximately 16 to 21 ft below grade on three sides. The floor of the basin excavation pit on the north side is covered with approximately 2 ft of clean overburden for radiation shielding and to reduce contamination levels when backfill is resumed. A structural stability analysis was performed, and concluded that this configuration has adequate structural stability until the SSE construction resumes (currently scheduled for 2016). A delay beyond 2016 may require temporary filling of these areas to retain structural stability of the exposed building, as well to prevent residual contaminates in the exposed soils from migrating toward groundwater.

In addition, long delays in constructing the SSEs over each of the K-East and K-West Reactor buildings could cause a loss of building envelope integrity such that precipitation and animals can infiltrate. There is also the potential for building decay and spread of hazardous materials such as contamination that could complicate further cleanup.

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

Populations and Resources at Risk or Potentially Impacted After Cleanup Actions (from residual contaminant inventory or long-term activities)

These responses are for the period between construction of the SSE and some date in the future when the SSE and reactor building would be dismantled. There is no information on how those final cleanup actions would impact these different receptors.

Table F.3-8. Populations and Resources at Risk

Population or Resource		Risk/Impact Rating	Comments
Human	Facility Worker	ND-Low	Other than periodic inspections of the SSE, no workers will be present.
	Co-located Person	ND	None
	Public	ND-Low	Public access will be prevented by physical barriers and institutional controls
Environmental	Groundwater	ND	The bulk of the inventory for this EU is contained in the reactor cores inside the buildings and is not expected to impact either the groundwater or the Columbia River. It is noted that Sr-90 has been measured in the groundwater above the DWS and has a shoreline impact. Thus, it is possible for a very small amount to move through the groundwater to the Columbia River. However, there is insufficient Sr-90 inventory exterior to the building to support a plume relative to decay. This leads to an ND rating.
	Columbia River	ND	No groundwater plume is expected from this EU. Thus, there is no impact on the Columbia River, leading to a ND rating.
	Ecological Resources*	ND-Low	Any risk depends upon the quality and quantity of re-vegetation following remediation. Could be a risk from invasion of exotic species.
Social	Cultural Resources*	**Native American:** Direct: Known Indirect: Known **Historic Pre-Hanford:** Direct: Known Indirect: Known **Manhattan/Cold War**: Direct: None Indirect: None	Permanent direct and indirect effects are possible due to high sensitivity of area.

*For both Ecological and Cultural Resources see Appendices J and K respectively for a complete description of Ecological Field Assessments and literature review for Cultural Resources.

Long-Term, Post-Cleanup Status – Inventories and Risks and Potential Impact Pathways

In or about 2068, DOE has proposed to demolish the SSE and the remaining reactor shell around the reactor block, followed by a one-piece removal of the reactor block that would be transported to ERDF for permanent disposal. Contaminated structural surfaces would also be removed, packaged, and also transported to the ERDF for disposal. Noncontaminated material and equipment could be released for salvage, in compliance with applicable policies and procedures, or disposed of in place or in an ordinary landfill. The site would be backfilled, graded, seeded and released for other DOE use. Dismantlement of each of the K Reactors would take about 3 years, after which the excavated area would be filled and revegetated.

Part VII. Supplemental Information and Considerations

Physical maintenance of K-East Reactor building structure should be priority if long delay expected in constructing SSE (holes in roof, etc.).

Increase current fill grade depth surrounding the three exposed sides of KE Reactor building if long delay expected in constructing SSE.

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APPENDIX F.4

PUREX (CP-DD-1, CENTRAL PLATEAU)
EVALUATION UNIT SUMMARY TEMPLATE

Table of Contents

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PART I. EXECUTIVE SUMMARY

EU LOCATION

200 East (Inner) Area

RELATED EUS

Other D&D Canyon Related Projects

PRIMARY CONTAMINANTS, CONTAMINATED MEDIA AND WASTES

The Plutonium-Uranium Extraction (PUREX) facility is one of the five plutonium process canyon facilities in the Hanford 200 area, and operated from 1953 to 1990. The PUREX deactivation project in 1995 removed, reduced, or stabilized the major radioactive sources and wastes within the main 202-A building. Liquids in equipment/tanks were flushed and emptied, or have a minimum heel remaining. Radioactive materials are primarily in the form of contaminated equipment and surfaces, dust, debris, sludge, with some remaining Pu metal and oxide dust in gloveboxes and deep bed filters. In 1996, four areas were identified as containing significant quantities of Plutonium: L-Cell, which is estimated to contain between 3 and 4 Kg of Pu in sludge on the floor; Deep-Bed filters #1 and #2, each containing 100-200 g of Pu; and N-Cell, which contains 1-2 Kg of Pu material in gloveboxes. The predominant radioactive contaminants of concern are the following: Cs^{137}, $Pu^{238\text{-}242}$, Sr^{90} and Am^{241}.

The deactivation project also removed, reduced, or stabilized the hazardous chemicals and waste. All bulk chemicals were removed, and only residual quantities remain. Various pieces of dangerous debris and equipment containing or contaminated with dangerous/mixed waste that had been on the PUREX Canyon Deck were removed and placed in PUREX Storage Tunnel #2. Some mixed waste and debris remains in storage in the PUREX Plant, and are considered to be managed in a containment building (F-Cell). These wastes consist of a steel open-top skid containing concrete chips from the floor of E-Cell.

In addition to the PUREX building, there are two railroad tunnels in which waste material was stored from 1956 to 2000. During deactivation some material from Building 324, including remote-handled mixed waste from B-Cell was placed in Tunnel #2. The equipment and other materials stored in the two Tunnels are heavily contaminated with Cs^{137} and Sr^{90}, as well as $Pu^{238\text{-}242}$ and Am^{241}. The Tunnels are designated as a Miscellaneous Unit for storage of mixed wastes by the State of Washington (WAC 173-303-680), and contain barium, cadmium, chromium, lead, mercury, lead, silver and silver salts, and mineral oil. The potential for ignition of the silver nitrates is considered negligible because this material is dispersed on ceramic packing and is physically isolated from contact with any combustible material or ignition source.

Based on the facility inventory and potential energy sources, all three facility segments (i.e. 202-A Building and ventilation system, Storage Tunnel No. 1 and No. 2) are categorized as Hazard Category 2 nuclear facilities. The primary contractor is CH2MHill Plateau Remediation Company (CMHPRC).

The PUREX site also includes a number of legacy crib-subsurface liquid disposal areas, several burial grounds and unplanned release-surface/near surface areas. No contaminant data is available for 100 of the 139 individual waste areas, and the aggregate amounts of each of Cs-137, Sr-90, C-14, H-3, I-129, U-232 to 238, and Pu-239 to 242 that are believed to be present across the 39 sites having data are estimated be in a range of from about 5E-04 to as little as 5E-09.

BRIEF NARRATIVE DESCRIPTION:

The PUREX complex is a nuclear fuel processing facility that was constructed between 1953 and 1955 and was operated until 1990 to chemically separate plutonium, uranium and neptunium from Hanford Site nuclear reactor fuel elements. Plutonium was recovered as an acidic solution of plutonium nitrate or was converted to plutonium oxide in N-cell. Various products were then transferred to the Plutonium Finishing Plant. Uranium was recovered as uranyl nitrate hexahydrate, which was transferred for further processing to the Uranium Trioxide Plant (U Plant). It quickly became the most efficient and largest processor of plutonium output, and when the REDOX Plant closed in 1967, PUREX became the sole, operating processing facility. Nearly 70% of Hanford's uranium was reprocessed through PUREX.

The main 202-A Building consists of three main structural components: a thick-walled, heavily shielded concrete portion called the canyon, which contains the former processing equipment; a section comprised of three gallery levels parallel to and isolated from the canyon; and a steel and transite annex to the north of the gallery section that houses offices, the laboratory, and a number of building service areas. The plant's canyon is approximately 860 feet long and 39.5 feet deep from floor to underside of the reinforced concrete cover blocks, and subdivided into a single row of 12 process cells paralleled on the south side by a hot (radioactive) pipe trench. An air tunnel lies directly below the pipe trench and exhausts the ventilation air from the individual cells (which in turn draws air from the canyon void above each cell and pipe trench cover blocks) to the main ventilation exhaust filters and from there to the main 291-A Stack. Adjoining the north wall of the building is a 750-foot long, 60-foot wide service area containing three control rooms (central, head end, and power unit), the PUREX process control laboratory, the aqueous make-up and storage area, and the acid concentration vault. An underground solvent storage and make-up facility was adjacent to the service side of the 202-A Building.

The PUREX Plant incorporated a unique feature for disposing of large pieces of radioactive solid waste, such as failed or outworn equipment. A 500-foot rail extension running southward was built onto the single-track rail tunnel that was used to bring irradiated slugs to the east end of the PUREX building. Between June 1960 and January 1965, eight railcars with radioactive equipment were pushed into the tunnel by a remote controlled electric engine. In 1964 a 1,700-foot tunnel was constructed to provide storage space for 40 railcars after the first tunnel had become full and was sealed. It currently contains 28 railcars of radioactively contaminated equipment.

In 1972, the PUREX Plant entered a temporary shutdown period, intended to be 18 months but which became 11 years. In 1983, the Plant reopened to process N Reactor fuel. Following a safety violation, it closed for about six weeks in 1988, and operated intermittingly until being placed in standby status in 1990. A final closure order was issued by DOE in December 1992. During 1995-1997 the PUREX Plant was brought to a safe, low-cost, low-maintenance deactivation status, and active facility systems are limited to electrical distribution, exhaust ventilation, instrumentation systems, and fire detection/alarms systems in 252-AB and 217-A buildings. Since the facility was placed into S&M, a new roof was placed over the canyon and aqueous makeup areas. According to a 2014 report[1] from the primary contractor CH2MHill Plateau Remediation Company (CHPRC), conditions in the facility have been relatively stable since deactivation with minor exceptions. Final D&D of the PUREX building is expected to be similar to the "Close in Place-Partially Demolished Structure" alternative chosen for the U Canyon.

The two PUREX Tunnels represent a short-term hazard and risk to an individual located 100 meters from the PUREX site boundaries ("CW") if the final D&D of the 202-A processing canyon building is delayed,

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[1] CH2MHill Plateau Remediation Company, *Plutonium-Uranium Extraction Facility Documented Safety Analysis, CP-14977 Revision 7*, for U.S. Department of Energy, Assistant Secretary for Environmental Management, September 25, 2014

because of their highly radioactive contents and intent to be used as "temporary" storage units. Tunnel #1, which contains similar total curies of Pu, Am^{241}, Cs^{137} and Sr^{90} as the 202-A canyon building (21,205 versus 29,304 curies) was constructed almost entirely of railroad ties in 1956. Ongoing degradation is occurring from continued exposure to the gamma radiation from equipment being stored there. It estimated that the strength of the timbers was 60% of original strength in 2001, and that a standard factor of safety will be breached about 2040. Tunnel #2 was constructed with stronger materials as additional temporary storage 10 years later, but it contains nearly 25 times the radiation of Tunnel #1 measured in curies (508,977 curies).

There are several D&D options for the rail cars and equipment in the two tunnels. One is to retrieve each rail car unit and dispose of it as part of the main building D&D, and a second is to grout the railcars and equipment in place and backfill the storage tunnels. An RI/FS Work Plan is scheduled to be submitted by DOE for EPA and Washington Ecology review in September 2015.

Summary Tables of Risks and Potential Impacts to Receptors

Table F.4-1 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 PUREX facility boundary; a Co-located Person (CP) is an individual located 100 meters from the PUREX boundary line; and Public is an individual located at the closest point on the Hanford Site boundary not subject to DOE access control, which in this instance is about 9.5 miles away. The nuclear related risks to humans are based on unmitigated (unprotected or controlled conditions) dose exposures expressed in a range of from Non-Discernable (ND) to Very High. The estimated mitigated exposure that takes engineered and administrative controls and protections into consideration, is shown in parenthesis.

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 Non-Discernable (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: No risk ratings are provided for Cultural Resources. The Table 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.

Table F.4-1. Risk Rating Summary (for Human Health, unmitigated nuclear safety basis indicated, mitigated basis indicated in parenthesis (e.g., "Very High" (Low)).

		Evaluation Time Periods	
		Active Cleanup (to 2064)	
Population or Resource		Current Condition - Surveillance & Maintenance	From Cleanup Actions - D&D
Human	Facility Worker	High (Low)	High (Low)
	Co-located Person	High (Low)	Medium (Low)
	Public	ND-Low (ND)	ND-Low (ND)
Environmental	Groundwater	Low	Low
	Columbia River	ND	ND
	Ecological Resources*	ND-Low	Low-Medium
Social	Cultural Resources*	**Native American:** Direct: Unknown Indirect: Known **Historic Pre-Hanford:** Direct: Unknown Indirect: None **Manhattan/Cold War**: Direct: Known Indirect: None	**Native American**: Direct: Unknown Indirect: Known **Historic Pre-Hanford**: Direct: Unknown Indirect: None **Manhattan/Cold War**: Direct: Known Indirect: None

*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.

SUPPORT FOR RISK AND IMPACT RATINGS FOR EACH TIME PERIOD

Human Health

Current

The PUREX physical boundary (see Figure F.4-4) includes the buildings/structures with greater than Hazard Category 3 inventory (identified as 202-A, Laboratory Annex, 203-A, 204-A, 211-A, 213-A, 214-A, 221-A, 271-AB, 276-A, 291-A, 291-AE, Storage Tunnels 1 and 2, deep-bed filters No. 1 and No. 2), and the yard area within the fence topped with concertina wire surrounding the facility to prevent public or inadvertent access. The only current planned activities consist primarily of S&M, which includes pre-approved activities for surveillance of the facility, preventative maintenance of selected equipment, and incidental storage of necessary supplies and equipment. The two tunnels are sealed and the stored equipment is not currently accessible.

Seismic Event: The highest risk in the facility's current condition is a seismic event that causes a catastrophic structural failure of the 202-A Building and PUREX Storage Tunnel Nos. 1 and 2. The Hazard Analysis does not provide a radiation dose consequence for the Facility Worker, but its binning of risks indicate that the Facility Worker would have the same risk rating as a Co-located Person.

Unmitigated Risks:

Building 202-A: Facility Worker – High; CP – High; Public – ND to Low

Tunnel #1: Facility Worker – High; CP – High; Public – ND to Low

Tunnel #2: Facility Worker – High; CP – High; Public – ND to Low

PUREX Site Total: Facility Worker – High; CP – High; Public – Low

Mitigation: This is a natural phenomenon hazard event for which there are no mitigation controls, however it is deemed to have an "unlikely" (10^{-2} to 10^{-4} per year) frequency that cannot be prevented from occurring. Applicable safety management and emergency response programs that reduce worker injury for these types of events include the work control process, hazardous material control program, and initial testing, in service surveillance, and maintenance program.

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

Fire in PUREX Tunnel #1: A fire is postulated in PUREX Storage Tunnel No. 1. The potential for a fire is considered due to the extensive use of timbers as storage tunnel structural material. It is assumed that the entire inventory of the storage tunnel is at risk. The scenario assumes that the resulting fire burns with sufficient energy to result in releasing material to the environment.

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

Mitigation: The storage tunnel is isolated with no access and the site's work control program, which includes a thorough Job Hazard Analysis, prohibit access to the storage tunnels, the combination of which reduce the likelihood of such an event. The DOE Hanford and contractor security and safety policies and procedures reduce the potential exposure risk of these events to the S&M worker and CP 100 meters from the PUREX boundaries to Low

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

Partial Roof Collapse Over Cells A, B and C: Use of a crane outside the facility or a moderate seismic event may result in a partial roof collapse. The east crane maintenance platform (ECMP) is a less robust structure than the remainder of the 202-A Building, a failure of the ECMP and adjoining roof structure is postulated from the crane drop. A moderate seismic event would cause the same damage. The failure is assumed to impact the three adjacent cells (A, B, and C) located in close proximity to the platform. The crane drop event impacting the 202-A Building is considered an "anticipated" event, while the seismic event is "unlikely."

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

Mitigation: There are limited authorized activities at these S&M facilities and control of any crane work on or around the 202-A Building by implementation of the applicable requirements of DOE/RL-92-36, *Hanford Site Hoisting and Rigging Manual,* will serve to reduce the potential for a crane drop event; particularly one that could result in the catastrophic failure of the entire structure.

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

Staged Waste Fire:

A hypothetical waste container with an inventory of 100 g of 239Pu is engulfed in a fire while being removed from the 202-A Building. The isotopic distribution is based on A-cell. This is a conservative assessment of the distribution of materials within the 202-A Building and results in the most conservative dose consequences.

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

Mitigation: No safety -significant or safety-class SSCs or TSRs are required to prevent or mitigate this event. However, because the inventory value is an assumed number and because of uncertainties regarding the actual staged TRU, an administrative TSR for inventory control is a prudent control selection for the designated waste staging area. Additional controls include commitment to the Radiological Control Program, Hazardous Material Control Program, and the Work Control Program

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

N-Cell Gloveline Fire:

The most significant fire hazard in the canyon building is the lubrication oil for the mechanical pulsers in the process cells. A potential fire in N-cell was deemed to have the greatest risk and potential consequences because of the residual inventory in the gloveboxes, potential combustibles, and potential ignition from S&M operations. The dry gloveline was selected because it is a single glovebox assembly that contains a significant portion of the total N-cell inventory.

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

Mitigation: Commitment to the Work Control Program, the Fire Protection Program, which includes combustible control, and the Radiological Control Program will ensure the safety of the activities.

Industrial Safety: The only current planned activities consist primarily of S&M, which includes pre-approved activities for surveillance of the facility, preventative maintenance of selected equipment, and incidental storage of necessary supplies and equipment. The two tunnels are sealed and the stored equipment is not currently accessible. These are all related to Low consequence accident risks. Industrial accidents would not have impact outside the PUREX boundaries (hence no risk to CP or Public). It should be noted that there were no accidents or injuries during the U Canyon D&D work. Reflecting the ability of DOE and its contractors to implement Integrated Safety Management and recognize hazards, prevent, and/or mitigate industrial accidents.

Risks and Potential Impacts from Selected or Potential Cleanup Approaches

The several radiological event scenarios identified with current S&M activities at the PUREX site would still likely be present during the early D&D phases of the building and tunnels, but the most serious consequences would diminish as contaminated areas and equipment are removed and/or grouted in place.

The radioactive material inventory remaining at the end of PUREX deactivation was primarily in the form of contaminated equipment and surfaces, dust and debris, located below the deck in the process cells, with some remaining plutonium and oxide dust stabilized in gloveboxes in N Cell. No workers are expected to enter the process Cells during D&D, except for possible further decontamination and disposition of the gloveboxes. A fixative would be applied to all equipment located on the deck surface before being moved into the cells and all workers would wear protective gear.

The D&D of the U Canyon is being used as a pilot for D&D of the other four canyons, and CHPRC has developed an extensive review of lessons learned that will benefit similar work carried out at PUREX in the future. Although the PUREX and U Plants are not identical with respect to their prior uses and levels of contamination, the two U Plant DSAs (HNF-13829 Revisions 4 [OUO Doc] and 5) provide discussions of some of the accidents or events that could cause radiological exposure to workers and co-located persons during D4 of the PUREX canyon facilities. The primary risks were determined to be a seismic event and accidents involving size reduction and waste management types of activities, that are required for the preparations for the canyon demolition but which could cause a fire.

Radiological, chemical and industrial related risks during D&D of the two tunnels should be low if the rail cars and equipment are grouted in place and the tunnel walls used as a permanent cover, since no workers will need to enter the tunnels and thus come into contact with the contaminants. The risk of seismic events and fire will still exist during this final D&D phase however.

Unmitigated Risks: Facility Worker – High; CP – Medium; Public – ND

Mitigation: The PUREX structures provide passive confinement of the significant residual contamination in the 202-A Building and Tunnels #1 and #2. Grouting of contaminated equipment in the cells and tunnels and application of a fixative to all above grade equipment should also reduce the PUREX facilities, like the U-Plant to less than HC-3. In addition, worker risks should be minimized through benefit of lessons learned from the D4 of the U-Plant and through contractor implemented safety management programs that include the work control process, hoisting and rigging requirements and the radiological protection program.

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

An RI/FS Work Plan for future D&D phases is scheduled to be submitted by DOE for EPA and Washington Ecology review in September 2015.

Ecological Resources

Current

The impacts on Ecological Resources would be generally Not Discernable (ND) because there are few ecological resources (5 % level 3 resources), Low because of possible contamination to ecological receptors on buffer area (31 % level 3 and 4 resources)

Risks and Potential Impacts from Selected or Potential Cleanup Approaches

There are few high level Ecological Resources in this EU (5 % level 3 resources), but low to medium in buffer area because of high value resources (nearly a third of area has level 3 and 4 resources).

Cultural Resources

Current

Manhattan Project/Cold War significant resources have already been mitigated. Area is heavily disturbed and even thought the entire area has not been inventoried for archaeological resources, it has very low potential to contact intact archaeological resources on the surface or subsurface. Traditional cultural places (e.g., Gable Mountain) are visible from EU.

Risks and Potential Impacts from Selected or Potential Cleanup Approaches

Area has not been investigated either on the surface or subsurface, archaeological investigations may need to occur within pockets of undisturbed land if any prior to remediation. Potential for intact archaeological material to be present is very low.

Considerations for timing of the cleanup actions

The PUREX building is being maintained in a safe low-maintenance condition and is surround by barbed wire fencing to prevent public or inadvertent access, and the two tunnels are sealed and the stored equipment is not currently accessible. There is however the ongoing risk of a seismic event causing damage to the building and/or tunnels. In addition, PUREX Tunnel 1 was constructed in 1956. Except for a 103 foot section one wall that is composed of 3 foot thick reinforced concrete, the remaining walls and roof of the 358 foot long tunnel were constructed using 12 inch by 14 inch creosoted No. 1 Douglas Fir timbers, arranged side by side with the 12 inch side exposed. The last evaluation of the structural integrity of the tunnel was made in May 1991 by Los Alamos Technical Associates (LATA). It concluded that there was very low probability of any degradation of the timbers due to decay or insect attack, but that there was ongoing degradation occurring from continued exposure to the gamma radiation from equipment being stored there. It estimated that the strength of the timbers would be 60% of their original strength in 2001. Applying the same formulas used in that analysis to the year 2014 would indicate that the timbers are currently at about 55% of their original strength. This study indicates that standard factor of safety will be breached about 2040.

Near-Term, Post-Cleanup Risks and Potential Impacts

The PUREX EU and surrounding areas are designated industrial-exclusive in the CLUP, with the intention of maintaining control of the residual contamination by the U.S. Federal Government, in perpetuity. The most probable D&D scenarios would clean-up the PUREX site so that its highly contaminated equipment and refuse is buried and grouted in place within the subsurface concrete canyon walls, and an engineered barrier constructed to cover the collapsed building structure to reduce water infiltration and the risk of human and biotic intrusion. Periodic inspection and maintenance would be required in perpetuity to maintain these barriers and Institutional controls would be required to protect the remedy and ensure that the potential for human exposure to contaminants is minimized by limiting land and resource use to industrial uses. The remediated area would be fenced (size not determined) in case future industrial construction in the 200 Area, includes nearby facilities.

PART II. ADMINISTRATIVE INFORMATION

OU AND/OR TSDF DESIGNATION(S)

200-CP-1

COMMON NAME(S) FOR EU

PUREX Building

KEY WORDS

D&D, Canyons, Tunnels

REGULATORY STATUS

Regulatory basis: The 1996 Agreement in Principle (DOE-RL1996) among the Tri-Parties of DOE, USEPA, and Washington State Department of Ecology established that the CERCLA Remedial Investigation/Feasibility Study process would be followed, on a case-by-case basis, to evaluate potential cleanup remedies and identify preferred alternatives for the final end state for the five major canyon buildings in the 200 Area of the Hanford Site. The 221-U Facility was selected as a pilot project for this effort.

Applicable regulatory documentation

Applicable Consent Decree or TPA milestones: Milestone M-085-02: requires submittal of a change package by 9/30/2015 to establish a schedule for submittal of the RI/ES Work Plans for the 200-CB-1 (B Plant), 200-CP-1 (PUREX), and 200-CR-1 (REDOX) Operable Units and a schedule for submittal of the Removal Action Work Plans for 224B and 224T Plutonium Concentration Facilities.

EU Designation: CP-DD-1 (PUREX)

Risk Review Evaluation Information

Completed (revised): June 23, 2015

Evaluated by: H. Mayer

Ratings/Impacts Reviewed by: M. Gochfeld, D. Kosson

PART III. SUMMARY DESCRIPTION

Current land use

Industrial

Designated future land use

Pursuant to the 1999 Record of Decision: Hanford Comprehensive Land-Use Plan Environmental Impact Statement (HCP EIS), the Central Plateau (200 Areas) geographic area is designated as Industrial-Exclusive (an area suitable and desirable for treatment, storage, and disposal of hazardous, dangerous, radioactive, nonradioactive wastes, and related activities).

Primary EU Source Components

Legacy Source Sites

The PUREX site includes a number of legacy crib-subsurface liquid disposal areas, several burial grounds and unplanned release-surface/near surface areas. No contaminant data is available for 100 of the 139 individual waste areas, and the aggregate amounts of each of Cs-137, Sr-90, C-14, H-3, I-129, U-232 to 238, and Pu-239 to 242 that are believed to be present across the 39 sites having data are estimated be in a range of from about 5E-04 to as little as 5E-09. See attached schedule of all legacy source sites by WIDS code which have known contaminant data.

High-Level Waste Tanks and Ancillary Equipment

Not Applicable

Groundwater Plumes

Groundwater in the 200 Area is contaminated from multiple sources and is being addressed separately by DOE.

D&D of Inactive Facilities

The PUREX deactivation project in 1995 removed, reduced, or stabilized the major radioactive sources and wastes within the main 202-A building. Liquids in equipment/tanks were flushed and emptied, or have a minimum heel remaining. Radioactive materials are primarily in the form of contaminated equipment and surfaces, dust, debris, sludge, with some remaining Pu metal and oxide dust in gloveboxes and deep bed filters. In 1996, four areas were identified as containing significant quantities of Pu: L-Cell, which is estimated to contain between 3 and 4 Kg of Pu in sludge on the floor; Deep-Bed filters #1 and #2, each containing 100-200 g of Pu; and N-Cell, which contains 1-2 Kg of Pu material in gloveboxes.

The predominant radioactive contaminants of concern are the following (with estimated current Curie levels): $Pu^{238-242}$ (871Ci), Am^{241} (1,210Ci), Cs^{137} (11,200Ci) and Sr^{90} (9,010Ci). In addition to the PUREX building, there are two railroad tunnels in which waste material was stored (1956-2000). During deactivation some material from Building 324, including remote-handled mixed waste from B-Cell was placed in Tunnel #2. The equipment and other materials stored in the two Tunnels are contaminated with $Pu^{238\text{-}242}$ (653Ci) and Am^{241} (785Ci), and especially Cs^{137} (347,300Ci) and Sr^{90} (180,240Ci). The Tunnels are designated as a Miscellaneous Unit for storage of mixed wastes by the State of Washington (WAC 173-303-680), and contain barium, cadmium, chromium, lead, mercury, lead, silver and silver salts, and mineral oil.

Operating Facilities

Not Applicable

Location and Layout Maps

Figure F.4-1. PUREX Plant and Tunnels Location Relative to AY Tank Farm and HLW Treatment Facilities in 200 Area

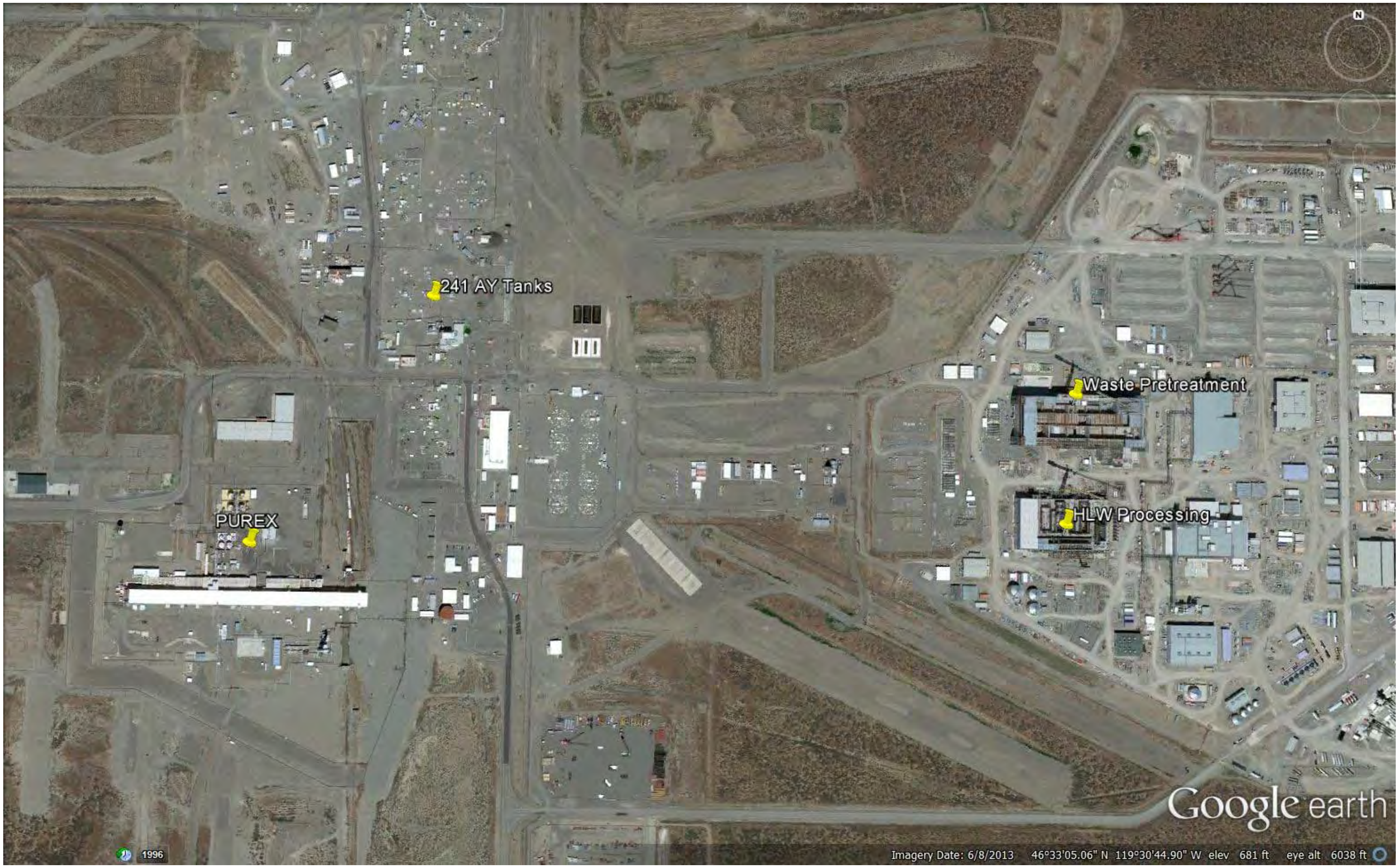


Figure F.4-2. PUREX Evaluation Unit

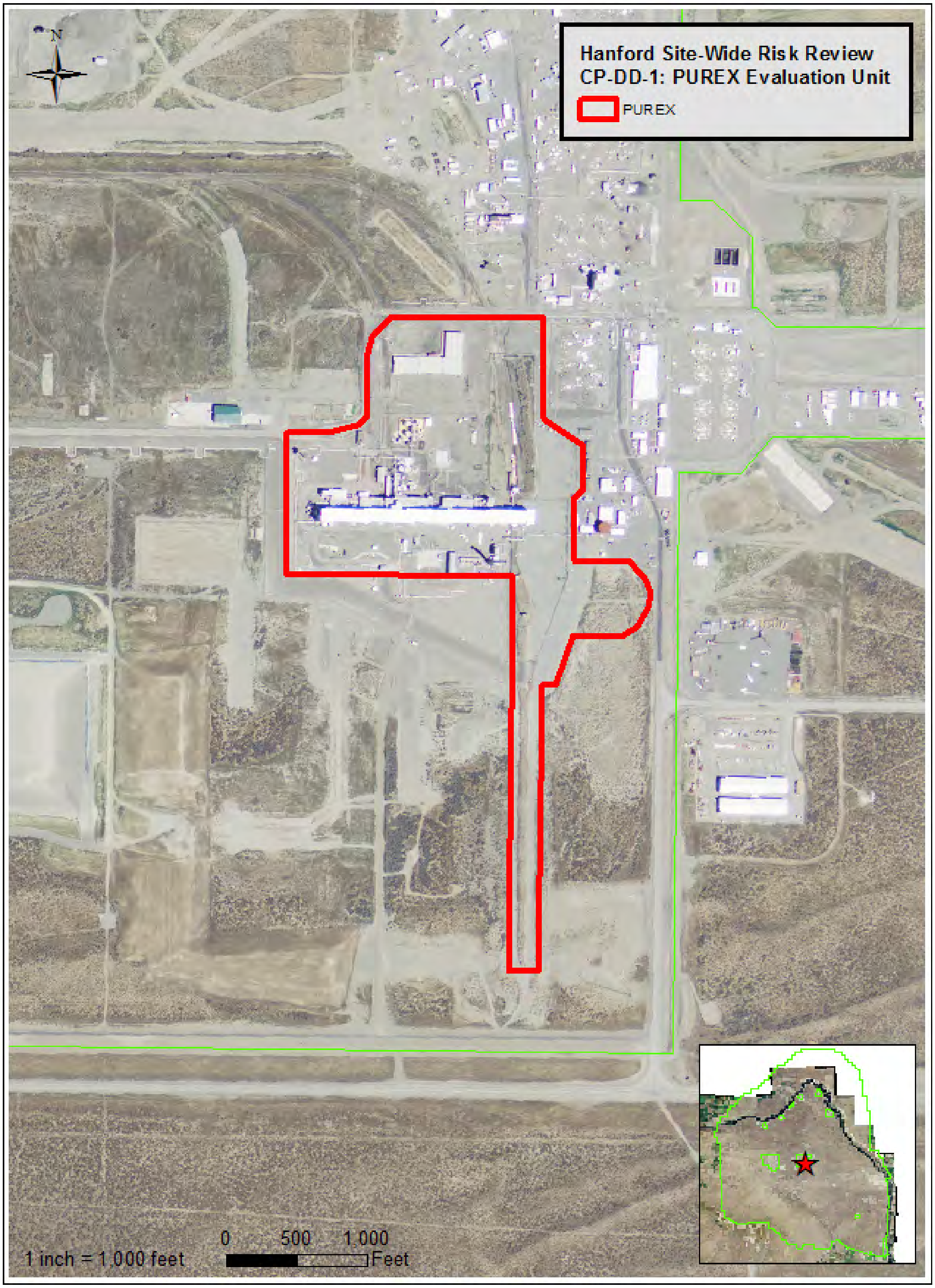
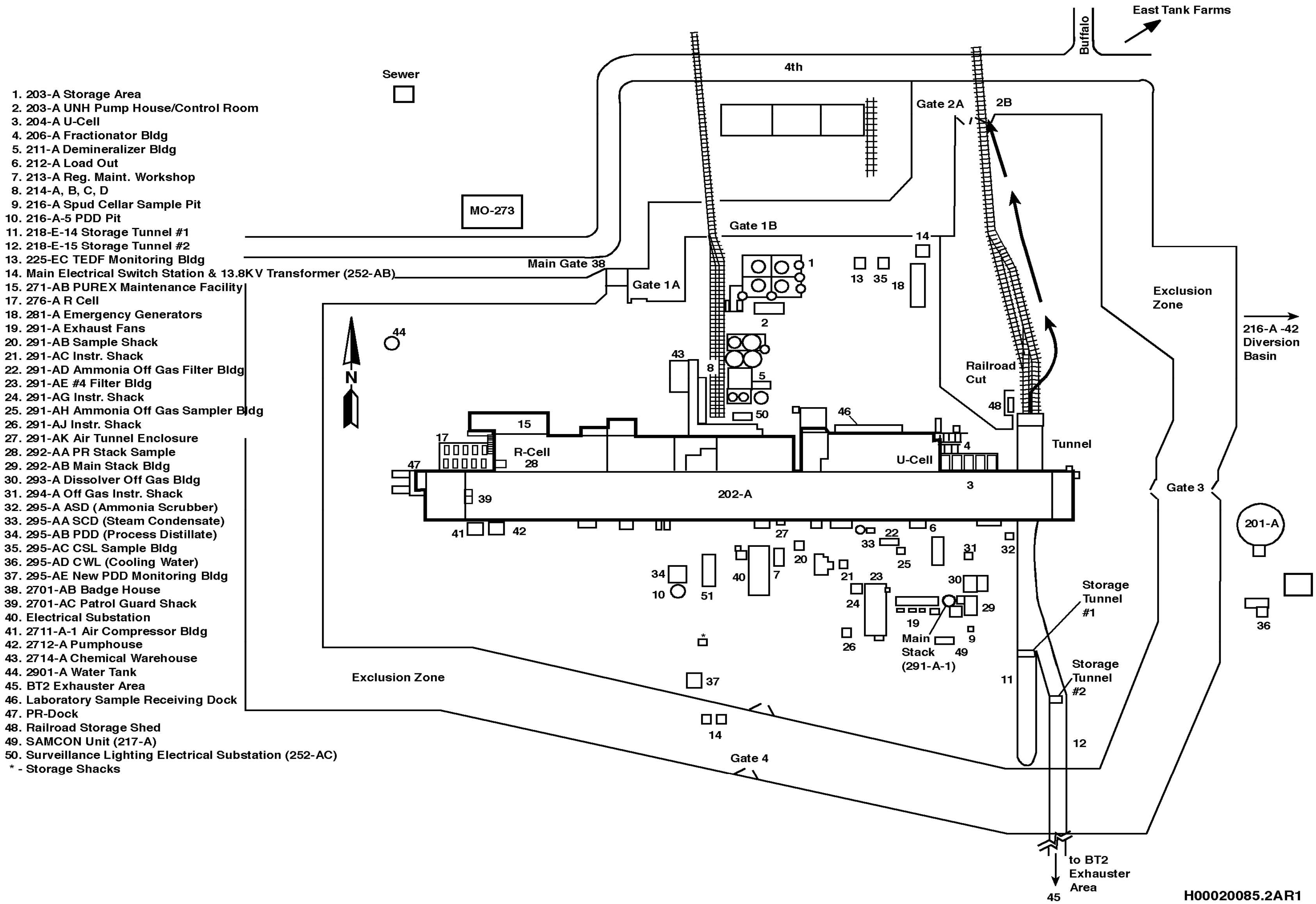


Figure F.4-3. PUREX Plant and Tunnels to South (above the plant in photo)

Figure F.4-4. PUREX Facilities Boundaries (Geographic Direction Reversed from Photo in Figure 2)



PART IV. UNIT DESCRIPTION AND HISTORY

EU Former/Current Use(s)

The Plutonium-Uranium Extraction (PUREX) facilities are located in the 200 West Area, which is an elevated, flat area that is approximately 3.2 sq. mi. in size near the middle of the Hanford Site and about 5 miles from the Columbia River. The 200 Area contains waste management facilities and former irradiated-fuel reprocessing facilities, and is often referred to as the Central Plateau. The PUREX complex is a nuclear fuel processing facility used to chemically separate plutonium, uranium and neptunium from Hanford Site nuclear reactor fuel elements. Construction was completed in 1955 and the plant operated until 1990. It quickly became the most efficient and largest processor of plutonium output, and when the REDOX Plant closed in 1967, PUREX became the sole, operating processing facility at the Hartford Site. Nearly 70% of Hanford's uranium was reprocessed through PUREX. During 1995-1997 the PUREX Plant was brought to a safe, low-cost, low-maintenance deactivation status. Since the facility was placed into the S&M, a new roof was placed over the 202-A canyon and aqueous makeup (AMU) areas. According to a 2014 report[2], conditions in the facility have been relatively stable since deactivation with minor exceptions. An RI/FS Work Plan is scheduled to be submitted by DOE for EPA and Washington Ecology review by September 2015.

Legacy Source Sites

The PUREX site includes a number of legacy crib-subsurface liquid disposal areas, several burial grounds and unplanned release-surface/near surface areas. No contaminant data is available for 100 of the 139 individual waste areas, and the aggregate amounts of each of Cs-137, Sr-90, C-14, H-3, I-129, U-232 to 238, and Pu-239 to 242 that are believed to be present across the 39 sites having data are estimated be in a range of from about 5E-04 to as little as 5E-09.

High-Level Waste Tanks

Not Applicable

Groundwater Plumes

Groundwater in the 200 Area is contaminated from multiple sources and is being addressed separately by DOE.

D&D of Inactive Facilities

Construction of the PUREX plant was completed in 1955 and the facilities were operated until 1990. The original Plant was a concrete rectangle 1,005 feet long, 104 feet high (with approximately 40 feet below grade), and 61.5 feet wide. The shielding capacity of the concrete was designed so that personnel in non-regulated service areas would not receive radiation in excess of 0.1 millirem per hour. Its main "canyon" portion is approximately 860 feet long and contains 11 cells, each 14 feet wide, 42.5 feet deep, and 39.5 feet deep from floor to underside of the reinforced concrete cover blocks. The cells were used as follows:

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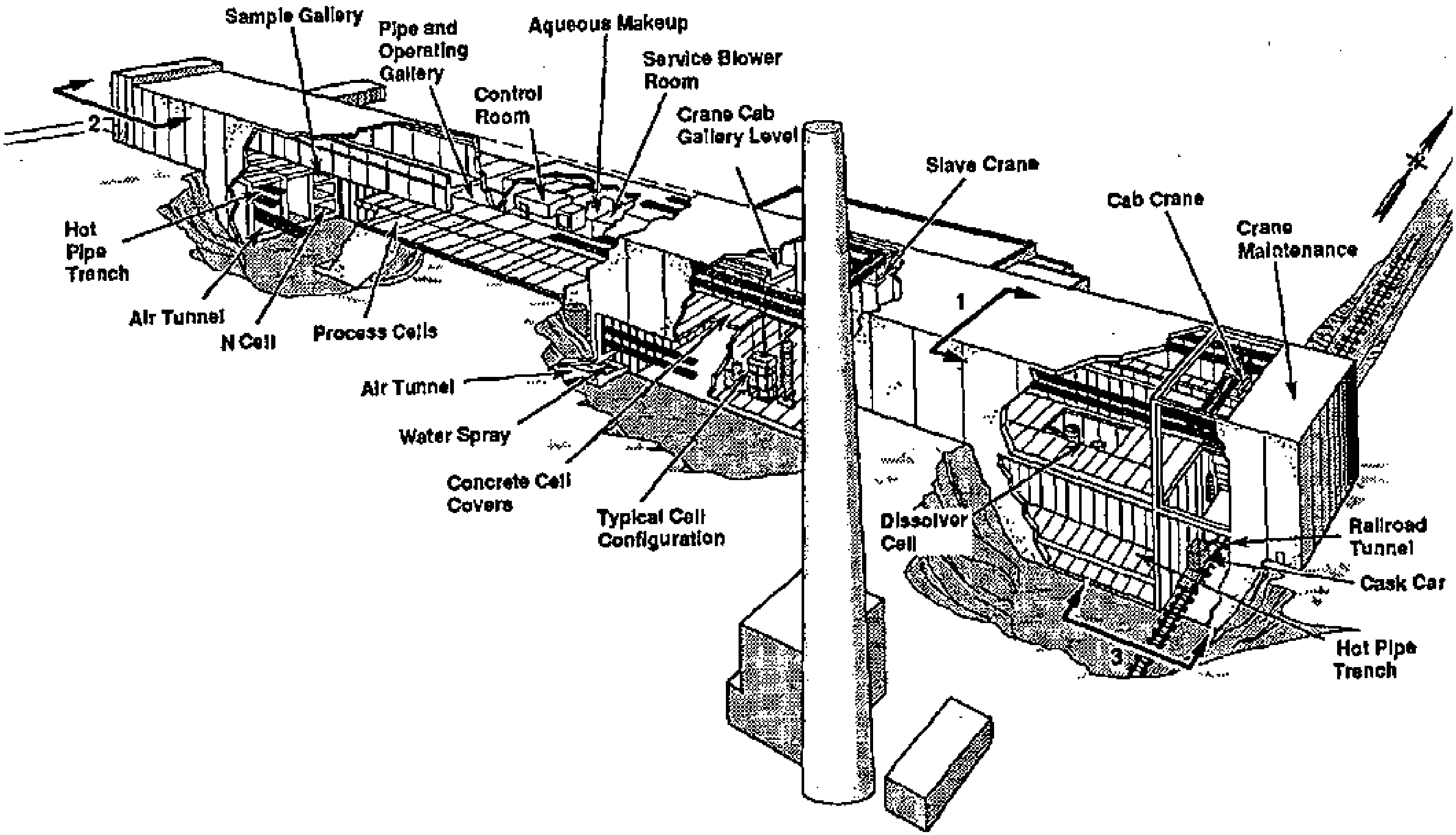
[2] CH2MHill Plateau Remediation Company, *Plutonium-Uranium Extraction Facility Documented Safety Analysis, CP-14977 Revision 7*, for U.S. Department of Energy, Assistant Secretary for Environmental Management, September 22, 2014.

EU Designation: CP-DD-1 (PUREX)

- A-, B-, C-Cells housed metal dissolution equipment and activities
- D-Cell contained equipment used in preparing dissolved metal into feed solution for the PUREX process
- F-Cell housed waste treatment and acid recovery operations

Figure F.4-5. PUREX Building 202-A Configuration



- G-Cell used for organic recovery (sometimes called first-cycle solvent recovery)
- H-, J-, K-, L-Cells incorporated remaining solvent extraction and concentration steps.

Additional portions of the PUREX Plant (the 202-A building) are comprised of a hot pipe trench (an 860-foot by 12-foot by 33-foot enclosure which housed pipes that transported radioactive solutions) and an air tunnel (an 860-foot by 11-foot by 7.5-foot space through which contaminated air from the canyon and the process ventilation system passed on its way to the filters and the 291-A Stack). Adjoining the north wall of the main 202-A Building is a 750-foot long, 60-foot wide service area containing three control rooms (central, head end, and power unit), the PUREX process control laboratory, the aqueous make-up and storage area, and the acid concentration vault. An underground solvent storage and make-up facility was adjacent to the service side of the 202-A Building.

Additionally, a regulated area of the 202-A Building contained M-Cell with a water pool for decontamination of major process equipment, a "hot shop," and a regulated shop for decontamination and repair of smaller equipment having varying levels of radioactivity. The decontamination cell incorporated leaded glass windows and flexible jumpers for the first time in a Hanford processing plant.

Many other service facilities were built adjacent to the PUREX Plant building. These included the 203-A Uranium Storage and Pumping Station; the 207-A Retention Basin; 211-A Chemical Tank Farm; the 252-A Electrical Substation; the 272-E Mock-Up Building; additions to the 282-E Raw Water Pump House, the 283-E Filter Plant, and the 284-E Power House; the 291-A Stack and Filter Building; a series of electrical and piping facilities, warehouses, rail systems; and many other structure (see Figure **F.4-**4).

The main canyon building; deep-bed filters No. 1 and 2; exhaust plenum, fans, main stack and No. 4 filter building; U-cell; liquid chemical tank farm; and buildings 211-A, 213-A, 214-A, 221-A and 271-AB are categorized as Hazard Category 2 (HC-2; potential for significant on-site consequences) and all others are less than HC-3.

PUREX Tunnels

The original PUREX Plant incorporated a unique feature for disposing of large pieces of radioactive solid waste, such as failed or outworn equipment. A 500-foot extension running southward was built onto the single-track rail tunnel to bring irradiated slugs to the east end of the PUREX building. Material selected for storage is loaded on railcars modified to serve as both transport and storage platforms. Normally, a remote-controlled, battery-powered locomotive was used to position the railcar in the storage tunnel. Each railcar is retrievable; however, because the railcars are stored on a single, dead-end railroad track, the railcars can be removed only in reverse order (i.e., last in, first out). Each storage tunnel is isolated from the railroad tunnel by a water-fillable shielding door.

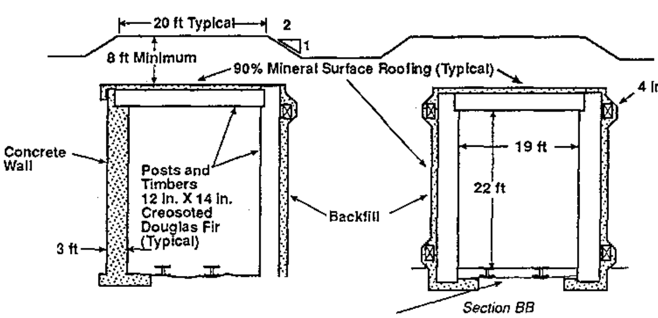
The PUREX Storage Tunnels are permitted as a miscellaneous unit under WAC 173-303-680 because the tunnels are not a typical containerized storage unit. That is, the bulk of the material stored in the tunnels is not placed in a container; rather, this material is placed on a portable device (railcar) used as a storage platform. The mixed waste stored in the Tunnels is encased or contained within carbon or stainless steel plate, pipe, or vessels that meet the WAC 173-303-040 definition of container. Therefore, the mixed waste normally is not exposed to the tunnel environment.

Tunnel Number 1 was completed in 1956. It is rectangular in construction and approximately 19 feet wide by 22 feet high by 358 feet long and provides storage space for eight railcars. The first 100 feet of the tunnel wall closest to Tunnel #2 is constructed with a three foot concrete wall. The other walls and ceiling are constructed of 12 in. x 14 in. creosoted timbers arranged side by side with the 12-inch face exposed. Vertical sidewall timbers were placed on a reinforced concrete footing 3 feet wide and 1 foot thick. A 9-inch high curb on the interior face of the footing restrains the timbers and resists forces imposed by the earth backfill. Continuous creosoted wood rail ties between the east and west footings carry the steel rails and permit soil loads to be transferred from one footing to the other. All timbers and rail ties are No. 1 Douglas Fir. A 90 lb. mineral-surface roofing material was used to cover the exterior roofing surface of the timbers, and then covered with at least eight feet of fill. There is a vent shaft at the tunnel end, but as part of the deactivation process, the ventilation fan was deactivated electrically and the exhaust stack and filter were isolated from the system by installing blanks upstream and downstream of both the exhaust fan and filter and the stack was removed. The descriptions are of PUREX equipment. Some of the equipment is in boxes. Most of the equipment is large and was placed directly on railroad cars. The rail cars serve as both transport and storage platforms. The description does not include a fissionable material inventory.

The construction of Tunnel Number 2 was completed in 1964. It is semicircular in cross-section, and is 19 feet wide by 22 feet high by 1,686 feet long, and has the capacity to provide storage space for up to 40 railcars. The semicircular walls/ceiling (17 ft. 3 in. radius) are supported by internal I-beams attached to externally constructed three foot thick reinforced concrete arches, with a bituminous coated steel liner on the interior. The top is covered with a minimum of eight feet of fill, and there is a vent shaft at the far end of the tunnel. The first railcar was placed in Tunnel Number 2 in December 1967 and as of August 2000, 28 railcars have been placed in the tunnel. The first 23 contain PUREX equipment, the next two hold equipment from 324 Building, and the last three are 20,000-gallon liquid waste tank railroad cars. Some of the equipment is in boxes. Most of the equipment is large and was placed directly on a railroad car. During deactivation of Tunnel #2, a blank was installed downstream of the filter and the Tunnel's ventilation shaft was capped and sealed with the fans abandoned in place.

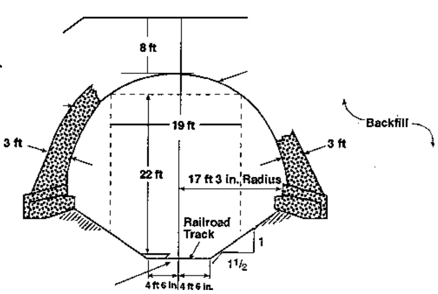
The tracks are on a one percent downward slope to the south to ensure that the railcars remain in their storage position. A railcar bumper is located about eight feet from the south end of the tracks to act as a stop. There are no electrical utilities, water lines, drains, fire detection or suppression systems, radiation monitoring, or communication systems provided inside either of the PUREX Storage Tunnels.

Tunnel #1



Sand and Gravel Floor

Tunnel #2



Sand and Gravel Floor

Current Status

During 1995-1997 the PUREX Plant was brought to a safe, low-cost, low-maintenance deactivation status. As part of the deactivation, the water-fillable doors of both tunnels and the outer PUREX railroad tunnel door were sealed. The scope of work includes S&M that maintains confinement of hazardous wastes and protects the worker. This work scope includes pre-approved activities for surveillance of the facility, preventative maintenance of selected equipment, and incidental storage of necessary supplies and equipment. Since the facility was placed into the S&M, a new roof was placed over the 202-A canyon and aqueous makeup (AMU) areas. According to the 2014 report (CPA-14977 DSA Rev. 7), conditions in the facility have been relatively stable since deactivation with minor exceptions.

Final D&D of the PUREX building is expected to be similar to the "Close in Place-Partially Demolished Structure" alternative chosen for the 221-U Plant. There are several D&D options for the rail cars and equipment in the two tunnels, ranging from retrieving each rail car unit and disposing of it as part of the main building D&D, to leaving the railcars in place and injecting grout and backfilling the storage tunnels. The Tri Party Agreement DOE to submit a change package by September 30, 2015 to establish a schedule for submittal of the RI/ES Work Plans for PUREX and other 200 Area canyon facilities. No firm date for D&D of the buildings or tunnels has been established.

Operating Facilities

Not Applicable

Ecological Resources Setting

Landscape Evaluation and Resource Classification

The amount of each category of biological resources at the PUREX EU was examined within a circular area radiating approximately 995 m from the geometric center of the unit (equivalent to 768 acres). Within the 44.6 acres of the EU, only 2.2 acres are classified as level 3 habitat, but these consist of fragmented and narrow patches. Approximately 31% of the total combined area (EU plus adjacent landscape buffer) consists of level 3 or greater resources.

Field Survey

The EU associated with the PUREX facilities was surveyed by pedestrian and vehicle reconnaissance and field measurement of remaining habitat on the southeast side of the area in October 2014. The majority of the EU consists of buildings, disturbed areas, parking lots, and facilities, except for the extension of the unit to the south and a small area just south of the parking lot on the east side of the unit. Field measurements in the southeast habitat confirmed that the area consisted of level 2 habitat resources. Patches of level 3 resources within the EU are associated with individual occurrences of sensitive plant species; Piper's daisy (*Erigeron piperianus*) had been noted in previous ECAP surveys and an Erigeron spp. was noted in the field survey, but could not be verified as Piper's daisy.

Wildlife observations within the level 2 habitat included several side-blotched lizards (*Uta stansburiana*), small mammal burrows and trails, coyote (*Canis latrans*) tracks, and a common raven (*Corvus corax*) flying overhead. No wildlife were observed within the fenced area around PUREX facilities.

Cultural Resources Setting

Cultural resources known to be recorded within the PUREX EU are limited to the National Register-eligible buildings associated with the Manhattan Project/Cold War Era Landscape some with documentation required and some without documentation requirements. Those with documentation required include the Hanford Site Plant Railroad, 202A (PUREX Canyon and Service Facility), 2701AB (PUREX Badge House), 294A (Offgas Treatment Monitoring Station), and 293A (Offgas Treatment Facility), and the 218-E-14 and 218-E-15 Burial Grounds. Those with no documentation required include the 212A Fission Product Load Monitoring Station, 275EA Storage Warehouse at 202A, and the 291A PUREX Maintenance Exhaust System. All National-Register-eligible Manhattan Project and Cold War Era buildings have been mitigated (e.g. documented as described in the *Hanford Site Manhattan Project and Cold War Era Historic District Treatment Plan* (DOE/RL-97-56)).

Most of the PUREX EU has not been inventoried for archaeological resources and it is unknown if an NHPA Section 106 review has been completed for remediation of the PUREX EU as one was not located. A few archaeological surveys with negative findings have been completed in the PUREX EU. No archaeological sites have been located by any of these surveys within the PUREX EU or near it. There is a slight possibility that intact archaeological material is present in the areas that have not been inventoried for archaeological resources (both on the surface and in the subsurface), particularly if undisturbed soil deposits exist within the PUREX EU. Given the extensive ground disturbance in the PUREX EU however, this is unlikely. The closest recorded archaeological site, located within 500 meters of the PUREX EU is an historic-era isolated find likely associated with the Pre-Hanford Early Settlers/Farming Landscape and is not considered to be National Register-eligible.

Geomorphology, ground disturbance, historic maps, and the lack of cultural resources located within and in the vicinity of PUREX EU all suggest that the potential for archaeological resources associated with the all three landscapes to be present on the surface or within the subsurface areas within the EU is very low. Because large areas have not been investigated for archaeological sites and pockets of undisturbed soil may exist, it may be appropriate to conduct subsurface archaeological investigations in these areas prior to initiating a remediation activity.

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 associated with these landscapes (e.g. East Benton Historical Society, the Franklin County Historical Society, Prosser Cemetery Association, B-Reactor Museum Association and the Reach) may need to occur. Indirect effects are always possible when TCPs are known to be located in the general vicinity. Consultation with Hanford Tribes may also 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

CONTAMINATION WITHIN PRIMARY EU SOURCE COMPONENTS

Legacy Source Sites

The PUREX site includes a number of legacy crib-subsurface liquid disposal areas, several burial grounds and unplanned release-surface/near surface areas. No contaminant data is available for 100 of the 139 individual waste areas, and the aggregate amounts of each of Cs-137, Sr-90, C-14, H-3, I-129, U-232 to 238, and Pu-239 to 242 that are believed to be present across the 39 sites having data are estimated be in a range of from about 5E-04 to as little as 5E-09. See attached schedule of all legacy source sites by WIDS code which have known contaminant data.

High Level Waste Tanks and Ancillary Equipment

Not Applicable

Vadose Zone Contamination

Not Applicable

Groundwater Plumes

Not Applicable

Facilities for D&D

The radioactive material inventory remaining at the end of deactivation in 1995-97 was primarily in the form of contaminated equipment and surfaces, dust and debris, with some remaining plutonium and oxide dust stabilized in gloveboxes. However, there are sufficient quantities to warrant a nuclear Hazard Category 2 (potential for significant on-site consequences) classification of the PUREX building and both tunnels. Other hazardous materials that remain are a relatively minor risk, as there are no substantial volatiles, caustics, or reactives remaining. Former process solution and stocks were removed as part of deactivation. Only residual quantities remain in the tank, vessels, and piping system that were pumped, emptied, and/or flushed. Various pieces of dangerous debris and equipment containing or contaminated with dangerous/mixed waste stored on the PUREX Canyon Deck were removed and placed in PUREX Storage Tunnel #2. Some mixed waste and debris remains in storage in the PUREX Plant, and are considered to be managed in a containment building (F-Cell). These wastes consist of a steel open-top skid containing concrete chips from the floor or E-Cell.

Table F.4-2. Inventory of Primary Radiological Contaminants (grams)[3]

Material	202-A building, including ventilation system (grams)	Storage Tunnel No. 1 (grams)	Storage Tunnel No. 2 (grams)
Total Pu	14,000	4,960	5,530
Am-241	350	129	97.5
Cs-137	126	116	3,790
Sr-90	65.5	59.9	1,250

Table F.4-3. Inventory of Primary Radiological Contaminants (Curies – 2003 Decayed Values)[4]

Material	202-A building, including ventilation system (Curies)	Storage Tunnel No. 1 (Curies)	Storage Tunnel No. 2 (Curies)
Total Pu	8,134	2,460	7,178
Am-241	1,210	442	334
Cs-137	11,000	10,127	330,873
Sr-90	8,940	8,175	170,611

The PUREX Storage Tunnels are permitted as a miscellaneous unit under WAC 173-303-680 because the tunnels are not a typical containerized storage unit. That is, the bulk of the material stored in the tunnels is not placed in a container; rather, this material is placed on a portable device (railcar) used as a storage platform. The mixed waste stored in the Tunnels is encased or contained within carbon or stainless steel plate, pipe, or vessels that meet the WAC 173-303-040 definition of container. Therefore, the mixed waste normally is not exposed to the tunnel environment. The only free-liquid dangerous waste stored in the tunnels is elemental mercury. The mercury is contained within thick-walled (0.8-centimeter) thermowells. The amount of mercury per thermowell is less than 1.7 liters. The only stored mixed waste that is designated as either reactive or ignitable is silver nitrate in the silver reactors [WAC 173-303-090(5)]. The potential for ignition from this source is considered negligible because this material is dispersed on ceramic packing and is physically isolated from contact with any combustible

[3] CH2MHill Plateau Remediation Company, *Plutonium-Uranium Extraction Facility Documented Safety Analysis, CP-14977 Revision 7*, for U.S. Department of Energy, Assistant Secretary for Environmental Management, September 22, 2014

[4] CH2MHill Plateau Remediation Company, *Plutonium-Uranium Extraction Facility Documented Safety Analysis, CP-14977 Revision 7*, for U.S. Department of Energy, Assistant Secretary for Environmental Management, September 22, 2014

material or ignition source. There is no reactive or incompatible waste known to be stored in the PUREX Storage Tunnels.

The Report authors have not located data on the aggregate inventories of each of the various mixed wastes by amount or weight that are located in the PUREX Tunnels or main canyon building.

Detailed inventories are provided in Table F.4-4,

Table F.4-5, and. All values are to 2 significant figures. The source document should be consulted for greater precision data. The sum for each primary contaminant is shown in the first row.

EU Designation: CP-DD-1 (PUREX)

Table F.4-7 provides a summary of the evaluation of threats to groundwater as a protected resource from saturated zone and remaining vadose zone contamination associated with the evaluation unit.

Operating Facilities

Not Applicable

Table F.4-4. Inventory of Primary Contaminants[(a)]

WIDS	Description	Decay Date	Ref[(b)]	Am-241 (Ci)	C-14 (Ci)	Cl-36 (Ci)	Co-60 (Ci)	Cs-137 (Ci)	Eu-152 (Ci)	Eu-154 (Ci)	H-3 (Ci)	I-129 (Ci)
All	Sum			2000	1.50E-05	NP	0.00018	350000	1.20E-05	0.0013	42	2.60E-06
218-E-14	Burial Ground	2003	Foot-note 4	440	NP	NP	NP	10000	NP	NP	NP	NP
218-E-15	Burial Ground	2003	Foot-note 4	330	NP	NP	NP	330000	NP	NP	NP	NP
200-E-62	Other	2001	SIM	3.70E-10	7.20E-07	NP	NP	NP	NP	NP	NP	1.00E-08
200-E-63	Other	2001	SIM	3.70E-10	7.20E-07	NP	NP	NP	NP	NP	NP	1.00E-08
200-E-64	Other	2001	SIM	3.70E-10	7.20E-07	NP	NP	NP	NP	NP	NP	1.00E-08
200-E-65	Other	2001	SIM	3.70E-10	7.20E-07	NP	NP	NP	NP	NP	NP	1.00E-08
200-E-67	Other	2001	SIM	3.70E-10	7.20E-07	NP	NP	NP	NP	NP	NP	1.00E-08
200-E-68	Other	2001	SIM	3.70E-10	7.20E-07	NP	NP	NP	NP	NP	NP	1.00E-08
200-E-69	Other	2001	SIM	3.80E-10	7.30E-07	NP	NP	NP	NP	NP	NP	1.00E-08
200-E-70	Other	2001	SIM	3.80E-10	7.30E-07	NP	NP	NP	NP	NP	NP	1.00E-08
200-E-71	Other	2001	SIM	3.80E-10	7.30E-07	NP	NP	NP	NP	NP	NP	1.00E-08
200-E-73	Other	2001	SIM	3.70E-10	7.20E-07	NP	NP	NP	NP	NP	NP	1.00E-08
200-E-74	Other	2001	SIM	3.80E-10	7.30E-07	NP	NP	NP	NP	NP	NP	1.00E-08
200-E-75	Other	2001	SIM	3.80E-10	7.30E-07	NP	NP	NP	NP	NP	NP	1.00E-08
200-E-76	Other	2001	SIM	3.80E-10	7.30E-07	NP	NP	NP	NP	NP	NP	1.00E-08
200-E-77	Other	2001	SIM	3.80E-10	7.30E-07	NP	NP	NP	NP	NP	NP	1.00E-08
200-E-78	Other	2001	SIM	3.70E-10	7.20E-07	NP	NP	NP	NP	NP	NP	1.00E-08
200-E-79	Other	2001	SIM	3.80E-10	7.30E-07	NP	NP	NP	NP	NP	NP	1.00E-08

WIDS	Description	Decay Date	Ref[b]	Am-241 (Ci)	C-14 (Ci)	Cl-36 (Ci)	Co-60 (Ci)	Cs-137 (Ci)	Eu-152 (Ci)	Eu-154 (Ci)	H-3 (Ci)	I-129 (Ci)
200-E-80	Other	2001	SIM	3.70E-10	7.20E-07	NP	NP	NP	NP	NP	NP	1.00E-08
200-E-81	Other	2001	SIM	8.90E-08	2.80E-08	NP	2.30E-07	0.0031	8.70E-09	7.00E-07	1.20E-06	1.50E-09
200-E-82	Other	2001	SIM	3.80E-10	7.30E-07	NP	NP	NP	NP	NP	NP	1.00E-08
200-E-84	Other	2001	SIM	5.10E-10	9.90E-07	NP	NP	NP	NP	NP	NP	1.40E-08
200-E-136	Process Building	2003	Foot-note 4	1200	NP	NP	NP	11000	NP	NP	NP	NP
216-A-11	Cribs	2001	SIM	2.00E-10	3.90E-07	NP	NP	NP	NP	NP	NP	5.50E-09
216-A-12	Cribs	2001	SIM	2.00E-10	3.90E-07	NP	NP	NP	NP	NP	NP	5.50E-09
216-A-13	Cribs	2001	SIM	2.00E-09	6.20E-10	NP	5.00E-09	6.90E-05	1.90E-10	1.50E-08	2.70E-08	3.20E-11
216-A-14	Cribs	2001	SIM	2.00E-10	6.20E-11	NP	5.00E-10	6.90E-06	1.90E-11	1.50E-09	2.70E-09	3.20E-12
216-A-22	Cribs	2001	SIM	4.70E-12	9.10E-09	NP	NP	NP	NP	NP	8.00E-02	1.30E-10
216-A-26	Cribs	2001	SIM	7.60E-10	2.40E-10	NP	1.90E-09	2.70E-05	7.30E-11	5.90E-09	1.00E-08	1.20E-11
216-A-26A	Cribs	2001	SIM	2.00E-10	6.20E-11	NP	5.00E-10	6.90E-06	1.90E-11	1.50E-09	2.70E-09	3.20E-12
216-A-28	Cribs	2001	SIM	NP	NP	NP	NP	NP	NP	NP	0.37	NP
216-A-3	Cribs	2001	SIM	2.70E-05	4.00E-07	NP	2.70E-06	2.50E-02	4.20E-07	3.00E-05	4.10E+01	NP
216-A-32	Cribs	2001	SIM	7.90E-10	2.50E-10	NP	2.00E-09	2.80E-05	7.60E-11	6.20E-09	1.10E-08	1.30E-11
216-A-35	Cribs	2001	SIM	2.00E-09	6.20E-10	NP	5.00E-09	6.90E-05	1.90E-10	1.50E-08	2.70E-08	3.20E-11
200-E-103	UPR	2001	SIM	7.80E-10	2.50E-10	NP	2.00E-09	2.80E-05	7.60E-11	6.20E-09	1.10E-08	1.30E-11
200-E-107	UPR	2001	SIM	5.30E-10	1.70E-10	NP	1.30E-09	1.90E-05	5.10E-11	4.10E-09	7.30E-09	2.30E-06
200-E-54	UPR	2001	SIM	3.90E-08	1.20E-08	NP	1.00E-07	0.0014	3.80E-09	3.10E-07	5.40E-07	6.40E-10
UPR-200-E-39	UPR	2001	SIM	0.0034	NP	NP	1.60E-04	0.97	1.10E-05	1.20E-03	0.14	NP

EU Designation: CP-DD-1 (PUREX)

WIDS	Description	Decay Date	Ref[b]	Am-241 (Ci)	C-14 (Ci)	Cl-36 (Ci)	Co-60 (Ci)	Cs-137 (Ci)	Eu-152 (Ci)	Eu-154 (Ci)	H-3 (Ci)	I-129 (Ci)
UPR-200-E-40	UPR	2001	SIM	0.00026	NP	NP	1.30E-05	0.075	8.40E-07	9.30E-05	0.011	NP

a. NP = Not present at significant quantities for indicated EU
b. SIM = RPP-26744, Rev. 0

Table F.4-5. Inventory of Primary Contaminants (cont)[(a)]

WIDS	Description	Decay Date	Source[(b)]	Ni-59 (Ci)	Ni-63 (Ci)	Pu (total) (Ci)	Sr-90 (Ci)	Tc-99 (Ci)	U (total) (Ci)
All	Sum			1.10E-07	1.00E-05	18000	190000	0.28	2.2
218-E-14	Burial Ground	2003	Foot-note 4	NP	NP	2500	8200	NP	NP
218-E-15	Burial Ground	2003	Foot-note 4	NP	NP	7200	1.70E+05	NP	NP
200-E-62	Other	2001	SIM	NP	NP	0.00013	4.40E-08	NP	7.10E-06
200-E-63	Other	2001	SIM	NP	NP	0.00013	4.40E-08	NP	7.10E-06
200-E-64	Other	2001	SIM	NP	NP	0.00013	4.40E-08	NP	7.10E-06
200-E-65	Other	2001	SIM	NP	NP	0.00013	4.40E-08	NP	7.10E-06
200-E-67	Other	2001	SIM	NP	NP	0.00013	4.40E-08	NP	7.10E-06
200-E-68	Other	2001	SIM	NP	NP	0.00013	4.40E-08	NP	7.10E-06
200-E-69	Other	2001	SIM	NP	NP	0.00014	4.50E-08	NP	7.30E-06
200-E-70	Other	2001	SIM	NP	NP	0.00014	4.50E-08	NP	7.30E-06
200-E-71	Other	2001	SIM	NP	NP	0.00014	4.50E-08	NP	7.30E-06
200-E-73	Other	2001	SIM	NP	NP	0.00013	4.40E-08	NP	7.10E-06
200-E-74	Other	2001	SIM	NP	NP	0.00014	4.50E-08	NP	7.30E-06
200-E-75	Other	2001	SIM	NP	NP	0.00014	4.50E-08	NP	7.30E-06
200-E-76	Other	2001	SIM	NP	NP	0.00014	4.50E-08	NP	7.30E-06
200-E-77	Other	2001	SIM	NP	NP	0.00014	4.50E-08	NP	7.30E-06
200-E-78	Other	2001	SIM	NP	NP	0.00013	4.40E-08	NP	7.10E-06
200-E-79	Other	2001	SIM	NP	NP	0.00014	4.50E-08	NP	7.30E-06
200-E-80	Other	2001	SIM	NP	NP	1.30E-04	4.40E-08	NP	7.10E-06

WIDS	Description	Decay Date	Source[b]	Ni-59 (Ci)	Ni-63 (Ci)	Pu (total) (Ci)	Sr-90 (Ci)	Tc-99 (Ci)	U (total) (Ci)
200-E-81	Other	2001	SIM	4.50E-08	4.30E-06	4.60E-07	2.50E-05	7.60E-07	2.50E-09
200-E-82	Other	2001	SIM	NP	NP	0.00014	4.50E-08	NP	7.30E-06
200-E-84	Other	2001	SIM	NP	NP	0.00018	6.10E-08	NP	9.70E-06
200-E-136	Process Building	2003	Foot-note 4	NP	NP	8.10E+03	8.90E+03	NP	NP
216-A-11	Cribs	2001	SIM	NP	NP	4.40E-05	2.40E-08	NP	3.50E-06
216-A-12	Cribs	2001	SIM	NP	NP	4.30E-05	2.40E-08	NP	3.50E-06
216-A-13	Cribs	2001	SIM	1.00E-09	9.50E-08	1.00E-08	5.50E-07	1.70E-08	5.40E-11
216-A-14	Cribs	2001	SIM	9.90E-11	9.50E-09	1.00E-09	5.50E-08	1.70E-09	5.40E-12
216-A-22	Cribs	2001	SIM	NP	NP	6.40E-07	5.60E-10	4.90E-04	3.10E-03
216-A-26	Cribs	2001	SIM	3.80E-10	3.70E-08	3.90E-09	2.10E-07	6.40E-09	2.10E-11
216-A-26A	Cribs	2001	SIM	1.00E-10	9.50E-09	1.00E-09	5.50E-08	1.70E-09	5.40E-12
216-A-28	Cribs	2001	SIM	NP	NP	NP	NP	0.0025	0.44
216-A-3	Cribs	2001	SIM	3.80E-08	3.70E-06	7.90E-04	2.10E-02	2.70E-01	1.80E+00
216-A-32	Cribs	2001	SIM	4.00E-10	3.80E-08	4.00E-09	2.20E-07	6.70E-09	2.20E-11
216-A-35	Cribs	2001	SIM	9.90E-10	9.50E-08	1.00E-08	5.50E-07	1.70E-08	5.40E-11
200-E-103	UPR	2001	SIM	4.00E-10	3.80E-08	4.00E-09	2.20E-07	6.70E-09	2.20E-11
200-E-107	UPR	2001	SIM	2.70E-10	2.60E-08	2.70E-09	1.50E-07	4.50E-09	1.40E-11
200-E-54	UPR	2001	SIM	2.00E-08	1.90E-06	2.00E-07	1.10E-05	3.30E-07	1.10E-09
UPR-200-E-39	UPR	2001	SIM	NP	NP	0.029	1.1	6.90E-04	1.70E-04
UPR-200-E-40	UPR	2001	SIM	NP	NP	0.0022	0.086	5.30E-05	1.30E-05

a. NP = Not present at significant quantities for indicated EU
b. SIM = RPP-26744, Rev. 0

Table F.4-6. Inventory of Primary Contaminants (cont)[(a)]

WIDS	Descrip-tion	Decay Date	Source[(b)]	CCl4 (kg)	CN (kg)	Cr (kg)	Cr-VI (kg)	Hg (kg)	NO3 (kg)	Pb (kg)	TBP (kg)	TCE (kg)	U (total) (kg)
All	Sum			NP	NP	2	NP	0.011	47000	1.80E-06	NP	NP	3300
218-E-14	Burial Ground	2003	Foot-note 4	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP
218-E-15	Burial Ground	2003	Foot-note 4	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP
200-E-62	Other	2001	SIM	NP	NP	NP	NP	NP	0.1	NP	NP	NP	0.0089
200-E-63	Other	2001	SIM	NP	NP	NP	NP	NP	0.1	NP	NP	NP	0.0089
200-E-64	Other	2001	SIM	NP	NP	NP	NP	NP	0.1	NP	NP	NP	0.0089
200-E-65	Other	2001	SIM	NP	NP	NP	NP	NP	0.1	NP	NP	NP	0.0089
200-E-67	Other	2001	SIM	NP	NP	NP	NP	NP	0.1	NP	NP	NP	0.0089
200-E-68	Other	2001	SIM	NP	NP	NP	NP	NP	0.1	NP	NP	NP	0.0089
200-E-69	Other	2001	SIM	NP	NP	NP	NP	NP	0.11	NP	NP	NP	0.0091
200-E-70	Other	2001	SIM	NP	NP	NP	NP	NP	0.11	NP	NP	NP	0.0091
200-E-71	Other	2001	SIM	NP	NP	NP	NP	NP	0.11	NP	NP	NP	0.0091
200-E-73	Other	2001	SIM	NP	NP	NP	NP	NP	0.1	NP	NP	NP	0.0089
200-E-74	Other	2001	SIM	NP	NP	NP	NP	NP	0.11	NP	NP	NP	0.0091
200-E-75	Other	2001	SIM	NP	NP	NP	NP	NP	0.11	NP	NP	NP	0.0091
200-E-76	Other	2001	SIM	NP	NP	NP	NP	NP	0.11	NP	NP	NP	0.0091
200-E-77	Other	2001	SIM	NP	NP	NP	NP	NP	0.11	NP	NP	NP	0.0091
200-E-78	Other	2001	SIM	NP	NP	NP	NP	NP	0.1	NP	NP	NP	0.0089
200-E-79	Other	2001	SIM	NP	NP	NP	NP	NP	0.11	NP	NP	NP	0.0091
200-E-80	Other	2001	SIM	NP	NP	NP	NP	NP	0.1	NP	NP	NP	8.90E-03

WIDS	Descrip-tion	Decay Date	Source[(b)]	CCl4 (kg)	CN (kg)	Cr (kg)	Cr-VI (kg)	Hg (kg)	NO3 (kg)	Pb (kg)	TBP (kg)	TCE (kg)	U (total) (kg)
200-E-81	Other	2001	SIM	NP	NP	0.012	NP	2.30E-09	140	1.20E-06	NP	NP	6.40E-07
200-E-82	Other	2001	SIM	NP	NP	NP	NP	NP	0.11	NP	NP	NP	0.0091
200-E-84	Other	2001	SIM	NP	NP	NP	NP	NP	0.14	NP	NP	NP	0.012
200-E-136	Process Building	2003	Foot-note 4	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP
216-A-11	Cribs	2001	SIM	NP	NP	NP	NP	NP	0.056	NP	NP	NP	0.0048
216-A-12	Cribs	2001	SIM	NP	NP	NP	NP	NP	0.056	NP	NP	NP	4.80E-03
216-A-13	Cribs	2001	SIM	NP	NP	2.60E-04	NP	5.00E-11	3	2.60E-08	NP	NP	1.40E-08
216-A-14	Cribs	2001	SIM	NP	NP	2.60E-05	NP	5.00E-12	0.3	2.60E-09	NP	NP	1.40E-09
216-A-22	Cribs	2001	SIM	NP	NP	0.00083	NP	2.60E-05	120	NP	NP	NP	4.60E+00
216-A-26	Cribs	2001	SIM	NP	NP	1.00E-04	NP	1.90E-11	1.2	1.00E-08	NP	NP	5.40E-09
216-A-26A	Cribs	2001	SIM	NP	NP	2.60E-05	NP	5.00E-12	0.3	2.60E-09	NP	NP	1.40E-09
216-A-28	Cribs	2001	SIM	NP	NP	0.0031	NP	0.00011	430	NP	NP	NP	650
216-A-3	Cribs	2001	SIM	NP	NP	0.34	NP	1.10E-02	47000	NP	NP	NP	2.60E+03
216-A-32	Cribs	2001	SIM	NP	NP	0.0001	NP	2.00E-11	1.2	1.00E-08	NP	NP	5.60E-09
216-A-35	Cribs	2001	SIM	NP	NP	0.00026	NP	5.00E-11	3	2.60E-08	NP	NP	1.40E-08

EU Designation: CP-DD-1 (PUREX)

WIDS	Descrip-tion	Decay Date	Source[b]	CCl4 (kg)	CN (kg)	Cr (kg)	Cr-VI (kg)	Hg (kg)	NO3 (kg)	Pb (kg)	TBP (kg)	TCE (kg)	U (total) (kg)
200-E-103	UPR	2001	SIM	NP	NP	0.0001	NP	2.00E-11	1.2	1.00E-08	NP	NP	5.60E-09
200-E-107	UPR	2001	SIM	NP	NP	1.7	NP	NP	39	NP	NP	NP	3.80E-09
200-E-54	UPR	2001	SIM	NP	NP	0.0052	NP	1.00E-09	60	5.20E-07	NP	NP	2.80E-07
UPR-200-E-39	UPR	2001	SIM	NP	NP	NP	NP	NP	6.2	NP	NP	NP	0.21
UPR-200-E-40	UPR	2001	SIM	NP	NP	NP	NP	NP	4.80E-01	NP	NP	NP	0.016

a. NP = Not present at significant quantities for indicated EU
b. SIM = RPP-26744, Rev. 0

Table F.4-7. Summary of the Evaluation of Threats to Groundwater as a Protected Resource from Saturated Zone (SZ) and Remaining Vadose Zone (VZ) Contamination associated with the Evaluation Unit

PC	Group	WQS	Porosity[a]	K_d (mL/g)[a]	ρ (kg/L)[a]	VZ Source M^{Source}	SZ Total M^{SZ}	Treated[c] M^{Treat}	VZ Remaining M^{Tot}	VZ GTM (Mm^3)	VZ Rating[d]
C-14	A	2000 pCi/L	0.25	0	1.82	1.53E-05Ci	---	---	1.53E-05Ci	7.64E-06	Low
I-129	A	1 pCi/L	0.25	0.2	1.82	2.56E-06Ci	---	---	2.56E-06Ci	1.04E-03	Low
Sr-90	B	8 pCi/L	0.25	22	1.82	1.79E+05Ci	---	---	1.79E+05Ci	1.39E+05	ND[e]
Tc-99	A	900 pCi/L	0.25	0	1.82	2.77E-01Ci	---	---	2.77E-01Ci	3.08E-01	Low
CCl4	A	5 µg/L	0.25	0	1.82	0.00E+00kg	---	---	0.00E+00kg	0.00E+00	ND
Cr	B	100 µg/L	0.25	0	1.82	2.03E+00kg	---	---	2.03E+00kg	2.03E-02	Low
Cr-VI	A	48 µg/L[b]	0.25	0	1.82	2.03E+00kg	---	---	2.03E+00kg	4.22E-02	Low
TCE	B	5 µg/L	0.25	2	1.82	---	---	---	0.00E+00kg	0.00E+00	ND
U(tot)	B	30 µg/L	0.25	0.8	1.82	3.30E+03kg	---	---	3.30E+03kg	1.61E+01	ND[e]

a. Parameters obtained from the analysis provided in Attachment 6-1 to Methodology Report.

b. "Model Toxics Control Act—Cleanup" (WAC 173-340) Method B groundwater cleanup level for hexavalent chromium.

c. Treatment amounts from the 2013 Hanford Annual Groundwater Report (DOE/RL-2014-32, Rev. 0).

d. Groundwater Threat Metric rating based on Table 6-3, Methodology Report.

e. Based on an analysis similar to the one discussed in Appendix E.6 (A-AX Tank and Waste Farms) Section 6.5 (Vadose Zone Contamination), no appreciable uranium or Sr-90 plume would be expected in the next 150 years due to transport and decay (Sr-90) considerations. Thus the *Low* rating would apply after the Active Cleanup is completed to account for uncertainties.

PART VI. POTENTIAL RISK/IMPACT PATHWAYS AND EVENTS

CURRENT CONCEPTUAL MODEL

Narrative description of pathways and barriers to receptors and conditions/events that can lead to completed pathways

Pathways and Barriers: (1. description of institutional, natural and engineered barriers (including material characteristics) that currently mitigate or prevent risk or impacts, 2. Time scale from loss of each barrier to realization of risk or impacts)

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?*

The 2014 DSA (CP-14977 Revision 7*)* prepared by CH2MHill Plateau Remediation Company identified six potential events that might cause a release of radioactive materials having a unmitigated dose of at least 10 rems to an individual located 100 meters outside the PUREX boundary. They are:

- Structural failure of each of the 202-A Building and PUREX Storage Tunnel Nos. 1 and 2 would cause approximately 120, 58 and 76 rems release respectively in each from a seismic event (aggregate total of 254 rems).
- Fire in PUREX Storage Tunnel No. 1 – about 70 rems
- Isolated failure of a portion of the 202-A building from a moderate seismic event, vehicle impact or an external crane drop (roof collapse over Cells A, B and C) – about 25 rems
- N-Cell Gloveline Fire – about 25 rems
- Crane falling on top of Tunnel #2 – about 14 rems
- Staged Waste Fire – about 14 rems

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

Facility structural damage can occur as a consequence of either local seismic activity or a facility mechanical structural failure from other Natural Phenomenon Hazards (snow/ash load, winds). Based on the PUREX facility design criteria, a Uniform Building Code (UBC) seismic demand is expected to result in some structural damage (cracking, spalling, and minor structural damage) to building structures. A much more significant seismic event would be required to cause catastrophic failure of these structures. Such an event assumes that the entire radiological inventory of the structures is at risk; therefore, no safety significant or safety-class structure, systems, or components (SSCs) or Technical Safety Requirements (TSRs) are required.

A fire in PUREX Storage Tunnel No. 1 would result in an unmitigated dose of about 70 rems to the CW, however, given the conservatism identified in the analysis of the fire, and because the storage tunnel is isolated with no access, the DSA concluded that no safety SSCs or TSRs are required.

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

The large canyon structure provides passive containment of radiological contaminants, as does the fully sealed and entombed storage tunnels. In addition, the DSA noted that the work control, including job hazards analysis (JHA), program prohibits access to the storage tunnels, which reduces the likelihood of such an event.

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?*

The PUREX Plant physical construction was designed as a radiation and blast barrier which will remain until demolished. It is a concrete rectangle 1,005 feet long, 104 feet high (with approximately 40 feet below grade), and 61.5 feet wide. The concrete walls and floor range from approximately 3 feet to 9 feet thick, and the shielding capacity of the concrete was designed so that personnel in non-regulated service areas would not receive radiation in excess of 0.1 millirem per hour. The main 202-A building has been maintained in a safe low-maintenance condition since 1997 and is surround by barbed wire fencing to prevent public or inadvertent access. The two tunnels are under eight feet of earth, are sealed and the stored equipment is not currently accessible. Active facility systems are limited to electrical distribution, exhaust ventilation, instrumentation systems, and fire detection/alarms systems in 252-AB and 217-A buildings. Since the facility was placed into an S&M mode, a new roof was placed over the canyon and aqueous makeup areas. Unless there is an emergency, no workers are permitted to enter the building except for scheduled S&M inspections. According to the 2014 DSA, conditions in the facility have been relatively stable since deactivation with minor exceptions.

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

See #1 above

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

Primary pathways would be airborne releases of contaminant materials and smoke affecting workers and CWs. A seismic catastrophic failure of building and tunnels would exposure the public at the site's boundary (9.5 miles from PUREX facility) to about 0.17 rems.

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

DSA models assume near immediate co-worker human exposure of TED as noted in #6 above.

8. *Are there current on-going releases to the environment or receptors?*

The PUREX deactivation project reduced the four separate ventilation systems in the facility to one cascaded flow scheme, and the 13 effluent points from the PUREX facility and storage tunnels were reduced to one main exhaust stack. Of the 177 fans in the facility, only two main exhaust fans (one active and one on standby) continue to function. The 202-A Building is ventilated by cascade systems into the canyon ventilation system with the exhaust through deep-bed filter 2 that remove 99.9 percent of the particulates from the air stream before discharging to the atmosphere through the 61 m (200 ft) stack. The ventilation system is designed to flow air from clean areas to progressively more contaminated areas.

POPULATIONS AND RESOURCES CURRENTLY AT RISK OR POTENTIALLY IMPACTED

Facility Worker

Only those involved in quarterly S&M activities.

Co-located Person

Not Applicable

Public

The nearest public access point is 9.5 miles (CP-14977 Revision 7).

Groundwater

Based on an analysis similar to the one discussed in Appendix E.6 (A-AX Tank and Waste Farms) Section 6.5 (Vadose Zone Contamination), no appreciable uranium or Sr-90 plume would be expected in the next 150 years due to transport and decay (Sr-90) considerations. Thus the *Low* rating would apply after the Active Cleanup is completed to account for uncertainties.

The overall groundwater rating for the EU is based on the Low ratings for C-14, I-129, Tc-99, Cr, and Cr-VI as shown in Table F.4-7.

Columbia River

Based on an analysis similar to the one discussed in Appendix E.6 (A-AX Tank and Waste Farms) Section 6.6, the Columbia River rating for this EU is ND.

Ecological Resources

- The majority of the EU consists of buildings, disturbed areas, parking lots, and facilities.
- Patches of level 3 resources within the EU are associated with individual occurrences of sensitive plant species, Piper's daisy.
- Removal or loss of individual occurrences of the sensitive plant species, Piper's daisy, would be unlikely to alter population viability for this species.
- Remediation actions would result in only a 0.3% change in level 3 and above biological resources at the landscape scale.
- Because the PUREX facilities are adjacent to and contiguous with other disturbed and industrial areas within the 200 East Area, the loss of habitat that could potentially occur within this EU would not be expected to impact habitat connectivity on the 200 Area plateau.

Cultural Resource

- There are no known recorded archaeological sites or TCPs located within the EU.
- Segments of the National Register-eligible Hanford Site Plant Railroad a contributing property within the Manhattan Project and Cold War Era Historic District, with documentation required, are located within the PUREX EU. In accordance with the 1998 *Hanford Site Manhattan Project and Cold War Era Historic District Treatment Plan (*DOE/RL-97-56), all documentation requirements have been completed for this property.
- There are several National Register-eligible buildings that are contributing properties within the Manhattan Project and Cold War Era Historic District, with documentation required, that are located within the PUREX EU. In accordance with the 1998 *Hanford Site Manhattan Project and Cold War Era Historic District Treatment Plan (*DOE/RL-97-56), all documentation requirements have been completed for these properties. These include:

202A	PUREX Canyon and Service Facility
2701AB	PUREX Badge House
294A	Offgas Treatment Monitoring Station
293A	Offgas Treatment Facility

- The 218-E-14 and 218-E-15 Burial Grounds are also contributing properties within the Manhattan Project and Cold War Era Historic District, with documentation required, that are located within the PUREX EU.
- The 212A Fission Product Load Monitoring Station, 275EA Storage Warehouse at 202A, and the 291A PUREX Maintenance Exhaust System, are National Register-eligible contributing properties within the Manhattan Project and Cold War Era Historic District, with no documentation required located within the PUREX EU.

Archaeological sites and TCPs located within 500 meters of the EU

- An isolated find associated with the Pre-Hanford Early Settlers/Farming Landscape is located within 500 meters of the PUREX EU is ineligible for the National Register.

Recorded TCPs Visible from the EU

- Two recorded TCPs associated with the Native American Precontact and Ethnographic Landscape that are visible from the PUREX EU.

Cleanup Approaches and End-State Conceptual Model

Selected or Potential Cleanup Approaches

The 1996 Agreement in Principle (DOE-RL1996) among the Tri-Parties of DOE, USEPA, and Washington State Department of Ecology (Ecology) established that the CERCLA Remedial Investigation/Feasibility Study process would be followed, on a case-by-case basis, to evaluate potential cleanup remedies and identify preferred alternatives for the final end state for the five major canyon buildings in the 200 Area of the Hanford Site. The 221-U Facility was selected as a pilot project for this effort. Its final RI/FS evaluated five remedial action alternatives, one of which was "Full Removal and Disposal". In this alternative, the 221-U Facility structure and contents would be removed and demolished, including the foundation below existing grade level. Structural material, facility contents, and associated soil above risk-based standards would be disposed at the ERDF. The selected remedy was "Close in Place-Partially Demolish Structure", under which equipment on the canyon deck will be consolidated into the process cells and hot pipe trench; equipment, process cells, and other open areas will be filled with grout, the structure will be partially demolished, and the remaining structure will be buried under an engineered barrier. This alternative was determined to be more protective of remedial action workers and provide somewhat greater long-term effectiveness and permanence when compared to full removal and disposal of the facilities. It was also determined to provide somewhat greater long-term effectiveness and permanence at a lower cost than the two Entombment alternatives considered.

As described in a U Plant DSA (HNF-13829, p 2-15), "grouting the canyon was done by grouting the most contaminated areas first, beginning with the grouting of the cell drain header and followed by the process cells and hot pipe trench. The base of equipment in the process cells was locked into place with a layer of strong grout to prevent shifting and cavities of equipment with large voids were grouted to prevent buoyancy during flood grouting of the process cells through the key block opening. The top couple of feet in each cell was filled with a flowable non-aggregate void-filling slurry grout which filled the remaining voids and locked the cover blocks into place.

The hot pipe trench ventilation pipes were plugged with selected risers installed. The ventilation pipe extensions (risers) permitted grouting the hot pipe trench while the ventilation system continued operating. The lower galleries were then grouted beginning with the electrical gallery and followed by the pipe gallery. The ventilation tunnel was grouted last, through ventilation pipes in the hot pipe trench or from the ventilation duct outside the canyon. The order of grouting ensured that all the voids in the canyon were filled to the maximum extent practical."

A 2011 Interim Completion Report for the 221-U Facility indicate that the first three of five D&D project components were been completed successfully. The remaining components of the remedy selected for the disposition of the U Plant Facility items are to demolish the canyon to the level of the operating deck and the placement of an engineered barrier.

A 2011 Waste Management Conference presentation indicated that an engineering study had been undertaken on the feasibility of demolishing the U Canyon walls down to the deck level, and that the safest method of taking down these huge thick concrete walls would be to use explosives to weaken the walls and structure, and then to use heavy machinery to collapse the canyon walls and roof onto the deck. It is believed that these same methods will be used to D&D the PUREX plant and adjacent buildings, assuming that the results at U Plant continue to be satisfactory.

The PUREX Storage Tunnels will be managed as a RCRA storage unit until closure can be coordinated with the final closure plan for the PUREX Plant. There are several D&D options for the rail cars and equipment in the two tunnels, ranging from retrieving each rail car unit and disposing of it as part of the main building D&D, to leaving the railcars in place and injecting grout and backfilling the storage tunnels. An RI/FS Work Plan is scheduled to be submitted for review in September 2015. No firm date for D&D of the buildings or tunnels has been established.

Contaminant Inventory Remaining at the Conclusion of Planned Active Cleanup Period

The contaminant inventory within the demolished and buried PUREX Plant and tunnels will likely be the same as their starting points, although one option may be to move some or all of the contaminated rail cars and equipment out of the tunnels and into the canyon before final D&D. However, risk to human health, ecological receptors, or natural resources will be minimized by containment and institutional controls to eliminate potential pathways of exposure to the contaminants. This would be accomplished through waste encapsulation in grout, use of the substantial concrete canyon structure for entombment of waste, and the construction of an engineered barrier over the remaining grouted structure.

Risks and Potential Impacts Associated with Cleanup

The radioactive material inventory remaining at the end of deactivation was primarily in the form of contaminated equipment and surfaces, dust and debris, located below the deck in the process cells, with some remaining plutonium and oxide dust stabilized in gloveboxes in N Cell. No workers are expected to enter the process cells, except for possible further decontamination and disposition of the gloveboxes. A fixative would be applied to all equipment located on the deck before being moved into the cells and all workers would wear protective gear. Such workers will be required to have extensive training on hazardous waste and radiologic safety, and will wear proper protective suits and respirators, radiation monitoring badges, and will undergo regular biomonitoring.

Movement of equipment on the deck and into the cells may require size reduction and will require lifting and movement with overhead or portable cranes. Although experienced skill craft workers will be responsible for these operations and special precautions will be taken, there is always the potential for an industrial type accident or injury within these confined spaces. It should be noted that there were no accidents or injuries during the U Canyon D&D work.

Radiological, chemical and industrial related risks during D&D of the two tunnels should be low if the rail cars and equipment are grouted in place and the tunnel walls used as a permanent cover, since no workers will come into contact with the contaminants. A decision to bring the contaminated equipment inside the canyon to be made part of the Plant D&D would create potential industrial type accident risks as well as potential exposure to the contaminated equipment.

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

Facility Worker

Protection of workers from physical, chemical, and radiological hazards would be achieved by mitigating hazards, extensive planning, use of mock ups, and worker training and protection (see attached *Hanford Site Hazards Guide* and CH2MHill Safety Reference Documents at http://chprc.hanford.gov/page.cfm/CHPRCSafetyReferenceDocuments).

Co-Located Person

Protection of workers and other individuals located 100 meters from the PUREX boundary from physical, chemical, and radiological hazards would be achieved by mitigating hazards, extensive planning, use of mock ups, and worker training. Also see references in Worker section above.

Public

Surveillance and maintenance activities will continue throughout the D&D process to monitor radiological conditions, check safety related items, provide for facility-security controls and ensure there is no public access to the PUREX site by unauthorized personnel or the public.

Groundwater

Protection of groundwater will be achieved by waste encapsulation of contaminants in grout, use of the substantial concrete structure for entombment of waste, and the construction of an engineered barrier over the remaining grouted structure.

Based on an analysis similar to the one discussed in Appendix E.6 (A-AX Tank and Waste Farms) Section 6.5 (Vadose Zone Contamination), no appreciable uranium or Sr-90 plume would be expected in the next 150 years due to transport and decay (Sr-90) considerations. Thus the *Low* rating would apply after the Active Cleanup is completed to account for uncertainties.

Based on an analysis similar to the one discussed in Appendix E.6 (A-AX Tank and Waste Farms) Section 6.5, the Low rating is maintained for the Active Cleanup evaluation period.

Columbia River

Based on an analysis similar to the one discussed in Appendix E.6 (A-AX Tank and Waste Farms) Section 6.6, the Columbia River rating for this EU is ND.

Ecological Resources

Impacts on ecological resources are provided for the selected cleanup strategy as well as the “Full Removal and Disposal” alternative that was considered.

Construction of a barrier: Personnel, cars, trucks, heavy equipment and drill rigs 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).

Irrigation for re-vegetation requires a system of pumps and water, resulting in physical disturbance. Repeated irrigation from the same locations could result in some soil compaction, which can decrease plant growth in those areas, decrease abundance and diversity of soil invertebrates, and prevent fossorial snakes or mammals from using the area. Soil removal can cause complete destruction of existing ecosystem, all of the above effects on adjacent sites, but these effects are potentially more severe because of blowing soil (and seeds) and the potential for exposure of dormant seeds. In the re-vegetation stage, there is the potential for invasion of exotic species, changing the species diversity of native communities. 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. Caps and other containment systems can disrupt local resources and drainage; often non-native plants are used on caps (which can become exotic/alien adjacent to the containment site).

Removal of waste to ERDF: Trucks, heavy equipment and drill rigs 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. Drilling can cause destruction of soil invertebrates at greater depths, and has the potential to bring up dormant seeds from deeper soil layers. Drilling can cause disruption of ground-living small mammals and hibernation sites of snakes and other animals. 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). Additional water from dust suppression could lead to more diverse and abundant vegetation in areas that receive water, which could encourage invasion of exotic species. The latter could displace native plant communities. Excessive dust suppression activities could lead to compaction, which can decrease plant growth in those areas, decrease abundance and diversity of soil invertebrates, and prevent fossorial snakes or mammals from using the area. Soil removal can cause complete destruction of existing ecosystem, all of the above effects on adjacent sites, but these effects are potentially more severe because of blowing soil (and seeds) and the potential for exposure of dormant seeds. In the re-vegetation stage, there is the potential for invasion of exotic species, changing the species diversity of native communities. 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, car, and truck traffic on paved roads as well as use of heavy equipment will not have any direct impact on archaeological resources because there is no disturbance to soil/ground or alteration to the landscape. Assuming heavy equipment locations 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 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 paved roads located on TCP, direct effects include visual, auditory and vibrational alterations to landscape/setting. Heavy equipment 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.

Construction of buildings, staging areas, caps 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 building locations and staging areas 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 buildings and staging areas 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, capping 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 include 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, car, and truck traffic on paved roads as well as use of heavy equipment 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. Existing road causes no alteration to 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 construction, 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

The main PUREX building is being maintained in a safe low-maintenance condition and is surround by barbed wire fencing to prevent public or inadvertent access, and the two tunnels are sealed and the stored equipment is not currently accessible. Since the facility was placed into the S&M, a new roof was placed over the canyon and aqueous makeup areas. According to a 2014 DSA report, conditions in the facility have been relatively stable since deactivation with minor exceptions, and it is anticipated that these conditions can be maintained for a long period of time if cleanup is delayed.

PUREX Tunnel 1 was constructed in 1956. Except for a 103 foot section one wall that is composed of 3 foot thick reinforced concrete, the remaining walls and roof of the 358 foot long tunnel were constructed using 12 inch by 14 inch creosoted No. 1 Douglas Fir timbers, arranged side by side with the 12 inch side exposed. The last evaluation of the structural integrity of the tunnel was made in May 1991 by Los Alamos Technical Associates (LATA). It concluded that there was very low probability of any degradation of the timbers due to decay or insect attack, but that there was ongoing degradation occurring from continued exposure to the gamma radiation from equipment being stored there. It estimated that the strength of the timbers would be 60% of their original strength in 2001. Applying the same formulas used in that analysis to the year 2014 would indicate that the timbers are currently at about 55% of their original strength. This study indicates that standard factor of safety will be reached at 47.5% of original value. It is estimated this could occur sometime about 2040. This wood structure also offers the potential for a fire in the tunnel that would release its entire 21,200 Ci radiological inventory to the environment.

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

Populations and Resources at Risk or Potentially Impacted After Cleanup Actions (from residual contaminant inventory or long-term activities)

Table F.4-8. Populations and Resources at Risk

Population or Resource		Risk/Impact Rating	Comments
Human	Facility Worker	ND-Low	Other than periodic inspections of the final burial area, no workers will be present.
	Co-located Person	ND	None
	Public	ND-Low	Public access will be prevented by physical barriers and institutional controls
Environmental	Groundwater	Low	Based on an analysis similar to the one discussed in Appendix E.6 (A-AX Tank and Waste Farms) Section 6.5 (Vadose Zone Contamination), no appreciable uranium or Sr-90 plume would be expected in the next 150 years due to transport and decay (Sr-90) considerations. Thus the *Low* rating would apply after the Active Cleanup is completed to account for uncertainties. Based on an analysis similar to the one discussed in Appendix E.6 (A-AX Tank and Waste Farms) Section 6.5, the Low rating is maintained for this evaluation period.
	Columbia River	ND	Based on an analysis similar to the one discussed in Appendix E.6 (A-AX Tank and Waste Farms) Section 6.6, the Columbia River rating for this EU is ND.
	Ecological Resources*	ND-Low	Remote chance of penetration of roots into contaminated site, allowing exposure to residual contamination.
Social	Cultural Resources*	**Native American:** Direct: Unknown Indirect: Known	Permanent indirect effects to viewshed are possible from

		Historic Pre-Hanford: Direct: None Indirect: None **Manhattan/Cold War**: Direct: None Indirect: None	capping. No other expected cultural resources impacts.

*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.

Long-Term, Post-Cleanup Status – Inventories and Risks and Potential Impact Pathways

Risk to human health, ecological receptors, or natural resources will be minimized by containment and institutional controls to eliminate potential pathways of exposure to the contaminants. This would be accomplished through waste encapsulation in grout, use of the substantial concrete canyon structure for entombment of waste, and the construction of an engineered barrier over the remaining grouted structure. This will be designed to deter even the intrusion of future “industrial archaeologists”.

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APPENDIX G.1

LEGACY SOURCE EVALUATION UNITS

Overview of Past Practices

Radiological and hazardous waste was generated throughout the nuclear fuel cycle at Hanford Site, from fabrication and testing of nuclear fuel elements in the 300 Area, to operation of the nuclear production reactors in the 100 Areas, to chemical extraction of plutonium and other special nuclear materials from irradiated fuel elements in the 200 Areas. Radiological and hazardous waste was managed using a number of waste disposal facilities. Gaseous waste was released to the atmosphere via tall ventilation stacks. Solid waste was disposed of in landfills (termed burial grounds), and liquid waste was managed using a number of different storage and disposal facilities. Low volumes of high-level (highly radioactive) liquid waste were sent to underground storage tanks. Some of this tank waste was reprocessed to remove uranium or high-activity fission products, and then disposed into single-use specific retention trenches. Intermediate-level liquid waste was routinely discharged to underground percolation facilities (cribs, tile fields, French drains) and reverse wells. High volumes of low-level liquid waste and cooling water were discharged to ditches and ponds.

In addition to planned waste disposal, radiological and hazardous materials were accidentally released to the environment through spills, leaks (e.g., from tanks or pipelines) or intrusion into contaminated areas. Processing and waste disposal operations also resulted in an expanse of contaminated buildings, equipment, pipelines, diversion boxes, and other infrastructure.

Legacy source sites evaluated include all past practice liquid waste disposal sites, buried solid waste sites, unplanned releases, and associated underground piping and infrastructure. These include associated near-surface and deep vadose zone contaminated sediments associated with these sites. They do not include the high-level waste storage tanks or their associated infrastructure, unplanned releases, and contaminated sediments, which are covered by the tank waste and farms evaluation. Nor do they include the contaminated processing plants or associated facilities and infrastructure that are covered by the deactivation, decommissioning, decontamination, and demolition of inactive facilities evaluation.

Evaluation of the legacy source sites will include, to the extent that information is available and clearly identifies uncertainties, a summary of the amount and physical-chemical-radiological nature of contamination and all relevant pathways (including potential to impact groundwater resources) using a conceptual site model for the combined inventories within each evaluation unit.

APPENDIX G.2

618-11 BURIAL GROUND (RC-LS-1, RIVER CORRIDOR)

EVALUATION UNIT SUMMARY TEMPLATE

Table of Contents

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PART I. EXECUTIVE SUMMARY

EU LOCATION

600 Area

EU DESIGNATION

618-11 Solid Waste Burial Ground, ID: RC-LS-1

RELATED EUS

CP-GW-1

PRIMARY CONTAMINANTS, CONTAMINATED MEDIA AND WASTES

The burial ground received low to high-activity dry waste, fission products, plutonium, and other transuranic constituents in a variety of waste forms from research operations associated with the 300 Area. The inventory in the waste is varied and uncertain, and includes:

- Radioactive constituents including kg quantities of plutonium, TRU wastes, Tc oxide, thousands of curies (TBq) of mixed fission products including ^{90}Sr, ^{137}Cs, ^{147}Pm, ^{244}Cm ^{103}Ru, ^{144}Ce, and others. TRU nuclides include ^{241}Am, ^{238}Pu, ^{240}Pu, ^{237}Np, Pu-239, Ci Pu-241. There is also N-Reactor fuel, enriched to 0.95 to 1.25% ^{235}U.
- Hazardous constituents include, lead shielding, ignitable metal turnings, Th oxide, salt cycle residues, and lithium aluminate targets with tritium (PNNL 2001).
- The inventory is not well documented. A presentation to the NRC on October 18, 2012 (Dunham, 2012) (http://pbadupws.nrc.gov/docs/ML1229/ML12292A164.pdf) listed an inventory for 618-11 as ^{90}Sr (4200 Ci), ^{137}Cs (5300 Ci), ^{241}Am (226 Ci), Ci Pu-239 (132), Ci Pu-241 (639)and Beryllium(330 kg). Data from WIDS identifies only 1000 Ci ^{90}Sr, ^{137}Cs (1000 Ci), and $^{239-240}$Pu (623 Ci).

BRIEF NARRATIVE DESCRIPTION

The 618-11 Waste Burial Ground is located directly west of Energy Northwest's Columbia Generating Station and approximately 100 meters from its Nuclear Plant No. 1. (From (HNF-EP-0649 Rev. 0, 1997) pages i and ii) The 618-11 burial ground received transuranic and mixed fission waste from 9 March 1962 until 31 December 1967 (HNF-EP-0649 Rev. 0, 1997). Waste came from all of the 300 Area radioactive material handling facilities. The inventory is varied, and includes kg quantities of plutonium and other TRU wastes in three trenches. There are discrepancies in both inventory and structures within this site. Thousands of curies (TBq) of mixed fission products were disposed in trenches, caissons, and drum storage units. The burial ground consists of three trenches, approximately 900 feet long, 25 feet deep and 50 feet wide, laid out in an east-west direction(HNF-EP-0649 Rev. 0, 1997). The trenches comprise 75% of the site area. There are 50 drum storage units that consist of five, 55-gallon steel drums welded together and placed vertically in the soil. There are also approximately five, eight-foot diameter caissons situated at the west end of the drum storage units. There is some discrepancy in the number of caissons at the site. In addition to the radiological waste, this site contains hazardous chemical constituents. In 1992, USEPA and the Washington Department of Ecology requested an analysis of alternatives for the 618-11 Burial ground. Proximity of the waste to the water table and the potential for migration of contaminants were a concern based on the limited information about the waste inventory. A removal action was eliminated as an immediate need based on the absence of data to identify a threat to human health and the environment and the lack of facilities to receive, process, and/or dispose of the excavated high-activity transuranic material. A tritium plume underlies the site and extends beyond its boundaries. Tritium was not identified in the waste inventory but its presence has been attributed to the disposal of targets(PNNL-13675, 2001). Remediation of the site is problematic due to the potential for fire and explosion from waste constituents.

SUMMARY TABLE OF RISKS AND POTENTIAL IMPACTS TO RECEPTORS

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

Human Health: A Facility Worker is deemed to be an individual located anywhere within the physical boundaries of 618-11 site and a Co-located Person (CP) is an individual located 100 meters from the 618-11 site boundary, which in this case includes workers and visitors to the adjacent Energy Northwest facility; and Public is an individual located at the closest point on the Hanford Site boundary not subject to DOE access control, which in this case is also a worker or visitor to the Energy Northwest facility . The nuclear related risks to humans are based on unmitigated (unprotected or controlled conditions) dose exposures expressed in a range of from Non-Discernable (ND) to Very High. The estimated mitigated exposure that takes engineered and administrative controls and protections into consideration is shown in parenthesis.

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 Non-Discernable (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: No risk ratings are provided for Cultural Resources. A rating for cultural resources is not being made because cultural resources will be evaluated under Section 106 of the National Historic Preservation Act (16 USC 470, et. seq.) during the planning for remedial action. The resulting Section 106 process will engage all stakeholders, including Native American Tribes, concerning the Native American, Historic Pre-Hanford, and Manhattan Project/Cold War landscapes. This process will identify all cultural resources and evaluate their eligibility for the National Register of Historic Places, any direct and indirect effects from remediation, as well as the need for any mitigation actions. CRESP has consulted with the Native American Tribes having historical ties to Hanford and they consider the entire Hanford Site to be culturally and historically important.

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

Population or Resource		**Evaluation Time Periods**	
		Active Cleanup (to 2064)	
		Current Condition: Inactive Buried Waste Site	From Cleanup Actions
Human	Facility Worker	ND	Medium (Low)
	Co-located Person	ND	Medium (Low)
	Public	ND	Medium (Low)
Environmental	Groundwater	Low (Sr-90)	Low (Sr-90)
	Columbia River	ND	ND
	Ecological Resources*	ND	Low to Medium
Social	Cultural Resources*	**Native American**: Direct: Unknown Indirect: Known **Historic Pre-Hanford**: Direct: Unknown Indirect: Known **Manhattan/Cold War**: Direct: Known Indirect: Unknown	**Native American**: Direct: Unknown Indirect: Known **Historic Pre-Hanford**: Direct: Unknown Indirect: Unknown **Manhattan/Cold War**: Direct: Known Indirect: Unknown

*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.

SUPPORT FOR RISK AND IMPACT RATINGS FOR EACH TIME PERIOD

Human Health

Current

The waste site is closed, covered with soil, and vegetated. It is currently embedded with unconsolidated sands and gravels of the Hanford Formation and covered with eolian silts characteristic of this region that have been vegetated with crested wheatgrass. The vegetated silt acts as hydraulic barrier that limits percolation of meteoric water into the waste to minute amounts (1-3 mm per year).

A plume containing tritium and nitrate is beneath the site. Concentrations are diminishing due to natural dilution, dispersion, and decay such that the tritium concentration is not expected to exceed drinking water standards when the plume reaches the Columbia River. That is, natural attenuation processes are managing the plume effectively.

Risks and Potential Impacts from Selected or Potential Cleanup Approaches
Remediation of this site is currently slated for completion before the end of the Active Cleanup Period (US EPA 2013) with industrial exposure criteria set as the cleanup level. Buried wastes and associated hard infrastructure (caissons, VPUs) will be removed and disposed in ERDF. During remediation the primary pathways are likely to be air releases from energetic events and or accidental fires (the site has a mixture of potentially explosive and or pyrophoric constituents). This pathway probably would have limited distance from the area. Several activities related to characterization of the site (not remediation) have anticipated frequencies of occurrence in the 10^{-2} per year, maximum unmitigated facility worker risk from characterization is categorized as moderate (≥25 rem TEDE (0.25 Sv). Ongoing remediation of a similar site (618-10), which contains lower inventories, has already experienced small fires during excavation (see Washington Closure Hanford, LLC, Report from the Department of Energy Voluntary Protection Program Onsite Review June 11-14, 2012 – pages 14 and 15).

The risk categorization for the 618-10 burial ground (a similar, but less hazardous site) has been revised three times since 2012, making categorization of hazards from 618-11 removal activities uncertain (see Washington Closure Hanford, LLC, Report from the Department of Energy Voluntary Protection Program Onsite Review June 11-14, 2012 – pages 14 and 15). In addition, the DSA has not been updated to reflect possible changes in the Hanford site security boundaries that now allow casual non-worker offsite individuals to travel closer to the 618-11 waste site (i.e. from ca. 5 miles to ca. 0.5 miles from 618-11 to the Hanford Site security boundary). Thus, estimated dose may be greater than indicated in the DSA and this uncertainty is reflected in the risk ratings.

Sampling Pit Accident: The 618-10 and 618-11 waste sampling operations may include digging a pit to expose a trench. It is assumed that a backhoe or truck falls into the pit during the digging activities, impacting the waste in the trench. The pit is assumed to be approximately 8 ft in diameter and 6 ft deep. The potential for a fire exists because of fuel that is released when the vehicle falls or tips into the pit and because of the possibility of finding buried barrels of oil or other flammable liquids.

Unmitigated Risk: Facility Worker – Low; CP – Low; Public – Low

Mitigation: These low risk events do not require events do not require safety-class or safety-significant controls to protect the public or the collocated workers. This accident does pose a risk to the facility worker since a backhoe tip-over could result in significant non-radiological injury to the operator or to people working in the vicinity of the backhoe. Risk will be minimized by adherence to industrial safety and radiological procedures.

Caisson Waste Penetration: The 618-10 and 618-11 waste sampling operation includes plans to drill a hole in the ground near or into the top of a caisson or VPU to allow the insertion of instrumentation. This scenario assumes that the sampling operation causes the instrumentation to become contaminated. The material released is assumed reach the surface and cause an airborne release.

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

Mitigation: These low risk events do not require safety-class or safety-significant controls to protect the public or the collocated workers. Risk to the workers doing the sampling will be minimized by radiological procedures

Caisson Penetration with Fire: The caisson penetration with fire accident is similar to the scenario described above except that the penetration of the caisson is assumed to induce a fire and explosion in the caisson. The penetration of the caisson is assumed to induce an explosion in a can (used to package waste) in the caisson. This explosion is assumed to pressurize the caisson and cause a release of radioactive material. The material remaining in the caisson is assumed to be exposed to a fire and produce an additional release. The release is therefore a combination of an explosion and a fire.

Unmitigated Risk: Facility Worker –Medium; CP – Medium; Public – Medium

Mitigation: This is considered an unlikely event, but the 618-11 site is located adjacent to a public access area, Energy Northwest's Columbia Generating Station, which is located on the Hanford Site dose area. This area is not considered off site, and the unmitigated onsite dose is large enough that it is appropriate to consider administrative controls to minimize impact to this area.

Groundwater

There is no or low potential impact to a public entity in the current condition because there are no receptors in direct contact with groundwater contaminated with tritium from the 618-11 site. The tritium concentrations will be below drinking water standards by the time the reach a public receptor.

There is no known plume associated with Sr-90 from this EU. Based on the transport and decay properties of Sr-90 relative to tritium, Sr-90 is not expected to impact the groundwater. However, a *Low* rating is given to account for uncertainties.

Columbia River

Not at risk during remediation unless hydrologic events allow significant infiltration into the interred waste when the cover soil is removed for remediation. In such cases, contaminant releases could occur that could ultimate reach the Columbia River. However, there is essentially no risk imposed to the Columbia River during the remedial action.

Given the transport and decay properties of Sr-90 relative to tritium, Sr-90 is not expected to reach the Columbia River in the next 50 years. This leads to a ND rating.

Ecological Resources

Current

ND because currently there is no disturbance to site, although 10% of EU is level 3 resources and over half of buffer area is level 4 resources.

Risks and Potential Impacts from Selected or Potential Cleanup Approaches:
Low in EU because only about 10% is level 3 resources (none higher), but low to medium in buffer zone because 65 percent is level 3 and 4 resources. Disturbance could result during soil removal.

Cultural Resources

Current
There are no known recorded cultural resources located within or near this EU.

Risks and Potential Impacts from Selected or Potential Cleanup Approaches:
There are no known recorded cultural resources located within or near this EU. Surface and subsurface investigations may be necessary prior to ground disturbance.

Considerations for timing of the cleanup actions

Delay of cleanup for several decades will allow reduction in activity of the moderate lived radionuclides present at the site (e.g., ^{90}Sr and ^{137}Cs). If un-remediated in the long term, erosion may compromise the surficial soils, allowing exposure of the waste and ingress of meteoric water. Inadvertent intruders could also access the waste site if it is not subject to institutional controls.

Near-Term, Post-Cleanup Risks and Potential Impacts

This site is slated to be cleaned to industrial exposure criteria. Following cleanup activities there may be some potential for enhanced infiltration of rainwater into the site until the soil covering is sufficiently vegetated and stabilized.

PART II. ADMINISTRATIVE INFORMATION

OU AND/OR TSDF DESIGNATION(S):

This site is part of the 300 FF-2 Operable Unit[1]

COMMON NAME(S) FOR EU:

618-11 Solid Waste Burial Ground, also known as the Wye or 318-11 Burial ground

KEY WORDS:

Legacy Site, Burial ground, soils

REGULATORY STATUS:

Regulatory basis: CERCLA

Applicable regulatory documentation: Hanford Site 300 Area Record of Decision for 300-FF-2 and 300-FF-5, and Record of Decision Amendment for 300-FF-1. U.S. Environmental Protection Agency, Region 10 U.S. Department of Energy, Richland Operations Office November 2013

Applicable Consent Decree or TPA milestones: The Tri-Party Agreement Milestone M-16-00B indicates that completion of all 300 Area remedial actions are expected by 9/30/2018 (which includes 618-10/11 Burial Grounds).[2]

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[1]Page ii, Hanford Site 300 Area Record of Decision for 300-FF-2 and 300-FF-5, and Record of Decision Amendment for 300-FF-1. U.S. Environmental Protection Agency, Region 10 U.S. Department of Energy, Richland Operations Office November 2013

[2]From the 618-10-11 Project Status to EMHQ on 3-18-2014 by Matt McCormick Manager, DOE-RL. Power point presentation. Page 8.

Risk Review Evaluation Information:

Completed (Revised): January 30, 2015

Evaluated by: Kathryn A. Higley, Craig H. Benson

Reviewed by: H. Mayer

PART III. SUMMARY DESCRIPTION

Current land use

DOE Hanford Site

Designated future land use

Industrial with institutional controls

Primary EU Source Components

Legacy Source Sites

The 618-11 burial site is a closed near surface disposal site containing radioactive and hazardous solid wastes from the 300 Area. The site consists of trenches, vertical pipe units and caissons. There is a tritium and nitrate plume underlying and extending beyond the boundary of the waste site. For closure the site was capped with clean soil and vegetated.

Groundwater Plumes

The 618-11 site sits over a groundwater plume originating from two sources: 200 –East and one originating from waste within the site itself.

LOCATION AND LAYOUT MAPS

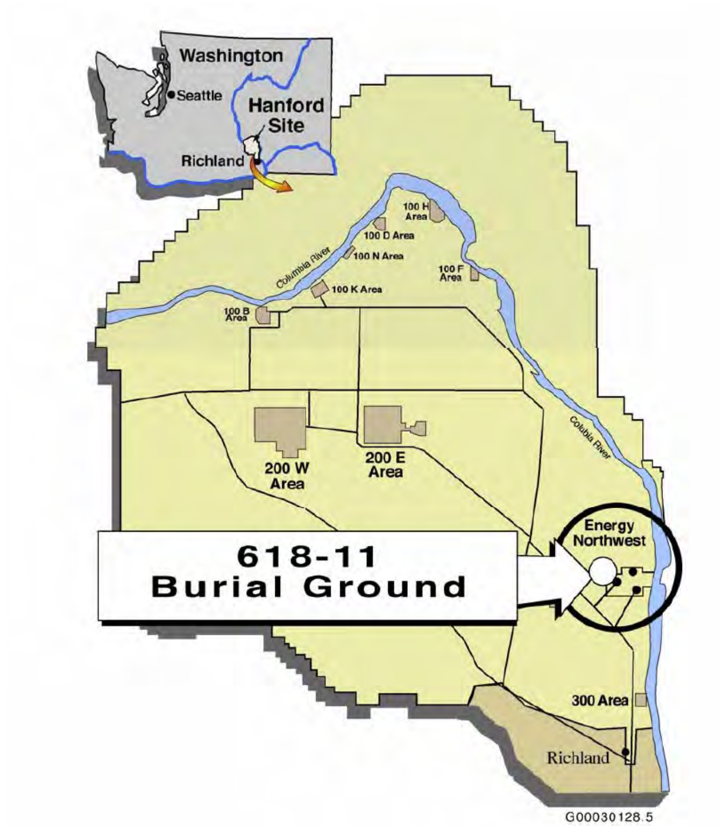


Figure G.2-1. Location of 618-11 Solid Waste Burial Ground on Hanford Site.

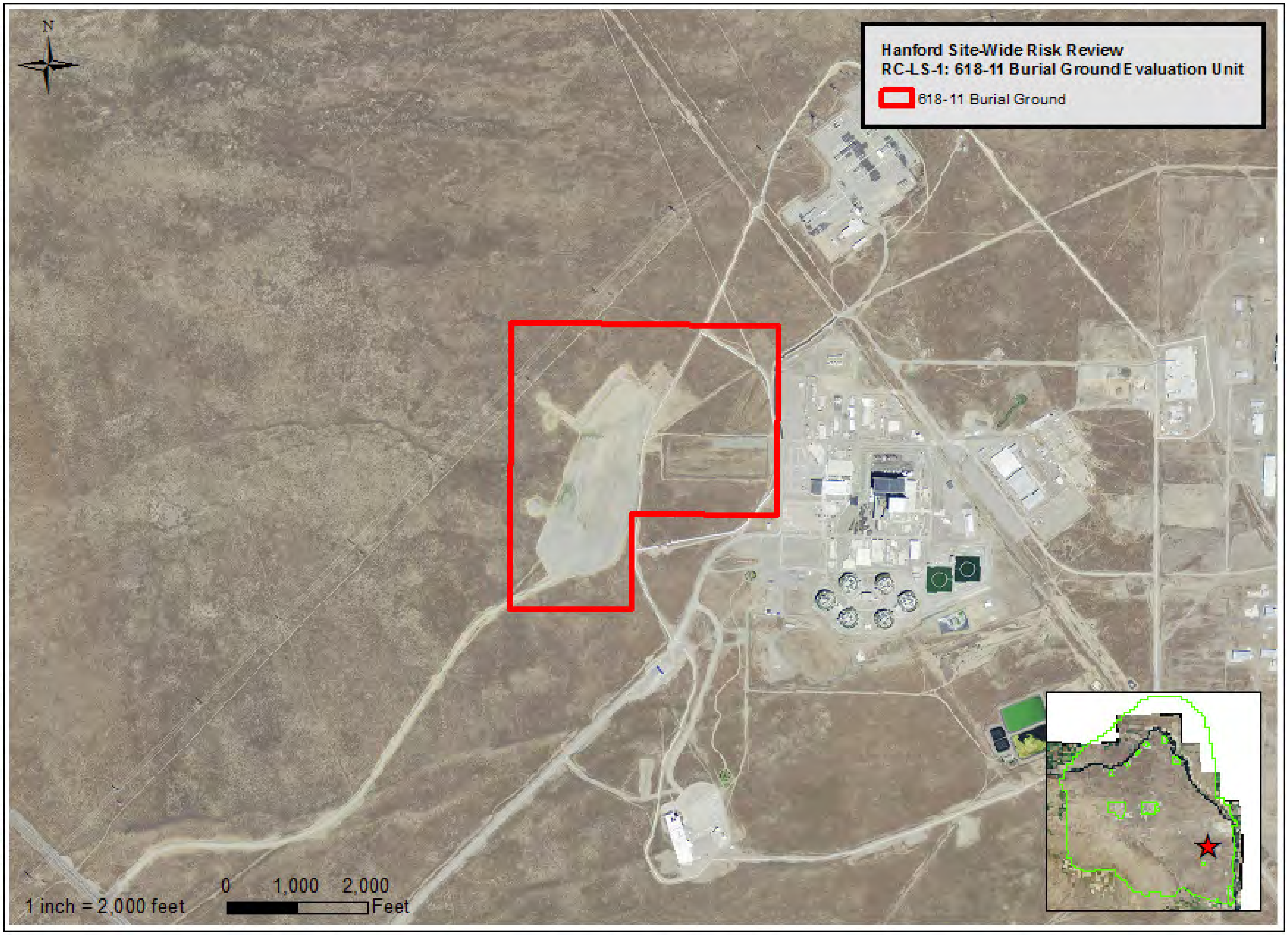


Figure G.2-2. 618-11 Burial Ground

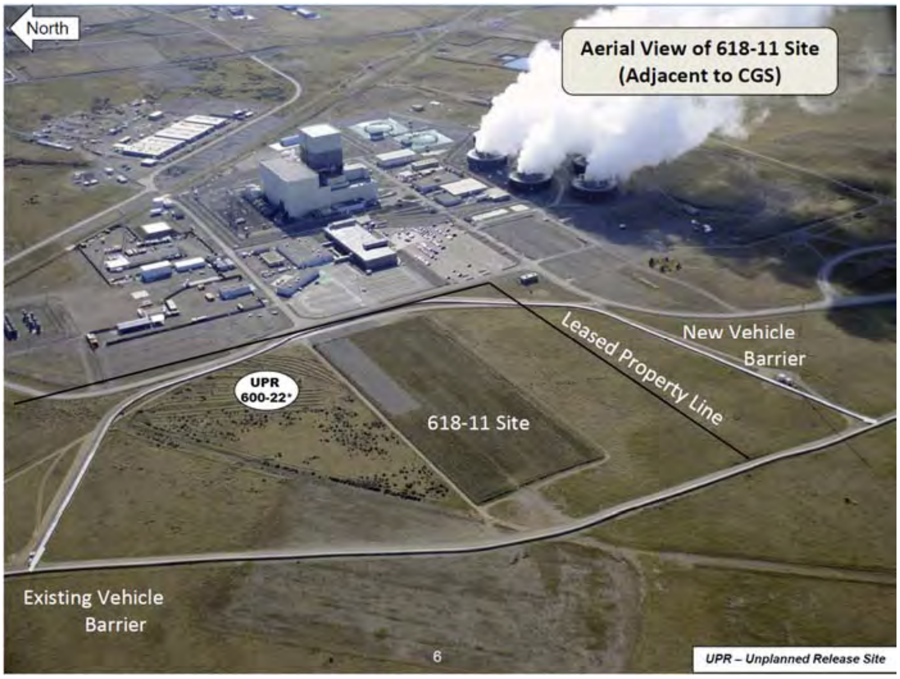


Figure G.2-3. Aerial photograph of 618-11 Solid Waste Burial Ground (rectangular area directly west of plant) adjacent to Energy Northwest plant.

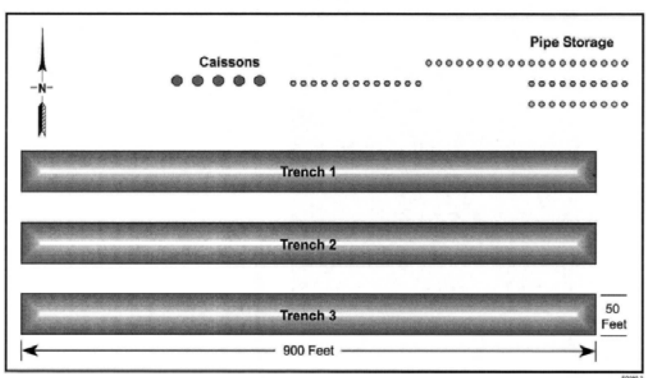


Figure 2-4. The 618-11 Waste Burial Ground.

Figure G.2-4. Schematic of 618-11 Solid Waste Burial Ground showing trenches, pipe storage units, and caissons.

PART IV. UNIT DESCRIPTION AND HISTORY

EU Former/Current Use(s)

Legacy Source Sites

What is the origin and history of the contamination (e.g., accidental release, intentional discharge, multiple discharges)?

The 618-11 burial ground received transuranic and mixed fission waste from 9 March 1962 through 2 October 1962. The burial ground was temporarily closed, additional burial facilities added, and re-opened on 16 September 1963. Waste was received until 31 December 1967. Waste disposed in 618-11 was from all of the 300 Area radioactive material handling facilities.

What are the primary contaminants (risk drivers)?

The inventory in the waste is varied, and includes kg quantities of plutonium and other TRU wastes in three trenches. There are discrepancies in both inventory and structures within this site. Thousands of curies (TBq) of mixed fission products including ^{90}Sr, ^{137}Cs, ^{147}Pm, ^{244}Cm ^{103}Ru, ^{144}Ce and others were disposed in trenches, caissons, and drum storage units. The TRU nuclides include ^{241}Am, ^{238}Pu, ^{240}Pu, ^{237}Np. Also included in the inventory is N-Reactor fuel, enriched to 0.95 to 1.25% ^{235}U. Tritium has not been listed as a primary contaminant, but has been detected in groundwater beneath the site. The tritium presence is attributed to the disposal of lithium aluminate targets used in the production of tritium (PNNL-13675, 2001).

Table G.2-2. Primary Contaminants

Category	WIDS	Data Source	Data Status	Identified Contaminants, Ci						Hazardous constituents, kg
				Sr-90	Cs-137	Pu-239, 240	Am-241	Pu - 239	Pu - 241	Be
Burial ground	600-235		No Data Found							
Burial ground	618-11	EIS-S	Data Found	1000	1000	623				
Burial ground	618-11	Dunham	Data Found	4200	5300		226	132	639	330
UPR	UPR-600-10		No Data Found							
UPR	UPR-600-22		No Data Found							
UPR	UPR-600-4		No Data Found							
UPR	UPR-600-5		No Data Found							
UPR	UPR-600-6		No Data Found							
UPR	UPR-600-7		No Data Found							
UPR	UPR-600-8		No Data Found							
UPR	UPR-600-9		No Data Found							

Are there co-contaminants that will affect mobility of the primary contaminants?

Unknown.

What is the depth of contamination and soil type/stratigraphy associated with the contamination? Is the soil profile primarily natural or heavily disrupted?

The site contains 50 vertical pipe units (11% of site), approximately 4 (actual number not confirmed) caissons, and 3 trenches (75- 88% of site) that are 900 feet long, 25 feet deep, and 50 feet wide; (see location maps in Part III). Schematics of the pipe units are shown in Fig. 1 and the caissons in Fig. 2. The trenches are shown in Fig. 3. At closure the entire area was backfilled and covered with four feet of silt loam soil in 1967 that is now vegetated with local species (HNF-EP-0649 Rev. 0, 1997). An additional two feet of clean soil was added in 1982 (page 2-27, (HNF-EP-0649 Rev. 0, 1997). Thickness of the soil cover varies based on what is covered (trench, caisson, vertical pipe units), but is at least 2 m. The waste site is currently embedded with unconsolidated sands and gravels of the Hanford Formation and covered with eolian silts characteristic of this region that have been vegetated with crested wheatgrass. The vegetated silt acts as hydraulic barrier that limits percolation of meteoric water into the waste to minute amounts (1-3 mm per year).

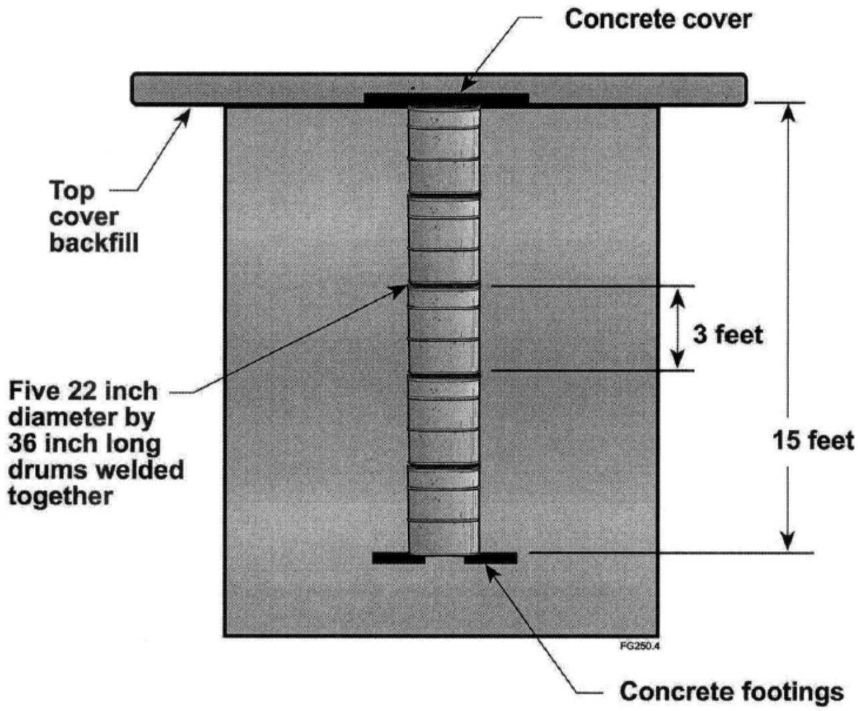


Figure G.2-5. Schematic of vertical pipe unit from CH-14592, Rev 0, 2003.

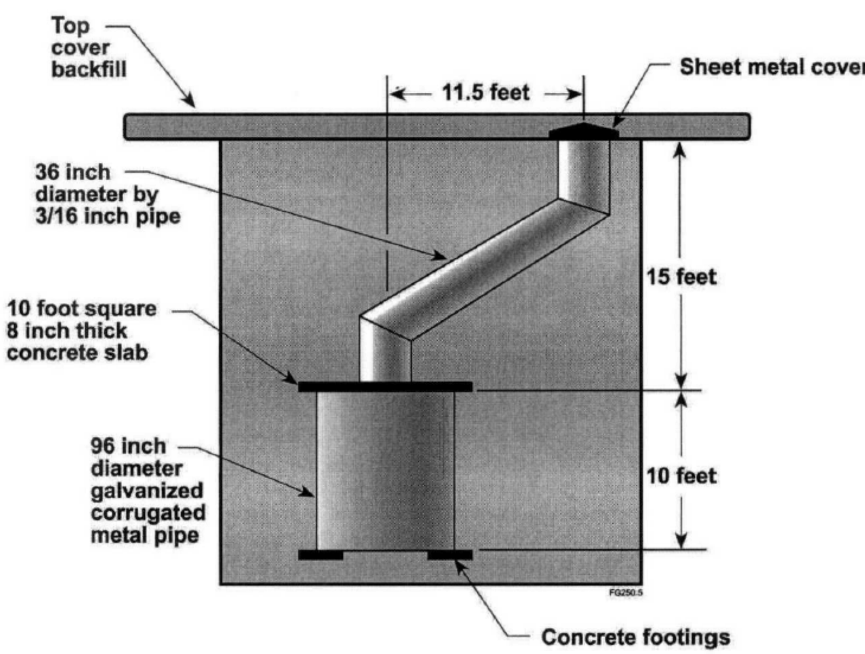


Figure G.2-6. Caisson in 618-11 area as depicted in CH-14592 Rev. 0, 2003.

Figure G.2-7. Covering boxes with radioactive contents disposed 618-11 trenches with soil, from HNF-EP-0649 Rev. 0, 1997.

What is the physical state of the primary contaminants (i.e., adsorbed in contaminated soil, as debris, in subsurface piping)?

PNNL 13765 (page 1) states the following: "The burial ground received low to high-activity dry waste, fission products, plutonium, and other transuranic constituents in a variety of waste forms from research operations associated with the 300 Area." Most of the primary contaminants are likely associated with the solid wastes and adjacent soils in the trenches, VPUs, and caissons. Some over excavation of adjacent soils will probably be necessary during the remediation.

A plume containing tritium and nitrate is beneath the site. Concentrations are diminishing due to natural dilution, dispersion, and decay such that the tritium concentration is not expected to exceed drinking water standards when the plume reaches the Columbia River. That is, natural attenuation processes are managing the plume effectively.

Is information available indicating the partition coefficients and other important transport parameters for the primary contaminants with the type of soil (if yes, provide table)?

None identified to date.

What is the source and reliability of the information available to describe the contaminants (risk drivers) and materials present?

The site is reasonably well characterized, although there remain some inconsistencies in the number of subsurface caissons, and the radionuclide inventory is incomplete.

The burial ground consists of three trenches, approximately 900 feet long, 25 feet deep and 50 feet wide, laid out in an east-west direction. The trenches comprise 75% of the site area. There are 50 drum storage units that consist of five, 55-gallon steel drums welded together and placed vertically in the soil. These are buried in three rows in the northeast corner of the site. There are also approximately five, eight-foot diameter caissons situated at the west end of the center row of the drum storage units. There is some discrepancy in the number of caissons at the site. Geophysical surveys have identified five anomalies that are presumed to be caissons (but not confirmed).

In addition to the radiological waste, this site contains hazardous chemical constituents that. Thus, the waste extracted during remediation most likely will be a mixed waste requiring disposal in accordance with both DOE 435.1 and RCRA Subtitle C.

In 1992, USEPA and the Washington Department of Ecology (henceforth "Ecology") requested an analysis of alternatives for the 618-11 Burial ground. Proximity of the waste to the water table and the potential for migration of contaminants were a concern based on the limited information about the waste inventory. A removal action was eliminated as an immediate need based on the absence of data to identify a threat to human health and the environment and the lack of facilities to receive, process, and/or dispose of the excavated high-activity transuranic material (see page 2.7 of HNF-EP-0649).

Tritium was not listed as a waste, and therefore was not a waste analyte.

GROUNDWATER PLUMES

What is the source and reliability of the information available to describe the contaminants (risk drivers) and materials present?

There are multiple sources of information regarding the plume under the 618-11 site. Two recent publications by PNNL specifically address the presence and distribution of ^{3}H under the 618-11 site. These are (PNNL-13675, 2001) and (PNNL-15293, 2005).

What is the origin of the contamination (e.g., spills, intentional discharges, disposal areas)?

Tritium is the only contaminant currently reported in groundwater (Fig. 4) that can be attributed to 618-11. PNNL conducted core drillings near the site in 1978 and gross alpha, beta, and other natural radionuclides were listed as within background ((PNNL-15293, 2005) page 2.6). The tritium is within the Hanford formation (Fig. 5). However, a contaminated groundwater plume extends from the 200 Area adjacent to 618-11, as shown in Fig. 6. Cover soils placed over the wastes in the 618-11 area are comprised of eolian sediments similar to those shown at the surface in Fig. 4.

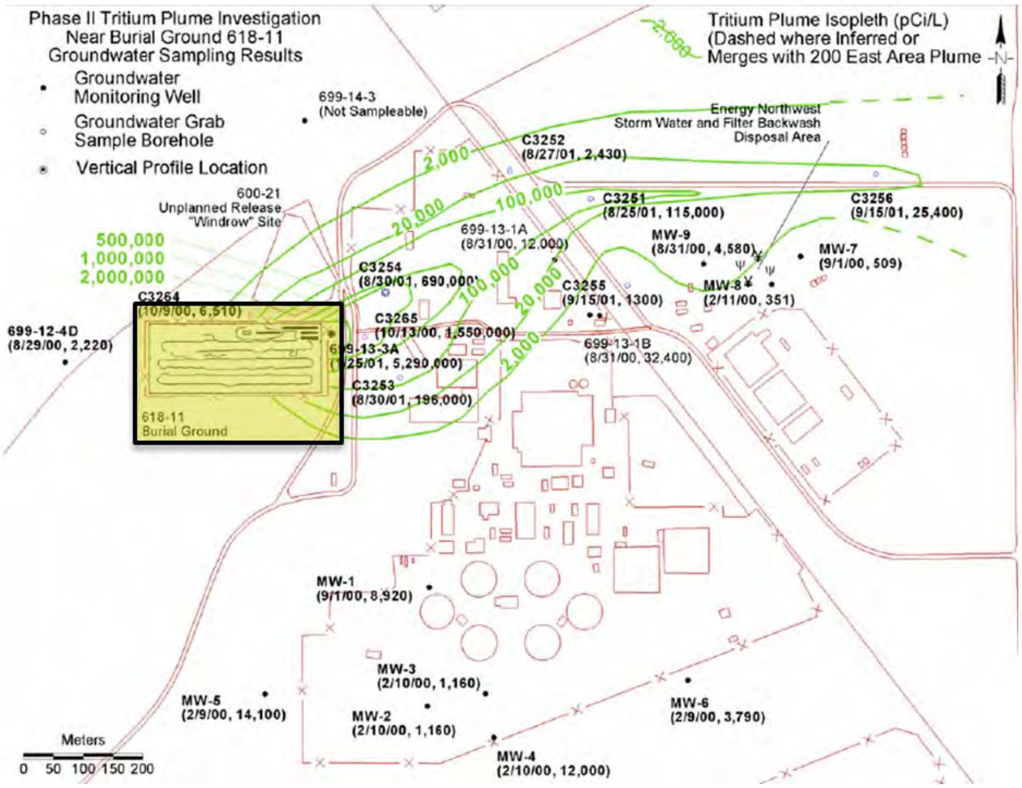


Figure G.2-8. Tritium isochors associated with the 618-11 site (yellow box), from page 2.9 of PNNL 15293.

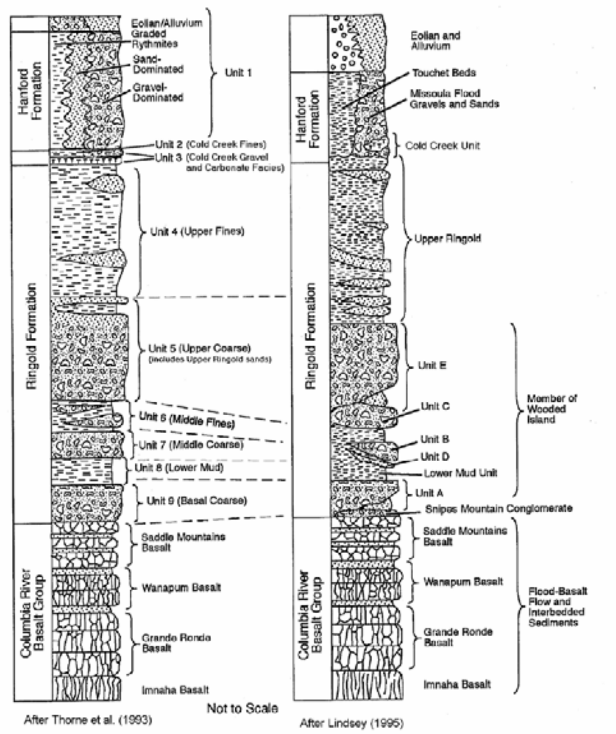


Figure G.2-9. Geological cross-section at 618-11 site.

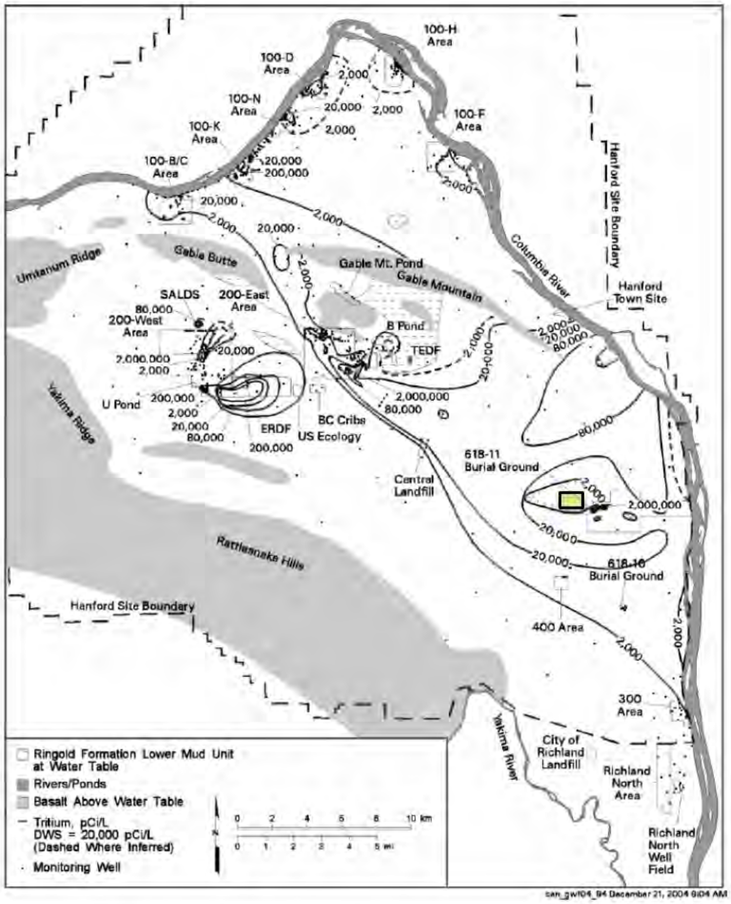


Figure G.2-10. Location of 618-11 (yellow box) and isochors of tritium concentration in Hanford formation from other sources.

What are the primary contaminants (risk drivers)?

As noted in PNNL 15293: "*The mechanisms controlling tritium release from the 618-11 Burial Ground are not well understood or have not been well characterized; thus, developing a detailed conceptual model of historic releases from the site is not possible* "(PNNL-15293, 2005)

Are there co-contaminants that will affect mobility of the primary contaminants?

The primary driver of tritium migration will be dictated by surface recharge. While this is generally low across the site (5 – 10 mm / year) there is the possibility of episodic events that may result in pulses of water through the surface.(PNNL-15293, 2005)

What is the depth of the groundwater table from the ground surface? Has the depth to groundwater changed significantly since the contamination was emplaced? How is the depth to groundwater expected to change over the period of evaluation?

From (PNNL-15293, 2005): The current water table surrounding the 618-11 Burial Ground is elevated compared to pre Hanford conditions. At a maximum, the water table was elevated more than 4.6 m (15 ft) from pre-Hanford conditions due to infiltration of a large volume of artificial recharge to the aquifer in the 200 Areas west of the site. Water level measurements more representative of pre- Hanford conditions are available from wells drilled in the 1950s. These older water level measurements suggest that the pre-Hanford water table near the 618-11 Burial Ground was close to where the Ringold Formation contacts the overlying Hanford/Pre-Missoula gravel and sand sequences. This regionally stable water table condition likely existed because the water table could not be sustained in the high hydraulic conductivity Hanford formation sediments above this contact under the low natural recharge conditions.

> From (DOE/RL-2011-47, 2013) “ the thickness of the vadose zone at the 618-11 Burial Ground is…. 19 m (63 ft).”

What is the depth of contamination and sediment types/stratigraphy associated with the contamination?

From (PNNL-15293, 2005):

> “The 618-11 Burial Ground and the Energy Northwest nuclear power plant complex are constructed on suprabasalt sediments of Miocene to Pleistocene age (Figure 5). The stratigraphic column includes, in ascending order from oldest to most recent, the Columbia River Basalt Group, Ringold Formation coarse-grained facies of the Cold Creek unit, and Hanford formation. In addition, a thin, regionally discontinuous veneer of Holocene alluvium and eolian sediment overlies the principal geologic units.”
>
> “The suprabasalt sediments are the most significant hydrogeological units in terms of contaminant transport beneath the area because they form the uppermost aquifer system. This aquifer system is the primary groundwater contaminant pathway to the Columbia River. The upper aquifer system consists of an upper unconfined aquifer and deeper zones that have confined to semi-confined aquifer conditions. The Elephant Mountain Member basalt forms the bottom of this uppermost aquifer system more than 150 m (500 ft) beneath the surface. Confined aquifer conditions exist beneath the Elephant Mountain Member basalt. The confined aquifer system is used for water supply at WNP-1 (two wells) and for emergency supply at WNP-2 (one well). Information obtained from well drilling records, and recent water level measurements confirm that the basalt-confined aquifers have a higher water level (potentiometric surface) than the uppermost unconfined aquifer, resulting in upward flow if any leakage occurs between the two aquifers. This condition significantly reduces the possibility of a downward movement of tritium into the lower, deeper confined aquifer.”
>
> “The water table may be found within the Hanford formation, the Cold Creek gravel unit, or the Ringold Formation in the vicinity of the 618-11 Burial Ground because of structural features created at the top of the Ringold Formation by cataclysmic flooding, fluvial reworking, and erosion by the Columbia River. Areas where saturated Hanford formation sediments are thin or absent are expected to provide barriers to flow or to significantly decrease groundwater velocity. Ringold Formation sediments are interpreted to exist above the water table beneath the 618-11 Burial Ground and in some areas east (i.e., no saturated Hanford sediments are present “.

What is the physical state of the primary contaminants (e.g., adsorbed in contaminated sediments, dissolved in groundwater, present in or as non-aqueous phase fluids)?

Dissolved

Are perched water or contaminated hydrologic lenses present?

Not certain, but unlikely.

Are there continuing contaminant sources that are currently adding to the extent of contamination or may in do so in the future over the evaluation period? (Can the source concentrations be defined for the primary contaminants?)

Not certain, but unlikely.

Is information available indicating the partition coefficients and other important transport parameters for the primary contaminants in the site hydrologic materials? (If yes, provide table.)

No

Is there information on the site contamination and hydrology with respect to interpreting current and future plume migration (e.g., temporal history of plume to estimate rate of spread)?

Yes. Quoting from (PNNL-15293, 2005):

- Tritium concentrations near the 618-11 Burial Ground show a decreasing trend since peak values occurred during 2000. Current levels (~2 M pCi/L) still greatly exceed the drinking water standard.
- The decrease in concentration close to the source cannot be entirely accounted for by radioactive decay, indicating that transport processes are impacting tritium concentrations and suggesting dispersal of a "pulse" release that was first identified in 1999~2000.
- Relatively constant or gradually increasing trends are observed at wells along the downgradient flow path from the burial ground, indicating a relatively slow downgradient migration of the tritium plume
- The general shape of the tritium plume has remained nearly constant since the first maps were drawn in 2000.

ECOLOGICAL RESOURCES SETTING

Landscape Evaluation and Resource Classification

The spatial area of each level of biological resources was evaluated at two scales: 1) within the 618-11 Burial Grounds EU, and 2) within a circular area radiating 1164 m from the geometric center of the site (equivalent to 1052 acres).

The EU was originally characterized as containing habitats classified as levels 0, 2, and 4 (DOE/RL-96-32 2013). However, those areas of the EU that were originally classified as level 4 habitat were reclassified in this assessment as level 0 (bladed lay down area to west), and level 2 and 3 habitats based on field observations and data collected during the July 2014 field visit. Resource levels within the landscape buffer area outside the EU were not re-classified for this assessment.

Field Survey

Vegetation on the area of the 618-11 Burial Ground within the EU was visually estimated to be composed of approximately 30% to 40% crested wheatgrass (Agropyron cristatum), an introduced perennial bunchgrass planted for erosion control, and approximately 10% to 20% Russian thistle (Salsola tragus).

Vegetation was measured in habitat patches to the north in a stand dominated by big sagebrush (Artemisia tridentata) and gray rabbitbrush (Ericameria nauseosa), in grasslands to the west, and south of the burial ground, as well as within the bladed laydown area.

No information was found documenting previous wildlife surveys of the 618-11 Burial Ground. Wildlife species (or their sign) observed during the July 2014 survey include horned lark (Eremophila alpestris), loggerhead shrike (Lanius ludovicianus), western meadowlark (Sturnella neglecta), common raven (Corvus corax), unknown hawk (Buteo spp.), northern pocket gopher (Thomomys talpoides), coyote (Canis latrans), and American badger (Taxidea taxus).

CULTURAL RESOURCES SETTING:

Most of the 618-11 EU has been inventoried for archaeological sites with negative findings. There is a possibility that intact archaeological material is present in the areas that have not been inventoried for archaeological resources (both on the surface and in the subsurface), particularly if undisturbed soil deposits exist within the 618-11 EU. Closure and remediation of the 618-11 EU have addressed in an

NHPA Section 106 review completed. The Hanford Site Plant Railroad a contributing property within the Manhattan Project/Cold War era Landscape with documentation required is located within 500 meters of the 618-11 EU. In accordance with the 1998 Hanford Site Manhattan Project and Cold War Era Historic District Treatment Plan (DOE/RL-97-56), all documentation requirements have been completed for this property.

Historic maps indicate that there is no evidence of historic-era land use within the 618-11 EU. Given the presence of roads on 1943 aerial photographs, the potential for Manhattan Project/Cold War archaeological resources to be present in the 618-11 EU is slightly higher but still low. Varying geomorphology and ground disturbance indicators suggests a range of potential for the presence of intact archaeological resources associated with all three landscapes to be present depending on the location of these soils within the 618-11 EU. Because none of the 618-11 EU has been investigated for subsurface for archaeological sites especially where Holocene deposits and pockets of undisturbed soil exist, it may be appropriate to conduct surface and subsurface archaeological investigations in these areas prior to initiating a remediation activity. 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 associated with these landscapes (e.g. East Benton Historical Society, Prosser Cemetery Association, Franklin County Historical Society, the Reach, and the B-Reactor Museum Association) may need to occur. Indirect effects are always possible when TCPs are visible from the 618-11 EU. Consultation with Hanford Tribes may also 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

CONTAMINATION WITHIN PRIMARY EU SOURCE COMPONENTS

Legacy Source Sites

This site was a near surface waste disposal facility that received waste from the 300 Area. The waste was primarily solid waste in a variety of forms.

From (Landon and Nolan, 2007):

> "The waste material was generated during laboratory examinations and studies, including analyses of fuel reactor samples, characterization of the chemical and physical properties of immobilized forms of plutonium, and analysis of ruptured reactor fuel. … These analyses, performed in glove boxes, fume hoods and hot cells, used a wide variety of electrochemical, spectrophotometric, and physical tests that generated primarily inorganic (e.g., aluminum- and iron-based metal, glass, ceramics, and asbestos) and organic debris (e.g., plastic, rubber, paper, cloth, wood) waste materials. Specific waste items may include wipes, towels, protective clothing, cardboard, metal cans, High Efficiency Particulate Air (HEPA) filters, stainless steel tubing, plastic pipe, lead (brick s and sheeting), polyethylene bottles, failed machinery, used lab WM'07 Conference, February 25 – March 1, 2007, Tucson, AZ ware (beakers, pipettes, vial s, and tubing), gloves, lab equipment (balances, drying ovens, heating mantles, pumps and reaction vessels), thermometers, concrete, soil, plumbing fixtures, and tools (screw drivers, wrenches, and shears). .… Some drums disposed in trenches contain oil. Also included are sample residues from fuel pellets, ruptured fuel elements, ceramics and grouted plutonium in cans. … The radiological inventory includes uranium oxides, fission products, and plutonium. In most cases, plutonium will be found with various fission products, but in some of the generating facilities, separation of various isotopes took place, creating isolated streams of plutonium, promethium, cesium, curium, strontium, and americium…"

What are the primary contaminants (risk drivers)?

The inventory is not well documented. A presentation to the NRC on October 18, 2012 by Zach Dunham (http://pbadupws.nrc.gov/docs/ML1229/ML12292A164.pdf) listed an inventory for 618-11 as ^{90}Sr (4200 Ci), ^{137}Cs (5300 Ci), ^{241}Am (226 Ci), 132 Ci Pu-239, 639 Ci Pu-241 and 330 kg Beryllium. Data from WIDS identifies only 1000 Ci ^{90}Sr, ^{137}Cs (100 Ci), and $^{239-240}$Pu (623 Ci).

The time of estimated activity for the radioactive constituents needs to be confirmed. The waste constituents are classified as "principal threat waste" because of TRU (DOE/RL-2011-47, 2013)(pg. 24).

What is the physical state of the primary contaminants (e.g., adsorbed in contaminated soil, as debris, in subsurface piping)?

Surficial contamination was noted (1980) after the site was initially closed and covered with soil. The entire site was subsequently re-graded, backfilled with an additional two feet of soil, ad seeded with crested wheat grass. The seed was irrigated for six weeks to establish the vegetation (page 2-27 (HNF-EP-0649 Rev. 0, 1997)).

After a marked increase in tritium concentration (January 2000) was detected in monitoring well 699-13-3A down gradient of the site, a detailed investigation was launched (PNNL-15293, 2005) to determine the source. Although tritium was not listed as one of the radioactive constituents of the waste inventory for 618-11, operation of the burial ground coincided with development of lithium aluminate targets used for the production of tritium (PNNL-13675, 2001). Waste from the tritium target activities may have been disposed in 618-11 and be the source of the tritium.

According to DOE/RL-2011-47 (Revision 0, page 33), "tritium concentrations would decline to below the DWS by 2031 under all alternatives, assuming no additional tritium input to groundwater." This statement, however, does not address additional tritium releases that might occur. However, provided the site remains covered with a vegetated soil layer, additional releases of tritium are unlikely due to the very low percolation rates at the near surface in the region.

Other contaminants associated with the inventory likely are bound within the existing solid waste as sorbed material or as part of a complex (e.g., salt) based on their original disposition. With limited infiltration and deep percolation of meteoric water, most of the contaminants likely are in their original or near original state.

Detailed inventories are provided in Table G.2-3, Table G.2-4, and Table G.2-5. All values are to 2 significant figures. The source document should be consulted for greater precision data. The sum for each primary contaminant is shown in the first row. Table G.2-6 provides a summary of the evaluation of threats to groundwater as a protected resource from saturated zone and remaining vadose zone contamination associated with the evaluation unit.

Vadose Zone Contamination

As part of the effort to determine the source of ^{3}H contamination near 618-11 helium-3/helium-4 ratios were measured in soil gas samples collected near the burial ground and along downgradient transects oriented both longitudinally and transverse to the direction of groundwater flow. Results from this investigation indicated that the source of the tritium was the 618-11 Burial Ground, as evidenced by the high helium-3/helium-4 ratio soil gas results in the vadose zone, high tritium in groundwater grab samples, and low tritium values from upgradient wells (PNNL-13675, 2001, PNNL-15293, 2005)

Groundwater Plumes

Specific inventory of ^{3}H in groundwater attributed to the 618-11 burial site has not been found.

From (DOE/RL-2011-47, 2013) " Tritium in groundwater that exceeds the 20,000 picocurie per liter (pCi/L) DWS occurs in five wells downgradient from the 618-11 Burial Ground. Tritium concentrations from the 618-11 Burial Ground do not, and are not predicted to, affect the Columbia River above the DWS (Section 5.7.4 of the 300 Area RI/FS report [DOE/RL-2010-99])."

From (DOE/RL-2011-47, 2013): "Nitrate concentrations also exceed the DWS at four wells downgradient from the 618-11 Burial Ground. The extent of the nitrate plume is similar to the extent of the tritium plume shown on Figure 4-73 in the 300 Area RI/FS report (DOE/RL-2010-99)."

Table G.2-3. Inventory of Primary Contaminants[(a)]

WIDS	Description	Decay Date	Ref	Am-241 (Ci)	C-14 (Ci)	Cl-36 (Ci)	Co-60 (Ci)	Cs-137 (Ci)	Eu-152 (Ci)	Eu-154 (Ci)	H-3 (Ci)	I-129 (Ci)
All	Sum			230	NP	NP	NP	5300	NP	NP	NP	NP
618-11	Burial Ground	Unknown	DUNHAM, Z. 2012	230	NP	NP	NP	5300	NP	NP	NP	NP

a. NP = Not present at significant quantities for indicated EU

Table G.2-4. Inventory of Primary Contaminants (cont)[(a)]

WIDS	Description	Decay Date	Ref	Ni-59 (Ci)	Ni-63 (Ci)	Pu (total) (Ci)	Sr-90 (Ci)	Tc-99 (Ci)	U (total) (Ci)
All	Sum			NP	NP	770	4200	NP	NP
618-11	Burial Ground	Unknown	DUNHAM, Z. 2012	NP	NP	770	4200	NP	NP

a. NP = Not present at significant quantities for indicated EU

Table G.2-5. Inventory of Primary Contaminants (cont)[(a)]

WIDS	Descrip-tion	Ref[(b)]	CCl4 (kg)	CN (kg)	Cr (kg)	Cr-VI (kg)	Hg (kg)	NO3 (kg)	Pb (kg)	TBP (kg)	TCE (kg)	U (total) (kg)
All	Sum		NP	NP	NP	NP	NP	NP	NP	NP	NP	NP
618-11	Burial Ground	DUNHAM, Z. 2012	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP

a. NP = Not present at significant quantities for indicated EU

Table G.2-6. Summary of the Evaluation of Threats to Groundwater as a Protected Resource from Saturated Zone (SZ) and Remaining Vadose Zone (VZ) Contamination associated with the Evaluation Unit

PC	Group	WQS	Porosity[a]	K_d (mL/g)[a]	ρ (kg/L)[a]	VZ Source M^{Source}	SZ Total M^{SZ}	Treated[c] M^{Treat}	VZ Remaining M^{Tot}	VZ GTM (Mm^3)	VZ Rating[d]
C-14	A	2000 pCi/L	0.18	0	1.84	---	---	---	---	---	ND
I-129	A	1 pCi/L	0.18	0.2	1.84	---	---	---	---	---	ND
Sr-90	B	8 pCi/L	0.18	22	1.84	4.20E+03 Ci	---	---	4.20E+03 Ci	2.32E+03	Low[e]
Tc-99	A	900 pCi/L	0.18	0	1.84	---	---	---	---	---	ND
CCl4	A	5 µg/L	0.18	0	1.84	---	---	---	---	---	ND
Cr	B	100 µg/L	0.18	0	1.84	---	---	---	---	---	ND
Cr-VI	A	10 µg/L[(b)]	0.18	0	1.84	---	---	---	---	---	ND
TCE	B	5 µg/L	0.18	2	1.84	---	---	---	---	---	ND
U(tot)	B	30 µg/L	0.18	0.8	1.84	---	---	---	---	---	ND

a. Parameters obtained from the analysis provided in Attachment 6-1 to Methodology Report.

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

c. Treatment amounts from the 2013 Hanford Annual Groundwater Report (DOE/RL-2014-32, Rev. 0).

d. Groundwater Threat Metric rating based on Table 6-3, Methodology Report.

e. There is no known plume associated with Sr-90 from this EU. Based on the transport and decay properties of Sr-90 relative to tritium, Sr-90 is not expected to impact the groundwater. However, a *Low* rating is given to account for uncertainties.

PART VI. POTENTIAL RISK/IMPACT PATHWAYS AND EVENTS

CURRENT CONCEPTUAL MODEL

Narrative description of pathways and barriers to receptors and conditions/events that can lead to completed pathways

Pathways and Barriers: (1. description of institutional, natural and engineered barriers (including material characteristics) that currently) mitigate or prevent risk or impacts, 2. Time scale from loss of each barrier to realization of risk or impacts)

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

From (DOE/RL-2011-47, 2013) page 27, "The current human exposure scenario is industrial. Exposure to contamination in the 300 Area is currently controlled by DOE's site controls to prevent unacceptable exposure to humans. Risks to current workers are managed through health and safety programs."

1. *What nuclear and non-nuclear safety accident scenarios dominate risk at the facility?*

The hazard evaluation (from CP-14592 rev 0) identified two categories of accidents: fire and inadvertently exhumed waste. The caisson penetration with fire dominated the risk. What are the response times associated with each postulated scenario? Response times were not specified

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

This accident is assessed as a risk bin III, Hazard Category 3

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

Administrative controls are considered sufficient.

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?*

The current barriers to release include an intact soil cover over the waste site. The depth varies based on what is covered (trench, caisson, vertical pipe units), but the cover is at least 2 m of clean soil. In addition, specific waste disposal units such as the vertical pipe units and caissons hold the higher activity wastes in a constrained fashion. Boxes containing low level wastes that were disposed in the trenches probably have degraded.

The tritium and nitrate plumes that have extended beyond the site boundaries indicate that some wastes may have reduced physical integrity. However, as noted in (DOE/RL-2011-47, 2013): "A fate and transport model was constructed for tritium in the groundwater that exceeds the federal DWS beneath the 618-11 Burial Ground. This analysis determined that the tritium concentrations would decline to below the DWS by 2031 under all alternatives, assuming no additional tritium input to groundwater."

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

This site is scheduled for remediation within the next five years. Deep erosion of the cover soils or structural failure of any buried components (e.g., caissons) is unlikely, and therefore release due to degradation is unlikely. However, an atmospheric release of radioactivity is likely during characterization and remediation of the site (risk > 10^{-2}).

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

This site is situated adjacent to the Columbia Generating Station. The principal pathways of release are through fire and /or explosion of reactive contents of the site, triggered by remediation activities. The primary population at risk is the onsite worker conducting the remediation. Secondary populations include workers at the adjacent nuclear plant and members of the public in the vicinity of the site.

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

Seconds.

8. *Are there current on-going releases to the environment or receptors?*

There is a tritium and nitrate plume extending from underneath the site. The tritium plume is possibly a pulsed release historically, and very slow and low-flux release currently due to percolation of meteoric water.

Table G.2-7. Table of relevant initiating events and potential impacts.

Risk posed by 681-11 waste site (primary facility)			
Population or Resource	**At risk?** (Yes or No)	**If yes, identify & estimate quantity where applicable**	**Brief description**
Facility Worker	Yes	See (CP-14592 Rev. 0, 2003) Table 3-4 and 3-5	Several activities related to characterization of the site (not remediation) have anticipated frequencies of occurrence in the 10^{-2} per year, maximum worker risk is categorized as Low to Medium
Co-located Person and Public (same definition of onsite worker because of Energy Northwest facility)	Yes		Several activities related to characterization of the site (not remediation) have anticipated frequencies of occurrence in the 10^{-2} per year, maximum Co-located Worker and Public risk is categorized as Low to Medium.
Soils	Yes		May become contaminated as wastes are removed.
Vadose zone (below 5 m depth)	Yes	Already contaminated	Additional releases possible, but unlikely, when cover soils are removed to access wastes for removal.
Groundwater	Yes	Principally tritium	From past releases. Additional releases possible, but unlikely, when cover soils are removed to access wastes for removal.
Surface water	Yes	Note PNNL's modeling suggest concentrations will not exceed DWS	Additional releases possible, but unlikely, when cover soils are removed to access wastes for removal.
Specific protected biota or ecosystem	No		
Cultural Resources	No		

POPULATIONS AND RESOURCES CURRENTLY AT RISK OR POTENTIALLY IMPACTED

Facility Worker

None except for those associated with groundwater monitoring. They are exposed to low risk.

Co-located Person

None.

Public

Not Applicable

Groundwater

There is no or low potential impact to a public entity in the current condition because there are no receptors in direct contact with groundwater contaminated with tritium from the 618-11 site. The tritium concentrations will be below drinking water standards by the time the reach a public receptor.

There is no known plume associated with Sr-90 from this EU. Based on the transport and decay properties of Sr-90 relative to tritium, Sr-90 is not expected to impact the groundwater. However, a *Low* rating is given to account for uncertainties.

Columbia River

Tritium concentrations will be below drinking water standards by the time the reach a public receptor. There is no known plume associated with Sr-90 from this EU. This leads to a rating of ND.

Ecological Resources (from ecological summary for 618-11 Burial Grounds)

Summary of Ecological Review:

- More than half of the EU consists of level 2 (mixed native and non-native grassland) resources. Approximately 13 acres of the EU contain a mixed sagebrush and rabbitbrush stand that qualifies as level 3 habitat, although it is degraded by invasion with non-native grasses and forbs. This area is also adjacent to another operable unit.
- The EU is adjacent and contiguous to a large industrial site— because this industrial area already affects habitat connectivity, cleanup activities inside the EU are not expected to impact habitat connectivity through loss of habitat or fragmentation;
- No species of concern were observed within or in the vicinity of the EU during the July 2014 surveys.
- Approximately 56% of the total landscape area evaluated is classified as level 3 or higher biological resources, which are not expected to be significantly impacted by cleanup actions within the EU.

Cultural Resources:

Summary:

- There are no known recorded archaeological sites, buildings or TCPs located within the 618-11 EU.

Archaeological sites and TCPs located within 500 meters of the EU

- The Hanford Site Plant Railroad a contributing property within the Manhattan Project/Cold War era Landscape with documentation required is located within 500 meters of the 618-11 EU. In accordance with the 1998 Hanford Site Manhattan Project and Cold War Era Historic District Treatment Plan (DOE/RL-97-56), all documentation requirements have been completed for this property.

Recorded TCPs Visible from the EU

- TCPs associated with the Native American Precontact and Ethnographic Landscape may be visible from the 618-11 EU.

CLEANUP APPROACHES AND END-STATE CONCEPTUAL MODEL

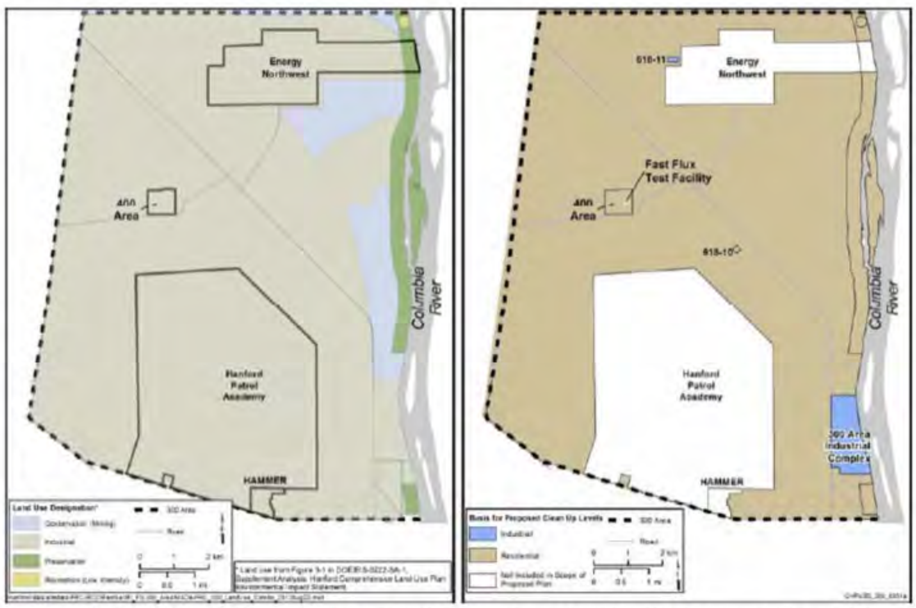
Selected or Potential Cleanup Approaches:

What are the selected cleanup actions or the range of potential remedial actions?

The major components of the selected remedy for 618-11 under the 300-FF-2 OU are[3]:

- Remove, treat, and dispose (RTD) at waste sites
- Temporary surface barriers and pipeline void filling
- Enhanced attenuation of uranium using sequestration in the vadose zone, periodically rewetted zone (PRZ) and top of the aquifer, and
- Institutional Controls (ICs), including the requirement that DOE prevent the development and use of property that does not meet residential CULs at 618-11 for other than industrial uses, including use of property for residential housing, elementary and secondary schools, childcare facilities and playgrounds.

From Figure 13 of (DOE/RL-2011-47, 2013) the proposed industrial level cleanup for 618-11:



Source: DOE/EIS-0222-SA-01, *Supplement Analysis: Hanford Comprehensive Land-Use Plan Environmental Impact Statement* (left figure).

Figure 13. Land Use Plan in DOE's NEPA Document (on left), and Exposure Basis for the Proposed Cleanup Levels (on right)

The proposed remediation goals for 618-11 are shown in the table below (DOE/RL-2011-47, 2013) pages 67-69

[3] Hanford Site 300 Area Record of Decision for 300-FF-2 and 300-FF-5, and Record of Decision Amendment for 300-FF-1 U.S. Environmental Protection Agency, Region 10 U.S. Department of Energy, Richland Operations Office November 2013

Table A-1. Preliminary Remediation Goals for Protection of Human Health and for Groundwater and Surface Water Protection

Contaminant	Hanford Site Background Concentration[d]	PRGs[a,b] Based on the Residential Scenario for Areas Outside Both the 300 Area Industrial Complex and the 618-11 Burial Ground		PRGs[b,c] for Areas Inside the 300 Area Industrial Complex and the 618-11 Burial Ground	
		Proposed Shallow PRGs for Protection of Human Health (<= 4.6 m [15 ft] bgs)	Proposed Vadose Zone PRGs (Irrigation) for Groundwater and Surface Water Protection[f]	Proposed Shallow PRGs for Protection of Human Health (<= 4.6 m [15 ft] bgs)	Proposed Vadose Zone PRGs for Groundwater and Surface Water Protection[e]
Radionuclides (pCi/g)					
Americium-241	--	32	--[g]	210	--[g]
Cesium-137	1.1	4.4	--[g]	18	--[g]
Cobalt-60	0.0084	1.4	--[g]	5.2	--[g]
Europium-152	--	3.3	--[g]	12	--[g]
Europium-154	0.033	3.0	--[g]	11	--[g]
Europium-155	0.054	125	--[g]	518	--[g]
Iodine-129	--	0.076	12.8	1,940	37.1
Plutonium-238	0.0038	39	--[g]	155	--[g]
Plutonium-239/240	0.025	35	--[g]	245	--[g]
Plutonium-241	--	854	--[g]	12,900	--[g]
Technetium-99	--	1.5	272	166,000	420
Total beta radiostrontium (Strontium-90)	0.18	2.3	227,000	1,970	--[g]
Tritium	--	459	9,180	1,980	12,200
Uranium-233/234	1.1	27.2	--[h]	167	--[h]
Uranium-235	0.11	2.7	--[h]	16	--[h]
Uranium-238	1.1	26.2	--[h]	167	--[h]
Total uranium isotopes (summed)	--	56.1	--[h]	350	--[h]
Chemicals (mg/kg)					
Antimony	0.13	32	252	1,400	760
Arsenic	6.5	20[i]	20[i]	20[i]	--[g]
Barium	132	16,000	--[g]	700,000	--[g]
Beryllium	1.5	160	--[g]	7,000	--[g]
Cadmium	0.56	80	176	3,500	--[g]
Chromium (total)	18.5	120,000	--[g]	>1,000,000	--[g]
Chromium (hexavalent)	--	2.1	2.0[j]	10,500	2.0[j]
Cobalt	15.7	24	--[g]	1,050	--[g]
Copper	22	3,200	3,400	140,000	--[g]
Lead	10.2	250	1,480	1,000	--[g]

Table A-1. Preliminary Remediation Goals for Protection of Human Health and for Groundwater and Surface Water Protection

Contaminant	Hanford Site Background Concentration[d]	PRGs[a,b] Based on the Residential Scenario for Areas Outside Both the 300 Area Industrial Complex and the 618-11 Burial Ground		PRGs[b,c] for Areas Inside the 300 Area Industrial Complex and the 618-11 Burial Ground	
		Proposed Shallow PRGs for Protection of Human Health (<= 4.6 m [15 ft] bgs)	Proposed Vadose Zone PRGs (Irrigation) for Groundwater and Surface Water Protection[f]	Proposed Shallow PRGs for Protection of Human Health (<= 4.6 m [15 ft] bgs)	Proposed Vadose Zone PRGs for Groundwater and Surface Water Protection[e]
Lithium	13.3	160	--[g]	7,000	--[g]
Manganese	512	11,200	--[g]	490,000	--[g]
Mercury	0.013	24	8.5	1,050	--[g]
Nickel	19.1	1,600	--[g]	70,000	--[g]
Selenium	0.78	400	302	17,500	912
Silver	0.17	400	--[g]	17,500	--[g]
Strontium	--	48,000	--[g]	>1,000,000	--[g]
Thallium	0.19	--	--[g]	--	--[g]
Tin	--	48,000	--[g]	>1,000,000	--[g]
Uranium	3.2	81	102	505	157
Vanadium	85.1	400	--[g]	17,500	--[g]
Zinc	68	24,000	64,100	>1,000,000	--[g]
Asbestos	--	--[k]	--[k]	--[k]	--[k]
Cyanide	--	48	636	42	1,960
Fluoride	2.8	4,800	--[g]	210,000	--[g]
Nitrate	52	568,000	13,600	>1,000,000	21,000
Aroclor 1016	--	5.6	--[g]	245	--[g]
Aroclor 1221	--	0.50	0.017	66	0.026
Aroclor 1232	--	0.50	0.017	66	0.026
Aroclor 1242	--	0.50	0.14	66	--[g]
Aroclor 1248	--	0.50	0.13	66	--[g]
Aroclor 1254	--	0.50	--[g]	66	--[g]
Aroclor 1260	--	0.50	--[g]	66	--[g]
1,1,1-Trichloroethane	--	3,660	361	8,000	686
1,2-Dichloroethene (total)	--	720	55	31,500	89
Methyl ethyl ketone (2-butanone)	--	28,400	1,670	62,200	2,590
Methyl isobutyl ketone (hexone) (4-methyl-2-pentanone)	--	6,400	285	28,700	445
Benzene	--	0.57	0.82	5.7	1.4

Table A-1. Preliminary Remediation Goals for Protection of Human Health and for Groundwater and Surface Water Protection

Contaminant	Hanford Site Background Concentration[d]	PRGs[a,b] Based on the Residential Scenario for Areas Outside Both the 300 Area Industrial Complex and the 618-11 Burial Ground		PRGs[b,c] for Areas Inside the 300 Area Industrial Complex and the 618-11 Burial Ground	
		Proposed Shallow PRGs for Protection of Human Health (<= 4.6 m [15 ft] bgs)	Proposed Vadose Zone PRGs (Irrigation) for Groundwater and Surface Water Protection[f]	Proposed Shallow PRGs for Protection of Human Health (<= 4.6 m [15 ft] bgs)	Proposed Vadose Zone PRGs for Groundwater and Surface Water Protection[e]
cis-1,2-Dichloroethylene	--	160	11	7,000	18
Carbon tetrachloride	--	0.61	0.44	6.1	0.86
Chloroform	--	0.24	1.3	2.4	2.1
Ethyl acetate	--	72,000	--	>1,000,000	--
Ethylene glycol	--	160,000	5,030	>1,000,000	7,770
Hexachlorobutadiene	--	13	--[g]	1,680	--[g]
Hexachloroethane	--	2.5	23	25	72
Tetrachloroethene	--	20	2.4	82	6.0
Toluene	--	4,770	1,150	10,400	2,190
Trichloroethene	--	1.1	1.3	3.5	2.4
Vinyl chloride	--	0.53	0.013	5.2	0.021
Xylenes (total)	--	103	4,700	227	11,090
Benzo(a)pyrene	--	0.14	--[g]	18	--[g]
Chrysene	--	14	--[g]	1,800	--[g]
Phenanthrene	--	--	--	--	--
Tributyl phosphate	--	111	217	14,600	658
Normal paraffin hydrocarbon (kerosene)	--	2,000	2,000	2,000	2,000
Total petroleum hydrocarbons- diesel	--	2,000	2,000	2,000	2,000
Total petroleum hydrocarbons- motor oil	--	2,000	2,000	2,000	2,000

Note: The contaminants provided in this table are consistent with the contaminants of potential concern identified in the *300 Area Remedial Investigation/Feasibility Study Work Plan for the 300-FF-1, 300-FF-2, and 300-FF-5 Operable Units* (DOE/RL-2009-30). The soil COCs (Table 1 in this Proposed Plan) represent the primary risk-driver contaminants for the majority of the waste sites but are not comprehensive for all sites such as the 618-10 and 618-11 Burial Grounds. For these waste sites, the additional COCs will be identified in the remedial design report/remedial action work plan.

a. Vadose zone PRGs are based on the residential exposure scenario represented using the State's "*Model Toxics Control Act*—Cleanup" (WAC 173-340) unrestricted use for chemicals and a residential exposure scenario for radionuclides.

b. Vadose zone PRGs for the protection of groundwater and surface water were calculated based on site-specific data and specific parameters using the STOMP code with a one-dimensional model for all contaminants except uranium. For uranium, the STOMP code was used with a two-dimensional model that includes the effects of uranium's more complex sorption behavior.

For highly mobile contaminants (K_d <2), the model assumes the entire vadose zone from ground surface to groundwater is contaminated. For less mobile contaminants ($K_d \geq 2$), the model assumes the top 70 percent is contaminated and the bottom 30 percent is not contaminated. For the 300 Area Industrial Complex and 618-11 Burial Ground, a groundwater recharge rate of 25 mm/year was used for the long term, representing a permanently disturbed soil with cheatgrass vegetative cover. For the residential scenario, a groundwater recharge rate of approximately 72 mm/year was used, representing an irrigated condition. Model details are contained in the 300 Area RI/FS report (Section 5.7 and Table 5.4 of DOE/RL-2010-99).

What is the sequence of activities and duration of each phase?

From (DOE/RL-2011-47, 2013) page 38, monitored natural attenuation is the proposed strategy for the groundwater contaminated by releases from 618-11. Model predictions show that tritium concentrations will be below DWS by 2031. The waste within 618-11 will be removed by RTD. Groundwater monitoring will be performed to evaluate the effectiveness of the alternative.

What is the magnitude of each activity (i.e., cubic yards of excavation, etc.)?

The following are estimates of the volume of material associated with remediation of the trenches, pipe units and caissons at the 618-11 area (these inventories have not been corrected for decay to present time):

Table G.2-8. Estimates of the volume of material associated with remediation of the trenches, pipe units and caissons at the 618-11 area.

Contaminated Facility Components	Primary Contaminants	Amt. with low levels of contamina-tion (m^3, linear m or number as appropriate)	Amt. with high levels of contamina-tion (m^3, linear m or number as appropriate)	Total Amt. Media	Total amt. of each primary contaminant
Within trenches, pipe units, and caissons	TRU, ^3H, U, Be, solid metallic sodium, lead shielding, Tc oxide, ignitable metal turnings, Th oxide, wide range fission products, salt cycle residues	96,000 m^3 in trenches	56 m^3 in caissons, 220 m^3 in VPUs. VPUs likely contain lower levels.	96,300 m^3	4,200 Ci Sr-90 5,300 Ci Cs-137 226 Ci Am-241 132 Ci Pu-239 639 Ci Pu-241 330 kg Be
Structural materials (i.e., concrete and steel)	Same as above	None	Steel pipe: 24 m @ 1 m d, 120 m @ 2.4 m diam, 229 m @ 0.5 m Concrete: 40 m^3	Will likely be grouted. Volume will depend on grouting method.	Not available.

Contaminant Inventory Remaining at the Conclusion of Planned Active Cleanup Period

When remediation is completed, contaminant levels will be below industrial cleanup standards. Over time, tritium in ground water will diminish below drinking water standards due to natural attenuation.

Risks and Potential Impacts Associated with Cleanup

Can any (or all) of the potential remedial actions serve as initiating events for risks or impacts (i.e., to workers, to natural resources, etc.)?

The remediation activity is primary risk driver at the 618-11 site in the near term. The remediation activities associated with removal of wastes from the pipe units and caissons can serve as initiating events for airborne releases with high risk to remediation workers and any worker outside the Energy Northwest plant that are in the vicinity of the 618-11 site.

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

Facility Workers

Remediation workers have medium risk when involved in removal and blending of existing wastes and transport to ERDF. Workers involved in post-remediation monitoring will have low risk.

Co-located Person

Workers at Energy Northwest facility will have low risk except when wastes are exhumed from the pipe units and caissons. These workers may have medium risk if outside the Energy Northwest facility and near the 618-11 area when waste is exhumed from the pipe units and caissons.

Public

The Public is considered to be equally at risk as a Co-located Worker because the Hanford site boundary allows for public access to the Energy Northwest facility. These individuals may have medium risk if outside the Energy Northwest facility and near the 618-11 area when waste is exhumed from the pipe units and caissons.

Groundwater

There is no risk to a public entity via groundwater during remediation because there are no receptors in direct contact with groundwater contaminated with tritium from the 618-11 area. The tritium concentrations will be below drinking water standards by the time the tritium reaches a public receptor. Moreover, if a release occurred during remediation, the time elapsed before a receptor was affected would be much longer than the time period associated with the remediation.

There is no known plume associated with Sr-90 from this EU. Based on the transport and decay properties of Sr-90 relative to tritium, Sr-90 is not expected to impact the groundwater in the Active Clean-up Period. However, a *Low* rating is given to account for uncertainties.

Columbia River

Not at risk during remediation unless hydrologic events allow significant infiltration into the interred waste when the cover soil is removed for remediation. In such cases, contaminant releases could occur that could ultimate reach the Columbia River. However, there is essentially no risk imposed to the Columbia River during the remedial action.

Given the transport and decay properties of Sr-90 relative to tritium, Sr-90 is not expected to reach the Columbia River in the next 50 years. This leads to a ND rating.

Ecological Resources

Trucks, heavy equipment and drill rigs 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). Additional water from dust suppression could lead to more diverse and abundant vegetation in areas that receive water, which could encourage invasion of exotic species. The latter could displace native plant communities. Excessive dust suppression activities could lead to compaction, which can decrease plant growth in those areas, decrease abundance and diversity of soil invertebrates, and prevent fossorial snakes or mammals from using the area. Soil removal can cause complete destruction of existing ecosystem, all of the above effects on adjacent sites, but these effects are potentially more severe because of blowing soil (and seeds) and the potential for exposure of dormant seeds. In the re-vegetation stage, there is the potential for invasion of exotic species, changing the species diversity of native communities. 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, car, and truck traffic on paved roads as well as use of heavy equipment and drill rigs will not have any direct impact on archaeological resources because there is no disturbance to soil/ground or alteration to the landscape. Assuming heavy equipment locations 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 paved 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 buildings, staging areas, caps 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 building locations and staging areas 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 buildings and staging areas 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, capping 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, car, and truck traffic on paved roads as well as use of heavy equipment 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. Existing road causes no alteration to 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 construction, 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

None.

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

Populations and Resources at Risk or Potentially Impacted After Cleanup Actions

(from residual contaminant inventory or long-term activities)

Table G.2-9. Populations and Resources at Risk

Population or Resource		Risk/Impact Rating	Comments
Human	Facility Worker	Low	Other than periodic ground water monitoring, no workers will be present.
	Co-located Person	ND	None
	Public	ND	Public access will be prevented by physical barriers and institutional controls
Environmental	Groundwater	ND	The remediation will eliminate the source of potential contaminants, thereby eliminating risks to groundwater (US EPA 2013)
	Columbia River	ND	The remediation will eliminate the source of potential contaminants, thereby eliminating risks to the Columbia River (US EPA 2013).
	Ecological Resources*	Low-Medium	Re-vegetation in EU will result in some additional level 3 and 4 resources potentially at risk because of disturbance, especially from invasive species and change of species composition. Similar effects in buffer zone.
Social	Cultural Resources*	**Native American:** Direct: Unknown Indirect: Known **Historic Pre-Hanford:** Direct: Unknown Indirect: Unknown **Manhattan/Cold War**: Direct: None Indirect: None	No expectations for impacts to known cultural resources.

*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.

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

The cleanup standard selected for this site is industrial exposure criteria. The proposed retrieval mechanisms may leave heterogeneous spots of distributed activity, which will be more prone to migration.

PART VII. SUPPLEMENTAL INFORMATION AND CONSIDERATIONS

The site needs to remain under control to minimize the possibility of subsidence or accidental intrusion.

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APPENDIX G.3

K Area Waste Sites (RC-LS-2, River Corridor)
EVALUATION UNIT SUMMARY TEMPLATE

Table of Contents

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PART I. EXECUTIVE SUMMARY

EU Location

100 K-Reactor Area

Related EUs

RC-DD-2; operable unit cross walk is 100- KR-1 and 100- KR-2

Primary Contaminants, Contaminated Media and Wastes

The K Area Waste Sites consists of a variety of sites within the fence at the 100 K area associated with the original plant facilities constructed to support K Reactor operation. Included within the EU are 4 burial grounds, (includes pits, dumping areas, burial grounds), 33 cribs (subsurface liquid disposal, includes French drains, cribs, sumps), 2 infrastructure buildings, 10 pipelines and associated valves, 1 pond/ditch, 6 process buildings, 10 septic systems, 19 storage pads, 11 underground storage tanks, and 9 unplanned release sites.

Brief Narrative Description:

This EU contains a variety of sites within the fence at the 100 K area associated with the original plant facilities constructed to support K Reactor operation. RC LS 2 includes diverse sites, many with no contamination, but that need to be removed as part of remediation efforts. The waste site remediation needs to be coordinated with Sludge treatment project and reactor cocooning. The known/likely presence of tribal cultural resources complicates remediation efforts.

Many of the waste sites identified with this evaluation unit will be remediated through the process of 'confirmatory sampling, no action' also known as CNSA. Others will be remediated through the process of remove-treat-dispose (RTD). For these sites, excavation, coupled with removal of underground structures such as piping will take place, samples will confirm that cleanup criteria are met, and the site will be backfilled with clean and compacted soil. The contaminated soil will be disposed of at ERDF or elsewhere if it contains hazardous materials.

Summary Table of Risks and Potential Impacts to Receptors:

Table G.3-1 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 K Area Waste sites; a Co-located Person (CP) is an individual located 100 meters from the boundary; and the Public is an individual located at the closest point on the Hanford Site boundary not subject to DOE access control, which in this instance is the south bank of the Columbia River approximately 150 m (500 ft) north of the facility. The nuclear related risks to humans are based on unmitigated (unprotected or controlled conditions) dose exposures expressed in a range of from Non-Discernable (ND) to Very High. The estimated mitigated exposure that takes engineered and administrative controls and protections into consideration is shown in parenthesis.

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 Non-Discernable (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: A rating for cultural resources is not being made because cultural resources will be evaluated under Section 106 of the National Historic Preservation Act (16 USC 470, et.seq.) during the planning for remedial action. The resulting Section 106 process will engage all stakeholders, including Native American Tribes, concerning the Native American, Historic Pre-Hanford, and Manhattan Project/Cold War landscapes. This process will identify all cultural resources and evaluate their eligibility for the National Register of Historic Places, any direct and indirect effects from remediation, as well as the need for any mitigation actions. CRESP has consulted with the Native American Tribes having historical ties to Hanford and they consider the entire Hanford Site to be culturally and historically important.

Table G.3-1. Risk Rating Summary (for Human Health, unmitigated nuclear safety basis indicated, mitigated basis indicated in parenthesis (e.g., "Very High" (Low)).

Population or Resource		Evaluation Time Periods	
		Active Cleanup (to 2064)	
		Current Condition/ Operations: D4	**From Cleanup Actions:** Same activities as Current
Human Health	Facility Worker	Low (Low)	Low (Low)
	Co-located Person	Low (ND to Low)	Low (ND to Low)
	Public	Low (ND to Low)	Low (ND to Low)
Environmental	Groundwater	Medium (C-14)	Medium (C-14)
	Columbia River	ND	Low (C-14)
	Ecological Resources*	ND to Low	ND to Medium
Social	Cultural Resources*	**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

*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.

SUPPORT FOR RISK AND IMPACT RATINGS FOR EACH TIME PERIOD

Human Health

Current and from Selected or Potential Cleanup Approaches

As the 100 K Area deactivation, decommissioning, decontamination, and demolition organization completes work, sites will be remediated either by the process of 'confirmatory sampling, no action' also known as CNSA or by the process of remove-treat-dispose (RTD). For these sites, excavation, coupled with removal of underground structures such as piping will take place, samples will confirm that cleanup criteria are met, and the site will be backfilled with clean and compacted soil. The contaminated soil will be disposed of at ERDF or elsewhere if it contains hazardous materials. About half of the identified sites will undergo remediation. Trenching and potholing will be performed as required to support sampling at depths up to 20 ft below the ground surface. Following confirmation of sampling results, excavations will be backfilled to grade with clean soil and compacted if needed.

Many of the sites, such as underground pipelines, were never used with radioactive materials and so remediation is not likely to expose radioactive contamination. Other sites are considered to have minimal contamination. A Hazard and accident analysis for these sites found only low unmitigated risk:

> From SGW-40938, Rev 0, page 3-4*: "The hazard analysis identified 18 potential scenarios... The postulated unmitigated hazardous conditions result in "low" consequences to the onsite and offsite receptors and no significant impact to the facility worker. Several scenarios were identified as presenting a standard industrial hazard to the facility worker, which is consistent with the nature of the activities. All scenarios are in Risk Bin III, which require Safety Management Programs"*

Three scenarios were identified as requiring further evaluation. These included: 1) a dropped ERDF canister with spill; 2) collapse of the KE basin excavation pit with subsequent resuspension of contaminated soils; and 3) a spill from an ERDF container as a result of two trucks colliding. These scenarios were considered bounding of other accidents. In all cases the low radiological consequences and unlikely probability put these as a risk class III, which is defined as ".. generally provided with adequate mitigation and prevention by the existing safety management programs."

Ecological Resources

Current
Most of the EU is non-vegetated, but risk is Low (rather than ND) because part of the EU falls in area of Eagle roosting, which is a species of concern, and 8% is level 4 resources.

Risks and Potential Impacts from Selected or Potential Cleanup Approaches
ND to Low in EU because of eagle roosting, but Low to Medium in buffer because of high percent of level 3 and 4 resources (78 % is level 3 and 4 resources), and it is close to the riparian habitat (all of which is level 5 habitat). Removal of dirt will result in disturbance and disruption.

Cultural Resources

Current
Manhattan Project/Cold War significant resources have already been mitigated. Area within the EU is heavily disturbed, but the entire area is extremely culturally sensitive based on prehistoric, ethno-historic, and historic land use in the area. 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
Due to high cultural sensitivity of area, consultation may need to occur. Archaeological investigations or monitoring may also need to occur. Direct and indirect effects are likely to archaeological sites and traditional cultural places.

Considerations for timing of the cleanup actions

There is no risk to the Facility Worker, CP or Public if cleanup of the soils or building is delayed. There is no known physical deterioration of these facilities. There are potential benefits to delaying cleanup due to radioactive decay (ca. 90 years) or allowing natural attenuation to achieve long-term environmental safety.

Near-Term, Post-Cleanup Risks and Potential Impacts

The cleanup actions will remove contaminated soils and overlying structures and stabilize soils. 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. Similar effects are possible in the buffer zone. Permanent direct and indirect effects to cultural resources are possible due to high sensitivity of area.

PART II. ADMINISTRATIVE INFORMATION

OU AND/OR TSDF DESIGNATION(S)

100-KR-1 100-KR-2

COMMON NAME(S) FOR EU

K Area Waste Sites

KEY WORDS

D4, soils

REGULATORY STATUS

Regulatory basis: The OUs are currently in various stages of the CERCLA process (DOE/RL-96- 17 page 1-1). 100-KR-i and 100-KR-2 are source OUs.

Applicable regulatory documentation

- Interim Action Record of Decision for the 100-BC-i, 100-DR-i, and 100-HR-i Operable Units, Hanford Site, Benton County, Washington (hereinafter referred to as the Interim Action Record of Decision [ROD]) (EPA 1995)
- Amendment to the Interim Action Record of Decision for the 100-BC-i, 100-DR-i, and 100-HR-i Operable Units (hereinafter referred to as the ROD Amendment) (EPA 1997a)
- *Interim Action Record of Decision for the iOO-BC-i, 100-BC-2, 100-DR-i, i00-DR-2,100-FR-i, 100-FR -2 , 100-HR-i, 100-HR -2 , 100-KR-i, 100-KR -2, i00-IU-2, i00-IU-6, and 200-C W-3 Operable Units, Hanford Site, Benton County, Washington* (hereinafter referred to as the Remaining Sites ROD) (EPA 1999)
- *Record of Decision for the 100-BC-i, 100-BC-2, 100-DR-i, 100-DR-2, 100-FR -2 , 100-HR -2, and 100-KR-2 Operable Units, Hanford Site (100 Area Burial Grounds), Benton County Washington* (hereinafter referred to as the 100 Area Burial Grounds ROD) (EPA 2000b).

Applicable Consent Decree or TPA milestones

RISK REVIEW EVALUATION INFORMATION

Completed: Revised January 30, 2015

Evaluated by: K.A. Higley

Reviewed by: H. Mayer

PART III. SUMMARY DESCRIPTION

CURRENT LAND USE:

DOE Hanford industrial site area

DESIGNATED FUTURE LAND USE:

"To the extent practicable, return soil concentrations to levels that allow for unlimited future use and exposure. Where it is not practicable to remediate to levels that will allow for unrestricted use in all areas, institutional controls and long-term monitoring will be required" (EPA 1995, page 26). [1]

PRIMARY EU SOURCE COMPONENTS

Legacy Source Sites

This EU contains a variety of sites within the fence at the 100 K area. In general, the area contains waste units associated with the original plant facilities constructed to support K Reactor operation. Included within the EU are 4 burial grounds, (includes pits, dumping areas, burial grounds), 33 cribs (subsurface liquid disposal, includes French drains, cribs, sumps), 2 infrastructure buildings, 10 pipelines and associated valves, 1 pond/ditch, 6 process buildings, 10 septic systems, 19 storage pads, 11 underground storage tanks, and 9 unplanned release sites. RC LS 2 includes diverse sites, many with no contamination, but that need to be removed as part of remediation efforts. The waste site remediation needs to be coordinated with Sludge treatment project and reactor cocooning. The known/likely presence of tribal cultural resources complicates remediation efforts.

Many of the waste sites identified with this evaluation unit will be remediated through the process of 'confirmatory sampling, no action' also known as CNSA. Others will be remediated through the process of remove-treat-dispose (RTD). For these sites, excavation, coupled with removal of underground structures such as piping will take place, samples will confirm that cleanup criteria are met, and the site will be backfilled with clean and compacted soil. The contaminated soil will be disposed of at ERDF or elsewhere if it contains hazardous materials.

"To the extent practicable, return soil concentrations to levels that allow for unlimited future use and exposure. Where it is not practicable to remediate to levels that will allow for unrestricted use in all areas, institutional controls and long-term monitoring will be required" (EPA 1995, page 26). [2]

High-Level Waste Tanks and Ancillary Equipment

Not Applicable

Groundwater Plumes

Not Applicable

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[1] EPA, 1995, *Interim Action Record of Decision for the 100-BC-i, 100-DR-i, and 100-HR-I Operable Units, Hanford Site, Benton County, Washington,* September 1995, U.S. Environmental Protection Agency, Region 10, Seattle, Washington.

[2] EPA, 1995, *Interim Action Record of Decision for the 100-BC-i, 100-DR-i, and 100-HR-I Operable Units, Hanford Site, Benton County, Washington,* September 1995, U.S. Environmental Protection Agency, Region 10, Seattle, Washington.

EU Designation: RC-LS-2 (K Area Waste Site)

Operating Facilities

Not Applicable

D&D of Inactive Facilities

Not Applicable

Location and Layout Maps

Figure G.3-1. EU Boundary Map.

Figure G.3-2. K-Area Waste Sites.

Figure 1-5. 100-K Area Radioactive Liquid Effluent Waste Sites.

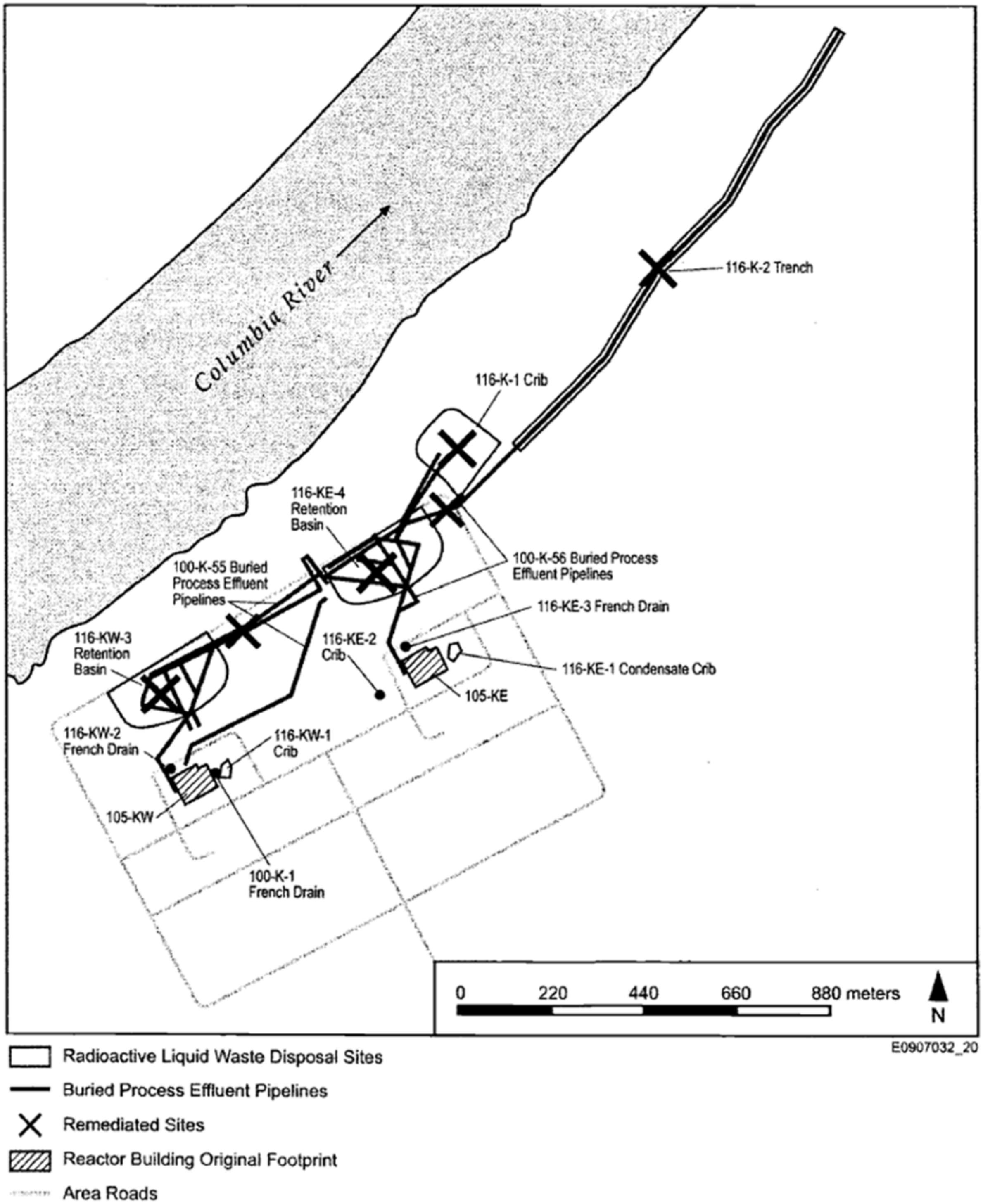

Figure G.3-3. 100-k Area Radioactive Liquid Effluent Waste Sites (DOE/RL-96-17 page 1-9).

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Figure 1-10. 100-K Area Remaining Sites.

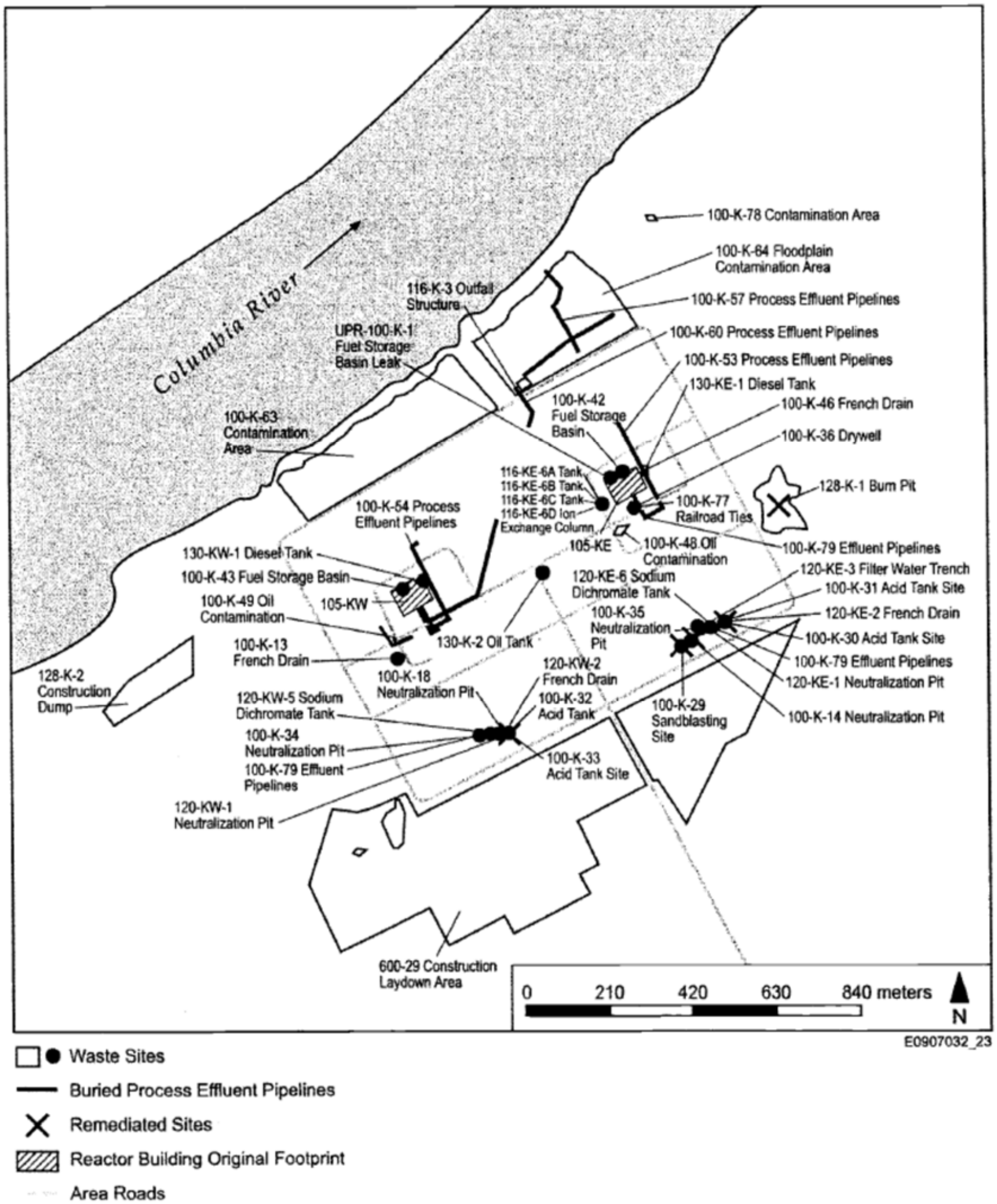

Figure G.3-4. 100-K Area Remaining Sites (DOE/RL-96-17 page 1-14).

Figure 4 From DOE/RL-96-17 page 1-14

Figure 1-16. Waste Sites in the 100-K East Area Added to the Remaining Sites ROD.

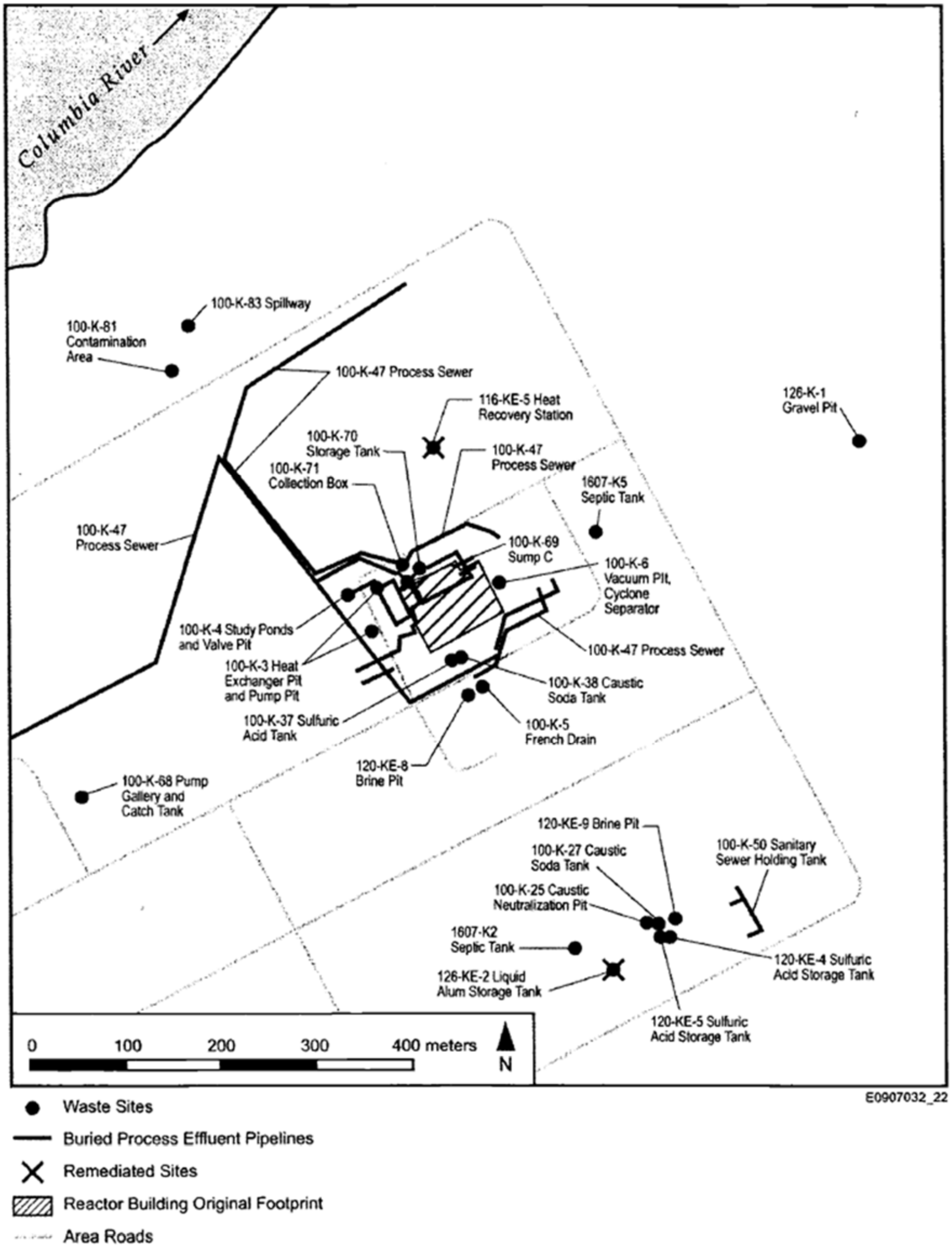

Figure G.3-5. Waste Sites in the 100-K East Area Added to the Remaining Sites ROD (DOE/RL-96-17 page 1-20).

Figure 1-17. Waste Sites in the 100-K West Area Added to the Remaining Sites ROD.

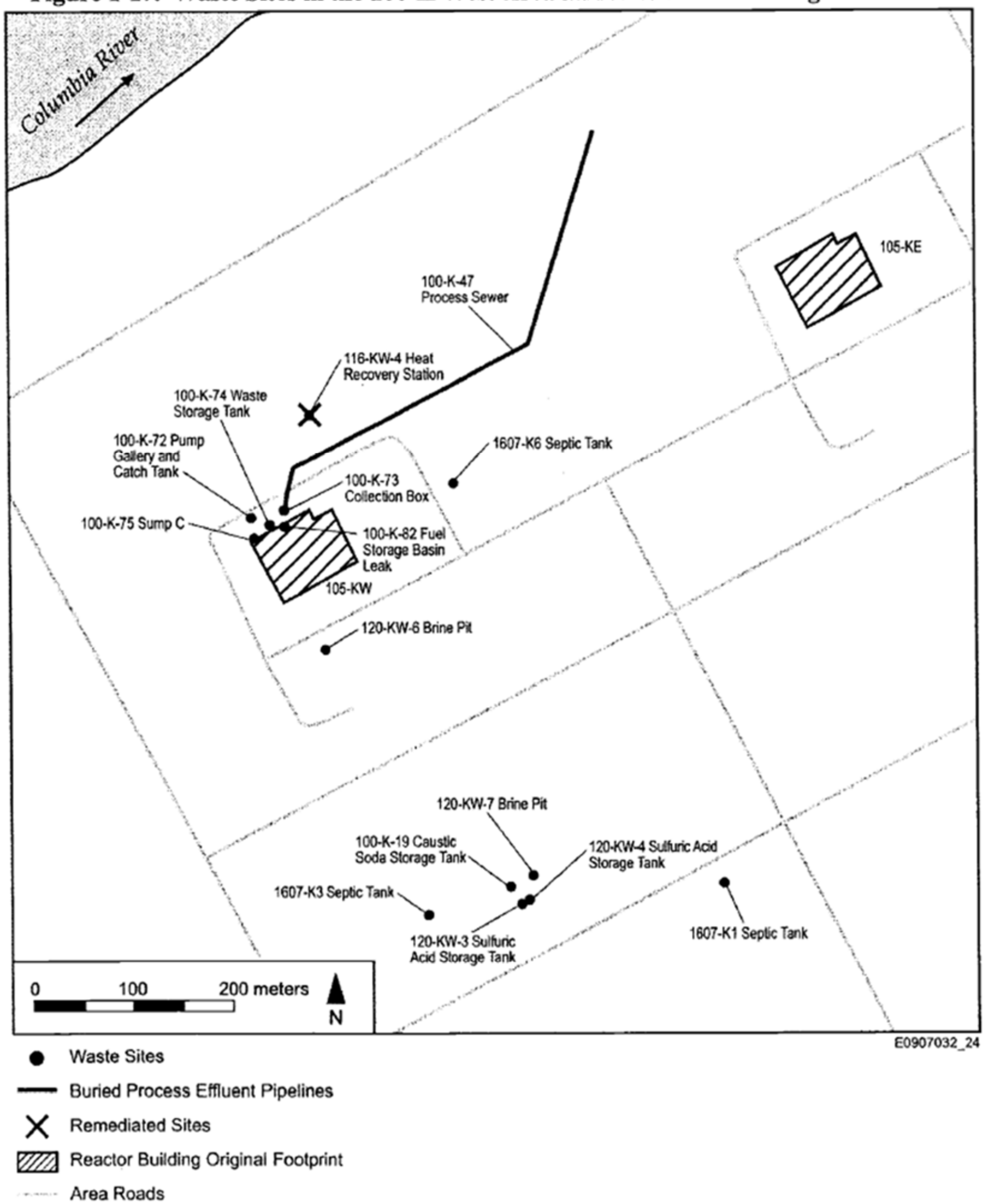

Figure G.3-6. Waste Sites in the 100-K West Area Added to the Remaining Sites ROD (DOE/RL-96-17 page 1-21).

Figure 1-21. Burial Grounds at the 100-K Area.

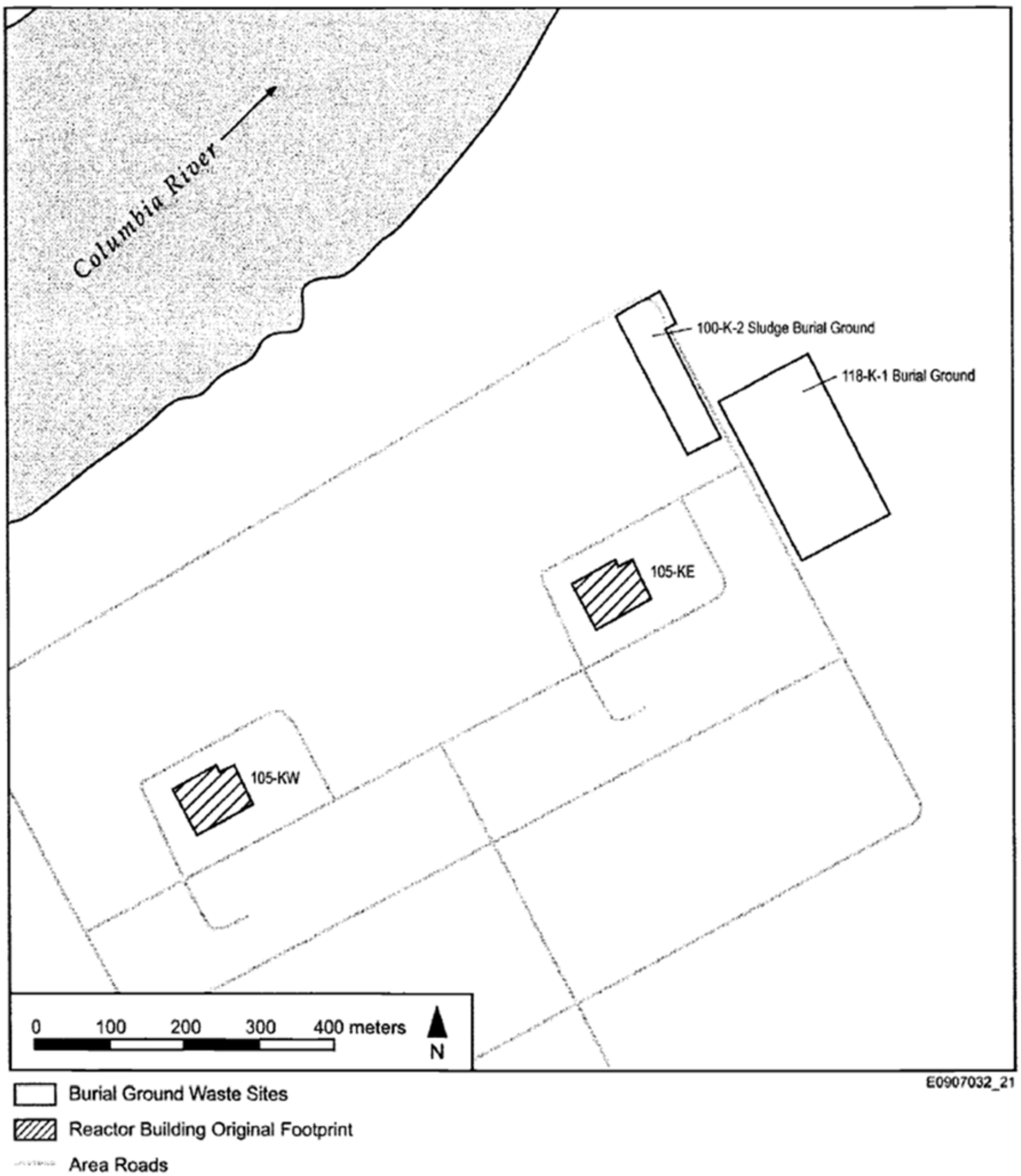

Figure G.3-7. Burial Grounds at the 100-K Area (DOE/RL-96-17 Page 1-25).

PART IV. UNIT DESCRIPTION AND HISTORY

EU Former/Current Use(s)

This EU contains a variety of sites within the fence at the 100 K area. In general, the area contains waste units associated with the original plant facilities constructed to support K Reactor operation. Included within the EU are 4 burial grounds, (includes pits, dumping areas, burial grounds), 33 cribs (subsurface liquid disposal, includes French drains, cribs, sumps), 2 infrastructure buildings, 10 pipelines and associated valves, 1 pond/ditch, 6 process buildings, 10 septic systems, 19 storage pads, 11 underground storage tanks, and 9 unplanned release sites. RC LS 2 includes diverse sites, many with no contamination, but that need to be removed as part of remediation efforts. The waste site remediation needs to be coordinated with Sludge treatment project and reactor cocooning. The known/likely presence of tribal cultural resources complicates remediation efforts.

Legacy Source Sites

EU RC-LS-2 contains a variety of sites within the fence at the 100 K area. Included within the EU are 4 burial grounds, (including pits, dumping areas, burial grounds), 33 cribs (subsurface liquid disposal, includes French drains, cribs, sumps), 2 infrastructure buildings, 10 pipelines and associated valves, 1 pond/ditch, 6 process buildings, 10 septic systems, 19 storage pads, 11 underground storage tanks, and 9 unplanned release sites.

From SGW-5471 Rev O page 4: The 116-KE-3 waste site is an engineered structure that received contaminated cooling water from the 105-KE FSB during KE Reactor operation from 1955 through 1971. The waste site was originally constructed to dispose of water from the FSB that accumulated in the sub-basin drainage area. It was later modified to serve as an overflow for drainage from the 105-KE FSB. This site is located approximately 75 ft north of the KE Reactor building. The waste site was composed of a drain field with a reverse well in the center of the drain field that extended to below the water table. Contaminated cooling water was discharged directly to the unconfined aquifer via the reverse well.

The UPR-100-K-1 waste site is the result of an unplanned release of cooling water leaking from a failed construction joint between the 105-KE Reactor and the 105-KE FSB at the discharge chute. The leak contaminated the vadose zone beneath a portion of the 105-KE FSB and the foundation of the KE Reactor. The leak was first discovered in the early 1970s and continued until at least May 1980. The leak rate was observed to vary over the years and the actual volume of contaminated water released to the vadose zone has not been quantified.

Total radionuclide inventory estimates for all these sites include H-3 (9.E+01 Ci), Pu-239-240 (1.E+00 Ci), Cs-137 (1.E+00 Ci), Sr-90 (1.E-01 Ci), U-233-234-235-238 (1.E-09 Ci) and U-total (4.4 E-8 kg).

From Morgans et al, 2012: “The operational area within the perimeter fence has been disturbed and graded extensively by human activity since reactor construction began in the 1950s through present-day waste site remedial activities”

From Morgans et al 2012: “Contaminated wastes released from reactor support facilities, cooling water processing facilities, underground piping, liquid waste disposal sites, solid waste disposal sites, and surface spills were primary sources of contamination in 100-K during operations and secondary sources may have developed in vadose zone and aquifer materials. The potential for transport of contaminants within the vadose zone and aquifer at 100-K is affected by historical high volume liquid waste disposal during operations on vadose zone moisture and the water table, the development of secondary sources of contamination in the vadose zone material, groundwater/surface water interactions, and the effect of Columbia River stage fluctuations on contaminant transport.”

Is information available indicating the partition coefficients and other important transport parameters for the primary contaminants with the type of soil (if yes, provide table)?

Partition coefficients can be found within the Hanford Contaminant Distribution Coefficient Database and Users Guide (PNNL 13895, May 2002, Cantrell, Serne, Last). In addition, PNNL 14072 rev 1 lists Kd estimates for key radionuclides. The values provided are shown in the table below:

Waste Chemistry/Source Category 4: Low Organic/Low Salt/Near Neutral												
Analyte	High Impact (4H)			Intermediate Impact – Sand (4I1)			Intermediate Impact – Gravel (4I2)			Groundwater (4C)		
	Kd Estimate (mL/g)			Kd Estimate (mL/g)			Kd Estimate (mL/g)			Kd Estimate (mL/g)		
	Best	Min	Max	Best	Min	Max	Best	Min	Max	Best	Min	Max
Highly Mobile Elements												
H3	0	0	0	0	0	0	0	0	0	0	0	0
Tc99	0	0	0.1	0	0	0.1	0	0	0.01	0	0	0.1
Cl36	0	0	0	0	0	0	0	0	0	0	0	0
Somewhat Mobile Elements												
I129	0.2	0	2	0.2	0	2	0.02	0	0.2	0.2	0	2
U238	0.8	0.2	4	0.8	0.2	4	0.08	0.02	0.4	0.8	0.2	4
Se79	5	3	10	5	3	10	0.5	0.3	1	5	3	10
Np237	10	2	30	10	2	30	1	0.2	3	10	2	30
C14	0	0	100	0	0	100	0	0	10	0	0	100
Moderately Immobile Elements												
Sr90	22	10	50	22	10	50	7	3	16	22	10	50
Cs137	2000	200	10000	2000	200	10000	620	62	3100	2000	200	10000
Pu239	600	200	2000	600	200	2000	190	62	620	600	200	2000
Eu152	200	10	1000	200	10	1000	62	3.1	310	200	10	1000

DOE-RL-96-17 Rev 6 also contains tabulated values of Kds:

Soil Water Distribution Coefficients form DOE RL 96-17 rev 6 Table E-2		
Nuclide/Contaminant	Kd mL/g	Reference
H-3	0	Hanford Site-specific K.1 value: Seine and Wood 1989
Pu-239-240	200	Hanford Site-specific K.1 value: Seine and Wood 1990
Cs-137	50	Hanford Site-specific K.1 value: Ames and Seine 1991
Sr-90	25	Hanford Site-specific K.1 value: Ames and Seine 1992
U-233-234-235-238	2	Hanford Site-specific K.1 value: Seine and Wood 1990
Uranium (soluble salts)	2	Hanford Site-specific K.1 value: Seine and Wood 1990

Compared to other sites the inventory remaining is relatively modest. There is substantial experience with remediating other sites along the river, and consequently the assessment of potential risk is likely to be fairly accurate. The biggest challenge is likely to be modeling the subsurface transport of contaminants through an area that has been heavily remodeled and is also strongly influenced by the influence of the Columbia River on the ground water in the vicinity.

ECOLOGICAL RESOURCES SETTING

Landscape Evaluation and Resource Classification

Approximately 89% of the area within EU is classified as level 0 or level 1 biological resources. A small hillslope north of the reactors is classified as level 2 resources. The level 4 resources within the EU reflect a restricted use buffer area for the bald eagle (*Haliaeetus leucocephalus*) roosting site to the northwest of the 100-K Area along the river and do not consist of any habitat resources.

The amount and proximity of biological resources to the 100-K Waste Sites EU was examined within the adjacent landscape buffer area radiating 1,396 m from the geometric center of the EU (equivalent to 1,286 acres). Note that within the landscape buffer area, obvious areas where vegetation was cleared or removed were reclassified as level 0 resources. Numerous areas within the adjacent landscape buffer had been revegetated with varying degrees of success; these areas were not reclassified, but retain the original biological resource level assigned in DOE/RL-96-32 2013. The adjacent landscape buffer area extends across the Columbia River shoreline and into the riverine habitat. Level 4 resource patches along the river shoreline and in the river reflect the riparian habitat along the shoreline and a small patch of level 5 habitat in the river reflects a known spawning location for Fall Chinook salmon (*Oncorhynchus tshawytscha).*

Field Survey

Field evaluation of the 100-K Area Waste Sites EU revealed that most of the EU consists of built infrastructure, roads, parking lots, buildings, with small fragments of habitat to the north of the two reactors. Much of the surrounding area has been re-vegetated after cleanup of waste areas and trenches outside the 100-K fence lines. Installation of numerous pump and treat wells, well pads, buildings and transfer pipes has occurred both within and outside the EU.

No observations of wildlife were made during the October survey of the EU. However, a PNNL ECAP review of the 100-K Area and buildings done in 2010 noted numerous birds in association with the buildings and structures that existed within the EU at that point in time. Since then, clean up and decommissioning activities may have removed much of the infrastructure that previously was used as nesting and perching habitat.

CULTURAL RESOURCES SETTING

Cultural resources documented within the K Area Waste Sites EU include 2 historic era linear resources (1 representing the Pre-Hanford Early Settlers/Farming Landscape and 1 representing the Manhattan Project and Cold War era), 23 contributing resources to the NRHP Eligible Manhattan Project and Cold War era historic district (9 with individual documentation required, 12 with no individual documentation required), and no precontact archaeological resources. No TCPs are known within the EU. In accordance with the 1998 *Hanford Site Manhattan Project and Cold War Era Historic District Treatment Plan (*DOE/RL-97-56), all documentation requirements have been completed for properties contributing to the Manhattan Project and Cold War era historic district.

Portions of the EU have been inventoried for cultural resources by several surveys in the past. Remediation of waste sites within the K Area Waste Sites Evaluation Unit has been addressed by two

NHPA Section 106 reviews. There are 14 archaeological sites within 500 meters of the EU; 7 archaeological sites (3 eligible and 4 unevaluated) and 2 isolates (2 not eligible) represent the Native American Precontact and Ethnographic landscape, 3 archaeological sites (1 not eligible and 2 unevaluated) and 2 isolates (2 not eligible) represent the Manhattan Project/Cold War landscape.

The geomorphologic composition of the EU and historic map data suggest some subsurface potential for cultural resources presence within the north 1/3 of the EU. However, the large earthworks disturbances shown in modern aerial imagery within the entire EU indicate that discovery of surface or near-surface cultural resources are not likely within the EU. 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) may need to occur. Consultation with Hanford Tribes may also 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

There are several discrete sites within the RC-LS-2 EU. Many contain residual contamination in soils stemming from liquid waste disposal within the 100 K areas. Other sites are not contaminated, but will need to be removed as part of the demolition and remediation process. The inventory is noted below

Table G.3-2. List of Waste Sites Considered.

Site Code	Name	Site Status	Site Type	Site Type Category	Operable Unit
100-K-1	100-K-1; 100-K-45; 119-KW Exhaust Air Sample Building French Drain; 119-KW French Drain	Inactive	French Drain	Crib - Subsurface Liquid Disposal Site	100-KR-2
100-K-100	100-K-100; 116-KW-3 Remaining Contaminated Soil and Items; Radioactive Material Area Remaining After 107-KW Basin Removal	Inactive	Unplanned Release	Unplanned Release - Surface/Near Surface	100-KR-1
100-K-101	100-K-101; French Drains and Mercury Stained Soils near the 183KE Sedimentation Basin	Inactive	French Drain	Crib - Subsurface Liquid Disposal Site	100-KR-2
100-K-102	100-K-102; French Drains and Mercury Stained Soils near the 183KW Sedimentation Basin	Inactive	French Drain	Crib - Subsurface Liquid Disposal Site	100-KR-2
100-K-103	100-K-103; 1704-K and 1717-K Septic Systems; Additional Components of 1607-K4	Unknown	Settling Tank	Septic System	100-KR-2
100-K-104	100-K-104; 166-KE French Drain	Unknown	French Drain	Crib - Subsurface Liquid Disposal Site	100-KR-2
100-K-105	100-K-105; Pit at Southeast Corner of 100K	Inactive	Depression/Pit (nonspecific)	Burial Ground	100-KR-2
100-K-106	100-K-106; 182-K Fuel Oil Crib	Inactive	Crib	Crib - Subsurface Liquid Disposal Site	100-KR-2
100-K-107	100-K-107; 1706-KER Abandoned Drain Field	Inactive	Drain/Tile Field	Septic System	100-KR-2
100-K-108	100-K-108; 1706-KER Septic System; 1706-KER Septic Tank; Crib and Sewer Line	Unknown	Septic Tank	Septic System	100-KR-2
100-K-109	100-K-109; Unplanned Chemical Release near 183.1KW Head House; Yellow Stained Soil adjacent to 183.1KW Head House	Inactive	Unplanned Release	Unplanned Release - Surface/Near Surface	100-KR-2
100-K-110	100-K-110; Soil beneath 183.2-KW Flocculation and Sedimentation Basins; the 183.3- KW Sand Filter Basins	Inactive	Unplanned Release	Unplanned Release - Surface/Near Surface	TBD
100-K-112	100-K-112; Surface Contamination from Waste Storage Operations	Inactive	Unplanned Release	Unplanned Release - Surface/Near Surface	TBD
100-K-13	100-K-13; French Drain West of the 166-KW Oil Storage Tank Facility	Inactive	French Drain	Crib - Subsurface Liquid Disposal Site	100-KR-2
100-K-14	100-K-14; 183-KE Acid Neutralization Pit and Overflow French Drain	Inactive	French Drain	Crib - Subsurface Liquid Disposal Site	100-KR-2
100-K-18	100-K-18; 183-KW Caustic Neutralization Pit	Inactive	Sump	Crib - Subsurface Liquid Disposal Site	100-KR-2
100-K-19	100-K-19; 183-KW Caustic Soda Storage Tank Site	Inactive	Foundation	Storage Pad	100-KR-2
100-K-2	100-K-2; 118-K-2; 118-K-2 Sludge Burial Ground; Burial Area	Inactive	Burial Ground	Burial Ground	Not Applic
100-K-25	100-K-25; 183-KE Caustic Neutralization Pit	Inactive	Sump	Crib - Subsurface Liquid Disposal Site	100-KR-2

100-K-27	100-K-27; 183-KE Caustic Soda Storage Tank Site	Inactive	Foundation	Storage Pad	100-KR-2
100-K-29	100-K-29; 183-KE Sandblasting Site	Inactive	Dumping Area	Burial Ground	100-KR-2
100-K-3	100-K-3; 1706-KE Fish Pond Heat Exchanger Pit and Pump Pit; Water Studies Semi- Works	Inactive	Valve Pit	Pipeline and associated valves, etc.	100-KR-2
100-K-30	100-K-30; 183-KE Sulfuric Acid Tank Bases (West Tank)	Inactive	Storage Tank	Storage Pad	100-KR-2
100-K-31	100-K-31; 183-KE Sulfuric Acid Tank Bases (East Tank)	Inactive	Storage Tank	Storage Pad	100-KR-2
100-K-32	100-K-32; 183-KW Sulfuric Acid Tank Bases (East Tank)	Inactive	Storage Tank	Storage Pad	100-KR-2
100-K-33	100-K-33; 183-KW Sulfuric Acid Tank Bases (West Tank)	Inactive	Storage Tank	Storage Pad	100-KR-2
100-K-34	100-K-34; 183-KW Acid Neutralization Pit	Inactive	Sump	Crib - Subsurface Liquid Disposal Site	100-KR-2
100-K-35	100-K-35; 183-KE Acid Neutralization Pit	Inactive	Sump	Crib - Subsurface Liquid Disposal Site	100-KR-2
100-K-36	100-K-36; 1706-KE Chemical Storage Facility Dry Well	Inactive	French Drain	Crib - Subsurface Liquid Disposal Site	100-KR-2
100-K-37	100-K-37; 1706-KE Sulfuric Acid Tank	Inactive	Storage Tank	Storage Pad	100-KR-2
100-K-38	100-K-38; 1706-KE Caustic Soda Tank	Inactive	Unplanned Release	Unplanned Release - Surface/Near Surface	100-KR-2
100-K-4	100-K-4; 1706-KE Wet Fish Studies Ponds and Valve Pit	Inactive	Pond	Pond/Ditch – Surface Liquid Disposal Site	100-KR-2
100-K-46	100-K-46; 119-KE French Drain; Drywell	Inactive	French Drain	Crib - Subsurface Liquid Disposal Site	100-KR-2
100-K-47	100-K-47; 1904-K Process Sewer	Active	Process Sewer	Pipeline and associated valves, etc.	100-KR-2
100-K-48	100-K-48; 100-KE Oil Contamination Areas	Inactive	Unplanned Release	Unplanned Release - Surface/Near Surface	100-KR-2
100-K-49	100-K-49; 100-KW Oil Contamination Areas	Inactive	Unplanned Release	Unplanned Release - Surface/Near Surface	100-KR-2
100-K-5	100-K-5; 1705-KE French Drain	Inactive	French Drain	Crib - Subsurface Liquid Disposal Site	100-KR-2
100-K-50	100-K-50; 1725-K & 1726-K Sanitary Sewer System Holding Tank	Active	Storage Tank	Septic System	100-KR-2
100-K-51	100-K-51; 105-KE 90-Day Waste Accumulation Area; 100K 90-Day Waste Storage Facility	Active	Storage Pad (<90 day)	Storage Pad	Not Applic
100-K-53	100-K-53; 100-KE Glycol Heat Recovery Underground Pipelines	Inactive	Product Piping	Pipeline and associated valves, etc.	100-KR-2
100-K-54	100-K-54; 100-KW Glycol Heat Recovery Underground Pipelines	Inactive	Product Piping	Pipeline and associated valves, etc.	100-KR-2
100-K-55	100-K-55; 100-KW Reactor Cooling Water Effluent Underground Pipelines	Inactive	Radioactive Process Sewer	Pipeline and associated valves, etc.	100-KR-2
100-K-56	100-K-56; 100-KE Reactor Cooling Water Effluent Underground Pipelines	Inactive	Radioactive Process Sewer	Pipeline and associated valves, etc.	100-KR-2

100-K-6	100-K-6; 105-KE Vacuum Pit; Cyclone Separator; Vacuum Pit	Inactive	Process Unit/Plant	Process Building	100-KR-2
100-K-60	100-K-60; 1904-K Process Sewer (165-KW)	Inactive	Process Sewer	Pipeline and associated valves, etc.	100-KR-2
100-K-61	100-K-61; 117-KW Filter Building	Inactive	Process Unit/Plant	Process Building	100-KR-2
100-K-62	100-K-62; 117-KE Filter Building	Inactive	Process Unit/Plant	Process Building	100-KR-2
100-K-66	100-K-66; 165-KW Power Control Building	Inactive	Control Structure	Infrastructure Building	100-KR-2
100-K-67	100-K-67; 165-KE Power Control Building	Active	Control Structure	Infrastructure Building	100-KR-2
100-K-68	100-K-68; 105-KE Pump Gallery and Catch Tank; D Sump	Inactive	Catch Tank	Underground Storage Tank	100-KR-2
100-K-69	100-K-69; 105-KE Sump C	Inactive	Sump	Crib - Subsurface Liquid Disposal Site	100-KR-2
100-K-70	100-K-70; 105-KE Waste Storage Tank; Holding Tank	Inactive	Storage Tank	Storage Pad	100-KR-2
100-K-71	100-K-71; 105-KE Collection Box	Inactive	Diversion Box	Pipeline and associated valves, etc.	100-KR-2
100-K-72	100-K-72; 105-KW Pump Gallery and Catch Tank; D Sump	Active	Catch Tank	Underground Storage Tank	100-KR-2
100-K-73	100-K-73; 105-KW Collection Box	Inactive	Diversion Box	Pipeline and associated valves, etc.	100-KR-2
100-K-74	100-K-74; 105-KW Waste Storage Tank; Holding Tank	Inactive	Storage Tank	Storage Pad	100-KR-2
100-K-75	100-K-75; 105-KW Sump C	Inactive	Sump	Crib - Subsurface Liquid Disposal Site	100-KR-2
100-K-77	100-K-77; Underground Railroad Ties Southeast of 1706KE	Inactive	Dumping Area	Burial Ground	100-KR-2
100-K-79	100-K-79; Sodium Dichromate and Sulfuric Acid Product Pipelines at 100-K	Inactive	Product Piping	Pipeline and associated valves, etc.	100-KR-2
100-K-97	100-K-97; 183-KW French Drain and Rail Spur Unplanned Release	Inactive	French Drain	Crib - Subsurface Liquid Disposal Site	100-KR-2
100-K-98	100-K-98; 183-KE French Drain and Rail Spur Unplanned Release	Inactive	French Drain	Crib - Subsurface Liquid Disposal Site	100-KR-2
100-K-99	100-K-99; 116-KE-4 Contaminated Soil and Items; Radioactive Material Area Remaining After 107-KE Basin Removal	Inactive	Unplanned Release	Unplanned Release - Surface/Near Surface	100-KR-1
116-KE-1	116-KE-1; 115-KE Condensate Crib	Inactive	Crib	Crib - Subsurface Liquid Disposal Site	100-KR-2
116-KE-2	116-KE-2; 1706-KER Waste Crib	Inactive	Crib	Crib - Subsurface Liquid Disposal Site	100-KR-2
116-KE-3	116-KE-3; 105-KE Fuel Storage Basin Sub-Basin Drainage Disposal System Crib; 105- KE Storage Basin French Drain	Inactive	Injection/Reverse Well	Crib - Subsurface Liquid Disposal Site	100-KR-2
116-KE-4	116-KE-4; 107-KE; 107-KE Retention Basins	Inactive	Retention Basin	Crib - Subsurface Liquid Disposal Site	100-KR-1
116-KE-5	116-KE-5; 150-KE Heat Recovery Station	Inactive	Process Unit/Plant	Process Building	100-KR-2
116-KE-6A	116-KE-6A; 1706-KE Condensate Collection Tank; 1706-KE Waste Treatment System	Inactive	Storage Tank	Underground Storage Tank	100-KR-2
116-KE-6B	116-KE-6B; 1706-KE Evaporation Tank; 1706-KE Waste Treatment System	Inactive	Storage Tank	Underground Storage Tank	100-KR-2

EU Designation: RC-LS-2 (K Area Waste Site)

116-KE-6C	116-KE-6C; 1706-KE Waste Accumulation Tank; 1706-KE Waste Treatment System	Inactive	Storage Tank	Underground Storage Tank	100-KR-2
116-KE-6D	116-KE-6D; 1706-KE Ion Exchange Column; 1706-KE Waste Treatment System	Inactive	Process Unit/Plant	Process Building	100-KR-2
116-KW-1	116-KW-1; 115-KW Condensate Crib	Inactive	Crib	Crib - Subsurface Liquid Disposal Site	100-KR-2
116-KW-2	116-KW-2; 105-KW Basin Reverse Well; 105-KW Fuel Storage Basin Sub-Basin Drainage Disposal System Crib; 105-KW Storage Basin French Drain	Inactive	Injection/Reverse Well	Crib - Subsurface Liquid Disposal Site	100-KR-2
116-KW-3	116-KW-3; 107-KW; 107-KW Retention Basin	Inactive	Retention Basin	Crib - Subsurface Liquid Disposal Site	100-KR-1
116-KW-4	116-KW-4; 150-KW Heat Recovery Station	Inactive	Process Unit/Plant	Process Building	100-KR-2
118-KE-2	118-KE-2; Rod Cave; 105-KE Horizontal Control Rod Storage Cave	Inactive	Storage	Storage Pad	100-KR-2
118-KW-2	118-KW-2; 105-KW Horizontal Control Rod Storage Cave	Inactive	Storage	Storage Pad	100-KR-2
120-KE-1	120-KE-1; 183-KE Acid Neutralization Pit; 183-KE Filter Waste Facility Dry Well; 183-KE Filter Water Facility; 100-K-26; 100-KE-1	Inactive	Sump	Crib - Subsurface Liquid Disposal Site	100-KR-2
120-KE-2	120-KE-2; 183 KE Filter Water Facility; 183-KE Filter Waste Facility French Drain; 100-KE-2	Inactive	French Drain	Crib - Subsurface Liquid Disposal Site	100-KR-2
120-KE-3	120-KE-3; 183-KE Filter Water Facility Trench; 100-KE-3	Inactive	Trench	Crib - Subsurface Liquid Disposal Site	100-KR-2
120-KE-4	120-KE-4; 183-KE1 Sulfuric Acid Storage Tank	Inactive	Storage Tank	Storage Pad	100-KR-2
120-KE-5	120-KE-5; 183-KE2 Sulfuric Acid Storage Tank	Inactive	Storage Tank	Storage Pad	100-KR-2
120-KE-6	120-KE-6; 183-KE Sodium Dichromate Tank	Inactive	Foundation	Underground Storage Tank	100-KR-2
120-KE-8	120-KE-8; 165-KE Brine Mixing Tank; 165-KE Brine Pit	Inactive	Sump	Crib - Subsurface Liquid Disposal Site	100-KR-2
120-KE-9	120-KE-9; 183-KE Brine Pit; 183-KE Salt Dissolving Pits and Brine Pump Pit	Inactive	Sump	Crib - Subsurface Liquid Disposal Site	100-KR-2
120-KW-1	120-KW-1; 183-KW Acid Neutralization Pit; 183-KW Filter Water Facility Dry Well; 100-K-17; 100-KW-1	Inactive	Sump	Crib - Subsurface Liquid Disposal Site	100-KR-2
120-KW-2	120-KW-2; 183-KW Filter Water Facility French Drain; 100-KW-2	Inactive	French Drain	Crib - Subsurface Liquid Disposal Site	100-KR-2
120-KW-3	120-KW-3; 183-KW1 Sulfuric Acid Storage Tank	Inactive	Storage Tank	Storage Pad	100-KR-2
120-KW-4	120-KW-4; 183-KW2 Sulfuric Acid Storage Tank	Inactive	Storage Tank	Storage Pad	100-KR-2
120-KW-5	120-KW-5; 183-KW Sodium Dichromate Storage Tank	Inactive	Foundation	Storage Pad	100-KR-2
120-KW-6	120-KW-6; 165-KW Brine Mixing Tank; 165-KW Brine Pit	Inactive	Sump	Underground Storage Tank	100-KR-2
120-KW-7	120-KW-7; 183-KW Brine Pit; 183-KW Salt Dissolving Pits and Brine Pump Pit	Inactive	Sump	Crib - Subsurface Liquid Disposal Site	100-KR-2
126-KE-2	126-KE-2; 183-KE Liquid Alum Storage Tank #2	Inactive	Storage Tank	Storage Pad	100-KR-2
130-K-2	130-K-2; 1717-K Waste Oil Storage Tank	Inactive	Storage Tank	Storage Pad	100-KR-2

130-KE-1	130-KE-1; 105-KE Emergency Diesel Fuel Tank; 105-KE Emergency Diesel Oil Storage Tank	Inactive	Storage Tank	Underground Storage Tank	100-KR-2
130-KE-2	130-KE-2; 166-KE Oil Storage Tank; Oil Bunker	Inactive	Storage Tank	Underground Storage Tank	100-KR-2
130-KW-1	130-KW-1; 130-KW-1A/130-KW-1B Tanks; 105-KW Emergency Diesel Fuel Tank; 105-KW Emergency Diesel Oil Storage Tank	Inactive	Storage Tank	Underground Storage Tank	100-KR-2
130-KW-2	130-KW-2; 166-KW Oil Storage Tank	Inactive	Storage Tank	Underground Storage Tank	100-KR-2
1607-K1	1607-K1; 1607-K1 Sanitary Sewer System; 1607-K1 Septic Tank; 1607-K1 Septic Tank and Associated Drain Field; 124-K-1	Active	Septic Tank	Septic System	100-KR-2
1607-K2	1607-K2; 1607-K2 Sanitary Sewer System; 1607-K2 Septic Tank; 1607-K2 Septic Tank and Associated Drain Field; 124-KE-1	Active	Septic Tank	Septic System	100-KR-2
1607-K3	1607-K3; 1607-K3 Sanitary Sewer System; 1607-K3 Septic Tank; 1607-K3 Septic Tank and Associated Drain Field; 124-KW-2	Inactive	Septic Tank	Septic System	100-KR-2
1607-K4	1607-K4; 1607-K4 Sanitary Sewer System; 1607-K4 Septic Tank; 1607-K4 Septic Tank and Associated Drain Field; 124-K-2	Inactive	Septic Tank	Septic System	Not Applic
1607-K5	1607-K5; 1607-K5 Sanitary Sewer System; 1607-K5 Septic Tank; 1607-K5 Septic Tank and Associated Drain Field; 124-KE-2	Active	Septic Tank	Septic System	100-KR-2
1607-K6	1607-K6; 1607-K6 Sanitary Sewer System; 1607-K6 Septic Tank; 1607-K6 Septic Tank and Associated Drain Field; 124-KW-1	Active	Septic Tank	Septic System	100-KR-2
UPR-100-K-1	UPR-100-K-1; 105-KE Fuel Storage Basin Leak; UN-100-K-1; UN-116-KE-2	Inactive	Unplanned Release	Unplanned Release - Subsurface	100-KR-2

Table G.3-3. Inventory Identified for the Individual Waste Sites.

WIDS ID:	116 KE-2	116-KE-4	116 KW-3	120-KE-1	116 KW-1	UPR 100 K-1
Data Source:	DOE-RL-88-30-R24	EIS-S	EIS-S	WHC SD EN TI 239[a]	DOE-RL-88-30-R24	EIS-S
Category:	Wooden crib and piping	Retention basin	Retention basin	Sump	Condensate crib	Unplanned release
Nuclide	Curies					
C-14	1.20E-01				1.10E+02	
Co60	1.11E+01					
Cs137	6.62E-01	0.997	0.302			
Eu152	2.63E-03					
Eu154	1.70E-01					
Eu155	1.52E-02					
H-3	4.28E-01	0.361	0.138			
Pu239	1.70E-02					
Pu240	1.90E-03					
Pu 239/240		0.000538	0.00361			1.3
Sr90	2.13	0.094	0.465			
U-233/234		0.00000000126	8.19 E-11			
U-235	2.00E-05					
U-238	2.08E-03					
Hazardous Constituents	Kg					
U total		5.85 E-09	3.79E-08			
Mercury				220		
Sodium hydroxide	100000					
Sulfuric Acid	100000					

[a](Carpenter, 1994)

Most of the contamination resides in the soil sorbed onto sediments and soils.

CONTAMINATION WITHIN PRIMARY EU SOURCE COMPONENTS

Legacy Source Sites

Radionuclide inventory data is from the following sources:

EIS-S Appendix S. Final Tank Closure and Waste Management Environmental Impact Statement for the Hanford Site, Richland, Washington (TC & WM EIS) (DOE/EIS-0391), 2012

SIM BHI-01496/LA-UR-00-4050, 2001, Groundwater/Vadose Zone Integration Project: Hanford Soil Inventory Model, Rev. 0, Bechtel Hanford, Inc., Richland, Washington.

Detailed inventories are provided in Table G.3-4, Table G.3-5, and Table G.3-6. All values are to 2 significant figures. The source document should be consulted for greater precision data. The sum for each primary contaminant is shown in the first row. Table G.3-7 provides a summary of the evaluation of threats to groundwater as a protected resource from saturated zone and remaining vadose zone contamination associated with the evaluation unit.

High Level Waste Tanks and Ancillary Equipment

Not Applicable

Vadose Zone Contamination

Not Applicable

Groundwater Plumes

Not Applicable

Facilities for D&D

Not Applicable

Table G.3-4. Inventory of Primary Contaminants[a]

WIDS	Description	Decay Date	Ref[b]	Am-241 (Ci)	C-14 (Ci)	Cl-36 (Ci)	Co-60 (Ci)	Cs-137 (Ci)	Eu-152 (Ci)	Eu-154 (Ci)	H-3 (Ci)	I-129 (Ci)
All	Sum			NP	110	NP	11	0.67	0.0026	0.17	82	NP
116-KE-2	Cribs	1986	Stenner	NP	0.12	NP	11	0.66	0.0026	0.17	0.43	NP
116-KW-1	Cribs	1986	Stenner	NP	110	NP	0.001	0.0036	NP	0.00008	82	NP

a. NP = Not present at significant quantities for indicated EU

Table G.3-5. Inventory of Primary Contaminants (cont)[a]

WIDS	Description	Decay Date	Ref[b]	Ni-59 (Ci)	Ni-63 (Ci)	Pu (total) (Ci)	Sr-90 (Ci)	Tc-99 (Ci)	U (total) (Ci)
All	Sum			NP	NP	0.019	2.1	NP	0.0022
116-KE-2	Cribs	1986	Stenner	NP	NP	0.019	2.1	NP	0.0021
116-KW-1	Cribs	1986	Stenner	NP	NP	NP	0.0062	NP	0.00011

a. NP = Not present at significant quantities for indicated EU

Table G.3-6. Inventory of Primary Contaminants (cont)[a]

WIDS	Descrip-tion	Ref[b]	CCl4 (kg)	CN (kg)	Cr (kg)	Cr-VI (kg)	Hg (kg)	NO3 (kg)	Pb (kg)	TBP (kg)	TCE (kg)	U (total) (kg)
All	Sum		NP	NP	NP	NP	NP	NP	NP	NP	NP	NP
116-KE-2	Cribs	Stenner	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP
116-KW-1	Cribs	Stenner	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP

a. NP = Not present at significant quantities for indicated EU

Table G.3-7. Summary of the Evaluation of Threats to Groundwater as a Protected Resource from Remaining Vadose Zone (VZ) Contamination associated with the Evaluation Unit

PC	Group	WQS	Porosity[a]	K_d (mL/g)[a]	ρ (kg/L)[a]	VZ Source M^{Source}	SZ Total M^{SZ}	Treated[c] M^{Treat}	VZ Remaining M^{Tot}	VZ GTM (Mm^3)	VZ Rating[d]
C-14	A	2000 pCi/L	0.18	0	1.84	1.10E+02 Ci	8.27E-01 Ci	---	1.09E+02 Ci	5.46E+01	Medium
I-129	A	1 pCi/L	0.18	0.2	1.84	---	---	---	---	---	ND
Sr-90	B	8 pCi/L	0.18	22	1.84	2.14E+00 Ci	---	---	2.14E+00 Ci	1.18E+00	Low[e]
Tc-99	A	900 pCi/L	0.18	0	1.84	---	---	---	---	---	ND
CCl4	A	5 µg/L	0.18	0	1.84	---	---	---	---	---	ND
Cr	B	100 µg/L	0.18	0	1.84	---	---	---	---	---	ND
Cr-VI	A	10 µg/L[(b)]	0.18	0	1.84	---	---	---	---	---	ND
TCE	B	5 µg/L	0.18	2	1.84	---	4.00E-01 kg	---	0 kg[(f)]	---	---
U(tot)	B	30 µg/L	0.18	0.8	1.84	---	---	---	---	---	---

a. Parameters obtained from the analysis provided in Attachment 6-1 to Methodology Report.

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

c. Treatment amounts from the 2013 Hanford Annual Groundwater Report (DOE/RL-2014-32, Rev. 0).

d. Groundwater Threat Metric rating based on Table 6-3, Methodology Report.

e. There is no known plume associated with Sr-90 from this EU. Based on the transport and decay properties of Sr-90, Sr-90 is not expected to impact the groundwater. A rating of Low is given.

f. Negative number obtained by difference. No rating was made for these which represents a data gap.

PART VI. POTENTIAL RISK/IMPACT PATHWAYS AND EVENTS

CURRENT CONCEPTUAL MODEL

Narrative description of pathways and barriers to receptors and conditions/events that can lead to completed pathways

Pathways and Barriers: (1. description of institutional, natural and engineered barriers (including material characteristics) that currently mitigate or prevent risk or impacts, 2. Time scale from loss of each barrier to realization of risk or impacts)

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?*

Most potential accidents were deemed to be low risk. Three accident scenarios were identified as requiring further evaluation. These included: 1) a dropped ERDF canister with spill; 2) collapse of the KE basin excavation pit with subsequent resuspension of contaminated soils; and 3) a spill from an ERDF container as a result of two trucks colliding. These scenarios were considered bounding of other accidents. In all cases the low radiological consequences and unlikely probability put these as a risk class III, which is defined as ".. generally provided with adequate mitigation and prevention by the existing safety management programs." (from SGW-40938 REV 0)

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

From SGW-40938 Rev 0, The required or applicable Safety Management Programs (SMPs) are:.

- Fire Protection Program. The 100OK Area Fire Protection Program is used.
- Radiation Protection Program. The SGRP Radiological Control Program is used.
- Occupational Safety Program. The SGRP Site-Specific Health and Safety Plan is used.
- Training Program. The CHPRC Safety Program Specifications for Contractors is used. This ensures that the remediation contractor performs work in accordance with applicable Hanford Site safety requirements (e.g., the Hoisting and Rigging Program).
- Work Management Program. The CHPRC Work Management Program is used. All work will be coordinated with the 1 05-KW Shift Office.
- Hazardous Material Protection Program. The CHPRC Hazardous Material Protection Program is used.

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?*

The current barriers to release are soil and or structures covering the site. The site also has limited contamination for most areas.

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

Dropped canister, collapse of 105 KE Basis excavation pit, or vehicle accident resulting in spill.

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

Facility worker and collocated persons

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

Seconds.

8. *Are there current on-going releases to the environment or receptors?*

Minimal

POPULATIONS AND RESOURCES CURRENTLY AT RISK OR POTENTIALLY IMPACTED

Facility Workers

Workers may be exposed to residual radioactive and chemical contaminants, but are protected by special equipment.

Workers (co-located)

CPs are not directly exposed to the contaminated soils unless through an accidental release (dropped canister, vehicle accident or pit collapse.

Public

The contamination remains underground until remediation. Dispersion from accidents is localized and so there is not a dispersion pathway for the material to reach the atmosphere and travel outside the site boundary.

Groundwater

Migration of the contaminants through the soil into groundwater requires a driving force (source of water to mobilize the contamination). This driver is not present at this time.

There is no known plume associated with Sr-90 from this EU. Based on the transport and decay properties of Sr-90, Sr-90 is not expected to impact the groundwater. A rating of Low is given. However, the inventory of C-14 leads to a GTM of 54.6 and thus an overall rating of Medium.

Columbia River

Migration of the contaminants through the soil into groundwater requires a driving force (source of water to mobilize the contamination).

Neither the C-14 plume is shown to currently intersect the Columbia River (PHOENIX, http://phoenix.pnnl.gov/). Thus, leading to a rating of ND.

Ecological Resources

Summary of Ecological Review

- Most of the K Waste Sites EU (nearly 90% of the area) has been disturbed or consists of buildings, roadways, parking areas, and infrastructure that are classified as level 0 or level 1 habitat.
- Level 4 resources within the EU reflect the bald eagle roost site buffer area (~400 m diameter) that extends into the EU. Noise and construction activities associated with clean-up activities within 400 m of the roost site could potentially influence eagle use of the roost, during the seasonal use period when eagles are present along the river.
- Because most of the EU is disturbed, and remaining habitat within the unit is not contiguous with the adjacent landscape, the loss of habitat resources within the K Waste Sites evaluation unit would not be expected to negatively impact habitat connectivity at the landscape level.

Cultural Resources

- There are no known TCPs within the EU.
- A National Register-eligible irrigation canal associated with the Pre-Hanford Early Settlers/Farming Landscape is located within this EU. This large linear historic resource has been extensively documented and contains miles of main canal and dozens of miles of laterals. It is eligible for the NRHP. However, within the EU, visible evidence of the canal is minimal; within the EU the canal has been destroyed by 100-K Area Hanford construction and remediation activities.
- Segments of the National Register-eligible Hanford Site Plant Railroad a contributing property within the Manhattan Project and Cold War Era Historic District, with documentation required, are located within the EU. In accordance with the 1998 *Hanford Site Manhattan Project and Cold War Era Historic District Treatment Plan* (DOE/RL-97-56), all documentation requirements have been completed for this property.
- In addition to the Hanford Site Railroad, there are 23 Manhattan Project and Cold War Era buildings located within the Evaluation Unit (9 with individual documentation required, 12 with no individual documentation required). Mitigation for contributing buildings/structures have been completed as per the *Hanford Site Manhattan Project and Cold War Era Historic District Treatment Plan* (DOE/RL-97-56) and building demolition is ongoing.

Table G.3-8. Buildings Located in K Area Evaluation Unit.

Name	Description
115-KE	Gas Recirculation Building
115-KW	Gas Recirculation Building
116-KE	Reactor Exhaust Stack
117-KE	Exhaust Air Filter Building
117-KW	Exhaust Air Filter Building
165-KE	Power Control Building
165-KW	Power Control Building

167-K	Cross-tie Tunnel Building
1706-KE	Rad Con Count Lab Facility
1706-KER	Water studies Recirculation Building
1713-KER	Shop Building
1717-K	Maintenance Transportation
1720-K	Administration Office Building
1724-K	Maintenance Shop
181-KE	River Pump House
181-KW	River Pump House
182-K	Emergency Water Reservoir Pump House
183-KE	Complex
183-KW	Complex
1908-K	Outfall Structure
1908-KE	Outfall Structure
190-KE	Main Pump House
190-KW	Main Pump House

Archaeological sites and TCPs located within 500 meters of the EU

- There are no documented TCPs located within 500 meters of the EU.
- Fourteen additional archaeological sites have been documented within 500-meters of the EU.
- Seven archaeological sites (3 eligible and 4 unevaluated) and two isolates (2 not eligible) represent the Native American Precontact and Ethnographic landscape.
- 3 archaeological sites (1 not eligible and 2 unevaluated) and 2 isolates (2 not eligible) represent the Manhattan Project and Cold War era landscape.

Closest Recorded TCP

- There are known TCPs exist in the vicinity of the EU.

CLEANUP APPROACHES AND END-STATE CONCEPTUAL MODEL

Selected or Potential Cleanup Approaches

From SGw-40938 Rev 0

"Remediation activities will be performed using SGRP sampling rigs, typical construction vehicles (e.g., trucks, trackhoes, cranes) and may involve refueling vehicles. Contaminated soil and debris will be transferred to the Environmental Remediation Disposal Facility (ERDF), which is managed by the River Corridor Contractor (RCC). A queue area for ERDF roll-off containers will be located at the site of the demolished 1 07-KE retention basins. ERDF containers are large (approximately 15 i),truck-mounted,

reusable steel containers that typically are equipped with plastic liners. ERDF containers will be used to transport demolition debris and contaminated soil to ERDF. SGRP personnel will fill the ERDF containers and transport them to the queue area. Excavated material will be sorted as necessary in the queue area and all shipments will be verified to meet the ERDF Waste Acceptance Criteria (WAC). RCC drivers will transport the containers to ERDF. The queue area will accommodate 78 empty ERDF containers and 78 full containers, but it is estimated that a nominal 60 ERDF containers will be present in the queue area at one time, and that the traffic increase will be a maximum of 45 trucks per day.

Work activities may be controlled by the lOOK Area Safety Basis (e.g., 105-KW Basin Final Safety Analysis Report [FSAR] and Technical Safety Requirement [TSR], Cold Vacuum Drying Facility FSAR and TSR), and will be subjected to the Unreviewed Safety Question process as appropriate."

From DOE-RL 96-17 In conducting the remedial action, various waste steams will be encountered. Each waste stream will require specific processing and disposal. Similar types of OU-specific waste will be managed uniformly. Assignment of waste to the appropriate waste stream depends on knowing the designation of the waste and appropriate disposal facility. Projected waste streams include, but are not limited to, the following:

- Nonhazardous, nondangerous miscellaneous solid waste
    - Filter paper, wipes, personal protective equipment, cloth, plastic, equipment, tools, pumps, wire, metal and plastic piping, and materials from cleanup of unplanned releases
    - "Demolition waste," which means solid waste, largely inert waste, resulting from the demolition or razing of buildings, roads, or other man-made structures
- Low-level radioactive waste, including soil and associated miscellaneous solid waste. Decommissioning debris includes such materials as concrete, wood, rebar, metal/plastic pipe and screens, wire, liners, equipment, pumps, and tanks
- Mixed waste (i.e., waste that is both low-level radioactive waste and hazardous waste)
- Liquids including, but not limited to, the following:
    - Water from unplanned releases (i.e., spills)
    - Decontamination/cleaning fluids
    - Unknown (i.e., liquid in pipes).
- Used oil/hydraulic fluids
- Returned sample waste associated with these waste sites i
- Nonradioactive waste (e.g., asbestos, PCBs, TPH)
- Hazardous or dangerous waste
- Spent nuclear fuel

From SGW-40938 Rev 0

As the 100OK Area D4 organization completes work on the sites listed in Table 1, SGRP will remediate the sites by one of two methods. For sites designated as Confirmatory Sampling –N Action (CSNA), SGRP will sample the soil to confirm that the site meets DOE/RL-96-17 cleanup criteria. For sites designated as Remove-Treat-Dispose (RTD), SGRP will excavate the site, remove any underground structures (e.g., *piping) and verify that the site meets DOE/RL-96- 17 cleanup criteria. For all sites, SGRP will backfill the excavated area with clean soil, compacted as necessary.*

Contaminant Inventory Remaining at the Conclusion of Planned Active Cleanup Period

The proposed cleanup actions will remove contaminated soils and stabilize the filled sites. Where contamination must be left in place due to the need to maintain structural integrity, soils will be remediated to 15 feet below ground surface. To the extent practical the soils will be cleaned such that unlimited future use is allowed. Where not practical, institutional controls and long term monitoring will be required.

Risks and Potential Impacts Associated with Cleanup

Cleanup activities have the potential to put workers at risk from standard industrial hazards (slips, trips, falls, fires). However, risks were assessed and determined manageable through a safety management program.

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

Facility Worker

From sgw-40938 Rev 0

All sites …. are below Hazard Category-3 (KBC-36585, JOOK Area Project Facility Hazard Categorization, and SGW-42 107, Initial Hazard Categorization for S&GRP Waste Sites Near JOOK Area). Some sites, such as the underground pipelines and the 1 83-KW sites listed in Section 2.2.2.3, were never used with radioactive materials; therefore, debris from these sites is not expected to have any radioactive contamination. Other sites have only minor residual contamination.

The hazard analysis identified 18 potential scenarios (Appendix C of SGW-40938). The postulated unmitigated hazardous conditions result in "low" consequences to the onsite and offsite receptors and no significant impact to the facility worker. Several scenarios were identified as presenting a standard industrial hazard to the facility worker, which is consistent with the nature of the activities. All scenarios are in Risk Bin III, which require Safety Management Programs (SMP).

Co-located Person

The postulated unmitigated hazardous conditions result in "low" consequences to the onsite receptors.

Public

The postulated unmitigated hazardous conditions result in "low" consequences to the offsite receptors.

Groundwater

There is no known plume associated with Sr-90 from this EU. Based on the transport and decay properties of Sr-90, Sr-90 is not expected to impact the groundwater. A rating of Low is given. However, the inventory of C-14 leads to a GTM of 54.6 and thus an overall rating of Medium.

Columbia River

The C-14 plume is shown to currently intersect the Columbia River (PHOENIX, http://phoenix.pnnl.gov/). However, due to uncertainties associated with the transport of C-14, which does not decay quickly, a Low rating is given.

Ecological Resources

Trucks, heavy equipment and drill rigs 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. Drilling can cause destruction of soil invertebrates at greater depths, and has the potential to bring up dormant seeds from deeper soil layers. Drilling can cause disruption of ground-living small mammals and hibernation sites of snakes and other animals. 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). Additional water from dust suppression could lead to more diverse and abundant vegetation in areas that receive water, which could encourage invasion of exotic species. The latter could displace native plant communities. Excessive dust suppression activities could lead to compaction, which can decrease plant growth in those areas, decrease abundance and diversity of soil invertebrates, and prevent fossorial snakes or mammals from using the area. Soil removal can cause complete destruction of existing ecosystem, all of the above effects on adjacent sites, but these effects are potentially more severe because of blowing soil (and seeds) and the potential for exposure of dormant seeds. In the re-vegetation stage, there is the potential for invasion of exotic species, changing the species diversity of native communities. 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, car, and truck traffic on paved roads as well as use of heavy equipment will not have any direct impact on archaeological resources because there is no disturbance to soil/ground or alteration to the landscape. Assuming heavy equipment locations 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 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 paved roads located on TCP, direct effects include visual, auditory and vibrational alterations to landscape/setting. Heavy equipment 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. Revegetation activities may cause direct effects to TCPs include 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, car, and truck traffic on paved roads as well as use of heavy equipment 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. Existing road causes no alteration to 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. 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

There is no risk to workers if cleanup of the soils or building is delayed**. There may be some potential for groundwater impact. (From SGW 54741 Rev 0, Page 6:** *Near the Columbia River, the unconfined aquifer is strongly influenced by fluctuations in river stage, which affect the pattern of movement and the rate at which groundwater discharges to the river. During periods of prolonged high river conditions, the elevated water table may contact and mobilize contaminants held in the normally unsaturated lower vadose zone (DOE/RL-2010-11, Hanford Site Groundwater Monitoring and Performance Report for 2009*)**.**

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

Populations and Resources at Risk or Potentially Impacted After Cleanup Actions (from residual contaminant inventory or long-term activities)

Table G.3-9. Populations and Resource at Risk.

Population or Resource		Risk/Impact Rating	Comments
Human	Facility Worker	ND-Low	Other than periodic inspections, no workers will be present.
	Co-located Person	ND	None
	Public	ND	Public access will be prevented by physical barriers and institutional controls
Environmental	Groundwater	Medium	There is no known plume associated with Sr-90 from this EU. Based on the transport and decay properties of Sr-90, Sr-90 is not expected to impact the groundwater. A rating of Low is given. However, the inventory of C-14 leads to a GTM of 54.6 and thus an overall rating of Medium.
	Columbia River	Low	The C-14 plume is shown to currently intersect the Columbia River (PHOENIX, http://phoenix.pnnl.gov/). However, due to uncertainties

			associated with the transport of C-14, which does not decay quickly, a Low rating is given.
	Ecological Resources*	Low - Medium	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. Similar effects in buffer zone.
Social	Cultural Resources*	**Native American:** Direct: Known Indirect: Known **Historic Pre-Hanford:** Direct: Known Indirect: Known **Manhattan/Cold War**: Direct: None Indirect: None	Permanent direct and indirect effects are possible due to high sensitivity of area.

*For both Ecological and Cultural Resources see Appendices J and K respectively for a complete description of Ecological Field Assessments and literature review for Cultural Resources.

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

Cleanup will be dictated by the extent of the contamination and the ability to remediate the site. The point of compliance for human exposure via direct contact will be 15 feet below ground surface (from the Washington Administrative Code (WAC) 173-340 (1996)). From EPA 1995: To the extent practicable, return soil concentrations to levels that allow for unlimited future use and exposure. Where it is not practicable to remediate to levels that will allow for unrestricted use in all areas, institutional controls and long-term monitoring will be required.

PART VII. SUPPLEMENTAL INFORMATION AND CONSIDERATIONS

Not Applicable

REFERENCES

DOE/RL-96-1 7, * Rev. 6, Remedial Design Report/ Remedial Action Work Plan for the 100 Area, US Department of Energy, Sept 2009. Richland WA 99352

PNNL-13895. Hanford Contaminant Distribution Coefficient Database and Users Guide, K. J. Cantrell R. J. Serne G. V. Last May 2002

Donna Morgans*, John Lowe**, Chris McCarthy**, and Alaa Aly, "A Conceptual Site Model for Nature and Extent of Contamination in a Riparian-Near Shore Area -12410" WM2012 Conference, February 26 – March 1, 2012, Phoenix, AZ

EPA, 1995, *Interim Action Record of Decision for the 100-BC-i, 100-DR-i, and 100-HR-I Operable Units, Hanford Site, Benton County, Washington,* September 1995, U.S. Environmental Protection Agency, Region 10, Seattle, Washington.

Carpenter, R. W., Cote, S.L. 1994. 100-K Area Technical Baseline Report. Richland: Westinghouse Hanford Company.

Stenner, R.D., KH Cramer, KA Higley, SJ Jette, DA Lamar, TJ McLaughlin, DR Sherwood, and NC Van Houten. October1988, Hazard Ranking System Evaluation of CERCLA Inactive Waste Sites at Hanford Volume 1, 2, 3. PNL 6456, Pacific Northwest Laboratory, Richland, Washington.

APPENDIX G.4

BC CRIBS AND TRENCHES (CP-LS-1, CENTRAL PLATEAU) EVALUATION UNIT SUMMARY TEMPLATE

Table of Contents

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PART I. EXECUTIVE SUMMARY

EU LOCATION:

200 Industrial Area

RELATED EUS

Other Central Plateau Projects

PRIMARY CONTAMINANTS, CONTAMINATED MEDIA AND WASTES

The primary contaminants of concern in the BC Cribs and Trenches area include Nitrate (NO_3^-), Tc-99, Sr-90, Cs-137, and U-238. Other constituents and inventories are provided by Corbin et al. 2005, Kincaid et al. 2006 (PNNL-15829), and Serne et al. 2009, and is also summarized in Table G.4-7 below.

BRIEF NARRATIVE DESCRIPTION

CP-LS-1, or the BC Cribs and Trenches Evaluation Unit (EU), includes the 200-BC-1 Operable Unit (OU), which is part of the 200 Area National Priority List (NPL) site, located in the central portion (or Central Plateau area) of the Hanford Site. The BC Cribs and Trenches site lies within the 200-BC-1 OU, south of the 200 East area (DOE-RL 2011, p. 1-1). The 200-BC-1 OU consists of 28 waste sites, including 26 cribs and trenches, one siphon tank, and one pipeline (DOE-RL 2011, p. 1-15). These waste sites were used in the 1950s to dispose of more than 140 million L (38 million gal) of tank waste supernatant from the B, BX, BY, and C Tank Farms. Four trenches received smaller quantities of liquid waste that were generated in the 300 Area and transferred by tanker truck to the 200 Area. The largest volume of waste at these sites was disposed of in six cribs and 16 trenches and was conveyed by an underground pipeline from the B, BX, BY, and C Tank Farms (DOE-RL 2011). The primary contaminants present at the BC Cribs and Trenches include Nitrate (NO_3^-), Tc-99, Sr-90, Cs-137, and U-238. The current land use activities in the Central Plateau Inner Area are industrial in nature. For the BC Cribs and Trenches Area waste sites, five remedial alternatives were identified for detailed and comparative analyses: (i) No Action; (ii) Maintain Existing Soil Cover, Institutional Controls, and Monitored Natural Attenuation; (iii) Removal, Treatment, and Disposal; (iv) Capping; and (v) Partial Removal, Treatment, and Disposal with Capping. These five alternatives also were evaluated for their applicability to the 200-E-14 Siphon Tank and 200-E-114 Pipeline. The designated future land use is Industrial Exclusive Area (DOE-RL 2011, p. 3-25). A complete summary of the CP-LS-1 BC Cribs and Trenches waste site and facility list is provided in Table G.4-1 below.

SUMMARY TABLE OF RISKS AND POTENTIAL IMPACTS TO RECEPTORS

Table G.4-2 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 BC Cribs and Trenches areas; a Co-located Person (CP) is an individual located 100 meters from the physical boundaries of the BC Cribs and Trenches 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 Non-Discernable (ND) to Very High. The estimated mitigated exposure that takes engineered and administrative controls and protections into consideration, is shown in parenthesis.

Groundwater and Columbia River: Evaluation of the threats to groundwater as a protected resource from saturated zone contamination utilized the groundwater evaluation framework procedure outlined in Chapter 6 of the "Methodology for the Hanford Site-Wide Risk Review Project" report (CRESP

Table G.4-1. CP-LS-1 BC Cribs and Trenches Waste Site and Facility List. (Note that only those waste sites with a Waste Information Data System (WIDS) Classification of "Accepted" are shown, along with non-duplicate facilities, identified via Hanford Geographic Information System (HGIS).)

Site Code	Name, Aliases, Description	Site Status	Site Type	Site Type Category	Operable Unit	Exclude from Evaluation
200-E-114-PL	200-E-114-PL; 216-BC-2805; 2805-E1, 2805-E2, 2805-E3 and 2805-E4; Pipeline from 216-BY-201 to 216-BC-201; Pipeline from 241-BY Tank Farm to 241-C Tank Farm and BC Cribs Trenches	Inactive	Radioactive Process Sewer	Pipeline and associated valves, etc.	200-BC-1	
200-E-14	200-E-14; 216-B-201; 216-BC-201 Siphon Tank; IMUST; Inactive Miscellaneous Underground Storage Tank	Inactive	Storage Tank	Underground storage tank	200-BC-1	
200-E-222-PL	200-E-222-PL; Distribution Pipelines from 216-BC-201 Siphon Tank to BC Cribs	Inactive	Radioactive Process Sewer	Pipeline and associated valves, etc.	TBD	
216-B-14	216-B-14; 216-BC-1 Crib	Inactive	Cribs	Crib - Subsurface Liquid Disposal Site	200-BC-1	
216-B-15	216-B-15; 216-BC-2 Crib	Inactive	Cribs	Crib - Subsurface Liquid Disposal Site	200-BC-1	
216-B-16	216-B-16; 216-BC-3 Crib	Inactive	Cribs	Crib - Subsurface Liquid Disposal Site	200-BC-1	
216-B-17	216-B-17; 216-BC-4 Crib	Inactive	Cribs	Crib - Subsurface Liquid Disposal Site	200-BC-1	
216-B-18	216-B-18; 216-BC-5 Crib	Inactive	Cribs	Crib - Subsurface Liquid Disposal Site	200-BC-1	
216-B-19	216-B-19; 216-BC-6 Crib	Inactive	Cribs	Pipeline and associated valves, etc.	200-BC-1	
216-B-20	216-B-20; 216-B-20 Trench; 216-BC-7 Trench	Inactive	Trenches	Crib - Subsurface Liquid Disposal Site	200-BC-1	
216-B-21	216-B-21; 216-B-21 Trench; 216-BC-8 Trench	Inactive	Trenches	Pipeline and associated valves, etc.	200-BC-1	
216-B-22	216-B-22; 216-B-22 Trench; 216-BC-9 Trench	Inactive	Trenches	Crib - Subsurface Liquid Disposal Site	200-BC-1	
216-B-23	216-B-23; 216-B-23 Trench; 216-BC-10 Trench	Inactive	Trenches	Crib - Subsurface Liquid Disposal Site	200-BC-1	
216-B-24	216-B-24; 216-B-24 Trench; 216-BC-11 Trench	Inactive	Trenches	Pipeline and associated valves, etc.	200-BC-1	
216-B-25	216-B-25; 216-B-25 Trench; 216-BC-12 Trench	Inactive	Trenches	Crib - Subsurface Liquid Disposal Site	200-BC-1	
216-B-26	216-B-26; 216-B-26 Trench; 216-BC-13 Trench	Inactive	Trenches	Crib - Subsurface Liquid Disposal Site	200-BC-1	
216-B-27	216-B-27; 216-B-27 Trench; 216-BC-14 Trench	Inactive	Trenches	Crib - Subsurface Liquid Disposal Site	200-BC-1	
216-B-28	216-B-28; 216-B-28 Trench; 216-BC-15 Trench	Inactive	Trenches	Crib - Subsurface Liquid Disposal Site	200-BC-1	
216-B-29	216-B-29; 216-BC-16 Trench	Inactive	Trenches	Pipeline and associated valves, etc.	200-BC-1	
216-B-30	216-B-30; 216-B-30 Trench; 216-BC-17 Trench	Inactive	Trenches	Crib - Subsurface Liquid Disposal Site	200-BC-1	
216-B-31	216-B-31; 216-B-31 Trench; 216-BC-18 Trench	Inactive	Trenches	Crib - Subsurface Liquid Disposal Site	200-BC-1	
216-B-32	216-B-32; 216-B-32 Trench; 216-BC-19 Trench	Inactive	Trenches	Crib - Subsurface Liquid Disposal Site	200-BC-1	
216-B-33	216-B-33; 216-B-33 Trench; 216-BC-20 Trench	Inactive	Trenches	Crib - Subsurface Liquid Disposal Site	200-BC-1	
216-B-34	216-B-34; 216-BC-21 Trench	Inactive	Trenches	Crib - Subsurface Liquid Disposal Site	200-BC-1	
216-B-52	216-B-52; 216-B-52 Trench; 216-BC-22	Inactive	Trenches	Crib - Subsurface Liquid Disposal Site	200-BC-1	
216-B-53A	216-B-53A; 216-B-53A Trench; PRTR Trench	Inactive	Trenches	Crib - Subsurface Liquid Disposal Site	200-BC-1	

EU Designation: CP-LS-1 (200-BC-1 Operable Unit)

216-B-53B	216-B-53B; 216-B-53B Trench; 216-B-53 Trench	Inactive	Trenches	Crib - Subsurface Liquid Disposal Site	200-BC-1	
216-B-54	216-B-54; 216-B-54 Trench	Inactive	Trenches	Crib - Subsurface Liquid Disposal Site	200-BC-1	
216-B-58	216-B-58; 216-B-58 Trench; 216-B-59 Crib	Inactive	Trenches	Crib - Subsurface Liquid Disposal Site	200-BC-1	
600-235	600-235; Buried Lead Sheathed Telephone Cables	Inactive	Dumping Area	Burial Ground	TBD	
UPR-200-E-63	UPR-200-E-63; Radioactively Contaminated Tumbleweeds; UN-200-E-63; UN-216-E-63	Inactive	Unplanned Release	Unplanned Release – Surface/Near Surface	NA	
6120	Salt and Sand Storage	Active	Structure	Infrastructure Building	-	X

Methodology Report, February 2015). These impacts are also expressed in a range of from Non-Discernable (ND) to 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: No risk ratings are provided for Cultural Resources. The Table 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.

Table G.4-2. Risk Rating Summary (for Human Health, unmitigated nuclear safety basis indicated, mitigated basis indicated in parenthesis (e.g., "Very High" (Low)).

Population or Resource		Evaluation Time Period Active Cleanup (to 2064) **Current Condition:** Sampling & Monitoring	**From Cleanup Actions:** Five Options
Human Health	Facility Worker	Low	Low-High
	Co-located Person	Low to ND	Low-Medium
	Public	ND	Low to ND
Environmental	Groundwater	High (I-129, Tc-99, Cr, and Cr-VI)	High (I-129, Tc-99, Cr, and Cr-VI)
	Columbia River	ND	ND
	Ecological Resources	ND to Low	Low to Medium
Social	Cultural Resources	**Native American:** Direct: Known Indirect: Known **Historic Pre-Hanford:** Direct: Unknown Indirect: None **Manhattan/Cold War:** Direct: Known Indirect: Unknown	**Native American:** Direct: Known Indirect: Known **Historic Pre-Hanford:** Direct: Unknown Indirect: None **Manhattan/Cold War:** Direct: Known Indirect: Unknown

SUPPORT FOR RISK AND IMPACT RATINGS FOR EACH TIME PERIOD

Human Health

<u>Current</u>
The Central Plateau industrial/exclusive zone contains the former processing facilities, tank farms, and the majority of the waste disposal sites. A buffer area around this zone has been proposed to facilitate implementation of institutional controls within it. Current remediation activities are associated with sampling and monitoring and site access maintenance only. The site is covered with clean soil backfill to isolate contaminated areas from the surface.

The characterization workforce is thus described as Low risk. Risk to the Co-located Person is rated Low to ND and Public is rated as ND due to the remote distance to the site, depth from ground surface to soil contamination and depth to groundwater contamination. Groundwater threat is evaluated high due to the presence of technetium-99 and nitrate, both highly mobile primary contaminants, with high concentrations detected 18 to 53 m below the ground surface (Serne et al. 2009). Due to the large technetium-99 inventory (over 400 Ci), and high mobility of this contaminant, groundwater risk is categorized as high. Surface water is rated non-discernible (ND) since the contaminants are not currently impacting the Columbia River and not expected to do so from this area within the next 150 years.

<u>Risks and Potential Impacts from Selected or Potential Cleanup Approaches</u>
The five cleanup alternatives span from no action (monitoring only with Alternative No. 1) to significant action associated with removal treatment and disposal (Alternative No. 3) to partial RTD and monitoring (Alternative No. 5). As such, impacts from potential cleanup approaches will vary significantly. The Facility Worker is thus described as low to high risk (Low for Alternatives 1 and 2; medium for Alternatives 4 and 5; and high for Alternative 3.

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

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

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

Groundwater and Columbia River

<u>Current</u>
Evaluation of the threats to groundwater as a protected resource from saturated zone contamination utilized the groundwater evaluation framework procedure outlined in Chapter 6 of the "Methodology for the Hanford Site-Wide Risk Review Project" report (CRESP Methodology Report, February 2015), and summarized in Table 6-3. Groundwater risk is evaluated high based on the Groundwater Threat Metric for Sr-90 (3420 – Very High), Cr-VI (489 - High), Tc-99 (456 - High), I-129 (263 - High), Cr (total) (235 - High), and U (total) (18 – Medium). Surface water is rated non-discernible (ND) since there are no

current groundwater contaminant plumes, and thus the contaminants are not currently impacting the Columbia River.

<u>Risks and Potential Impacts from Selected or Potential Cleanup Approaches</u>
Groundwater risk is evaluated high based on the Groundwater Threat Metric for Sr-90 (3420 – Very High), Cr-VI (489 - High), Tc-99 (456 - High), I-129 (263 - High), Cr (total) (235 - High), and U (total) (18 – Medium). Surface water is rated non-discernible (ND) since there are no current groundwater contaminant plumes, and thus the contaminants are not currently impacting the Columbia River. Surface water is rated ND since the contaminants are not expected to impact the Columbia River due to potential cleanup approaches.

Ecological

<u>Current</u>
ND to Low in EU because nearly 30% is level 3 and 4 resources, along with the buffer area. There is the potential for disturbance and invasion of exotic species in both EU and buffer area.

<u>Risks and Potential Impacts from Selected or Potential Cleanup Approaches</u>
Depending upon remediation option, could result in disturbance and disruption to level 3 and 4 (30% of EU and 77% of buffer), including increases in exotic species and changes in species composition of native species.

Cultural

<u>Current</u>
There are unevaluated cultural resources located within this EU. Manhattan Project/Cold War significant resources have already been mitigated. Traditional cultural places in view-shed.

<u>Risks and Potential Impacts from Selected or Potential Cleanup Approaches</u>
There is one unevaluated (for National Register) cultural resource. Traditional cultural places in view-shed. Indirect effects are possible from capping.

Considerations for timing of the cleanup actions

"The primary risk to human health would be through direct contact with the waste, particularly cesium-137 and strontium-90. Because high concentrations of cesium-137 and slrontium-90 are at relatively shallow depths in the cribs and trenches, less than 4.6 m (15 ft), the potential for direct contact exists following the period of institutional controls. This direct contact could result from modest excavation activities such as pipeline installation or construction of a building basement. The high concentrations of cesium-137 observed during characterization of the 216-B-26 Trench exhibited dose rates that could be lethal (~4.5 rad/h) if exposure time were sufficient (a few hundred years). The deep mobile contaminants (technetium-99 and nitrate) are predicted to eventually reach groundwater at levels exceeding the drinking water standard, potentially rendering the groundwater unfit for human consumption following the 150 year evaluation period. Baseline risk (without remedial action) assessment was performed using the industrial scenario to establish the need for remedial action. The inadvertent intruder scenario was considered to evaluate potential post-remediation risk. The baseline risk assessment for the 216-B-26 Trench indicated the significant shallow-zone contaminants (primarily cesium-137 and strontium-90) in the 3.7 to 4.6 m (12 to 15 ft) range would require nearly 450 yr to decay to levels corresponding to acceptable risk to industrial workers. The maximum dose to industrial workers is calculated to be 310,000 mrem/yr, which greatly exceeds the 15 mrem/yr criterion. Predicted migration of technetium-99 and nitrate may exceed the groundwater drinking water standards for those contaminants. With respect to potential intruders past the 150-yr period of active institutional controls, humans are not protected until radioactive decay proceeds for nearly 450 yr. The 216-B-46 Crib, which is representative of the BC Cribs and Trenches Area cribs, indicated similar risks. The baseline risk assessment for the 216-B-58 Trench indicated lesser shallow-zone contaminant concentration and essentially no deep mobile contaminants. Even so, human health risk standards related to direct exposure were exceeded. Groundwater protection standards (equivalent to drinking water standards (DOE/RL-2009-85, REV. 1, p. 5-58)) are not predicted to be exceeded. Risk to inadvertent intruders is essentially acceptable 250 yr from now with no action. Uncertainties with the exact nature of future industrial and inadvertent intruder exposures may lead to under- or over-estimation of human health risk. Another source of uncertainty is the limited sample data. Because the investigation and sampling focused on the most highly radioactive wastes, the risk assessment is more likely to overestimate the potential human risk." (DOE/RL 2004-69, Draft A, p. 12)

Near-Term, Post-Cleanup Risks and Potential Impacts

Technetium-99 and nitrate are both highly mobile primary contaminants, with high concentrations detected 18 to 53 m below the ground surface (Serne et al. 2009). Cesium-137 and strontium-90 are expected to remain in the vadose zone with little to no migration due to their high sorption affinity for the surrounding soils and sediments. Technetium-99 is considered a highly mobile, highly persistent contaminant, while nitrate may be categorized as a highly mobile, low persistence contaminant (Table 6-1, CRESP 2015. *Methodology for the Hanford Site-Wide Risk Review Project*, The Consortium for Risk Evaluation with Stakeholder Participation III (CRESP), Vanderbilt University, Nashville, TN. Available at: www.cresp.org/hanford). Groundwater risk is evaluated high based on the Groundwater Threat Metric for Sr-90 (3420 – Very High), Cr-VI (489 - High), Tc-99 (456 - High), I-129 (263 - High), Cr (total) (235 - High), and U (total) (18 – Medium). Surface water is rated non-discernible (ND) since there are no current groundwater contaminant plumes, and thus the contaminants are not currently impacting the Columbia River. Risk to the public, inadvertent intruder, and trespasser is rated as low due to the remote distance to the site, depth from ground surface to soil contamination, and depth to potential groundwater contamination.

Long-Term, Post-Cleanup Conditions

The DOE is expected to continue industrial exclusive activities for at least 50 years, in accordance with DOE/EIS-0222-F, *Final Hanford Comprehensive Land-Use Plan Environmental Impact Statement,* and the Record of Decision (64 FR 61615, "Record of Decision: Hanford Comprehensive Land-Use Plan Environmental Impact Statement (HCP EIS)". Based on discussions with the HAB, the alternative risk evaluations used the following anticipated land-use assumptions:

• Industrial-Exclusive use for the next 50 years inside the Central Plateau industrial exclusive zone.

• Industrial land use (non-DOE worker) after the next 50 years inside the Central Plateau industrial/ exclusive zone.

• Native American uses consistent with treaty rights.

• No groundwater consumption for at least the next 150 yr.

In addition, risks were calculated considering the possibility of intruders beginning 150 yr from now (2155) to evaluate impacts from the potential loss of institutional control.

EU Designation: CP-LS-1 (200-BC-1 Operable Unit)

PART II. ADMINISTRATIVE INFORMATION

OU AND/OR TSDF DESIGNATION(S)

200-BC-1

COMMON NAME(S) FOR EU

BC Cribs and Trenches

KEY WORDS

BC Cribs and Trenches, 200 Area, 200-BC-1 OU, Soils, Central Plateau

REGULATORY STATUS

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

APPLICABLE REGULATORY DOCUMENTATION

- DOE-RL-2010-49, 2011, *Draft A: Remedial Investigation Feasibility Study Work Plan 200-WA-1 and 200-BC-1 Operable Units,* U.S. Department of Energy, Richland Operations Office, Richland, Washington.
- DOE-RL-2004-66, 2004, *Focused Feasibility Study for the BC Cribs and Trenches Area Waste Site*, Rev. 0, U.S. Department of Energy, Richland Operations Office, Richland, Washington.
- DOE-RL-2003-64, 2004, *Feasibility Study for the 200-TW-1 Scavenged Waste Group, the 200-TW-2 Tank Waste Group, and the 200-PW-5 Fission-Product Rich Waste Group Operable Units,* Draft A Re-issue, U.S. Department of Energy, Richland Operations Office, Richland, Washington.

Applicable Consent Decree or TPA milestones: None.

RISK REVIEW EVALUATION INFORMATION

Completed: 20 January 2015; updated 26 May 2015.

Evaluated by: E.J. LeBoeuf and J.H. Clarke

Ratings/Impacts Reviewed by: D. Kosson, M. Gochfeld, J. Burger, K. Brown, J. Salisbury, H. Mayer

PART III. SUMMARY DESCRIPTION

CURRENT LAND USE

DOE Hanford industrial site area

DESIGNATED FUTURE LAND USE

Industrial Exclusive Area (DOE-RL 2011, p. 3-25)

PRIMARY EU SOURCE COMPONENTS

Legacy Source Sites

The BC Cribs and Trenches waste sites, although currently covered with clean soil backfill, remain in place. The waste sites are separated into four distinct groups based on waste site configuration, primary waste source, and relative volume of waste received. These include: (i) High-volume Scavenged Waste Cribs and Trenches; (ii) Specific Retention Scavenged Waste trenches; (iii) Specific Retention 300 Area Waste Trenches; and one underground storage tank (200-E-14). An additional primary legacy source site is derived from the contaminated vadose zone underneath the cribs and trenches.

High-Level Waste Tanks and Ancillary Equipment

Not Applicable.

Vadose Zone and Groundwater Plumes

The depth of contamination varies by waste site and contaminant. Serne et al. 2009 (pp. 9.2-9.3), indicate that there is a an approximately 15 ft thick layer of sandy silt and fine silty sand at a depth of approximately 120 to 130 feet below ground surface that contains “elevated technetium-99 and EC (electrical conductivity)”, and that “the most elevated nitrate concentrations are found from 28 to 245 ft bgs.” According to Ward et al. 2004, “Tc-99 at concentrations over 75,000 pCi/L were recently reported for a monitoring well near SX-115 (Hartman et al. 2004). In contrast, some 3.686 $x \cdot 10^6$ L (9.737 × 10^6 gal) of supernatant fluid containing 128 Ci of Tc-99 were discharged to seven trenches over a period of about 1.5 years in the BC Cribs and Trenches area, yet there is no evidence of groundwater contamination from the cribs or trenches. The current distribution of Tc-99 in the vadose zone beneath 216-B-26 is therefore not easy to explain using current conceptual models. Recent sampling at the 216-B-26 Trench shows a zone of Tc-99 contamination between 18 and 53 m. The peak soil concentration exceeds 100 pCi/g, while the pore water concentration is approximately $1.4 \cdot x\ 10^6$ pCi/L, both at a depth of about 30 m.”

D&D of Inactive Facilities

Not Applicable.

Operating Facilities

Not Applicable.

LOCATION AND LAYOUT MAPS

The 200-BC-1 OU is located in the Central Plateau's Inner Area (see Figures G.4-1 and G.4-2 below). The BC Cribs and Trenches site lies within the 200-BC-1 OU, in the southeast portion of the 200 East area (DOE-RL 2011, p. 1-1). Waste sites of the 200-BC-1 OU for the BC Cribs and Trenches are provided in Figure G.4-3 below. Each of these waste sites are separated into four groups based on (i) waste site configuration, (ii) primary waste source, and (iii) relative volume of waste received (DOE-RL 2011, p. 3-7).

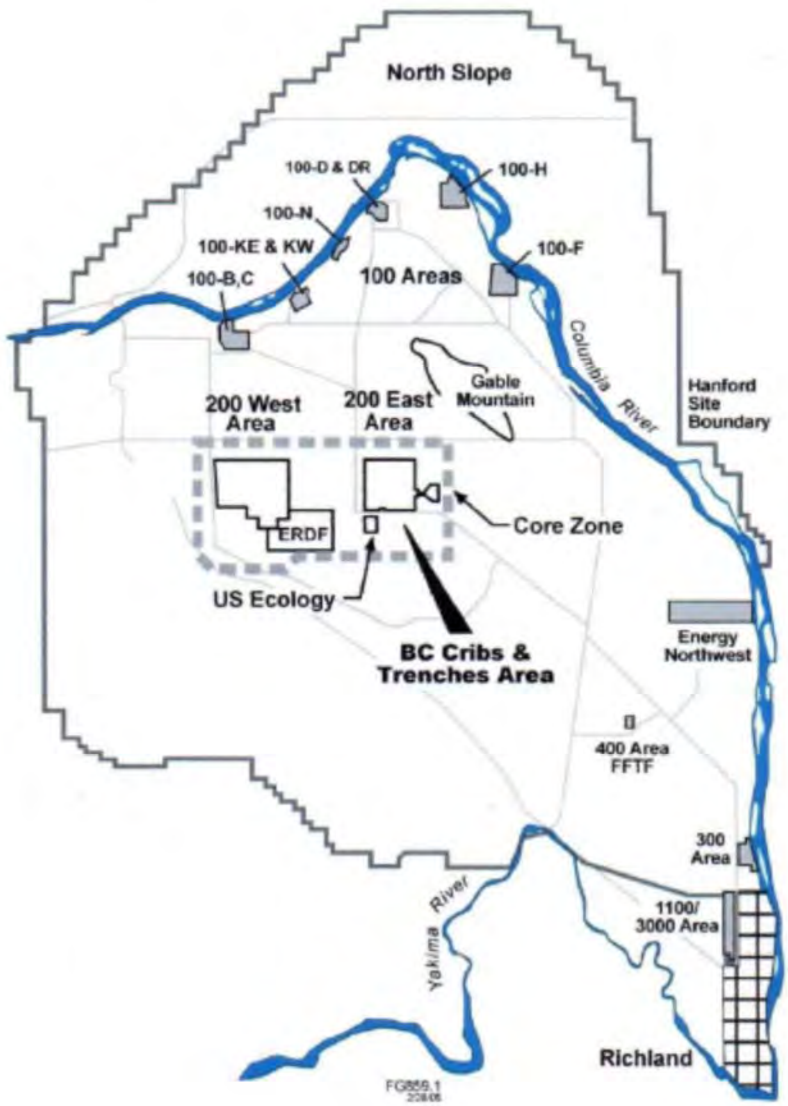

Figure G.4-1. Location of the BC Cribs and Trenches Area Waste Sites on the Hanford Site (DOE-RL 2004-69, Draft A, p. 5).

EU Designation: CP-LS-1 (200-BC-1 Operable Unit)

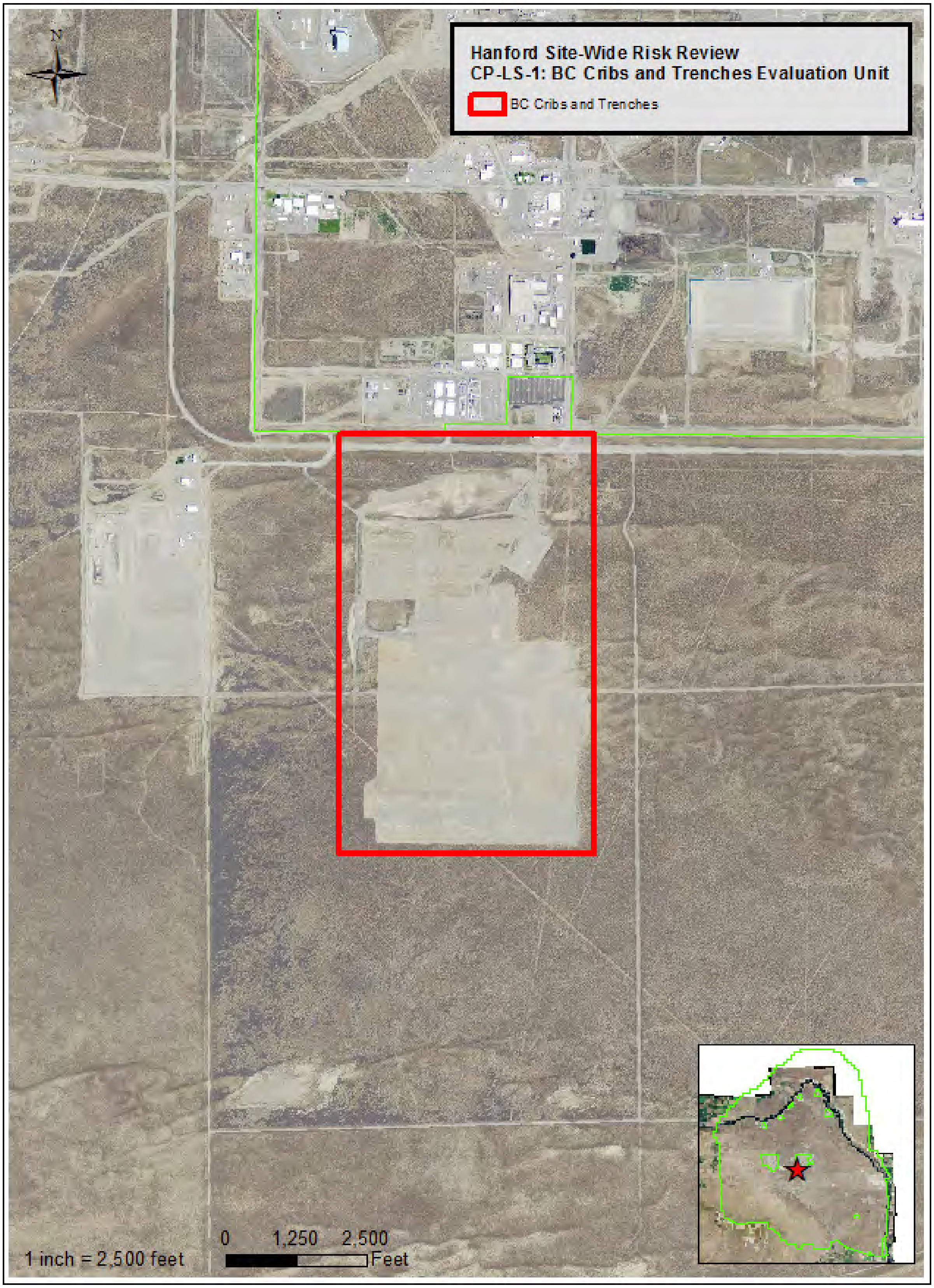

Figure G.4-2. EU Boundary Map

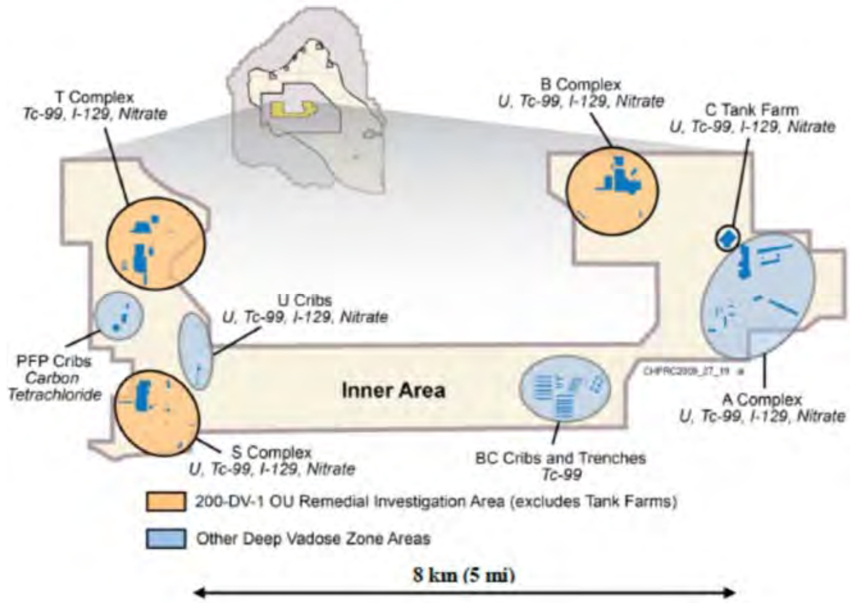

Figure G.4-3. Central Plateau Inner Area illustrating the location of the BC Cribs and Trenches, including examples of deep vadose zone (DVZ) problem areas (after Wellman et al. 2011, Figure 2.1, p. 2.5).

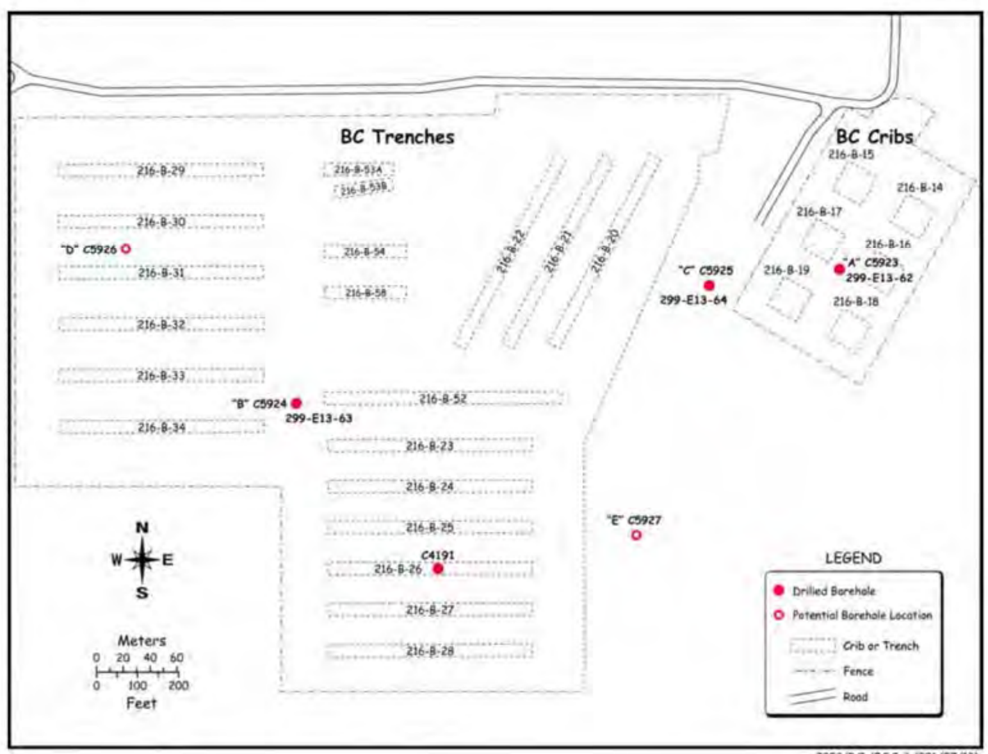

Figure G.4-4. Location of BC Cribs and Trenches waste sites (after DOE-RL 2011-50, Figure 1.1, p. 1.5).

PART IV. UNIT DESCRIPTION AND HISTORY

EU Former/Current Use(s)

The BC Cribs and Trenches Area includes 6 cribs and 16 trenches. The area received "scavenged" waste (or waste where most of the highly radioactive cesium-137 is chemically removed) from uranium recovery and ferrocyanide processes at the 221/22-l-U Plant. Discharges of these scavenged wastes provided the primary liquid contribution of contaminants within the 200 Areas. "Four additional trenches, formerly in the 200-LW-1 Operable Unit, are also located in this area. Three of these four trenches received waste from the 300 Area laboratory facilities and the 340 Waste Neutralization Facility; the fourth trench received waste from the Plutonium Recycle Test Reactor. Discharges to these liquid waste disposal sites were limited to avoid exceeding the estimated capacity of the soil to retain the liquid above the water table. Two other waste sites are included in this area: a Siphon tank that held liquid waste before its discharge to the cribs and the pipeline that delivered liquid waste to the siphon tank…" (DOE/RL 2004-69, Draft A, p. 6).

Legacy Source Sites

Not Applicable.

Tank Waste and Tank Farms

Not Applicable.

Groundwater Plumes

The BC Cribs and Trenches Area is within the 200-PO-1 Groundwater monitoring OU under CERCLA, as described in the Sampling and Analysis Plan for the 200-PO-1 Groundwater OU (DOE/RL 2003-04).

D&D of Inactive Facilities

Not Applicable.

Operating Facilities

Not Applicable.

Ecological Resources Setting

Landscape Evaluation and Resource Classification

The amount of each category of biological resources at the BC Cribs and Trenches EU was examined within a circular area radiating 1830 m from the geometric center of the unit (equivalent to 2598 acres). Approximately 71 percent of the total combined area (evaluation unit and associated adjacent landscape) is classified as level 3 or higher biological resources in the existing resource level map. However, the majority of the level 3 and level 4 resources lie to outside of the evaluation unit boundary (Figure G.4-2).

Field Survey

Reconnaissance of the BC Cribs and Trenches evaluation unit indicated that most of the EU currently consists of non-vegetated areas, heavily disturbed or revegetated areas, and compacted gravel areas (i.e., level 0 resources; {Table G.4-2). A portion of this area that was previously classified as level 3 and 4 (approximately 153 acres) was reclassified as level 0 for this assessment to reflect current vegetation conditions (Figure G.4-2 and G.4-3). Habitat around the level 0 resources in the disturbed area of the evaluation unit consists of level 3 and 4 resources along the boundary of the evaluation unit. These patches are contiguous with the adjacent landscape, but no pedestrian surveys or field data collection were attempted in these areas because this waste site and evaluation unit lie within a radiological control area. A project review letter summarizing data collected within the evaluation unit boundary in 2008 and 2009 provided information on habitat quality in the remaining level 3 and level 4 resources. Figure G.4-3 shows the condition of the area where revegetation was attempted and failed, resulting in scattered cover of Russian thistle (*Salsola tragus)* and scurf pea (*Psoralea lanceolata*) across the southern portion of the EU.

CULTURAL RESOURCES SETTING

Cultural resources known to be recorded within the BC Cribs and Trenches EU are limited to the archaeological finds associated with the Native American Precontact and Ethnographic Landscape (an isolated find and a site). The site has been unevaluated for National Register eligibility and the isolate is considered to not be National Register-eligible. Additionally, the BC Cribs are contributing properties within the Manhattan Project and Cold War Era Historic District, with documentation required. In accordance with the 1998 *Hanford Site Manhattan Project and Cold War Era Historic District Treatment Plan (*DOE/RL-97-56), all documentation requirements have been completed for this property.

A little over half of the BC Cribs and Trenches EU has been inventoried for archaeological resources and remediation of the BC Cribs and Trenches EU has been addressed by an NHPA Section 106 review. There is a possibility that intact archaeological material is present in the areas that have not been inventoried for archaeological resources (both on the surface and in the subsurface), particularly if undisturbed soil deposits exist within the BC Cribs and Trenches EU. There are two National Register-eligible buildings that are contributing properties within the Manhattan Project /Cold War Era District with documentation required (2101M Machine Shop/Office and 2750E Office Building), and three National Register-eligible contributing buildings within the Manhattan Project /Cold War Era District with no documentation required (2751E, 2752E and 2753E Office Buildings. In accordance with the 1998 *Hanford Site Manhattan Project and Cold War Era Historic District Treatment Plan (*DOE/RL-97-56), all documentation requirements have been completed for these properties.

Geomorphology, ground disturbance, historic maps, and the presence of archaeological resources associated with the Native American Precontact and Ethnographic landscape located within the BC Cribs and Trenches EU all suggest that the potential exists for additional archaeological resources associated with the Native American Precontact and Ethnographic landscape to be present on the surface or within the subsurface within the EU. The potential for intact archaeological resources associated with the Pre-Hanford Early Settlers/Farming Landscape and the Manhattan Project associated archaeological resources is also possible.

Because some areas of the BC Cribs and Trenches EU have not been investigated for archaeological sites and pockets of undisturbed soil likely exist, it may be appropriate to conduct surface and subsurface archaeological investigations in these areas prior to initiating a remediation activity. 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 associated with these landscapes (e.g. East Benton Historical Society, Prosser Cemetery Association, Franklin County Historical Society, the Reach, and the B-Reactor Museum Association) may need to occur. Indirect effects are always possible when TCPs are known to be located in the general vicinity. Consultation with Hanford Tribes may also 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 BC Cribs and Trenches contain 27 waste sites (DOE-RL 2011) separated into four distinct groups based on waste site configuration, primary waste source, and relative volume of waste received. These include: (i) High-volume Scavenged Waste Cribs and Trenches (Table G.4-3); (ii) Specific Retention Scavenged Waste trenches (Table G.4-4); (iii) Specific Retention 300 Area Waste Trenches (Table G.4-5), and one underground storage tank (200-E-14). Table 6 summarizes each of the four waste sites within the 200-BC-1 OU. These waste sites were used in the 1950s to dispose of more than 140 million L (38 million gal) of tank waste supernatant from the B, BX, BY, and C Tank Farms. Four trenches received smaller quantities of liquid waste that were generated in the 300 Area and transferred by tanker truck to the 200 Area. The largest volume of waste at these sites was disposed of in six cribs and 16 trenches and was conveyed by underground pipeline from the B, BX, BY, and C Tank Farms (DOE-RL 2011).

Table G.4-3. High-volume Scavenged Waste Cribs and Trenches (Data from Maxfield, RHO-CD-673).

WIDS Identification	Area (square feet)	Discharge Volume (liters)
216-B-14	40×40 = 1600	8.71×10^{6}
216-B-15	40×40 = 1600	6.32×10^{6}
216-B-16	40×50 = 2000	5.6×10^{6}
216-B-17	40×40 = 1600	3.41×10^{6}
216-B-18	40×40 = 1600	8.52×10^{6}
216-B-19	40×40 = 1600	6.4×106
216-B-20	500×10 = 5000	4.68×106
216-B-21	500×10 = 5000	4.67×106
216-B-22	500×10 = 5000	4.74×106

Table G.4-4. Specific Retention Scavenged Waste Trenches (Data from Maxfield, RHO-CD-673).

WIDS Identification	Area (square feet)	Discharge Volume (liters)
216-B-23	500×10 = 5000	4.52×10^{6}
216-B-24	500×10 = 5000	4.7×10^{6}
216-B-25	500×10 = 5000	3.76×10^{6}
216-B-26	500×10 = 5000	5.88×10^{6}
216-B-27	500×10 = 5000	4.42×10^{6}
216-B-28	500×10 = 5000	5.05×10^{6}
216-B-29	500×10 = 5000	4.84×10^{6}
216-B-30	500×10 = 5000	4.78×10^{6}
216-B-31	500×10 = 5000	4.74×10^{6}
216-B-32	500×10 = 5000	4.77×10^{6}
216-B-33	500×10 = 5000	4.74×10^{6}
216-B-34	500×10 = 5000	4.87×10^{6}
216-B-52	580×10 = 5800	8.53×10^{6}

Table G.4-5. Specific Retention 300 Area Waste Trenches (Data from Maxfield, RHO-CD-673).

WIDS Identification	Area (square feet)	Discharge Volume (liters)
216-B-53A	60×10 = 600	5.49×10^{5}
216-B-53B	150×10 = 1500	1.51×10^{4}
216-B-54	200×10 = 2000	9.99×10^{5}
216-B-58	200×10 = 2000	4.13×10^{5}

Table G.4-6. Summary of Waste Site Types within the 200-BC-1 OU (after DOE-RL 2011, Figure 3-1, p. 3-8). (See Table 1 above for complete WIDS information.)

Site Type	Associated Waste Sites	Overview of Impacted Vadose Zone	Historical Groundwater Impacts?
Underground Storage Tank	200-E-14	Residual waste in tank. No vadose impacts identified.	No
High-Volume Scavenged Waste Cribs and Trenches	216-B-14, 216-B-15, 16-B-16, 216-B-17, 216-B-18, 216-B-19216-B-20, 216-B-2,1216-B-22	Full thickness vadose zone impacts.	Yes
Specific Retention Scavenged Waste Trenches	216-B-23, 216-B-24, 216-B-25, 216-B-26, 216-B-27, 216-B-28, 216-B-29, 216-B-30, 216-B-31, 216-B-32, 216-B-33, 216-B-34, 216-B-52	Partial thickness vadose zone impacts.	No
Specific Retention 300 Area Waste Trenches	216-B-53A, 216-B-53B, 216-B-54, 216-B-58	Partial thickness vadose zone impacts.	No

The primary contaminants present at the BC Cribs and Trenches include Nitrate (NO_3^-), Tc-99, Sr-90, Cs-137, and U-238. Other constituents and inventories are provided by Corbin et al. 2005, Kincaid et al. 2006 (PNNL-15829), and Serne et al. 2009. The contaminant inventories are summarized in Table G.4-8, as derived from RPP-26744, Rev. 0.

Table G.4-**7. Primary contaminants and other constituents present at BC Cribs and Trenches.**

Risk-Based COPCs[a]	Other COPCs[b]	Anions and Cations	Geochemical and Physical Properties
Nitrate (as nitrogen)[c, d]	Aluminum	Calcium	Moisture content
Selenium[e]	Manganese	Chloride	Electrical resistivity of soil/sediment
Uranium[c, d]	Mercury	Fluoride[b]	Specific electrical conductivity of pore water
Cesium-137[c, d, e]	Nickel-63	Magnesium	Ionic strength of pore water
Cobalt-60[e]	Nitrite	Nitrite (as nitrogen)[b]	Alkalinity (bicarbonate) of pore water
Plutonium-239/240[d]	Radium-226	Potassium	Borehole neutron and natural gamma logs
Strontium-90[c, d, e]	--	Phosphate	--
Technetium-99[c, d]	--	Sodium	--
--	--	Sulfate[b]	--

(a) Concentrations of risk-based COPCs that were identified in Table 3-1 of DOE/RL-2004-66.
(b) Concentration of other COPCs identified in Table 3-1 of DOE/RL-2004-66 that could correlate with electrical-resistivity data based on results for Borehole C4191.
(c) Applies to the 216-B-26 Trench representative site and analogous sites as presented in DOE/RL-2004-66.
(d) Applies to the 216-B-46 Crib (representative site in BY Tank Farm) and analogous sites as presented in DOE/RL-2004-66.
(e) Applies to the 216-B-58 Trench representative site and analogous sites as presented in DOE/RL-2004-66.

DOE/RL-2004-66, *Focused Feasibility Study for the BC Cribs and Trenches Area Waste Sites*.
COPC = contaminant of potential concern.

According to Ward et al. 2004, the BC Cribs and Trenches are believed to have received approximately 30 Mgal of scavenged tank waste containing an estimated 400 Ci of Tc-99 as well as large quantities of NO_3^- and U-238. Kinkaid et al. 2006 report cumulative inventories as of 2005. Detailed contaminant inventories are also provided in Table G.4-7 below. The physical state of the primary contaminants are adsorbed in the contaminated soil and presence in crib and trench debris.

Table G.4-7. Inventory of Primary Contaminants and Other Constituents at BC Cribs and Trenches (after RPP-26744, Rev. 0).

Contaminant	Cribs and Other Inventory WIDS: 216-B-14, 216-B-15, 216-B-16, 216-B-17, 216-B-18, 216-B-19 (Units: Radionuclides: Curies Non-Radionuclides: Kilograms)	Trenches Inventory WIDS: 216-B-20, 216-B-21, 216-B-22, 216-B-23, 216-B-24, 216-B-25, 216-B-26, 216-B-27, 216-B-28, 216-B-29, 216-B-30, 216-B-31, 216-B-32, 216-B-33, 216-B-34, 216-B-52, 216-B-53A, 216-B-53B, 216-B-54, 216-B-58 (Units: Radionuclides: Curies Non-Radionuclides: Kilograms)
Tritium	242.60	499.53
Nitrate (as nitrogen)	7,414,459	14,721,830
Selenium-79	0.40	0.80
Uranium-238	0.40	0.85
Cesium-137	1,364.27	3,639.01
Cobalt-60	8.35	18.90
Plutonium-239/240	34.29	78.04
Strontium-90	1,376.14	3,050.10
Technetium-99	138.98	271.80
Aluminum	3,000.04	11,067.37
Manganese	-	0.01
Mercury	11.79	23.48
Nickle-63	31.60	63.75
Nitrite (as nitrogen)	53,346	194,360
Radium-226	0.0019	0.0038
Calcium	5,737.33	11,908.75
Chloride	108,135	225,318
Fluoride	135,936	244,623
Potassium	24,824	49,908
Phosphate	252,650	507,490
Sodium	3,432,740	6,935,067
Sulfate	449,434	912,846

Detailed inventories are provided in Table G.4-8, Table G.4-9, and Table G.4-10. All values are to 2 significant figures. The source document should be consulted for greater precision data. The sum for each primary contaminant is shown in the first row. Table G.4-11 provides a summary of the evaluation of threats to groundwater as a protected resource from saturated zone and remaining vadose zone contamination associated with the evaluation unit.

CONTAMINATION WITHIN PRIMARY EU SOURCE COMPONENTS

Legacy Source Sites

Not Applicable.

High Level Waste Tanks and Ancillary Equipment

Not Applicable.

Vadose Zone Contamination

Please see above.

Groundwater Plumes

Not Applicable.

Facilities for D&D

Please see above.

Operating Facilities

Not Applicable.

Table G.4-8. Inventory of Primary Contaminants(a).

WIDS	Description	Decay Date	Ref[b]	Am-241 (Ci)	C-14 (Ci)	Cl-36 (Ci)	Co-60 (Ci)	Cs-137 (Ci)	Eu-152 (Ci)	Eu-154 (Ci)	H-3 (Ci)	I-129 (Ci)
All	Sum			190	28	NP	27	5000	1.7	130	740	0.65
216-B-14	Cribs	2001	SIM	14	2.1	NP	1.6	300	0.13	9.7	54	0.042
216-B-15	Cribs	2001	SIM	11	1.5	NP	1.2	220	0.093	7.1	39	0.031
216-B-16	Cribs	2001	SIM	8.8	1.3	NP	1.2	200	0.079	6	35	0.03
216-B-17	Cribs	2001	SIM	4.7	0.74	NP	1	120	0.043	3.3	21	0.022
216-B-18	Cribs	2001	SIM	14	2.1	NP	1.6	300	0.13	9.6	53	0.042
216-B-19	Cribs	2001	SIM	9.2	1.4	NP	1.7	220	0.084	6.4	40	0.037
216-B-20	Trenches	2001	SIM	6.9	1.1	NP	1.2	550	0.063	4.8	29	0.027
216-B-21	Trenches	2001	SIM	7.6	1.1	NP	0.95	160	0.068	5.1	29	0.024
216-B-22	Trenches	2001	SIM	7.3	1.1	NP	1.1	170	0.066	5	30	0.026
216-B-23	Trenches	2001	SIM	7	1	NP	1	160	0.063	4.8	28	0.025
216-B-24	Trenches	2001	SIM	8.1	1.2	NP	0.92	170	0.072	5.5	30	0.024
216-B-25	Trenches	2001	SIM	8.2	1.2	NP	0.92	170	0.073	5.5	31	0.024
216-B-26	Trenches	2001	SIM	7.9	1.1	NP	0.89	590	0.07	5.3	30	0.023
216-B-27	Trenches	2001	SIM	7.4	1.1	NP	0.83	160	0.065	5	28	0.022
216-B-28	Trenches	2001	SIM	7.9	1.2	NP	1.1	180	0.071	5.4	32	0.027
216-B-29	Trenches	2001	SIM	8	1.2	NP	0.91	170	0.071	5.4	30	0.024
216-B-30	Trenches	2001	SIM	6.9	1.1	NP	1.3	170	0.063	4.8	30	0.028
216-B-31	Trenches	2001	SIM	7	1.1	NP	1.3	170	0.064	4.9	30	0.029
216-B-32	Trenches	2001	SIM	6.8	1.1	NP	1.3	170	0.062	4.7	30	0.029
216-B-33	Trenches	2001	SIM	6.6	1	NP	1.4	170	0.061	4.6	30	0.029

EU Designation: CP-LS-1 (200-BC-1 Operable Unit)

WIDS	Description	Decay Date	Ref[b]	Am-241 (Ci)	C-14 (Ci)	Cl-36 (Ci)	Co-60 (Ci)	Cs-137 (Ci)	Eu-152 (Ci)	Eu-154 (Ci)	H-3 (Ci)	I-129 (Ci)
216-B-34	Trenches	2001	SIM	6.8	1.1	NP	1.4	170	0.062	4.7	31	0.03
216-B-52	Trenches	2001	SIM	12	1.9	NP	2.4	300	0.11	8.4	53	0.052
216-B-53A	Trenches	2001	SIM	0.31	0.014	NP	0.0074	10	0.00018	0.013	0.018	NP
216-B-53B	Trenches	2001	SIM	0.015	0.0005	NP	0.00085	6.1	1.10E-04	0.0076	0.01	NP
216-B-54	Trenches	2001	SIM	0.55	0.026	NP	0.012	6.1	0.00011	0.0076	0.01	NP
216-B-58	Trenches	2001	SIM	0.23	0.011	NP	0.0053	4.9	8.40E-05	0.0061	0.0084	NP

a. NP = Not present at significant quantities for indicated EU
b. SIM = RPP-26744, Rev. 0

Table G.4-9. Inventory of Primary Contaminants (cont)[(a)]

WIDS	Description	Decay Date	Ref[(b)]	Ni-59 (Ci)	Ni-63 (Ci)	Pu (total) (Ci)	Sr-90 (Ci)	Tc-99 (Ci)	U (total) (Ci)
All	Sum			1.1	95	170	4400	410	2.9
216-B-14	Cribs	2001	SIM	0.069	6	9.1	590	33	0.18
216-B-15	Cribs	2001	SIM	0.066	5.8	6.7	170	24	0.13
216-B-16	Cribs	2001	SIM	0.054	4.8	5.9	150	20	0.12
216-B-17	Cribs	2001	SIM	0.025	2.4	3.7	83	9.8	0.07
216-B-18	Cribs	2001	SIM	0.089	7.8	9	230	32	0.18
216-B-19	Cribs	2001	SIM	0.053	4.8	6.8	160	20	0.13
216-B-20	Trenches	2001	SIM	0.044	4	5.1	310	15	0.1
216-B-21	Trenches	2001	SIM	0.047	4.1	4.9	120	17	0.098
216-B-22	Trenches	2001	SIM	0.044	3.9	5	120	16	0.099
216-B-23	Trenches	2001	SIM	0.042	3.7	4.8	120	16	0.095
216-B-24	Trenches	2001	SIM	0.051	4.5	5.1	130	19	0.1
216-B-25	Trenches	2001	SIM	0.051	4.5	5.2	130	19	0.1
216-B-26	Trenches	2001	SIM	0.052	4.5	5.1	490	18	0.11
216-B-27	Trenches	2001	SIM	0.046	4	4.7	120	17	0.093
216-B-28	Trenches	2001	SIM	0.048	4.2	5.4	130	18	0.11
216-B-29	Trenches	2001	SIM	0.043	3.8	5.1	250	18	0.1
216-B-30	Trenches	2001	SIM	0.04	3.6	5.1	120	15	0.099
216-B-31	Trenches	2001	SIM	0.04	3.7	5.2	120	15	0.1
216-B-32	Trenches	2001	SIM	0.037	3.4	5.1	150	15	0.099
216-B-33	Trenches	2001	SIM	0.034	3.1	5.1	170	14	0.098

EU Designation: CP-LS-1 (200-BC-1 Operable Unit)

WIDS	Description	Decay Date	Ref[b]	Ni-59 (Ci)	Ni-63 (Ci)	Pu (total) (Ci)	Sr-90 (Ci)	Tc-99 (Ci)	U (total) (Ci)
216-B-34	Trenches	2001	SIM	3.50E-02	3.2	5.2	170	14	0.1
216-B-52	Trenches	2001	SIM	5.80E-02	5.4	9.1	390	26	0.18
216-B-53A	Trenches	2001	SIM	3.40E-05	0.0033	23	8.9	0.0031	0.22
216-B-53B	Trenches	2001	SIM	1.50E-05	0.0014	6.6	5.2	0.0018	0.064
216-B-54	Trenches	2001	SIM	1.50E-05	0.0014	7.2	5.2	0.0018	0.067
216-B-58	Trenches	2001	SIM	1.20E-05	0.0011	5.5	4.2	1.40E-03	5.30E-02

a. NP = Not present at significant quantities for indicated EU
b. SIM = RPP-26744, Rev. 0

Table G.4-10.   Inventory of Primary Contaminants (cont)[a]

WIDS	Descrip-tion	Ref[b]	CCl4 (kg)	CN (kg)	Cr (kg)	Cr-VI (kg)	Hg (kg)	NO3 (kg)	Pb (kg)	TBP (kg)	TCE (kg)	U (total) (kg)
All	Sum		NP	NP	23000	NP	35	22000000	61	NP	NP	3700
216-B-14	Cribs	SIM	NP	NP	1500	NP	2.8	1700000	NP	NP	NP	270
216-B-15	Cribs	SIM	NP	NP	1100	NP	2	1300000	NP	NP	NP	200
216-B-16	Cribs	SIM	NP	NP	1100	NP	1.7	1100000	2.3	NP	NP	170
216-B-17	Cribs	SIM	NP	NP	820	NP	0.87	560000	4.6	NP	NP	100
216-B-18	Cribs	SIM	NP	NP	1500	NP	2.7	1700000	NP	NP	NP	260
216-B-19	Cribs	SIM	NP	NP	1400	NP	1.7	1100000	5.9	NP	NP	190
216-B-20	Trenches	SIM	NP	NP	1000	NP	1.4	830000	3.8	NP	NP	150
216-B-21	Trenches	SIM	NP	NP	850	NP	1.4	910000	0.9	NP	NP	140
216-B-22	Trenches	SIM	NP	NP	940	NP	1.4	880000	2.5	NP	NP	150
216-B-23	Trenches	SIM	NP	NP	900	NP	1.3	840000	2.4	NP	NP	140
216-B-24	Trenches	SIM	NP	NP	840	NP	1.6	970000	NP	NP	NP	150
216-B-25	Trenches	SIM	NP	NP	840	NP	1.6	980000	NP	NP	NP	150

EU Designation: CP-LS-1 (200-BC-1 Operable Unit)

WIDS	Descrip-tion	Ref[b]	CCl4 (kg)	CN (kg)	Cr (kg)	Cr-VI (kg)	Hg (kg)	NO3 (kg)	Pb (kg)	TBP (kg)	TCE (kg)	U (total) (kg)
216-B-26	Trenches	SIM	NP	NP	820	NP	1.6	950000	NP	NP	NP	160
216-B-27	Trenches	SIM	NP	NP	760	NP	1.4	880000	NP	NP	NP	140
216-B-28	Trenches	SIM	NP	NP	990	NP	1.5	950000	2.3	NP	NP	160
216-B-29	Trenches	SIM	NP	NP	830	NP	1.5	960000	NP	NP	NP	150
216-B-30	Trenches	SIM	NP	NP	1100	NP	1.3	830000	4.7	NP	NP	150
216-B-31	Trenches	SIM	NP	NP	1100	NP	1.3	850000	4.7	NP	NP	150
216-B-32	Trenches	SIM	NP	NP	1100	NP	1.3	820000	4.9	NP	NP	150
216-B-33	Trenches	SIM	NP	NP	1100	NP	1.2	800000	5.7	NP	NP	140
216-B-34	Trenches	SIM	NP	NP	1100	NP	1.3	820000	6	NP	NP	150
216-B-52	Trenches	SIM	NP	NP	1900	NP	2.3	1500000	9.3	NP	NP	260
216-B-53A	Trenches	SIM	NP	NP	3.9	NP	0.012	1500	0.28	NP	NP	31
216-B-53B	Trenches	SIM	NP	NP	2.1	NP	0.00033	890	0.0079	NP	NP	8.3
216-B-54	Trenches	SIM	NP	NP	2.6	NP	0.022	890	0.52	NP	NP	13

EU Designation: CP-LS-1 (200-BC-1 Operable Unit)

WIDS	Description	Ref[b]	CCl4 (kg)	CN (kg)	Cr (kg)	Cr-VI (kg)	Hg (kg)	NO3 (kg)	Pb (kg)	TBP (kg)	TCE (kg)	U (total) (kg)
216-B-58	Trenches	SIM	NP	NP	1.9	NP	0.0091	710	0.22	NP	NP	8.8

a. NP = Not present at significant quantities for indicated EU
b. SIM = RPP-26744, Rev. 0

Table G.4-11. Summary of the Evaluation of Threats to Groundwater as a Protected Resource from Saturated Zone (SZ) and Remaining Vadose Zone (VZ) Contamination associated with the Evaluation Unit

PC	Group	WQS	Porosity[a]	K_d (mL/g)[a]	ρ (kg/L)[a]	VZ Source M^{Source}	SZ Total M^{SZ}	Treated[c] M^{Treat}	VZ Remaining M^{Tot}	VZ GTM (Mm^3)	VZ Rating[d]
C-14	A	2000 pCi/L	0.25	0	1.82	2.77E+01 Ci	---	---	2.77E+01 Ci	1.38E+01	Medium
I-129	A	1 pCi/L	0.25	0.2	1.82	6.45E-01 Ci	---	---	6.45E-01 Ci	2.63E+02	High
Sr-90	B	8 pCi/L	0.25	22	1.82	4.43E+03 Ci	---	---	4.43E+03 Ci	3.43E+03	ND[e]
Tc-99	A	900 pCi/L	0.25	0	1.82	4.11E+02 Ci	---	---	4.11E+02 Ci	4.56E+02	High
CCl4	A	5 µg/L	0.25	0	1.82	---	---	---	---	---	ND
Cr	B	100 µg/L	0.25	0	1.82	2.35E+04 kg	---	---	2.35E+04 kg	2.35E+02	High
Cr-VI	A	48 µg/L[b]	0.25	0	1.82	2.35E+04 kg	---	---	2.35E+04 kg	4.89E+02	High
TCE	B	5 µg/L	0.25	2	1.82	---	---	---	---	---	ND
U(tot)	B	30 µg/L	0.25	0.8	1.82	3.74E+03 kg	---	---	3.74E+03 kg	1.83E+01	ND[e]

a. Parameters obtained from the analysis provided in Attachment 6-1 to Methodology Report.

b. "Model Toxics Control Act—Cleanup" (WAC 173-340) Method B groundwater cleanup level for hexavalent chromium.

c. Treatment amounts from the 2013 Hanford Annual Groundwater Report (DOE/RL-2014-32, Rev. 0).

d. Groundwater Threat Metric rating based on Table 6-3, Methodology Report. These contaminants are being treated using the 200-West Groundwater Treatment Facility.

e. Based on an analysis similar to the one discussed in Appendix E.6 (A-AX Tank and Waste Farms) Section 6.5 (Vadose Zone Contamination), no appreciable uranium or Sr-90 plume would be expected in the next 150 years due to transport and decay (Sr-90) considerations. Thus the *Low* rating would apply after the Active Cleanup is completed to account for uncertainties.

PART VI. POTENTIAL RISK/IMPACT PATHWAYS AND EVENTS

CURRENT CONCEPTUAL MODEL

Narrative description of pathways and barriers to receptors and conditions/events that can lead to completed pathways

Pathways and Barriers: (1. description of institutional, natural and engineered barriers (including material characteristics) that currently mitigate or prevent risk or impacts, 2. Time scale from loss of each barrier to realization of risk or impacts)

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?*

Existing soil covers (e.g., the current soils .that have been placed over the waste site to stabilize it, as well as the clean fill placed during construction of the waste site) are maintained as needed to continue to provide protection from intrusion by biological receptors (such as badgers who could burrow through the clean soil cover into the contaminated soils) and humans.

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

Active controls include groundwater monitoring and active surveillance of the site surface to assist in the detection of intrusion of biological receptors such as burying animals (e.g., badgers).

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

The passive system and controls include the presence of clean soil backfill placed over the contaminated waste sites to prevent direct contact with contaminated soils and sediments.

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?*

The primary barriers to release from the contaminated soil include: (i) sorption to soil and other vadose zone components; (ii) temporary soil caps on select sites; and (iii) sorption and dispersion in saturated zone groundwater environments. The integrity of the soil barriers appears to be currently intact.

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

In its current state, the greatest risk is an event that would (i) damage the integrity of soil caps, such as through a burrowing animal; and (ii) contribution of a very large amount of water on the ground above the cribs and trenches leading to infiltration into the vadose zone regions containing significant amounts of highly mobile nitrate and Tc-99 (especially beneath Cribs 216-B-18 and 216-B-19), which could cause additional mobilization of these two primary contaminants into groundwater.

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

Should such an event occur, both nitrate and ^{99}TC at concentrations at or above the drinking water standard could eventually make their way to the Columbia River.

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

It is unknown and dependent on the amount of infiltration being sufficient to cause considerable migration of the contaminants.

8. *Are there current on-going releases to the environment or receptors?*

Not at this time.

POPULATIONS AND RESOURCES CURRENTLY AT RISK OR POTENTIALLY IMPACTED

Facility Worker

Only workers at risk or impacted would be working on the active remediation activities. Otherwise, workers are not directly exposed to the contaminated soils because they are located below grade beneath a clean soil cover.

Co-Located Person (CP)

Workers are not directly exposed to the contaminated soils because they are located below grade beneath a clean soil cover.

Public

The contamination remains underground, and there is not a dispersion pathway for the material to reach the atmosphere.

Groundwater

Technetium-99 and nitrate are in large concentrations 18 to 53 m below the ground surface (Serne et al. 2009). Cesium-137 and strontium-90 are expected to remain in the vadose zone with little to no migration due to their high sorption affinity for the surrounding soils and sediments. Rate of contaminant migration is very slow (approximately 0.08 m/year). Individual groundwater ratings for this EU are Medium for C-14 and High for I-129, Tc-99, Cr, and Cr-VI. Sr-90 and uranium are rated ND based on an analysis similar to the one discussed in Appendix E.6 (A-AX Tank and Waste Farms) Section 6.5 (Vadose Zone Contamination). No appreciable uranium or Sr-90 plume would be expected in the next 150 years due to transport and decay (Sr-90) considerations. Thus the *Low* rating would apply after the Active Cleanup is completed to account for uncertainties.

There is an existing nitrate plume, but the focus is on Group A and B PCs based on persistence and mobility. Furthermore, the nitrate plume would be at most a Low rating and would not drive risk.

This leads to an overall rating of High.

Columbia River

Migration of the primary contaminants of concern (technetium-99 and nitrate) originating from the BC Cribs and Trenches area have not migrated to groundwater, and based on migration rates of approximately 0.08 m/year, are not expected to impact the Columbia River within the next 150 years. Leading to an overall rating of ND.

Ecological Resources

ND to Low in EU because nearly 30% is level 3 and 4 resources, along with the buffer area. There is the potential for disturbance and invasion of exotic species in both EU and buffer area.

Cultural Resources:

There are unevaluated cultural resources located within this EU. Manhattan Project/Cold War significant resources have already been mitigated. Traditional cultural places in viewshed.

CLEANUP APPROACHES AND END-STATE CONCEPTUAL MODEL

Selected or Potential Cleanup Approaches

As discussed in DOE/RL-2003-64, *Feasibility Study for the* 200-7W-l *Scavenged Waste Group, the* 200-7W-2 *Tank Waste Group, and the 200-PW-5 Fission Product Rich Waste Group Operable Units,* remedial technologies were identified and evaluated on the basis of their ability to reduce potential risks to human health and the environment at the waste sites. Collective experience gained from previous studies and evaluations of cleanup methods were used to identify technologies that would be carried forward to develop remedial alternatives to address the RAOs. This process focused on treatment and removal activities because the Regulatory Agencies (Washington State Department of Ecology (Ecology) and EPA) have a preference for these alternatives rather than containment remedies. For the BC Cribs and Trenches Area waste sites, five remedial alternatives were identified for detailed and comparative analyses.

These five alternatives also were evaluated for their applicability to the 200-E-14 Siphon Tank and 200-E-114 Pipeline. The volumes of sludge and/or liquid estimated to remain in this tank are uncertain. However, up to 3.8 m^3 (1,010 gal) of sludge and 41.9 m^3 (11,060 gal) of liquid may exist. The following alternatives were evaluated in the focused feasibility study.

- **Alternative 1: No Action**. When this alternative is selected, no further action is taken at the site, other than periodic review to ensure continued protection. No legal restrictions, access controls, or active remedial measures are applied to the site. "No action" implies "walking away from the site" and allowing the wastes to remain in their current configuration, affected only by natural processes.

- **Alternative 2: Maintain Existing Soil Cover, Institutional Controls, and Monitored Natural Attenuation**. When this alternative is selected, existing soil covers (e.g., the current soils .that have been placed over the waste site to stabilize it, as well as the clean fill placed during construction of the waste site) are maintained as needed to continue to provide protection from intrusion by biological receptors (such as badgers) and humans. Selective herbicides may be applied to prevent establishment of deep-rooted plants. In addition, institutional controls (such as deed restrictions, land-use zoning, and excavation permits) are put in place to further prevent human access to the site. Where appropriate, monitored natural attenuation (such as the decay of radionuclides) is accounted for, because this is an ongoing process that reduces risk over time. Monitoring would be conducted to demonstrate that natural attenuation is occurring and that contamination is being contained as the concentrations decrease.

- **Alternative 3: Removal, Treatment, and Disposal.** When this alternative is selected, soil and structures with contaminant concentrations above PRGs are excavated. The 216-B-20 through 216-B-34 and 216-B-52 Trenches would be excavated to a depth of ~46 m (~150 ft); the cribs would be excavated to a depth of ~67 m (-220 ft); and the 216-B-53A, 216-6-53B, 216-8-54, and 216-B-58 Trenches would be excavated to a depth of ~7.6 m (~25 ft). Because near-surface contamination levels at the majority of the waste sites pose a significant dose threat to workers, specialized equipment and activities are required to protect the workers, the environment in the area, and the public that could be exposed near roads or facilities In addition, some less-contaminated material is needed to blend with the more contaminated material to allow safe excavation, loading, transporting, and disposal of the material and to meet health and safety and waste acceptance criteria at the disposal facility. Excavated material that is above the PRGs will be disposed of at the ERDF in accordance with that facility's established waste acceptance criteria. This disposal facility is near the waste sites and currently is being used for remediation wastes on the Hanford Site. Excavation would continue until all contaminated material exceeding the cleanup goal was removed. The site then would be backfilled with clean material.

• **Alternative 4: Capping**. When this alternative is selected, a surface barrier (such as an evapotranspiration barrier) is built over the contaminated waste site, thus "capping" the site to reduce the quantity of water infiltrating into the waste and to deter or prevent intrusion by human or ecological receptors into the waste. Cap intrusion-deterrence features would vary with the severity of the risk to a potential intruder. For those waste sites where the majority of the risk will diminish within a few hundred years, an evapotranspiration barrier with intruder-deterrent features is recommended for individual cribs and trenches. Between the waste sites and around the periphery of waste site groupings, a simple evapotranspiration barrier without intrusion-deterrent features is recommended. Details of the barrier design, particularly the intrusion-deterrent feature, would be determined later. Institutional controls (such as deed restrictions, land-use zoning, and excavation permits) are required to further minimize the potential for exposure to contamination and to ensure the integrity of the cap. Extension of the institutional control period beyond the nominal 150-yr period is considered because of the need to maintain the cap. Performance monitoring is included as a part of this alternative to ensure that the cap is performing as expected. Groundwater monitoring is included to watch for movement of more mobile contaminants.

• **Alternative 5: Partial Removal, Treatment, and Disposal with Capping**. When this alternative is selected, near-surface soil associated with high concentrations of cesium-137 is removed, reducing the intruder risk associated with the highly contaminated zone at the bottom of the waste site. This alternative removes contaminants to a lesser depth than Alternative 3 (4.6 to 6.1 m [15 to 20 ft]). Risk to remediation workers is similar to that associated with Alternative 3. Once the near-surface contamination has been removed and the excavation backfilled, a simple evapotranspiration barrier would be constructed to provide protection to the groundwater from contaminants that remain deeper in the soil column. This barrier would not require intrusion-deterrent features, because the high concentrations of near-surface contaminants would be excavated. This alternative would reduce the risks of potential intruders and provide protection of the groundwater. Performance monitoring is included as a part of this alternative to ensure that the cap performs as expected, and groundwater monitoring is included to watch for movement of more mobile contaminants. As with Alternative 4, extension of institutional controls beyond 150 yr is considered because of the need to maintain the cap.

CERCLA Evaluation Criteria and Process

As a critical part of the evaluation process, the alternatives are evaluated against nine CERCLA criteria:

• *Overall protection of human health and the environment* is the primary objective of the remedial action and addresses whether a remedial action provides adequate overall protection of human health and the environment. This criterion must be met for a remedial alternative to be eligible for consideration.

• *Compliance with ARARs* addresses whether a remedial action will meet all of the applicable or relevant and appropriate requirements and other Federal and State environmental statutes, or provide grounds for invoking a waiver of the requirements. This criterion must be met for a remedial alternative to be eligible for consideration.

• *Long-term effectiveness and permanence* refers lo the magnitude of residual risk and the ability of a remedial action to maintain long-term, reliable protection of human health and the environment after remedial goals have been met.

• *Reduction of toxicity, mobility, or volume through treatment* refers to an evaluation of the anticipated performance of the treatment technologies that may be employed in a remedy. Reduction of toxicily, mobility, and/or volume contributes toward overall protectiveness.

• *Short-term effectiveness* refers to evaluation of the speed with which the remedy achieves protection. It also refers to any potential adverse effects on human health and the environment during the construction and implementation phases of a remedial action.

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

• Cost refers to an evaluation of the capital, operation and maintenance, and monitoring costs for each alternative.

• *State acceptance* indicates whether the State concurs with, opposes, or has no comment on the preferred alternative based on a review of the focused feasibility study and the Proposed Plan.

• *Community acceptance* assesses the public response to the Proposed Plan, following a review of the public comments received during the public comment period and open community meetings. The remedial action is selected only after consideration of this criterion.

The first two criteria (overall protection of human health and the environment and compliance with ARAR) are threshold criteria. Alternatives that do not protect human health and the environment or do not comply with ARAR, (or justify a waiver) do not meet statutory requirements and are eliminated from further consideration in the focused feasibility study.

The next five criteria (long-term effectiveness and permanence; reduction of toxicity, mobility, or volume through treatment; short-term effectiveness; implementability; and cost) are balancing criteria on which the remedy selection is based.

The final two criteria (State and community acceptance) are modifying criteria. Ecology concurs with the proposed alternatives outlined in the Plan. The ability of a preferred remedy to meet the criterion of community acceptance, however, can be evaluated only after the public review and comment period for this Plan. State and community acceptance criteria are not discussed separately in the following paragraphs or in the alternatives presented. The preferred alternatives could change in response to public comments or new information.…"(DOE/RL 2004-69, Draft A)

Contaminant Inventory Remaining at the Conclusion of Planned Active Cleanup Period

The high concentrations of cesium-137 observed during characterization of the 216-B-26 Trench exhibited dose rates that could be lethal (-4.5 rad/h) if exposure time were sufficient (a few hundred years). The deep mobile contaminants (technetium-99 and nitrate) are predicted to eventually reach groundwater at levels exceeding the drinking water standard, potentially rendering the groundwater unfit for human consumption. Baseline risk (without remedial action) assessment was performed using the industrial scenario to establish the need for remedial action. The inadvertent intruder scenario was considered to evaluate potential post-remediation risk. The baseline risk assessment for the 216-B-26 Trench indicated the significant shallow-zone contaminants (primarily cesium-137 and strontium-90) in the 3.7 to 4.6 m (12 to 15 ft) range would require nearly 450 yr to decay to levels corresponding to acceptable risk to industrial workers. The maximum dose to industrial workers is calculated to be 310,000 mrem/yr, which greatly exceeds the 15 mrem/yr criterion. Predicted migration of technetium-

99 and nitrate may exceed the groundwater drinking water standards for those contaminants. With respect to potential intruders past the 150-yr period of active institutional controls, humans are not protected until radioactive decay proceeds for nearly 450 yr. The 216-B-46 Crib, which is representative of the BC Cribs and Trenches Area cribs, indicated similar risks. The baseline risk assessment for the 216-B-58 Trench indicated lesser shallow-zone contaminant concentration and essentially no deep mobile contaminants. Even so, human health risk standards related to direct exposure were exceeded. Groundwater protection standards are not predicted to be exceeded. Risk to inadvertent intruders is essentially acceptable 250 yr from now with no action. Uncertainties with the exact nature of future industrial and inadvertent intruder exposures may lead to under- or over-estimation of human health risk. Another source of uncertainty is the limited sample data. Because the investigation and sampling focused on the most highly radioactive wastes, the risk assessment is more likely to overestimate the potential human risk.

Risks and Potential Impacts Associated with Cleanup

Cleanup Alternative No. 1 (No Action), will not place cleanup workers at risk. All other alternatives (Alternatives No. 2 through 5) will put cleanup workers at risk. In particular, Alternative No. 3 (Removal, Treatment, and Disposal) and No. 5 (Partial Removal, Treatment, and Disposal with Capping) will place cleanup workers at the greatest risk due to site disturbance and exposure of workers to contaminated dust and debris.

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

Facility Workers

Please see above.

Co-located Person

Only workers at risk or impacted would be working on the cleanup.

Public

Risk to the Public is rated as low to ND because of long distance between contaminates and Hanford security boundary.

Groundwater

Please see above. Overall rating of High (I-129, Tc-99, Cr, and Cr-VI).

Columbia River

ND based on analysis provided above.

Ecological Resources

Depending upon remediation option, could result in disturbance and disruption to level 3 and 4 (30% of EU and 77% of buffer), including increases in exotic species and changes in species composition of native species.

Cultural Resources

There is one unevaluated (for National Register) cultural resource. Traditional cultural places in view-shed. Indirect effects are possible from capping.

ADDITIONAL RISKS AND POTENTIAL IMPACTS IF CLEANUP IS DELAYED.

Please see above.

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

Please see above.

POPULATIONS AND RESOURCES AT RISK OR POTENTIALLY IMPACTED AFTER CLEANUP ACTIONS (from residual contaminant inventory or long-term activities)

Table G.4-8. Populations and Resources at Risk or Potential Impacted After Cleanup Actions.

Population or Resource		Risk/Impact Rating	Comments
Human	Facility Worker	Low	Only workers at risk or impacted would be working on the active remediation activities, to include monitoring and sampling.
	Co-located Person	Low	Workers are not directly exposed to potentially contaminated groundwaters because they are located below grade beneath a clean soil cover.
	Public	Not Discernable	The contamination remains underground, except where the potentially contaminated groundwater may the Columbia River.
Environmental	Groundwater	High (I-129, Tc-99, Cr, and Cr-VI)	Individual groundwater ratings for this EU are Medium for C-14 and High for I-129, Tc-99, Cr, and Cr-VI. Sr-90 and uranium are rated ND based on an analysis similar to the one discussed in Appendix E.6 (A-AX Tank and Waste Farms) Section 6.5 (Vadose Zone Contamination). No appreciable uranium or Sr-90 plume would be expected in the next 150 years due to transport and decay (Sr-90) considerations. Thus the *Low* rating would apply after the Active Cleanup is completed to account for uncertainties. This leads to an overall rating of High.
	Columbia River	ND	The large dilution effect of the Columbia River results in a rating of *Not Discernable* for the free-flowing ecology for all evaluation periods. The rating threat evaluations to the benthic and riparian ecologies is not discernable due to the absence of a contaminant plume.
	Ecological Resources*	Low	Contamination remaining in areas for monitored natural attenuation may still result in uptake in biota, but is not likely to cause an effect to the biota. Continued long-term monitoring activities may disrupt terrestrial habitats.
Social	Cultural Resources*	**Native American:** Direct: Known Indirect: Known **Historic Pre-Hanford:** Direct: Unknown Indirect: None	Permanent direct and indirect effects are possible due to high sensitivity of area.

		Manhattan/Cold War: Direct: Known Indirect: Unknown	

*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.

Long-Term, Post-Cleanup Status – Inventories and Risks and Potential Impact Pathways

The long-term cleanup status is highly dependent on the selected remedial alternative. Regardless of that alternative selected, long-term site use restriction and groundwater monitoring must remain due to the long-term presence of contaminants deep in the vadose zone that are not amendable to excavation, and the likely continued migration of contaminants through the vadose zone to the groundwater.

The DOE is expected to continue industrial exclusive activities for at least 50 years, in accordance with DOE/EIS-0222-F, Final Hanford Comprehensive Land-Use Plan Environmental Impact Statement, and the Record of Decision (64 FR 61615, "Record of Decision: Hanford Comprehensive Land-Use Plan Environmental Impact Statement (HCP EIS)". Based on discussions with the HAB, the alternative risk evaluations used the following anticipated land-use assumptions:

• Industrial-Exclusive use for the next 50 years inside the Central Plateau industrial exclusive zone.

• industrial land use (non-DOE worker) after the next 50 years inside the Central Plateau industrial/ exclusive zone.

• Native American uses consistent with treaty rights.

• No groundwater consumption for at least the next 150 yr.

In addition, risks were calculated considering the possibility of intruders beginning 150 yr from now (2155) to evaluate impacts from the potential loss of institutional control.

PART VII. SUPPLEMENTAL INFORMATION AND CONSIDERATIONS

The BC Cribs and Trenches area needs to remain under DOE control to maintain a safety buffer for all remedial alternatives except Alternative No. 3 (complete RTD).

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APPENDIX G.5

Plutonium Contaminated Waste Sites
(CP-LS-2, Central Plateau)
EVALUATION UNIT SUMMARY TEMPLATE

Table of Contents

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PART I. EXECUTIVE SUMMARY

EU LOCATION:

CP-LS-2 is located in the central portion of the 200 W area.

RELATED EUS:

CC-DD-5 and CP-GW-2; Operable Unit Cross-Walk: 200-PW-1, 3, 6 200-CW-5

PRIMARY CONTAMINANTS, CONTAMINATED MEDIA AND WASTES:

CP-LS-2 is composed of plutonium (Pu) contaminated cribs and trenches and ancillary structures associated with PFP in the central part of the 200-W area. This EU consists of multiple radioactive process sewers, buried Tank Farm pipelines, a burn pit, cribs (a subsurface liquid disposal site), ponds, trenches, ditches, tile fields, French drains, a settling tank, septic tanks, buildings (including process and infrastructure buildings), and storage pads. Only one process sewer is active (the 200-W-207-PL-B; PFP Process Sewer Segments Connecting to the TEDF System). There is one active septic tank (2607-WA). Only three of the 54 buildings in this EU are inactive.

The radionuclide contaminants for this collection of sites totals

Table G.5-1. Radionuclide Inventory.

Radionuclides	Listed inventory > 0.1 Ci (from EIS and/or SIM)
Pu-241	3.31E+04
Am-241	2.65E+04
Pu-239-240	1.30E+04
Pu-239	1.01E+04
Pu-240	2.56E+03
Pu-238	6.42E+02
Cs-137	1.61E+02
Sr-90	1.56E+02
Y-90	1.56E+02
Ba-137m	1.52E+02
Np-237	4.17E+01
Cm-244	3.32E+01
Cm-242	1.88E+01
Am-243	1.11E+01
U-233-234-235-238	1.64E+00
U-233	1.45E+00

Cm-243	1.37E+00
Pu-242	2.90E-01
Sm-151	1.99E-01
Chemical	Listed Inventory > 1kg
K	3.25E+07
F	8.08E+06
NO3	7.93E+06
Na	4.77E+06
Cl	1.47E+06
CCl4	9.11E+05
Hg	7.57E+05
Ca	2.86E+05
CO3	2.76E+05
Al	2.10E+05
SO4	1.14E+05
TBP	1.12E+05
Fe	9.73E+04
NO2	1.36E+04
NPH	1.12E+04
Cr	3.52E+03
Si	3.15E+03
Butanol	1.44E+03
Ni	8.09E+02
Pb	4.85E+02
U-Total	2.22E+02
PO4	2.14E+02
NH3	2.00E+02
Mn	9.85E+01

Brief Narrative Description:

This Evaluation Unit consists of a variety of plutonium (Pu) contaminated cribs, trenches, piping, burn pits and ancillary structures associated with PFP in the central part of the 200-W area.

From the ROD: these sites "*are associated with subsurface waste handling and disposal sites that were engineered and constructed to dispose of liquid waste into the soil beneath the sites. Pipes conveyed the* *liquid waste from nuclear processing facilities to the waste sites. At the cribs, tile field, and French drain, liquid waste was discharged into a layer of gravel that drained into the underlying soil and may have drained laterally as well as downward*". As a consequence, the soils in, or underlying, these sites contain substantial amounts of radionuclides including plutonium and cesium, as well as large quantities of chemical constitutes such as carbon tetrachloride, chromium and nitrate.

The large volume of waste associated with these sites and structures makes complete retrieval and disposal infeasible. Where possible transuranic waste will be recovered and disposed of at the Waste Isolation Pilot Plant. Other contaminated soils will be disposed at the Hanford Site Environmental Restoration Disposal Facility (ERDF). However, there will be residual waste left in place that is not feasible to retrieve.

The Record of Decision notes that "Removal, Treatment (as needed) and Disposal (RTD) of soil and debris to the specified depths or specified cleanup levels will be used to address plutonium-contaminated soils and subsurface structures and debris. This consists of: (1) removing a portion of contaminated soil, structures, and debris; (2) treating these removed wastes as required to meet disposal requirements at ERDF, which is located on the Hanford Site or waste acceptance criteria for off-site disposal at WIPP; and (3) disposal at ERDF or WIPP."

Cleanup levels have been set for these sites which are intended to be protective of groundwater, as well as current and future industrial land use. Examples of selected remedies include excavating contaminated soils and debris that exceed cleanup levels to a depth of 15 feet below ground surface. The excavated material will be disposed of either at WIPP or ERDF.

SUMMARY TABLE OF RISKS AND POTENTIAL IMPACTS TO RECEPTORS

Table G.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 immediate areas around the facilities; a Co-located Person (CP) is an individual located 100 meters from the facilities; 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 Non-Discernable (ND) to Very High. The estimated mitigated exposure that takes engineered and administrative controls and protections into consideration, is shown in parenthesis.

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 Non-Discernable (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: A rating for cultural resources is not being made because cultural resources will be evaluated under Section 106 of the National Historic Preservation Act (16 USC 470, et.seq.) during the planning for remedial action. The resulting Section 106 process will engage all stakeholders, including Native American Tribes, concerning the Native American, Historic Pre-Hanford, and Manhattan Project/Cold War landscapes. This process will identify all cultural resources and evaluate their eligibility for the National Register of Historic Places, any direct and indirect effects from remediation, as well as the need for any mitigation actions. CRESP has consulted with the Native American Tribes having historical ties to Hanford and they consider the entire Hanford Site to be culturally and historically important.

Table G.5-2. Risk Rating Summary (for Human Health, unmitigated nuclear safety basis indicated, mitigated basis indicated in parenthesis (e.g., "Very High" (Low)).

Population or Resource		Evaluation Time Periods	
		Active Cleanup (to 2064)	
		Current Condition – Operations	From Cleanup Actions
Human	Facility Worker	Low to ND	Low to Medium
	Co-located Person	Low to ND	Low
	Public	ND	ND
Environmental	Groundwater	Very High (CCl4)	Very High (CCL4)
	Columbia River	ND	ND
	Ecological Resources*	ND to Low	Low to Medium
Social	Cultural Resources*	**Native American:** Direct: Known Indirect: Known **Historic Pre-Hanford:** Direct: Known Indirect: Known **Manhattan/Cold War:** Direct: Known Indirect: Unknown	**Native American**: Direct: Known Indirect: Known **Historic Pre-Hanford**: Direct: Known Indirect: Known **Manhattan/Cold War:** Direct: Known Indirect: Unknown

*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.

SUPPORT FOR RISK AND IMPACT RATINGS FOR EACH TIME PERIOD

Human Health

<u>**Current**</u>

Building and facilities: EU CP-LS-2 is situated in the 200 W area of the Hanford site, which is in the middle of the Central Plateau encompassing the region where chemical processing and waste management activities occurred. Cleanup levels for the Inner Area are expected to be based on industrial land use. There is ongoing remediation activity in the vicinity of the structures associated with this EU. This site includes EU encompasses multiple discrete entities including:

- 2 Burial Grounds
- 12 Cribs (sub surface disposal includes crib, trench, drain, tile field)

- 49 Infrastructure buildings
- 13 Pipelines
- 4 pond/ditches
- 6 Process buildings
- 5 Septic systems
- 2 structures (including storage pads)
- Underground storage tank

Many of the infrastructure buildings associated with this Evaluation Unit are assessed as less than a hazard category 3 in accordance with DOE-STD-1027-92, Hazard Categorization and Accident Analysis Techniques for compliance with DOE Order 5480.23, Nuclear Safety Analysis Reports, based on the fact that no radioactive sources are present in the facilities. Consequently the risk from demolition associated with these facilities is a standard industrial accident scenario.

Soils associated with several of the sites under this EU are contaminated with significant concentrations of plutonium or cesium, as well as toxic chemicals such as carbon tetrachloride. However, many of these sites are backfilled and surface stabilized, and marked as to the presence of underground contamination.

There is some potential for long-term groundwater contamination from mobile contaminants such as carbon tetrachloride and technetium 99. The exposure pathways for workers and the general public, are however, fairly limited. From the ROD (page 19) "*Under current industrial land use and Hanford site-wide institutional control conditions, only a construction worker has the potential to encounter impacted soil. There are no complete and significant pathways for current regular workers. Exposure routes to groundwater and surface water are incomplete*."

Ecological Resources

Current
There are currently no ecological resources on EU or buffer area.

Risks and Potential Impacts from Selected or Potential Cleanup Approaches
Any ecological risk depends upon the quality and quantity of re-vegetation following remediation; there could be a risk from invasion of exotic species.

Cultural Resources

Current
A rating for cultural resources is not being made because cultural resources will be evaluated under Section 106 of the National Historic Preservation Act (16 USC 470, et. seq.) during the planning for remedial action. The resulting Section 106 process will engage all stakeholders, including Native American Tribes, concerning the Native American, Historic Pre-Hanford, and Manhattan Project/Cold War landscapes. This process will identify all cultural resources and evaluate their eligibility for the National Register of Historic Places, any direct and indirect effects from remediation, as well as the need for any mitigation actions. CRESP has consulted with the Native American Tribes having historical ties to Hanford and they consider the entire Hanford Site to be culturally and historically important.

Risks and Potential Impacts from Selected or Potential Cleanup Approaches
There are no expectations for impacts to known cultural resources.

Considerations for timing of the Cleanup Actions

The selected remedy requires that structures and other debris be removed in order to conduct required remediation. Clean soil covers will be added back over sites to provide at least 15 feet over cesium contaminated soils. Institutional controls and long term monitoring will be required for those sites where contamination is left in place, and to ensure that land use is consistent with the ROD. The selected remedy has some moderate potential for exposure of construction workers as a consequence of local excavation of contaminated material. Neither ground water nor surface water pathways will be completed.

Many of the principal contaminants of concern (plutonium, cesium, strontium, and uranium) are relatively immobile in soils in the absence of significant amounts of water to mobilize them. However, other contaminants such as Tc-99 and carbon tetrachloride will continue to pose a long term threat to groundwater unless they are reduced in concentration.

Near-Term, Post-Cleanup Risks and Potential Impacts

The cleanup criteria for this Evaluation Unit are to industrial use standards. These standards will preclude accessing the subsurface environment where residual contamination resides. Consequently, the near-term post cleanup risks are expected to be low for workers, the public, and the environment.

Long-Term, Post-Cleanup Conditions

The ROD established final cleanup levels for the sites within the EU. These are identified in the table below:

Table G.5-3. From ROD (Table 35. Final Cleanup Levels for 200-CW-5, 200-PW-1, 200-PW-3, and 200-PW-6 Soils)

Plutonium-239-240	765	Human Health (Industrial	Cancer risk < 1 x 10^{-4} [c, d]
Americium-241	940	Human Health (Industrial	Cancer risk = 1 x 10^{-4} [d]
Cesium-137	17.7	Human Health (Industrial	Cancer risk = 1 x 10^{-4} [d]
Radium-226	4	Human Health (Industrial	Cancer risk = 1 x 10^{-4} [d]
Strontium-90	20	Ecological Receptor	HQ = 1
PCBs	0.65 mg/kg	Ecological Receptor	HQ = 1
Boron	0.5	Ecological Receptor	HQ = 1
Mercury	0.1	Ecological Receptor	HQ = 1
Carbon Tetrachloride	100 ppmv[a]	Groundwater Protection	Excess Lifetime Cancer Risk = 1 x 10^{-5} [e]
Methylene Chloride	50 pmv[a]	Groundwater Protection	1 x 10^{-5} [e]

a. Soil vapor concentrations will be further refined and assessed to ensure they are protective of groundwater.
b. Cleanup levels are based on an industrial land use scenario. When cleanup levels for ecological receptors or groundwater protection were lower than human health protection, the lower value was used as the final cleanup level.
c. The preliminary remediation goal identified in the FSs based on 10-4 risk was 2,900 pCi/g for plutonium 239-240. However, DOE has agreed to a more conservative value of 765 pCi/g for this remedial action.
d. Final verification sampling for radiological contaminants at the Z-Ditches Waste Group will be valuated to confirm that the aggregate risk level is less than 1 x 10^{-4}.
e. The DOE will cleanup up COCs for the 200-PW-1 OU subject to WAC 173-340, "Model Toxics Control Act-Cleanup" (carbon tetrachloride and methylene chloride), so the total excess lifetime cancer risk

from carbon tetrachloride and methylene chloride does not exceed 1 x 10-5 at the conclusion of the remedy.

PART II. ADMINISTRATIVE INFORMATION

OU and/or TSDF Designation(s)

200-PW-1, 3, 6; 200-CW-5

Common name(s) for EU

Plutonium Contaminated Waste Sites

Key Words

D7D, Soils, Cribs, Trenches

Regulatory Status

Regulatory basis: Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (CERCLA), as amended by the Superfund Amendments and Reauthorization Act of 1986 (SARA), the Hanford Federal Facility Agreement and Consent Order (also known as the Tri-Party Agreement), and, to the extent practicable, the "National Oil and Hazardous Substances Pollution Contingency Plan" (40 Code of Federal Regulations [CFR] 300) (National Contingency Plan [NCP]).

Applicable regulatory documentation

Record of Decision Hanford 200 Area Superfund Site

200-CW-5 AND 200-PW-1, 200-PW-3, AND 200-PW-6 Operable Units, September 2011

Applicable Consent Decree or TPA milestones

Not Applicable

Risk Review Evaluation Information

Completed: January 30, 2015

Evaluated by: KA Higley

Reviewed by: H. Mayer

PART III. SUMMARY DESCRIPTION

Current land use

DOE Hanford industrial area site

Designated future land use

Industrial (From the USDOE Hanford 200 Area ROD - Cleanup levels for the Inner Area are expected to be based on industrial land use)

PRIMARY EU SOURCE COMPONENTS

Legacy Source Sites

This site includes EU encompasses multiple discrete entities including:

- 2 Burial Grounds
- 12 Cribs (sub surface disposal includes crib, trench, drain, tile field)
- 49 Infrastructure buildings
- 13 Pipelines
- 4 pond/ditches
- 6 Process buildings
- 5 Septic systems
- 2 structures (including storage pads)
- Underground storage tank

High-Level Waste Tanks and Ancillary Equipment

Not Applicable

Groundwater Plumes

Not Applicable

Operating Facilities

Not Applicable

D&D of inactive facilities

Not Applicable

Location and Layout Maps

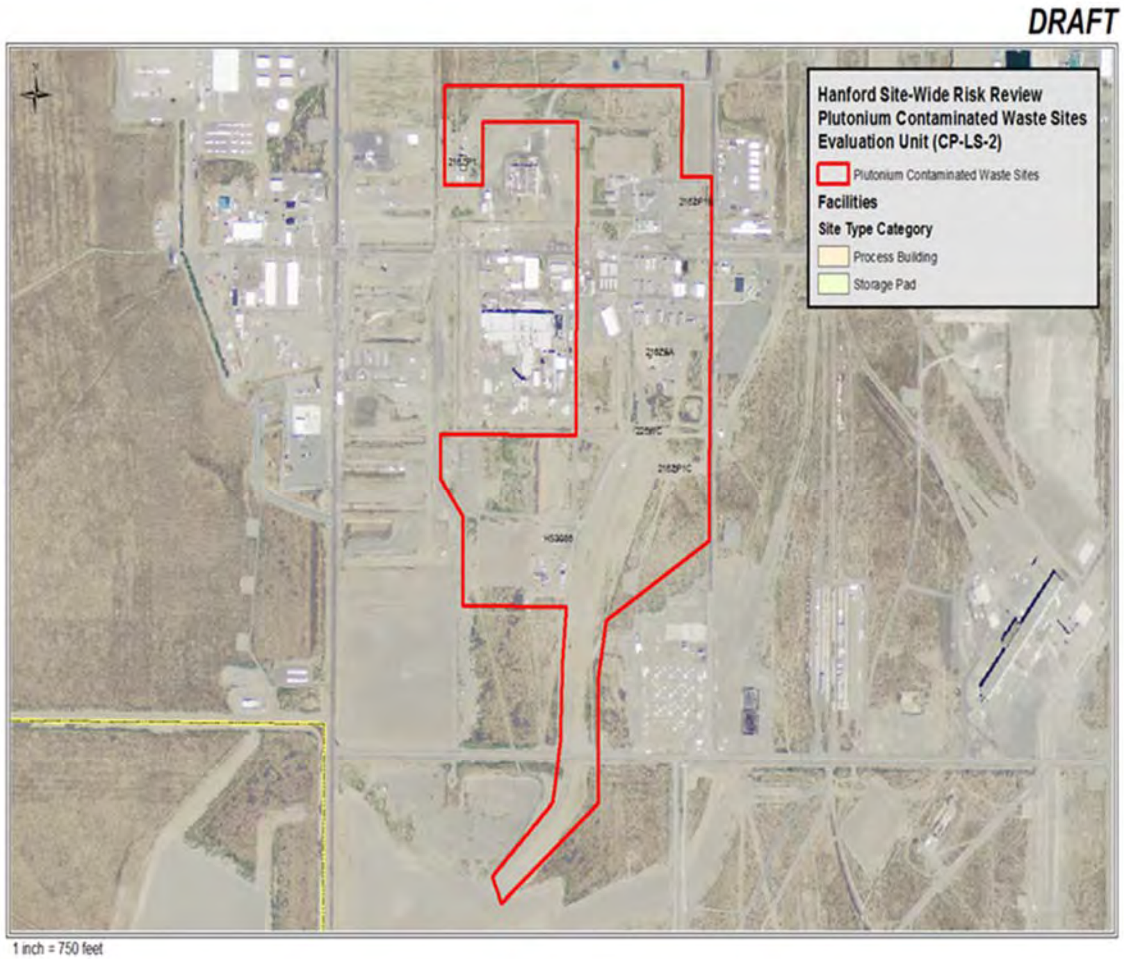

Figure G.5-1 Location of EU CP-LS-2

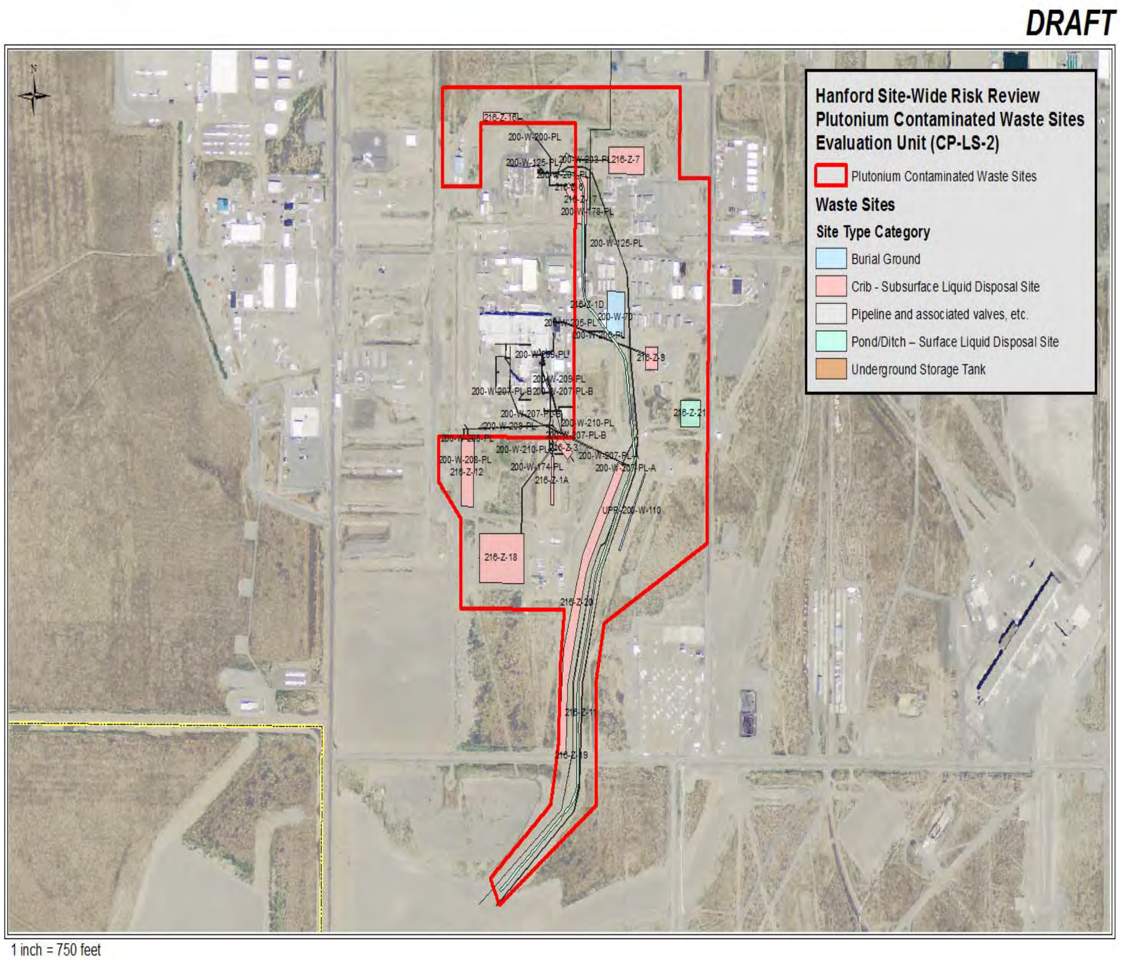

Figure G.5-2 Categories of sites within EU CP-LS-2

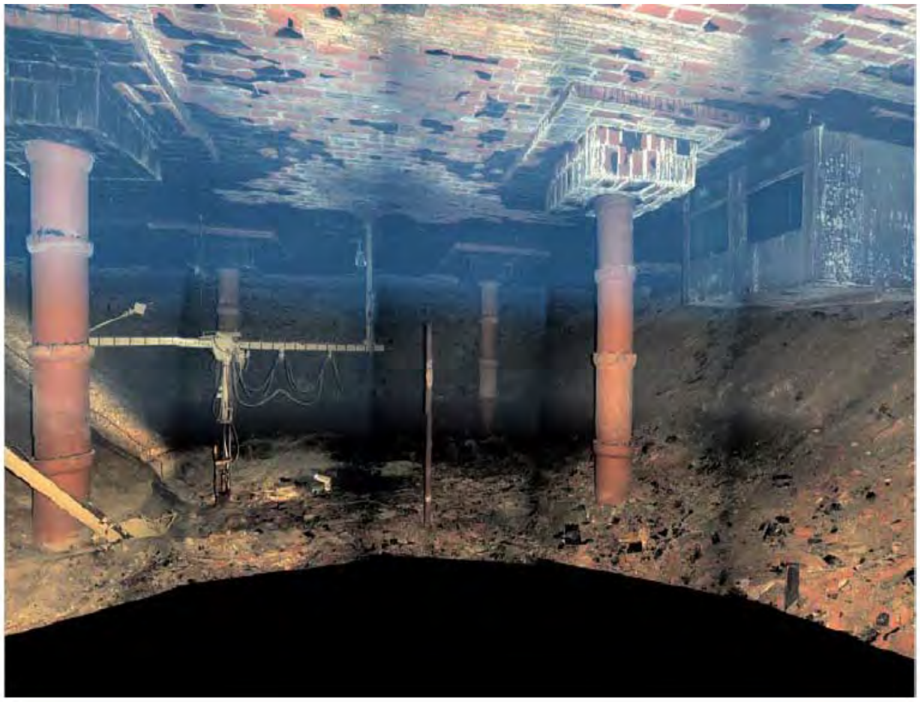

Figure G.5-3. Composite of High Resolution Pictures of the Interior of the Z-9 Crib

PART IV. UNIT DESCRIPTION AND HISTORY

EU FORMER/CURRENT USE(S)

What is the origin and history of the contamination (e.g., accidental release, intentional discharge, multiple discharges)?

This Evaluation Unit consists of a variety of plutonium (Pu) contaminated cribs, trenches, piping, burn pits and ancillary structures associated with PFP in the central part of the 200-W area.

> From the ROD: these sites "*are associated with subsurface waste handling and disposal sites that were engineered and constructed to dispose of liquid waste into the soil beneath the sites. Pipes conveyed the liquid waste from nuclear processing facilities to the waste sites. At the cribs, tile field, and French drain, liquid waste was discharged into a layer of gravel that drained into the underlying soil and may have drained laterally as well as downward*". As a consequence, the soils in, or underlying, these sites contain substantial amounts of radionuclides including plutonium and cesium, as well as large quantities of chemical constitutes such as carbon tetrachloride, chromium and nitrate.

EU Designation: CP-LS-2 (Plutonium Contaminated Waste Sites)

What are the primary contaminants (risk drivers)?

Radionuclides	Listed inventory > 0.1 Ci (from EIS and/or SIM)
Pu-241	3.31E+04
Am-241	2.65E+04
Pu-239-240	1.30E+04
Pu-239	1.01E+04
Pu-240	2.56E+03
Pu-238	6.42E+02
Cs-137	1.61E+02
Sr-90	1.56E+02
Y-90	1.56E+02
Ba-137m	1.52E+02
Np-237	4.17E+01
Cm-244	3.32E+01
Cm-242	1.88E+01
Am-243	1.11E+01
U-233-234-235-238	1.64E+00
U-233	1.45E+00
Cm-243	1.37E+00
Pu-242	2.90E-01
Sm-151	1.99E-01

Chemical	Listed Inventory > 1kg
K	3.25E+07
F	8.08E+06
NO3	7.93E+06
Na	4.77E+06
Cl	1.47E+06
CCl4	9.11E+05
Hg	7.57E+05
Ca	2.86E+05
CO3	2.76E+05

Al	2.10E+05
SO4	1.14E+05
TBP	1.12E+05
Fe	9.73E+04
NO2	1.36E+04
NPH	1.12E+04
Cr	3.52E+03
Si	3.15E+03
Butanol	1.44E+03
Ni	8.09E+02
Pb	4.85E+02
U-Total	2.22E+02
PO4	2.14E+02
NH3	2.00E+02
Mn	9.85E+01

Figure 8. 200-CW-5, 200-PW-1, 200-PW-6 OU IC Boundaries

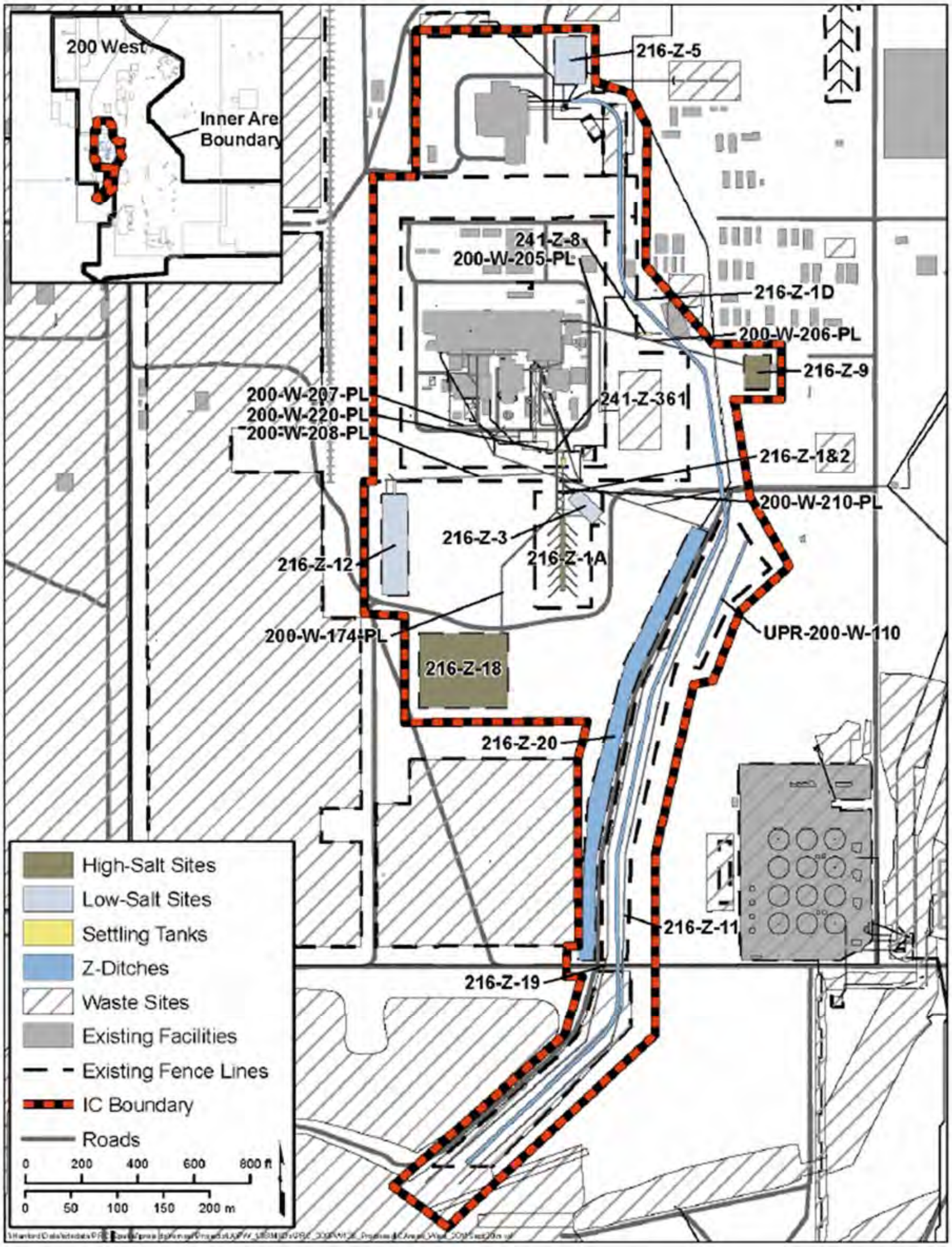

Figure G.5-4. 200-CW-5, 200-PW-1, 200-PW-6 OU IC Boundaries (From ROD, page 95).

Are there co-contaminants that will affect mobility of the primary contaminants?

Waste site within this EU consist of high-salt sites (such as 216-Z-9), low salt sites, settling tanks ditches and more. Sites such as the 216-Z-9 trench have an inventory of transuranics as well as high concentrations of carbon tetrachloride.

What is the depth of contamination and soil type/stratigraphy associated with the contamination? Is the soil profile primarily natural or heavily disrupted?

From the ROD (PAGE 25): "*At the 216-Z-9 Trench, the discharged effluent volume was greater than soil column pore volume, which indicates the volume of effluent released was sufficient to reach the unconfined aquifer during operation of this waste site. The data, including soil moisture content measurements, indicates that the 216-Z-9 Trench is not a significant current source of groundwater contamination*."

What is the physical state of the primary contaminants (i.e., adsorbed in contaminated soil, as debris, in subsurface piping)?

The contaminants are in the soil. For some waste sites the highest concentration of contaminants in the vadose zone are associated with fine-grained layers of silt.

Is information available indicating the partition coefficients and other important transport parameters for the primary contaminants with the type of soil (if yes, provide table)?

There is a general Hanford database that provides lists of distribution coefficients.

What is the source and reliability of the information available to describe the contaminants (risk drivers) and materials present?

There are a variety of sources of information of reasonable reliability. Some sites, such as 216-Z-9 have been the subject of substantial characterization and remediation efforts.

Legacy Source Sites

Not Applicable

High-Level Waste Tanks

Not Applicable

Groundwater Plumes

Not Applicable

D&D of Inactive Facilities

Not applicable

Operating facilities

Not applicable

ECOLOGICAL RESOURCES SETTING

Landscape Evaluation and Resource Classification

More than 60% of the acreage in the Plutonium Contaminated Waste Sites EU is classified as level 0 or level 1 habitat and does not provide significant habitat resources**.** The EU contains approximately 4.2 acres (less than 5%) of level 3 biological resources. The amount and proximity of the biological resources to the EU was examined within the adjacent landscape buffer area radiating 1,365 m from the geometric center of the EU (equivalent to 1,357 acres). More than half of the combined total area (EU and adjacent landscape buffer area) is classified as level 0 or 1 habitat, with level 2 habitat resources comprising

38.5% and level 3 and above resources comprising only 3.4% of the area at the landscape level. Some of the habitat patches within this EU are contiguous with habitat in the surrounding adjacent landscape buffer area, but the patches in the adjacent landscape buffer are not contiguous with habitat outside the 200 West industrial area and generally represent isolated habitat fragments.

Field Survey

PNNL biologists conducted pedestrian and vehicle surveys throughout the EU. Canopy cover of species was estimated visually in level 2 resource areas, and measured along a transect in a level 3 resource area. Much of the EU has been previously disturbed by ongoing operations and the installation and operation of various pump and treat wells and remaining habitat occurs in strips and patches surrounded by roads and infrastructure. Vegetation measurements confirmed the status of resources within the EU. Two individual species occurrences of Piper's daisy (Erigeron piperianus) were previously noted in the EU, but were not relocated during October 2014 survey of the unit.

Some wildlife sign was observed during the October survey including small mammal tracks and burrows, coyote tracks (Canis latrans), unidentified lizards, rabbit tracks, and harvester ant hills. These observations match wildlife observations and sign noted previously by the PNNL ECAP surveys. PNNL ECAP surveys conducted in 2009 and 2010 recorded mountain cottontail (Sylvilagus nutalli), northern pocket gopher (Thomomys talpoides), side-blotched lizard (Uta stansburiana), western kingbird (Tyrannus verticalis), lark sparrow (Chondestes grammacus), rock dove (Columba livia), American robin (Turdus migratorius), American kestrel (Falco sparverius), and mourning dove (Zenaida macroura) within the multiple habitat patches in this EU.

Cultural Resources Setting

Cultural resources known to be recorded within the Plutonium Contaminated Waste Sites EU are limited to the National Register-eligible buildings associated with the Manhattan Project/Cold War Era Landscape with documentation required. These include the Hanford Site Plant Railroad and the seven buildings listed below.

Table G.5-4. Cultural Resource National Register-eligible Buildings.

242Z	Waste Treatment Facility
234-5ZA	PFP Micon, Aces, and Mask Fit Stations
231Z	Materials Engineering Laboratory
234-5Z	Plutonium Fabrication Facility
2736Z	Plutonium Storage Building
2736ZB	Plutonium Storage Support Facility
291Z	Exhaust Air Filter Stack Building
236Z	Plutonium Reclamation Facility
2736ZA	Plutonium Storage Ventilation Structure

All National-Register-eligible Manhattan Project and Cold War Era buildings been documented as described in the *Hanford Site Manhattan Project and Cold War Era Historic District Treatment Plan* (DOE.RL-97-56).

Much of the Plutonium Contaminated Waste Sites EU has not been inventoried for archaeological resources and it is unknown if an NHPA Section 106 review has been completed for remediation of the Plutonium Contaminated Waste Sites EU as one was not located. One small archaeological survey was completed under with negative findings. It is unlikely that intact archaeological material is present in the areas that have not been inventoried for archaeological resources (both on the surface and in the subsurface), because the soils in the EU are extensively disturbed.

There are 2 archaeological sites identified within 500 meters of the Plutonium Contaminated Waste Sites EU a non-contributing segment of a National Register-eligible historic/ethnohistoric Trail/Road associated with the Pre-Hanford Early Settlers/Farming and Native American Precontact and Ethnographic Landscapes, and a site likely associated with the Pre-Hanford Early Settlers/Farming Landscape. Additionally two isolated finds one associated with the Native American Precontact and Ethnographic Landscape and one associated with the Pre-Hanford Early Settlers/Farming Landscape have also been identified. None of these resources is considered to be National Register-eligible.

Historic maps and cultural resources surveys indicate there is evidence of historic and ethnohistoric land use associated with transportation and travel through the area as a historic/ethnohistoric Trail/Road is located within close proximity to the Plutonium Contaminated Waste Sites EU. Geomorphology indicates a moderate potential for the presence of Native American Precontact and Ethnographic cultural resources to be present subsurface within the small pocket of Holocene Dune Sands deposits contained within the Plutonium Contaminated Waste Sites EU. Extensive ground disturbance within the entire EU however, may negate this moderate potential. Because the historic/ethnohistoric Trail/Road is located in such close proximity to the Plutonium Contaminated Waste Sites EU, mitigation for indirect impacts may need to be considered as part of the remediation efforts including measures undertaken to avoid and protect this area. 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 associated with these landscapes (e.g. East Benton Historical Society, the Franklin County Historical Society, the Prosser Cemetery Association, the Reach, and the B-Reactor Museum Association) may need to occur. Indirect effects are always possible when TCPs are known to be located in the general vicinity. Consultation with Hanford Tribes may also 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

From the ROD: these sites "*are associated with subsurface waste handling and disposal sites that were engineered and constructed to dispose of liquid waste into the soil beneath the sites. Pipes conveyed the liquid waste from nuclear processing facilities to the waste sites. At the cribs, tile field, and French drain, liquid waste was discharged into a layer of gravel that drained into the underlying soil and may have drained laterally as well as downward*". As a consequence, the soils in, or underlying, these sites contain substantial amounts of radionuclides including plutonium and cesium, as well as large quantities of chemical constitutes such as carbon tetrachloride, chromium and nitrate.

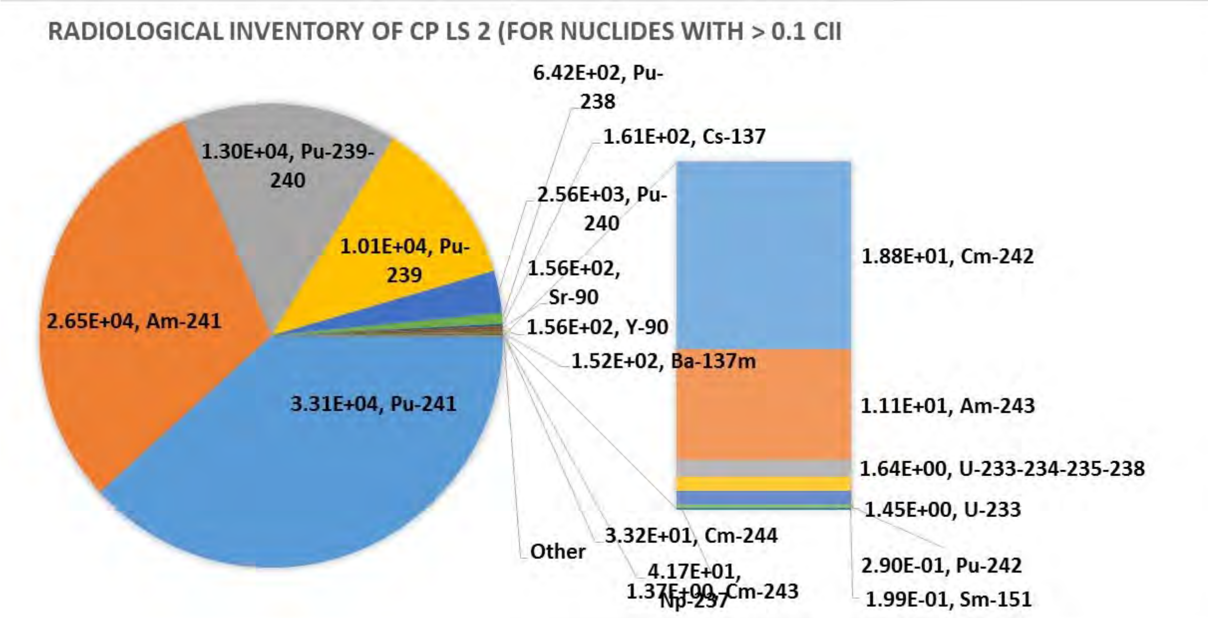

Figure G.5-5. Radiological Inventory of CP-LS-2

What is the physical state of the primary contaminants (e.g., adsorbed in contaminated soil, as debris, in subsurface piping)?

Primary contaminants are in soils underlying the waste sites.

CONTAMINATION WITHIN PRIMARY EU SOURCE COMPONENTS

Legacy Source Sites

The sites that are included as part of this EU are shown in the following Table below in Table G.5-5.

Table G.5-5. Sites included in EU CP-LS-2.

Site Code	Name, Aliases, Description	Site Status	Site Type	Site Type Category	Operable Unit	Exclude from Evaluation
216ZP1	MAIN 200W PUMP AND TREAT PROCESS FACILITY	ACTIVE	BUILDING	Process Building		
216ZP1B	EXTRACTION MANIFOLD BUILDING	ACTIVE	BUILDING	Process Building		
216ZP1C	EXTRACTION MANIFOLD BUILDING	ACTIVE	BUILDING	Process Building		

225WC	INSTRUMENTATION AND LOCAL CNTRL UNIT 55C-23	ACTIVE	BUILDING	Process Building		
2702Z	TELECOMMUNICATIO NS	ACTIVE	BUILDING	Infrastructure Building		X
HO6403544	SEMI-TRAILER NEAR Z-9	ACTIVE	BUILDING	Infrastructure Building		X
MO011	MOBILE OFFICE EAST OF PFP	ACTIVE	BUILDING	Infrastructure Building		X
MO015	MOBILE OFFICE AT 234-5Z	ACTIVE	BUILDING	Infrastructure Building		X
MO016	MOBILE OFFICE AT 234-5Z	ACTIVE	BUILDING	Infrastructure Building		X
MO017	MOBILE OFFICE AT 234-5Z	ACTIVE	BUILDING	Infrastructure Building		X
MO031	MOBILE OFFICE AT 234-5Z	ACTIVE	BUILDING	Infrastructure Building		X
MO032	MOBILE OFFICE AT 234-5Z	ACTIVE	BUILDING	Infrastructure Building		X
MO191	ZP-1 OPERATIONS TRAILER	ACTIVE	BUILDING	Infrastructure Building		X
MO2100	MO2100 CREW TRAILER	ACTIVE	BUILDING	Infrastructure Building		X
MO2101	MO2101 OFFICE TRAILER	ACTIVE	BUILDING	Infrastructure Building		X
MO2102	MO2102 OFFICE TRAILER	ACTIVE	BUILDING	Infrastructure Building		X
MO2103	MO2103 CREW TRAILER	ACTIVE	BUILDING	Infrastructure Building		X
MO2104	MO2104 OFFICE TRAILER	ACTIVE	BUILDING	Infrastructure Building		X
MO2105	MO2105 OFFICE TRAILER	ACTIVE	BUILDING	Infrastructure Building		X

MO2106	MO2106 CREW TRAILER	ACTIVE	BUILDING	Infrastructure Building		X
MO2107	MO2107 CREW TRAILER	ACTIVE	BUILDING	Infrastructure Building		X
MO2108	MO2108 CREW TRAILER	ACTIVE	BUILDING	Infrastructure Building		X
MO2109	MO2109 CREW TRAILER	ACTIVE	BUILDING	Infrastructure Building		X
MO2110	MO2110 CREW TRAILER	ACTIVE	BUILDING	Infrastructure Building		X
MO2111	MO2111 CREW TRAILER	ACTIVE	BUILDING	Infrastructure Building		X
MO2112	MO2112 OFFICE TRAILER	ACTIVE	BUILDING	Infrastructure Building		X
MO2113	MO2113 CREW TRAILER	ACTIVE	BUILDING	Infrastructure Building		X
MO2114	MO2114 OFFICE TRAILER	ACTIVE	BUILDING	Infrastructure Building		X
MO2115	MO2115 OFFICE TRAILER	ACTIVE	BUILDING	Infrastructure Building		X
MO2116	MO2116 CREW TRAILER	ACTIVE	BUILDING	Infrastructure Building		X
MO2117	MO2117 OFFICE TRAILER	ACTIVE	BUILDING	Infrastructure Building		X
MO2118	MO2118 OFFICE TRAILER	ACTIVE	BUILDING	Infrastructure Building		X
MO2119	MO2119 OFFICE TRAILER	ACTIVE	BUILDING	Infrastructure Building		X
MO2120	MO2120 OFFICE TRAILER	ACTIVE	BUILDING	Infrastructure Building		X
MO2121	MO2121 CREW TRAILER	ACTIVE	BUILDING	Infrastructure Building		X
MO2122	MO2122 OFFICE TRAILER	ACTIVE	BUILDING	Infrastructure Building		X

MO2123	MO2123 OFFICE TRAILER	ACTIVE	BUILDING	Infrastructure Building		X
MO2124	TOOL CRIB AT PFP PROTECTED AREA	ACTIVE	BUILDING	Infrastructure Building		X
MO2301	MO2301 RESTROOM TRAILER	ACTIVE	BUILDING	Infrastructure Building		X
MO2302	MO2302 RESTROOM TRAILER AT PFP PARKING LOT	ACTIVE	BUILDING	Infrastructure Building		X
MO2303	RESTROOM TRAILER AT PFP N PARKING LOT	ACTIVE	BUILDING	Infrastructure Building		X
MO2304	RESTROOM TRAILER AT PFP PARKING LOST W OF MO290	ACTIVE	BUILDING	Infrastructure Building		X
MO2305	RESTROOM TRL AT PFP PARKING LOT WEST OF MO290	ACTIVE	BUILDING	Infrastructure Building		X
MO2306	RESTROOM TRL AT PFP PARKING LOT EAST OF MO273	ACTIVE	BUILDING	Infrastructure Building		X
MO2307	RESTROOM TRL AT PFP PARKING LOT EAST OF MO273	ACTIVE	BUILDING	Infrastructure Building		X
MO244	CHANGE TRAILER EAST OF PFP	ACTIVE	BUILDING	Infrastructure Building		X
MO249	MOBILE OFFICE AT 234-5Z PFP TRAINING	ACTIVE	BUILDING	Infrastructure Building		X
MO250	MOBILE OFFICE AT 234-5Z PFP TRAINING	ACTIVE	BUILDING	Infrastructure Building		X
MO273	MOBILE OFFICE AT PFP	ACTIVE	BUILDING	Infrastructure Building		X
MO290	MOBILE OFFICE	ACTIVE	BUILDING	Infrastructure Building		X
MO939	MOBILE OFFICE AT 234-5Z	ACTIVE	BUILDING	Infrastructure Building		X
216Z9A	CONTAINMENT STRUCTURE 216Z9 MINING OPERATION	INACTIVE	BUILDING	Process Building		
216Z9B	OPERATOR'S CUBICLE 216Z9 MINING OPERATION	INACTIVE	BUILDING	Process Building		

MO546	GRP FIELD TRAILER SOUTH OF 234-5	INACTIVE	BUILDING	Infrastructure Building		X
200-W-70	200-W-70; 2731 Burning Pit; Old Burn Pit Southeast of Z Plant; 200 West Original Burn Pit	Inactive	Burn Pit	Burial Ground	Not Applic	
216-Z-1&2	216-Z-1&2; 216-Z-7; 234-5 No. 1 Crib; 234-5 No. 2 Crib; 216-Z-1 & 2TF; 216- Z-1 and 216-Z-2 Cribs	Inactive	Crib	Crib - Subsurface Liquid Disposal Site	200-PW-1	
216-Z-12	216-Z-12; 241-Z-12 Crib	Inactive	Crib	Crib - Subsurface Liquid Disposal Site	200-PW-1	
216-Z-16	216-Z-16; 216-Z-16 Crib	Inactive	Crib	Crib - Subsurface Liquid Disposal Site	200-WA-1	
216-Z-18	216-Z-18; 216-Z-18 Crib	Inactive	Crib	Crib - Subsurface Liquid Disposal Site	200-PW-1	
216-Z-20	216-Z-20; Z-19 Ditch Replacement Tile Field	Inactive	Crib	Crib - Subsurface Liquid Disposal Site	200-CW-5	
216-Z-3	216-Z-3; 216-Z-3 Culvert; 216-Z-8; 234-5 No. 3 & 4 Cribs	Inactive	Crib	Crib - Subsurface Liquid Disposal Site	200-PW-1	
216-Z-6	216-Z-6; 216-Z-6 & 6A Crib; 231-W Crib; 231-W-4 Crib; 231-Z-6; 216-W-4; 216-Z-4	Inactive	Crib	Crib - Subsurface Liquid Disposal Site	200-WA-1	
216-Z-7	216-Z-7; 231-W Crib; 231-W Trench; 216-Z-6	Inactive	Crib	Crib - Subsurface Liquid Disposal Site	200-WA-1	
200-W-178-PL	200-W-178-PL; Lines HSW-202 and HSW-203; Pipeline from 241-Z to 244-TX DCRT	Inactive	Direct Buried Tank Farm Pipeline	Pipeline and associated valves, etc.	TBD	

216-Z-11	216-Z-11; 216-Z-11 Ditch; Z Plant Ditch	Inactive	Ditch	Pond/Ditch – Surface Liquid Disposal Site	200-CW-5	
216-Z-19	216-Z-19; 216-Z-19 Ditch; Z Plant Ditch; 216-U-10 Ditch	Inactive	Ditch	Pond/Ditch – Surface Liquid Disposal Site	200-CW-5	
216-Z-1D	216-Z-1D; Drainage Ditch to U Swamp; Z Plant Ditch; 216-Z-1	Inactive	Ditch	Pond/Ditch – Surface Liquid Disposal Site	200-CW-5	
216-Z-1A	216-Z-1A; 216-Z-1A Tile Field; 216-Z-1AA; 216-Z-1AB; 216-Z-1AC; 216-Z-7; 234-5 Tile Field	Inactive	Drain/Tile Field	Crib - Subsurface Liquid Disposal Site	200-PW-1	
216-Z-8	216-Z-8; 216-Z-8 Crib; 216-Z-9; 234-5 Recuplex French Drain	Inactive	French Drain	Crib - Subsurface Liquid Disposal Site	200-PW-6	
216-Z-21	216-Z-21; 216-Z-21 Seepage Basin; PFP Cold Waste Pond	Inactive	Pond	Pond/Ditch – Surface Liquid Disposal Site	200-WA-1	
200-W-207-PL-B	200-W-207-PL-B; PFP Process Sewer Segments Connecting to TEDF System	Active	Radioactive Process Sewer	Pipeline and associated valves, etc.	Not Applic	
200-W-125-PL	200-W-125-PL; 216-Z-1 Ditch Replacement Pipeline	Inactive	Radioactive Process Sewer	Pipeline and associated valves, etc.	TBD	
200-W-174-PL	200-W-174-PL; 216-Z-1A Modified Pipeline; Lines 1035 and 1036; Pipelines from 234-5Z to 216-Z-1A and 216-Z-18 Crib	Inactive	Radioactive Process Sewer	Pipeline and associated valves, etc.	TBD	
200-W-200-PL	200-W-200-PL; 216-Z-16 Crib Pipeline	Inactive	Radioactive Process Sewer	Pipeline and associated valves, etc.	TBD	
200-W-201-PL	200-W-201-PL; 216-Z-17 Crib Pipeline	Inactive	Radioactive Process Sewer	Pipeline and associated valves, etc.	TBD	
200-W-203-PL	200-W-203-PL; Pipeline from 231-W-	Inactive	Radioactive Process Sewer	Pipeline and associated valves, etc.	TBD	

	151 Vault to 216-Z-7 Crib					
200-W-205-PL	200-W-205-PL; Pipelines from 235-5Z to 241-Z-8 Silica Storage Tank and 216-Z-8 French Drain	Inactive	Radioactive Process Sewer	Pipeline and associated valves, etc.	TBD	
200-W-206-PL	200-W-206-PL; Pipelines from 234-5Z to 216-Z-9 Crib	Inactive	Radioactive Process Sewer	Pipeline and associated valves, etc.	TBD	
200-W-207-PL-A	200-W-207-PL-A; Segment of PFP Process Sewer from manhole Z8 to Z Ditches	Inactive	Radioactive Process Sewer	Pipeline and associated valves, etc.	TBD	
200-W-208-PL	200-W-208-PL; Pipeline from Diversion Boxes 200-W-58 and 200-W-59 to 216- Z-12 Crib	Inactive	Radioactive Process Sewer	Pipeline and associated valves, etc.	TBD	
200-W-209-PL	200-W-209-PL; 207-Z Pipelines	Inactive	Radioactive Process Sewer	Pipeline and associated valves, etc.	TBD	
200-W-210-PL	200-W-210-PL; Pipeline from 241-Z-361 Settling Tank to 216-Z-1, 216-Z-2 and 216-Z-3 Cribs and 216-Z-1A Tile Field	Inactive	Radioactive Process Sewer	Pipeline and associated valves, etc.	TBD	
2607-WA	2607-WA	Active	Septic Tank	Septic System	Not Applic	X
2607-W8	2607-W8	Inactive	Septic Tank	Septic System	200-WA-1	X
2607-WB	2607-WB; 2607-WB Septic System	Inactive	Septic Tank	Septic System	Not Applic	X
2607-Z	2607-Z	Inactive	Septic Tank	Septic System	200-WA-1	X
2607-Z8	2607-Z8	Inactive	Septic Tank	Septic System	Not Applic	X
241-Z-8	241-Z-8; 241-Z-TK-8; IMUST; Inactive Miscellaneous Underground Storage Tank; Silica Slurry Tank; 216-Z-8	Inactive	Settling Tank	Underground Storage Tank	200-PW-6	

2508W12	SIREN NORTHWEST OF 231Z EAST OF RR SPUR	ACTIVE	STRUCTURE	Infrastructure Building		X
HS0086	HAZARDOUS STORAGE CONTAINER S OF 216Z1A	ACTIVE	STRUCTURE	Storage Pad		
HS0087	HAZARDOUS STORAGE CONTAINER S OF 216Z1A	ACTIVE	STRUCTURE	Storage Pad		
216-Z-17	216-Z-17; 216-Z-17 Ditch	Inactive	Trench	Crib - Subsurface Liquid Disposal Site	200-WA-1	
216-Z-9	216-Z-9; 216-Z-9 Cavern; 216-Z-9 Covered Trench; 216-Z-9 Crib and Support Structures; 216-Z-9A; 216-Z-9B; 216-Z-9C; 234-5 Recuplex Cavern	Inactive	Trench	Crib - Subsurface Liquid Disposal Site	200-PW-1	
UPR-200-W-110	UPR-200-W-110; Contaminated Soil from 216-Z-1; UN-216-W-20 Spoil Trench	Inactive	Trench	Burial Ground	200-CW-5	

The sites can be categorized as follows:

Table G.5-6. Facilities in EU CP-LS-2.

Number of Facilities	Category
54	Building
2	Burial Ground
12	Crib - Subsurface Liquid Disposal Site
49	Infrastructure Building
13	Pipeline and associated valves, etc.
4	Pond/Ditch – Surface Liquid Disposal Site
6	Process Building
5	Septic System
2	Storage Pad
1	Underground Storage Tank

Many of the buildings are excluded from evaluation and are assessed as less than Hazard Category 3 because they do not contain an inventory of radionuclides. Several of the waste sites do have substantial inventories of

The following descriptions of waste sites are taken verbatim from DOE RL 88 30 R23, Feb 2014.

200 CW 3

216-Z-1D; Drainage Ditch to U Swamp; Z Plant Ditch; 216-Z-1

Description The 216-Z-1D Ditch is a backfilled, surface stabilized ditch that runs from a point east of the 231-Z Building, curving southward to the 216-U-10 Pond. In 1949, the northern portion of the ditch was backfilled. The backfilled portion of the ditch was replaced with an underground pipeline (see sitecode 200-W-125-PL) to transport 231-Z effluent. The southern portion of the ditch is co-located within a large Underground Radioactive Material area that also includes the 216-Z-11 and 216-Z-19 ditches.

Waste description The 216-Z-1D Ditch received process cooling water, steam condensate, and pump sealant waters from the 231-Z, 234-5Z, and 291-Z Buildings. It is classified as a transuranic contaminated soil site. Plutonium and americium are the dominant radionuclides present in the ditch. The majority of the plutonium was retained in the ditch sediments and did not flow into the 216-U-10 Pond. A comparison of annual plutonium discharges for the dates when the 216- Z-1 Ditch was active indicates that at least 1.4 kilograms (3 pounds) of plutonium was released to the 216-Z-1 Ditch. The contamination burden includes 137 curies of Pu-239 and 37 curies of Pu-240. Previously, in 1959, when the entire ditch was open from its original inlet from the 234-5Z Building (before the upper 526 meters were replaced with a pipeline), a mud sampling project took three samples of the ditch sediment every 100 feet from the inlet pipe to the outlet into 216-U-10 Pond (81 samples from the Z-1D ditch, plus others from 216-U-10 Pond shoreline). The levels of plutonium ranged up to 27.1 micrograms per gram plutonium (almost all plutonium 239) at 800 feet from the inlet. The levels at 485 meters (1600 feet) from the inlet were still at 1.7 micrograms per gram plutonium. The 1959 report concluded that there was between 3 and 10 kilograms of plutonium in the ditch.

216-Z-11; 216-Z-11 Ditch; Z Plant Ditch

Description The 216-Z-11 ditch is a backfilled, surface stabilized ditch that ran from the east side of the 234- 5Z facility southward to the 216-U-10 Pond. The ditch is currently co-located within a large, posted Underground Radioactive Material area that also includes the 216-Z-1D and 216-Z-19 ditches. When active, the unit was a long narrow ditch with 2.5:1 sloped sides and a 0.05% grade.

Waste description The total volume discharged to this ditch is unknown. The ditch received process cooling water and steam condensate from the 234-5Z Building, cooling and seal water from the 291-Z Stack, and laboratory waste from 231-Z. It also received storm water from an elevated tank located south to 234-5Z. The site is a transuranic contaminated soil site. During the 1960's, a special Space Nuclear Auxiliary Power program was operating in Z-Plant. The program isolated plutonium-238 and released plutonium 239/240 to the 216-Z-11 ditch as waste. Plutonium and americium were the dominant radionuclides in the effluent discharge. The ditch has been reported to contain 137 curies of plutonium 239 and 37 curies of plutonium 240.

216-Z-19; 216-Z-19 Ditch; Z Plant Ditch; 216-U- 10 Ditch

Description The 216-Z-19 Ditch is a backfilled, surface stabilized site. The ditch is currently co-located within a large Underground Radioactive Material area that also includes the 216-Z-1D and 216- Z-11 ditches.

Waste description The unit is considered a transuranic contaminated soil site. The effluents received by this ditch include process cooling water, steam condensate, pump seal waste from Plutonium Finishing Plant, and cooling water from the 231-Z Buildings. The dominant radionuclides present include plutonium, americium, strontium, and cesium. Approximately 60 grams of plutonium was released to the ditch in March 1976.

<u>216-Z-20; Z-19 Ditch Replacement Tile Field</u>
Description The site is marked and posted as an Underground Radioactive Material area. The site was permanently isolated by filling the manhole at the head end of the crib with concrete on 6/1/95.

Waste description The site has received cooling water, steam condensate, storm sewer, building drains, Hanford Engineering and Development Laboratory Radioactive Acid Digestion Test Unit (HEDL RADTU) cooling water, and chemical drains waste from the 234-5Z Building; cooling water steam condensate and laboratory drains from the 231-Z Building; and miscellaneous drains waste from 291-Z, 232-Z, and 236-Z buildings. The unit also received wastes from 2736-Z Building, (Construction Project B-246). In 1987, 70 gallons per minute of non-radioactive, thermally warm (105 degrees F), water from Z Plant was permanently diverted from the 216-Z- 20 to the 216-Z-21 Seepage Basin.

<u>UPR-200-W-110; Contaminated Soil from 216-Z- 1; UN-216-W-20 Spoil Trench</u>
Description The site is a one-time use waste disposal trench. The trench is the location where backfill material from the north end of the 216-Z-1 Ditch was placed following excavation for a new ditch. During construction for the 216-Z-19 Replacement Ditch, workers placed the excavated material on a spoils pile. Later that material was found to be contaminated and it was moved to the disposal trench.

The ditches and the trench have been backfilled and are co-located within an "Underground Radioactive Material" (URM) zone. This area was surface stabilized in 1982. The area is marked with concrete posts and an intermittent light chain.

The site is vegetated with crested wheatgrass and Indian rice grass over very sandy soil. There is evidence of rodent burrowing on and adjacent to the URM area. An air monitor is on the site at the north end.

Waste description. Decayed vegetation matting from the bottom of the 216-Z-1 Ditch was found to contain alpha contamination to a maximum of 100,000 disintegrations per minute. The 216-Z-1 Ditch was contaminated with americium and plutonium originating from process leaks contaminating the Z Plant cooling water discharge system. The contamination subsequently settled out of the water or was absorbed by aquatic plant life growing on the sides and bottom of the ditch. Radioactivity computed from soil samples taken from the spoil pile showed an alpha concentration of 0.34 nanocuries per gram of soil. This was 30 times less than the minimum 10 nanocuries per gram standard that required packaging for recovery" plutonium burials.

200 PW – 1

<u>216-Z-1&2; 216-Z-7; 234-5 No. 1 Crib; 234-5 No. 2 Crib; 216-Z-1 & 2TF; 216-Z-1 and 216-Z- 2 Cribs</u>
Description The 216-Z-1&2 Cribs consist of two wooden timber boxes connected by a central pipe. The 216-Z-2 crib overflowed into the 216-Z-1 crib which overflowed into the 216-Z-1A tile field. Each unit is set and backfilled in a deep, square excavation. Two risers were visible from the surface of each crib.

Waste description The 216-Z-1 and 2 Cribs received liquid process waste from the 234-5Z Building. The cribs received aqueous and organic wastes from the Plutonium Reclamation Facility, Americium Recovery Line wastes from the 236-Z and 242-Z Buildings, and uranium wastes from the 236-Z Building.

<u>216-Z-1A; 216-Z-1A Tile Field; 216-Z-1AA; 216-Z-1AB; 216-Z-1AC; 216-Z-7; 234-5 Tile Field</u>
Description: The tile field is located inside a chain link fence. It is a below grade trunk line orientated north to south with seven pairs of lateral pipes spaced in a herring bone pattern. The vitrified clay pipe lies on a gravel bed. The length of the tile field was expanded twice. The original section is known as

216-Z-1AA. The expanded sections are known as 216-Z-1AB, and 216-Z-1AC. The excavation was backfilled to grade. The fence is radiologically posted.

Waste description: The216-Z-1A Tile Field originally received overflow from the 216-Z-1 and the 216-Z-2 Cribs. The cribs received aqueous and organic wastes from the Plutonium Reclamation Facility, americium recovery line wastes from the 236-Z and the 242-Z Buildings, and uranium wastes from the 236-Z Building.

Material discharged to the tile field reportedly included 57 kg (126 lb) of plutonium, 1 kg (2.2 lb) of Am-241, 270,000 kg (594,000 lb) of carbon tetrachloride, and 3,000 kg (6,600 lb) of nitrate. The carbon tetrachloride was discharged to the 216-Z-1A Tile Field in combination with other organics, as a small entrained fraction of process aqueous wastes, and as DNAPL.

216-Z-3; 216-Z-3 Culvert; 216-Z-8; 234-5 No. 3 & 4 Cribs

Description: The crib is posted with identification signs. It is inside the locked and posted chain link fence surrounding the 216-Z-1A tile field. The 216-Z-3 Crib was constructed of three 1.2 meter (4 foot) long, perforated corrugated metal culverts that were laid horizontally, end to end, on a gravel filled excavation. Wire screens were welded on the ends of the pipes to prevent gravel from intruding into the pipe. 2.5 centimeter (1 inch) holes were drilled every 15 centimeters (6 inches) around the circumference of the pipe at 30 centimeter (1 foot) intervals. The culvert rests on a 5 meter (17 foot) bed of gravel, 2.4 meters (8 feet) below grade. Two layers of asphalt roofing paper were laid over the crib construction and the site was backfilled to grade.

Waste description: The site received process waste, analytical and development laboratory wastes from the 234-5Z Building via the 241-Z Settling Tank. The waste was neutral to basic. The waste includes approximately 5.7 kilograms (12.6 lbs) of plutonium.

216-Z-9; 216-Z-9 Cavern; 216-Z-9 Covered Trench; 216-Z-9 Crib and Support Structures; 216-Z-9A; 216-Z-9B; 216-Z-9C; 234-5 Recuplex Cavern

Description: The 216-Z-9 trench is marked and posted with Underground Radioactive Material signs. In 1999, a gravel bio-barrier, measuring 6.1 meter (20 feet) by 4 meters (13 feet), was placed over an area of surface contamination. This area is also posted as Underground Radioactive Material. The 216-Z-9 Crib is an inactive, below grade waste management unit. It is a rectangular structure, with a concrete cover supported by six concrete columns with a concrete cover. The trench walls and support columns are covered in an acid resistant brick. Two stainless steel pipes discharge effluent above the trench bottom. Three above grade structures (216-Z-9A, 216-Z-9B and 216-Z-9C) were constructed to support the crib soil mining operations.

Waste description: The trench received aqueous process waste, and organic process waste. The aqueous process waste is characterized as an acidic, high salt, low level radioactive waste, and the organic process is considered slightly acidic, low salt, high organic, radioactive liquid waste with intermediate levels of plutonium and other transuranic components. Fabrication oil used as a cutting and milling lubricant was estimated to be 50% carbon tetrachloride and 50% lard oil. The site received an estimated 270,000 to 460,000 liters of carbon tetrachloride as waste.

216-Z-12; 241-Z-12 Crib

Description: The site is an inactive, below-grade waste management unit. The site consists of a deep rectangular excavation with a vitrified, perforated, clay pipe running the length of the crib. A second six inch diameter steel pipe (bypass pipeline) was installed in 1968 and runs the length of the crib to the west of the original pipe. The bottom 1.5 meters (5 feet) of the excavation was backfilled with gravel and covered with a polyethylene barrier. The remaining excavation was backfilled to grade. It is marked and posted with Underground Radioactive Material signs.

Waste description: The site received process waste and analytical and development laboratory waste from the 234- 5Z Building via the 241-Z-361 Settling Tank. The waste is slightly acidic. Low salt waste was adjusted to a pH of 8 to 10 before disposal. The waste disposed of to the crib included approximately 25 kilograms (55 lbs) of plutonium.

216-Z-18; 216-Z-18 Crib
Description: The 216-Z-18 Crib is a below grade inactive management unit. The crib consists of five parallel, north-south running trenches bisected by a steel distribution pipe. Near the center of each trench two perforated, fiberglass reinforced epoxy pipes exit each side of the distribution line. The distribution and trench piping lie on a 0.3-meter (1-foot) thick bed of gravel. The pipes were buried under an additional 0.3 meters (1 foot) of gravel, a membrane, and sand cover. The trenches were then backfilled to grade. The site is marked and posted with Underground Radioactive Material signs.

Waste description: The crib received solvent and acidic aqueous waste from the Plutonium Reclamation Facility in the 236-Z Building. The crib received high salt, acidic, and organic liquid waste. Wastes disposed of at the site include carbon tetrachloride, tributyl phosphate, and plutonium.

241-Z-361; 241-Z-361 Settling Tank; IMUST Inactive Miscellaneous Underground Storage Tank
Description: The unit is an underground reinforced concrete structure with a 0.95 centimeter (3/8 inch) steel iner. The tank has inside dimensions of 7.9 by 4.0 meters (26 by 13 feet) with 0.3 meter (1 foot) thick walls. The bottom slopes, resulting in a internal height variation between 5.2 and 5.5 meters (17 and 18 feet). The top is 0.6 meters (2 feet) below grade. A 15 centimeter (6 inch) stainless steel inlet pipe from the 241-Z Tank Pit (WIDS SiteCode 241-Z) enters the tank from the north. A single 20 centimeter (8 inch) stainless steel pipe exits the tanks from the south. There are two manhole covers and frames and several risers visible above grade.

Waste description: The unit received radioactively contaminated liquid. The tank is estimated to contain a residual 30 to 75 kilograms (66 to 165 pounds) plutonium in the sludge. (See HNF-8735 for detailed sludge sample analysis)

200-PW-6

216-Z-5; 231-W Sumps; 231-W-1 & 2 Cribs
Description: The 216-Z-5 Crib is an inactive waste management unit located below grade. The crib is oriented in a north-south configuration with a transfer pipe connecting to two wooden sump boxes. Each box was placed at the bottom of a rectangular excavation. The two excavations were the backfilled to grade.

Waste Description: The site received process waste from the 231-Z Building via the 231-W-151 Vault. An estimated 3,000 grams of plutonium was discharged from 231-Z to these cribs. The cribs were plugged with sludge and abandoned. It is believed the plutonium is in the sludge or directly beneath the crib area.

216-Z-8; 216-Z-8 Crib; 216-Z-9; 234-5 Recuplex French Drain
Description: The french drain is constructed of two sections of 0.9-meter (3-foot) high standard clay tile culverts, stacked vertically underground. The culverts are filled with gravel and rest on a 1.5-meter (5-foot) diameter by 0.9-meter (3-foot) deep bed of gravel with a slope of 2.5:1. There is a 10-centimeter (4-inch) thick concrete top that is 2.4 meter (8 feet) below grade. The bottom of the french drain is 5.57 meters (17 feet) below grade.

Waste description: The site received overflow from the Recuplex Silica Tank (neutral to basic Recuplex waste). As of June 30 1978 the calculated radionuclide content included 48.4 grams (0.1 pounds) of plutonium. The adjacent well (#299-W15-202) shows a maximum of 4,400 picocuries/gram of plutonium-239 and 440 picocuries/gram of americium-241 near the bottom of the french drain structure.

216-Z-10; 216-Z-2; 231-W Reverse Well; 231-W-150; 231-W-151 Dry Well or Reverse Well; 231-Z Well; 299-W15-51

Description: This site is a reverse well that protruded approximately 0.31 meters (1 foot) above grade. The protruding end is capped with a flange. The well casing is constructed of steel pipe. The site was interim stabilized in 1990.

Waste description: The site received process and laboratory waste from the 231-Z Building, via the 231-W-151 Sump. The transuranic contaminated process waste was discharged at a rate of 76 liters (20 gallons) per minute. HW-28471 states that the small diameter well became plugged with sludge in June 1945. Approximately 988,000 liters (260,000 gallons) of liquid containing approximately 50 grams of plutonium was discharged to this unit.

241-Z-8; 241-Z-TK-8; IMUST; Inactive Miscellaneous Underground Storage Tank; Silica Slurry Tank; 216-Z-8

Description: The tank is a horizontal cylindrical vessel located 1.8 meters (6 feet) below grade. The area above the tank is surrounded by a light weight chain barricade marked "Caution Underground Radioactive Material" and IMUST signs. Inside the barricade on the north end are two capped 10 centimeters (4 inches) steel vent pipes.

Waste description: The tank was used as a solids settling tank for backflushes of the feed filter in the Recuplex. Silica gel was used as a settling agent on the dissolved solids. The solids and the silica gel were then flushed to this unit with nitric acid. In July 1959, records indicate the tank was filled to capacity 58,428 liters (15,435 gallons). No records were found to indicate the tank was pumped between 1959 and 1962. In 1974, a total waste volume of 30,850 liters (8,150 gallons) was reported. A total of 27,580 liters (7,285 gallons) has not been accounted for in historical records. The tank measures 2.4 meters (8 feet) diameter. by 12.2 meters (40 feet) length, constructed of 0.79 centimeters (5/16 inch) steel or wrought iron pate, buried horizontally about 1.8 meters (6 feet) below grade. There are two blanked inlet pipes on the west end and on overflow pipe on the east end of the tank, all three are 15 centimeters (6 inches) below tank top. In the east half of the top centerline of the tank, there are two 10 centimeters (4 inches) vent risers that extend above grade, a 0.3 meters (1 foot) diameter pump access opening, and a 0.6 meter (2 feet) diameter manhole; both bolted over.

Vadose Zone Contamination

For some of the waste sites within this EU there are no contaminants that will migrate through the soil that could affect groundwater. However, based on vadose zone plume data, some of these waste sites were past sources of groundwater contamination. The current unsaturated vadose zone conditions are such that the remaining contaminants in the vadose zone are not considered a significant current source of groundwater contamination. However, for others the presence of volatile contaminants (notably carbon tetrachloride and methyl chloride) have the potential to migrate through the soil from sites such as the 216-Z-1A Tile Field, 216-Z-9 Trench, and 216-Z-18 Crib (and impact groundwater above the federal MCLs within 1,000 years if remediation is discontinued. Technetium-99 and nitrate also have the potential to contaminate groundwater.

Detailed inventories are provided in Table G.5-7, Table G.5-8, and Table G.5-9. All values are to 2 significant figures. The source document should be consulted for greater precision data. The sum for each primary contaminant is shown in the first row. Table G.5-10 provides a summary of the evaluation of threats to groundwater as a protected resource from saturated zone and remaining vadose zone contamination associated with the evaluation unit.

Table G.5-7. Inventory of Primary Contaminants[(a)]

WIDS	Description	Decay Date	Ref[(b)]	Am-241 (Ci)	C-14 (Ci)	Cl-36 (Ci)	Co-60 (Ci)	Cs-137 (Ci)	Eu-152 (Ci)	Eu-154 (Ci)	H-3 (Ci)	I-129 (Ci)
All	Sum			27000	0.000015	NP	0.026	160	0.000069	0.007	0.0015	0.0037
216-Z-11	Other	1986	EIS-S	NP	NP	NP	NP	NP	NP	NP	NP	NP
216-Z-1A	Other	2001	SIM	3900	NP	NP	0.0024	1	0.0000011	0.00012	NP	NP
216-Z-1D	Other	1986	EIS-S	NP	NP	NP	NP	NP	NP	NP	NP	NP
216-Z-21	Pond	2001	SIM	0.0000019	NP	NP	NP	0.0000011	NP	NP	NP	NP
216-Z-1&2	Cribs	2001	SIM	190	NP	NP	0.00016	0.011	0.000000059	0.0000069	NP	NP
216-Z-12	Cribs	2001	SIM	8500	NP	NP	0.0081	0.71	0.0000032	0.00036	NP	NP
216-Z-16	Cribs	2001	SIM	2.7	NP	NP	NP	0.000048	0.00000011	0.000011	NP	NP
216-Z-18	Cribs	2001	SIM	760	NP	NP	0.0014	0.059	0.00000052	0.000058	NP	NP
216-Z-20	Cribs	2001	SIM	0.54	NP	NP	NP	0.00000045	NP	NP	NP	NP
216-Z-3	Cribs	2001	SIM	5200	NP	NP	0.000092	0.32	0.00000012	0.000014	NP	NP
216-Z-6	Cribs	2001	SIM	19	NP	NP	0.000038	0.5	0.00000015	0.000017	NP	NP
216-Z-7	Cribs	2001	SIM	7300	0.000015	NP	0.012	160	0.000063	0.0064	0.0015	0.0037
216-Z-8	Cribs	2001	SIM	0.67	NP	NP	NP	6.8E-12	NP	NP	NP	NP
216-Z-17	Trenches	2001	SIM	0.99	NP	NP	NP	0.000017	0.000000038	0.000004	NP	NP
216-Z-9	Trenches	2001	SIM	560	NP	NP	0.0015	0.062	0.00000054	0.000061	NP	NP

a. NP = Not present at significant quantities for indicated EU
b. SIM = RPP-26744, Rev. 0
c. EIS-S = DOE/EIS-0391 2012

Table G.5-8. Inventory of Primary Contaminants (cont)[(a)]

WIDS	Description	Decay Date	Ref[(b)]	Ni-59 (Ci)	Ni-63 (Ci)	Pu (total) (Ci)	Sr-90 (Ci)	Tc-99 (Ci)	U (total) (Ci)
All	Sum			0.00014	0.013	47000	160	0.0036	1.7
216-Z-11	Other	1986	EIS-S	NP	NP	170	NP	NP	NP
216-Z-1A	Other	2001	SIM	NP	NP	19000	0.98	0.000071	0.000066
216-Z-1D	Other	1986	EIS-S	NP	NP	170	NP	NP	NP
216-Z-21	Pond	2001	SIM	NP	NP	0.000068	0.00000048	NP	0.00048
216-Z-1&2	Cribs	2001	SIM	NP	NP	720	0.017	0.0000048	0.0000072
216-Z-12	Cribs	2001	SIM	NP	NP	12000	0.71	0.00021	0.00015
216-Z-16	Cribs	2001	SIM	NP	NP	16	0.000044	0.0000055	0.00031
216-Z-18	Cribs	2001	SIM	NP	NP	10000	0.057	0.000033	0.000018
216-Z-20	Cribs	2001	SIM	NP	NP	13	0.00000019	NP	0.00019
216-Z-3	Cribs	2001	SIM	NP	NP	180	0.32	0.0000084	0.000011
216-Z-6	Cribs	2001	SIM	NP	NP	1.7	0.49	0.0000095	0.00002
216-Z-7	Cribs	2001	SIM	0.00014	0.013	720	150	0.0033	1.7
216-Z-8	Cribs	2001	SIM	NP	NP	5.2	3E-12	NP	3.2E-09
216-Z-17	Trenches	2001	SIM	NP	NP	5.9	0.000016	0.000002	0.00011
216-Z-9	Trenches	2001	SIM	NP	NP	3300	0.06	0.000035	0.000017

a. NP = Not present at significant quantities for indicated EU
b. SIM = RPP-26744, Rev. 0
c. EIS-S = DOE/EIS-0391 2012

Table G.5-9. Inventory of Primary Contaminants (cont)[(a)]

WIDS	Descrip-tion	Ref[(b)]	CCl4 (kg)	CN (kg)	Cr (kg)	Cr-VI (kg)	Hg (kg)	NO3 (kg)	Pb (kg)	TBP (kg)	TCE (kg)	U (total) (kg)
All	Sum		910000	NP	3500	NP	760000	7900000	480	110000	NP	220
216-Z-11	Other	EIS-S	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP
216-Z-1A	Other	SIM	310000	NP	93	NP	140000	1300000	93	32000	NP	0.093
216-Z-1D	Other	EIS-S	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP
216-Z-21	Pond	SIM	7900	NP	400	NP	22	NP	16	NP	NP	0.63
216-Z-1&2	Cribs	SIM	38000	NP	16	NP	5300	55000	16	1300	NP	0.01
216-Z-12	Cribs	SIM	140000	NP	52	NP	430000	4400000	50	6100	NP	0.19
216-Z-16	Cribs	SIM	NP	NP	13	NP	NP	NP	NP	NP	NP	0.42
216-Z-18	Cribs	SIM	190000	NP	7.1	NP	88000	840000	7.1	20000	NP	0.024
216-Z-20	Cribs	SIM	290	NP	290	NP	0.16	100000	290	30000	NP	0.25
216-Z-3	Cribs	SIM	22000	NP	16	NP	0.0077	190000	14	NP	NP	0.016
216-Z-6	Cribs	SIM	1.2	NP	0.001	NP	NP	160	NP	2.7	NP	0.03
216-Z-7	Cribs	SIM	360	NP	2600	NP	NP	160000	NP	850	NP	220
216-Z-8	Cribs	SIM	360	NP	0.0024	NP	0.00014	NP	0.000096	38	NP	0.0000048
216-Z-17	Trenches	SIM	NP	NP	4.6	NP	NP	NP	NP	NP	NP	0.15
216-Z-9	Trenches	SIM	210000	NP	NP	NP	92000	890000	NP	22000	NP	0.025

a. NP = Not present at significant quantities for indicated EU
b. SIM = RPP-26744, Rev. 0
c. EIS-S = DOE/EIS-0391 2012

Table G.5-10. Summary of the Evaluation of Threats to Groundwater as a Protected Resource from Saturated Zone (SZ) and Remaining Vadose Zone (VZ) Contamination associated with the Evaluation Unit

PC	Group	WQS	Porosity[a]	K_d (mL/g)[a]	ρ (kg/L)[a]	VZ Source M^{Source}	SZ Total M^{SZ}	Treated[c] M^{Treat}	VZ Remaining M^{Tot}	VZ GTM (Mm^3)	VZ Rating[d]
C-14	A	2000 pCi/L	0.23	0	1.84	1.50E-05 Ci	---	---	1.50E-05 Ci	7.51E-06	Low
I-129	A	1 pCi/L	0.23	0.2	1.84	3.71E-03 Ci	---	---	3.71E-03 Ci	1.43E+00	Low
Sr-90	B	8 pCi/L	0.23	22	1.84	1.56E+02 Ci	---	---	1.56E+02 Ci	1.10E+02	ND[e]
Tc-99	A	900 pCi/L	0.23	0	1.84	3.64E-03 Ci	---	---	3.64E-03 Ci	4.04E-03	Low
CCl4	A	5 µg/L	0.23	0	1.84	9.11E+05 kg	1.20E+05 kg	9.78E+04 kg	6.93E+05 kg	1.39E+05	Very High
Cr	B	100 µg/L	0.23	0	1.84	3.52E+03 kg	---	---	3.52E+03 kg	3.52E+01	Medium
Cr-VI	A	48 µg/L[b]	0.23	0	1.84	3.52E+03 kg	---	---	3.52E+03 kg	7.33E+01	Medium
TCE	B	5 µg/L	0.23	2	1.84	---	---	---	---	---	ND
U(tot)	B	30 µg/L	0.23	0.8	1.84	2.22E+02 kg	---	---	2.22E+02 kg	1.00E+00	ND[e]

a. Parameters obtained from the analysis provided in Attachment 6-1 to Methodology Report.

b. "Model Toxics Control Act—Cleanup" (WAC 173-340) Method B groundwater cleanup level for hexavalent chromium.

c. Treatment amounts from the 2013 Hanford Annual Groundwater Report (DOE/RL-2014-32, Rev. 0).

d. Groundwater Threat Metric rating based on Table 6-3, Methodology Report. These contaminants are being treated using the 200-West Groundwater Treatment Facility.

e. Based on an analysis similar to the one discussed in Appendix E.2 (T Tank and Waste Farms) Section 2.5 (Vadose Zone Contamination), no appreciable uranium or Sr-90 plume would be expected in the next 150 years due to transport and decay (Sr-90) considerations. Thus the *Low* rating would apply after the Active Cleanup is completed to account for uncertainties.

PART VI. POTENTIAL RISK/IMPACT PATHWAYS AND EVENTS

CURRENT CONCEPTUAL MODEL

Pathways and Barriers: (1. description of institutional, natural and engineered barriers (including material characteristics) that currently mitigate or prevent risk or impacts, 2. Time scale from loss of each barrier to realization of risk or impacts)

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?*

The inactive waste facilities have a range of contamination; some is high activity or high hazard. However a hazard assessment or DBA has not been found for these specific sites. It is estimated that the principal hazards are due to collapse of trenches with potential for small localized release of radioactive materials.

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

The majority of buildings associated with this EU are classified as less than hazard category three – they do not have a radiological inventory associated with them that leads to a release. The majority of buildings associated with this EU are classified as less than hazard category three – they do not have a radiological inventory associated with them that leads to a release.

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

Standard industrial safety activities

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?*

The waste sites are stabilized backfilled and covered with soil. There are no completed pathways

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

Animal intrusion or inadvertent excavation

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

Workers and collocated workers exposed to small resuspension of contamination

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

Seconds to minutes

8. *Are there current on-going releases to the environment or receptors?*

Some animal intrusion has been noted for some of the inactive waste sites and there is groundwater contamination from past discharges (but the driving force has been removed through soil vapor extraction and cessation of the addition of process water).

POPULATIONS AND RESOURCES CURRENTLY AT RISK OR POTENTIALLY IMPACTED

Facility Worker

Workers may be exposed to residual radioactive and chemical contaminants, but are protected by special equipment. Workers not currently directly exposed to the contaminated soils because they are located below grade beneath a concrete slab and / or backfilled soils. Because the contamination remains underground, there is not a dispersion pathway for the material to reach the atmosphere.

Co-Located Person (CP)

Under current industrial land use and Hanford site-wide institutional control conditions, only a construction worker (outdoor workers that are involved in active soil disturbance (e.g., putting in an underground utility line or constructing a building) have the potential to encounter impacted soil. There are no complete and significant pathways for current regular workers. Exposure routes to groundwater and surface water are incomplete.

Public

The contamination remains underground, there is not a dispersion pathway for the material to reach the atmosphere and travel outside the site boundary.

Groundwater

The liquid waste infiltrated the soil and, in some cases, reached groundwater. However, migration of the contaminants through the soil into groundwater requires a driving force (source of water to mobilize the contamination). This driver is not present at this time.

Based on an analysis similar to the one discussed in Appendix E.2 (T Tank and Waste Farms) Section 2.5 (Vadose Zone Contamination), no appreciable uranium or Sr-90 plume would be expected in the next 150 years due to transport and decay (Sr-90) considerations. Thus the *Low* rating would apply after the Active Cleanup is completed to account for uncertainties

Nonetheless, Table G.5-10 shows that C-14, I-129, and Tc-99 have low ratings; Cr and Cr-VI have Medium ratings; and CCl4 has a Very High rating. The overall rating is Very High due to CCl4.

Columbia River

The liquid waste infiltrated the soil and, in some cases, reached groundwater. The existing contamination will potentially continue migration towards the Columbia River. However, new mobilization of contamination through the soil into groundwater and onto the Columbia River requires a driving force (source of water to mobilize the contamination). This driver is not present at this time. Based on a similar evaluation as that discussed in Appendix G.6 (CP-GW-2 (Operable Units 200-UP-1 and 200-ZP-1) in 200-West Evaluation Unit Summary Template) Part 5, the rating is Not Discernible (ND).

Ecological Resources

Summary of Ecological Review:

- More than 60% of the acreage in the Plutonium Contaminated Waste Sites EU is classified as level 0 or level 1 habitat and does not provide significant habitat resources.
- Approximately 4 acres of level 3 habitat exist within the Plutonium Contaminated Waste Sites EU; total loss of this habitat would result in a change of 0.3% at the landscape level.
- The remaining level 2 and level 3 habitat within the EU are fragmented and isolated from habitat surrounding the 200 West Area.

- Individual species occurrences of Piper's daisy represent approximately 1 acre of level 3 resources within the EU. Loss of individual plants of this species is not likely to affect population viability for the Washington State sensitive species.
- Because remaining habitat within the EU and adjacent landscape buffer area is isolated from contiguous habitat outside the 200 West Area, any loss of habitat within the Plutonium Contaminated Waste Sites EU would not be expected to impact habitat connectivity at the landscape level.

Cultural Resources

Summary

- A non-contributing segment of the National Register-eligible historic/ethnohistoric Trail/Road is located within 100 meters of the Plutonium Contaminated Waste Sites EU.
- There are one archaeological site, likely associated with the Pre-Hanford Early Settlers/Farming Landscapes and two isolated finds one associated with the Native American Precontact and Ethnographic Landscape and one associated with the Pre-Hanford Early Settlers/Farming Landscape have also been identified. None of these resources is considered to be National Register-eligible.
- The 270Z PFP support building is a National Register-eligible contributing property within the Manhattan Project and Cold War Era Historic District, with no documentation required, located adjacent to the Plutonium Contaminated Waste Sites EU.

Closest Recorded TCP

- There are two recorded TCPs associated with the Native American Precontact and Ethnographic Landscape that are visible from the Plutonium Contaminated Waste Sites EU.

CLEANUP APPROACHES AND END-STATE CONCEPTUAL MODEL

Selected or Potential Cleanup Approaches

What are the selected cleanup actions or the range of potential remedial actions?

Because this EU has multiple sites within it, the ROD has identified a series of remedial actions that will be taken with the sites, based on their specific characteristics and inventories. The cleanup actions that have been selected are (taken from the ROD, page 88, Table 32):

Table 32. Summary of Remedial Actions Selected by Waste Group (From ROD).

Waste	Selected Remedy
Z-Ditches	RTD with disposal at ERDF or WIPP, as appropriate.
High-Salt	RTD—Option A: Remove soil to 0.6 m (2 ft) below the bottom of the disposal structure to 20 ft – 23 ft bgs. Plutonium waste will be disposed of at WIPP or ERDF, as appropriate. SVE to treat

Low-Salt	RTD—Option C: Remove soil up to a depth of 22 ft - 33 ft at each waste site. Plutonium waste will be disposed of at
Cesium-137	Maintain/ Enhance Soil Cover. Maintain a 15 ft thickness of soil cover over these waste sites.
Settling Tanks	Sludge Removal and Tank Stabilization.
Other Sites	No action since these waste sites do not pose a risk to human health and the environment

What is the sequence of activities and duration of each phase?

From the ROD

Z Ditches

- Removal and stockpiling of clean overburden for backfilling.
- Removal of contaminated soils and debris to a depth of 15 ft bgs that exceed the cleanup levels identified in Table 35 for contaminants specified above.
- Removal of structures and other debris within the excavation areas. This includes the 200-W-207PL pipeline associated with this waste group.
- Sampling during design to confirm the extent of excavation required.
- Placement of contaminated soil and debris in waste containers.
- Screening of waste in containers to determine if it qualifies for disposal at ERDF. If transuranic waste is present in the containers, it will be packaged to meet waste disposal criteria for disposal at WIPP.
- Treatment of waste to meet disposal requirements (if needed).
- Sampling for plutonium 239/240, americium-241, cesium-137, radium-226, strontium-90, PCBs, boron, and mercury to verify the remediation meets the cleanup levels identified in Table 35 after excavation is complete and before backfilling occurs.
- Sampling of nitrate, at the request of Ecology, to confirm that nitrate levels do not pose an unacceptable risk to groundwater. Sampling will be done in accordance with a sampling and analysis plan that will be part of the RD/RA work plan. In the event sampling indicates contaminant levels do pose an unacceptable risk to groundwater, then the CERCLA process will be used to modify the remedy as necessary to protect groundwater.
- Backfilling of the excavations with clean fill followed by compaction and revegetation.

High Salt Waste Group

- Removal and stockpiling of clean overburden for backfilling.
- Removal of soils and debris to 6.1 m (20 ft) bgs at the 216-Z-1A Tile Field, 7 m (23 ft) bgs at the 216-Z-9 Trench, and 6.1 m (20 ft) bgs at the 216-Z-18 Crib. This includes the 200-W-174-PL and 200-W-206-PL pipelines and removal of the above-grade structures at the 216-Z-9 Trench.

- Removal of structures and other debris within the excavation areas or that must be removed in order to conduct required remediation. This may include removal of parts of the 200-W-178 pipeline from the 241-Z building to the 3rd bend in the 200-W-178-PL pipeline. The 200-W-178 pipeline is part of a Dangerous Waste Management Unit (DWMU) and any necessary removal of parts of the 200-W-178 pipeline will satisfy applicable or relevant and appropriate requirements for DWMUs.
- Placement of contaminated soil and debris in waste containers.
- Screening of waste in containers to determine if it qualifies as transuranic waste. Waste that qualifies as transuranic waste will be packaged to meet waste disposal criteria for disposal at WIPP. Other waste will be packaged to meet disposal criteria for disposal at ERDF.
- Treatment of waste to meet disposal requirements (if needed).
- Sampling of nitrate and technetium-99, at the request of Ecology, to confirm that contaminant levels do not pose an unacceptable risk to groundwater. Sampling will be done in accordance with a sampling and analysis plan that will be part of the RD/RA work plan. In the event sampling indicates contaminant levels do pose an unacceptable risk to groundwater, then the CERCLA process will be used to modify the remedy as necessary to protect groundwater.
- After excavating to the specified depths in these waste sites, plutonium-239/240 levels will be assessed in accordance with a sampling and analysis plan that will be part of the RD/RA work plan. DOE will consider removing additional plutonium-contaminated soil from these waste sites.
- Backfilling of the excavations with clean fill, followed by compaction.
- Construction of evapotranspiration (ET) barriers over each waste site. ET barrier construction will include planting the barrier surface with vegetation.

Low Salt Waste Group

- Removal and stockpiling of clean overburden for backfilling.
- Removal of soils and debris to 7.6 m (25 ft) bgs at the 216-Z-1&2 Crib, 10.1 m (33 ft) bgs at the 216-Z-3 Crib, 6.7 m (22 ft) bgs at the 216-Z-5 Crib, and 7.3 m (24 ft) bgs at the 216-Z-12 Crib.
- Removal of structures and other debris within excavation areas or that must be removed in order to conduct required remediation. This includes the 200-W-208-PL and 200-W-210-PL pipelines.
- Placement of contaminated soil and debris in waste containers
- Screening of waste in containers to determine if it qualifies for offsite disposal at the Waste Isolation Pilot Plant (WIPP). Waste that does not meet waste acceptance criteria for WIPP will be sent to the Hanford Environmental Restoration and Disposal Facility (ERDF).
- Treatment of waste to meet disposal requirements (if needed).
- Backfilling of the excavations with clean fill, followed by compaction.
- Construction of evapotranspiration (ET) barriers over each waste site. The requirements for these ET barriers are the same as for the High-Salt Waste Group.

Settling Tanks

- Removal of sludge from the tanks.
- Packaging of sludge to meet waste disposal criteria for disposal at WIPP.

- Screening of waste in container to confirm it meets the requirements for disposal at WIPP. Waste in containers that does not meet WIPP disposal criteria will be treated if necessary and sent to ERDF.
- Verification of removal of tank contents prior to grouting will be conducted in accordance with the RD/RA work plan.
- Grouting of empty tanks with a suitable fill material to remove the potential for collapse. Tanks will remain in place.

Other Sites

The two waste sites in the Other Sites Group, the 216-Z-8 French Drain and 216-Z-10 Injection/Reverse Well, were determined to have limited contamination and do not pose a risk to human health and the environment; therefore, no action has been selected for these waste sites.

What is the magnitude of each activity (i.e., cubic yards of excavation, etc.)?

Unknown from available data sources; however capital costs are available from the ROD for each of the waste groups.

Contaminant Inventory Remaining at the Conclusion of Planned Active Cleanup Period

Unknown from current data sources. The preferred cleanup remedy approach will remove or fully stabilize the contaminated soils.

Risks and Potential Impacts Associated with Cleanup

The preferred cleanup alternatives will put cleanup workers at risk from exposure to contaminated soils and from potential industrial accidents.

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

Facility Workers

From the ROD, page 100: "*The selected remedy for remediation of the 200-CW-5, 200-PW-1, 200-PW-3, and 200-PW-6 OUs will be protective of human health and the environment through removal, treatment (if needed), and disposal of contaminated soils, evapotranspiration barriers, soil covers, institutional controls, and long-term monitoring. These portions of the selected remedy will eliminate the exposure pathways for workers to encounter contaminated soil, thus controlling the potential exposure pathways from ingestion, inhalation, dermal contact, and external radiation. Additionally, exposure pathways to ecological receptors will be removed*."

Co-Located Person (CP)

See statement above – there is limited potential for co-located worker exposure during or as a consequence of cleanup actions

Public

See statement above – there is limited potential for public exposure during or as a consequence of cleanup actions

Groundwater

The liquid waste infiltrated the soil and, in some cases, reached groundwater. However, migration of the contaminants through the soil into groundwater requires a driving force (source of water to mobilize the contamination). This driver is not present at this time.

Based on an analysis similar to the one discussed in Appendix E.2 (T Tank and Waste Farms) Section 2.5 (Vadose Zone Contamination), no appreciable uranium or Sr-90 plume would be expected in the next 150 years due to transport and decay (Sr-90) considerations. Thus the *Low* rating would apply after the Active Cleanup is completed to account for uncertainties

Table G.5-10 shows that C-14, I-129, and Tc-99 have low ratings; Cr and Cr-VI have Medium ratings; and CCl4 has a Very High rating. The overall rating is Very High due to CCl4.

Columbia River

See statement above – there is limited potential for impact to the Columbia River during or as a consequence of cleanup actions. Based on a similar evaluation as that discussed in Appendix G.6 (CP-GW-2 (Operable Units 200-UP-1 and 200-ZP-1) in 200-West Evaluation Unit Summary Template) Part 5, the rating is Not Discernible (ND).

Ecological Resources

There are two options proposed that have different types of disturbances and effects on ecological resources. Removal of waste to ERDF: Trucks, heavy equipment and drill rigs 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. Drilling can cause destruction of soil invertebrates at greater depths, and has the potential to bring up dormant seeds from deeper soil layers. Drilling can cause disruption of ground-living small mammals and hibernation sites of snakes and other animals. 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). Additional water from dust suppression could lead to more diverse and abundant vegetation in areas that receive water, which could encourage invasion of exotic species. The latter could displace native plant communities. Excessive dust suppression activities could lead to compaction, which can decrease plant growth in those areas, decrease abundance and diversity of soil invertebrates, and prevent fossorial snakes or mammals from using the area. Soil removal can cause complete destruction of existing ecosystem, all of the above effects on adjacent sites, but these effects are potentially more severe because of blowing soil (and seeds) and the potential for exposure of dormant seeds. In the re-vegetation stage, there is the potential for invasion of exotic species, changing the species diversity of native communities. 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. Construction of a barrier: Personnel, cars, trucks, heavy equipment and drill rigs 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). Irrigation for re-vegetation requires a system of pumps and water, resulting in physical disturbance. Repeated irrigation from the same locations could result in some soil compaction, which can decrease plant growth in those areas, decrease abundance and diversity of soil invertebrates, and prevent fossorial snakes or mammals from using the area. Soil removal can cause complete destruction of existing ecosystem, all of the above effects on adjacent sites, but these effects are potentially more severe because of blowing soil (and seeds) and the potential for exposure of dormant seeds. In the re-vegetation stage, there is the potential for invasion of exotic species, changing the species diversity of native communities. 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. Caps and other containment systems can disrupt local resources and drainage; often non-native plants used on caps (which can become exotic/alien adjacent to the containment site).

Cultural Resources

Personnel, car, and truck traffic on paved roads as well as use of heavy equipment and drill rigs will not have any direct impact on archaeological resources because there is no disturbance to soil/ground or alteration to the landscape. Assuming heavy equipment locations 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 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 paved roads located on TCP, direct effects include visual, auditory and vibrational alterations to landscape/setting. Heavy equipment 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. Construction of buildings, staging areas, caps 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 building locations and staging areas 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 buildings and staging areas 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, capping 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 include 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, car, and truck traffic on paved roads as well as use of heavy equipment 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. Existing road causes no alteration to 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 construction, 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

Limited additional risks to workers if cleanup is delayed. The risks are attributed to loss of institutional knowledge of placement of waste sites and associated inventories. Some minor potential for migration of some residual wastes. No additional risks for co-located workers or public.

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

Table G.5-11. Population or Resource Risk/Impact Rating.

Population or Resource		Risk/Impact Rating	Comments
Human	Facility Worker	ND to Low	No workers other than monitoring
	Co-located Person	ND	None
	Public	ND	None
Environmental	Groundwater	Very High (CCl4)	Based on an analysis similar to the one discussed in Appendix E.2 (T Tank and Waste Farms) Section 2.5 (Vadose Zone Contamination), no appreciable uranium or Sr-90 plume would be expected in the next 150 years due to transport and decay (Sr-90) considerations. Thus the *Low* rating would apply after the Active Cleanup is completed to account for uncertainties Table G.5-10 shows that C-14, I-129, and Tc-99 have low ratings;

			Cr and Cr-VI have Medium ratings; and CCl4 has a Very High rating. The overall rating is Very High due to CCl4.
	Columbia River	ND	See Appendix G.6 (CP-GW-2 (Operable Units 200-UP-1 and 200-ZP-1) in 200-West Evaluation Unit Summary Template) Table G.6-5. Summary of Populations and Resources at Risk or Potentially Impacted after Cleanup.
	Ecological Resources*	Low-Medium	There are 2 waste sites with contamination in place, which will have continued monitoring, which leads to disturbance, and the potential for exotic species to invade and disrupt native habitat.
Social	Cultural Resources*	**Native American:** Direct: Unknown Indirect: Known **Historic Pre-Hanford:** Direct: None Indirect: None **Manhattan/Cold War**: Direct: None Indirect: None	No expectations for impacts to known cultural resources.

*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.

The preferred cleanup option will remove a majority of the contamination and fully stabilize the contaminated soil sites with the contamination transported to ERDF or WIPP. The site will be maintained at industrial use standards.

Populations and Resources at Risk or Potentially Impacted After Cleanup Actions

Facility Workers

Limited potential for exposure, as residual contamination is buried

Co-located Person

Limited potential for exposure, as residual contamination is buried

Public

Limited potential for exposure, as residual contamination is buried and area will be maintained for institutional controls.

Groundwater

Based on an analysis similar to the one discussed in Appendix E.2 (T Tank and Waste Farms) Section 2.5 (Vadose Zone Contamination), no appreciable uranium or Sr-90 plume would be expected in the next 150 years due to transport and decay (Sr-90) considerations. Thus the *Low* rating would apply after the Active Cleanup is completed to account for uncertainties

Table G.5-10 shows that C-14, I-129, and Tc-99 have low ratings; Cr and Cr-VI have Medium ratings; and CCl4 has a Very High rating. The overall rating is Very High due to CCl4.

Columbia River

See statement above – there is limited potential for impact to the Columbia River during or as a consequence of cleanup actions. Based on a similar evaluation as that discussed in Appendix G.6 (CP-GW-2 (Operable Units 200-UP-1 and 200-ZP-1) in 200-West Evaluation Unit Summary Template) Part 5, the rating is Not Discernible (ND).

Ecological Resources

There are two options proposed that have different types of disturbances and effects on ecological resources. Removal of waste to ERDF: Personnel, car, and pick-up truck traffic through non-target and remediated areas will likely no longer cause an effect on the ecological resources, unless heavy traffic caused ruts. If alien/exotic species became established during remediation, their presence could continue to affect the ecological resources. Construction of a barrier: Personnel, car, and pick-up truck traffic through non-target and remediated areas will likely no longer cause an effect on the ecological resources, unless heavy traffic caused ruts. If alien/exotic species became established during remediation, their presence could continue to affect the ecological resources. Permanent effects remain in the area of site with barrier or cap. Permanent effects remain in area surrounding cap or containment, depending upon traffic and current activities. 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 community.

Cultural Resources

Personnel, car and truck traffic on paved roads will likely have no direct effects on the cultural resources assuming the resources were not disturbed during remediation. If the remedial action included construction of buildings, cap or other type of containment then there are permanent effects in the area of the site. If archaeological resources or TCPs were directly or indirectly damaged or altered during construction of buildings or cap, cumulative effects include continued erosion and adverse effects to both archaeological site and TCP. If contamination is left behind and controlled by a barrier or other containment, then permanent effects to the cultural resources may occur in the area. If archaeological resources or TCPs were directly or indirectly damaged or altered during contamination, then cumulative effects include permanent adverse effects to both archaeological site and TCP.

Long-Term, Post-Cleanup Status – Inventories and Risks and Potential Impact Pathways

From the ROD: An unrestricted land use scenario is not the anticipated land use> Under current industrial land use and Hanford site-wide institutional control conditions, only a construction worker has the potential to encounter impacted soil. There are no complete and significant pathways for current regular workers. Exposure routes to groundwater and surface water are incomplete. The direct soil pathways for future regular industrial workers are identified as potentially complete but insignificant, under the assumption that the drill cuttings would not be spread around a place of business.

PART VII. SUPPLEMENTAL INFORMATION AND CONSIDERATIONS

The ROD for the Hanford 200 Area Superfund Site 200-CW-5 AND 200-PW-1, 200-PW-3, AND 200-PW-6 Operable Units presents the selected final remedial action for the 200-CW-5, 200-PW-1, 200-PW-3, and 200PW-6 OUs which are part of the overall soil remediation effort in the Inner Area. Groundwater located beneath these OUs in the 200 West Area is being addressed through separate CERCLA processes for the 200-ZP-1 and 200-UP-1 groundwater OUs. The remaining Inner Area waste sites and 200 East groundwater OUs will be addressed under separate CERCLA processes for the appropriate OUs.

REFERENCES

Hanford Site Manhattan Project and Cold War Era Historic District Treatment Plan DOE.RL-97-56

Section 106 of the National Historic Preservation Act (16 USC 470, et. seq.)

Record Of Decision Hanford 200 AREA SUPERFUND SITE 200-CW-5 AND 200-PW-1, 200-PW-3, AND 200-PW-6 OPERABLE UNITS September 2011

Plutonium Finishing Plant Hazard Categorizations, HNF 32080 Revision 1, Prepared for the U. S. Department of Energy Assistant Secretary for Environmental Management by CCH2MHILL, Plateau Remediation Company, Richland, Washington 99352, October 2012.

Feasibility study for the plutonium/organic-rich process waste group operable unit: includes the 200-OPW-1, 200- PW03 and 200 PW-6 Operable units; DOE/RL 2007-27 Draft C. November 2010, US Department of Energy, Assistant Secretary for Environmental Management.

APPENDIX H.1

OPERATING FACILITIES EVALUATION UNITS

OVERVIEW

The operating facilities evaluation units (EUs) will be organized around three principal operating functions: (1) solid waste treatment, storage, and disposal; (2) liquid waste processing and disposal; and (3) supporting infrastructure facilities. Considerations of the operating functions, interactions of waste processing functions, and geographic proximity will be used in assembling the EUs for the operating facilities. A brief description of the overall process flow for each of these functional areas will be provided as context for the roles these facilities play in the cleanup efforts and to provide insight into the hazards present. In addition, a description of the offsite facilities that are important elements of the Hanford Site cleanup will be referenced as part of the overall cleanup context. They include such facilities as the Waste Isolation Pilot Plant (WIPP), where transuranic (TRU) waste is disposed, various commercial waste treatment and disposal facilities, and the yet to be established geologic repository.

Solid Waste Treatment, Storage and Disposal

The Solid Waste Operations Complex (SWOC) facilities are permitted treatment, storage, and/or disposal units that manage low-level radioactive waste (LLW), mixed low-level waste (MLLW), TRU waste, transuranic mixed (TRUM), and Toxic Substances Control Act (TSCA) polychlorinated biphenyl (PCB) waste at Hanford Site as illustrated in the process flow diagram provided in Figure H-1.

1. **Store, package, certify, and ship transuranic, hazardous, and mixed wastes**. The SWOC consists of four facilities: the Central Waste Complex (CWC), two Resource Conservation and Recovery Act permitted disposal trenches, the T Plant, and the Waste Receiving and Processing Facility (WRAP). Collectively, these four facilities enable the storage, packaging, and certification of transuranic, mixed and hazardous waste. This waste results from the retrieval of stored waste and from TRU-contaminated materials that are newly generated as a result of cleanup operations. The CWC accepts LLW/MLLW with no identifiable disposition path and the TRU and TRUM that has to be certified for shipment to WIPP in New Mexico throughout cleanup. Once generated, the TRU waste is stored in the CWC. In addition, LLW, MLLW, hazardous waste, and other materials are also stored at CWC awaiting treatment or final disposition. Trenches 31 and 34 are permitted disposal units for certain MLLW and LLW and also certain types of TSCA PCB waste.

   Transuranic waste is packaged and certified for shipment in the WRAP, adjacent to the CWC. WRAP is a multipurpose facility for processing and treating LLW and TRU waste including mixed and TSCA PCB waste. It can also perform nondestructive assay (NDA) and nondestructive examination (NDE) of waste containers. Some mixed waste is shipped offsite for treatment at commercial facilities and returned to the site for disposal. WRAP is being maintained in an operational status, even though it has been several years since TRU waste was sent to WIPP. The CWC and WRAP facilities, both located in the 200 West Area, will be maintained and operated until Hanford Site cleanup operations are completed, at which time all inventory will be removed and the facilities closed.

   The T Plant complex is currently used by SWOC for storage, repackaging, treatment, and decontamination of radioactive waste. T Plant can accept LLW and TRU waste, including mixed and TSCA PCB waste. T Plant can also perform NDA/NDE analysis, including the sampling of gases trapped inside drums of waste. Radioactive and mixed wastes are processed and packaged to meet state and federal regulations as well as criteria associated with transporting waste to certain specific waste disposal facilities. The T Plant complex is also being evaluated for receiving, storing, and treating the radioactive sludge that has been containerized within the K-West Basin. T Plant has been identified as a potential historic site as part of the Manhattan Project National Historical Park legislation, and as such, for the purpose of this Risk Review Project, T Plant operations will need to be partitioned from any potential deactivation (decontamination) and decommissioning (D&D) activities (including possible preservation under the National Historical Park legislation).

2. **Safely store used fuel and nuclear materials**. The Hanford Site will continue to operate the Canister Storage Building (CSB) and the adjacent interim storage area for management of used fuel and nuclear materials that will eventually be moved to offsite locations. In addition, nearly 2000 cesium and strontium capsules are currently stored underwater inside the Waste Encapsulation and Storage Facility adjoining the B Plant canyon facility. For the purpose of this Risk Review Project, the disposition of the capsules will need to be partitioned from the D&D of the B Plant canyon, yet their schedules are linked. Some of these materials are yet to be generated (e.g., immobilized high-level waste from Hanford's tanks), and to date the final disposition pathway, schedule, and location for off-site disposal is uncertain. Therefore, safe management of these materials (for interim storage and preparation for shipment) may be required for decades in new facilities similar to the CSB.
3. **Operate solid low-level waste and mixed low-level waste disposal facilities**. Waste disposal facilities including solid waste burial grounds (two mixed waste trenches in the 200 West Area), the Integrated Disposal Facility (IDF), and the Environmental Restoration Disposal Facility (ERDF) will continue to operate and receive inventory well into the future, and when no longer needed will be closed. The ERDF receives bulk low-level radioactive, hazardous, and mixed wastes generated during environmental remediation and building demolition activities. The mixed waste trenches received containerized mixed-waste generated during cleanup operations. IDF is designed to hold the immobilized low-activity waste and other low-level and mixed wastes generated during the tank waste processing mission. Strictly hazardous wastes and municipal solid wastes are packaged and shipped offsite for disposal at commercial facilities.

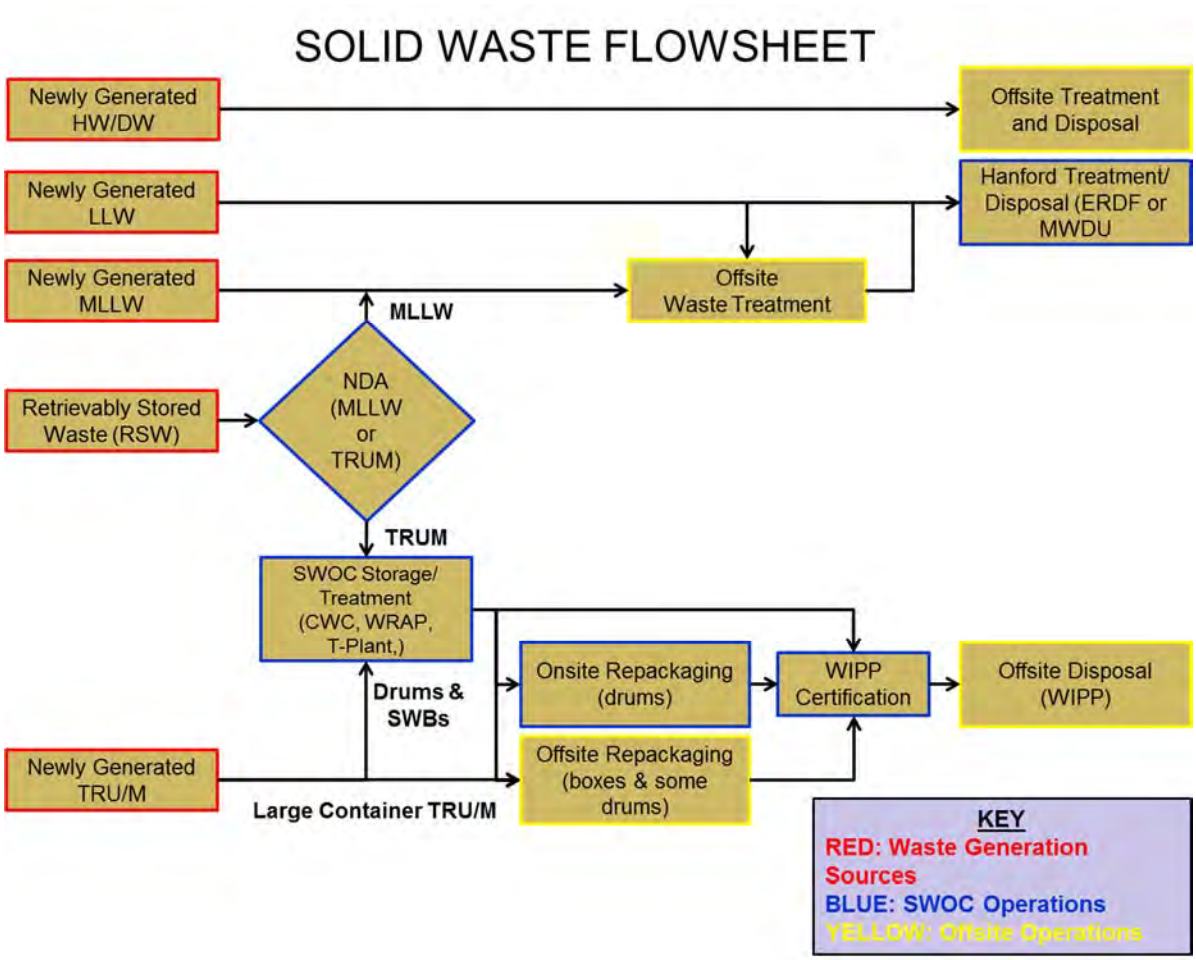

Figure H-1. Hanford solid waste operations flow sheet.

APPENDIX H.2

PART 1. KW BASIN SLUDGE (RC-OP-1, RIVER CORRIDOR)

EVALUATION UNIT SUMMARY TEMPLATE

Table of Contents

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PART I. EXECUTIVE SUMMARY

EU LOCATION

100K Area

The KW Basin and the Sludge Treatment Project (STP) Facility are located in the 100 area at the KW Reactor Facility in the K area near the Columbia River.

T Plant, which will serve as a storage area for the sludge is located in 200 West are several miles inland from the Columbia River.

RELATED EUS

KE/KW Reactors, T Plant

PRIMARY CONTAMINANTS, CONTAMINATED MEDIA AND WASTES:

The waste that is the focus of the STP is the sludge stored in the KW Basin which will be packaged and transferred to T Plant for interim storage. The sludge in KW Basin is classified as remote handled TRU. This waste consists primarily of sludge retrieved from the KE Basin and contains aluminum cladding shards, oxidized fuel, and metal fuel particles as well as windblown sand and environmental debris, spalled concrete from the basin walls, iron and aluminum corrosion products, and ion exchange resin beads. Sludge retrieved from the KW Basin floor and pit sludge stream prior to the retrieval and packaging of SNF for its removal and receipt of sludge transferred from the KE Basin consisted primarily of windblown sand and environmental debris, spalled concrete from the basin walls, iron and aluminum corrosion products, flexible graphite [GrafoilTM1], plus limited amounts of uranium oxides, and uranium fuel particles. The KE Basin sludge generally contains a higher percentage of uranium fuel particles, while the KW Basin sludge stream contains a higher percentage of windblown sand and environmental debris because the SNF elements in the KW West Basin were stored in closed canisters so less fuel particles mixed with the floor sludge.[1]

BRIEF NARRATIVE DESCRIPTION

The Sludge Treatment Project consists of two phases that are described in this document. These phases are: (1) Storage and transfer of sludge from KW Basin to T Plant and (2) Treatment of sludge and shipment for disposal. Each of these phases has several stages. Phase 1 stages include: (a) storage of sludge in KW Basin; (b) the Engineered Container Removal and Transfer System (ECRTS); and (c) storage of sludge in T Plant. Phase 2 stages include (a) Sludge Treatment. A third phase, processing of Knock out pot (KOP) material, has been completed and is not discussed in this review.

Stage a, mostly takes place in the KW Basin. Typical operations in the basin include the operation of the water treatment system; management of fuel fragments, retrieval, storage, movement and containerization of sludge; sorting and removal of debris (e.g. dust and sand), removal and disposition of equipment no longer in use; and handling and interim storage of waste, and the construction of the KW Basin Annex, which will house ECRTS, is also part of Stage a.[2]

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[1] HNF-40475- 2013. Page 5.
[2] HNF-SD-WM-SAR-062, 2014. Page 2-13.

Stage b, is ECRTS which will take place in the KW basin and an annex of the KW Basin currently under construction. The sludge will be transferred from the KW Basin using the Xago Hydrolance™ tool[3] to the annex for packaging in sludge transport and storage containers (STSCs). The duration of operations in this phase is planned to be one year. The STSCs, which are made of stainless steel, are designed to store sludge for 30 years. Operations in ECRTS include STSC preparation, sludge retrieval and transfer into the STSC, flushing the transfer lines to the STSC, adding flocculant to the supernate in the STSC to increase sludge settling velocity, decanting supernate from the STSC, backwashing sludge from the sand filter to the STSC, removing any excess sludge from the STSC, disconnecting the piping and purging the STSC, and inerting the STS with nitrogen and pressurizing it.[4]

Stage c involves transporting the STSCs to T Plant and then storage in cells at T Plant. Transportation will meet the requirements of the Hanford Sitewide Transportation Safety Document[5] and will involve the transport of the STSC on non-public site roads via tractor trailer.[6] This tractor trailer will back up into the T Plant rail loading bay, where the cask will be unloaded and stored in cells covered by concrete shield blocks in the T Plant canyon for interim storage[7].

Phase 2: At a point in the future that is not defined because of funding uncertainties this stored sludge will be retrieved from the STSCs, processed into a form that is certifiable for transportation and disposal at the Waste Isolation Pilot Plant (WIPP) (or alternate future disposal facility)[8], and packaged. Although several technology options have been identified, this phase is still in the design and decision-making process.

Summary Tables of Risks and Potential Impacts to Receptors

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

Human Health: A Facility Worker is deemed to be an individual located anywhere within the physical boundaries of the KW Reactor Building (where the sludge is currently housed) or immediate areas around the outside of the building; a Co-located Person (CP) is an individual located 100 meters from the KW Reactor Building; and Public is an individual located at the closest point on the Hanford Site boundary not subject to DOE access control, which in this instance is the bank of the Columbia River. The nuclear related risks to humans are based on unmitigated (unprotected or controlled conditions) dose exposures expressed in a range of from Non-Discernable (ND) to Very High. The estimated mitigated exposure that takes engineered and administrative controls and protections into consideration, is shown in parenthesis.

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 Non-Discernable (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.

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[3] The Xago Hydrolance is a combined sludge fluidizer and eductor for creating and removing a sludge slurry for further processing.
[4] PRC-STP-00718, 2014. Pages x-xii.
[5] DOE-RL-2001-36, 2002.
[6] SNF-10823, Rev. 1E, 2008.
[7] PRC-STP-00109, Rev. 0.
[8] PRC-STP-00615, Rev. 0, 2012. Page ES-1.

Cultural Resources: No risk ratings are provided for Cultural Resources. The Table 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.

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

Population or Resource		Evaluation Time Period	
		Active Cleanup (to 2064)	
		Current Condition: Safe Storage at KW Basin	**From Cleanup Actions:** ECRTS
Human Health	Facility Worker	Medium (ND)	High (Low)
	Co-located Person	Medium (Low)	High (Low)
	Public	Low (Low)	Low (Low)
Environmental	Groundwater	ND	ND
	Columbia River	ND	ND
	Ecological Resources*	ND	ND
Social	Cultural Resources*	**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

*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.

SUPPORT FOR RISK AND IMPACT RATINGS FOR EACH POPULATION OR RESOURCE

Human Health

<u>Current</u>
The current condition is Stage a: sludge storage at K Basin along with continued cleanup of the pool contents such as sludge, debris, and equipment. There are 117 total accidents analyzed in the Streamline (sic) Hazards Analysis for KW Basin. Of the 117, 43 are no longer applicable because the activities that could lead to the initiating events have ended. Of the 74 accidents remaining, all had low consequences to the maximally exposed offsite individual (MOI) and the collocated worker (CW). All 74 accidents also had no consequences to the facility worker. Several accidents did have potential consequences to the environment; 3 of these had a frequency of anticipated.[9]

Building and Facility: The safe storage of sludge at KW Basin can impacted by the following accident and natural phenomenon hazards:

<u>Hydrogen Explosion</u>: Integrated Water Treatment System Annular Filter Hydrogen Explosion. Deflagration of accumulated hydrogen has been identified through one major accident scenario: hydrogen is generated through radiolysis and fuel corrosion accumulating in the headspace of the annular filter vessel while the IWTS is out of service for an extended period of time (a leak allows air to enter, and a deflagration results). The likelihood of this event is unlikely.

Unmitigated Risk: Collocated Person – Medium; Public – Low

Mitigation: No safety SSCs or TSRs are credited for prevention or mitigation of hydrogen deflagrations in the annular filter vessel or IXMs. Design features of the annular filter vessel and the particulate vessel may mitigate the consequences. There is also a defense in depth control in the periodic operation of the Integrated Water Treatment System to flush the filter vessel headspace.

Mitigated Risk: Collocated Person: Low; Public: Low

<u>Fire</u>: Diesel fuel spills that could result in a fire can occur from (1) forklift (maximum diesel fuel capacity of 30 gal); and (2) IXM transport tractor (maximum controlled fuel capacity of 100 gal). The likelihood of this event is extremely unlikely.

Unmitigated Risk: Collocated Person – Medium; Public – Low

Mitigation: Controls in place: Active: KW transfer bay bridge cranes; Passive: KW Basin Superstructure, KW Basin Structure; Administrative: TSR controls include vehicle controls, KW heavy load controls, KW basin water controls, Fire Protection Program.

Mitigated Risk: Collocated Person: Low; Public: Low

<u>Seismic Event</u>: Beyond Design Basis Earthquake: A BDBE occurs causing drain down and dryout of the basin. Leakage rates could be higher than that for the seismic event (i.e., >50 gal/min). Consequences are based on pre-cleanout inventories. This analysis is retained for historical reference.

Unmitigated Risk: Collocated Person – Medium; Public – Low

Mitigation: This event is retained for historical purposes. The design basis event has consequences that are not discernible. There are controls in place to mitigate the design basis earthquake. These

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[9] DD-53838, Rev. 0, 2014. Appendix C.

include: Passive: KW Basin Superstructure, KW Basin Structure; Administrative: TSR controls include KW basin water controls.

Mitigated Risk: Collocated Person: Low; Public: Low

Industrial Safety: Potential industrial safety accidents at the KW Basin include crane incidents, fires, slips, trips and falls, and others. Industrial accidents would not have impact outside the KW Basin (hence no risk to CW or Public).

Unmitigated Risk: Facility Worker – Medium

Mitigation: The DOE and contractor Safety Management programs that include work control, fire protection, training, occupational safety and industrial hygiene, emergency preparedness, and management and organization have proven to be effective in reducing industrial accidents at the Hanford site to well below that in private industry.

Mitigated Risk: Facility Worker – Low

Risks and Potential Impacts from Selected or Potential Cleanup Approaches

For ECRTS (Stage b), it is important to note that the hazards and operability (HAZOP) study[10] only provides unmitigated consequences. Therefore the risk ratings below may seem higher than they would be in the hazards analysis that considers mitigation measures which will be prepared further along in the design and operations of the facility. The HAZOP Study for ECRTS analyzes 260 events. Of these events, 143 have high unmitigated consequences to the facility worker, and the majority of these high consequence events are anticipated[11]. For the co-located worker, there are 13 events that are anticipated and have high consequences including uncontrolled releases from a number of initiating events. There are also 22 events that are anticipated and will have a moderate effect on co-located workers. All analyzed events have either low or no unmitigated consequences to the public. The environment was not included in this study.[12]

Based on available information, we estimated the following ratings:

Unmitigated Risk Operation of ECRTS: Facility Worker – High; CP – High; Public – Low

Mitigation: In ECRTS, the following safety systems and controls will be used: above water slurry transfer lines, slurry transfer line rupture disk, double valve isolation, slurry transfer line secondary containment, slurry transfer line secondary confinement, slurry transfer line leak detection systems, safety control panels, the physical structure of the annex, auxiliary ventilation system, oxygen analyzer, pressure indicators, STSC design features such as the sloped fin, STSC liquid level instrumentation, truck scale instrumentation, nitrogen purge panel, safety control panel, and the STSC vent assembly.[13]

Mitigated Risk: Collocated Person – Low; Public – Low

Ecological Resources

Current

Currently no ecological resources on EU, and only 1 acre of level 3 on buffer area.

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[10] PRC-STP-00687, Rev.1, 2013. Appendix D.

[11] Note: The HAZOP study which considers unmitigated consequences is the most current documentation of hazards at ECRTS. As a consequence, the risk ratings will be higher than mitigated consequences. When the project ultimately considers mitigative measures the risks will be lower to an extent unknown.

[12] PRC-STP-00687, Rev.1, 2013. Appendix D.

[13] PRC-STP-00718, Rev 0 (2014). Pages xviii to xx.

Risks and Potential Impacts from Selected or Potential Cleanup Approaches
Any risk depends upon the quality and quantity of re-vegetation following remediation. Could be a risk from invasion of exotic species.

Cultural Resources

Current
Manhattan Project/Cold War significant resources have already been mitigated.

Area within the EU is heavily disturbed, but the entire area is extremely culturally sensitive based on prehistoric, ethno-historic, and historic land use in the area. 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
Due to highly sensitive cultural resources in vicinity of the EU, consultation is needed.

Archaeological investigations or monitoring may also need to occur. Direct and indirect effects are likely to archaeological sites and traditional cultural places in vicinity of EU.

Permanent direct and indirect effects are possible due to high sensitivity of area.

Considerations for timing of the cleanup actions

If the ECRTS project is delayed, the waste will remain in K Basin and proportionately delay D&D activities of the KW reactor site.

Near-Term, Post-Cleanup Risks and Potential Impacts

The Phase 2 Sludge Treatment Process is in the technology selection phase and, thus, there is insufficient information to provide risk ratings at this time.

PART II. ADMINISTRATIVE INFORMATION

OU AND/OR TSDF DESIGNATION(S)

RC-OP-1 K Basins Sludge

COMMON NAME(S) FOR EU

KW Basin Sludge, ECRTS, Sludge Treatment Project

KEY WORDS

KW Basin, KE Basin, Sludge, TRU, ECRTS, STP, T Plant

REGULATORY STATUS

Regulatory basis: The regulatory basis for managing the K Basin sludge is CERCLA combined with TSCA. The removal action from the K Basin will be a CERCLA action, and the sludge contains enough PCBs that it will be managed under TSCA authority at T Plant.

Applicable regulatory documentation

Removal of Sludge from the K Basins and transport to T Plant: The CERCLA documentation associated with the removal of sludge from the KW Basin is either in place or identified in the project's Field Execution Schedule as "to be completed/approved" and consists of the following[14]:

- Remedial Design and Action Work Plan (DOE/RL-2010-63, Remedial Design/Remedial
- Action Work Plan for the K Basins Interim Remedial Action: Removal of K Basins Sludge from the River Corridor to the Central Plateau; and Removal of Knock Out Pot Contents from the K Basin),
- Waste Management Plan (SNF-9430, Waste Management Plan for K Basins Interim Remedial Action),
- Air Monitoring Plan (In development),
- Data Quality Objectives (HNF-36985, Data Quality Objectives for Sampling and Analysis of K Basin Sludge)
- End Point Criteria (HNF-20632, Endpoint Criteria for the K-Basins Interim Remedial Action),
- Qualified Process and Plan to Meet End Point Criteria (DOE/RL-2010-107, 105-K West Basin Qualified Process and Plan to Satisfy End-Point Criteria -Fuel, Sludge, and Below-Water Debris)
- Quality Assurance Project Plans/Sampling and Analysis Plans (e.g., KBC-33786, Quality Assurance Project Plan/Sampling and Analysis Plan for Sludge in the KW Engineered Containers and DOE/RL-2010-63-ADD2, Appendix A, Quality Assurance Project Plan/Sampling and Analysis Plan (QAPjP/SAP) for the Hanford KW Basin Knockout Pot Product Material for 105-K West Basin Field Measurements and HNF-6479, Sampling and Analysis Plan For Sludge from the 105 K Basins to Support Transport to and Storage in T Plant).

Storage of Sludge at T Plant: The sludge management activities at T Plant involving the receipt and interim storage of packages sludge in casks pending treatment have been previously determined by the U.S. Environmental Protection Agency (EPA) to be "off-site". Therefore modifications to that facility and the storage of sludge are subject to all applicable administrative permitting and licensing requirements. Permitting actions will involve screening the following facility environmental documentation for sufficiency and updating and obtaining approvals as necessary: National Environmental Policy Act (NEPA) documentation including past Environmental Impact Statements (EISs) and Environmental Assessments; cultural resource review documentation; air permitting documentation; Toxic Substance Control Act documentation; and RCRA documentation.[15]

In accordance with TPA milestone M-016-140, DOE/RL-2011-15, Remedial Design/Remedial Action Work Plan for the K Basins Interim Remedial Action: Treatment and Packaging of K Basins Sludge, was prepared and approved by DOE-RL and EPA. Phase 2 Treatment and Packaging has not been defined in sufficient detail at this time to provide information that can be used in identifying those associated permits, licenses, or other environmental documentation that may be required to support construction and operational activities of this phase of the project.[16]

Applicable Consent Decree or TPA milestones

TPA milestone M-016-140

[14] KBC-30811, Rev. 5. 2012. Pages 1-16-1-17.
[15] KBC-30811, Rev. 5. 2012. Pages 1-16-1-17.
[16] KBC-30811, Rev. 5. 2012. Page 1-17.

RISK REVIEW EVALUATION INFORMATION

Completed: Revised February 4, 2015

Evaluated by: B. Burkhardt, A. Croff, L. Fyffe, S. Krahn

Ratings/Impacts Reviewed by: D. Kosson, J. Burger, H. Mayer, J. Salisbury, A. Bunn

PART III. SUMMARY DESCRIPTION

CURRENT LAND USE

DOE Hanford Site

DESIGNATED FUTURE LAND USE:

The Columbia River would continue to be managed to allow limited public access and use as a Low-Intensity Recreation area. Access to the Columbia River's islands would remain restricted to protect cultural and biological resources. Public access to the Reactors on the River area (i.e., the 100 Areas) would remain restricted.[17]

PRIMARY EU SOURCE COMPONENTS

High-Level Waste Tanks and Ancillary Equipment

Not Applicable

Legacy Source Sites

There are several soil contamination sites in the 100K area surrounding the reactors as well as waste sites. See Section V for a full description.

Groundwater Plumes

There is a chromium plume that extends to the KW reactor facility from the south, a Sr-90 plume to the northeast of the KW Basin Annex, an nitrate plume that directly underlies the KW basin and Annex, a chromium plume that extends under the KW basin and annex facility, and a C-14 plume that also extends under the KW basin and annex facility. See section V for a full description.

Operating Facilities

The operating facilities of concern for the STP include the KW Basin, the KW Basin Annex, and T Plant.

D&D of Inactive Facilities

The KW basin will begin D&D after the removal of the sludge, and the KE Basin has undergone D&D and been removed. D&D continues on the surrounding KE facility. The activities on the KW Basin are expected to continue into the future.

[17] EIS-0222, 1990. Page 19.

Location and Layout Maps

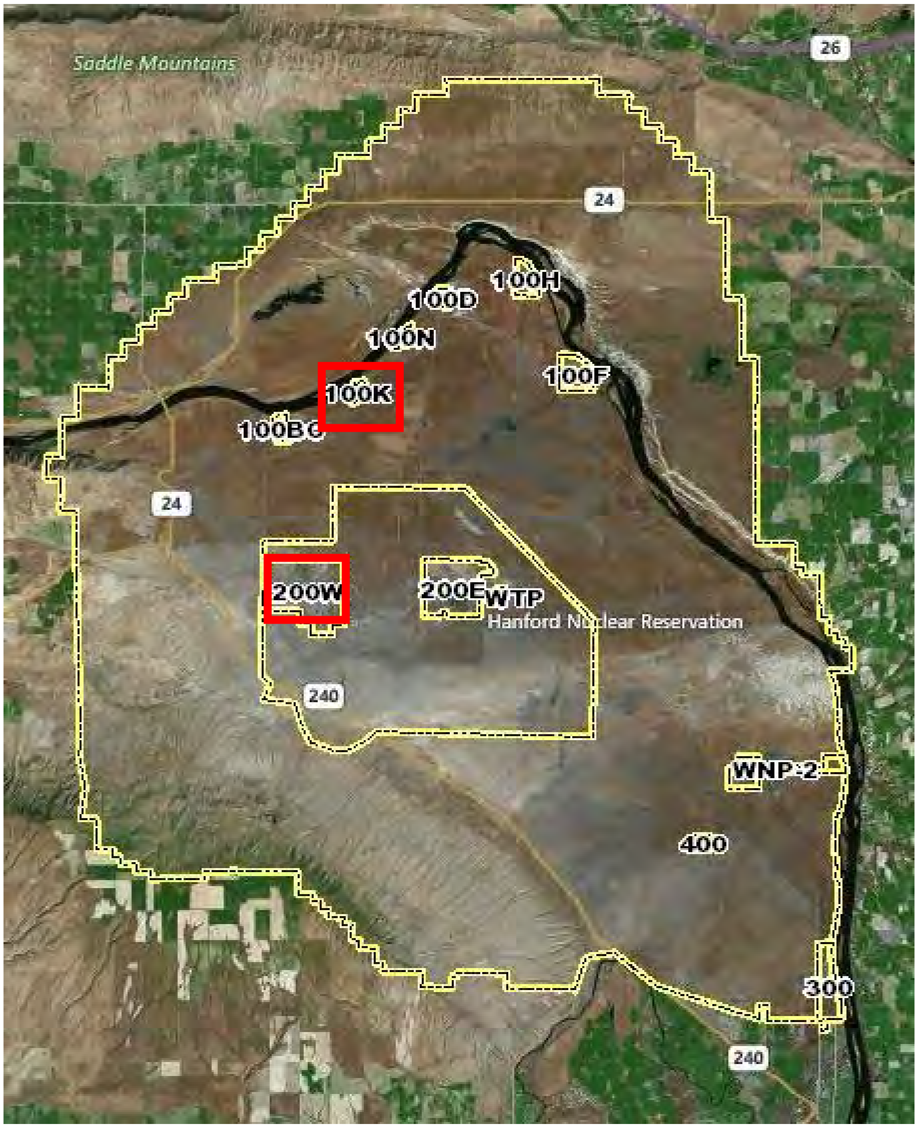

Figure H.2-1. Location of STP Facilities on the Hanford Site.

Figure H.2-1. Location of STP Facilities on the Hanford Site. illustrates the Hanford site. The 100K area where the KW Basin and KW Basin Annex are located is highlighted in a red rectangle, as is the 200W area where the STSCs will be stored until sludge treatment.

Figure H.2-2. Location of the KW Basin and Annex within the 100K Area.

Within the 100K area, the K West Basin and Annex location are highlighted by the red rectangle. The KE basin has been removed, and the KE Reactor facility is in the D&D process. Some sludge in the KW Basin came from this area which is highlighted by the green rectangle.

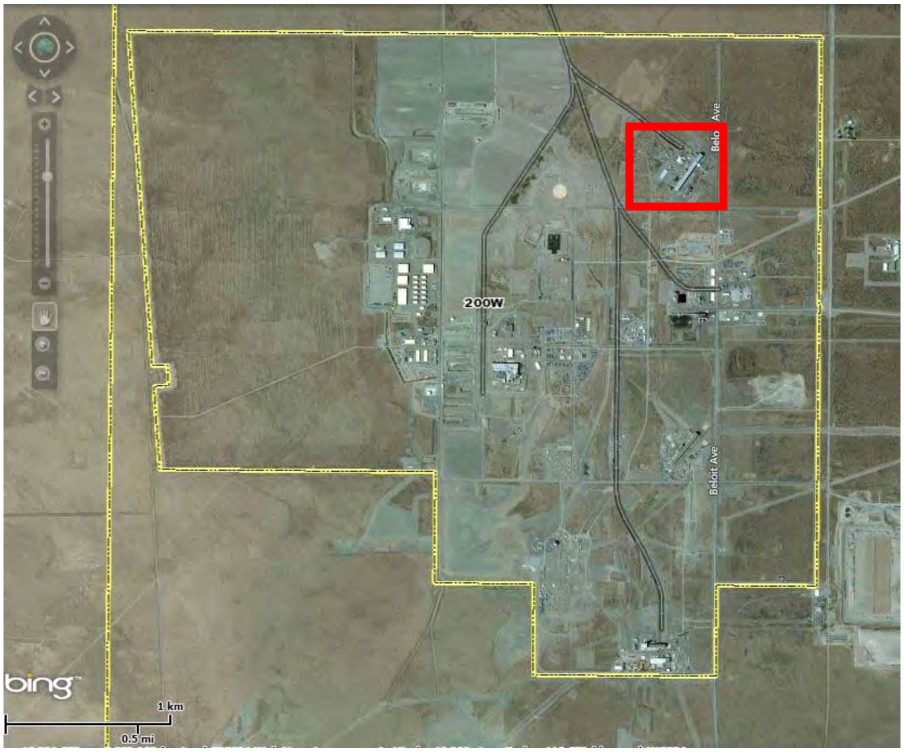

Figure H.2-3. Location of T Plant within the 200W Area.

T Plant where the STSCs will be stored is highlighted by the red rectangle.

Figure H.2-4. EU Boundary Map.

PART IV. UNIT DESCRIPTION AND HISTORY

EU Former/Current Use(s)

The evaluation units of interest here are the KW Basin, the KW Basin Annex, and T Plant all of which are or will be operating facilities.

Legacy Source Sites

Not Applicable

High-Level Waste Tanks

Not Applicable

Groundwater Plumes

Not Applicable

D&D of Inactive Facilities

To be completed in a separate evaluation.

OPERATING FACILITIES

What processes produced the radioactive material and waste contained in the facility?

The sludge stored at the K Basins was created when irradiated fuel rods from the N Reactor that had been stored in these basins began to deteriorate. , The sludge is a mixture of fuel corrosion particles, fuel rod and metal fragments, and wind-blown soil and sand.

What are the primary radioactive and non-radioactive constituents that are considered risk drivers?

The sludge is ultimately to be classified as TRU. As of the most recent analysis, the following radionuclides are present in the sludge at a concentration exceeding 100 Ci/m^3: Pu-241, Cs-137, Ba-137m, Sr-90, Y-90 and Am-241.[18]

What types of containers or storage measures are used for radioactive materials at the facility?

In Phase 1 stage a, the present stage, the waste is stored in KW Basin in sludge containerization system (SCS) containers which are rigid, self-supporting, free-standing structures of bolted stainless steel construction with Lexan covers. Each SCS container is able to store 11.6 m^3 of sludge, with more than 6 ft of water above the sludge for shielding purposes.[19] Also included in the basins are settler tanks, and ion exchange modules (IXM), as well as sand filters with a sand-garnet filtration material.

Once the sludge is processed through stage b, ECRTS, it will be packaged in STSCs. These containers will meet American Society of Mechanical Engineers Section VIII pressure vessels requirements and are approximately 5 ft in diameter and 9.5 ft tall, with elliptical top and bottom heads. [20]

Phase 2, transferring the waste from the STSCs stored at T Plant and treating it for final disposal at WIPP will involve placing the waste in transportation and WIPP (or alternate disposition) certified containers. These containers have yet to be designed.[21]

How is the radioactive material and waste contained or stored within the facility classified?

The sludge is classified as RH TRU.

What are the average and maximum occupational radiation doses incurred at the facility?

Average and maximum radiation doses incurred in the current (Phase 1 stage a) remain to be acquired. The 2013 year-to-date collective doses for KW Basin are included given in Table H.2-2[22]:

[18] HNF 41051. 2010.
[19] HNF-SD-WM-SAR-062, Rev. 20, 2014. Page 2-32.
[20] PRC-STP-00718, Rev. 0- 2014, Page x.
[21] PRC-STP-00615, Rev.0, 2012.
[22] Hastings, 2014.

Table H.2-1. 2013 Year to Date Person-Rem for K Basins Activities.

Low, Medium, and High Hazards Tasks for 2013

Description	Goal (1.525 P-Rem)	YTD P-Rem	% Comp
K Basins (Ops & Maint.) Craft Routines:	0.3	0.142	**100%**
Sludge Depth Measurements	0.125	0.139	**100%**
Settler Tank Surveys	0.2	0.0	**0%**
Sand Filter Operations Activities	0.1	0.030	**100%**
Facility Modifications & Support Activities	0.4	0.30	**100%**

CH2MHILL
Plateau Remediation Company

12

ECRTS is not yet operational, however, the ALARA dose estimates for workers in ECRTS have been determined and are listed in Tables H.2-3 and H.2-4[23].

[23] PRC-STP-00702, Rev.3 2013. Pages 27-28.

Table H.2-2. Mitigated Dose Rate for ECRTS Process Workers.

Worker Type	Dose per normal STSC filling operation (person-mRem)		Dose per STSC filling operation including overfill recovery operation (person-mRem)		Dose for 26 normal STSC filling operations (person-mRem) No Overfill Recovery	
	Extremity	ED	Extremity	ED	Extremity	ED
Nuclear Chemical Operators (NCO)	380	59	772	121	9,880	1,534
Radiological Control Technicians (RCT)	346	49	886	127	8,996	1,274
Truck Driver	0.6	0.4	0.6	0.4	16	10
Millwright	254	31	271	33	6,604	806
Quality Assurance/Engineering	4.6	1	4.6	1	120	26
Pipefitter	0.1	0.1	0.1	0.1	2.6	2.6
Total Dose (person-mRem)	**985**	**140**	**1,934**	**282**	**25,618**	**3,653**

Table H.2-3. Mitigated Dose Rates and Doses in Continuously Occupies Areas of the Annex during Sludge Transfer Operations.

Mitigated Dose Rates and Total Dose for Normal Sludge Transfers						
Room	Maximum Dose Rate (mrem/hr)	Maximum Dose in One Hour (mrem)	Maximum Total Dose for 26 STSCs (mrem)	Average Dose Rate (mrem/hr)	Average Dose in One Hour (mrem)	Average Total Dose for 26 STSCs (mrem)
Mechanical Equipment	0.25	<0.06	1.6	0.09	<0.02	0.6
HEPA Filter	1.14	<0.29	7.5	0.3	<0.08	2.0
Change	0.91	<0.23	6.0	0.57	<0.14	3.7

Stage c and Phase 2 associated with the STP (storage in T Plant and eventual treatment and shipment to WIPP) do not have dose calculations associated with them at this time.

What processes and operations are conducted within the facility?

In Phase 1 , stage a, storage in KW Basin, the following operations are conducted: operation of the water treatment system, management of fuel fragments, retrieval, storage, movement and containerization of sludge, sorting and removal of debris, removal and disposal of equipment no longer in use, and packaging, handling and interim storage of waste.[24] In addition to storage at KW Basin, construction on the K-Basin annex is ongoing. The construction approach uses conventional practices to prepare the site and construct the Modified Annex. Construction involves the following activities: KW Basin Fuel Transfer System Annex Modifications, installation of buyer-furnished equipment, and interface with existing facilities and programs. The equipment expected to be used during these processes includes: excavator, bulldozer, backhoe, front end loader, haul truck, dump truck, semi delivery trucks, water truck, concrete truck, concrete pump truck, grader, asphalt paving equipment, light trucks, support vehicles, Environmental Restoration Disposal Facility Containers, forklifts, extended forklifts, powered and non-powered hand tools, cutting/welding torch, concrete saw, cranes and boom trucks, man lifts, aerial lifts, scissor lifts, and scaffolding.[25]

In ECRTS (Phase 1, stage b), the following processes will be conducted: a batch of sludge is retrieved from an Engineered Container now stored in KW Basin and transferred directly into a sludge transport and storage container (STSC) located inside a Sludge Transport System (STS) cask. The STSC and STS cask are located on a trailer inside the modified annex building adjacent to the K West (KW) Basin. For settler sludge, an STSC with a water filled annulus is used to enhance the heat transfer rate, thereby increasing the amount of sludge that can be contained in the STSC. The sludge is allowed to settle within the STSC to concentrate the solids and clarify the supernate. A flocculant is being evaluated to coalescence small sludge particles and increase sludge settling rates to reduce the loading time. After sludge settling, the supernate is decanted and filtered through a sand filter to remove suspended sludge particles. The filtered supernate is returned to the basin. Subsequent batches of sludge are added to the STSC, settled, and excess supernate removed in the same manner until the prescribed quantity of sludge is collected into a STSC. The solids collected on the sand filter unit are then removed by backwashing and transferred back into the STSC. The STS cask is purged with an inert gas (nitrogen), the seal is leak tested and the cask transported to T Plant, the interim storage facility.[26]

While in storage at T Plant, the STSCs would be monitored annually for water loss due to evaporation and replenished with make-up water as necessary. This is necessary to ensure the sludge remains in a fully wetted environment to prevent drying out and potential uranium metal oxidation. During storage, the headspace in the STSC is vented via natural circulation through two vents at different heights. The concentration of hydrogen is maintained at less than 4 volume percent in the T Plant cells and in the headspace of the STSC through operation of the T Plant exhaust ventilation system. In the event the T Plant exhaust ventilation system is inoperable, the chimney effect of the STSC vents and the natural circulation of air through the T Plant cells as a result of temperature differential will ensure the concentration of hydrogen is maintained at less than 4 volume percent in the T Plant cells and in the headspace of the STSC.[27]

What is the process flow of material into and out of the facility?

The following process flow diagram illustrates the collection of the sludge from the existing containers currently in safe storage in KW Basin, through the ECRTS process described above in the KW Basin Annex, and out for interim storage at T Plant.[28]

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[24] HNF-SD-WM-SAR-062, Rev. 20, 2014. Page 2-13.
[25] DD-50769, Rev. 1, 2014. Pages 3-5 and 3-6.
[26] HNF-41051, Rev. 6 Page X
[27] HNF 41051, Rev. 6, 2014. Page 41.
[28] Process flow diagram taken from: HNF 41051, Rev. 6, 2014. Page 11.

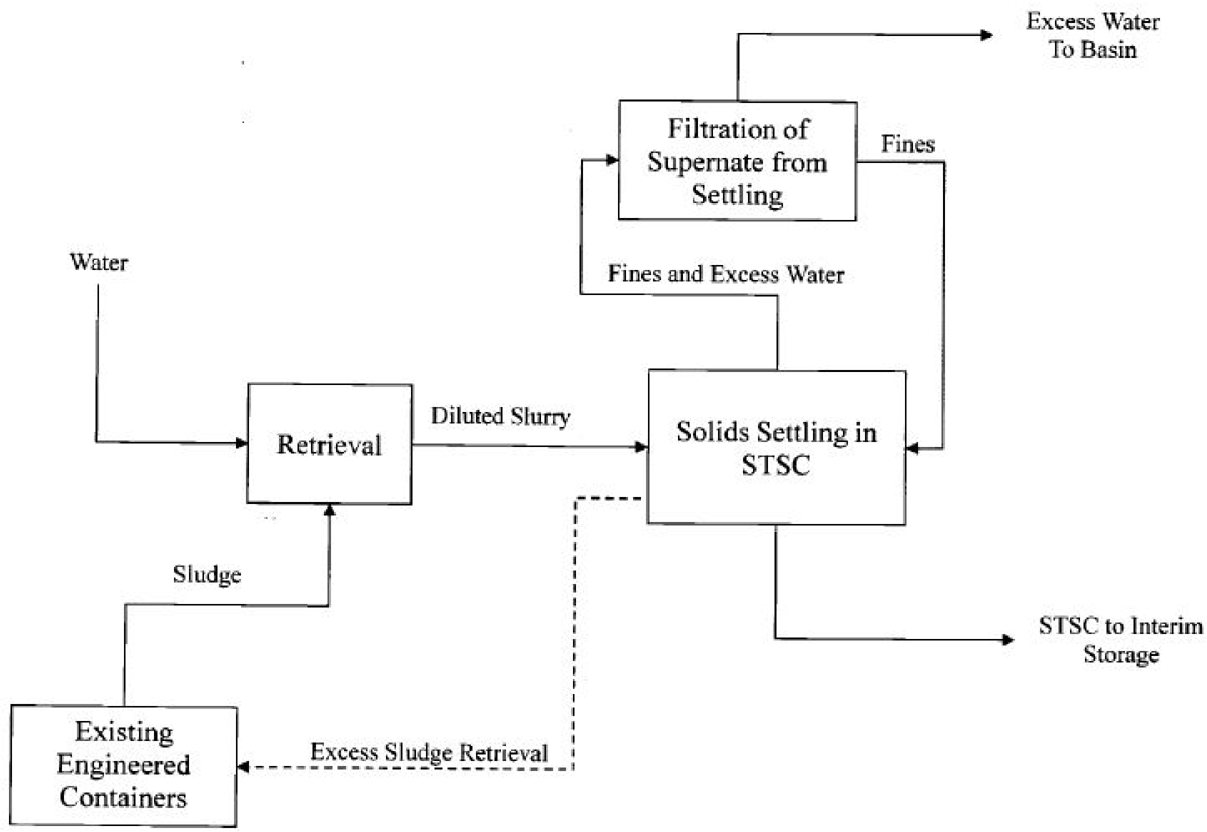

Figure H.2-5: Process Flow Diagram for Sludge through Storage at T Plant

Once in T Plant, the material will be stored until it is removed for final processing and packaging for disposition at WIPP. This is the Phase 2 processing flow, and is illustrated in the following diagram.[29]

[29] Process flow diagram taken from: PRC-STP-00615, Rev. 0, 2012. Page 1-3.

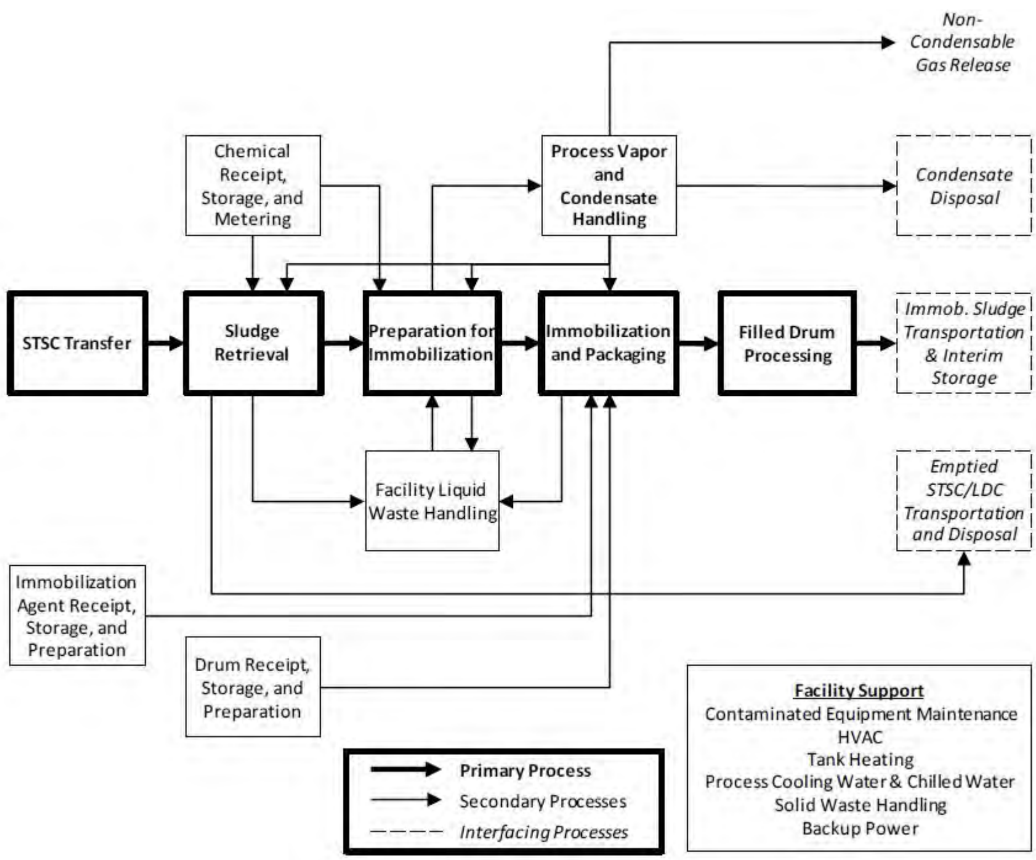

Figure H.2-6: Process Flow Diagram for Phase 2 Sludge Treatment

What effect do potential delays have on the processes, operations, and radioactive materials in the facility?

This is a multi-phase project and delay would have different impacts, depending on when it occurred. These will be addressed in chronological order.

1. Delay in Removing the Sludge from the KW-Basin – the sludge stored in Engineered Containers at KW-Basin is the last significant quantity of nuclear material in the K Area (and for that matter on the River Corridor). Transportation of this material out of the K Area to T Plant is on the critical path to being able to complete environmental restoration activities on the K Area.
2. Delay in Design, Construction and Construction of the Phase 2 Sludge Treatment System – T Plant is intended to be only an interim stop for the sludge material from K Basins. CHPRC has completed alternatives analysis[30] and recommended a warm water oxidation system to stabilize the remaining uranium in the sludge (along with some limited development of backup/enhancement technologies). DOE-RL has approved[31] this path forward and CHPRC has developed a preliminary technology development plan[32] to mature the technologies to support design of the Phase 2 treatment system. Delays in design and construction of the Phase 2 treatment system, or the technology development program to support it, would result in the sludge being stored for a

[30] PRC-STP-00465, "K-Basins Sludge Treatment Project – Phase 2 Technology Evaluation and Alternatives Analysis," 2011
[31] DOE-RL letter 12-AMRC-0051, December 23, 2011
[32] PRC-STP-00615, "Preliminary Technology Maturation Plan for the K-Basins Sludge Treatment and Packaging Facility," March 2012

longer time period in T-Plant. Such a delay could make retrieval of the sludge for processing problematic (note: the aging properties of the sludge materials while in storage at T Plant is a line of inquiry in the technology development planning) or challenge the design life of the STS casks or STSCs.

What other facilities or processes are involved in the flow of radioactive material into and out of the facility?

There are no other Hanford facilities beyond the Modified KW Basin Annex and ECRTS, T Plant, and the eventual Phase 2 Sludge Treatment system. These steps are all described elsewhere in the document.

In addition, contaminated materials may be removed to the Environmental Restoration Disposal Facility (ERDF) for disposal. ERDF is discussed in H.5, a further appendix in this report.

Is shipping of material involved and if so, how often and by what means?

Shipment of material is involved in two distinct phases.

The first phase of shipment is the transfer of the inerted STSCs in STS casks from the KW Basin Annex and ECRTS process to T Plant for interim storage. The STS cask is loaded on a trailer that is a four-axle single drop flat bed with an overall length of 10.7m and a width of 3m. The trailer is fabricated of welded carbon steel shapes, plates and tubular sections in accordance with industry-accepted standards. The cask tiedown system consists of deck-mounted lugs, which engage four slots at the base of the STS cask and a framework that envelops the top of the STS cask. The authorized payload consists of the 60/40 settled sludge mix, and can contain one cask that may be loaded with no more than 2 m^3 of sludge covered with water to a minimum depth of 25.4 cm. The payload is a fissile, Type B highway route controlled quantity with a total maximum activity of 1.23×10^{15} Bq and maximum heat load of 107.6W.[33]

The STSC is placed into the transport system, assumed to be the same as the Sludge Transport System (STS) used for the ECRTS to bring the STSCs to T Plant from the 100 K Area. Prior to shipment of the loaded STSC, inert gas (nitrogen) will be introduced into the STSC headspace until the measured oxygen concentration of the purge outlet stream is below 1% by volume. The shipping cask lid will then be installed and the airspace in the sealed cask will be purged to less than 1% by volume oxygen. This will provide a shipping window of at least 72 hours before venting and/or purging is required again.[34]

The second shipment phase will transport sludge that has been treated and packaged at T Plant to the WIPP. This transportation system has not yet been designed, but will be consistent with shipping standards for TRU to WIPP already used on site.

What infrastructure is considered a part of the facility?

There are several facilities currently involved in the planning and mission of STP.

In KW Basin, the infrastructure associated with STP includes the KW Basin, the Modified KW Basin Annex, and the transfer line.

At T Plant, the infrastructure involved includes the rail loading dock as well as the storage bins reserved for STSCs.

There will also be infrastructure required for the sludge treatment and packaging process that has not yet been designed.

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[33] SNF-10823, Rev. 1-E. Page viii.

Ecological Resources Setting

Landscape Evaluation and Resource Classification

The ecological resources in the vicinity of the K Basins are based on the evaluation for the KE and KW Reactors. The amount and proximity of biological resources in the EU was examined within two adjacent landscape buffer areas; each landscape buffer area is defined by a circle radiating approximately 146 m from the geometric center of each reactor (equivalent to 27.8 acres for the two buffer zones combined). Most of the EU the adjacent landscape buffer areas consist of level 0 biological resources—94.2% of the combined total area. The adjacent landscape buffer area includes a small area designated as resource level 4. The level 4 area is a species resource and is considered a level 4 resource because it intersects a designated buffer zone for a bald eagle (*Haliaeetus leucocephalus*) roosting area at the river's edge close to the northwest corner of the 100-K Area.

Field Survey

The K Basin Sludge EU, along with the KE and KW Reactors EU, and the adjacent habitat were evaluated by vehicle and pedestrian surveys in October 2014. The EU consists entirely of built structures and graveled and concrete surfaces and no field measurements of vegetation were made. Some sparse Russian thistle (*Salsola tragus*) was noted around the periphery of parking areas and graveled slopes. No wildlife was observed at the K basins during the October survey. Data collected during an ECAP survey of 100-K Area buildings notes various bird species using the reactors buildings at that time. Much of the infrastructure around the reactors has been removed since that survey was completed, and the available nesting/perching areas that were used by birds likely no longer exist.

Cultural Resources Setting

Cultural resources documented within the K Basin Sludge EU include two Manhattan Project/Cold War Era Landscape resources. In accordance with the 1998 *Hanford Site Manhattan Project and Cold War Era Historic District Treatment Plan (*DOE/RL-97-56), all documentation requirements have been completed for properties contributing to the Manhattan Project and Cold War era historic district. No other archaeological resources or TCPs are known to be recorded within the EU.

A small portion of the K Basin Sludge EU has been inventoried for archaeological resources. Remediation of waste sites within the K Area Waste Sites Evaluation Unit has been addressed by a NHPA Section 106 review. There are 10 archaeological sites within 500 meters of the EU: 4 archaeological sites (3 eligible and 1 unevaluated) represent the Native American Pre-contact and Ethnographic landscape; 1 archaeological site (eligible) represents the Pre-Hanford Early Settlers/Farming landscape, 3 archaeological sites (1 eligible, 1 not eligible, and 1 unevaluated); and 2 isolates (2 not eligible) represent the Manhattan Project/Cold War era landscape.

The geomorphologic composition of the EU, historic map, and modern aerial imagery all suggest low potential for subsurface intact archaeological resources in EU. 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) may need to occur. Consultation with Hanford Tribes may also 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

Brief description of contaminated media and materials

The KE and KW Basins were constructed in the early 1950's to support K-reactor operations. After irradiation, fuel was pushed from the horizontal fuel channels in the reactors into the discharge chutes and then sorted, canned, and queued underwater in the basins. This allowed for decay of radionuclides with short half-lives prior to reprocessing the fuel at either the 202-S Reduction-Oxidation (REDOX) or the 202-A Plutonium Uranium Extraction (PUREX) facilities for plutonium and uranium recovery. The basins originally had a 20-year design life and were deactivated when the KW and KE reactors were shut down. They were placed in long-term standby in February 1970 and January 1971, respectively.

In 1967, the REDOX reprocessing facility was shutdown. In the early 1970s, the PUREX reprocessing facility was placed on standby while the N Reactor continued to operate with a dual-purpose mission to produce fuels-grade plutonium and electricity. Spent fuel storage at N Reactor filled up so the KE Basin was reactivated in 1975. The KW Basin was reactivated in 1981 as supplemental storage for irradiated N Reactor fuel. The fuel stored in the KE Basin was contained in open-topped canisters, many of which had screened or perforated bottoms. The fuel stored in the K West Basin was contained in closed and sealed canisters that contained Grafoil [Grafoil is a registered trademark of Graffech International] gaskets.

The PUREX reprocessing facility was operated again from 1983 through 1990 and processed much of the N Reactor fuel (Zircaloy clad metallic uranium) that contained weapons-grade plutonium. When a U.S. government policy decision was made in the early 1990s to stop recovery of plutonium, some 2,100 metric tons (MT) of irradiated fuel remained in storage in the KE and KW basins. This inventory was irradiated uranium metal fuel, some of which was aluminum clad and the majority of which was Zircaloy clad. Some of the fuel suffered cladding damage or breaches during reactor operation, primarily during discharge and handling. This provided a pathway for water contact of the fuel and, eventually, corrosion of the metallic uranium fuel. Over time, well beyond the design basis of the fuel (approximately 20 years for KE Basin and 15 years for KW Basin), significant fuel element corrosion occurred and the resulting corrosion products escaped from the canisters to the basins floors and pits.

The basin superstructures are not sealed from the environment, which allowed sand, dirt, and organic material (weeds, bugs, etc.) to be deposited in the basins. Normal and off-normal basin operations contributed spent ion exchange resins and other detritus like spalled concrete, paint chips, Grafoil gasket material, and sand filter material; polychlorinated biphenyls (PCB) bearing materials; and hydroxides of iron, aluminum, and uranium to the sludge accumulation, mostly in the KE Basin. Sludge accumulations in the KW Basin were considerably less due to the sealed fuel storage canisters, better condition of the fuel placed into the basin, better control of the basin water quality, and a prior basin c1eanout campaign along with sealing the surfaces of the basin walls.

During the years of fuel storage, basin operation periodically required sludge relocation. This often resulted in portions of the sludge being pumped from the floor of the fuel storage area and settled in the various pits adjacent to the main basins. Over time, the sludge became identified by its deposition location: floor sludge, pit sludge, and canister sludge. The floor and pit sludge in the basins became a non-homogenous accumulation. By DOE-RL definition, sludge was defined to be anything in the basins that would pass through a 0.64 cm (0.25 in) screen. Material larger than that has been separated and managed as spent fuel, scrap or debris.

In the mid-1990s, the decision was made to disposition the fuel stored in the KE and KW Basins by packaging it, drying it, and moving it to dry storage on the 200 Area Central Plateau at the Hanford site.

After the fuel was transferred from November 2002 to July 2004, four Engineered Containers were installed in the KE Basin to collect and consolidate most of the KE Basin sludge, which was completed in 2006. In June 2004, approximately 3.5 m^3 of sludge from the KE North Load-out Pit was determined to be contact-handled transuranic (CH-TRU) waste. This sludge was transported to T Plant, then grouted and packaged into approximately 300 drums for disposal. The sludge collected in the Engineered Containers within the KE Basin was hydraulically transferred to three out of six Engineered Containers (numbers SCS-CON-240, 250, and 260) located in the fuel storage bays of the KW Basin beginning in October 2006. Removal of all sludge from the KE Basin was completed in June 2007, which allowed basin decommissioning.

Sludge retrieved from the KW Basin floor and pits was transferred into two Engineered Containers (number SCS-CON-210 and 220) in the KW Basin, which was completed in July 2007. The source of the sludge contained in Engineered Container numbers SCS-CON-210 and 220 is primarily sludge from the west bay in KW Basin (consisting of small fuel pieces), KE and KW canister sludge, and KW floor sludge. The fuel pieces contain higher concentration of uranium metal than other sludge types. The distribution of the KW Basin west bay sludge between Engineered Container number SCS-CON-210 and 220 is uncertain. A sixth Engineered Container (number SCS-CON-230) has received the Settler Tank sludge. . The contaminant inventory for the K Basins sludge is provided in Table H.2-5.

Table H.2-5: Contaminant Inventory- K Basins Sludge[35],[36]

WIDS	Description and Reference	Radionuclide Inventory (Ci)								Chemical Inventory (kg)				
		Cs-137	Sr-90	Tc-99	I-129	H-3	Pu (total)	Am-241	U (total)	CCl_4	Cr (total)	Cr (VI)	TCE	NO_3
100-K-42	Closed- Inventory has been moved to KW Basin and is included in KW Basin Listing- WID 100-K-43.	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
100-K-43	Sludge inventory for KW basin obtained from HNF41051 pages 20-21. The design concentration for each source of sludge is used and multiplied by the volumes from PRC-STP00718.	12739	16807	9	None known.	None known.	14867	2097	17.2	Not known.	Not known.	Not known.	Not known.	Not known.

[35] HNF41051, 2010. Pages 20-22.
[36] PCR-STP-00718, 2014.

CONTAMINATION WITHIN PRIMARY EU SOURCE COMPONENTS

Legacy Source Sites and Vadose Zone Contamination

There are several soil contamination sites in the 100K area surrounding the reactors as well as waste sites. Figure H.2-8 illustrates the waste sites in blue and the soil sites by white or yellow dots. [37]

Figure H.2-7: Soil Contamination and Waste Sites around KW Basin and ECRTS

Groundwater Plumes

There is a chromium plume that extends to the KW reactor facility from the south, a Sr-90 plume to the northeast of the KW Basin Annex, a nitrate plume that directly underlies the KW Basin and Annex, a second chromium plume that extends under the KW Basin and annex facility, and a C-14 plume that also extends under the facility. Figure H.2-9 illustrates the groundwater plumes that could affect the KW basin and ECRTS. [38]

[37] Data obtained using the Phoenix Mapping Tool. Accessed 10/23/14.
[38] Data obtained using the Phoenix mapping tool, accessed 10/23/14.

Figure H.2-8: Groundwater Plumes around KW Basin and ECRTS

Facilities for D&D

The KE/KW reactors are currently undergoing D&D. The KW Basin resides within the KW Reactor complex, and can be affected by D&D activities.

Operating Facilities

The operating facilities involved at the present time include KW Basin, Modified KW Basin Annex, T Plant.

Detailed inventories are provided in Table H.2-4, Table H.2-5, and Ref = HNF 41051, 2010 and PCR-STP-00718, 2014

Table H.2-6. All values are to 2 significant figures. The source document should be consulted for greater precision data. The sum for each primary contaminant is shown in the first row. Table H.2-7 provides a summary of the evaluation of threats to groundwater as a protected resource from saturated zone and remaining vadose zone contamination associated with the evaluation unit.

Table H.2-4. Inventory of Primary Contaminants[(a)]

WIDS	Description	Decay Date	Ref[(b)]	Am-241 (Ci)	C-14 (Ci)	Cl-36 (Ci)	Co-60 (Ci)	Cs-137 (Ci)	Eu-152 (Ci)	Eu-154 (Ci)	H-3 (Ci)	I-129 (Ci)
All	Sum			2100	NP	NP	NP	13000	NP	NP	NP	NP
100-K-43	UPR	2013	See note b	2100	NP	NP	NP	13000	NP	NP	NP	NP

a. NP = Not present at significant quantities for indicated EU
b. Ref = HNF 41051, 2010 and PCR-STP-00718, 2014

Table H.2-5. Inventory of Primary Contaminants (cont)[(a)]

WIDS	Description	Decay Date	Ref[(b)]	Ni-59 (Ci)	Ni-63 (Ci)	Pu (total) (Ci)	Sr-90 (Ci)	Tc-99 (Ci)	U (total) (Ci)
All	Sum			NP	NP	15000	17000	9	17
100-K-43	UPR	2013	See note b	NP	NP	15000	17000	9	17

a. NP = Not present at significant quantities for indicated EU
b. Ref = HNF 41051, 2010 and PCR-STP-00718, 2014

Table H.2-6. Inventory of Primary Contaminants (cont)[(a)]

WIDS	Descrip-tion	Ref[(b)]	CCl4 (kg)	CN (kg)	Cr (kg)	Cr-VI (kg)	Hg (kg)	NO3 (kg)	Pb (kg)	TBP (kg)	TCE (kg)	U (total) (kg)
All	Sum		NP	NP	NP	NP	NP	NP	NP	NP	NP	NP
100-K-43	UPR	See note b	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP

a. NP = Not present at significant quantities for indicated EU
b. Ref = HNF 41051, 2010 and PCR-STP-00718, 2014

Table H.2-7. Summary of the Evaluation of Threats to Groundwater as a Protected Resource from Saturated Zone (SZ) and Remaining Vadose Zone (VZ) Contamination associated with the Evaluation Unit

PC	Group	WQS	Porosity[a]	K_d (mL/g)[a]	ρ (kg/L)[a]	VZ Source M^{Source}	SZ Total M^{SZ}	Treated[b] M^{Treat}	VZ Remaining M^{Tot}	VZ GTM (Mm^3)	VZ Rating[c]
C-14	A	2000 pCi/L	0.18	0	1.84	---	---	---	---	---	ND
I-129	A	1 pCi/L	0.18	0.2	1.84	---	---	---	---	---	ND
Sr-90	B	8 pCi/L	0.18	22	1.84	---	---	---	---	---	ND
Tc-99	A	900 pCi/L	0.18	0	1.84	---	---	---	---	---	ND
CCl4	A	5 µg/L	0.18	0	1.84	---	---	---	---	---	ND
Cr	B	100 µg/L	0.18	0	1.84	---	---	---	---	---	ND
Cr-VI	A	10 µg/L	0.18	0	1.84	---	---	---	---	---	ND
TCE	B	5 µg/L	0.18	2	1.84	---	---	---	---	---	ND
U(tot)	B	30 µg/L	0.18	0.8	1.84	---	---	---	---	---	ND

a. Parameters obtained from the analysis provided in Attachment 6-1 to Methodology Report.

b. Treatment amounts from the 2013 Hanford Annual Groundwater Report (DOE/RL-2014-32, Rev. 0).

c. Groundwater Threat Metric rating based on Table 6-3, Methodology Report. These contaminants are being treated using the 200-West Groundwater Treatment Facility.

PART VI. POTENTIAL RISK/IMPACT PATHWAYS AND EVENTS

CURRENT CONCEPTUAL MODEL

Narrative description of pathways and barriers to receptors and conditions/events that can lead to completed pathways

Pathways and Barriers: (1. description of institutional, natural and engineered barriers (including material characteristics) that currently mitigate or prevent risk or impacts, 2. Time scale from loss of each barrier to realization of risk or impacts)

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?*

In the present condition, sludge storage in KW Basin and Construction of the Modified KW Basin Annex, there are several accident scenarios that dominate risk. For storage in KW Basin, these include: Heavy load drops, cask-multi canister overpack (MCO) drops, damage to drain valves, damage to outside weirs or north wall, SNF overlift, hydrogen explosion in the integrated water treatment system annular filter, spray releases from IWTS, overflow or pumpout of radioactive water from the KW Basin, design basis earthquake, uncontrolled vehicles, fires and CERCLA fires.[39]

For construction at the Modified KW Basin Annex, the following accident scenarios dominate risk: uncontrolled vehicles, loss of confinement from vehicle impact (collision or damage occurs in specific locations) results in release from KW Basin, Load dropped into the KW Basin, vehicle fuel spill and fire/explosion impacts KW Basin superstructure, and construction material fire spreads to KW basin superstructure.[40] (Note: construction of the Annex is essentially complete.)

For ECRTS operation, there are three accident scenarios that dominate the risk at the facility and also the development of controls. These include: a spray release of sludge slurry from a ruptured hose, hydrogen explosion, and STSC and STS Cask over-pressurization release.[41]

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

For storage at the KW Basin, the following systems and controls are in place: KW Basin superstructure, KW transfer bay bridge cranes, KW Basin floor and pit sludge retrieval strainer, KW Basin structure, FRS manipulator rail support structure tether, particulate settler vessel and annular filter vessels. [42]

For the KW Basin Modified Annex construction, controls include the KW Basin structure, as well as several TSR controls including: vehicle controls, KW heavy load controls, KW Basin water level and KW Basin Water Makeup Controls.[43]

In ECRTS, the following safety systems and controls will be used: above water slurry transfer lines, slurry transfer line rupture disk, double valve isolation, slurry transfer line secondary containment, slurry transfer line secondary confinement, slurry transfer line leak detection systems, safety control panels,

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[39] HNF-SD-WM-SAR-062, Rev. 20, 2014. Page 3-23 to 3-36.
[40] DD-50769, Rev. 1, 2014. Page 5-2.
[41] PRC-STP-00718, Rev 0 (2014). Pages xiv to xv.
[42] HNF-SD-WM-SAR-062, Rev. 20, 2014. Page 4-7 to 4-10.
[43] DD-50769, Rev. 1, 2014. Page 6-2.

instrument bypass panels, the physical structure of the annex (including the truck stop and trailer entrance, the mezzanine), auxiliary ventilation system, oxygen analyzer, pressure indicators, STSC design features such as the sloped fin, STSC liquid level instrumentation, truck scale instrumentation, nitrogen purge panel, safety control panel, the STSC vent assembly, the cask vent tool, seismic shut-down switches, the shielded hose chases, the bridge crane and associated supports, the annex exhaust stack, the fire protection sprinkler system supports, HVAC duct supports, cable tray supports, and nuclear safety interlock.[44]

Present planning for removal of K-Basins Sludge from the KW Basins involves interim storage of the sludge in Sludge Transportation and Storage Containers (STSCs) in several unused cells at T-Plant. This storage mission will involve a limited amount of system modifications to T-Plant, which had been previously designed and evaluated for a mission that was not accomplished (storage of Large Diameter Cannisters, LDCs, containing high-activity KE Basin sludge). The changes to T-Plant systems and operations were evaluated to determine whether they amounted to a major modification under DOE-STD-1189, and thus would require the development of a Safety Design Strategy (SDS) and associated safety planning documentation (i.e., Conceptual Safety Design Report, etc.). The review[45] determined that although some changes were anticipated to T-Plant safety documentation[46] to address variation in sludge loading from prior analyses, along with the activation of a safety-related system (Inert Gas System), these minor modifications could be adequately addressed through the normal safety basis revision process.

3. *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? Credited controls, administrative controls*

There are three major types of barriers to release of contamination from the primary facility: (1) Engineered systems including the sludge containers and building features described in Question 2 above (2) Operating Procedures; and (3) Safety Management Systems such as transportation safety. These systems are graded according to their importance in preventing or mitigating accidents and include safety significant and safety class systems.

There is a completed pathway anticipated for the workers to receive a dose of radiation from operations at ECRTS. This anticipated dose has been calculated and measures have been put into place to keep it ALARA. Documentation for this anticipated pathway is described above in the previous section.

4. *What forms of initiating events may lead to degradation or failure of each of the barriers? E.G., seismic event resulting in loss of water in pools*

Initiating events considered for KW Basin include: floods, seismic events, extreme winds, rain and snow loads, ashfall loads, lightning, range fires, aircraft activity, and transportation accidents.[47]

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

The primary pathway of concern is airborne dispersion of material from sludge. The primary populations at risk from this source include workers and the co-located person.

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[44] PRC-STP-00718, Rev 0 (2014). Pages xviii to xx.
[45] PRC-STP-00109 (Rev. 0), “Sludge Treatment Project Major Modification Determination for T Plant,” February 2010
[46] HNF-14741 (Rev. 6A), “Master Documented Safety Analysis (MDSA) for the Solid Waste Operations Complex”
[47] HNF-SD-WM-SAR-062, Rev. 20, 2014. Page 1-9 to 1-19.

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

For all initiating events, because the primary pathway to the receptors is airborne, the duration of human exposure or impacts will be very short ranging from hours to weeks.

7. *Are there current on-going releases to the environment or receptors?*

There is an anticipated competed pathway through the occupational dose to workers described above from ECRTS.

There are no known releases ongoing from the KW Basins sludge project. However, there is soil and groundwater contamination in the area surrounding the KW Basin and Modified KW Basin Annex that is known and being monitored, but is not coming from the sludge in the KW basin. Maps of these releases are provided above in this report.

8. *Provide a table of initiating events and potential effects on the various receptors*

Table H.2-8 illustrates the potential impacts for the receptors from various initiating events that could occur during the present Phase 1, stage a, storage at the KW Basin.

The potential high impact to the environment from a worker accident involved human error with an equipment failure. This scenario was unlikely but the resulting release had high environmental consequences (in this case groundwater, surface water and ecological resources were included as environment). The high impact on the groundwater and surface water from the structural decay or failure involves a structural decay of the foundation of the KW Basins structure and is unlikely but has high consequences.

POPULATIONS AND RESOURCES CURRENTLY AT RISK OR POTENTIALLY IMPACTED

Facility Worker

Workers are the resource impacted by the only current completed pathway of occupational radiation exposure. In the instance of the initiating events described above, any exposure would likely be airborne dispersion of waste and exposure via inhalation or external radiation due to proximity to contamination.

Co-Located Person (CP)

See above. Co-located workers also could receive occupational radiation exposure as predicted for ECRTS and described previously.

Public

Risk to the public is low level but could be realized if airborne dispersion were to occur, or potential leakage into the groundwater which might then be transported to the river.

Groundwater

Threats to groundwater could emerge if the transfer lines leaked sludge, although there are several safety systems in place to prevent such a leak. However, KW Basin contamination is confined to the basin and there are no vadose zone sources or current groundwater contamination associated with this EU. This leads to a ND rating.

Columbia River

Due to the proximity to the river, an event at the KW Basins Modified Annex resulting in release of sludge could potentially affect the river. However, KW Basin contamination is confined to the basin and there are no vadose zone sources or current groundwater contamination associated with this EU. This leads to a ND rating.

Ecological Resources

- Deconstruction and decommissioning of the KE/KW reactors (with basins) would not be expected to result in loss of any additional habitat at the EU. All habitat resources are level 0.
- Previous surveys noted nesting birds associated with the KE and KW Reactor buildings; however it is not evident that the infrastructure and building features that supported nesting are still in existence.
- Remediation actions taken for this EU are not expected to impact habitat connectivity within the adjacent landscape.
- A portion of the adjacent landscape buffer area for the KW reactor is relatively near (within 400 meters) an active bald eagle roost site. Noise and construction activities associated with deconstruction and decommissioning could potentially influence eagle use of the roost.

Cultural Resources

- There are no known TCPs within the EU.
- No archaeological resources have been documented in the EU.
- Two Manhattan Project/Cold War Era Historic District resources are located within the Evaluation Unit. Mitigation for contributing buildings/structures have been completed as per the *Hanford Site Manhattan Project and Cold War Era Historic District Treatment Plan* (DOE/RL-97-56) and building demolition is ongoing.

Name	Description
105KE	Reactor Building
105KW	Reactor Building and Process Water Tunnels

Archaeological sites and TCPs located within 500 meters of the EU

- There are no known TCPs within 500 meters of the EU.
- Ten additional cultural resources have been documented within 500-meters of the EU. These resources include archaeological sites and isolates representing the pre-contact, ethnographic, historic era, and Manhattan Project/Cold War era cultural landscapes.

Closest Recorded TCP

- Known TCPs exist in the vicinity of the EU.

CLEANUP APPROACHES AND END-STATE CONCEPTUAL MODEL

Selected or Potential Cleanup Approaches

What are the selected cleanup actions or the range of potential remedial actions?

Cleanup of this project involves the closure of several facilities: KW Basin, K Basin Modified Annex, T Plant, and the future sludge treatment system facility.

In terms, of KW Basin, the removal sludge is an integral part of the D&D process. When the sludge has been removed from KW Basin, the KW basins will undergo D&D procedures including the K Basin Modified Annex.

Contaminant Inventory Remaining at the Conclusion of Planned Active Cleanup Period

At the conclusion of the ECRTS activities, the sludge will be stored in T Plant in the STSCs. These will eventually be removed from T Plant for Phase 2 of sludge processing from which point the treated and packaged sludge will be stored and eventually shipped to WIPP. The emptied remaining STSCs will be disposed of at a location TBD.

Once the sludge has been removed, some inventory will remain in the basin, consisting of the contaminated equipment and basin, as well as the ECRTS process equipment. The D&D of the KW Basin will be addressed as part of the K Area D&D.

Risks and Potential Impacts Associated with Cleanup

The project is taking place in several phases, each of which has a set of potential impacts. Some of the impacts and hazards associated with ECRTS and the Phase 2 sludge treatment project are described below.

The hazardous conditions identified by the HAZOP study for ECRTS are:

- Spray release
- Splash and splatter/pool release
- Hydrogen explosion
- STSC overpressurization
- Radiological Control
  - Airborne radioactive material
  - Contamination
  - High external dose rate.
- Industrial Safety
  - Hose whip
  - Oxygen deficient atmosphere.

The hose whip hazardous condition is considered to be a standard industrial hazard that is addressed by the Occupational Safety and Health Safety Management Program.[48]

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

Workers (directly involved)

The ECRTS phase of the project has several identified anticipated events with high consequence to the facility worker. There is also an anticipated completed pathway in occupational radiation exposure.

Co-located (CW)

The ECRTS phase of the project has several anticipated events with medium consequences to the co-located worker. There is also an anticipated completed pathway in occupational radiation exposure.

Public

The public risk from ECRTS would likely be due to public river access.The Preliminary Documented Safety Analysis evaluates a Slurry Spray Release accident that produces consequences to the MOI. Mitigation of

[48] PRC-STP-00687, Rev.1, 2013. Page 4-1.

this accident includes safety significant systems discussed in Section VI as a part of the current conceptual model.

Groundwater

Threats to groundwater could emerge if the transfer lines leaked sludge, although there are several safety systems in place to prevent such a leak. However, KW Basin contamination is confined to the basin and there are no vadose zone sources or current groundwater contamination associated with this EU and none are expected over the next 50 years. This leads to a ND rating.

Columbia River

Due to the proximity to the river, an event at the KW Basins Modified Annex resulting in release of sludge could potentially affect the river. However, KW Basin contamination is confined to the basin and there are no vadose zone sources or current groundwater contamination associated with this EU and none are expected over the next 50 years. This leads to a ND rating.

Ecological Resources

No ecological resources are in this EU, and thus there are no effects

Cultural Resources

Personnel, car, and truck traffic on paved roads as well as use of heavy equipment will not have any direct impact on archaeological resources because there is no disturbance to soil/ground or alteration to the landscape. Assuming heavy equipment locations 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 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 paved roads located on TCP, direct effects include visual, auditory and vibrational alterations to landscape/setting. Heavy equipment 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. Revegetation activities may cause direct effects to TCPs include 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, car, and truck traffic on paved roads as well as use of heavy equipment 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. Existing road causes no alteration to 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. 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

This is a multi-phase project and delay would have different impacts, depending on when it occurred. These will be addressed in chronological order.

Delay in Removing the Sludge from the KW-Basin – the sludge stored in Engineered Containers at KW-Basin is the last significant quantity of nuclear material in the K Area (and for that matter on the River Corridor). Transportation of this material out of the K Area to T Plant is on the critical path to being able to complete environmental restoration activities on the K Area.

Delay in Design, Construction and Construction of the Phase 2 Sludge Treatment System – T Plant is intended to be only an interim stop for the sludge material from K Basins. CHPRC has completed alternatives analysis[49] and recommended a warm water oxidation system to stabilize the remaining uranium in the sludge (along with some limited development of backup/enhancement technologies). DOE-RL has approved[50] this path forward and CHPRC has developed a preliminary technology development plan[51] to mature the technologies to support design of the Phase 2 treatment system. Delays in design and construction of the Phase 2 treatment system, or the technology development program to support it, would result in the sludge being stored for a longer time period in T-Plant. Such a delay could make retrieval of the sludge for processing problematic (note: the aging properties of the sludge materials while in storage at T Plant is line of inquiry in the technology development planning).

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

The Phase 2 Sludge Treatment Process is in the technology selection phase and, thus, there is insufficient information to provide risk ratings at this time.

Groundwater

It is assumed that the waste will have been removed from the basin by the end of the 150 year evaluation period. This leads to a ND rating.

Columbia River

It is assumed that the waste will have been removed from the basin by the end of the 150 year evaluation period. This leads to a ND rating.

[49] PRC-STP-00465, "K-Basins Sludge Treatment Project – Phase 2 Technology Evaluation and Alternatives Analysis," 2011
[50] DOE-RL letter 12-AMRC-0051, December 23, 2011
[51] PRC-STP-00615, "Preliminary Technology Maturation Plan for the K-Basins Sludge Treatment and Packaging Facility," March 2012

POPULATIONS AND RESOURCES AT RISK OR POTENTIALLY IMPACTED AFTER CLEANUP ACTIONS (from residual contaminant inventory or long-term activities)

Table H.2-8. Population or Resource Risk/ Impact Rating.

Population or Resource		Risk/Impact Rating	Comments
Human	Facility Worker	N/A	To be covered by D&D of KW Reactor
	Co-located Person	N/A	To be covered by D&D of KW Reactor
	Public	N/A	To be covered by D&D of KW Reactor
Environmental	Groundwater	ND	It is assumed that the waste will have been removed from the basin by the end of the 150 year evaluation period.
	Columbia River	ND	It is assumed that the waste will have been removed from the basin by the end of the 150 year evaluation period.
	Ecological Resources*	ND-Low	Any risk depends upon the quality and quantity of re-vegetation following remediation. Could be a risk from invasion of exotic species.
Social	Cultural Resources*	**Native American:** Direct: Known Indirect: Known **Historic Pre-Hanford:** Direct: Known Indirect: Known **Manhattan/Cold War**: Direct: None Indirect: None	Permanent direct and indirect effects are possible due to high sensitivity of area.

*For both Ecological and Cultural Resources see Appendices J and K respectively for a complete description of Ecological Field Assessments and literature review for Cultural Resources.

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

Dependent on D&D methodologies discussed in detail in the KE/KW Reactors D&D EU.

PART VII. SUPPLEMENTAL INFORMATION AND CONSIDERATIONS

DETAILED RISK RATINGS FOR SLUDGE STORAGE AT KW BASIN, ECRTS AND PHASE 2 SLUDGE TREATMENT

Sludge Storage in KW Basin- Ratings Details

The identified hazardous conditions fit into the following categories for the current condition of safe storage at K Basin.

- Criticality
- Loss of KW Basin Water
- IWTS Annular Filter Hydrogen Deflagration
- IWTS Spray Release
- Overflow of Radioactive Water from KW Basin
- Fires
- CERCLA Waste Staging Area Fire
- Facility Worker Hazards
- Spent Nuclear Fuel Overlift
- Pumpout or Siphoning of Radioactive Water from KW Basin
- Design Basis Earthquake
- Containerized Sludge Hydrogen Release and Deflagration

None of the postulated hazardous conditions result in “high” or “moderate” offsite or onsite radiological consequences. The postulated events were low risk for the CWs and the offsite public. No significant consequences were identified for the facility worker. Several hazardous conditions were selected for additional analysis to ensure a complete spectrum of accidents was evaluated.[52]

There are 117 total accidents analyzed in the Streamline Hazards Analysis for KW Basin. Of these, 43 are no longer applicable to ongoing activities. Of the 74 accidents remaining, all had low consequences to the maximally exposed offsite individual (MOI) and the collocated worker (CW). All 74 accidents also had no consequences to the facility worker. Several accidents did have potential consequences to the environment including 6 loss of confinement accidents of the basin due to various initiating events, 5 beyond design basis earthquake events, a loss of confinement with damage to the outside weirs and north wall, and 4 loss of confinement events due to overflow of the basin.

Among these events, there are three anticipated events which will have an environmental impact. There are also several direct dose events which are anticipated. [53]

ECRTS Ratings Details

This phase of the project will cover the ECRTS project and transfer to T Plant.

There are 260 events analyzed in the Hazards and Operability Study for ECRTS. Of these events, 143 have high unmitigated consequences to the facility worker, and the majority of these high consequence

[52] DD-53838, Rev. 0, 2014. Page 5-1.
[53] DD-53838, Rev. 0, 2014. Appendix C.

events are anticipated[54]. These include hydrogen explosions and uncontrolled releases from a number of initiating events. For the co-located worker, there are 13 events that are anticipated and have high consequences including uncontrolled releases from a number of initiating events. There are also 22 events that are anticipated and will have a moderate effect on co-located workers. All analyzed events have either low or no unmitigated consequences to the public. The environment was not included in this study.[55]

Phase 2 Sludge Treatment Ratings Details

This section will cover the Phase 2 Sludge Treatment System after the sludge has been retrieved from interim storage in T Plant. The preferred alternative, warm water oxidation has the following safety benefits: Warm Water Oxidation (WWO)

- Advantages
    - No significant safety hazards have been identified beyond those typical of all processes that handle (move, mix, pump, and package) bulk quantities of the highly radioactive K Basin sludge slurries.
    - No chemical additives required.
- Disadvantages
    - Relatively long processing time results in longer risk period.[56]

This project is still in the design and decision making stage. Insufficient data exists to complete a risk rating based on the current status of the project.

[54] Note: As the HAZOP study is the most current documentation of hazards at ECRTS, the risk ratings will tend to be high. This is due to the consideration of consequences without mitigation. When the project moves forward to a higher level of Hazards Analysis, mitigative measures will be considered and the risks may be lower.
[55] PRC-STP-00687, Rev.1, 2013. Appendix D.
[56] PRC-STP-00465, Rev 0, 2012. Page 4-3.

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APPENDIX H.3

CWC (CP-OP-1, CENTRAL PLATEAU)
EVALUATION UNIT SUMMARY TEMPLATE

Table of Contents

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PART I. EXECUTIVE SUMMARY

EU Location

Hanford 200 West Area

Related EUs

WRAP, Low Level Burial Grounds, T Plant

Primary Contaminants, Contaminated Media and Wastes:

In the Master Documented Safety Analysis for Solid Waste Operations Complex (SWOC) (HNF-14741), the bounding drum and array analysis assumptions of the Hanford Safety Analysis and Risk Assessment Handbook (SARAH, HNF-8739) are used. In that bounding drum, the radionuclides are assumed to be Pu-238, Pu-239 (more than 80% by activity), Pu-240, Pu-241 and Pu-242, along with the Pu decay product Am-241. The waste may also contain debris from D&D and operational wastes, notably from PNNL and Tank Farms, WRAP, Low Level Burial Grounds, and T Plant and may also contain fission products (Cs-137, Sr-90). However, majority of presently stored waste is classified as remote handled (RH) or contact handled (CH) TRU and TRUM. The waste also contains RCRA classified dangerous waste as well as pyrophoric materials including sodium.[1]

A list of all constituents in a sample container is included in Appendix 2. For the first sample container, the highest weight percent constituents include: inert material (wood, plastic, paper, etc.) and non-specified absorbents (~90% total weight); non-specified petroleum hydrocarbons and mineral oil and petroleum distillates (~1.5% total weight). All other constituents are <1%. For a second sample container, the highest weight percent constituents include: glass (40%), mixed esthers and phthalate (14.8%), aluminum (11%) and plastic (~5%). Constituents less than 10% include acetic acid, barium dinonylnaphthalenesulfonate, hydrotreated kerosene and naphtha, isopropyl alcohol and oil, among others. A third sample container includes inert material (paper, wood, plastic etc.) (~57%), conwed pads (~16%), carbon tetrachloride (~14.8%), oil (~4%) and tributyl phosphate (~2.3%).[2]

Two estimates on the inventory of radionuclides at the CWC are provided as follows:

The total dose equivalent using the bounding drum scenario from the Documented Safety Analysis as though each waste container (8,800 total containers) at the CWC contained the bounding estimate (82.5 DE-Ci) yields a total inventory of 726,000 DE-Ci.[3] The design basis estimate for the Design Basis Earthquake MAR at CWC estimates a total inventory of 195000 DE-Ci[4].

The SWOC Solid Waste Inventory Tracking System provides the following CWC Inventory Snapshot: Total Ci: 52,889 Pu. This is based on the estimated inventory of each individual container.[5]

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[1] Nester, (2014).
[2] SWITS (2014).
[3] HNF-14741-10, (2013).
[4] HNF 14741-10. (2013). Table 3-16.
[5] Snapshot inventory from SWITS posted on Sharepoint.

Table H.3-1. CWC Inventory Snapshot.

Contaminated Media, Nuclear Material	Primary Hazardous Materials Contributing to Risk	Amt. in Standard LLW or TRU Waste Packages[1]	Retrieved Large Boxes in Outdoor Storage	Total Containers	Total Volume	Est. amt. of each primary contaminant
Within facility						
Major Mission materials	Containerized waste being stored prior to final treatment.					
Waste Stored		~8,600	~175	~8,800	10,788 m3[6]	
Facility contamination (piping, gloveboxes, etc.)	Minor leaks and rainwater intrusion do occur. Regular RCRA inspection and radiological monitoring to identify problems, which are remediated.					
Facility Vicinity						
Known plumes	Facility is built over/adjacent two a known CCl_4 plume from the Plutonium Finishing Plant (PFP) that is under remediation via pump-and-treat with some wells within the CWC perimeter.					
Waste stored outside facility	There are several outside storage pads. The waste on these pads are managed and monitored similar to waste stored inside of the buildings but the pads do not have double containment.					
Subsurface infrastructure (i.e., piping, etc.)	Sumps in some storage buildings; electricity and fire suppression water lines in most buildings,					

BRIEF NARRATIVE DESCRIPTION:

The CWC provides storage, inspection (as required), limited processing, and staging for waste containers that are awaiting waste processing operations or disposal at other waste management facilities. The CWC receives waste from both onsite and offsite generators. Four types of waste are processed or stored at the CWC: low-level radioactive waste (LLW); mixed, low-level radioactive waste (MLLW),

[6] Total from a recent output of SWITS (Solid Waste Information Tracking System).

transuranic waste (TRU); and TRU mixed waste (TRUM). The CWC can receive, as necessary, unvented containers from retrieval operations for staging prior to venting (for example, at T-Plant).

Personnel receive and inspect waste packages at the Waste Receiving and Staging Area. In accordance with all applicable procedures, transport offloading operations are performed using handtrucks, forklifts, or cranes operated by qualified personnel. Packages are transferred from the offloading area to the appropriate CWC storage building or other storage area. Alternatively, waste packages may be received, inspected, and unloaded at the specific CWC building or storage area where the waste would be stored. Typical stored waste packages include 208-liter (55-gallon) drums; 322-liter (85-gallon) overpacks; and fiberglass-reinforced plywood, plywood, or metal boxes. Atypical packages include, but are not limited to, radioisotopic thermoelectric generators, vault tank filter assemblies, blanked-off gloveboxes, overpacks, and pipe overpacks in 208-liter (55-gallon) drums.[7]

The CWC main structures include the 2402 series (excluding 2402-W and 2402-WC), 2403 series, and 2404 series buildings. Other CWC facilities include the Low Flash Point Storage Modules (FS-1 to FS-3, FS-5 to FS-7, FS-9 to FS-12, and FS-14 to FS-27), Alkali Metal Waste Modules (AMW-1 to AMW-4) the Waste Receiving and Staging Area, the Mixed Waste Storage Pad, and the 2420-W Cask Storage Pad.

Permitted and potential activities at the CWC include performing headspace gas sampling (HSGS) on containers; NDEs and NDAs using portable units to characterize container contents; intrusive sampling operations to characterize or verify contents; minimal waste treatment (encapsulating, absorbing, stabilizing, neutralizing, and venting); and packaging and repackaging (adding shielding inside containers, filling voids, removing noncompliant items, and decontaminating shipping container interiors).[8] Treatment may consist of absorption of free liquids, absorption to accomplish deactivation, neutralization of corrosive materials. Further, CWC has contracted with off-site radioactive waste treatment vendors that provide additional capacity and capabilities. The CWC Operating Unit Group provides storage for dangerous and/or mixed waste from Hanford onsite generating locations including waste from the Waste Retrieval Project (WRP), and off-site generators.[9][10]

The primary hazards at the CWC are radiological and chemical hazards to the workers, both remediation and co-located as well as the environment including near surface soils and groundwater. There are several waste containers at the facility that have been determined to have leaks or have the potential of developing leaks in the near future. Leaking of the waste containers is the primary source of the hazards described above. Along with potential leaks, there is an exposure pathway completed in the exposure of workers to some radiation as they perform daily activities around the waste. These hazards are described below in the report.

Accident scenarios with high consequences to co-located workers had an unlikely frequency. These included two fire scenarios and a seismic building collapse. Several accident scenarios with moderate consequences to co-located workers and anticipated frequency were analyzed including fires, energetic reactions and radiological spills. There were several accident scenarios that led to possible discharge to the groundwater; all of these had an unlikely frequency. No accident scenarios analyzed had other than low consequences to the off-site individual.

[7] EIS 0391 (2012), Appendix E: Pages E236-E237
[8] EIS 0391 (2012), Appendix E: Page E237
[9] Permit WA7890008967, Part III, OU Group6, Central Waste Complex, Addendum C: Page 4
[10] The WA Department of Ecology Permit has not been finalized, however, the information included in the permit represents a satisfactory draft to make the risk evaluation.

The CWC is equipped with several safety systems to mitigate the analyzed accident scenarios including engineered systems, operating procedures and processes as well as safety management systems. The engineered systems include the waste containers, designed barriers, fire protection systems, and facility specific systems such as sumps among others. Operating procedures and processes include a waste acceptance criteria and waste characterization, container venting program, container management program, and abnormal container management program. Safety management systems include a nuclear safety program and transportation safety program. All are described in further detail in Appendix 1.

Summary Tables of Risks and Potential Impacts to Receptors

Table H.3-1 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 Central Waste Complex or immediate areas around the outside of the building; a Co-located Person (CP) is an individual located 100 meters from the Central Waste Complex; and Public is an individual located at the closest point on the Hanford Site boundary not subject to DOE access control, which in this instance is a point along Highway 240 approximately 5 km away from the facility. The nuclear related risks to humans are based on unmitigated (unprotected or controlled conditions) dose exposures expressed in a range of from Non-Discernable (ND) to Very High. The estimated mitigated exposure that takes engineered and administrative controls and protections into consideration, is shown in parenthesis.

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 Non-Discernable (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: No risk ratings are provided for Cultural Resources. The Table H.3-2 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.

Table H.3-2. Risk Rating Summary (for Human Health, unmitigated nuclear safety basis indicated, mitigated basis indicated in parenthesis (e.g., "Very High" (Low)).

Population or Resource		Evaluation Time Period: Active Cleanup (to 2064) — **Current Condition:** CWC Operating Facility	**From Cleanup Actions:** D&D of this facility is not yet planned.
Human Health	Facility Worker	High (Low)	D&D of this facility is not yet planned.
	Co-located Person	Very High (Low)	D&D of this facility is not yet planned.
	Public	Low (Low)	D&D of this facility is not yet planned.
Environmental	Groundwater	ND[b]	ND[c]
	Columbia River	ND[b]	ND[c]
	Ecological Resources[a]	ND	ND to Low
Social	Cultural Resources[a]	**Native American:** Direct: Known Indirect: Known **Historic Pre-Hanford:** Direct: Known Indirect: Known **Manhattan/Cold War:** Direct: None Indirect: None	**Native American:** Direct: Known Indirect: Known **Historic Pre-Hanford:** Direct: Known Indirect: Known **Manhattan/Cold War:** Direct: None Indirect: None

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.
b. CWC contamination is confined to the CWC building and there are no vadose zone sources or current groundwater contamination associated with this EU.
c. D&D of this facility is not yet planned.

SUPPORT FOR RISK AND IMPACT RATINGS FOR EACH POPULATION OR RESOURCE

Human Health

Current

The consequent categories and frequency estimates discussed in this section are consistent with the estimates made in HNF-15589, *Consolidated Hazard Analysis for the Master Documented Safety Analysis* (MDSA, Rev. 8). In the CHA, 91 total scenarios were evaluated for the CWC.

- There were sixteen (16) analyzed accident scenarios that produced consequences evaluated as "Moderate" for facility workers at CWC which had an estimated frequency of occurrence of "Anticipated"; these included eight (8) fire/energetic reaction scenarios and eight (8) radiological and/or chemical spills. Also, three (3) accident scenarios evaluated as "High" consequences with a frequency of "Low"; two fires and seismic building collapse.

- For on-site other workers, there were two accident scenarios that produced "High" consequences, but had an "Unlikely" estimated frequency of occurrence (Transportation-related fire & seismic building collapse); also, one fire was rated to have "Moderate" consequences with an estimate frequency of "Anticipated."
- There were no accidents evaluated to other than "Low" consequences to the maximum exposed off-site individual.
- Twenty (20) accidents evaluated, all "Unlikely" or less frequent, were deemed to have the potential to produce E3 consequences, that is: "off-site discharge to discharge to the groundwater." Discharges to the surface soil are assumed herein to be similar, as the primary dispersal pathway is airborne.
- Impacts to Cultural and Economic resources were evaluated by the appropriate CRESP teams and inserted.

Building and Facility: Work conducted at the CWC can be affected by the following design basis events from the Documented Safety Analysis:[11]

Small Outside Fire: A vehicle (propane-fueled forklift) impacts a single container or a pallet of containers, the containers breach, and any local ignition source burns the waste. The accident bounds impacts to a single container, pallet of containers, or a HEPA filter because it assumes fully loaded containers pursuant to the SARAH. Other release phenomena included in this bin are fires that spread to a single container, pallet of containers, or HEPA filters through vehicle impacts and ignition of liquid fuels such as gasoline, diesel fuel, or hydraulic oil. The small outside fire event is a conservative representation of other release phenomena contained within this bin because it is a high-energy event that ejects much of the contents and burns the contents outside and inside the container. It is also modeled as a small buoyant (0.2 MW sensible heat) non-meandering plume. The use of forklifts for handling containers or pallets of containers evaluated in FIR-2 is the highest probability initiator for a small outside fire event because of the frequency of use.

Unmitigated Consequence: Co-located Person – Low; Public – Low

Mitigation: Not credited: Passive: Storage container, Secondary Containment

Credited: Administrative: Waste Acceptance Criteria

Mitigated Risk: Co-located Person: Low; Public- Low

Small Inside Fire: A vehicle impacts a single container, the container breaches, and any local ignition source burns the waste. The accident bounds impacts to a single container, pallet of containers, or a HEPA filter because it assumes fully loaded containers pursuant to the SARAH. The unmitigated frequency is Anticipated. Other release phenomena included in this bin are fires that spread to a single container, pallet of containers, or HEPA filters through vehicle impacts and ignition of liquid fuels such as gasoline, diesel fuel, or hydraulic oil. The use of forklifts for handling containers or pallets of containers evaluated in FIR-5 is the highest probability initiator for a small outside fire event because of the frequency of use.

Unmitigated Consequence: Co-located Person – Very high; Public – Low

Mitigation: Active: Fire Protection; Passive: Storage container, Secondary Containment, Epoxy resin floor coating, Building stabilization and grading; and Administrative: Container Management and Venting Program, Waste Acceptance Criteria

[11] HNF-15589, Rev. 8. Appendix A.

Mitigated Risk: Co-located Person: Low; Public- Low

Medium Inside Fire: Studied initiating event is at WRAP, but a similar accident could occur at the CWC. A failure of the WRAP Automatic Stacker/Retriever System (AS/RS) results in a pallet of drums falling and breaching. The hydraulic line bursts, releasing fluid, and burning additional drums. The accident bounds impacts of a medium inside fire because FIR-6 assumes that several dozen drums are involved in the fire. Although the accident could occur at any SWOC facility, it is assumed to occur at the WRAP because the most MAR is involved without spreading to the entire structure. The unmitigated frequency is Anticipated because it is caused by human error.

Unmitigated Consequence: Co-located Person – High; Public – Low

Mitigation: Active: Fire Protection; Passive: Storage container, Secondary Containment, Epoxy resin floor coating, Building stabilization and grading; and Administrative: Vehicle Controls, Container Management and Venting Program, Waste Acceptance Criteria

Mitigated Risk: Co-located Person: Low; Public- Low

Large Fire: The studied event is a fire involving 8 drums or other greenhouse (confinement structure) fire involving 82.5 De-Ci due to mishandling, equipment malfunction or properties of TRU waste cause burning of container contents resulting in breach of glovebox or greenhouse confinement. This type of event is described as a fire in the WRAP glovebox enclosure due to flammable or combustion–ignition sources in the waste or electric or static ignition sources, but a similar scenario[12] could occur at CWC. The accident bounds impacts from other confinement fires such as at the APL gloveboxes, and the 221-T or 2706-TA greenhouse because FIR-8 uses eight containers in the event and the most material at risk involved is at WRAP. Other release phenomena included in this bin are fires that spread as a result of incompatible materials, accidental crushing of a TRU waste drum in the LLW supercompactor, breach of pressurized containers, and ignition from a spark or other ignition source.

Unmitigated Consequence: Co-located Person – Very high; Public – Low

Mitigation: Active: Fire suppression systems, Fire Protection; Passive: Storage container, Secondary Containment, Epoxy resin floor coating, Building stabilization and grading; and Administrative: Vehicle Access Control, Container Management and Venting Program, Waste Acceptance Criteria, Source Strength Controls, and Emergency Response.

Mitigated Risk: Co-located Person: Low; Public- Low

Design Basis Seismic Event: As a result of the design basis seismic event, facility structural damage occurs due to overloading or acceleration energy. The MAR is considered to be the radioactive waste at each facility. This accident involves release from storage containers that are damaged as a result of falling building structures or falling from their stacked position, resulting in a spill.

Unmitigated Consequence: Co-located Person – High; Public – Low

Mitigation: Passive: Storage container, Secondary Containment, Building stabilization and grading; and Administrative: Container Management and Venting Program, Waste Acceptance Criteria

Mitigated Risk: Co-located Person: Low; Public- Low

[12] FIR-08 is the scenario numbered in the DSA, CWC-06-01 is the applicable CWC scenario from the hazard analysis.

External Event: The aircraft crash (EE-2) can occur at any SWOC facility. The bounding accident occurs at the CWC 2403-WD Building. The MAR is a portion of the total waste containers in the building. This accident involves release from storage containers that are damaged as a result of impact and resulting fuel fire. This accident is considered a high-energy event. The frequency of the bounding event is Extremely Unlikely. Release phenomena included in this bin are restricted to an aircraft crash with fire.

Unmitigated Consequence: Co-located Person – Low; Public – Low

Mitigation: There are no controls to limit the risk from this event. However, there are some controls which might mitigate the effects. These include: Active: Fire Protection; Passive: Storage container, Secondary Containment, Building stabilization; and Administrative: Container Management and Venting Program, Waste Acceptance Criteria

Mitigated Risk: Co-located Person: Low; Public- Low

Contaminated Soils: Workers, CP and the Public are not directly exposed to the contaminated soil because it is located below grade beneath a concrete slab and portions of the building. There could be potential exposure on the outdoor storage areas without concrete.

Risks and Potential Impacts from Selected or Potential Cleanup Approaches
Addendum H of the RCRA Permit for CWC outlines closure activities as follows: (1) remove waste inventory; (2) decontaminate structural surfaces and equipment; (3) analyze decontamination waste to determine proper methods of treatment/disposal; and (4) dispose of decontamination waste based on results of waste analysis. The total duration of the cleanup phase is expected to be 180 days.[13]

Present information in the DSA indicates simply that SWOC facilities in general "have not identified any D&D activities that are unique, facility specific, or important to preventing or mitigating radiation exposure with respect to the D&D program."

Based on available information, we estimated the following ratings:

Unmitigated Risk: Facility Worker – Insufficient Information; CP – Insufficient Information; Public – Insufficient Information

Groundwater

CWC contamination is confined to the CWC building and there are no vadose zone sources or current groundwater contamination associated with this EU and none are expected over the next 150 years. This leads to a ND rating.

Columbia River

The Columbia River will not be impacted by the CWC due to the 13 km distance between the facility and the river. This leads a ND rating.

Ecological Resources

Current
There are little high quality resources on EU or on buffer.

[13] Permit WA7890008967, Part III, OU Group6, Central Waste Complex, Closure Plan: Page 6.

<u>Risks and Potential Impacts from Selected or Potential Cleanup Approaches</u>
There are little high quality resources on EU or on buffer, but remediation options are unknown. Remediation options could result in contamination of the few resources on site (only 2% level 3 resources in EU). Remediation options unknown, thus whether area with be re-vegetated is unknown. If re-vegetated, risk could be low (rather than ND) due to presence of higher quality resources (e.g. level 3 or 4) created by re-vegetation.

Cultural Resources

<u>Current</u>
Ratings for cultural resources are not being made because cultural resources will be evaluated under Section 106 of the National Historic Preservation Act (16 USC 470, et. seq.) during the planning for remedial action. The resulting Section 106 process will engage all stakeholders, including Native American Tribes, concerning the Native American, Historic Pre-Hanford, and Manhattan Project/Cold War landscapes. This process will identify all cultural resources and evaluate their eligibility for the National Register of Historic Places, any direct and indirect effects from remediation, as well as the need for any mitigation actions. CRESP has consulted with the Native American Tribes having historical ties to Hanford and they consider the entire Hanford Site to be culturally and historically important.

National Register eligible historic trail runs through the EU. Two National Register ineligible sites/isolates are located within the EU. Potential for additional resources within pockets of undisturbed soil if it exists based on presence of Native American and Historic era resources within 500 meters of EU. Traditional cultural places are visible from the EU.

<u>Risks and Potential Impacts from Selected or Potential Cleanup Approaches</u>
Both direct and indirect effects are likely on National Register eligible trail. Other sites have been determined ineligible. There is the potential for additional archaeological resources where pockets of undisturbed soils exist. Long-term protection measures may be in place to resolve adverse effects to National Register eligible trail. Permanent effects are possible due to presence of contamination.

Considerations for timing of the cleanup actions

Delay in cleanup will result in continued operations and maintenance of the facility. This may lead to a potential for increased container maintenance due to normal degradation mechanisms (e.g., corrosion).

Near-Term, Post-Cleanup Risks and Potential Impacts

Dependent on D&D methods chosen.

PART II. ADMINISTRATIVE INFORMATION

OU and/or TSDF Designation(s)

CP-OP-1

Common name(s) for EU

Central Waste Complex (CWC)

Key Words

radioactive waste, waste storage, mixed waste, transuranic waste (TRU)

REGULATORY STATUS

Regulatory basis: CWC is a Hazard Category 2 nuclear facility, as categorized by DOE-STD-1027. It is also categorized as Dangerous Waste Storage and Treatment Facility by Washington State Department of Ecology.

Applicable regulatory documentation:

In accordance with 10CFR830, Nuclear Safety Management, a documented safety analysis (HNF-14741) has been completed, with required safety controls. The State of Washington has issued a final status RCRA permit (WA7890008967, Part III, OU Group6, Central Waste Complex) for CWC operations, although CWC operates under interim status requirements.

Applicable Consent Decree or TPA milestones: M-091-Series Milestones (as applicable)

RISK REVIEW EVALUATION INFORMATION

Completed: Revised February 9, 2015

Evaluated by: S. Krahn, A. Croff, L. Fyffe

Ratings/Impacts Reviewed by: D. Kosson, J. Salisbury, A. Bunn, J. Burger, H. Mayer

PART III. SUMMARY DESCRIPTION

CURRENT LAND USE

DOE Hanford Site[14]

DESIGNATED FUTURE LAND USE

Industrial Exclusive[15]

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[14] The current land use is Industrial, for Waste Storage, Treatment and Management. The CWC Operating Unit Group Dangerous Waste Management Units are designed for storage but can also perform operations such as: opening, sorting, treating (e.g., segregation, sorting for assignment to treatment), repackaging, sampling, physically/chemically screening to characterize retrieved waste, and to verify the characterization of containers of mixed waste. The facility can perform nondestructive examination (NDE) on an as needed basis using portable equipment. Limited treatment of mixed waste is permitted in the 2401-W, 2402-W, and 2403-W series dangerous waste management units. Sampling and verification may be done at the CWC Operating Unit Group. However, receiving, evaluating the integrity of packaging, repackaging when necessary and storing wastes for final disposition are the primary activities at the CWC; other operations mentioned above, while authorized by the RCRA permit and analyzed in the Documented Safety Analysis (DSA), are performed infrequently.

[15] CWC is projected to be operated as long as the waste management mission requires. Thereafter, the Central Plateau is designated for Industrial-Exclusive use. This designation is defined as an area suitable and desirable for treatment, storage, and disposal of hazardous, dangerous, radioactive, and nonradioactive wastes. It includes related activities consistent with Industrial-Exclusive uses. This designation would allow for continued Waste Management operations within the Central Plateau geographic area.

PRIMARY EU SOURCE COMPONENTS

Legacy Source Sites

Not Applicable

High-Level Waste Tanks and Ancillary Equipment

Not Applicable

Groundwater Plumes

Facility rests on top of known Carbon Tetrachloride plume which is under active pump and treat remediation.

Operating Facilities

Containerized LLW, MLLW, TRU, TRUM

D&D of Inactive Facilities

Not Applicable

LOCATION AND LAYOUT MAPS

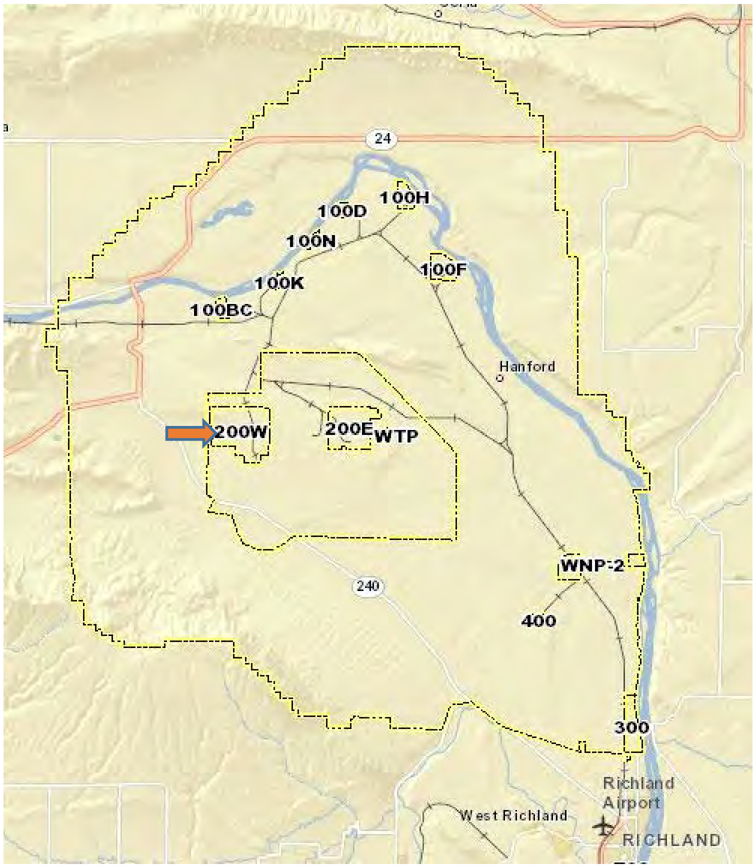

Figure1: Overall view of the Hanford Site with the 200W Area Highlighted[16]

This image illustrates the location of the 200 West (200W) Area in reference to the Hanford site and surrounding areas. The orange arrow indicates the location of the CWC. An important feature of this map is Highway 240, which is the closest public point to the CWC, and thus the location of the Maximum Exposed Individual.

[16] This image from the Hanford Phoenix System

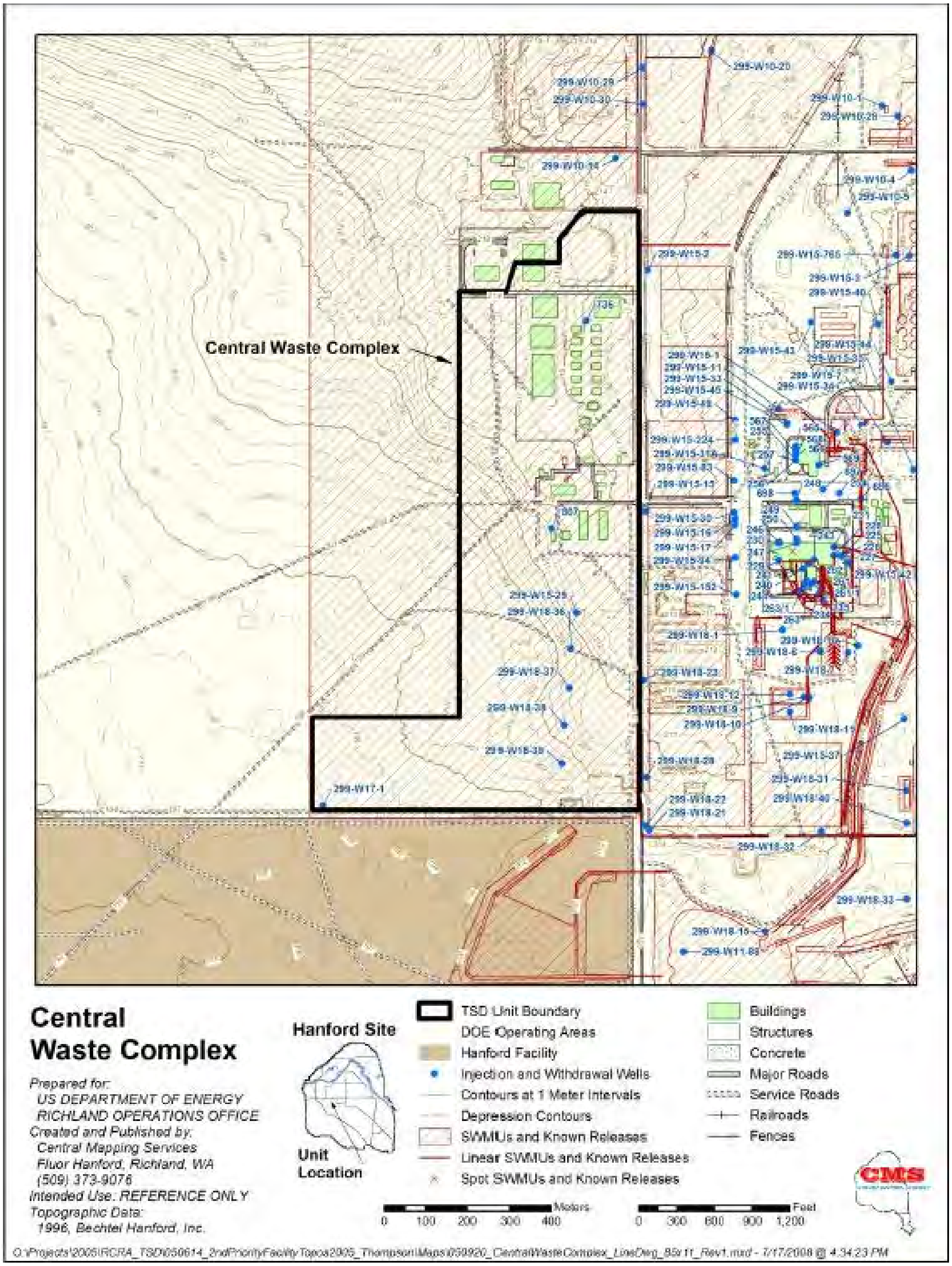

Figure 2: Map of CWC within the SWOC[17]

[17] Permit WA7890008967, Part III, OU Group6, Central Waste Complex, Addendum A Part A: Page 29

EU Designation: CP-OP-1 (CWC)

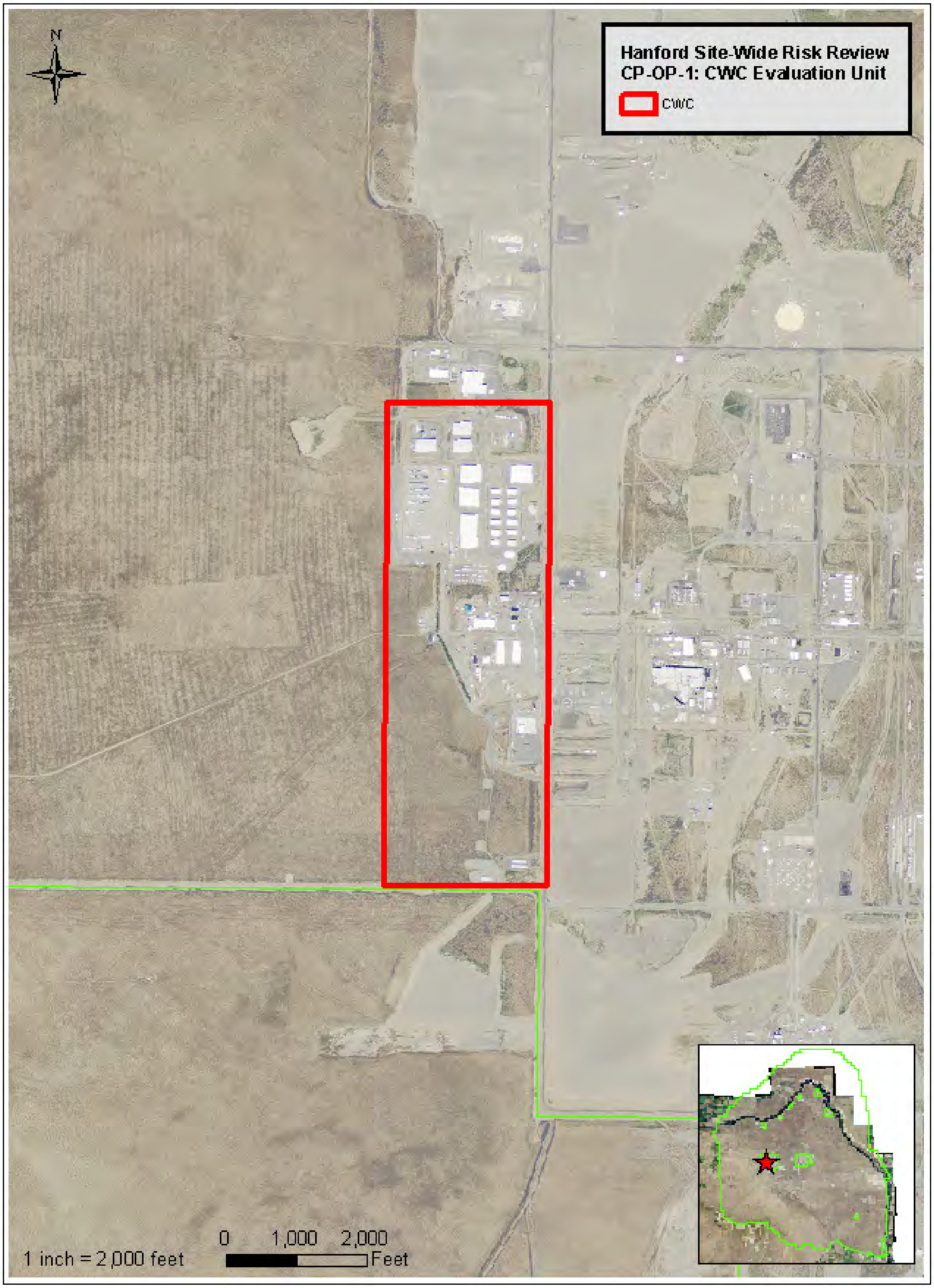

Figure 3. EU Boundary Map

PART IV. UNIT DESCRIPTION AND HISTORY

EU FORMER/CURRENT USE(S)

See Operating Facilities

LEGACY SOURCE SITES

Not Applicable

HIGH-LEVEL WASTE TANKS

Not Applicable

GROUNDWATER PLUMES

Not Applicable

D&D OF INACTIVE FACILITIES

Not Applicable

OPERATING FACILITIES

What processes produced the radioactive material contained in the facility?

The radioactive material contained at the CWC includes MLLW, LLW, TRU and TRUM from both Hanford and offsite. In its current status, the majority of the waste in the CWC is retrievably stored TRU retrieved from the old burial grounds[18].

What types of containers or storage measures are used for radioactive materials at the facility?

The waste containers at the CWC are for the most part 55 gallon drums, composed of a noncombustible material with coatings or liners sufficient to maintain the integrity of the containment system from corrosion over the anticipated storage life of the waste; in some cases an overpack will be used and sorbent where necessary. There are some (175, or about 2% of all containers) legacy, large containers that are 'strong, tight packages,' most frequently wood boxes with fiberglass reinforcement; these containers have been provided additional weather protection. Further, waste packages will not exceed 1 mSv/hr 20 cm away from the surface or 2 mSV/hr on the surface.[19]

How is the radioactive material and waste contained or stored within the facility classified?

There are four distinct classes of material stored at the CWC including LLW, MLLW, TRU and TRUM. The waste generator must determine the physical and chemical characteristics of the waste. This information can come from the following sources: A representative sample, test data from a nonradioactive surrogate sample, MSDS, mass balance data from the waste generation process, interview information, log books, procurement records, and others[20]. Upon reaching the CWC, a small sample of the waste may be assayed to determine the accuracy of the information provided by the generator.

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[18] WA7 89000 8967, Part III, Operating Unit 6- (2009), Page 1

[19] HNF-EP-0063-Rev. 16- (2011), Page 4-3.

[20] HNF-EP-0063-Rev. 16- (2011), Page 2-2.

The waste also contains hazardous chemicals that are considered dangerous waste under RCRA. These include: Ignitable, Corrosive, and/or Reactive materials, Regulated RCRA metals (e.g., lead, mercury, chromium, etc.); Regulated RCRA organics (e.g., CCL4, Tetrachloroethylene, MEK, etc.); RCRA Listed Waste (e.g., F001-5, F039, P & U listed waste, etc.); and Extremely Dangerous Waste (EHW).[21]

What nuclear and non-nuclear safety accident scenarios dominate risk at the facility[22]?

There were sixteen (16) analyzed accident scenarios that produced consequences evaluated as "Moderate" for facility workers at CWC which had an estimated frequency of occurrence of "Anticipated"; these included eight (8) fire/energetic reaction scenarios and eight (8) radiological and/or chemical spills. Also, three (3) accident scenarios evaluated as "High" consequences with a frequency of "Low"; two fires and seismic building collapse.

For on-site other workers, there were two accident scenarios that produced "High" consequences, but had an "Unlikely" estimated frequency of occurrence (Transportation-related fire & seismic building collapse); also, one fire was rated to have "Moderate" consequences with an estimate frequency of "Anticipated."

There were no accidents evaluated to other than "Low" consequences to the maximum exposed off-site individual.

Twenty (20) accidents evaluated, all "Unlikely" or less frequent, were deemed to have the potential to produce E3 consequences, that is: "off-site discharge to discharge to the groundwater."

What are the average and maximum occupational radiation doses incurred at the facility?

The average dose (TED) is 36.5 mrem; the cumulative dose for 2013 is 2630 mrem; the maximum individual dose is 217 mrem.[23]

What processes and operations are conducted within the facility?

The primary actions at the CWC are shipping and receiving, waste container handling and waste storage.

However, permitted activities at the CWC for all types of wastes packages include the following[24]:

- Shipping and receiving
- Waste container handling
- Waste staging and storage
- Nonintrusive survey and inspection (including non-destructive examination and non-destructive assay)
- Waste loading/transfers
- Container venting
- Waste treatment
- Decontamination
- Packaging and repackaging (overpacking)
- Waste Verification
- Headspace gas sampling

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[21] Nester (2014).
[22] HNF 15589-8 (2012), Appendix A.
[23] Collins, Mike (2014).
[24] HNF 14741-10 (2013). Pages 2-21 and 2-22

What is the process flow of material into and out of the facility?

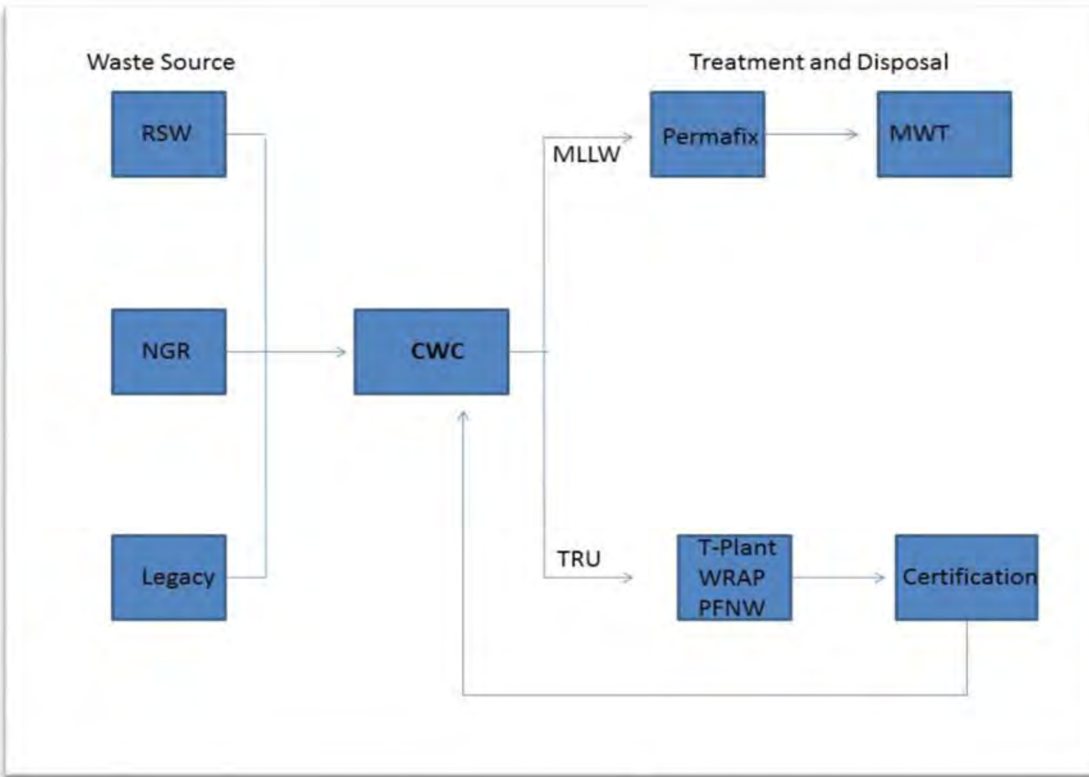

Figure 4: The Flow of Waste into and out of the CWC[25]

What effect do potential delays have on the processes, operations, and radioactive materials in the facility?

For the CWC there are 2 foreseeable delays: (1) overall delays for which the impact would be that the risks and hazards of the operating facility would continue as they are, without moving into a cleanup phase; (2) problems with WIPP or other long term storage would require the CWC to remain available to store TRU for an extended period of time for which the impact would also be the continuation of operating risks and hazards.

What other facilities or processes are involved in the flow of radioactive material into and out of the facility?

The CWC is a part of the Solid Waste Operating Group which also includes T-Plant and WRAP. The following process flow diagram illustrates the solid waste flow into and out of the facilities in the SWOC.

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[25] This diagram was created by Mike Collins during a group tour of the CWC.

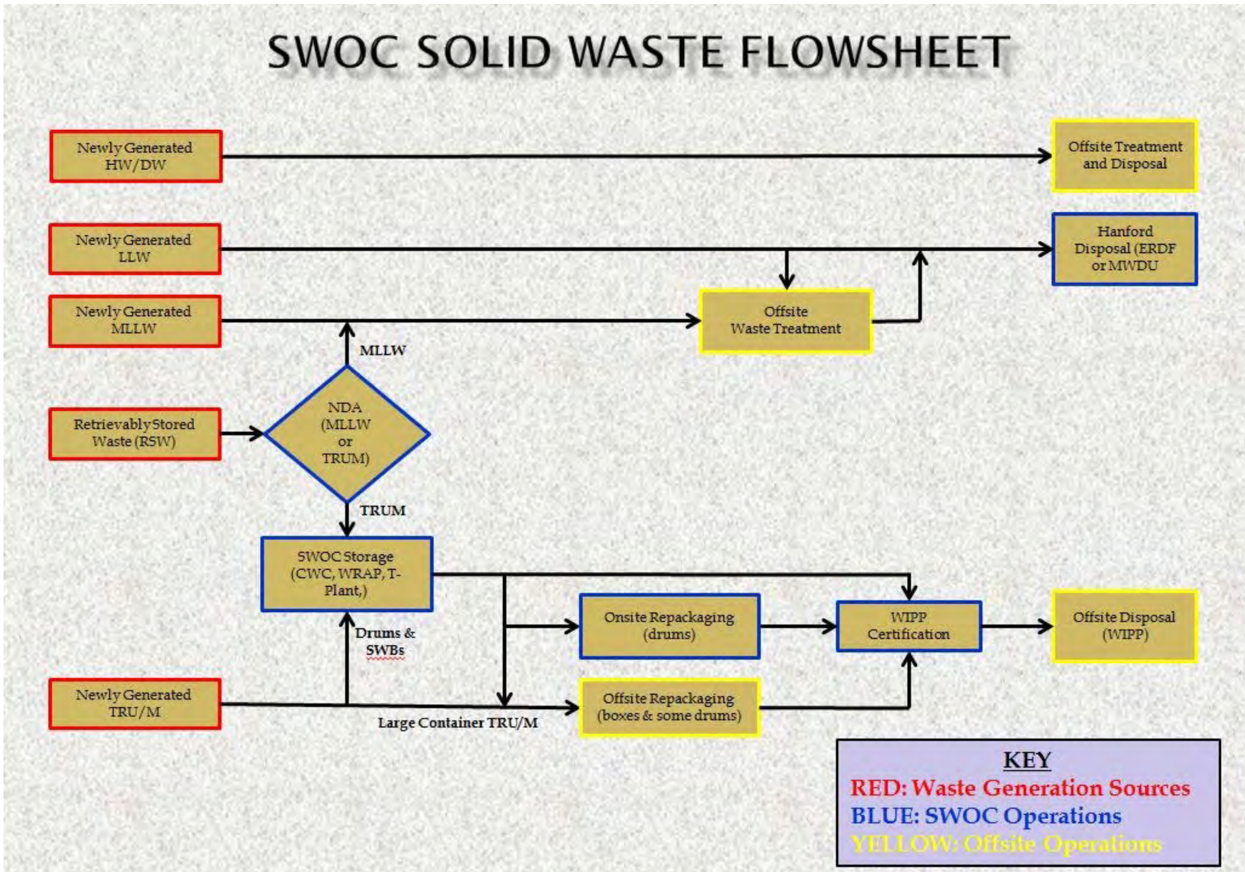

Figure 5: SWOC Solid Waste Flow Sheet[26]

Is shipping of material involved and if so, how often and by what means?

Waste transportation involves shipments from offsite and onsite waste generators to CWC facilities. Onsite shipments must comply with the Transportation Safety Document (TSD), required under DOE O 460.1C, Packaging and Transportation Safety. The TSD is the approved documented safety analysis for onsite transportation and packaging activities. Offsite shipments (arriving or leaving) must comply with the requirements of 49 CFR 171, "Hazardous Materials Regulations" unless exceptions are made, usually with attendant special provisions like temporary closure of public roads for transportation to Permafix NW. Offsite shipments may be made by truck, railroad, or other transportation conveyance. The railroad tracks are located outside of the boundaries of the CWC facilities with the exception of T Plant, which has taken measures to preclude entry of a train without positive actions by Operations.[27]

What infrastructure is considered a part of the facility?

The following units are considered a part of the CWC: 2403WA, 2403WB, 2403WC, 2403WD, 2404WA (permitted under WRAP but operated as a part of CWC), as well as the Flammable and Alkali Metal Waste Storage Modules, the 2401-W Building, the 2402-W Series of 12 buildings and outside storage areas A-F.

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[26] This flowsheet was provided after our site visit via Sharepoint. It was loaded by Mike Collins, but the author may be a different party.
[27] HNF 14741-10 (2013). Page 2-89

ECOLOGICAL RESOURCES SETTING

Landscape Evaluation and Resource Classification

The CWC EU includes levels 0, 1, 2, and 3 resources as classified in the existing resource level map (DOE/RL-96-32 2013). However, two locations classified as level 3 resources in the existing resource map have become degraded and were reclassified as level 2 for this assessment. Central and western portions of the EU have been converted into industrial areas and were reclassified as level 0 resources. The majority of the CWC site is characterized by level 0 (i.e., industrial sites, paved and compacted gravel areas) and level 2 resources (i.e., small patches with sparse climax or successional shrub overstory and non-native understory). Much of the area on the west side of the EU was reclassified as level 2 because it had burned previously, and was revegetatated with non-native and native species.

The amount and proximity of biological resources to the CWC EU was evaluated within the adjacent landscape buffer area radiating 1504 m from the geometric center of the site (equivalent to 1755 acres). Small patches of level 3 resources (ranging from 1.9 to 11.5 acres) are located to the east and southeast of the EU, including several point occurrences of sensitive species.

Field Survey

PNNL biologists conducted a reconnaissance and pedestrian survey of the EU. Much of the unit consists of buildings and parking areas with some scattered shrubs bordering the graveled areas. Some small patches of remnant shrub-steppe vegetation occur in between buildings, and canopy cover was visually evaluated, but not physically measured in the field. The patches between buildings contain some scattered big sagebrush (*Artemisia tridentata*) with mixed native and alien grass understory. Cheatgrass (*Bromus tectorum*) cover ranged from 30% to 50%. The canopy cover of dominant vegetation in the revegetated area that occurs to the west and south of the buildings and parking areas was primarily crested wheatgrass (*Agropyron cristatum*) along with sparse shrubs (*Artemisia tridentata and Atriplex canescens*).

No wildlife were observed within the unit during the July reconnaissance, however, PNNL ECAP surveys done in 2010 noted the following wildlife or wildlife signs: side-blotched lizard (*Uta stansburiana*), coyote (*Canis latrans*), mountain cottontail (*Sylvilagus nutalli*), and old scat from black-tailed jackrabbit (*Lepus californicus*).

CULTURAL RESOURCES SETTING

Cultural resources known to be recorded within the CWC EU consists of both contributing and noncontributing segments of a National register-eligible T historic/ethnohistoric trail/Road corridor associated with the Native American Precontact/Ethnographic and Pre-Hanford Early Settlers/Farming Landscapes as well as a historic site, likely associated with the Pre-Hanford Early Settlers/Farming Landscape. Additionally two isolated finds; one associated with the Native American Precontact and Ethnohistoric Landscape and one associated with the Pre-Hanford Early Settlers/Farming Landscape have also been identified. With the exception of the contributing portion of an historic/ethnohistoric Trail/Road, none of these resources is considered to be National Register-eligible. Previous cultural resources reviews have recommended a 60-foot easement of avoidance on either side of the contributing segment of the White Bluffs Trail/Road Corridor through this area.

Almost all of the CWC EU has been inventoried for archaeological resources. In addition to the archaeological resources already identified within the CWC EU, there is a possibility that intact archaeological material is present in the areas that have not been inventoried for archaeological resources (both on the surface and in the subsurface), particularly where the undisturbed soil deposits exist within the CWC EU.

The closest recorded archaeological sites, located within 500 meters of the CWC EU, consist of four isolated finds; one associated with the Native American and Ethnographic Landscape and three historic-era isolated finds that may be associated with the Pre-Hanford Early Settlers/Farming Landscape. All four are considered to be National Register ineligible.

The physical evidence of an historic/ethnohistoric Trail/Road within the CWC EU, indicates evidence of historic and ethnohistoric land use through the CWC EU. The geomorphology and presence of undisturbed soils suggests that there is a moderate potential for the presence of archaeological resources associated with all three landscapes to be present both in the surface and subsurface within the CWC EU. Pockets of undisturbed soil exist, it may be appropriate to conduct surface and subsurface archaeological investigations in these areas prior to initiating a remediation activity.

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 associated with these landscapes (e.g. East Benton Historical Society, the Franklin County Historical Society, the Prosser Cemetery Association, the Reach, and B-Reactor Museum Association) may need to occur. Indirect effects are always possible when TCPs are known to be located in the general vicinity. Consultation with Hanford Tribes may also 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

Brief description of contaminated media and materials

The predominant waste type at the CWC is containerized TRU/TRUM. There is presently one container 231ZDR-11 on an outside storage pad that is in a controlled area with rainwater collection and a roped off radiation/contamination protection zone.

What is the origin of the nuclear materials/wastes?

The CWC provides storage and staging for waste containers that are awaiting processing or shipment to other waste facilities. LLW, MLLW, TRU and TRUM waste is shipped from remediation projects elsewhere on the Hanford Site. Material is also received back from off-site treatment contractors (e.g., Perma-Fix Northwest) and prepared for shipment to final disposal sites, such as the Waste Isolation Pilot Plant (WIPP) for TRU waste; TRU and TRUM are the predominant waste types at CWC.

What are the primary radionuclides/contaminants?

In the Master Documented Safety Analysis for Solid Waste Operations Complex (HNF-14741), the bounding drum and array analysis assumptions of the SARAH are used. In that bounding drum, the radionuclides are assumed to be Pu-238, Pu-239 (more than 80% by activity), Pu-240, Pu-241 and Pu-242, along with the Pu decay product Am-241. Debris from D&D and operational wastes, notably from PNNL and Tank Farms, can also contain fission products (Cs-137, Sr-90). However, majority of presently stored waste is classified as TRU or TRUM. The contaminant inventory is provided in Table H.3-2.

What is the physical state of the materials, facility(ies), stored waste, and area surrounding the facility?

Waste received that the CWC is containerized LLW, MLLW, TRU, and TRUM in 55-gallon drums; less-frequently in larger packages (85-gallon over-packs), along strong, tight LLW containers such as wood and metal boxes[28]. The material condition is verified by the shipper as being satisfactory prior to shipment. Containers received in the CWC are either in good condition or are over-packed[29]. Shipping documentation is reviewed by CWC personnel upon receipt and a sample containers may be opened and visually inspected for adequate material condition and waste verification prior to entering the facility inventory[30].

The contaminant inventory is provided in Table H.3-2.

[28] EIS 0391 (2012), Section E.3.1.2.
[29] Permit WA7890008967, Part III, OU Group6, Central Waste Complex, Section C.2.1.1
[30] Permit WA7890008967, Part III, OU Group6, Central Waste Complex, Addendum B

Table H.3-2: CWC Contaminant Inventory[31],[32]

WIDS	Description and Reference	Isotope Inventory (Ci)								Chemical Inventory (kg)				
		Cs-137	Sr-90	Tc-99	I-129	H-3	Pu (total)	Am-241	U (total)	CCl4	Cr (total)	Cr (VI)	TCE	NO3
2120-WA	Snapshot inventory for CWC provided as estimate for all waste containers and storage areas as a total amount. The reference for this material is an e-mail from Mike Collins. The total Pu is based on a snapshot inventory estimate from the solid waste inventory tracking system (SWITS)						52,889			10700	2040	1.41	Not known.	2590
2120-WB	See 2120-WA for combined inventory estimate.													
213-W	Not presently known.													
213-W-1	See 2120-WA for combined inventory estimate.													

[31] Total Pu from Snapshot inventory from SWITS, 2014.
[32] Chemical inventory from Personal Communication with Mike Collins via e-mail from January, 2015.

213-WTK-1	Not presently known.													
216-ZP-1A	See 2120-WA for combined inventory estimate.													
2401-W	See 2120-WA for combined inventory estimate.													
2402-W	See 2120-WA for combined inventory estimate.													
2402-WB	See 2120-WA for combined inventory estimate.													
2402-WC	See 2120-WA for combined inventory estimate.													
2402-WD	See 2120-WA for combined inventory estimate.													
2402-WE	See 2120-WA for combined inventory estimate.													
2402-WF	See 2120-WA for combined inventory estimate.													
2402-WG	See 2120-WA for combined inventory estimate.													
2402-WH	See 2120-WA for combined inventory estimate.													
2402-WI	See 2120-WA for combined inventory estimate.													
2402-WJ	See 2120-WA for combined inventory estimate.													
2402-WK	See 2120-WA for combined inventory estimate.													

2402-WL	See 2120-WA for combined inventory estimate.													
2403-WA	See 2120-WA for combined inventory estimate.													
2403-WB	See 2120-WA for combined inventory estimate.													
2403-WC	See 2120-WA for combined inventory estimate.													
2403-WD	See 2120-WA for combined inventory estimate.													
2404-WA	See 2120-WA for combined inventory estimate.													
2404-WB	See 2120-WA for combined inventory estimate.													
2404-WC	See 2120-WA for combined inventory estimate.													
240-W	See 2120-WA for combined inventory estimate.													
2420-W	See 2120-WA for combined inventory estimate.													
286-W	See 2120-WA for combined inventory estimate.													
CC0594	See 2120-WA for combined inventory estimate.													
HS0057	See 2120-WA for combined inventory estimate.													
HS0058	See 2120-WA for combined inventory estimate.													

HS0059	See 2120-WA for combined inventory estimate.													
HS0060	See 2120-WA for combined inventory estimate.													
HS0061	See 2120-WA for combined inventory estimate.													
HS0062	See 2120-WA for combined inventory estimate.													
HS0063	See 2120-WA for combined inventory estimate.													
HS0064	See 2120-WA for combined inventory estimate.													
HS0077	See 2120-WA for combined inventory estimate.													
RMWSF	See 2120-WA for combined inventory estimate.													

Contamination within Primary EU Source Components

Legacy Source Sites

Not Applicable

High Level Waste Tanks and Ancillary Equipment

Not Applicable

Vadose Zone Contamination

Not Applicable

Groundwater Plumes

Carbon Tetrachloride plume exists below the CWC which is under active pump and treat remediation.

Facilities for D&D

Not Applicable

Operating Facilities

Stored radioactive material is normally contained within its engineered containers. Exceptions to this are remediated.

Detailed inventories are provided in Table H.3-3, Table H.3-4, and Table H.3-5. All values are to 2 significant figures. The source document should be consulted for greater precision data. The sum for each primary contaminant is shown in the first row. Table H.3-6 provides a summary of the evaluation of threats to groundwater as a protected resource from saturated zone and remaining vadose zone contamination associated with the evaluation unit.

Table H.3-3. Inventory of Primary Contaminants[(a)]

WIDS	Description	Decay Date	Ref[(b)]	Am-241 (Ci)	C-14 (Ci)	Cl-36 (Ci)	Co-60 (Ci)	Cs-137 (Ci)	Eu-152 (Ci)	Eu-154 (Ci)	H-3 (Ci)	I-129 (Ci)
All	Sum			NP	NP	NP	NP	NP	NP	NP	NP	NP
2120-WA	Infrastructure Building		SWITS	NP	NP	NP	NP	NP	NP	NP	NP	NP

a. NP = Not present at significant quantities for indicated EU

Table H.3-4. Inventory of Primary Contaminants (cont)[(a)]

WIDS	Description	Decay Date	Ref[(b)]	Ni-59 (Ci)	Ni-63 (Ci)	Pu (total) (Ci)	Sr-90 (Ci)	Tc-99 (Ci)	U (total) (Ci)
All	Sum			NP	NP	53000	NP	NP	NP
2120-WA	Infrastructure Building		SWITS	NP	NP	53000	NP	NP	NP

a. NP = Not present at significant quantities for indicated EU

Table H.3-5. Inventory of Primary Contaminants (cont)[(a)]

WIDS	Descrip-tion	Ref[(b)]	CCl4 (kg)	CN (kg)	Cr (kg)	Cr-VI (kg)	Hg (kg)	NO3 (kg)	Pb (kg)	TBP (kg)	TCE (kg)	U (total) (kg)
All	Sum		11000	NP	2000	1.4	NP	2600	NP	NP	NP	NP
2120-WA	Infrastructure Building	SWITS	11000	NP	2000	1.4	NP	2600	NP	NP	NP	NP

a. NP = Not present at significant quantities for indicated EU

Table H.3-6. Summary of the Evaluation of Threats to Groundwater as a Protected Resource from Saturated Zone (SZ) and Remaining Vadose Zone (VZ) Contamination associated with the Evaluation Unit

PC	Group	WQS	Porosity[a]	K_d (mL/g)[a]	ρ (kg/L)[a]	VZ Source M^{Source}	SZ Total M^{SZ}	Treated[c] M^{Treat}	VZ Remaining M^{Tot}	VZ GTM (Mm^3)	VZ Rating[d]
C-14	A	2000 pCi/L	0.23	0	1.84	---	---	---	---	---	ND
I-129	A	1 pCi/L	0.23	0.2	1.84	---	---	---	---	---	ND
Sr-90	B	8 pCi/L	0.23	22	1.84	---	---	---	---	---	ND
Tc-99	A	900 pCi/L	0.23	0	1.84	---	---	---	---	---	ND
CCl4	A	5 µg/L	0.23	0	1.84	---	---	---	---	---	ND
Cr	B	100 µg/L	0.23	0	1.84	---	---	---	---	---	ND
Cr-VI	A	48 µg/L[b]	0.23	0	1.84	---	---	---	---	---	ND
TCE	B	5 µg/L	0.23	2	1.84	---	---	---	---	---	ND
U(tot)	B	30 µg/L	0.23	0.8	1.84	---	---	---	---	---	ND

a. Parameters obtained from the analysis provided in Attachment 6-1 to Methodology Report.

b. “Model Toxics Control Act—Cleanup” (WAC 173-340) Method B groundwater cleanup level for hexavalent chromium.

c. Treatment amounts from the 2013 Hanford Annual Groundwater Report (DOE/RL-2014-32, Rev. 0).

d. Groundwater Threat Metric rating based on Table H.3-6-3, Methodology Report. These contaminants are being treated using the 200-West Groundwater Treatment Facility.

PART VI. POTENTIAL RISK/IMPACT PATHWAYS AND EVENTS

CURRENT CONCEPTUAL MODEL

Narrative description of pathways and barriers to receptors and conditions/events that can lead to completed pathways

Pathways and Barriers: (1. description of institutional, natural and engineered barriers (including material characteristics) that currently mitigate or prevent risk or impacts, 2. Time scale from loss of each barrier to realization of risk or impacts)

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 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?*

There are three major types of barriers to release of contamination from the primary facility: (1) Engineered systems including the waste container, and secondary containment systems (buildings, berms, sumps, etc.); (2) Operating Procedures such as Waste Acceptance Criteria, Venting Programs, RCRA and radiological inspections, and others; and (3) Safety Management Systems such as nuclear criticality safety and transportation safety. These are further defined in Appendix 1.

There is one identified completed pathway to receptors, which is the ionizing radiation associated with these packages. People in the vicinity of the packages do accumulate occupational exposure, but it is monitored to ensure it stays well below regulatory levels of concern.

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

The initiating events that may lead to degradation or failure of the barriers include: worker accidents, loss of institutional controls, loss of engineering controls, structural decay or failure, wild fire or facility fire, earthquake, dam failure, ash fall and plane crash; these are evaluated in the DSA (HNF-14741).

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

The primary pathway of concern is airborne dispersion of material from containerized waste; the populations at risk from this source include workers (on site and non-collocated).

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

For all initiating events, because the primary pathway to the receptors is airborne, the time frame to human exposure or impacts will be very short, on the order of hours, days or weeks.

5. *Are there current on-going releases to the environment or receptors?*

At the time of this study, we are unaware of on-going releases to the environment or receptors, but as mentioned previously, we do have one completed pathway to workers of an occupational radiation dose.

The rate at which CWC has been able to ship its inventory to disposal sites – especially for TRU waste – has been curtailed in recent years because of higher budget priorities elsewhere. The slow rate of shipping wastes for disposal has been exacerbated by the curtailment of operations at WIPP. As a consequence, the TRU waste inventory at CWC (the material at risk in accident scenarios) and, thus, the inventory available for release (material at risk) during certain accidents, has and will continue to increase until the facility inventory can be reduced.

POPULATIONS AND RESOURCES CURRENTLY AT RISK OR POTENTIALLY IMPACTED

Workers

Workers are the resource impacted by the only current completed pathway of occupational radiation exposure. In the instance of the initiating events described above, any exposure would likely be airborne dispersion of containerized waste and exposure via inhalation or external radiation due to proximity to contamination.

Public

The low level public is at risk due to airborne exposure of containerized waste in an event scenario.

Groundwater

CWC contamination is confined to the CWC building and there are no vadose zone sources or current groundwater contamination associated with this EU. This leads a ND rating.

Columbia River

The Columbia River will not be impacted by the CWC due to the 13 km distance between the facility and the river. This leads a ND rating.

Ecological Resources

- No level 3 or higher quality habitat patches occur within the CWC EU.
- Cleanup activities would result in no net change in the amount of level 3 or higher resources within a 1.5 km radius.
- The CWC EU is adjacent and contiguous to multiple industrial sites—no significant change in habitat connectivity would be expected if habitat resources within the EU are lost.

Cultural Resources Setting:

- Four isolated finds consisting of one associated with the Native American Precontact and Ethnographic Landscape and three historic-era finds associated with the Pre-Hanford Early Settlers/Farming Landscape are located within 500 meters of the CWC EU. All four are considered to be National Register ineligible.

Recorded TCPs Visible from the EU

- There are two recorded TCPs associated with the Native American Precontact and Ethnographic Landscape that are visible from the CWC EU.

CLEANUP APPROACHES AND END-STATE CONCEPTUAL MODEL

Selected or Potential Cleanup Approaches

Addendum H of the RCRA Permit for CWC outlines closure activities as follows: (1) remove waste inventory; (2) decontaminate structural surfaces and equipment; (3) analyze decontamination waste to determine proper methods of treatment/disposal; and (4) dispose of decontamination waste based on results of waste analysis. The total duration of the cleanup phase is expected to be 180 days.[33]

The DSA states that D&D and cleanup activities have yet to be planned. The following cultural and ecological risks have been identified:

Ecological Resources

Trucks, heavy equipment and drill rigs 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. Additional water from dust suppression could lead to more diverse and abundant vegetation in areas that receive water, which could encourage invasion of exotic species. The latter could displace native plant communities. Excessive dust suppression activities could lead to compaction, which can decrease plant growth in those areas, decrease abundance and diversity of soil invertebrates, and prevent fossorial snakes or mammals from using the area. Use of non-specific herbicides results in some mortality of native vegetation (especially native forbes), and allows exotic species to move in. It may change species composition of native communities, but it also could make it easier for native species to move in. Improved methods could result in positive results. Soil removal can cause complete destruction of existing ecosystem, all of the above effects on adjacent sites, but these effects are potentially more severe because of blowing soil (and seeds) and the potential for exposure of dormant seeds. In the re-vegetation stage, there is the potential for invasion of exotic species, changing the species diversity of native communities. 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, car, and truck traffic on paved and two-track roads as well as use of heavy equipment will not have any direct impact on archaeological resources because there is no disturbance to soil/ground or alteration to the landscape. Assuming heavy equipment locations 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 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 paved roads located on TCP, direct effects include visual, auditory and vibrational alterations to landscape/setting. Heavy equipment 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. Construction of staging areas 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 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

[33] Permit WA7890008967, Part III, OU Group6, Central Waste Complex, Closure Plan: Page 6.

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 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. 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 include 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, car, and truck traffic on paved and two-track roads as well as use of heavy equipment 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. Existing road causes no alteration to 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 construction, 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.

Not Applicable

Risks and Potential Impacts Associated with Cleanup

The DSA states that D&D and cleanup activities have yet to be planned. The following cultural and ecological risks and impacts have been identified:

Populations And Resources At Risk Or Potentially Impacted During Or As A Consequence Of Cleanup Actions

Workers (directly involved)

Not Applicable

Co-located (CW)

Not Applicable

Public

Not Applicable

Groundwater

CWC contamination is confined to the CWC building and there are no vadose zone sources or current groundwater contamination associated with this EU. However, threats to groundwater could emerge from container degradation and subsequent leaks into the subsurface. It is assumed that this will not occur over the next 50 years. This leads to a ND rating.

Columbia River

The Columbia River will not be impacted by the CWC due to the 13 km distance between the facility and the river. This leads to a ND rating.

Ecological Resources

Personnel, car, and pick-up truck traffic through non-target and remediated areas will likely no longer cause an effect on the ecological resources, unless heavy traffic caused ruts. If alien/exotic species became established during remediation, their presence could continue to affect the ecological resources. Permanent effects remain in the area of site with barrier or cap. Permanent effects remain in area surrounding cap or containment, depending upon traffic and current activities. 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 community.

Cultural Resources

Personnel, car and truck traffic on paved roads will likely have no direct effects on the cultural resources assuming the resources were not disturbed during remediation. If the remedial action included construction of buildings, cap or other type of containment then there are permanent effects in the area of the site. If archaeological resources or TCPs were directly or indirectly damaged or altered during construction of buildings or cap, cumulative effects include continued erosion and adverse effects to both archaeological site and TCP. If contamination is left behind and controlled by a barrier or other containment, then permanent effects to the cultural resources may occur in the area. If archaeological resources or TCPs were directly or indirectly damaged or altered during contamination, then cumulative effects include permanent adverse effects to both archaeological site and TCP.

Additional Risks and Potential Impacts if Cleanup is Delayed

None, continued operations and maintenance of the facility. Potential for increased container maintenance due to normal degradation mechanisms (e.g., corrosion).

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

Populations and Resources at Risk or Potentially Impacted After Cleanup Actions (from residual contaminant inventory or long-term activities)

Table H.3-7. Population or Resource Risk/ Impact Rating.

Population or Resource		Risk/Impact Rating	Comments
Human	Facility Worker	Unknown	Dependent on D&D methods chosen
	Co-located Person	Unknown	Dependent on D&D methods chosen
	Public	Unknown	Dependent on D&D methods chosen
Environmental	Groundwater	ND	Dependent on D&D methods chosen. CWC contamination is confined to the CWC building and there are no vadose zone sources or current groundwater contamination associated with this EU. However, threats to groundwater could emerge from container degradation and subsequent leaks into the subsurface. It is assumed that this will not occur over the next 150 years. This leads to a ND rating.
	Columbia River	ND	Dependent on D&D methods chosen. The Columbia River will not be impacted by the CWC due to the 13 km distance between the facility and the river. This leads to a ND rating.
	Ecological Resources*	ND-Low	Remediation options unknown, thus whether area with be re-vegetated is unknown. If re-vegetated, risk could be low (rather than ND) due to presence of higher quality resources (e.g. level 3 or 4) created by re-vegetation.
Social	Cultural Resources*	**Native American:** Direct: Known Indirect: Known **Historic Pre-Hanford:** Direct: Known Indirect: Known **Manhattan/Cold War**: Direct: None Indirect: None	Long-term protection measures may be in place to resolve adverse effects to National Register eligible trail. Permanent effects possible due to presence of contamination.

*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 Resources: Remediation options unknown, thus whether area with be re-vegetated is unknown. If re-vegetated, risk could be low (rather than ND) due to presence of higher quality resources (e.g. level 3 or 4) created by re-vegetation.

Cultural Resources: Long-term protection measures may be in place to resolve adverse effects to National Register eligible trail. Permanent effects possible due to presence of contamination.

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

Unknown.

PART VII. SUPPLEMENTAL INFORMATION AND CONSIDERATIONS

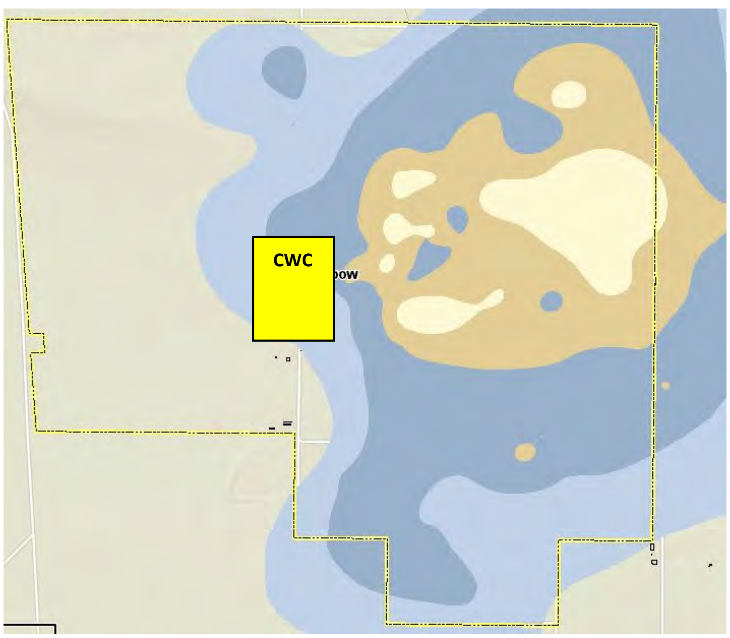
CURRENT CONDITIONS THAT IMPAIR OR PRECLUDE PLANNED FUTURE LAND USE:

The CWC is an active radioactive waste storage facility. Several large and number of smaller steel-framed structures are built on concrete pads for waste storage. In addition, several outdoor storage areas exist, the largest of which is compacted gravel, others are concrete or asphalt pads. Most other structures associated with CWC are mobile/modular in construction and are re-locatable.

Other uses would await post D&D condition assessment; however, CWC is located on the Central Plateau, an area presently scheduled for continued federal custody.

Remedial processes and impacts

There is a potential future impact from the carbon tetrachloride plume. The following Figure illustrates the plume and its proximity to the CWC within the 200 West Area.



Appendix 1

Description of Barriers

There are several barriers in place to prevent risk or impacts as follows:

Engineered Systems

- The waste container and/or overpack
- Secondary Containment
- CWC Fire Protection and Automatic Fire Suppression Systems[34]
    - 2403 buildings contain manual dry chemical, 20-lb, Type ABC fire extinguishers at strategic locations throughout each building.
    - In 2404-WA, fire protection water lines comply with applicable fire protection orders and standards. Each building has a manual fire extinguisher.
    - The LFMW storage modules are supplied with portable fire extinguishers in accordance with NFPA 10, Standard for Portable Fire Extinguishers. The LFWM modules have Class ABC (approximately 10 lbs agent weight) stored pressure dry chemical extinguishers. The AMW modules, including Module FS-19, have Class D portable fire extinguishers. A 14 kg, Type D fire extinguisher is mounted on the exterior of each module. All extinguishing equipment is hand operated.
    - Fire suppression for buildings 2402-W through -WL is provided by a single dry pipe automatic sprinkler system in each building. Piping is sized in accordance with National Fire Protection Association (NFPA) 13, *Standard for the Installation of Sprinkler Systems* (ordinary hazard pipe schedule or better). These buildings have two fire pull boxes located near personnel exit doors.
    - The 2401-W, 2402-W and 2402-WC buildings have been categorized as <HC-3 facilities. The fire suppression systems for these buildings are not a credited safety-significant (SS) structure, system or component (SSC).
    - Fire suppression for Buildings 2403-WA through -WD is provided by two dry pipe automatic sprinkler systems in each building. Each half of the structure is protected by a separate system, one located in each of two small heated rooms outside each building. Piping for the dry pipe sprinkler systems is sized in accordance with NFPA 13Fire pull boxes are located near exit doors.
    - The 2404-WA through WC buildings fire suppression systems (FSSs) were hydraulically designed with a density of 0.30 gpm/ft2 over 3,000 ft2 with high temperature heads. Adjustments made to the design basis of the sprinkler systems to allow storage of NFPA containers, resulted in a revised design specification of 0.25 gpm/ft2 over 3,900 ft2.
- Building specific features for the CWC Dangerous Waste Management Units[35]:

    Flammable and Alkali Metal Waste Storage Modules

    - Vented catch sump under the storage floor provides spill containment
    - Dedicated secondary containment system

    2401 – W Building

[34] HNF 14741-10 (2013). Page 2-139
[35] Permit WA7890008967, Part III, OU Group6, Central Waste Complex, Addendum C: Pages 5-9.

- Perimeter concrete curb 15.2 cm above grade with ramps for loading and unloading operations
- Floors coated with an epoxy resin floor surfacing system compatible with the waste

2402 – W Series Buildings

- Perimeter concrete curb 15.2 cm above grade with ramps for loading and unloading operations
- Floors are coated with an epoxy resin floor surfacing system compatible with the waste

2403 – W Series Buildings

- Floors are divided into quadrants by concrete curbs 12.7 cm high
- Floors are coated with an epoxy resin floor surfacing system compatible with the waste
- Adjacent areas to the buildings are stabilized and graded to slope away from the buildings

CWC Outside Storage Area A (gravel)

- Storage area graded and leveled with gravel
- No double containment

CWC Outside Storage Area B (gravel)

- Storage area graded and leveled with gravel
- No double containment

CWC Outside Storage Area C (gravel)

- Storage area graded and leveled with gravel
- No double containment

CWC Outside Storage Area D (epoxy coated concrete pad)

- Curbed with concrete and provided with epoxy coating to prevent contaminants from entering the concrete with access ramps
- Rainwater collection and removal system

CWC Outside Storage Area E (asphalt pad)

- No double containment

CWC Outside Storage Area F (asphalt pad)

- No double containment

Operating Procedures and Processes

- Waste Acceptance Criteria and Waste Characterization
  - Waste screening and documentation occurs as required by HNF-EP-0063, Hanford Site Solid Waste Acceptance Criteria, before waste is shipped to CWC.
    - Generators must receive advance approval to ship a waste package and must certify before shipment that the waste meets the SWOC waste acceptance criteria.

• The Hanford Site can accept only waste from offsite generators that have been approved by DOE. Offsite generators must submit information to DOE, Richland Operations Office, which forwards the information for evaluation.

• The information necessary to verify that the waste meets acceptance requirements (HNF-EP-0063) must be provided before the waste can be shipped to CWC. The information must address the following seven elements (as well as any other pertinent information necessary to ensure proper management of the waste):

− Identification number (must be the corresponding waste specification record number)
− Waste generating process description
− Physical characterization
− Radioactive characterization
− Chemical characterization
− Segregation
− Packaging

  - Analytical data or process knowledge documentation must be included with the waste information. Once waste is shipped to CWC, it is checked to ensure that each container matches the information approved during initial information review. Waste containers are inspected to determine if they meet acceptance criteria. Those meeting the criteria are accepted, offloaded, and stored. Noncompliant containers are isolated and evaluated, and either returned to the generator for resolution or remedied at SWOC using approved methods for handling the nonconforming condition safely.
- Venting Waste Containers[36]
  - There is a potential for hydrogen generation within specific waste containers, based on their contents. The amount of hydrogen generated is dependent on the radionuclide activity, organic or hydrogenous waste matrix, and distribution of the radionuclides in the organic or hydrogenous material matrix. Venting is performed to reduce the potential for flammable gas accumulations within waste containers.
  - Several different drum venting systems currently are available for use although other systems are also acceptable if they meet the safety functions specified in HNF-EP-0063. The venting systems facilitate installation of WIPP-certified filters in waste drums. These filters are designed to allow hydrogen and other flammable gases to diffuse from the drum while retaining radioactive materials.
  - While these capabilities exist in CWC, SWOC operations has decided that venting will normally be performed at T Plant.
- Container Management Program – limits source term (i.e., release fraction) for certain accidents
  - Container Management (Technical Safety Requirement-Specific Administrative Control (TSR-SAC)): The SAC elements of this program establish credited controls to ensure safe container staging and storage as follows. This control ensures that container handling, staging, and storing are conducted in a safe manner by providing controls on container acceptance, handling damaged containers, waste

[36] HNF 14741-10 (2013). Page 2-102

acceptance, and characterization. The SAC elements under this program that are credited as important controls are the following:[37]
- Bulged Container Exam
- Intrusive Operations
- Bulged Container Venting
- Container Integrity
- Venting/Staging Requirements

- Abnormal Container Management Program[38]
  - This control ensures that containers are inspected for potential damage prior to being handled (readily visible container surface areas), thus minimizing a potential accident that could lead to loss of containment and release of radioactive material during handling activities. The inspection allows early warning and taking a protective posture for identified hazardous conditions (e.g., bulging containers, unvented containers at inappropriate locations).

Safety Management Systems

- Nuclear Criticality Safety – spacing of high-SNM content containers, physical barriers
  - Criticality Safety Program at the Hanford Site (HNF-7098, CHPRC Criticality Safety Program) implements key requirements including the following[39]:
    - Fissionable material controls at locations where significant amounts of these materials might be present
    - Criticality safety training
    - CSERs
    - Criticality prevention specifications (CPS)
    - Criticality safety postings
    - Fissionable material labeling
    - Fissionable material storage
    - Criticality safety configuration control
    - Fissionable material packaging and transportation
    - Criticality safety for firefighting
    - Criticality safety inspections and assessments
    - Criticality safety nonconformance response
    - Emergency procedures following a criticality or potential criticality accidents
- Transportation Safety – for onsite and off-site shipments

Waste transportation involves shipments from offsite and onsite waste generators to CWC facilities. Onsite shipments must comply with the Transportation Safety Document (TSD), required under DOE O 460.1C, Packaging and Transportation Safety. The TSD is the approved documented safety analysis for onsite transportation and packaging activities. Offsite shipments (arriving or leaving) must comply with the requirements of 49 CFR 171, “Hazardous Materials Regulations” unless exceptions are made, usually with attendant special provisions like temporary closure of public roads for transportation to PermafixNW. Offsite shipments may be made by truck, railroad, or other transportation conveyance. The railroad tracks are located outside of the boundaries of the CWC facilities with the exception of T

[37] HNF 14741-10 (2013). Page 3-155
[38] HNF 14741-10 (2013). Page 3-157
[39] HNF 14741-10 (2013). Page 3-360

Plant, which has taken measures to preclude entry of a train without positive actions by Operations.[40]Appendix 2

Full List of Chemical Container Inventory for a Sample Container at the CWC

SWITS R310 for Container 0089068[41]

STYRENE

BARIUM NITRATE

CHROMIC CHLORIDE

FERRIC SULFATE

CALCIUM IODIDE

MAGNESIUM PERCHLORATE

STRONTIUM NITRATE

ALUMINUM SULFATE

BORIC ACID

CALCIUM CHLORIDE

FERROUS AMMONIUM SULFATE

MERCURIC NITRATE

NEODYMIUM NITRATE

LANTHANUM NITRATE

LEAD NITRATE

CALCIUM SULFATE (PLASTER OF PARIS)

URANYL NITRATE

CEROUS NITRATE

CALCIUM NITRATE

FERRIC AMMONIUM SULFATE

AMMONIUM BISULFITE, SOLID

SODIUM TUNGSTATE

SILVER SULFATE

CERIUM NITRATE

CADMIUM NITRATE

SODIUM METAPHOSPHATE

BARIUM CHLORIDE

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[40] HNF 14741-10 (2013). Page 2-89
[41] SWITS (2014).

YTTRIUM NITRATE

LITHIUM SULFATE

MAGNESIUM NITRATE

MANGANESE NITRATE

FERRIC NITRATE (TOX PER CAS 7782-61-8)

PERIODIC ACID

SODIUM DICHROMATE

P-CRESOL

P-DICHLOROBENZENE

VINYL CYCLOHEXENE DIOXIDE

1,2-DICHLOROETHANE

ETHYLENE GLYCOL

DIBUTYL PHOSPHATE

PROPYLENE GLYCOL MONOMETHYL ETHER

2-DIMETHYLAMINOETHANOL

4-METHYL-2-PENTANONE

M-CRESOL

TOLUENE

PHENOL

N-HEXANE

CYCLOHEXANE

PYRIDINE

ADIPONITRILE

SODIUM ALUMINATE

TRIOCTYLAMINEINE

OLEIC ACID

AMORPHOUS SILICA

BROMOCRESOL PURPLE

1,8-DIHYDROXYANTHRAQUINONE

GALLIUM OXIDE

PLUTONIUM II OXIDE

ARSENIC (V) OXIDE, HYDRATE

NICKEL HYDROXIDE

HAFNIUM OXIDE

BORON CARBIDE

2,4-DINITROTOLUENE

TRIETHYLAMINE

AMMONIUM FLUORIDE

AMMONIUM CHLORIDE

BORIC ACID, DISODIUM SALT, PENTAHYDRATE

HYDROQUINONE

BUTYL STEARATE

ALUMINUM HYDROXIDE SILICATE

TRIBUTYL PHOSPHATE (TBP)

ACETIC ACID, POTASSIUM SALT (POTASSIUM ACETATE)

TETRACHLOROETHYLENE

SODIUM BORATE, DECAHYDRATE

CALCIUM HYDROXIDE

CALCIUM OXIDE

CERIC OXIDE

FERRIC OXIDE

MAGNESIUM OXIDE

LEAD DIOXIDE

POTASSIUM HYDROXIDE

LITHIUM HYDROXIDE

SODIUM HYDROXIDE

AMMONIUM MOLYBDATE

MANGANESE DIOXIDE

NEODYMIUM OXIDE

NICKEL (II) NITRATE (1:2)

ZINC OXIDE

TUNGSTEN TRIOXIDE

PHOSPHORUS PENTOXIDE

VANADIUM PENTOXIDE (DUST) FUME NOT TOXIC

COPPER OXIDE

CALCIUM CARBONATE

SILICA, CRYSTALLINE - TRIPOLI

URANIUM OCTAOXIDE

TRANS-1,2-DIAMINOCYCLOHEXANE-N,N,N',N'-TETRAACETIC ACID

XYLENE (MIXED ISOMERS)

PROPYLENE GLYCOL

CHROMIUM TRIOXIDE

ALUMINUM SILICATE

AMMONIUM HYDROXIDE

SODIUM SELENATE

ALUMINUM OXIDE

URANIUM DIOXIDE

VANADYL SULFATE

TITANIUM OXIDE

ARSENOUS ACID, TRISODIUM SALT

HYDROXYLAMINE NITRATE

FERROUS CHLORIDE

CUPFERRON

CERIUM SULFATE

SODIUM PHOSPHITE

POTASSIUM FERROCYANIDE

ZINC NITRATE

THORIUM NITRATE

ZIRCONYL NITRATE

SODIUM SILICATE

NITRILOTRIACETIC ACID

AMMONIUM OXALATE

SODIUM OLEATE

SODIUM TETRAPHENYL BORON POWDER

SODIUM CITRATE

SODIUM BICARBONATE

OXALIC ACID

SILICA, CRYSTALLINE-CRISTOBALITE

CRYSTALLINE QUARTZ SILICA

SODIUM FORMALDEHYDE SULFOXYLATE

HYDROXYETHYLETHYLENEDIAMINETRIACETIC ACID, 2,NSODIUM

FLUOALUMINATE

HYDROFLUOSILICIC ACID

BARIUM HYDROXIDE

AMMONIUM THIOCYANATE

CHROMIUM (VI)

COPPER (II) NITRATE

SILVER (1+) OXIDE

CADMIUM HYDROXIDE

MERCURIC OXIDE

DIPHOSPHORIC ACID

SODIUM DODECYLBENZENESULFONATE

POLYETHYLENE GLYCOL

TRIHEPTYLAMINE, 6,6',6"-TRIMETHYLNONENYLSUCCINIC

ANHYDRIDE

BIS(2 ETHYL HEXYL)HYDROGEN PHOSPHATE

POTASSIUM BICARBONATE

LEAD ACETATE

POTASSIUM SODIUM TARTRATE

THENOYLTRIFLUOROACETONE

CHLORIC ACID, POTASSIUM SALT

EPOXY RESIN

ACETIC ACID, (1,2-CYCLOHEXYLENEDINITRILO)TETRA

SODIUM CARBONATE

FORMALDEHYDE

ASCORBIC ACID

SILVER CYANIDE

DINITROPHENOL, 2,4-

BARIUM CARBONATE

2-PROPANOL, 1-BUTOXY

GLUCONICACID 50% IN WATER

SULFAMIC ACID

HYDROXYLAMINE HYDROCHLORIDE
P-METHYLAMINOPHENOL SULFATE
ZINC STEARATE
CARBON TETRACHLORIDE
GLYCINE
GLYCEROL OR 1,2,3-PROPANETRIOL
UREA
SUCROSE
1,2-PROPANEDIOL
POTASSIUM CARBONATE
MERCURIC THIOCYANATE
EDTA (ETHYLENEDIAMINETETRAACETIC ACID)
SODIUM ACETATE
CRESOL RED, WATER SOLUBLE, INDICATOR GRADE
AMMONIUM ACETATE
SILICA GEL
TETRASODIUM N,N'-ETHYLENEDIAMINEDIACETATE
ETHANOL
FORMIC ACID
MINERAL OIL, PETROLEUM DISTILLATES (MILD & SEVERE)
NORMAL PARAFFINS
CLAY-TREATED RESIDUAL OILS (PETROLEUM)
HYDROTREATED (MILD & SEVERE) HEAVY PARAFFINIC DISTILLATE
HYDRODESULFURIZED KEROSENE (PETROLEUM)
GLYCINE, N,N-BIS(2-(BIS(CARBOXYMETHYL)AMINE)ETHYL)-
METHANOL
ISOPROPYL ALCOHOL
ACETONE
CHLOROFORM
HEXACHLOROETHANE
COTTONSEED OIL, HYDROGENATED
ZINC SALTS OF DIALKYLPHOSPHORODITHIOIC ACID (ADDITIVE INGRD)
D-MANNITOL

STYRENE/DVB ION EXCHANGE RESIN

BENZENE, DIETHENYL-, POLYMER; ETHENYLBENZENE &

ETENYLETHYLBENZENE, SU

SULFONATED COPOLYMER OF STYRENE AND DIVINYLBENZENE IN SODIUM

BUTYL ALCOHOL

BENZENE

1,1,1-TRICHLOROETHANE

PROPANE

ALUMINUM

IRIDIUM POWDER

IRON

LEAD

LITHIUM

MANGANESE

MERCURY

MOLYBDENUM

NICKEL

PLATINUM

PLUTONIUM

SILICON

SILVER

SODIUM

TIN

ARSENIC

BARIUM

BERYLLIUM

CADMIUM

CARBON

CHROMIUM

COPPER

GADOLINIUM

GOLD

VANADIUM

ZINC

ZIRCONIUM

BISMUTH

CALCIUM

ALUMINUM CHLORIDE

POTASSIUM CHLORIDE

VINYL CHLORIDE (CHLOROETHYLENE)

DICHLOROMETHANE

ISOBUTANE

1,1-DICHLOROETHYLENE

TRIMETHYL CHLOROSILANE

IODINE

SODIUM PHOSPHATE DIBASIC

1,1,2-TRICHLORO-1,2,2-TRIFLUOROETHANE

PERCHLORIC ACID

SILICON DIOXIDE

SODIUM BISULFITE (PH = 4.56 PER T. HUGHES)

SODIUM NITRATE

SODIUM NITRITE

STANNIC CHLORIDE

ZINC CHLORIDE (REFERENCE MERCK INDEX)(PH = 2.5 OF 1:1 SOLN)

HYDROCHLORIC ACID

SODIUM CHLORIDE

SODIUM BROMIDE

HYDROFLUORIC ACID

AMMONIA

SULFURIC ACID

POTASSIUM IODIDE

SODIUM BISULFATE

SODIUM FLUORIDE

SODIUM HYPOCHLORITE

SODIUM IODIDE

NITRIC ACID

EU Designation: CP-OP-1 (CWC)

2-AMINO-2-(HYDROXYMETHYL)-1-3-PROPANNEDIOL

CITRIC ACID

SULFUR

TITANIUM TRICHLORIDE

FERRIC CHLORIDE

NICKEL (II) CHLORIDE (1:2)

FERROUS SULFATE

POTASSIUM PERMANGANATE

HYDROGEN PEROXIDE

BARIUM SULFATE

CHROMIC (VI) ACID

SODIUM SULFATE

SODIUM SULFITE

POTASSIUM BROMIDE

POTASSIUM IODATE

PYROPHOSPHORIC ACID, DISODIUM SALT

LEAD CHLORIDE (PB = 74.5% WT.)

SILVER NITRATE

DISODIUM SALT THIOSULFURIC ACID

STANNOUS CHLORIDE

MANGANESE CHLORIDE

MERCURIC IODIDE

CALCIUM SALT SULFURIC ACID

DIPOTASSIUM DICHROMATE

POTASSIUM PHOSPHATE

ZINC NITRATE

GRAPHITE

SELENIUM

NITROUS ACID

MOLYBDIC ACID

AMMONIUM THIOSULFATE

AMMONIUM PHOSPHATE DIBASIC

MERCUROUS SULFATE

ALUMINUM NITRATE

SODIUM ARSENITE

MANGANOUS SULFATE

AMMONIUM CHROMATE

POTASSIUM CHROMATE

POTASSIUM FLUORIDE

CALCIUM FLUORIDE

POTASSIUM PYROSULFATE

DIETHYL ETHYLPHOSPHONATE

2-BUTOXYETHANOL, PHOSPHATE

METHYL ETHYL KETONE

HYDROXYLAMINE

AMMONIUM VANADATE

TRICHLOROETHYLENE

CHLOROACETIC ACID

METHYL LACTIC ACID (ETHYLESTER)

METHYL ESTER METHACRYLIC ACID

CORN OIL

CASTOR OIL

KEROSENE

ACENAPHTHENE

SODIUM TARTRATE

TARTARIC ACID

PENTACHLOROPHENOL

GLUCONIC ACID, DELTA-LACTONE, DTRITON

X-100

ACRYLIC ACID, POLYMERS (RESIN)

POLYOXYETHYLENE MONOOCTYLPHENL ETHER

GLYCOLS, POLYETHYLENEPOLYPROPYLENE, MONOBUTYL ETHER

COPOLYMER OF STYRENE AND DIVINYLBENZENE

NAPHTHALENE

DIMETHYLGLYOXIME

O-CRESOL

NITROBENZENE

CONWED PADS

PETROLEUM HYDROCARBONS (NON-SPECIFIED)

PIGMENTS

ABSORBENTS (NON-SPECIFIED)

INERT MATERIAL (PAPER, WOOD, PLASTIC, ETC.)

POLYESTER RESIN

NAPHTHENIC OIL (NON-SPECIFIED)

ACRYLIC EMULSION/POLYMER

SILICONES (EMULSIFIED)

ETHERS (NON-SPECIFIED)

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APPENDIX H.4

WASTE ENCAPSULATION AND STORAGE FACILITY (WESF)
(CP-OP-3, CENTRAL PLATEAU)
EVALUATION UNIT SUMMARY TEMPLATE

Table of Contents

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PART I. EXECUTIVE SUMMARY

EU LOCATION

General Hanford Area: 200 East; Building Alias: 225-B

RELATED EUS

- EU Designation: CP-DD-2
- EU Name: B Plant
- EU Group: D&D
- General Hanford Area: 200 East
- Building Alias: 224-B
- EU Relationship to EU under Evaluation: WESF capsules must be moved into dry storage before B Plant D&D can begin

PRIMARY CONTAMINANTS, CONTAMINATED MEDIA AND WASTES:

There are only a few primary contaminants for WESF: Cesium-137 (Cs-137), strontium-90 (Sr-90), and ingrown decay products (e.g., barium 137 [Ba-137m, Ba-137] from Cs-137, yttrium-90 [Y-90] from Sr-90). These contaminants reside in 3 locations within WESF that present potential signification human impacts (see Part V. Waste and Contamination Inventory for detailed lists): (1) capsules within pool cells (vast majority with total radioactivity of ~98 MCi); (2) contamination within hot cells, hot cell-connected ventilation ductwork, and hot cell-connected HEPA filters (combined total activity of ~300 kCi); (3) pool water cleaning ion exchange module [WIXM] (varying radioactivity with maximum at 56 kCi).

BRIEF NARRATIVE DESCRIPTION

Current WESF operations consist of essentially one task: safely storing cesium and strontium capsules within a series of interconnected pools within the WESF building (described in the documented safety analysis[1]). The majority of the radiological risk is driven by the high levels of radioactivity within the capsules at all phases of the presently planned WESF work scope. The safe containment of the cesium chloride and strontium fluoride within the capsules could be compromised under design basis accident- and beyond design basis accident-conditions if loss of water from the pool cells were to occur. The current scope of the WESF mission is limited to facility maintenance activities: inspection, decontamination, and movement of capsules; and storage and surveillance of capsules. Future plans are divided into two phases. The first phase of which is to upgrade the ventilation system and stabilize the hot cell contaminants. Upgrading the ventilation system does not directly relate to operations that affect the storage of the capsules, *per se*, but are required to keep the facility in an operable state that complies with various requirements (regulatory, operational, etc.). Stabilization by grouting of the majority of the hot cells will be performed by grouting in place all waste and remaining equipment[2]. A supplemental Hazards Analysis[3] was performed to understand any new or obsolete hazards that would be associated with these actions. There were new types of hazards identified[4] with the temporary operations to support building upgrades. The long-term, tentative plan is to remove the Cs and Sr

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[1] [HNF-8758 (Rev9)]
[2] [CHPRC-02203 (Rev0) pg. 10]
[3] [CHPRC-02203 (Rev0)]
[4] [CHPRC-02203 (Rev0) pg. 10]

capsules from the pools by packaging the capsules into dry storage overpacks and storing them on the Hanford Site. This movement into dry storage will allow the adjacent building (B-plant) to move forward with D&D plans that are tied to a Tri-Party Agreement Milestone.

Summary Table of Risks and Potential Impacts to Receptors

Table H.4-1 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 WESF Building or immediate areas around the outside of the building; a Co-located Person (CP) is an individual located 100 meters from the WESF Facility boundary; and Public is an individual located at the closest point on the Hanford Site boundary not subject to DOE access control, which in this instance is the State Highway 240 approximately 8,300 m (27,230 ft) east of the facility. The nuclear related risks to humans are based on unmitigated (unprotected or controlled conditions) dose exposures expressed in a range of from Non-Discernable (ND) to Very High. The estimated mitigated exposure that takes engineered and administrative controls and protections into consideration, is shown in parenthesis

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 Non-Discernable (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: No risk ratings are provided for Cultural Resources. The Table 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.

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

Population or Resource		Evaluation Time Periods	
		Current Operations Safe Storage of Cs/Sr Capsules	**From Cleanup Actions** Near-Term Building Upgrades
Human	Facility Worker (FW)	High (High)	High (Not Evaluated)
	Co-Located Person (CP)	High (Low)	Medium (Not Evaluated)
	Public as the Maximally Exposed Offsite Individual (MOI)	Low (Low)	Low (Not Evaluated)
Environ-mental	Groundwater	ND[c]	ND[c]
	Columbia River	ND[c]	ND[c]
	Ecological Resources[a]	ND	ND
Social	Cultural Resources[a]	**Native American:** Direct: Unknown Indirect: Unknown **Historic Pre-Hanford:** Direct: Unknown Indirect: Unknown **Manhattan/Cold War:** Direct: Known Indirect: Known	**Native American:** Direct: Unknown Indirect: Unknown **Historic Pre-Hanford:** Direct: Unknown Indirect: Unknown **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.

b. The highest rating from the set of accident scenarios and resultant unmitigated impacts were used in this table (see section below on the current condition of WESF.

c. WESF contamination is confined and there are no vadose zone sources or current groundwater contamination associated with this EU.

SUPPORT FOR RISK AND IMPACT RATINGS FOR EACH TIME PERIOD

Human Health

Current Condition:

Building and Facility: The safe storage of the cesium/strontium capsules and other radiological contamination can be impacted by the following accident and natural phenomenon hazards:

Loss of Pool Cell Water Event: The loss of pool cell water is a design basis event but has multiple potential causes that include man-made errors, natural events, and external events[5]. One of the

[5] [HNF 8758 (Rev9), Pg. 3-141, Figure 3-4]

potential initiating events for the loss of pool cell water is the design basis event (DBE) – earthquake. The design basis earthquake cannot cause the loss of pool cell water by itself; a combination of operational (man-made) errors and conditions required is, in effect, a ***beyond*** design basis event (BDBE)[6]. The BDBE earthquake could create conditions that produce failure of the pool cell structure and the BDBE earthquake is analyzed separately from the WESF DSA. The WESF DSA events are the described throughout this document with notes on the BDBE when appropriate. The safe containment of the cesium chloride and strontium fluoride within the capsules could be compromised due to thermal loading under design basis accident- and beyond design basis accident-conditions if the loss of water from the all pool cells were to occur.

Unmitigated Risk[7]: FW – High; CP – High; MOI – Low.

Mitigation: The open pool cell air dilution ports are identified as a design feature in active pool cells to allow for overflow of water if the Pool Cell 12 fill pipe is used and the transfer ports are closed. A defense-in-depth TSR-level AC on configuration management of the TSR design features will ensure this safety function is maintained. Damaged capsule(s) could result in very high radiation levels in the pool cell area. An additional TSR level control for mitigation of worker consequences is identified. This control requires an operable area radiation monitor ARM (permanently installed or portable) and an operable pool cell beta monitor in each active pool cell to protect workers from potential radiation hazards. The ARM protects workers from radiation hazards resulting from a large leak that occurs quickly and the beta monitors protect workers from slow developing radiation hazards (e.g., capsule leaks due to corrosion). Non-credited defense-in-depth facility equipment and processes exist that would help to mitigate the release of radioactive material and exposure to the onsite and offsite receptors[8]

Mitigated Risk[9]: FW – High; CP – Low; MOI – Low.

<u>Hydrogen Explosion in Hot Cell G and K3 Duct:</u> The second most potentially significant event that could impact human health is a hydrogen explosion in Hot Cell G and the connecting K3 duct that releases contamination from the hot cells and connecting contaminated ventilation ducts and thereby releases contaminants that become airborne and also cause external gamma radiation doses.

Unmitigated Risk[7]: FW – High; CP – High; MOI – ND to Low.

Mitigation: Active safety controls are used (backup power for ventilation systems and the hot cell ventilation system itself). The maximum cesium capsule inventory of 150 kCi and maximum strontium capsule inventory of 150 kCi in a single hot cell is a Specific Administrative Control (SAC).

Mitigated Risk[9]: FW – Not reported in Hazards Analysis; CP – Not reported in Hazards Analysis; MOI – Not reported in Hazards Analysis.

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[6] The similarity between the worst DBE Loss of pool cell water and the BDBE earthquake is that the result of loss of pool cell water occurs. The same number of capsules is assumed to fail (1,162 capsules) in each scenario; however, the difference between the scenarios is that estimated human health impacts differ because the estimated source term that is released differs: 3,400 Ci released in the DBE Loss of Pool Cell Water vs. the 38,000,000 Ci released due to the BDBE Earthquake and the co-located person dose is increased from 277 rem in to 380 rem (38 MCi vs. the ~98MCi that is currently estimated for the Cs/Sr capsules). The similarity of the DBE earthquake and BDBE earthquake is obviously, the root cause is a seismic event. The difference is that the DBE earthquake only releases material from the hot cells and connection ventilation system and the BDBE earthquake releases material from the capsules stored within the capsules.

[7] Facility Worker qualitative rating was taken from Hazard Analysis [CHPRC-01352 (Rev2)]; Co-located person and MOI quantitative values were taken from the DSA [HNF 8758 (Rev9)].

[8] [HNF 8758 (Rev9), Pg. 3-31]

[9] The mitigated dose consequences were not provided in the DSA so the CRESP dose consequence levels could not be assigned. The consequence levels from the Hazards Analysis [CHPRC-01352 (Rev2)] were used.

Hydrogen explosion in Ion exchange Module [WIXM]: As the resin in a WIXM becomes loaded with radioactive material, the ionizing radiation results in radiolysis of the resin/water and produces hydrogen. If hydrogen were to accumulate inside the WIXM vessel to sufficient quantities the hydrogen can become flammable and eventually detonable if combustion source exists. Such a combustion event could result in the release of contaminated resin and water. For such accident conditions to exist, the excess water in the WIXM vessel would have to be drained (allowing a void volume). Hydrogen would then accumulate in the head space of the vessel above the resin bed. An ignition source could potentially be provided by a static charge inside the vessel or possibly by a spark introduced by some outside activity (e.g., a worker's tool).[10]

Unmitigated Risk[7]: FW – Medium; CP – Medium; MOI – ND to Low.

Mitigation: The credited SSC for this accident scenario is to fill the void space of the WIXM to prevent hydrogen generation. Limiting the maximum radionuclide content within the WIXM is a credited TSR and would help prevent excess hydrogen generation and accumulation.[11]

Mitigated Risk[9]: FW – Low; CP – Low; MOI – Low.

Design Basis Earthquake Releases from Hot Cells, Ventilation Ductwork, HEPA filter (Current Operations): The DBE earthquake would result in the release of hazardous material from the hot cells and the K3 exhaust ducting. Some of the contamination in the hot cells and K3 duct is postulated to become suspended as a result of the shock of the DBE which may involve structural failure of the stack or A Cell due to failure of the 221-B Building end wall which is not qualified to survive the 0.25 g DBE associated with WESF. The same isotopes are present in the K3 exhaust ducting downstream of the hot cells and would also be subject to shock-vibration release in a DBE. The radioactive material in the truckport and in capsules located in the pool cells, F Cell, or G Cell would not be impacted by the immediate effects of the DBE. The hot cells (excluding A Cell which is assumed to fail from the collapse of the B Plant end wall), canyon, and truckport would survive the DBE.

Unmitigated Risk[7]: FW – High; CP – Medium; MOI – ND.

Mitigation: There are no credited active safety controls for the DBE earthquake accident. There a number of building infrastructure components that are credited passive SSCs[12]. Area 2 is also a credited SSC structure and includes the hot cells and canyon. Operational and institutional controls are in place[13] such that F Cell and G Cell each contain a maximum capsule inventory of 150,000 Ci Cs-137 and 150,000 Ci Sr-90, and capsules are located a minimum of 20 cm (7.9 in.) from any hot cell structural surface to protect against degradation of the concrete structure.

Mitigated Risk[9]: FW – High; CP – Low; MOI – Low.

Beyond Design Basis Earthquake Leads to Loss of Cooling and Shielding Water from All Pool Cells and Release of Cs/Sr from Overheating; Cs and Sr Capsules (Current Operations): As part of its response to the events that occurred at Fukushima, DOE had sites and operating contractors evaluate facility and site responses to beyond design basis events (BDBEs). One of the facilities that garnered particular attention was WESF, due to its similarity to a commercial reactor spent nuclear fuel pool.

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[10] [HNF-8758 (Rev 9), Pg. 3-109]
[11] Radionuclide limited to 25,000 Ci Sr-90 or 31,000 Ci Cs-137 with no less than 150 kg resin material. For combinations of Cs-137 and Sr-90, a maximum of 35,000 Ci Sr-90 and Cs-137 with no less than 150 kg resin material. [HNF-8758 (Rev 9), Pg. 3-117]
[12] [HNF-8758 (Rev 9) Pg. 3-64]
[13] AC = Administrative Control [HNF-8758 (Rev 9) Pg. 3-64]

In the scenario that was used for the basis of the DSA calculations, it was assumed that 1,162 capsules would fail that would release 38 MCi (of the 98 MCi estimated radioactivity of February 2014 within the Cs/Sr capsules). During a BDBA, the building structure is assumed to fail. Hot cell contamination is released due to impact from debris or vibration. The below grade pool cell structure is assumed to fail and releases pool cell water (water may be contaminated if capsules were damaged by debris). Once the water is gone, the capsules fail over time due to stress cracking or corrosion and material is released from pool cells via evaporation. Pool cell above grade structure is assumed to survive because this results in the largest consequence. Failure of the above ground pool cell area structure provides cooling for the capsules upon a loss of pool cell water and significantly reduces the release of capsule material due to evaporation.

Unmitigated Risk: FW – Not Evaluated in Separate BDBE Analysis; CP – High; MOI – Low.

Mitigation: In the CHPRC response to this DOE tasking a plan of action involved nine (9) actions to address issues at WESF. The major concern evaluated was a loss of water, and thus cooling, to the pool which presently provides both cooling to the capsules and shielding for personnel in the facility and surrounding area. WESF-specific actions included: revision of emergency planning/management procedures to better document actions to be taken to keep adequate water level in the pools; re-arrangement of capsules in the pools to reduce the net heat generation rate; and conduct of drills to demonstrate the ability of emergency response personnel to locate, identify and use emergency fill connections.

Further, the analysis of the seismic BDBE identified that about half of the calculated radiation exposure was due to the release of contamination from ventilation piping in areas of WESF no longer required for the present safe storage mission, of for potential future work, such as capsule movement for packing and dry storage. Thus a project was initiated to retire those portions of the ventilation system that are no longer required for present and anticipated missions, and stabilize the contamination (via grouting in-place); this work will be conducted in parallel with already planned ventilation modifications to be consistent with DOE commitments responding to DNFSB Recommendation 2004-2, Confinement Ventilation.

For a BDBA, the unmitigated frequency of occurrence for Natural Phenomena events cannot be reduced. As this was a BDBA, the contractor was to determine the unmitigated consequences only and not pursue control selection or mitigated consequence evaluation; therefore, no controls were identified to prevent/mitigate the BDBA. The evaluation does recognize that there are current credited design features, exhaust ventilation, and area radiation monitors that are operable and capable of performing their safety functions and that TSR surveillance are current.

There were listed "Existing Facility Controls That Might Help Prevent/Mitigate Event" that included a "Source Inventory Control" that allows for water addition to pool cells from outside facility if radiation levels in pool cell area are high.

Mitigated Risk: FW – Not Evaluated; CP – Not Evaluated; MOI – Not Evaluated.

Risks and Potential Impacts from Selected or Potential Cleanup Approaches:

Future operations and activities that are presently planned relate to building upgrades to the hot cell ventilation system and stabilizing the hot cell areas (Hot Cell A through F). The potential impacts of these activities have been analyzed within the Hazards Analysis[14] and a revised Documented Safety Analysis has not been performed for this phase of work. The Hazards Analysis includes descriptions of

[14] [CHPRC-02203 (Rev0)]

impacts and the applicable accident conditions and have been identified. New types of hazards were identified for operation of the replacement ventilation system. Radiation exposure to the facility worker from material on the aboveground (vice present below-grade filters) HEPA filters, external fire involving aboveground HEPA filters, and failure of the aboveground HEPA filters due to impact were identified as Risk Class III events[15]. There were also new types of hazardous conditions identified for performance of the stabilization activities (e.g., hydrogen explosion in the hot cells, structural failure of the hot cells due to heat, and a mobile crane drop on the canyon/hot cells) which were classified as a Risk Class II unmitigated events for the co-located person and will require additional analysis and potentially new controls

Building and Facility: The safe storage of the cesium/strontium capsules and other radiological contamination can be impacted by the following accident and natural phenomenon hazards:

Design basis earthquake with Ventilation Stack Collapse causes Damage Pool Cells and Capsules: If the stack falls over the pool cells, debris could damage capsules and there could be a loss of pool cell cooling or a loss of water. The WESF DSA[16] analyzes significant failure of roof/walls caused by hydrogen explosion in the pool cell area which causes failure of capsules. The unmitigated doses of this accident scenario were added to the unmitigated design basis earthquake impacts in the DSA for current operations[17].

Unmitigated Risk: FW – High; CP – Medium; MOI – Low.

Mitigation: Passive safety controls will be considered (design of the WESF building, stack, and capsules). Operational and institutional controls will be used (radiation protection measures, initial testing and in-service surveillance and maintenance, operational safety measures, procedures and training, and emergency preparedness)

Mitigated Risk: Not Evaluated

Crane drop through roof and impacts canyon and limited number of capsules in Hot Cell G failure: Human error or equipment failure could cause a moving mobile crane or the load to be dropped over Area 2 and could impact the canyon and aqueous makeup unit to the pool cells. Roof failure could cause debris and crane load to fall to canyon floor. The crane load would lose much of its energy breaking through the roof and it would be very unlikely for the debris and crane load to break the 30 inch high density concrete hot cell cover blocks. If the hot cell cover blocks do fail, it is assumed that there are a limited number of capsules located in Hot Cell G. The limited number of stored capsules within Hot Cell G would completely fail. The impacts would be a combination release of contamination from the Hot Cell G and limited capsule release[18].

Unmitigated Risk: FW – High; CP – Medium; MOI – Low.

Mitigation: Passive safety controls will be considered (design of the WESF building and capsules). Operational and institutional controls will be used (prohibiting movement of heavy loads over pool cell area, radiation protection measures, initial testing and in-service surveillance and maintenance, operational safety measures, procedures and training, and emergency preparedness)

Mitigated Risk: Not Evaluated

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[15] Risk Class ratings are assigned by the designations of the Hanford SARAH Document [HNF-8739 (Rev2)].
[16] [HNF-8758 (Rev9)]
[17] [CHPRC-02203 (Rev0), Pg. B-24, Table B-1]. The specific [HNF-8758 (Rev9)] section that describes the hydrogen explosion in the pool cell is within Section 3.4.2.4.3.
[18] [CHPRC-02203 (Rev0), Pg. B-8, Table B-1]

<u>Hydrogen explosion K3 Filter Housing:</u> The WESF DSA[19] analyzes a K3 filter hydrogen explosion and unmitigated consequences are moderate for the co-located person (CP; 58 rem) and low for the maximally-exposed offsite individual (MOI; 0.018 rem). The inventory assumed in this analysis is significantly higher than expected for the new system because the new system will ventilate the canyon and G cell only and there would be an insignificant inventory available in the facility to accumulate on the filters. However, the new system will likely be used while the grouting operation is being performed and there may be some disturbances of the contamination in the hot cells. Therefore, the same moderate level consequence will be assumed for the co-located person and the same low level consequence will be assumed for the MOI.

Unmitigated Risk: FW – High; CP – Medium; MOI – Low.

Mitigation: Active safety controls will be used (backup power for ventilation systems and ventilation system itself). Passive safety controls will be considered (design of filter system). Operational and institutional controls will be used (remove ignition sources).

Mitigated Risk: Not Evaluated

Groundwater

WESF contamination is confined and there are no vadose zone sources or current groundwater contamination associated with this EU and none are expected over the next 150 years. This leads to a ND rating.

Columbia River

The Columbia River will not be impacted by WESF due to the distance between the facility and the river. This leads a ND rating.

Ecological Resources

<u>Current</u>
No resources on EU or buffer, mainly level 2 or below.

<u>Risks and Potential Impacts from Selected or Potential Cleanup Approaches</u>

No resources on EU or buffer to be disturbed during active cleanup.

Cultural Resources

<u>Current</u>
This EU is located within a Manhattan Project/Cold War significant resource that has already been mitigated. There are no archaeological resources known to be located within this EU. Traditional cultural places are visible from this EU.

<u>Risks and Potential Impacts from Selected or Potential Cleanup Approaches</u>
Because no ground disturbance will occur, there should be no impact to archaeological resources.

Considerations for timing of the cleanup actions

Present Configuration: WET STORAGE: Continued need to perform surveillance and maintenance on WESF systems and Cs and Sr capsules.

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[19] [HNF-8758 (Rev9)]

***Near-Future Configuration: BUILDING UPGRADES*:** Impacts of delays to ventilation upgrades and stabilization actions are described in Section VI, "Additional Risks and Potential Impacts if Cleanup is Delayed"

***Longer-Term Future Configuration: CAPSULE DRY STORAGE, Limited D&D of 200E Area*:** Continued need to perform surveillance and maintenance on WESF systems and Cs and Sr capsules. The timeliness of moving capsules out of WESF *does* impact the progress of the D&D timeline of B plant and milestone TPA M-092-05.

Near-Term, Post-Cleanup Risks and Potential Impacts

N/A for Operating Facilities Group. Needs D&D Group evaluating B-Plant to work on this section

PART II. ADMINISTRATIVE INFORMATION

OU and/or TSDF Designation(s)

Not Applicable

Common name for EU

Waste Encapsulation and Storage Facility (WESF), Building 225-B, 200 East Area

Key Words

Cesium, strontium, capsules, type-W overpack

Regulatory Status

Present Configuration: WET STORAGE: WESF is a Hazard Category 2 nuclear facility based upon the quantity, form and location of radioactive material, as categorized by DOE-STD 1027-92[20]. It is also categorized as Dangerous Waste Storage and Treatment Facility by Washington State Department of Ecology.

Applicable regulatory documentation: In accordance with 10CFR830, *Nuclear Safety Management*, a documented safety analysis (HNF-8758) has been completed, with required safety controls implemented. The State of Washington has issued a RCRA permit (WA7890008967, Rev 8C, Part A)[21] for WESF operations. Waste at WESF is designated by waste designation "D" (WAC 173-303) and is also characterized with the requirements of 40CFR261 and 40CFR761[22] . Cs and Sr in the forms of cesium chloride and strontium fluoride are currently designated as mixed high-level waste[23]. The chemicals that qualify the capsules as mixed high-level waste are from the manufacturing process impurities (cadmium, chromium, lead, silver) and the decay products of Cs-137 (barium)[24]. WESF also operates under two Type E permits under the EPA[25]: (1) WAC-246-247, Radiation Protection – Air Emissions (Permit No: AIR-02-1218) and (2) 40CFR61, Subpart H, NESHAPS (Permit No: EPA-1999-8-12)

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[20] [HNF-8758 (Rev9) pg. iv]
[21] [DOE/RL-2006-35 (Rev1) pg. 8-3] and [DOE/RL-2013-47 (Rev0), pg. 5.22]
[22] [DOE/RL-2006-35 (Rev1) pg. 3-2]
[23] [CHPRC-01371 (Rev0), pg. i]
[24] [HNF-8758 (Rev9), Pg. 9-4]
[25] [DOE/RL-2006-35 (Rev1) pg. 14 of the PDF report]

Near-Future Configuration: BUILDING UPGRADES: WESF will remain a Hazard Category 2 when building upgrades are complete because the vast majority of the radiological source term is within the cesium and strontium capsules that have not been affected by the building upgrades[26]. A supplemental Hazards Analysis[27] was performed to understand any new or obsolete hazards that would be associated with these actions. There were new types of hazards identified[28] with the temporary operations to support building upgrades and will be discussed later (Part VI). The stabilization and ventilation project currently intends to tie into the existing facility K1/K3 stack placed on site, near WESF[29]. For the stabilization and ventilation project, a new set of Type E permits would be required from the EPA[30]. A list of the environmental strategy in regards to permitting is below[31]:

- Clean Air Act related permitting required for modifications to the ventilation system;
- Resource Conservation and Recovery Act (RCRA) permitting planned for stabilization of the contamination in the hot cells;
- Non-time critical removal action documentation under the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), as a contingent measure, in the event RCRA permitting process cannot be completed in a timely manner to support the project schedule; and
- Cultural, historic, and biological resources reviews.

Longer-Term Future Configuration: Capsule Dry Storage, Limited D&D of 200E Area: The determination of the disposition path of the Cs and Sr capsules, required by the Tri-Party Agreement (M-092-05) by June 2017, requires an understanding of the options that exist for safe storage while meeting other requirements directly related to the decontamination, deactivation, decommissioning, and demolition (D4) of the adjacent B Plant.

Applicable regulatory documentation

DOE Safety and Design (*Present Configuration: WET STORAGE*):

- CHPRC-01352 (Rev2), WESF Hazards Analysis. (2013).
- HNF-8758 (Rev9), WESF Documented Safety Analysis. (2014).
- HNF-SD-WM-TI-733 (Rev3), WESF DSA Supporting Calculations and Assumptions. (2014).
- CHPRC-02047 (Rev0), WESF Beyond Design Basis Accident Conditions and Plans. (2013).
- DOE/RL-2006-35 (Rev1), Hanford Facility Dangerous Waste Permit Application, WESF. (2006).
- HNF-7100 (Rev1), Capsule System Design Description Document. (2013).
- HNF-2822 (Rev0), Capsule Integrity Program Plan for WESF Cs, Sr Capsule Storage. (1998).
- HNF-28601 (Rev3), WESF Capsule Inspection Plan. (2013)

DOE Safety and Design (*Near-Future Configuration: BUILDING UPGRADES*):

- CHPRC-02203 (Rev0), WESF Stabilization and Ventilation Project Hazards Analysis. (2014).

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[26] [CHPRC-02203 (Rev0) pg. 10]
[27] [CHPRC-02203 (Rev0)]
[28] [CHPRC-02203 (Rev0) pg. 10]
[29] [CHPRC-02388 (Rev0), pg. 2]. Public release of CHPRC-02388 (Rev0) will occur near end of May 2015 (personal communication with RL and PNNL).
[30] Two Type E permits issued from the EPA are (1) WAC-246-247, Radiation Protection – Air Emissions (Permit No: AIR-02-1218) and (2) 40CFR61, Subpart H, NESHAPS (Permit No: EPA-1999-8-12) – as described in [DOE/RL-2006-35 (Rev1) pg. 14 of the PDF report].
[31] [CHPRC-02310 (Rev0) pg. 4]

- CHPRC-02269 (Rev0), WESF Stabilization and Ventilation Project Conceptual Design Report. (2014).
- CHPRC-02310 (Rev0), Project Execution Plan for WESF Stabilization and Ventilation Project. (2014).
- CHPRC-02192 (Rev1), WESF Stabilization and Ventilation Project Functional Design Criteria. (2014).

DOE Safety and Design (*Longer-Term Future Configuration: CAPSULE DRY STORAGE, Limited D&D of 200E Area*):

- CHPRC-02248 (Rev0), Estimate of WESF Capsule Decay Heat Values on 01/01/2018. (2014).
- CHPRC-01371 (Rev0), Functions and Requirements for Cs and Sr Capsule Dry Storage. (2011).
- 6734-Cs-Sr-Storag-001 (Rev2), Cs and Sr Capsule Dry Storage Facility, Data Form 316. (2010).
- WMP-17265 (Rev0), Summary Report for Capsules Dry Storage Project (2003).
- WMP-16938 (Rev0), Capsules Characterization Report for Capsules Dry Storage Project (2003).
- WMP-16937 (Rev0), Corrosion Report for Capsules Dry Storage Project (2003).
- WMP-16940 (Rev0), Thermal Analysis of A Dry Storage Concept for Capsules Dry Storage Project (2003).
- HNF-7367 (Rev0), WESF Interim Status Closure Plan. (2000).
- DOE/RL-2010-102 (Rev0), Active MemorandumD4 Activities for 200 East Tier 2 Buildings/Structures. (2010).

Decision Documents for Final Disposition of Cs/Sr Capsules

- HNF-SD-WM-RPT-294 (Rev0), Decision Document for the Final Disposition of Cs and Sr Capsules. (1997).
- DOE, Assessment of Disposal Options for DOE-Managed High-Level Radioactive Waste and Spent Nuclear Fuel. (October 2014).

NEPA FEIS and ROD:

- DOE/EIS-0391 (December 2012): Final Tank Closure and Waste Management EIS
- DOE/EIS-0391 ROD (December 2013): Federal Register Announcement

Applicable Consent Decree or TPA milestones

Tri-Party Agreement Milestones

- TPA Milestone M-092-05 (06/30/2017)[32]:
- *"Determine disposition path and establish interim Agreement Milestones for Hanford Site Cs/Sr capsules. DOE will assess the viability of direct disposal of the Hanford Cs/Sr capsules the national high-level waste repository and provide a schedule leading to its disposition. If DOE concludes that direct disposal is a viable and preferred alternative to vitrification, DOE will submit to Ecology specific documentation justifying its conclusion, with a proposed Milestone change request establishing enforceable Agreement Milestones for disposition of Hanford Cs/Sr capsules."*
- TPA Milestone M-092-03 (09/28/1998)[33]:

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[32] [CHPRC-01371 (Rev0)]
[33] [DOE-RL-2006-35 (Rev1), pg. 3-1]

- *"Only mixed waste packaged in capsules as identified in the Hanford Federal Facility Agreement and Consent Order Milestone M-92-03 are stored at WSF. No waste has been received into WESF since the return of the capsules completing Tri-Party Agreement Milestone M-92-04 on September 28, 1998. There are no future plans to place additional waste into WESF."*

RISK REVIEW EVALUATION INFORMATION

Completed (Revised): February 9, 2015

Evaluated by: B. Burkhardt, S. Krahn, L. Fyffe

Reviewed by: A. Croff, H. Mayer

PART III. SUMMARY DESCRIPTION

CURRENT LAND USE

The current land use of area 200 East is the DOE Hanford Site.

DESIGNATED FUTURE LAND USE

The DOE preferred alternative is the Industrial Exclusive Use Category for the WESF area (and 200E area)[34]

PRIMARY EU SOURCE COMPONENTS

Legacy Source Sites

Not Applicable

High-Level Waste Tanks and Ancillary Equipment

Not Applicable

Groundwater Plumes

Not Applicable

D&D of Inactive Facilities

Not Applicable

Operating Facilities

There are only a few primary contaminants for WESF: Cesium-137 (Cs-137), strontium-90 (Sr-90), and ingrown decay products (e.g., barium 137 [Ba-137m, Ba-137] from Cs-137, yttrium-90 [Y-90] from Sr-90). These contaminants reside in 3 locations within WESF that present potential signification human impacts (see Part V. Waste and Contamination Inventory for detailed lists): (1) capsules within pool cells (vast majority with total radioactivity of ~98 MCi); (2) contamination within hot cells, hot cell-connected ventilation ductwork, and hot cell-connected HEPA filters (combined total activity of ~300 kCi); (3) pool water cleaning ion exchange module [WIXM] (varying radioactivity with maximum at 56 kCi).

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[34] [DOE-EIS-0222 CLUP-EIS Summary document, Figure S-10 on page 45/131]

Location and Layout Maps

WESF is located in the 200 East Area of the U. S. Department of Energy (DOE) Hanford Site, north of Richland, Washington. The Hanford Site is a 1517 km^2 (about 586 mi^2) area located in the southeast corner of Washington State (as seen in Figure H.4-1). The Hanford Site is bordered on the north by the Saddle Mountains, on the east by the Columbia River, on the south by the Yakima River, and on the west by the Rattlesnake Hills[35].

[35] [DOE/RL-2013-18 (Rev0), pg. 1.4]

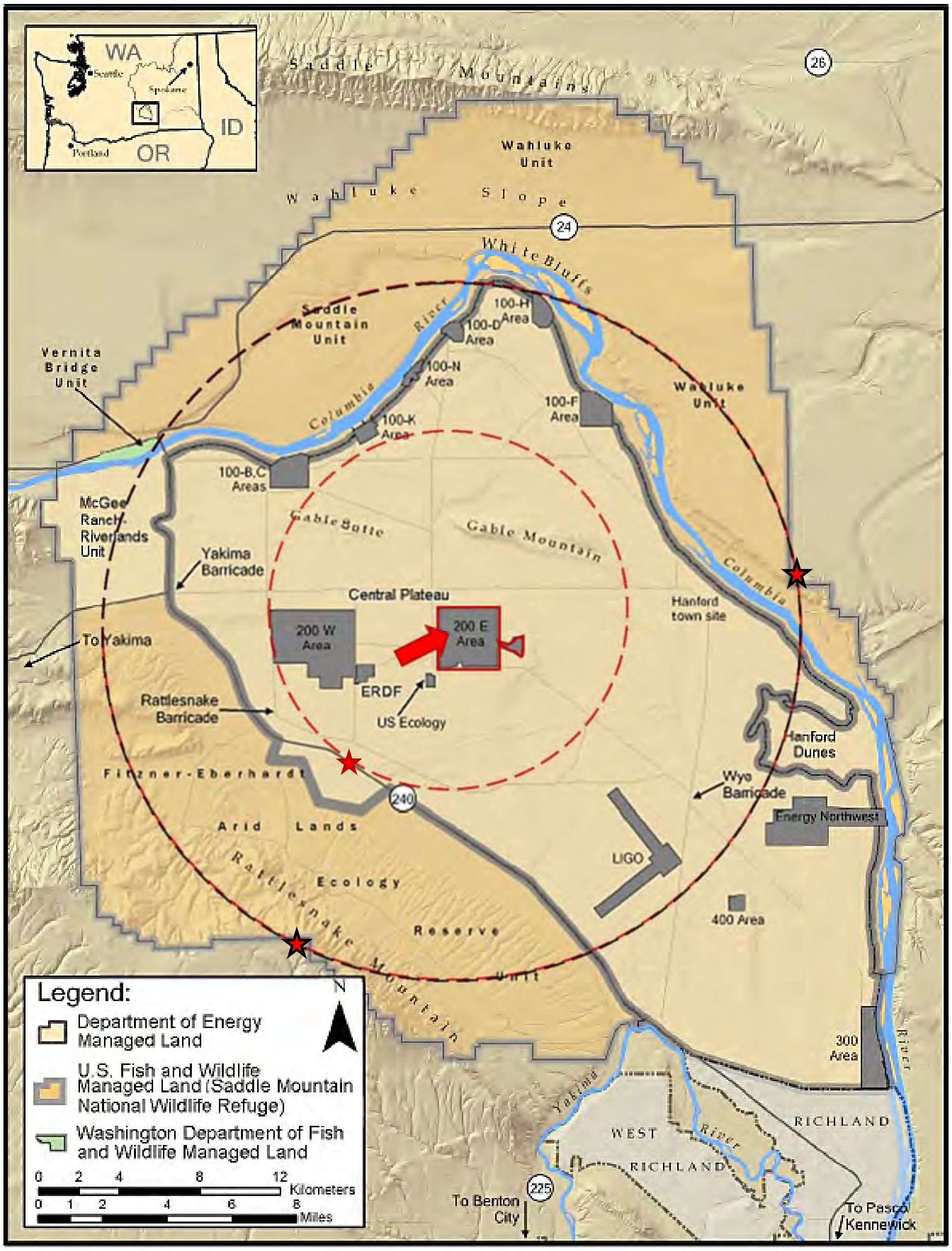

Figure H.4-1. Overall view of the Hanford Site with Highlighted Areas of Interest in Red[36]

Notes: The outline of the 200 East (200 E) Area is shown in red. The red arrow points to the approximate WESF Building location within the 200 E Area. The red star with the red outline marks the approximate location of the hypothetical Onsite Public Receptor on the State Highway 240[37] used for calculating estimated impacts to human health within the Hazards Analysis (HA)[38]

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[36] This image from [DOE/RL-2013-18 (Rev0), pg. 1.4]

[37] [HNF-8758 (Rev9), pg. 3-52] states that, "the onsite public represents an alternate site boundary bounded by the near bank of the Columbia River to the north and east, the Wye barricade to the southwest, and Highway 240 to the west and south. The closest distance for the onsite public from Table 3-7 is 8,260 m, which is used in the RADIDOSE calculations (rounded to 8,300 m). The MOI or offsite receptor represents the current Hanford Site boundary (i.e., the fence line). The closest distance for the offsite receptor from Table 3-7 is 16,640 m, which is used in the RADIDOSE calculations (rounded to 17,000 m)."

[38] [CHPRC-01352 (Rev2)]

and the Documented Safety Analysis (DSA)[39] for the WESF facility. The distance from the WESF facility boundary to the approximate location of the Onsite Public receptor is 8,300 m (8.3 km)[40]. The dashed red circle marks the circumference of 17 km that the hypothetical Offsite Public receptor is located for estimating impacts to human health impacts[41]. The two red stars with black outline denotes the two eligible places that could be the location of the hypothetical Offsite Public receptor.

Figure H.4-2 illustrates the location of the 200 East (200E) Area in reference to the Hanford site and surrounding areas. The red arrow indicates the location of WESF inside of the 200 East area. The regional highway network traversing the Hanford Site (State Highways 24 and 240) has restricted access roadways. The nearest road to WESF is Atlanta Avenue located approximately 60 m (200 ft) west of 225-B[42].

The subsequent figure (Figure H.4-3) is an enlarged photo of the WESF complex and nearby facilities.

Figure H.4-2. Overall view of the 200E Area (outlined in yellow) and the WESF complex is highlighted in Red and a Red Arrow points to its location adjacent to the B-Plant[43]

[39] [HNF-8758 (Rev9)]
[40] [HNF-8758 (Rev9), pg. 3-52 and Appendix A, Pg. 336 of 371 of the PDF report].
[41] [HNF-8758 (Rev9), pg. 3-52 and Appendix A, Pg. 336 of 371 of the PDF report]
[42] [HNF-8758 (Rev9), pg. 1-10]
[43] From the online mapping tool, Phoenix, created by PNNL.

Figure H.4-3. Zoomed-in view of the 200E Area and the WESF complex is highlighted in Red[44]

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[44] From the online mapping tool, Phoenix, created by PNNL.

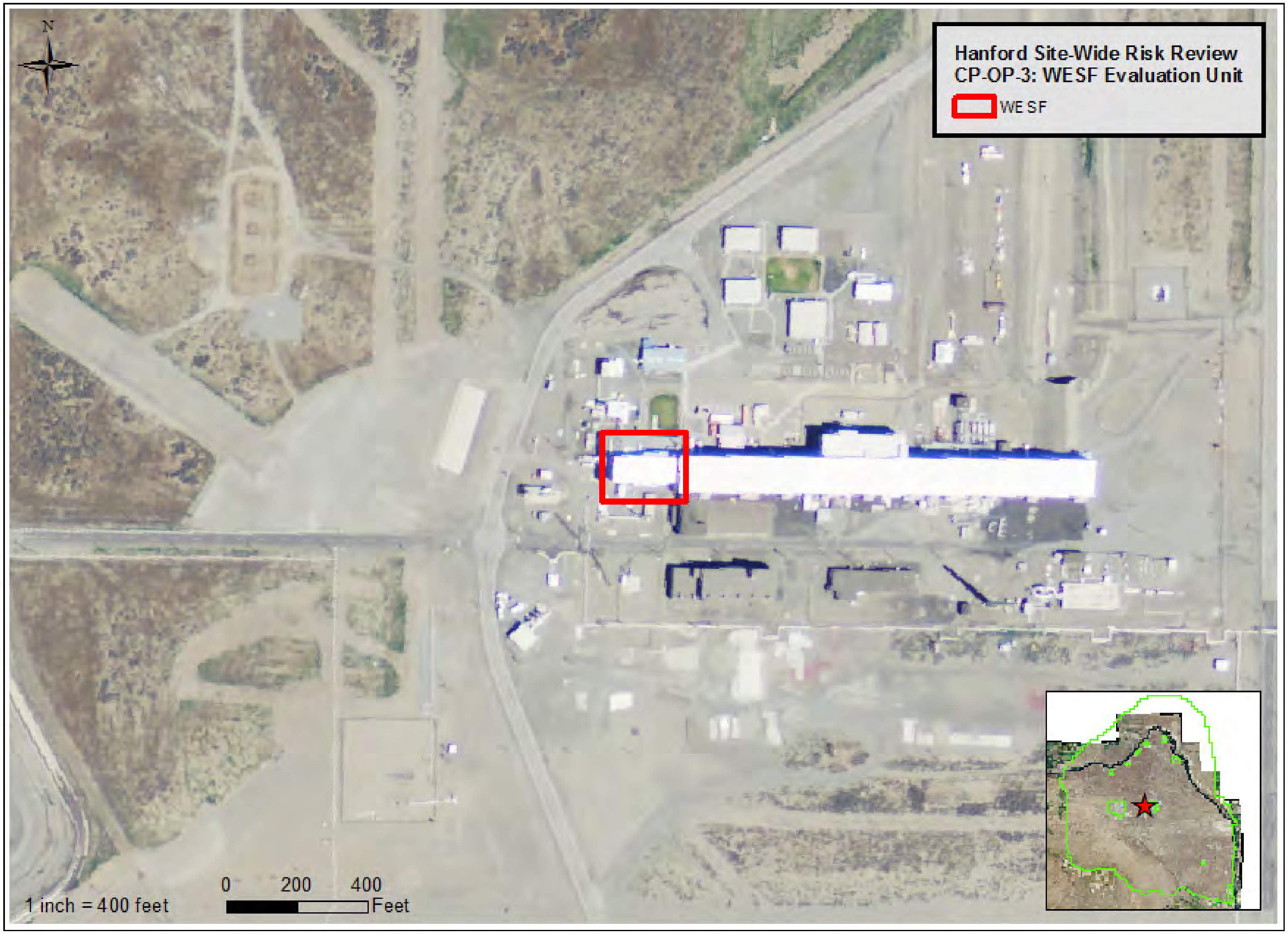
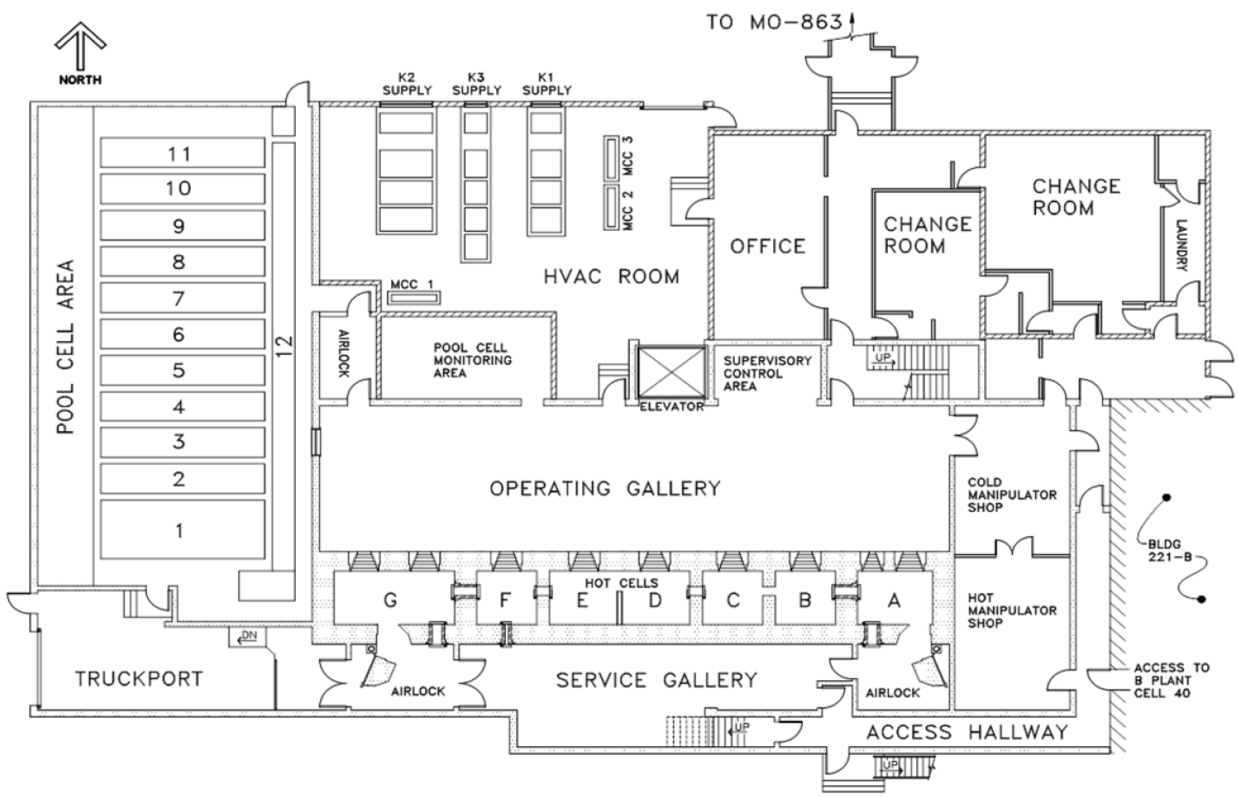


Figure H.4-4. EU Boundary Map

WESF is divided into three major functional unit areas. Area 1 is a one-story above grade reinforced masonry wall structure with a metal deck diaphragm roof supported on open-web steel joists and steel beams and includes the WESF support area, heating ventilation and air conditioning room, pool cell entry airlock, and pool cell monitoring area. Area 2 is a two-story above grade structure with reinforced concrete roof and floor slabs supported by reinforced concrete shear walls in the section of the 225-B Building enclosing the hot cells, canyon, hot and cold manipulator shops, manipulator repair shop, operating gallery, service gallery, and aqueous makeup area. Area 3 is a one-story structure that contains the truckport and pool cell area (pool cells are below grade)[45].

WESF consists of the 225-B Building and several support buildings and systems. The 225-B Building is a two-story structure 48 m (157 ft) long by 30 m (97 ft) wide by 12 m (40 ft) high at the outside dimensions. The first floor is 1300 m2 (14,000 ft^2) and the second floor is 560 m^2 (6,000 ft^2). The ground elevation at this facility is approximately 213 m (700 ft) above sea level and is approximately 61 m (200 ft) above the underground water table[46]. The plan views of the first and second floor are shown in Figure H.4-5 and Figure H.4-6. The following series of figures (Figure H.4-7 and Figure H.4-8) show the elevation views of the WESF complex according to various cardinal directions. It is not shown in Figure H.4-7, but it is important to note that the K3 ventilation ducts are subgrade and are located under the hot cells and will be grouted in place as part of the near-term phase for WESF.



Notes: MO = mobile office

[45] [HNF-8758 (Rev9) pg. iii] [HNF-8758 (Rev9), Figure 2-4]
[46] [DOE/RL-2013-18 (Rev0), pg. 1.4]

Figure H.4-5. WESF Pool and Process Cells Building Layout (1st Floor)[47]

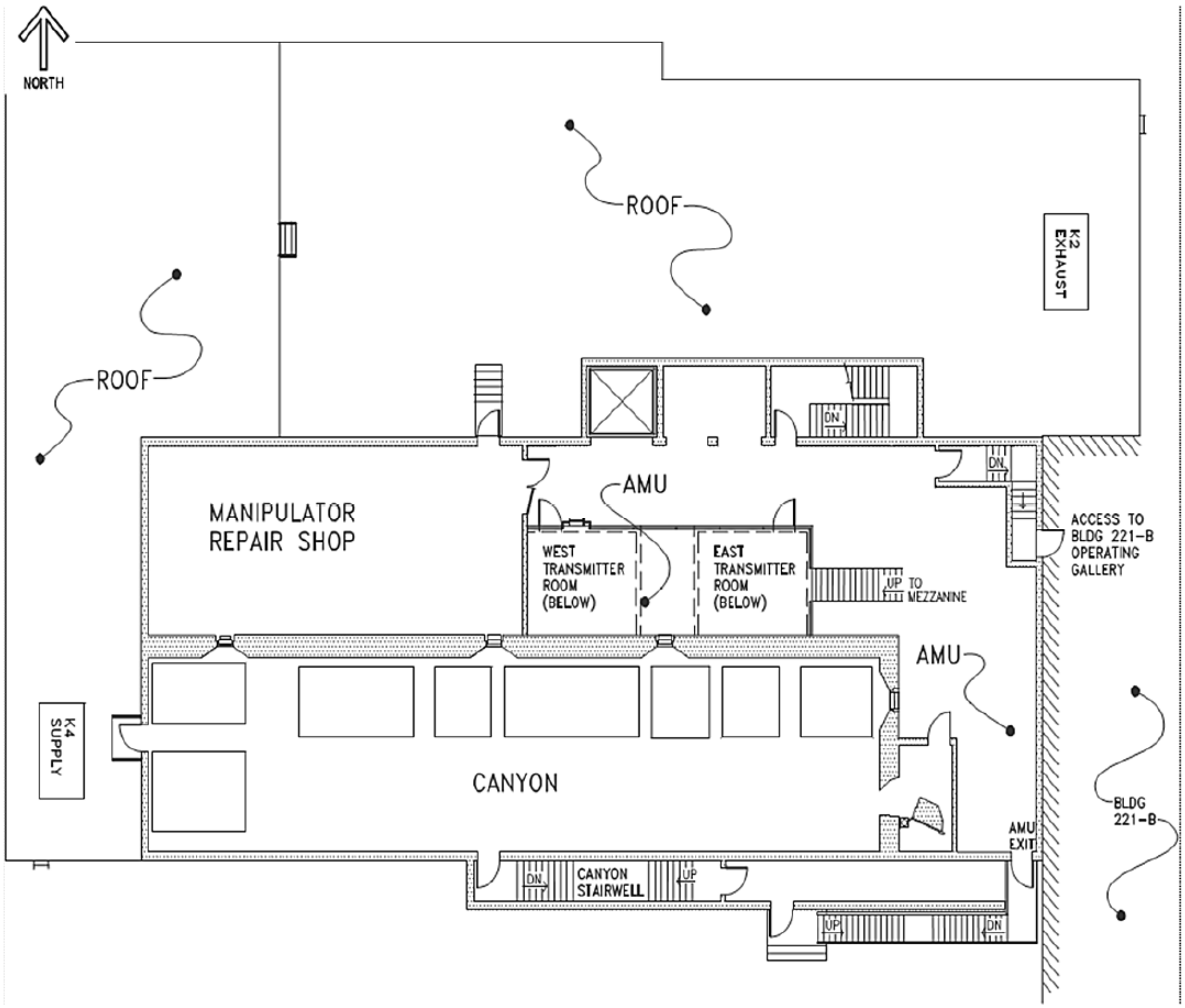


Figure H.4-6. WESF Pool and Process Cells Building Layout (2nd Floor)[48]

[47] [HNF-8758 (Rev9), Figure 2-5]
[48] [HNF-8758 (Rev9), Figure 2-6]

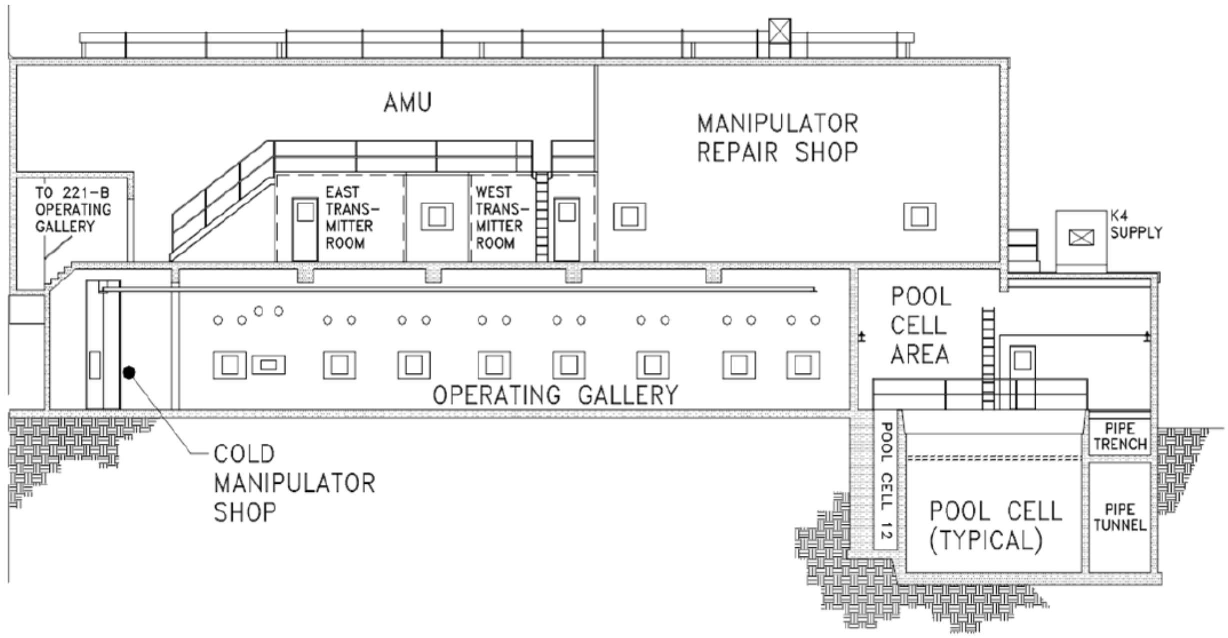


Figure H.4-7. WESF East-West Sectional View[49]

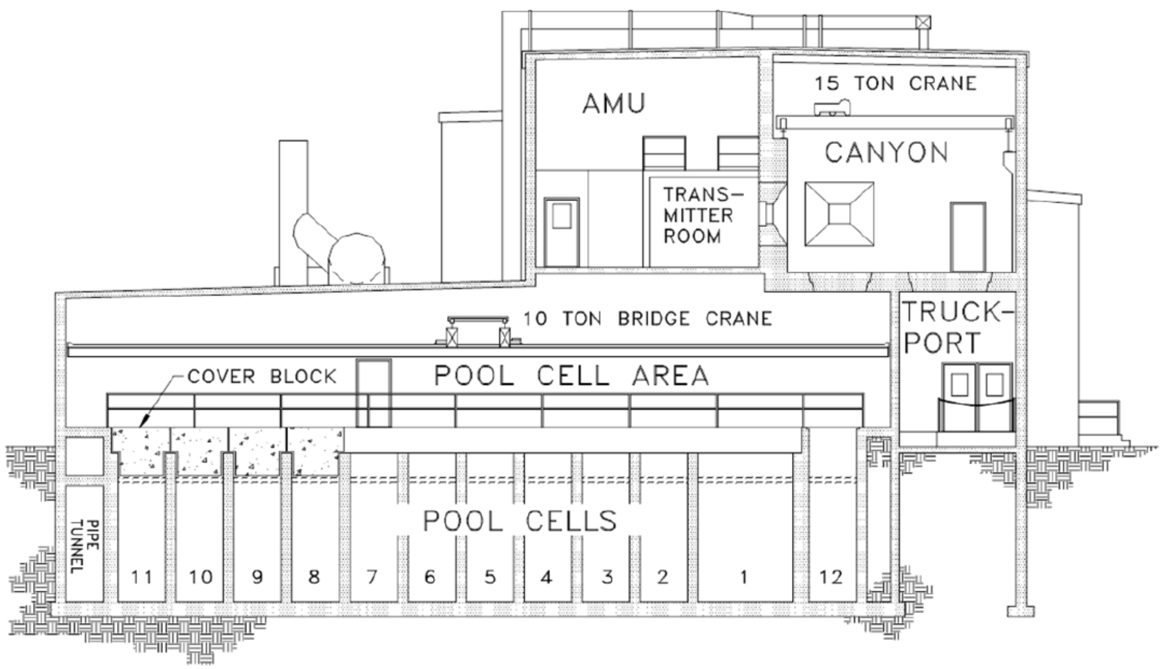


Figure H.4-8. WESF North-South Sectional View[50]

49 [HNF-8758 (Rev9), Figure 2-7]
50 [HNF-8758 (Rev9), Figure 2-8]

The general area of the K3 replacement ventilation and exhaust system is shown in the highlighted area in Figure H.4-9. The current configuration for the K3 ventilation system is shown in Figure H.4-11.

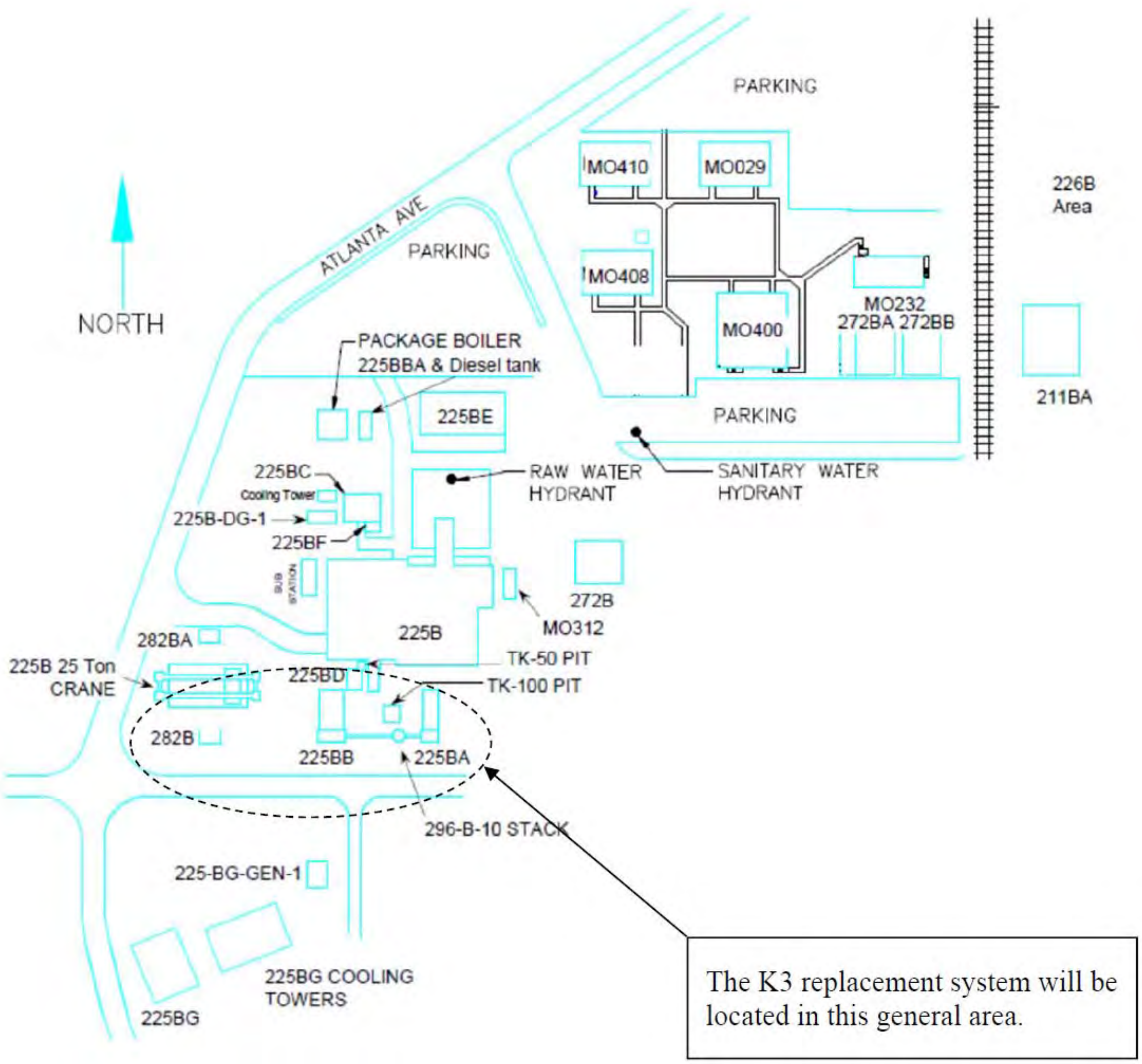


Figure H.4-9. WESF Site Plan and Anticipated K3 Replacement System General Location[51]

[51] [CHPRC-02203 (Rev0), Pg. 4, Figure 2]

PART IV. UNIT DESCRIPTION AND HISTORY

Former Uses and History

The Waste Encapsulation and Storage Facility (WESF) was designed and constructed to process, encapsulate, and store Sr-90 and Cs-137 separated from wastes generated during the chemical processing of used fuel on the Hanford Site. Hanford produced 1577 cesium capsules and 640 strontium capsules for a total of 2217 capsules. However, during the years since their production some capsules have been removed from WESF and sent elsewhere for a range of purposes under a range of conditions. The capsules that have been returned are in storage currently (1959 total capsules). The capsules that were not returned to WESF were deconstructed and placed into glass logs (Germany, 187 of the capsules) and the remaining 71 capsules were destructively examined by various entities.

The construction of WESF started in 1971 and was completed in 1973. Cesium processing was shut down in October 1983 and strontium processing was shut down in January 1985. Final overall process shutdown was accomplished in September 1985. Shutdown for the cesium and strontium processes involved equipment cleanout, equipment isolation or removal, jumper removal, nozzle blanking, window refurbishment, and instrumentation deactivation for the hot cells. Only equipment and instruments that were required for cell maintenance and surveillance remained operational in the hot cells. The water sources to A through F Cells have been isolated and the manipulators were removed from A through E Cells. Capsules can still be stored in F and G Cells if necessary (in addition, Cell G has very little contamination and only has a significant radiation source when capsules are present[52]). WESF continues to store the Hanford Site's inventory of cesium and strontium capsules in the pool cells. The current WESF mission is currently limited to facility maintenance activities; inspection, decontamination, and movement of capsules; and storage and surveillance of capsules[53].

WESF Risk Drivers

Present Configuration: WET STORAGE: WESF risk drivers are radioactive material (Cs, Sr, and decay products) contained in the capsules currently stored in the pool cell areas 1 through 11, the contamination from the production of these capsules remaining in the hot cells of Cs, Sr (and decay products), and contamination within the K3 ventilation system used as the dedicated exhaust and air-filtering system from the hot cells. There is also a bounded, but varying level of contamination from the pool water cleaning ion exchange module that is also considered as a potential source of radioactive material.

The radioactive Cs and Sr, and their decay products, poses a considerable hazard. To place the radioactivity of this radiological hazard source into context, the volume of the material in all of the Cs and Sr capsules combined is approximately 2 cubic meters (m^3) (70 ft^3), which is very small in comparison to the 2.1 E+5 m^3 (7.5 E+06 ft^3) in the waste storage tanks. Although the amount of material in the capsules is small, the amount of radioactivity contained in the capsules is approximately 35 percent of the total activity of the waste storage tanks and the capsules combined[54].

The chemical hazard evaluation estimated inhalation intakes for identified chemical emissions and evaluated potential Incremental Lifetime Cancer Risk (ILCR) and noncarcinogenic health hazards using chemical-specific cancer slope factors and reference doses, respectively. Although the cesium and

[52] [HNF-8758 (Rev9), pg. 2-23]
[53] [HNF-8758 (Rev9)]
[54] [DOE-EIS-0189 (1996), pg. 352/1780 of the PDF]

strontium capsules contain chloride, fluoride, and the decay products barium-137 and zirconium-90, no emissions of these chemicals would be associated with any of the capsule alternatives.[55,56]

In regards to chemicals, except for the K-5 cooling system glycol, the trisodium phosphate crystals (Na3PO4), WIXM Amberlite or Purolite resin beads, and the chemicals used for the closed loop cooling system the quantities of chemical materials used in WESF are extremely low. Most of the materials are in use for general housekeeping purposes and are in quantities used for the typical household but not in greater quantities than found in institutions (e.g., schools, hospitals, hotels/motels). None of the chemicals at WESF pose a credible onsite, 100 m (328 ft), offsite (Hanford boundary), or environmental risk based on the quantity of material and the dispersion properties due to the physical characteristics of the materials. The materials discussed are not considered as having any significant exposure potential outside the immediate spill or work area[57].

Near-Future Configuration: BUILDING UPGRADES**:** Risk drivers during the ventilation upgrades are limited to the release of radioactive material that presently contaminates the K3 filter. Risk drivers for the building stabilization portion of work include release of contaminated material and radioactive constituents during the grouting of the hot cells. Building stabilization performed will include grouting in place hot cells A through F (while leaving hot cell G for potential future use as a location for a dry transfer of capsules into dry storage containers).

Longer-Term Future Configuration: CAPSULE DRY STORAGE, Limited D&D of 200E Area**:** Risk drivers associated with longer-term future configuration are radioactive material contained in the capsules during movement into dry storage containers. Any D&D activities are tentative for WESF until plans for dry storage of capsules can be finalized.

WESF Radioactive Material Storage

Present Configuration: WET STORAGE: The majority of radioactive material (cesium chloride and strontium fluoride) at WESF is confined in doubly encapsulated stainless steel capsules. WESF currently stores 1,335 cesium capsules, 23 of which are single-contained Type W overpack capsules[58], and 601 strontium capsules in pool cells located in the 225-B building. The dimensions of the capsules are listed in Table H.4-2 and shown in Figure H.4-10. The 23 W type overpack capsules consist of 16 capsules were placed inside Type W overpacks. In addition to the 16 WESF capsules placed in Type W overpacks, there were seven additional Type W overpack capsules produced that contain material from previously cut-up cesium capsules. A Type W is a single overpack capsule tested to the requirements of original WESF inner and outer capsules. Type W overpack capsules contain failed/suspect WESF capsules, powder and pellets from former WESF capsules, Nordian Capsules, or Oak Ridge Type 4 containers. The reports containing engineering design details and regarding the inspection and integrity testing plan are the following:

- HNF-7100 (Rev1), Capsule System Design Description Document
- HNF-2822 (Rev0), Capsule Integrity Program Plan for WESF Cs, Sr Capsule Storage
- HNF-28601 (Rev3), WESF Capsule Inspection Plan

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[55] [DOE-EIS-0189 (1996), pg. 213/1780 of the PDF]
[56] [CHPRC-02047 (Rev0), pg. 91/172 of the PDF]
[57] [HNF-8758 (Rev9), Pg. 3-23]
[58] [HNF-8758 (Rev9), Pg. 2-38]

Table H.4-2. Capsule Properties[59]

Item	Initial activity	Containment boundary	Material	Wall thickness[a] (in.)	Outside diameter (in.)	Total length (in.)	Cap thickness (in.)
CsCl capsule	70 kCi Cs-137	Inner	316L	0.095, 0.103, or 0.136	2.25	19.75	0.4
		Outer	316L	0.109, 0.119, or 0.136	2.625	20.775	0.4
SrF_2 capsule	90 kCi Sr-90	Inner	Hastelloy[b]	0.12	2.25	19.75	0.4
		Outer	316L	0.12	2.625	20.1	0.4
Type W overpack	70 kCi Cs-137	Single	316L	0.125	3.25	21.825	Not applicable

Note:

a. The specified wall thickness of the CsCl capsules was increased twice during production.

b. Hastelloy is a registered trademark of Haynes International, Inc.

CsCl = cesium chloride.

SrF_2 = strontium fluoride.

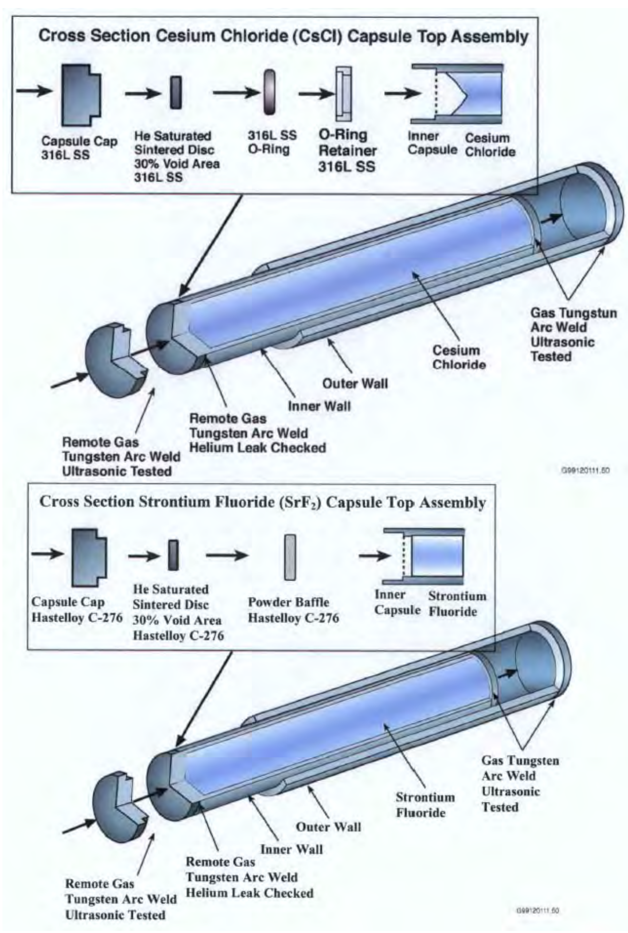

Figure H.4-10. Schematic of Cesium and Strontium Capsules[60]

59 [CHPRC-01371(Rev0), pg. 6, Table 3-1]

60 [CHPRC-01371(Rev0), pg. 7, Figure 3-1]

Near-Future Configuration: BUILDING UPGRADES**:** Radioactive materials at WESF will remain stored in the cooling pool cells while building upgrades occur. Radioactive material that contaminates the hot cells A through F will be physically removed by scraping the face of the vertical walls of the hot cells (the scrapings will fall to the hot cell floor and remain[61]) and then the material will be grouted in place. The contaminated radioactive material within the K3 ventilation system will be grouted in place for the section of the ductwork that is not connected to the new ventilation/filtration system.

The WESF hot cells and the canyon are contaminated areas and are supplied and exhausted by the K3 ventilation system. The supply air is filtered, heated or cooled appropriately, and distributed through a duct network (as shown in Figure H.4-11). The K3 HVAC system supplies 100 percent outside air and all of the K3 air supply flows into the canyon. Some of the air is drawn into the hot cells through two parallel inlet HEPA filters for each cell located in the canyon. The canyon is also directly exhausted to the K3 HEPA filters. The exhaust from the K3 filter is discharged to a stack common to the K1 and K3 exhaust systems at WESF[62].

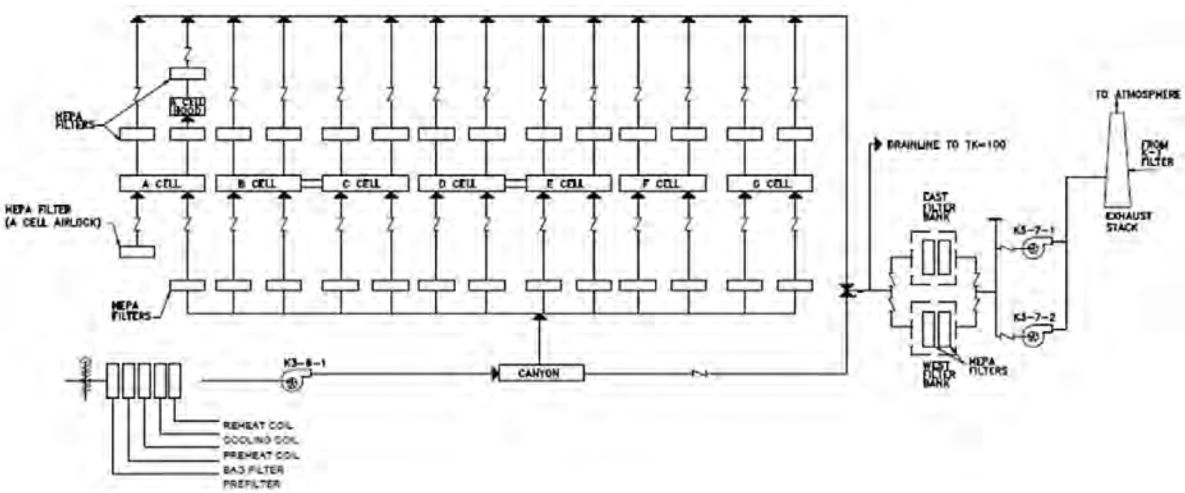

Figure H.4-11. K3 Ventilation Diagram[63]

Longer-Term Future Configuration: CAPSULE DRY STORAGE, Limited D&D of 200E Area**:** Radioactive material inside of the doubly-housed capsules will be placed into an additional overpack designed to sit within a basket of a dry cask storage container—similar to those presently used for spent nuclear fuel. The dry cask container will be placed on a concrete pad in the 200 East area near the current location of the WESF building and B Plant. The design of the dry cask container is in the initial stages of requesting proposals, initial conceptual ideas include placing around 16 capsules into a single dry cask[64]; it is estimated that 2 casks can be loaded each week and placed on a concrete pad outside of WESF.

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[61] Personal Communication with WESF Facility Managers during the CRESP visit in October 2014
[62] [HNF-8758 (Rev9), Pg. 2-40]
[63] [HNF-8758 (Rev9), Pg. 2-42, Figure 2-12]
[64] [CHPRC-01371 (Rev0), Pg. 12, Section 3.3]

WESF Radioactive Material Classifications

The waste at WESF, specifically the impurities and decay products within the Cs and Sr capsules, is designated by waste designation “D” (WAC 173-303) and is also characterized with the requirements of 40CFR261 and 40CFR761[65].

WESF Annual Average and Maximum Individual Worker Collective Doses

Present Configuration: WET STORAGE: The average and maximum annual individual dose for workers at the WESF facility was not available. The only value available described an assumed dose of 200 mrem/year for personnel operating evaporators, retrieval facilities, separation and treatment facilities (both in situ and ex situ), and for processing the capsules[66]. The data that were available and published related to the general 200 East area and assumed to be representative of the WESF facility. The average annual individual dose (averaged from 2011 to 2013) [67,68] was 102 mrem. The average of the maximum annual dose from 2011 to 2013 for an individual worker at WESF was 264 mrem (average of 100 mrem (2011); 176 mrem (2012); and 230 mrem (2013)).

Near-Future Configuration: BUILDING UPGRADES**:** The estimated average annual individual dose for workers at the WESF facility for during facility upgrades has not been quantified yet due to an absence of a documented safety analysis for this phase of work.

Longer-Term Future Configuration: CAPSULE DRY STORAGE, Limited D&D of 200E Area**:** The estimated average annual individual dose for workers has not been estimated but preliminary information was provided at a conceptual and high level[69]. The Capsule Dry Storage (CDS) Project shall be designed to limit occupational radiation exposures in accordance with the requirements in 10 CFR 835 and CHPRC-00073[70]. The CDS Project shall use WESF HVAC systems with high-efficiency particulate air (HEPA)-filtered exhaust to minimize potential releases from the building as a result of capsule retrieval and overpacking operations. Limiting radiation exposure to facility personnel is a key driver for operations at WESF, during transport, and at the Capsule Dry Storage Area (CDSA). Due to the high dose rates associated with the capsules, all capsule handling and overpacking activities will be conducted in the WESF G Cell with remote-operated equipment or with sufficient shielding to protect facility workers. After overpacking, all handling operations will be performed within the transfer cask and/or storage cask. The design objective for controlling personnel exposure from external sources of radiation in areas of continuous occupational occupancy (2,000 hours/year) shall be to maintain exposure levels below an average of *0.5* mrem *(5* mSv) per hour and as far below this average as is reasonably achievable. The design objectives for exposure rates for a potential exposure to a radiological worker where occupancy differs from the above shall be ALARA and shall not exceed 20 percent of the applicable standards in 10 CFR 835.202 of 5 rem (20% * 5 rem = 1 rem).

WESF Processes and Operations

Present Configuration: WET STORAGE: WESF is operated as a miscellaneous storage unit in accordance with the provision of WAC 173-303-680. Safe storage of the Cs and Sr capsules includes active monitoring, inspection, testing, and cooling of capsules in pool cells. Ancillary activities such as building maintenance are also conducted within the facility. Waste and drum load-out can be performed in Hot

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[65] [DOE/RL-2006-35 (Rev1) pg. 3-2]
[66] [DOE-EIS-0190 (1996), pg. 212/1780 of the PDF]
[67] [DOE/RL-2013-18 (Rev0), pg. 4.2)
[68] [DOE/RL-2013-47 (Rev0) pg. 4.3]
[69] [CHPRC-01371 (Rev0), Pg. 23]
[70] CH2MHill Plateau Remediation Company (CHPRC). (2013). CH2M HILL Plateau Remediation Company Radiological Control Manual. CHPRC-00073, Revision 10

Cell A. Hot Cells B through E are on cold standby status. Hot cells F and G remain active for cesium and strontium capsule storage[71]. F Cell is still an active hot cell with installed manipulators. G Cell is an active cell currently used for capsule inspections, capsule polishing and scribing, and providing dry storage of nonconforming capsules[72].

Monitoring and maintenance activities for the capsules involve calculating the annual inventory, physically verifying that the inner capsule can still move independently of the outer capsule (discussed below), and using online radiation monitors to detect pool cell water contamination. The annual inventory provides the exact storage location and accountability for all of the Cs and Sr capsules stored at WESF. The Cs and Sr capsules undergo the "Inner Capsule Movement (ICM)" test[73]. The ICM test involves physically grasping one end of a capsule with a pool tong and rapidly moving the capsule vertically approximately 15 cm (6 in.). This allows the inner capsule to slide within the outer capsule, making it possible to be easily heard and felt by the operator performing the test. This test verifies that the capsule has not bulged. The frequency that the ICM test is performed has evolved over time; presently is to perform the ICM test on 20% of the inventory every other year with all capsules being inspected every 10 years irrespective of statistical considerations[74].

Near-Future Configuration: Building Upgrades**:** No process operations to the radioactive material will be performed[75]. Stabilization by grouting of the majority of the hot cells will be performed by grouting in place all waste and remaining equipment. The ventilation ductwork of K3 will have sealed off air pathways to prevent airborne spreading of radioactive materials. Major assumptions of the operations required to perform the stabilization of the residual (legacy) contamination in hot cells A through F and the below grade K3 ventilation system ductwork[76]:

- The stabilization method used will be grout
- The grouting will not affect the seismic design of the facility
- No equipment/material will be removed from the hot cells before grouting (e.g., tanks, conduit, filters, etc.) and the hot cells will not be decontaminated (other facility areas may require minor decontamination efforts to support work activities)
- Sealing of windows and manipulator ports will be performed
- Heavy equipment will be located near the 225B Building and crane work will be required over Area 2 (hot cells/canyon)
- No heavy loads will be lifted over Area 3 (pool cells)

Major assumptions of the required activities to complete the construction and then operate the replacement ventilation system include the following actions[77]:

- The replacement ventilation system will consist of fan(s), stack and aboveground HEPA filter unit
- The existing K3 duct will be isolated from existing stack (296-B-10)
- The replacement exhaust ventilation system will be located southwest of the 225B

[71] [DOE/RL-2013-47 (Rev0), pg. 5.22]
[72] [HNF-8758 (Rev9), pg. 2-23]
[73] The ICM test was formerly called the "clunk test". The name originated due to the "clunk" noise when the inner capsule slid within the outer capsule would make a "clunk" sound that is easily heard and felt by the operator performing the test. This test verifies that the capsule has not bulged. Personal Communication with L. I. Covey and other WESF facility operators/managers during the CRESP visit to Hanford in October 2014.
[74] Personal Communication with L. I. Covey and other WESF facility operators/managers during the CRESP visit to Hanford in October 2014 and fully documented in [HNF-8758 (Rev9), pg. 2-31 and [HNF-28601 (Rev3), Pg. 7]
[75] [CHPRC-02203 (Rev0) pg. 10]
[76] [CHPRC-02203 (Rev0) pg. 5]
[77] [CHPRC-02202 (Rev0), pg. 6]

- Heavy equipment will be located near the 225B Building and crane work will be required southwest of the 225B Building
- No heavy loads will be lifted over Area 3 (pool cells)
- There will be no change to the function of the ventilation supply systems (flow rates may need to be adjusted)
- Hands-on filters change outs will be performed regularly
- The stack will have a monitoring system
- The filters will have a fire suppression system
- The replacement system will ventilate all hot cells until grouting is done and then will only vent G Cell and the canyon

***Longer-Term Future Configuration: CAPSULE DRY STORAGE, Limited D&D of 200E Area*:** The unit operations required for longer-term configuration include transferring capsules within an additional storage overpack and then placement into dry storage casks. The dry storage casks will be then transferred to a concrete pad on the Hanford site in the 200 East Area near WESF and B Plant. Limited D&D efforts are ongoing and to be determined.

WESF Complexity of Processes and Operations

Present Configuration: WET STORAGE: Under the current mission of safe storage and maintenance of the Cs and Sr capsules, there are a limited number of processes that occur. The treatment of pool cell water and capsule integrity testing are performed on a regular basis. The ancillary activities required for generic building maintenance are performed. The complexity of these listed activities is low.

***Near-Future Configuration: BUILDING UPGRADES*:** Ventilation upgrades and stabilization actions of grouting hot cells do not anticipate complex operations. Normal construction safety considerations will be observed. The additional prudent actions that must be taken to prevent release of contamination within the hot cells, K3 duct and ventilation system include avoiding dropping heavy loads to avoid opening a pathway to radiological exposure of facility workers. The level of complexity for this near-term operational phase is elevated from the present status, but remains low.

***Longer-Term Future Configuration: CAPSULE DRY STORAGE, Limited D&D of 200E Area*:** The unit operations required for longer-term configuration of Cs and Sr capsules within dry storage casks includes the transferal of capsules into the casks, placement of casks to and onto the designated CDSA (Capsules Dry Storage Area), and then dry storage of casks. All three types of operations have been performed extensively within the commercial nuclear power industry and are done so safely and efficiently. WESF facility managers know of this experience and have chosen to place a RFP from cask vendors that have such experience. The anticipated level of complexity required for this phase of work is comparable to operations in spent nuclear fuel storage pads at commercial nuclear power plants.

WESF Material Flows (Ingress and Egress)

Present Configuration: WET STORAGE: All of the waste in storage at WESF originated at WESF. WESF does not receive waste from other facilities at this time. Any additional waste accepted into WESF would require a revision to the Hanford Facility Dangerous Waste Permit Application[78] and a modification of the sitewide permit. Only mixed waste packaged in capsules as identified in the Tri-Party Agreement Milestone M-092-03 are stored at WESF. There are no plants to place additional waste into WESF[79].

[78] [DOE/RL-2006-35, pg. 3-2]
[79] [DOE/RL-2006-35 (Rev1) pg. 3-2]

During the site tour by the assigned CRESP team in mid-October 2014 – personal communication with the WESF managers and operators noted that the stainless steel liner of the pool for Pool Cells 5 and 10 are known to have small liner leaks. Pool cell water leakage was collected in a sump at a rate of approximately 12-15 liters every few months[80]. Collected water was then tested through the facility's testing equipment for beta-counts and resulting with no radioactive material within the collected water.

Near-Future Configuration: BUILDING UPGRADES: Ventilation upgrades and stabilization actions of grouting hot cells do not intend to move radioactive material or any hazard sources out of WESF.

Longer-Term Future Configuration: CAPSULE DRY STORAGE, Limited D&D of 200E Area: The unit operations required for longer-term configuration includes transferring capsules out of the facility. Doubly-contained capsules and W-type capsules will be placed into a dry cask. Initial conceptual ideas include placing around 16 capsules into a single dry cask, where it is estimated that 2 casks can be loaded each week and placed into a concrete storage module that will be located at a concrete pad outside of WESF. It was estimated that 8 dry casks will fit into a single concrete module. The total length of this process is estimated to take 16 months, as follows:

a. 1335 Cs capsules + 601 Sr capsules + 23 W-type capsules = 1959 total capsules
b. Total # of dry casks required = (1959 capsules) / (16 capsules/dry cask) ≈ 123 dry casks
c. Total # of concrete modules required = (123 casks) / (8 casks/module) ≈ 16 modules
d. Time to load all capsules (weeks) = (123 casks) / (2 casks/week) ≈ 62 weeks
e. Time to load all capsules (months) = (62 weeks) / (4 weeks/month) ≈ 16 months

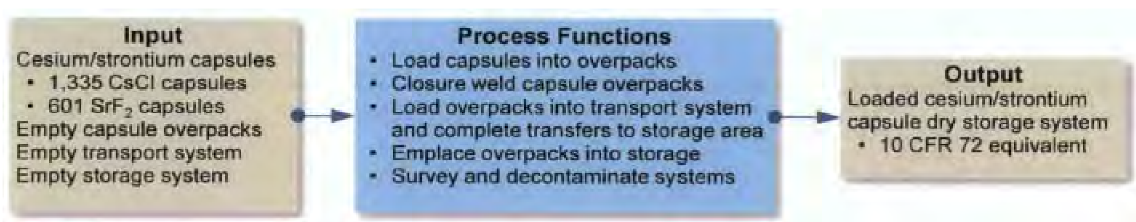

Figure H.4-12. Top-Level Process Function of Outloading Capsules from Pool Cells to a Dry Storage System [81]

WESF Impact of Delays

Present Configuration: WET STORAGE: Continued need to perform surveillance and maintenance on WESF systems and Cs and Sr capsules.

Near-Future Configuration: BUILDING UPGRADES: Impacts of delays to ventilation upgrades and stabilization actions are described in Section VI, "Additional Risks and Potential Impacts if Cleanup is Delayed"

Longer-Term Future Configuration: CAPSULE DRY STORAGE, Limited D&D of 200E Area: Continued need to perform surveillance and maintenance on WESF systems and Cs and Sr capsules. The timeliness of moving capsules out of WESF *does* impact the progress of the D&D timeline of B plant and milestone TPA M-092-05.

[80] [HNF-8758 (Rev9), Pg. 2-27] The quoted volumetric flow rate of the leak is 0.8 L/week.
[81] [CHPRC-01371 (Rev0), pg. 8, Figure 3-3]

WESF Infrastructure

Present Configuration: WET STORAGE: Infrastructure that is considered part of the WESF facility includes the pool cells, hot cells, and the superstructure (building)[82]. For additional details, see Part VI (answers to questions 2 through 4). The infrastructure is shown in the previous section (Part III: Summary Description) within Figure H.4-5, Figure H.4-6, Figure H.4-7, and Figure H.4-8).

Near-Future Configuration: BUILDING UPGRADES**:** The infrastructure will remain the same with the exception that there will be a new exhaust ventilation system installed for the K3 system. The ductwork connecting the hot cell and canyon will be grouted to the point right before the K3 ventilation system crosses through the building wall. This disconnect point this will be the location of the new connection where the K3 system will be repurposed by joining to other exhaust air ventilation systems and filter air from just the Hot Cell G and the canyon[83]. The ventilation activities will replace the existing K3 exhaust ventilation system with new equipment that is tailored to the needs of the facility during stabilization operations and after stabilization activities are complete. The replacement exhaust ventilation system will include exhaust fans, stack monitoring equipment, and ventilation controls. The currently existing K1/K3 stack on the WESF site will be used as part of the ventilation upgrade[84].

Longer-Term Future Configuration: CAPSULE DRY STORAGE, Limited D&D of 200E Area**:** The Capsule Dry Storage (CDS) Project has been identified for removal of cesium and strontium capsules from WESF and placement of the capsules into a compliant dry storage configuration pending final disposition. The initial planning for this activity has begun and documented[85]. There were several identified functions and requirements that establish the bases for initiating CDS Project scoping activities (e.g., preliminary conceptual design, preliminary cost estimate, design and construction schedule, and other related activities). The scope of the CDS Project will include (1) acquiring a new capsule dry storage area (CDSA) and storage systems for dry storage of the capsules; (2) implementing systems to remove the capsules from WESF and place the capsules into dry storage at the CDSA; (3) completing WESF modifications needed to support capsule retrieval, packaging, and transfer to the CDSA for dry storage; and (4) performing regulatory activities and operational preparations necessary for capsule removal from WESF and implementation of dry storage.

The Capsule Dry Storage (CDS) project shall use existing systems at WESF and canister storage building (CSB) to the maximum extent possible to distribute utilities (e.g., water, electricity, sanitation) required for facility operations, and to support a workforce of the size required to operate the facility at the required throughput rate. The CDS project shall interface with existing Hanford Site utilities and infrastructure to support design, construction, and operation. Interface requirements for utilities and infrastructure are undefined, pending facility siting and development of the facility concept. Assessment of utilities and infrastructure interfaces shall occur following preliminary facility definition and interface definition.[86]

Access roads, aprons, and walkways for the CDSA will be integrated into the existing infrastructure at the CSB. The CDS Project will provide a new absorption field and septic collection system separate from the current systems at existing facilities, if required due to insufficient capacity of the current system. It is anticipated that existing systems will be sufficient for these activities.[86]

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[82] [HNF-8758 (Rev9) pg. iii]
[83] [CHPRC-02203 (Rev0), pg. 6]
[84] [CHPRC-02388 (Rev0), pg. 2]. Public release of CHPRC-02388 (Rev0) will occur near end of May 2015 (personal communication with RL and PNNL).
[85] [CHPRC-01371 (Rev0), pg. i]
[86] [CHPRC-01371 (Rev0), pg. 16]

ECOLOGICAL RESOURCE SETTING

Landscape Evaluation and Resource Classification

The amount and proximity of the biological resources to the EU were examined within the adjacent landscape buffer area radiating approximately 64 m from the geometric center of the EU (equivalent to 3.2 acres). The WESF EU and surrounding adjacent landscape buffer area consist entirely of level 0 resources; that is, paved, graveled surfaces and buildings with some landscaping around them.

Field Survey

A visual survey of the EU for WESF confirmed that the EU consists entirely of built structures and paved, graveled, or landscaped surfaces. No wildlife was observed. No field data sheets were generated. PNNL ECAP surveys conducted in 2009 for the WESF area indicated the following wildlife around the buildings: American robin (*Turdus migratorius*), lark sparrow (*Chondestes grammacus*), killdeer (*Charadrius vociferous*), barn swallow (*Hirundo rustica*), and mourning dove (*Zenaida macroura*).

CULTURAL RESOURCE SETTING

Cultural resources that are located in the WESF EU are limited to the National Register-eligible 225 B Waste Encapsulation and Storage Facility, a contributing property within the Manhattan Project and Cold War Era Historic District with documentation required. All documentation has been addressed as described in the *Hanford Site Manhattan Project and Cold War Era Historic District Treatment Plan* (DOE.RL-97-56). None of the WESF EU has been inventoried for archaeological resources and none are known to be located there.

The 212 B Fission Products Load out Station (documentation required) is located within 500 meters of the WESF Evaluation Unit, also a contributing property within the Manhattan Project and Cold War Era Historic District. It has also been documented as described in the *Hanford Site Manhattan Project and Cold War Era Historic District Treatment Plan* (DOE.RL-97-56).

Historic maps indicate that there is no evidence of historic settlement in or near the WESF EU. Geomorphology and extensive ground disturbance further indicates a low potential for the presence of intact archaeological resources associated with all three landscapes to be present subsurface within the WESF EU. 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 associated with these landscapes (e.g. East Benton Historical Society, the Franklin County Historical Society, the Prosser Cemetery Association, the Reach and B-Reactor Museum Association) may need to occur. Indirect effects are always possible when are known to be located in the general vicinity. Consultation with Hanford Tribes may also 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

CONTAMINATION WITHIN PRIMARY EU SOURCE COMPONENTS

Legacy Source Sites

Not Applicable

High Level Waste Tanks and Ancillary Equipment

Not Applicable

Vadose Zone Contamination

Not Applicable

GROUNDWATER PLUMES

Not Applicable

Facilities for D&D

Not Applicable

Operating Facilities

There are only a few primary contaminants for WESF: Cesium-137 (Cs-137), strontium-90 (Sr-90), and ingrown decay products (e.g., barium 137 [Ba-137m, Ba-137] from Cs-137, yttrium-90 [Y-90] from Sr-90). These contaminants reside in 3 locations within WESF and present potential signification human impacts: (1) capsules within pool cells; (2) contamination within hot cells, hot cell-connected ventilation ductwork, and hot cell-connected HEPA filters; (3) non-constant level of contamination from the pool water cleaning ion exchange module. Because there are multiple phases that relate to the WESF complex, the inventories have been described within the context of these temporal designations (1) current operations under the safe storage of Cs/Sr capsules mission; (2) near-term operations with concurrent safe storage of capsules and stabilization of hot cell contamination and building upgrades specific to the K3; (3) transfer of capsules to dry storage; (4) final disposition of Cs and Sr radiological material. The relevant combinations of source terms described within the temporal designations are listed below. These combinations will be discussed in this section.

1. Cs/Sr Capsules (Current Operations)
2. Ion exchange Module (Current Operations)
3. Hot Cells, Ventilation Ductwork, HEPA Filter (Current Operations)
4. Hot Cells, Ventilation Ductwork, HEPA Filter (Building Stabilization, Near-term Operations)
5. Cs/Sr Capsules (Longer-term Operations Transfer to On-site Dry Storage)
6. Cs/Sr Capsules (Final Disposition Pathway)

1. Cs/Sr Capsules (Current Operations):

Radioactivity:

- o Cs-137[87]: 34 MCi (as of February 2014)
  - a. Ba-137m: ~34 MCi (same as Cs-137 due to secular equilibrium)
- o Sr-90: 15 MCi (as of February 2014)
  - a. Y-90: ~15 MCi (same as Sr-90 due to secular equilibrium)
- o Tc-99: 0 Ci;
- o Pu (total): 0 Ci
- o U (total): 0 Ci
- o Total Activity[88]: ~98 MCi

Mass[89]:

- o U (total): 0 kg
- o Cr: 0 kg

[87] Ionizing radiation types emitted from each radionuclide of interest: Beta (Cs-137, Sr-90, Y-90); Gamma (Ba-137m)
[88] [CHPRC-02248 (Rev0), Pg. 1]
[89] The mass of cesium chloride is around 3,600 kg and the mass of strontium fluoride is around 1,500 kg. This can be found if the masses of the each salt type are summed from the appendices A and B within [CHPRC-02248 (Rev0)].

Physical Form:

- o 1335 Cs capsules and 601 Sr capsules that also contain decay products of Cs and Sr (1936 total capsules)
  a. Capsules contain 5-15% other elements (Impurities from processing and makes these capsules RCRA waste
- o Waste form as solidified CsCl and SrF_2
- o Double containment for Cs and Sr capsules in corrosion resistant metal canisters
- o 23 W-type capsules containing failed Cs/Sr Capsules, remnants from original production of capsules originating from hot cells, remnants from other programs

Values used for inventory plots:

EU	Cs-137	Sr-90	Sum of other radionuclides	Names of other radionuclides
WESF (Cs/Sr capsules)	34,000,000	15,000,000	=34,000,000+15,000,000 =49,000,000	Ba-137m, Y-90

2. Ion exchange Module (Current Operations):

Radioactivity:

- o Cs-137: Maximum at any given time: 31,000 Ci
- o Sr-90: Maximum at any given time: 25,000 Ci
- o Tc-99: 0 Ci
- o Pu (total): 0 Ci
- o U (total): 0 Ci
- o Total Activity: Cs-137+Sr-90: 25,000 – 56,000 Ci range
  a. Minimum at any given time: 25,000 Ci (with no less than 150 kg resin)
  b. Maximum is the sum of Cs-137 and Sr-90 given in points above

Mass:

- o U (total): 0 kg
- o Cr: 0 kg

Physical Form:

- o Cs and Sr adsorbed onto ion exchange resin

Values used for inventory plots: *The level of radioactivity within the ion exchange module during normal operations is kept well below the maximum allowable radioactivity and thereby is small relative to capsules and hot cell/connecting ventilation, therefore not included in the inventory plots for comparison purposes.

3. Hot Cells, Ventilation Ductwork, HEPA Filter (Current Operations):

Radioactivity:

- o Hot cells, ventilation ductwork, and HEPA filters, containing a combined[90] ~300 kCi

[90] Although, all the numbers that were provided in the report and listed in these sub-bullets equals ~212,400 Ci (as stated in the HNF-8758 (Rev9), pgs 3-16 through 3-17)

a. K3 Filter: Maximum of 100 Ci Cs-137 and 4,500 Ci Sr-90 on each train (2 trains)[91]
b. K3 Below-grade Ventilation Ductwork: 2,700 Ci Cs-137 and 103,000 Ci Sr-90
c. Hot Cells (A → F [G is clean]): ~55,000 Ci Cs-137 and ~43,000 Ci Sr-90

- WESF Hot Cell and K3 Duct Inventory decayed to 2013 in Appendix O[92] was omitted from the report and the best estimates are from [HNF-8758 (Rev9), pg. 3-18]

Mass:

- Unknown

Physical Form:

- Small particulates and solids adsorbed onto interior surfaces of hot cells and ventilation ductwork, and absorbed within the interior of the HEPA filters

Values used for inventory plots:

EU	Cs-137	Sr-90	Sum of other radionuclides	Names of other radionuclides
WESF (Hot Cells, Ducts)	=100+2,700+54,537 =57,337	=4,500+4,500+103,000+42,937 =154,937	0	Not applicable

4. Hot Cells, Ventilation Ductwork, HEPA Filter (Building Stabilization, Near-term Operations):

WESF ventilation upgrades are to be completed by the end of Fiscal Year (FY) 2016[93] and it can be estimated that operations will begin for building upgrades will begin in the year 2015. Thus the inventory provided within the current operations can be assumed as the inventory for the near-term building upgrades and stabilization operations.

Radioactivity:

- Hot cells, ventilation ductwork, and HEPA filters, containing a combined[94] ~300 kCi

d. K3 Filter: Maximum of 100 Ci Cs-137 and 4,500 Ci Sr-90 on each train (2 trains)[95]
e. K3 Below-grade Ventilation Ductwork: 2,700 Ci Cs-137 and 103,000 Ci Sr-90
f. Hot Cells (A → F [G is clean]): 55,000 Ci Cs-137 and 43,000 Ci Sr-90

Mass:

- Unknown

Physical Form:

- Small particulates and solids adsorbed onto interior surfaces of hot cells and ventilation ductwork, and absorbed within the interior of the HEPA filters

5. Cs/Sr Capsules (Longer-term Operations Transfer to On-site Dry Storage):

Radioactivity[96]:

[91] [HNF-8758 (Rev9), pg. 3-18]
[92] [HNF-SD-WM-TI-733 (Rev6), Pg. O-1]
[93] The WESF K1/K3 Exhaust System Upgrade Project was initiated in 2009, then delayed in 2011 due to funding constraints The approach identified in CHPRC-01259 was later restructured to eliminate upgrades to the K1 system and focus on the K3 portion of the ventilation upgrades The revised approach includes stabilizing legacy contamination in WESF, isolating the K1 exhaust system from the K3 exhaust system, and replacing the existing K3 exhaust system. [CHPRC-02310 (Rev0), Pg. 2]
[94] Although, all the numbers that were provided in the report and listed in these sub-bullets equals ~212,400 Ci (as stated in the HNF-8758 (Rev9), pgs 3-16 through 3-17)
[95] [HNF-8758 (Rev9), pg. 3-18]
[96] The Capsule Extended Storage Project (W-135) is currently in the planning phase. This project will move the capsules from their current location inside WESF to a new storage location where the capsules will be stored under dry conditions. The earliest that this project is projected to be ready to move the capsules is January 1, 2018. To support design of the capsule storage system components, the decay heat of the

- o Cs-137: 32 MCi (dated to January 1, 2018)
  - a. Ba-137m: ~32 MCi (same as Cs-137 due to secular equilibrium)
- o Sr-90: 13.5 MCi (dated to January 1, 2018)
  - b. Y-90: ~13.5 MCi (same as Sr-90 due to secular equilibrium)
- o Tc-99: 0 Ci
- o Pu (all isotopes): 0 Ci
- o Total Activity: ~91 MCi

Mass:

- o Total U: 0 kg
- o Cr: 0 kg

Physical Form:

- o 1335 Cs capsules and 601 Sr capsules that also contain decay products of Cs and Sr
  - a. Capsules may contain 10-20% other elements (Impurities from processing and makes these capsules RCRA waste
- o 23 W-type capsules containing failed Cs/Sr Capsules, remnants from original production of capsules originating from hot cells
- o Waste form as solidified CsCl and SrF_2
- o Double containment for Cs and Sr capsules in corrosion resistant metal canisters

- o The unit operations required for longer-term configuration includes transferring capsules out of the facility. Doubly-contained capsules and W-type capsules will be placed into a dry cask.

6. Cs/Sr Capsules (Final Disposition Pathway):

No cleanup decisions have been made for final disposition of the cesium/strontium capsules. Decisions have been deferred to future decision-making processes.

a. Detailed inventories are provided in Table H.4-3, Table H.4-4, and Anc Eq = Hot Cells, Ventilation Ductwork, HEPA Filter

a. Table H.4-5. All values are to 2 significant figures. The source document should be consulted for greater precision data. The sum for each primary contaminant is shown in the first row. Anc Eq = Hot Cells, Ventilation Ductwork, HEPA Filter

Table H.4-6 provides a summary of the evaluation of threats to groundwater as a protected resource from saturated zone and remaining vadose zone contamination associated with the evaluation unit.

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capsules on this date needs to be known. Capsule data used to support reliable management of the capsules is contained within the Encapsulation Database System. Information within this database was used to project the WESF capsule decay heat on January 1, 2018. [CHPRC-02248 (Rev0), Pg. 1]. The radioactivity content was summed from each individual capsule from the appendices A and B within [CHPRC-02248 (Rev0)].

Table H.4-3. Inventory of Primary Contaminants[a]

WIDS	Description	Decay Date	Ref[b]	Am-241 (Ci)	C-14 (Ci)	Cl-36 (Ci)	Co-60 (Ci)	Cs-137 (Ci)	Eu-152 (Ci)	Eu-154 (Ci)	H-3 (Ci)	I-129 (Ci)
All	Sum			NP	NP	NP	NP	34000000	NP	NP	NP	NP
	Anc Eq[b]	2013	HNF-8758 (Rev9)	NP	NP	NP	NP	55000	NP	NP	NP	NP
WESF	Process Building	2014	CHPRC-02248 (Rev0)	NP	NP	NP	NP	34000000	NP	NP	NP	NP

a. NP = Not present at significant quantities for indicated EU
b. Anc Eq = Hot Cells, Ventilation Ductwork, HEPA Filter

Table H.4-4. Inventory of Primary Contaminants (cont)[a]

WIDS	Description	Decay Date	Ref	Ni-59 (Ci)	Ni-63 (Ci)	Pu (total) (Ci)	Sr-90 (Ci)	Tc-99 (Ci)	U (total) (Ci)
All	Sum			NP	NP	NP	15000000	NP	NP
	Anc Eq	2013	HNF-8758 (Rev9)	NP	NP	NP	100000	NP	NP
WESF	Process Building	2014	CHPRC-02248 (Rev0)	NP	NP	NP	15000000	NP	NP

b. NP = Not present at significant quantities for indicated EU
c. Anc Eq = Hot Cells, Ventilation Ductwork, HEPA Filter

Table H.4-5. Inventory of Primary Contaminants (cont)[a]

WIDS	Descrip-tion	Ref	CCl4 (kg)	CN (kg)	Cr (kg)	Cr-VI (kg)	Hg (kg)	NO3 (kg)	Pb (kg)	TBP (kg)	TCE (kg)	U (total) (kg)
All	Sum		NP	NP	NP	NP	NP	NP	NP	NP	NP	NP
	Anc Eq	HNF-8758 (Rev9)	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP

CP-OP-3: (WESF Operating Facility)

WIDS	Descrip-tion	Ref	CCl4 (kg)	CN (kg)	Cr (kg)	Cr-VI (kg)	Hg (kg)	NO3 (kg)	Pb (kg)	TBP (kg)	TCE (kg)	U (total) (kg)
WESF	Process Building	CHPRC-02248 (Rev0)	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP

b. NP = Not present at significant quantities for indicated EU

c. Anc Eq = Hot Cells, Ventilation Ductwork, HEPA Filter

Table H.4-6. Summary of the Evaluation of Threats to Groundwater as a Protected Resource from Saturated Zone (SZ) and Remaining Vadose Zone (VZ) Contamination associated with the Evaluation Unit

PC	Group	WQS	Porosity[a]	K_d (mL/g)[a]	ρ (kg/L)[a]	VZ Source M^{Source}	SZ Total M^{SZ}	Treated[c] M^{Treat}	VZ Remaining M^{Tot}	VZ GTM (Mm^3)	VZ Rating[d]
C-14	A	2000 pCi/L	0.25	0	1.82	---	---	---	---	---	ND
I-129	A	1 pCi/L	0.25	0.2	1.82	---	---	---	---	---	ND
Sr-90	B	8 pCi/L	0.25	22	1.82	---	---	---	---	---	ND
Tc-99	A	900 pCi/L	0.25	0	1.82	---	---	---	---	---	ND
CCl4	A	5 µg/L	0.25	0	1.82	---	---	---	---	---	ND
Cr	B	100 µg/L	0.25	0	1.82	---	---	---	---	---	ND
Cr-VI	A	48 µg/L[b]	0.25	0	1.82	---	---	---	---	---	ND
TCE	B	5 µg/L	0.25	2	1.82	---	---	---	---	---	ND
U(tot)	B	30 µg/L	0.25	0.8	1.82	---	---	---	---	---	ND

a. Parameters obtained from the analysis provided in Attachment 6-1 to Methodology Report.

b. "Model Toxics Control Act—Cleanup" (WAC 173-340) Method B groundwater cleanup level for hexavalent chromium.

c. Treatment amounts from the 2013 Hanford Annual Groundwater Report (DOE/RL-2014-32, Rev. 0).

d. Groundwater Threat Metric rating based on Table 6-3, Methodology Report. These contaminants are being treated using the 200-West Groundwater Treatment Facility.

PART VI. POTENTIAL RISK/IMPACT PATHWAYS AND EVENTS

CURRENT CONCEPTUAL MODEL

Narrative description of pathways and barriers to receptors and conditions/events that can lead to completed pathways

Pathways and Barriers: (1. description of institutional, natural and engineered barriers (including material characteristics) that currently mitigate or prevent risk or impacts, 2. Time scale from loss of each barrier to realization of risk or impacts)

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?

The accident scenarios that dominate the risk to human health at the WESF complex are all nuclear related safety accident scenarios. The following accident scenarios dominate the risk at the facility for <u>current operations</u> are listed below. The beyond design basis accident of an earthquake greater than 0.25g magnitude and its impacts on human health are also described. Also discussed is the evolution of how this event was selected as part of the evaluated set of events.

1. Cs/Sr Capsules (Current Operations):
   a. Loss of Cooling and Shielding Water from All Pool Cells
   b. Beyond Design Basis Earthquake Leads to Loss of Cooling and Shielding Water from All Pool Cells and Release of Cs/Sr from Overheating
2. Ion exchange Module (Current Operations):
   a. Hydrogen explosion in Ion exchange Module [WIXM]
3. Hot Cells, Ventilation Ductwork, HEPA Filter (Current Operations):
   a. Design Basis Earthquake Releases from Hot Cells, Ventilation Ductwork, HEPA filter
   b. Hydrogen explosion in Hot Cell G and K3 Duct

The accident scenarios that dominate the potential dose to human receptors at the WESF complex for the near-future phase of the building stabilization and ventilation upgrades have been analyzed within the Hazards Analysis[97]. The quantitative analysis within a Documented Safety Analysis for this phase of work has not been performed. The qualitative aspects of the dominating risks are described as available quantitative data allows and are considered the following:

4. Hot Cells, Ventilation Ductwork, HEPA Filter (Building Stabilization, Near-term Operations)[98]:
   a. Design basis earthquake with Ventilation Stack Collapse causes Damage Pool Cells and Capsules
   b. Crane drop through roof and impacts canyon and limited number of capsules in Hot Cell G failure
   c. Hydrogen explosion K3 Filter Housing

[97] [CHPRC-02203 (Rev0)]
[98] The impacts were evaluated by considering the impacts of potential new scenarios particular to the building stabilization operations and in tandem with the current mission of safe storage of the Cs/Sr capsules. The impacts (both qualitative and quantitative when available) include the levels of hazard and risk from the DSA and Hazards Analysis for current operations [HNF-8758 (Rev9); CHPRC-01352 (Rev2)] and the impacts evaluated in the Hazards Analysis for the near-term operations (building stabilization and ventilation upgrades) [CHPRC-02203 (Rev0)]

The accident scenarios that dominate the risk to human health at the WESF complex for future phases past the building stabilization and ventilation upgrades have yet to be analyzed quantitatively and qualitatively (i.e., Cs/Sr Capsules (Longer-term Operations Transfer to On-site Dry Storage) and Cs/Sr Capsules (Final Disposition Pathway)). Therefore, there is currently insufficient information to evaluate the hazard and risk rating and the specific initiating events that would cause risks to human health and other potential receptors.

The complete list of design-basis accidents analyzed for current operations under the Capsules safe storage mission includes[99]:

a) Natural Phenomena
   a. Design Basis Earthquake (0.25g force) (Result[100]: An extensive structural evaluation of the integrity (Non-Destructive Examination) of the pool cell walls was performed and the pool cell wall strength was sufficient to maintain structural integrity during the design basis earthquake. No capsules would be damaged and lead to a release of capsule material. The radioactive source released would be from the hot cells, ventilation ductwork, and filter housings.)
b) External Events
   a. Aircraft Impact (Result[101]: Probability too low to require a structural response evaluation)
   b. Ground Vehicle Accident
   c. Accidents at adjacent facilities (see discussion below)
c) Facility Fires[102]
   a. Hot Cell Fire
   b. Truckport Fire
d) Facility Explosions[103]
   a. Hydrogen Explosion in Hot Cells
   b. Hydrogen Explosion in K3 Filter
   c. Hydrogen Explosion in the Pool Cell Area
   d. Flammable Gas Explosions
   e. Hydrogen Explosion in the WIXM (WESF Ion Exchange Module)
e) Loss of Confinement[104]
   a. K3 HEPA Filter Failure
   b. EMIX Spray Leak (WESF Emergency Ion Exchange system for Cs, Sr, and decay products)
   c. Hot Cell Cover Block Drop
f) Loss of Containment[105]
   a. Underwater Capsule Failure
   b. Loss of Pool Cell Water

It should also be noted that the closest facility to WESF is B Plant, which is directly adjacent to the WESF 225-B Building. Accidents at B Plant are significant to WESF because a release at B Plant could initiate a subsequent accident at WESF or hamper recovery actions should WESF operating personnel be in the process of responding to a common cause event (e.g., an earthquake or loss of

[99] [HNF-8758 (Rev9), pg. iv, pg. 1-4]
[100] [HNF-8758 (Rev9), pg. iv, pg. 1-4]
[101] [HNF-8758 (Rev9), pg. iv, pg. 1-10]
[102] [HNF-8758 (Rev9), pg. iv, pg. 3-66, pg. 3-78]
[103] [HNF-8758 (Rev9), pg. iv, pg. 3-84 through pg. 3-116]
[104] [HNF-8758 (Rev9), pg. iv, pg. 3-117 through pg. 3-124]
[105] [HNF-8758 (Rev9), pg. iv, pg. 3-125 through pg. 3-156]

offsite power). Several accidents were postulated and analyzed in the B Plant safety basis (HNF-14804, B Plant Documented Safety Analysis). The highest unmitigated dose of approximately 22 rem is possible to the co-located person (CP) (i.e., 100 m) due to the B Plant DBE. It should be noted that the B Plant DBE of 0.12 g is less severe than the WESF DBE of 0.25 g and the B Plant roof would likely collapse during a WESF DBE. The dose for the B Plant roof collapse is 8 rem to the CP. The radiological releases from B Plant could cause the evacuation of WESF; however, this plume would be very brief and would not prevent entry of essential personnel back into WESF with the proper protective gear for long-term post-DBE actions, including maintaining water level in the pool cells.

Loss of Cooling and Shielding Water[106] from All Pool Cells (Current Operations):

ACTIVE SAFETY CONTROLS: Yes

1. Credited SSC[107]: Pool Cell Drainage Prevention System[108]
2. Credited SSC: Pool Cell Water Transfer Ports[109]
3. Credited SSC: Defense-in-Depth Area Radiation Monitor Warning System[110]

PASSIVE SAFETY CONTROLS: Yes

4. Credited SSC: Outer capsules of the Cs/Sr doubly-contained capsules[111]
5. Credited SSC: Pool Cell Structure, Circulation Lines, Drain Pipe Lines, Sump Lines[112]
6. Pool Cell Air Dilution Ports[113]

OPERATIONAL and INSTITUTIONAL CONTROLS: Yes

7. Credited TSR: LCO - Maintaining Pool Cell Water Levels at least 130 inches
8. Credited TSR: SAC - A single WESF pool cell capsule inventory shall be less than 100 kW to remain within the analyzed condition
9. Credited TSR: LCO - Maintain the transfer ports for Pool Cells 1 and 3 through 7 open unless required to be closed for emergency response
10. Credited TSR: Defense-in-Depth AC: Capsules Configuration Management
11. Credited TSR: Worker Safety AC: Maintaining Radiation Monitoring Systems

ACCIDENT SCENARIO DEVELOPMENT DESCRIPTION:

12. Loss of pool water can be caused by any of the initiating events: Seismic Failure, Liner Leak, Transfer of water from a filled pool cell to an empty pool cell that had been previously blocked and emptied, pool cell vacuum system drains pools, drain line or any circulation line failure, duration of time passes and water evaporates without active measures to refill[114]
13. A fault tree of initiating events and subsequent events was developed[115] (see Figure, below)

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[106] Loss of pool water can be caused by any of the initiating events: Seismic Failure, Liner Leak, Transfer of water from a filled pool cell to an empty pool cell that had been previously blocked and emptied, pool cell vacuum system drains pools, drain line or any circulation line failure, duration of time passes and water evaporates without active measures to refill
[107] SSC = System, Structure, and Component [HNF-8758 (Rev 9), Pg. 3-156]
[108] Safety Significant - Pool cell cleaning system has a suction break and the cleaning suction leg is partially hard-piped to prevent placement of suction hose into neighboring pool cell [HNF-8758 (Rev 9), Pg. 3-43]
[109] Fill pipe into Pool Cell 12 to allow for water addition to the pool cells from outside the facility [HNF-8758 (Rev 9), Pg. 3-43]
[110] [HNF-8758 (Rev 9), Pg. 3-43]
[111] Cs and Sr capsules are welded and constructed of stainless steel material [HNF-8758 (Rev 9), Pg. 3-43]
[112] Pool cell area structure, circulation lines, drain lines, and sump lines are qualified for a 0.25 g seismic event [HNF-8758 (Rev 9), Pg. 3-43]
[113] Not a credited SSC. Pool cell air dilution ports shall remain open for active pool cells with closed transfer ports to allow for overflow of water if Pool Cell 12 fill pipe is used [HNF-8758 (Rev9), Pg.3-43]
[114] [HNF-8758 (Rev9), Pgs. 3-134 through 3-139]
[115] [HNF-8758 (Rev9), Pgs. 3-141, Figure 3-4]

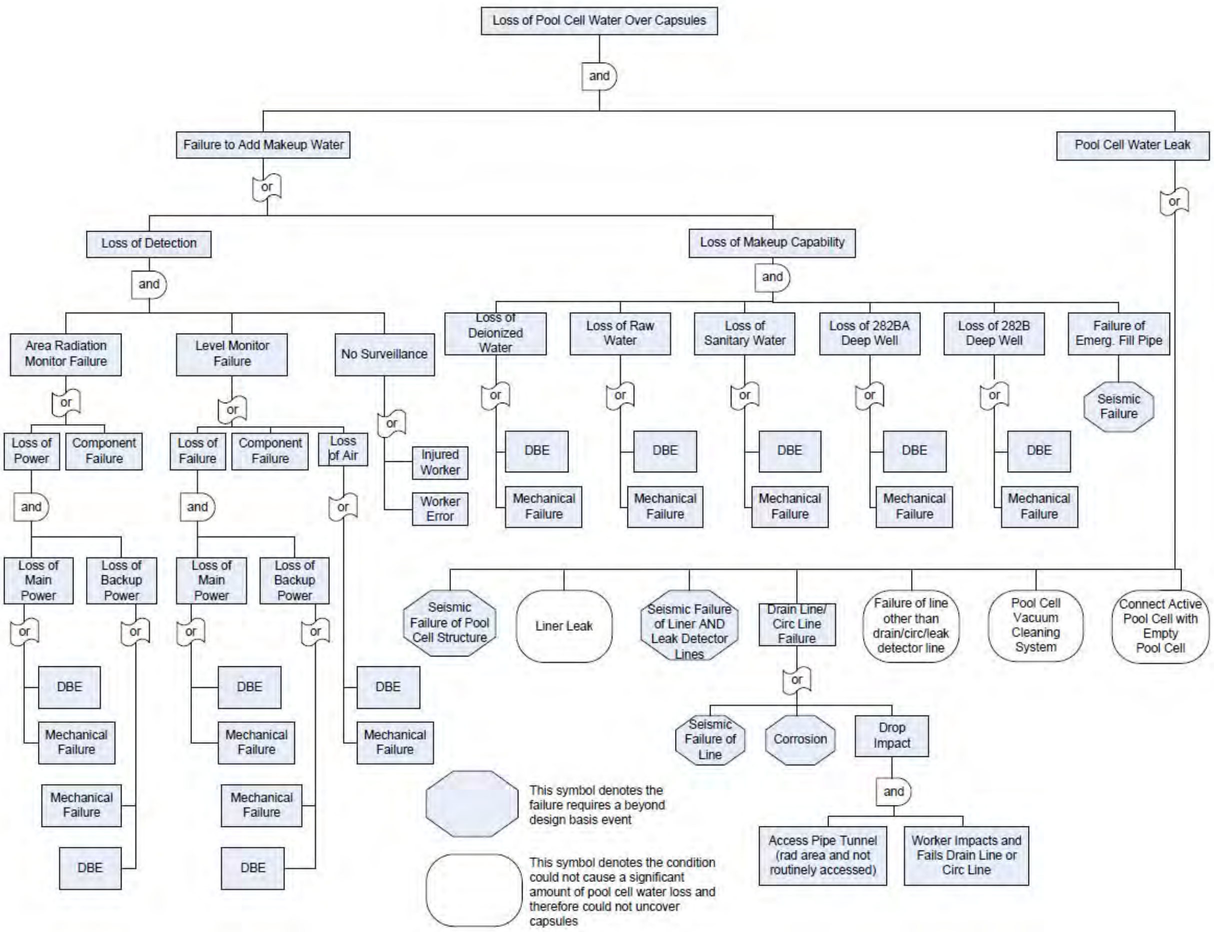

Figure H.4-13. Loss of Pool Cell Water Fault Tree Analysis (Design-Basis Accident, Earthquake, Loss of Water)[116]

There are several applicable barriers. Discussions of the integrity of those applicable barriers include:

Capsules (doubly-contained and W-type), Pool Cells (concrete and stainless steel liner), and WESF building superstructure

INTEGRITY OF APPLICABLE BARRIERS: Double-Walled Capsules (non Type-W Overpack capsules)

14. Routine testing of the integrity of the capsules is performed (as described before). The capsules are tested with the Inner Capsule Movement (ICM) test[117]. The ICM involves physically grasping one end of a capsule with a pool tong and rapidly moving the capsule vertically approximately 15 cm (6 in.). This allows the inner capsule to slide within the outer capsule, making an audible sound that is easily heard and felt by the operator performing the test. This test verifies that the

[116] [HNF 8758 (Rev9), Pg. 3-141, Figure 3-4]
[117] [HNF-8758 (Rev9), pgs. 2-30]; The ICM test was formerly called the "Clunk test" in former documentation because during the "clunk test" one would physically grasp one end of a capsule with a pool tong and rapidly moving the capsule vertically approximately 15 cm (6 in.). This allows the inner capsule to slide within the outer capsule, making a "clunk" sound that is easily heard and felt by the operator performing the test. This test verifies that the capsule has not bulged.

capsule has not bulged. The frequency that ICM test is performed has evolved over time. Presently it is to inspect (clunk test) 20% of the inventory every other year with all capsules being inspected every 10 years irrespective of statistics[118]. Listed below are criteria used by the facility to store capsules in the pool cells[119].

a. The capsule is designed for long-term storage in water.
b. A helium leak test was performed during production to verify containment integrity.
c. Thermally cycled capsules have been inspected to determine if there was capsule swelling.
d. The outer capsule is stainless steel and welded.
e. The capsule fits through the transfer chute on the transfer cart between G Cell and Pool Cell 12.
f. The capsule fits through the transfer ports into Pool Cell 12.
g. The capsule fits in the pool cell storage racks.
h. The capsule must be decontaminated to current Hanford Site radiological release limits.
i. The capsule is marked with a unique identification number.

15. These data support the conclusion that a capsule with a nominal amount of impurity will not see a significant amount of corrosion during the 50-year life in dry storage. In addition, an assessment of radiolytic production of chlorine or fluorine indicates that these gasses will not significantly contribute to corrosion during the 50-year storage life. Because capsules would not see significant corrosion during a 50-year dry storage condition, it is expected there would be very little if any corrosion under the cooler pool cell conditions[120].

INTEGRITY OF APPLICABLE BARRIERS: Type W Overpack Capsules

16. The Type W overpacks had both a helium leak check and ultrasonic weld inspection on the outer capsule to verify weld integrity. Because there has been essentially no stress placed on these capsules (i.e., no thermal cycling), there is no reason to suspect inner capsule swelling or weld failure of these capsules. It is the stress from thermal cycling that caused inner capsule swelling and likely caused the leak path to form in the outer capsule weld. Therefore, ICM testing of the Type W overpack capsules, whether in the pool cell or hot cell, will not be performed. However, it is prudent to ensure nothing unexpected is happening to the Type W capsules while they are stored at WESF. Therefore, a visual inspection of at least five of these capsules every ten years will be performed in a hot cell to ensure there is nothing obviously unusual about the capsule (e.g., visible corrosion or cracking, unexplained discoloration, etc.)[121].

INTEGRITY OF APPLICABLE BARRIERS: POOL CELLS (CONCRETE)

17. All pool cells have liners constructed of 16-gauge type 304L stainless steel at the sides and 14-gauge type 304L stainless steel flooring. Although all pool cells, except Pool Cell 12, are designed for cover block installation, cover blocks are not normally installed on pool cells that store capsules to prevent potential damage to the capsules due to a cover block drop. Cover blocks may be installed on a pool cell containing capsules in response to an emergency (e.g., loss of capsule integrity).

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[118] Personal Communication with L. I. Covey and other WESF facility operators/managers during the CRESP visit to Hanford in October 2014 and fully documented in [HNF-8758 (Rev9), pg. 2-31 and [HNF-28601 (Rev3), Pg. 7]
[119] [HNF-8758 (Rev9), Pg. 2-33]
[120] [HNF-28601 (Rev3), Pg. 2]. Corrosion nucleation points would be caused by impurities encapsulated into the capsule salt during original manufacturing process (cadmium, chromium, lead, and silver) or by the decay product of Cs-137 (barium) [HNF-8758 (Rev9), Pg. 9-4].
[121] [HNF-8758 (Rev9), pg. 2-32]

18. Several engineering reports for inspections and repairs to the reinforced concrete 225-B Building and the hot cell floor liners were obtained and reviewed. The lateral force resisting systems for the WESF structures were determined. The configuration, anchorages, and lateral supports for the systems and equipment items were determined and evaluations were made on the probability of survival for WESF structures and systems, based on engineering judgments about whether the responses of the items could be expected to be within acceptable limits[122].**This structural evaluation determined that the shear capacity of the pool cell divider walls significantly exceeds the maximum shear demand of the concrete walls during a WESF DBE and that the structural integrity of the WESF pool cells is not compromised under the levels of concrete degradation described in HNF-SD-WM-TI-733. This evaluation also concluded there would be no damage to the pool cell liner during a DBE[123].**

19. Appendix L – "Gamma Radiation Degradation of WESF Concrete Structure"[124], [125]

    Pool Cells 1, 3 through 7 store Cs/Sr capsules. The pool cell concrete has been exposed to significant gamma radiation due to the storage of cesium capsules. The conservatively estimated exposure (assuming maximum capsule loading) to the surface of the concrete divider walls is 3.3×10^{11} Rad. The continued storage of cesium capsules in the WESF pool cells for another 10 years would result in surface radiation exposures approaching 4×10^{11} Rad. The exposure in the center of the pool cell divider walls is 2×10^{10} Rad. Only the bottom three feet of the 18 foot pool cell divider walls has this exposure level. Floor exposures are lower by over a factor of 10 because the racks are mounted approximately eight inches above the floor, and the capsules have end caps with a combined stainless steel thickness of 0.8 inches. The top one inch of the 21-inch thick floor may have been exposed to the radiation level of concern (1×10^{10} Rad). Pool cell end walls have also seen greatly reduced exposures by over a factor of 100 compared to the pool cell divider walls due to; 1) routine practice of storing strontium capsules (primarily a beta emitter) in Rack 1 toward Pool Cell 12 end wall, and 2) not using the last four columns of Rack 3 under heat exchangers toward the pipe trench end wall. It is noted that after cesium capsules were returned from the offsite irradiators, Rack 1 in Pool Cell 7 contained cesium capsules, along with four strontium capsules. The cesium capsules were stored five columns away from the end wall until 2012 (which is similar to the other end wall where capsules are stored four columns away). In the summer of 2012, cesium capsules were spaced out with an empty rack location between each of the capsules. In this configuration, Pool Cells 2 through 6 still store only strontium capsules in Rack 1, but Rack 1 in Pool Cell 7 stored cesium capsules in all the columns. If the conservative values are assumed for radiation exposure from the maximum capsules into the side wall, approximately 1×10^{10} Rad would be added to the total Pool Cell 7

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[122] [HNF-8758 (Rev9), pg. 1-4]

[123] [HNF-8758 (Rev9), Pg.3-60]

[124] [HNF-SD-WM-TI-733 (Rev 6), Pg. L-1]

[125] Appendix L References – (1.) CHPRC-01858, Rev 0, Structural Evaluation of WESF Concrete Degradation Due to Radiation, dated August 2012.; (2.) HNF-8758, Revision 7, Waste Encapsulation and Storage Facility Documented Safety Analysis, dated April 6, 2012. (3.) HNF-8759, Revision 7, Waste Encapsulation and Storage Facility Technical Safety Requirements, dated April 6, 2012. (4.) INEEL/EXT-04-02319, Literature Review of the Effects of Radiation and Temperature on the Aging of Concrete, D. L. Fillmore, Ph.D., September 2004 (5.) Lowinska-Klugea, A., and Piszora, P., Effect of Gamma Irradiation on Cement Composites Observed with XRD and SEM Methods in the Range of Radiation Dose 0–1409 MGy, ACTA PHYSICA POLONICA A, vol. 114 (2008). (6.) Occurrence Report EM-RL--CPRC-WESF-2012-0002, Potential Inadequacy in the Safety Analysis (PISA) Related to Potential Radiation Degradation of Concrete in Pool Cells. (7.) SP-55-10, The Effects of Nuclear Radiation on the Mechanical Properties Concrete, American Concrete Institute report, 1978. (8.) SRNL-STI-2010-00004, Determining the Effects of Radiation on Aging Concrete Structures of Nuclear Reactors – 10243, by Cristian E. Acevedo, of Florida International University, and Michael G. Serrato, of Savannah River National Laboratory, 2010 Waste Management Conference. (9.) Unreviewed Safety Question Potential Inadequacy in the Safety Analysis Determination, WESF-12-145, Radiation Degradation of WESF Pool Cell Concrete. (10.) Unreviewed Safety Question Determination WESF-12-151, Radiation Degradation of WESF Pool Cell Concrete.

end wall exposure every two years (this also decreases over time). With every other space filled and the distance to the wall being much greater than two inches, approximately $1x10^{10}$ Rad would be anticipated to the Pool Cell 7 end wall exposure over the next 10 years. Operational restrictions have been imposed to prevent storage of cesium capsules in the first four columns of Rack 1 and the last four columns of Rack 3 to minimize the long term gamma radiation to the pool cell end walls.

A figure from H Hilsdorf, J. Kropp, H. Kock, *The Effects of Nuclear Radiation on the Mechanical Properties Concrete,* American Concrete Institute report SP-55-10, 1978. This document provides a graph of compressive and tensile strength of concrete exposed to gamma radiation from various data. Conservative estimates are made as to the potential reduced strength of the pool cell concrete using this graph (shown in Figure H.4-14, below).

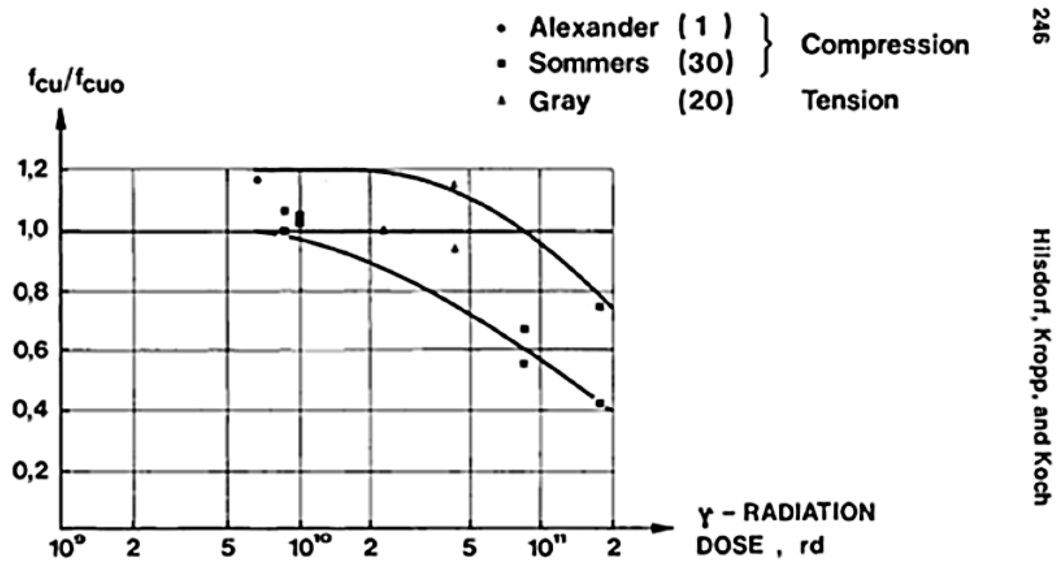


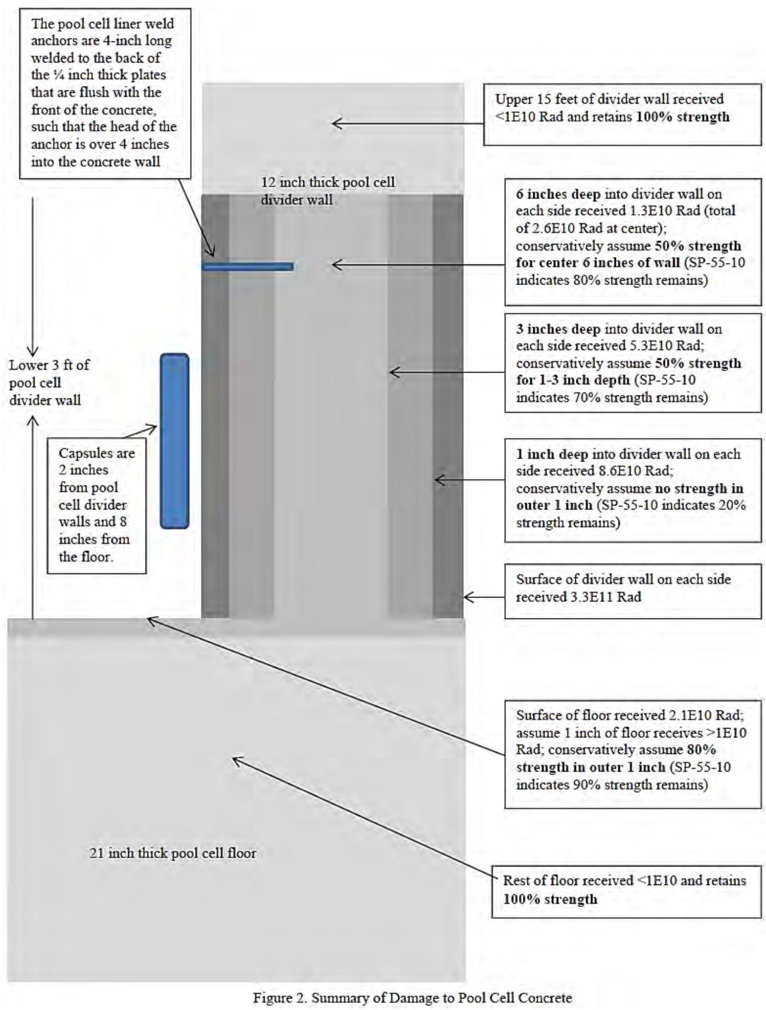
Fig. 7:
Compressive and Tensile Strength of Concrete Exposed to γ – Radiation f_{cu}, Related to Strength of Untreated Concrete f_{cuo}

Figure H.4-14. Concrete Strength vs. Gamma Radiation Dose[126]

A second study was also used to determine the possible gamma radiation degradation of concrete. Samples exposed to different doses of gamma radiation were tested using scanning electron microscopy and x-ray diffraction and the results are documented in Lowinska-Klugea, A., and Piszora, P., *Effect of Gamma Irradiation on Cement Composites Observed with XRD and SEM Methods in the Range of Radiation Dose 0–1409 MGy*, ACTA PHYSICA POLONICA A, vol. 114. There was significant visual change in the samples receiving >8.36E10 Rad indicating degradation but this degradation was not quantified in a loss of concrete strength. It will be conservatively assumed that any pool cell concrete receiving $>8.36x10^{10}$ Rad will have no strength even though SP-55-10 indicates that that concrete at this radiation level would still have 50% strength.

[126] [HNF-SD-WM-TI-733 (Rev6), Appendix L, Pg. L-5, Figure 1]

The top one inch of the 21-inch thick floor may have been exposed to the radiation level of concern and will be assumed to have a 20% loss of concrete strength. The remaining 20 inches of floor has no loss of concrete strength. It will be assumed that outer one inch on each side of the bottom 3 feet of the pool cell divider wall has 100% loss of concrete strength and that the middle 10 inches of the wall has 50% reduction of concrete strength. The remaining top 15 feet of divider wall has no loss of concrete strength. A Schematic Diagram that summarizes the assumed concrete degradation was provided[127] and shown in Figure , below.



Notes: The gray-scale is qualitatively depicting the radiation dose levels received. Darker shades of gray indicate higher levels of radiation.

Figure H.4-15. Summary of Assumed/Calculated Damage to Pool Cell Concrete[128]

[127] [HNF-SD-WM-TI-733 (Rev6), Appendix H, Pg. H-36]
[128] [HNF-SD-WM-TI-733 (Rev6), Appendix L, Pg. L-6, Figure 2]

INTEGRITY OF APPLICABLE BARRIERS: POOL CELLS (STEEL LINER)[129]:

20. During the site tour by the assigned CRESP team in mid-October 2014 – personal communication with the WESF managers and operators noted that the stainless steel liner of the pool for Pool Cells 5 and 10 are known to have small liner leaks. Pool cell water leakage was collected in a sump at a rate of approximately 12-15 liters every few months130. Collected water was then tested through the facility's testing equipment for beta-counts and resulting with no radioactive material within the collected water.

    Calculations were performed to estimate the volume of the leak detection sump boundary beneath the liner of the pool cells. For pool cells 2 through 11, this volume was calculated to be 68 gallons (258 liters) (assuming leak detector filled to 156 inch level) or equivalent to a 1.1 inch drop in pool cell water level. For pool cell 1 the volume was found to be 73 gallons (277 liters) or equivalent to 0.61 inches of pool cell water level.

INTEGRITY OF APPLICABLE BARRIERS: WESF BUILDING CONCRETE BARRIER STRUCTURE

21. Facility exterior walls that support the above grade structures have not seen any significant exposures as they are shielded by the primary storage pool cell physical structural arrangement so there is no assumed loss of concrete strength[131].

PRIMARY PATHWAYS AND POPULATIONS AT RISK:

22. The primary pathway is the air pathway/ radiological contaminants become airborne and present a radiological hazard because of the committed effective dose equivalent (CEDE) incurred from inhalation and the external effective dose equivalent that would be incurred from gamma radiation (and maybe some high energy beta radiation). The populations at risk are facility workers and potentially co-located persons as analyzed in the WESF DSA[132]. The dose fields that would result from a loss of water from all pool cells are shown below in Table H.4-7.

[129] [HNF-SD-WM-TI-733 (Rev6), Appendix H, Pg. H-36]
[130] [HNF-8758 (Rev9), Pg. 2-27] The quoted volumetric flow rate of the leak is 0.8 L/week.
[131] [HNF-SD-WM-TI-733 (Rev 6), Pg. L-5]
[132] [HNF-8758 (Rev9)]

Table H.4-7. Dose Fields within and near WESF for a Loss of Water from All Pool Cells[133]

Condition	Location	Dose rate rem/h (55 MCi ^{137}Cs)	Dose rate rem/h (38 MCi ^{137}Cs – capsule inventory decayed to February 2011)	Reference
Dry pools	Just outside north door	600[(b)]	400[(b)]	HNF-SD-WM-TI-733, App. G, KEH-8D150-94-001[(a)]
	5 m (16 ft) from pool cell area external wall	40	30	
	100 m (328 ft) from pool cell area external wall	4	3	

[(a)] This calculation did not account for the self-shielding provided by capsule array and appears conservative by a factor of 5 to 10.
[(b)] Dose rates represent capsules stored in center pool cells as calculated in KEH-8D150-94-001 because the all pool cell configuration assumes capsules are stored in Pool Cells 8 through 11.

TIME FRAMES (Response Times, Time for Impacts to be Realized)

23. Estimated Response Times[134]: minimum 25 seconds[135] for backup generators to respond and provide electricity to emergency coolant pumps; maximum several days (5-12 days) before remaining water would start to boil[136] and responders could add water by this time.
24. Time for impacts to be realized: Capsule failure would occur at the soonest at the second day after the loss of coolant and the remaining water would take nearly 5-12 days to boil to a point where loss of water would produce conditions in which potential damage to human health could be present[137].

Beyond Design Basis Earthquake Leads to Loss of Cooling and Shielding Water from All Pool Cells and Release of Cs/Sr from Overheating; Cs and Sr Capsules (Current Operations)

BACKGROUND:

1. As part of its response to the events that occurred at Fukushima, DOE had sites and operating contractors evaluate facility and site responses to beyond design basis events (BDBEs); specifically, they directed that for Category 1 and 2 facilities: a review of how BDBEs had been considered or analyzed be conducted; the facilities ability to safely manage a total loss of power event, including lass of backup capabilities; confirmation of safety system maintenance and operability; and a confirmation of emergency planning effectiveness, especially as regarded the potential loss of normal regional support infrastructure (e.g., off-site power, firefighting

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[133] [CHPRC-02047 (Rev0), Pg. 21]
[134] With understanding that accidents at B Plant are significant to WESF because the release at B Plant could initiate a subsequent accident at WESF or a release at B Plant could hamper recovery actions should WESF operating personnel be in the process of responding to a common cause event, (e.g., an earthquake or loss of offsite power) It should be noted that the B Plant DBE of 0.12 g is less severe than the WESF DBE of 0.25 g and the B Plant roof would likely collapse during a WESF DBE. The dose for the B Plant roof collapse is 8 rem to the onsite receptor. The radiological releases from B Plant could cause the evacuation of WESF; however, this plume would be very brief and would not prevent entry of essential personnel back into WESF with the proper protective gear. [HNF-8758 (Rev9), Pg. 3-65].
[135] [HNF-8758 (Rev9), Pg. 2-48]
[136] Assumed that the same response time from the beyond design basis accident of an earthquake would also result with a loss of water (coolant and shielding) to the capsules [CHPRC-02047 (Rev0), Pg. 21]
[137] Assumed that the same response time from the beyond design basis accident of an earthquake would also result with a loss of water (coolant and shielding) to the capsules [CHPRC-02047 (Rev0), Pg. 21]

capability, etc.)[138]. One of the facilities that garnered particular attention was WESF, due to its similarity to a commercial reactor spent nuclear fuel pool. In the CHPRC response[139] to this DOE tasking a plan of action involved nine (9) actions to address issues at WESF. The major concern evaluated was a loss of water, and thus cooling, to the pool which presently provides both cooling to the capsules and shielding for personnel in the facility and surrounding area. WESF-specific actions included: revision of emergency planning/management procedures to better document actions to be taken to keep adequate water level in the pools; re-arrangement of capsules in the pools to reduce the net heat generation rate; and conduct of drills to demonstrate the ability of emergency response personnel to locate, identify and use emergency fill connections.

Further, the analysis of the seismic BDBE identified that about half of the calculated radiation exposure was due to the release of contamination from ventilation piping in areas of WESF no longer required for the present safe storage mission, of for potential future work, such as capsule movement for packing and dry storage. Thus a project was initiated[140] to retire those portions of the ventilation system that are no longer required for present and anticipated missions, and stabilize the contamination (via grouting in-place); this work will be conducted in parallel with already planned ventilation modifications to be consistent with DOE commitments responding to DNFSB Recommendation 2004-2, *Confinement Ventilation*.

ACTIVE CONTROLS, PASSIVE SAFETY CONTROLS, OPERATIONAL AND INSTITUTIONAL CONTROLS:

2. For a BDBA, the unmitigated frequency of occurrence for NPH events cannot be reduced. As this was a BDBA, the contractor was to determine the unmitigated consequences only and not pursue control selection or mitigated consequence evaluation; therefore, no controls were identified to prevent/mitigate the BDBA. The evaluation does recognize that there are current credited design features, exhaust ventilation, and area radiation monitors that are operable and capable of performing their safety functions and that TSR surveillance are current[141].

   There were "Existing Facility Controls That Might Help Prevent/Mitigate Event" listed. This included a "Source Inventory Control" that limits heat load in a pool cell Pool Cell Fill Pipe (design feature) and allows for water addition to pool cells from outside facility if radiation levels in pool cell area are high.

ACCIDENT SCENARIO DEVELOPMENT DESCRIPTION

3. In the scenario that was used for the basis of the DSA calculations, it was assumed that 1,162 capsules would fail[142] that would release 38 MCi (of the 98 MCi estimated radioactivity of February 2014 within the Cs/Sr capsules). During a BDBA, the building structure is assumed to fail. Hot cell contamination is released due to impact from debris or vibration. The below grade pool cell structure is assumed to fail and releases pool cell water (water may be contaminated if capsules were damaged by debris). Once the water is gone, the capsules fail over time due to stress cracking or corrosion and material is released from pool cells via evaporation. Pool cell above grade structure is assumed to survive because this results in the largest consequence.

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[138] DOE-HS Safety Bulletin 2011-01, Events Beyond Design Safety Basis Analysis, March 23, 2011

[139] CHPRC letter 1104737A-R1, Evaluation of Events Beyond the Design Safety Basis, October 21, 2011; as supplemented by CHPRC letter 11047337A-R2 (same title), January 16, 2012

[140] The project execution plan for this effort is documented in CHPRC-02310 (Rev. 0), "Project Execution Plan for WESF Stabilization and Ventilation Project," September 2014

[141] [CHPRC-020407 (Rev0) Pg. 2A-7]

[142] [CHPRC-020407 (Rev0) Pg. 23]

Failure of the above ground pool cell area structure provides cooling for the capsules upon a loss of pool cell water and significantly reduces the release of capsule material due to evaporation.

INTEGRITY OF APPLICABLE BARRIERS:

4. See “Loss of Cooling and Shielding Water from All Pool Cells (Current Operations)” section

PRIMARY PATHWAYS AND POPULATIONS AT RISK:

5. The primary pathway is the air pathway/ radiological contaminants become airborne and present a radiological hazard because of the committed effective dose equivalent (CEDE) incurred from inhalation and the external effective dose equivalent that would be incurred from gamma radiation (and maybe some high energy beta radiation). The populations at risk are facility workers and potentially co-located persons as analyzed in the WESF documentation[143].

TIME FRAMES (Response Times, Time for Impacts to be Realized)

6. The 2-hr dose consequences are less than for a complete loss of pool cell water without failure of the aboveground structure so the loss of pool cell water dose consequences are used in the BDBE. However, it is noted that the failed capsule consequences and boiling of contaminated water could occur sooner than the loss of pool cell water consequences (**boiling of the water could occur in approximately 9 days).** Capsule failures due to corrosion from a loss of pool cell water with no failure of the structure would not start until approximately **50 days after a loss of all pool cell water assuming a packed rack configuration and approximately 300 days after a loss of all pool cell water for a spaced rack configuration**[144].
7. In the event of total loss of power (primary and backup power), no additional impact of this BDBE would be expected because the building structure and equipment are assumed to fail. It was assumed that the facility could continue to safely manage inventory. Water can be added to pool cells via tanker trucks and there are **several days (~12) to respond before capsules become uncovered**. Opening a door in the pool cell area will provide passive ventilation to prevent hydrogen accumulation above the flammability limit. There may be minor contamination spread due to loss of ventilation.
8. WESF Hanford Fire Department Pre-incident Plan was revised to include alternate water sources available to respond to a BDBE involving a WESF Loss of Pool Water event. The assumption is that the BDBE would cause severe damage to hydrant water supply and facility make-up water system capabilities. HFD may need to shuttle water from alternate water sources. Also, there are special considerations for adding water. The revised plan references facility procedures to assist in decision making.
9. The DSA also discusses post loss of water concerns. The question of whether or not to add water to a pool after capsules have been uncovered for a period of time was also addressed in the thermal analysis report (WHC-SD-WM-TI-770). The particular concerns addressed were: (1) the potential for thermal stresses causing new capsule failures, (2) molten salt-water interactions potentially damaging capsules or the pool, or increasing the source term by mechanical aerosol generation, (3) water reacting with cesium chloride to create new trace species that exacerbate the source term, (4) contaminated water leakage through failed confinement boundaries, and

[143] [CHPRC-020407 (Rev0)]
[144] [CHPRC-02047 (Rev0), Pg. 21]

(5) boiling of contaminated water. Items 2, 3, 4 and 5 are relevant only if capsule failures have occurred, but Item 1 is relevant anytime a pool cell is drained[145].

Hydrogen explosion in Ion exchange Module [WIXM] (Current Operations)

ACTIVE SAFETY CONTROLS[146]: Yes

1. Credited SSC: Fill of Void Space in WIXM (WESF Ion Exchange Module)

PASSIVE SAFETY CONTROLS: No

OPERATIONAL and INSTITUTIONAL CONTROLS: Yes

2. Credited TSR[147]: Limited Maximum Radionuclide Content (by Radioactivity and Mass)[148]
3. Credited TSR: Maintaining Pool Cell Water Levels at least 130 inches

ACCIDENT SCENARIO DEVELOPMENT DESCRIPTION[149]:

4. As the resin in a WIXM becomes loaded with radioactive material, the ionizing radiation results in radiolysis of the resin/water and produces hydrogen. If hydrogen were to accumulate inside the WIXM vessel to quantities of 4 percent volume or more, the hydrogen can become flammable and eventually detonable if it continues to increase. Such a combustion event could result in the release of contaminated resin and water. For such accident conditions to exist, the excess water in the WIXM vessel would have to be drained (allowing a void volume for the hydrogen to accumulate) and would likely be undergoing preparation for transport. The resin material would be water-soaked with the hydrogen originating from the water trapped within the resin bed. Hydrogen would then accumulate in the head space of the vessel above the resin bed. In order for the hydrogen to ignite, an energy source would have to be present in the WIXM. This could potentially be provided by a static charge inside the vessel or possibly by a spark introduced into the hydrogen-containing vent or inlet pipe from some outside activity (e.g., a worker's tool). The worst case would be ignition of the hydrogen at the end of the inlet pipe because the flame front could propagate down the inlet pipe, transition into a detonation, enter the WIXM and impact the resin bed with the maximum force. The detonation pressure pulse would impact the resin/water surface and rebound upward, possibly rupturing the WIXM assembly and ejecting some resin, radioactive material, and water into the truckport.

INTEGRITY OF APPLICABLE BARRIERS:

5. Condition of the credited void space in the WIXM is unknown.

PRIMARY PATHWAYS AND POPULATIONS AT RISK:

6. The primary pathway is the air pathway/ radiological contaminants become airborne and present a radiological hazard because of the committed effective dose equivalent (CEDE) incurred from inhalation and the external effective dose equivalent that would be incurred from gamma radiation (and maybe some high energy beta radiation). The populations at risk are facility workers and potentially co-located persons as analyzed in the WESF DSA[150].

[145] [CHPRC-02047 (Rev0), Pg. 22]
[146] [HNF-8758 (Rev 9), Pg. 3-109]
[147] TSR = Technical Safety Requirement [HNF-8758, (Rev9), Pg. viii]
[148] Radionuclide limited to 25,000 Ci Sr-90 or 31,000 Ci Cs-137 with no less than 150 kg resin material. For combinations of Cs-137 and Sr-90, a maximum of 35,000 Ci Sr-90 and Cs-137 with no less than 150 kg resin material. [HNF-8758 (Rev 9), Pg. 3-117]
[149] [HNF-8758 (Rev 9), Pg. 3-109]
[150] [HNF-8758 (Rev9)]

TIME FRAMES (Response Times, Time for Impacts to be Realized)

7. No response times or durations of times were provided of when impacts could be first realized. The amount of hydrogen to reach the lower flammability limit (LFL) is 4%. The time for the G cell to accumulate hydrogen to the LFL is weeks to months. It could be postulated that since the ion exchange column volume is smaller than the Hot Cell G volume that the time would be less.

Design Basis Earthquake Releases from Hot Cells, Ventilation Ductwork, HEPA filter (Current Operations)

ACTIVE SAFETY CONTROLS: No

PASSIVE SAFETY CONTROLS[151]: Yes

1. Credited SSC: 225-B Area 3 (pool cells); pool cell bridge crane, catwalk, and associated support structures; pool cell drain line, circulation piping, and sump lines
2. Credited SSC: 225-B Area 2 (hot cells, canyon, hot and cold manipulator shops, manipulator repair shop, operating gallery, service gallery, and AMU)

OPERATIONAL and INSTITUTIONAL CONTROLS[152]: Yes

3. Specific Administrative Control (SAC): F Cell and G Cell each contain a maximum capsule inventory of 150,000 Ci Cs-137 and 150,000 Ci Sr-90 (this keeps the total stored capsule wattage in F Cell or G Cell at less than 1.8 kW), and capsules are located a minimum of 20 cm (7.9 in.) from any hot cell structural surface to protect against degradation of the concrete structure.
4. Defense-in-Depth Administrative Control: A program is established and maintained to address configuration management of the TSR design features to ensure the continued integrity of the SSCs relied upon in the analysis.

ACCIDENT SCENARIO DEVELOPMENT DESCRIPTION[153]

5. Two design basis seismic events were considered in WESF design and construction. The first event, called the operating basis earthquake, has a peak ground acceleration of 0.12 g and was applied to the office and support areas of the 225-B Building (i.e., Area 1). The second event, called the safe shutdown earthquake, has a peak ground acceleration of 0.25 g and was applied to those portions of the 225-B Building having a radiological confinement function, such as the hot cells and pool cell area (i.e., Areas 2 and 3, respectively). The seismic event analyzed in this section is the more severe safe shutdown earthquake and will be referred to hereafter as the DBE.
6. The DBE would result in the immediate release of hazardous material from the hot cells and the K3 exhaust ducting. Some of the contamination in the hot cells and K3 duct is postulated to become suspended as a result of the shock of the DBE which may involve structural failure of the stack or A Cell due to failure of the 221-B Building end wall which is not qualified to survive the 0.25 g DBE associated with WESF. The same isotopes are present in the K3 exhaust ducting downstream of the hot cells and would also be subject to shock-vibration release in a DBE. The radioactive material in the truckport and in capsules located in the pool cells, F Cell, or G Cell would not be impacted by the immediate effects of the DBE. The hot cells (excluding A Cell

[151] [HNF-8758 (Rev 9) Pg. 3-64]
[152] AC = Administrative Control [HNF-8758 (Rev 9) Pg. 3-64]
[153] [HNF-8758 (Rev 9) Pgs. 3-28, 3-60 through 3-]

which is assumed to fail from the collapse of the B Plant end wall), canyon, and truckport would survive the DBE. The structures confining the capsules, including the hot cells and the pool cells, are also designed to survive the DBE. Thus, the capsules are not impacted by falling objects and, in the absence of such an impact, the capsules are adequately protected from the DBE. The packaging associated with any LLW located throughout the facility would likely be sufficient to prevent the suspension of contamination; however, the DSA assumes the containers fail due to potential impact from any surrounding unqualified structures.

INTEGRITY OF APPLICABLE BARRIERS: HOT CELL CONCRETE BARRIER STRUCTURE

7. The north and south walls of all the hot cells and both east and west walls of A and G Cell are 89 cm (35 in.) thick, high-density (3.8 g/cm^3 [235 lb/ft^3]) reinforced concrete for personnel shielding (HNF-SD-WM-DB-034). The A and G Cells also have an 89 cm (35 in.) high-density concrete shielding door for personnel entry from the service gallery[154].
8. The floor and walls of the Hot Cells A, B, C, F are lined with 14-gauge 304L stainless steel. The floor and lower portion of the walls of Hot Cells D and E are lined with 14-gauge Inconel™-600 alloy. Hot Cell G does not have an additional metal liner, only the walls and floor are coated with white, radiation-resistant and corrosion-resistant paint[155].
9. Calculations were performed to estimate the gamma radiation exposure to the pool cells and hot cells as well as the assumptions made regarding pool cell concrete degradation due to radiation exposure. Gamma exposure is from the cesium capsules. The estimated accumulated exposure in the hot cells was estimated in the $1x10^8$ to $1x10^9$ Rad range.[156] The accumulated gamma radiation exposure in the hot cells does not approach levels of concerns for beginning signs of concrete degradation ($1x10^{10}$ Rad) so there is no assumed loss of concrete strength.[157]

INTEGRITY OF APPLICABLE BARRIERS: HOT CELL VENTILATION SYSTEMS

10. K1 and K2 ventilation and exhaust systems are functional and capable. The K3 supply and exhaust system will be upgraded (as explained further in

[154] [HNF-8758 (Rev9), pgs. 2-21 through 2-23]
[155] [HNF-8758 (Rev9), pgs. 2-21 through 2-23]
[156] [HNF-SD-WM-TI-733 (Rev 6), Pg. L-1] Appendix L – "Gamma Radiation Degradation of WESF Concrete Structure"
[157] [HNF-SD-WM-TI-733 (Rev 6), Pg. L-5]

11. Part IV. Unit Description and History)

PRIMARY PATHWAYS AND POPULATIONS AT RISK:

12. The primary pathway is the air pathway/ radiological contaminants become airborne and present a radiological hazard because of the committed effective dose equivalent (CEDE) incurred from inhalation and the external effective dose equivalent that would be incurred from gamma radiation (and maybe some high energy beta radiation). The populations at risk are facility workers and potentially co-located persons as analyzed in the WESF DSA[158].

TIME FRAMES (Response Times, Time for Impacts to be Realized)

13. Water sources outside the facility (i.e., sanitary and raw water) are also vulnerable to failure in the DBE. Therefore, the DBE could result in failure of makeup water sources to the pool cells. Elapsed time to uncover the capsules due to evaporative losses from the highest heat load single pool cell would require at **least 7 days (without cooling). If the transfer ports were opened to all active pool cells, it would take 19 days (without cooling) to uncover the capsules. Because the loss of water would occur slowly, it is reasonable to assume that a source of water could be provided to the pool cells (e.g., tanker truck) within the 7 to 19 days required to uncover the capsules**. The fill pipe into Pool Cell 12 allows for water addition outside the facility and will be identified as a design feature.
14. For a loss of pool cell water analysis due to evaporation. It must be assumed that an explosion that resulted in falling debris also caused a loss of pool cell cooling. The contaminated water **could reach boiling temperatures in 17 hours as conservatively calculated**[159].

Hydrogen explosion in Hot Cell G and K3 Duct (Current Operations)

ACTIVE SAFETY CONTROLS: Yes

1. Backup power for ventilation system[160]
2. Hot cell ventilation[161]

PASSIVE SAFETY CONTROLS: Yes

3. Credited SSC: Safety Significant - G Cell capsule transfer chute is a design feature to prevent overflow of water into the other hot cells
4. G Cell is the only cell with water sources and it takes several weeks to months to generate 4% hydrogen[162]

OPERATIONAL and INSTITUTIONAL CONTROLS: Yes

5. Credited TSR: SAC - Maximum cesium capsule inventory of 150 kCi and maximum strontium capsule inventory of 150 kCi in a single hot cell
6. Credited TSR: Defense-in-Depth AC - Configuration control of design features

ACCIDENT SCENARIO DEVELOPMENT DESCRIPTION[163]:

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[158] [HNF-8758 (Rev9)]
[159] [HNF-8758 (Rev9), Pg. 3-101]
[160] [HNF-8758 (Rev9), Table B-3, Page B-65, Row 56]
[161] [HNF-8758 (Rev9), Table B-3, Page B-65, Row 56]
[162] [HNF-8758 (Rev9), Table B-3, Page B-65, Row 56]
[163] [HNF-8758 (Rev 9), Pg. 3-39, Pg. 3-91]

7. Loss of ventilation to hot cells with radiolytic hydrogen from water use in cell in combination with inadvertent accumulation of water in the K3 ventilation system. Potential consequences are a buildup of hydrogen gas and blockage of the K3 airflow resulting in a loss of facility ventilation. An explosion in a hot cell could also cause shock/vibration through the ventilation system such that contamination could be released from the other hot cells or the K3 duct. Capsules could also be located in F Cell but the material in the capsules would not be released due to the shock/vibration.

INTEGRITY OF APPLICABLE BARRIERS: HOT CELL CONCRETE BARRIER STRUCTURE

8. See " Design Basis Earthquake Releases from Hot Cells, Ventilation Ductwork, HEPA filter (Current Operations)" Section

PRIMARY PATHWAYS AND POPULATIONS AT RISK:

9. The primary pathway is the air pathway/ radiological contaminants become airborne and present a radiological hazard because of the committed effective dose equivalent (CEDE) incurred from inhalation and the external effective dose equivalent that would be incurred from gamma radiation (and maybe some high energy beta radiation). The populations at risk are facility workers and potentially co-located persons as analyzed in the WESF DSA[164].

TIME FRAMES (Response Times, Time for Impacts to be Realized)

10. Even with a seismic event causing a loss of power and damaging the K3 ventilation system, it would be reasonable to assume that hot cell ventilation could be restored, water could be removed from G Cell or capsules could be removed from G Cell **within six months**[165]**.**

Design Basis Earthquake + Stack Collapse Cause Releases (Building Stabilization, Near-term Operations)

ACTIVE SAFETY CONTROLS: Potentially, but no specific technology listed in the Hazards Analysis

PASSIVE SAFETY CONTROLS[166]: Yes

1. Design of 225B building
2. Design of Stack
3. Design of capsules

OPERATIONAL and INSTITUTIONAL CONTROLS[167]: Yes

4. When capsules are in the hot cells, radiation protection measures used
5. Initial testing, in-service surveillance and maintenance
6. Operational safety measures
7. Procedures and training
8. Emergency preparedness

ACCIDENT SCENARIO DEVELOPMENT DESCRIPTION

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164 [HNF-8758 (Rev9)]
165 [HNF-8758 (Rev 9), Pg. 3-39, Pg. 3-91]
166 [CHPRC-02203 (Rev0), Pg. B-24, Table B-1]
167 [CHPRC-02203 (Rev0), Pg. B-24, Table B-1]

9. If the stack falls over the pool cells, debris could damage capsules and there could be a loss of pool cell cooling or a loss of water. The WESF DSA[168] analyzes significant failure of roof/walls caused by hydrogen explosion in the pool cell area which causes failure of capsules. The unmitigated doses of this accident scenario were added to the unmitigated design basis earthquake impacts in the DSA for current operations[169].

INTEGRITY OF APPLICABLE BARRIERS:

10. See "Loss of Cooling and Shielding Water from All Pool Cells (Current Operations):"

PRIMARY PATHWAYS AND POPULATIONS AT RISK:

11. The primary pathway is the air pathway/ radiological contaminants become airborne and present a radiological hazard because of the committed effective dose equivalent (CEDE) incurred from inhalation and the external effective dose equivalent that would be incurred from gamma radiation (and maybe some high energy beta radiation). The populations at risk are facility workers and potentially co-located persons as analyzed in the WESF documentation[170].

TIME FRAMES (Response Times, Time for Impacts to be Realized)

12. To be determined in the revised Documented Safety Analysis
13. It can be postulated that the response time would be similar to the response time for a seismic event causing a loss of power and damaging the K3 ventilation system, it would be reasonable to assume that hot cell ventilation could be restored, water could be removed from G Cell or capsules could be removed from G Cell **within six months**[171]**.**

Crane/Heavy Load Drop Damages Canyon, Hot Cells, and Limited Number of Capsules Stored in Hot Cell G (Building Stabilization, Near-term Operations)

ACTIVE SAFETY CONTROLS: Potentially, but no specific technology listed in the Hazards Analysis

PASSIVE SAFETY CONTROLS[172]: Yes

1. Design of 225B building
2. Design of capsules

OPERATIONAL and INSTITUTIONAL CONTROLS[173]: Yes

3. Prohibited movement of heavy loads over pool cell area
4. When capsules are in the hot cells, radiation protection measures used
5. Initial testing, in-service surveillance and maintenance
6. Operational safety measures
7. Procedures and training
8. Emergency preparedness

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[168] [HNF-8758 (Rev9)]
[169] [CHPRC-02203 (Rev0), Pg. B-24, Table B-1]. The specific [HNF-8758 (Rev9)] section that describes the hydrogen explosion in the pool cell is within Section 3.4.2.4.3.
[170] [CHPRC-02203 (Rev0)]
[171] [HNF-8758 (Rev 9), Pg. 3-39, Pg. 3-91]
[172] [CHPRC-02203 (Rev0), Pg. B-8, Table B-1]
[173] [CHPRC-02203 (Rev0), Pg. B-8, Table B-1]

ACCIDENT SCENARIO DEVELOPMENT DESCRIPTION

9. Human error or equipment failure could cause a moving mobile crane or the load to be dropped over Area 2 and could impact the canyon and aqueous makeup unit to the pool cells. Roof failure could cause debris and crane load to fall to canyon floor. The crane load would lose much of its energy breaking through the roof and it would be very unlikely for the debris and crane load to break the 30 inch high density concrete hot cell cover blocks. If the hot cell cover blocks do fail, it is assumed that there are a limited number of capsules located in Hot Cell G. The limited number of stored capsules within Hot Cell G would completely fail. The impacts would be a combination release of contamination from the Hot Cell G and limited capsule release[174].

INTEGRITY OF APPLICABLE BARRIERS:

10. See "Hydrogen explosion in Hot Cell G and K3 Duct (Current Operations):"

PRIMARY PATHWAYS AND POPULATIONS AT RISK:

11. The primary pathway is the air pathway/ radiological contaminants become airborne and present a radiological hazard because of the committed effective dose equivalent (CEDE) incurred from inhalation and the external effective dose equivalent that would be incurred from gamma radiation (and maybe some high energy beta radiation). The populations at risk are facility workers and potentially co-located persons as analyzed in the WESF documentation[175].

TIME FRAMES (Response Times, Time for Impacts to be Realized)

12. To be determined in the revised Documented Safety Analysis
13. It can be postulated that the response time would be similar to the response time for a seismic event causing a loss of power and damaging the K3 ventilation system, it would be reasonable to assume that hot cell ventilation could be restored, water could be removed from G Cell or capsules could be removed from G Cell **within six months**[176]**.**

Hydrogen explosion in K3 Filter Housing (Building Stabilization, Near-term Operations)

ACTIVE SAFETY CONTROLS[177]: Yes

1. Ventilation

PASSIVE SAFETY CONTROLS[178]:

2. Design of filter system

OPERATIONAL and INSTITUTIONAL CONTROLS[179]:

3. Remove ignition sources

ACCIDENT SCENARIO DEVELOPMENT DESCRIPTION[180]:

4. The WESF DSA[181] analyzes a K3 filter hydrogen explosion and unmitigated consequences are moderate for the co-located person (CP; 58 rem) and low for the maximally-exposed offsite

[174] [CHPRC-02203 (Rev0), Pg. B-8, Table B-1]
[175] [CHPRC-02203 (Rev0)]
[176] [HNF-8758 (Rev 9), Pg. 3-39, Pg. 3-91]
[177] [CHPRC-02203 (Rev0), Pg. B-66, Table B-1]
[178] [CHPRC-02203 (Rev0), Pg. B-66, Table B-1]
[179] [CHPRC-02203 (Rev0), Pg. B-66, Table B-1]
[180] [CHPRC-02203 (Rev0), Pg. B-66, Table B-1]
[181] [HNF-8758 (Rev9)]

individual (MOI; 0.018 rem). The inventory assumed in this analysis is significantly higher than expected for the new system because the new system will ventilate the canyon and G cell only and there would be an insignificant inventory available in the facility to accumulate on the filters. However, the new system will likely be used while the grouting operation is being performed and there may be some disturbances of the contamination in the hot cells. Therefore, the same moderate level consequence will be assumed for the co-located person and the same low level consequence will be assumed for the MOI.

INTEGRITY OF APPLICABLE BARRIERS:

5. The replacement ventilation system will be new and not have any foreseeable issues with the level of integrity and ability to retain radioactive contamination

PRIMARY PATHWAYS AND POPULATIONS AT RISK:

6. The primary pathway is the air pathway/ radiological contaminants become airborne and present a radiological hazard because of the committed effective dose equivalent (CEDE) incurred from inhalation and the external effective dose equivalent that would be incurred from gamma radiation (and maybe some high energy beta radiation). The populations at risk are facility workers and potentially co-located persons as analyzed in the WESF documentation[182].

TIME FRAMES (Response Times, Time for Impacts to be Realized)

7. To be determined in the revised Documented Safety Analysis

Cs/Sr Capsules (Longer-term Operations Transfer to On-site Dry Storage)

Barriers to be utilized for the dry storage of capsules are the capsules and dry storage casks. A draft request for proposal (RFP) has been drafted but the project is not funded at the current time. The use of technology similar to/from the commercial nuclear power industry with storing used nuclear fuel in dry storage concrete casks is planned[183]. Many of the data points for understanding the potential risk of on-site dry storage of the Cs and Sr capsules are unknown; however, it can be noted that potential impacts could be estimated by the use of the dry storage operations of commercial used nuclear fuel currently ongoing in the nuclear power industry. There are a number of environmental impact statements that have been published as part of the licensure requirements by the Nuclear Regulatory Commission (NRC).

ACTIVE SAFETY CONTROLS: Unknown

PASSIVE SAFETY CONTROLS: Unknown to the full extent

10. There would be no credited controls for capsule integrity as part of the performance assessment of the dry storage casks[183].

OPERATIONAL and INSTITUTIONAL CONTROLS: Unknown

ACCIDENT SCENARIO DEVELOPMENT DESCRIPTION: Unknown

INTEGRITY OF APPLICABLE BARRIERS:

11. The integrity of the capsules is described in previous sections. The integrity of the dry storage canister is unknown at this time; however the requirements that were included as part of the draft RFP were that the dry casks metal-canisters must have a 300 year life and if concrete casks

[182] [CHPRC-02203 (Rev0)]
[183] Personal Communication with L. I. Covey and other WESF facility operators/managers during the CRESP visit to Hanford in October 2014.

are used, then a 100 year life is required. The dry storage casks, regardless of material, would not be licensed by the Nuclear Regulatory Commission (NRC).

A guideline for maximum temperatures for the interface between the salt and capsule during capsule movement and storage are provided in Table H.4-8. It was noted that heat rejection may be designed based on the blending of high and low hear capsules within an array. However, if blending is required, 10% must be added to the estimated decay heat in any specific array to allow for operating margin, and a complete loading sequence of all capsules must be addressed within the thermal analysis. Alternatively, the design may be developed that will accept the bounding array of capsules.

Table H.4-8. Maximum Temperatures for Salt/Capsule Interface during Capsule Movement and Storage[184]

	Strontium capsules	Cesium capsules
Accident conditions	800°C	600°C
Processing, including process upset	540°C	450°C
Interim storage configuration, summer storage conditions as described below per PNL-4622, *Climatological Summary for the Hanford Area*	540°C	317°C

Primary Pathways And Populations At Risk: Unknown

Time Frames (Response Times, Time for Impacts to be Realized): Unknown

POPULATIONS AND RESOURCES CURRENTLY AT RISK OR POTENTIALLY IMPACTED

Waste generated at WESF includes radioactive and non-radioactive solids, liquids, and gases from decontamination activities, maintenance, and miscellaneous operations[185]. The DSA does not report the volume or mass of the wastes produced. The DSA does not report the spent resin volume or mass that is used during a specific operational time frame. The types of waste produced are Liquid Low-Level Waste[186] (LLLW), solid and compacted LLW in drums and metal crates, solid and uncompacted LLW in bags, and mixed LLW[187]. A bounding and extremely conservative assumption of 1,000 Ci of 90Sr was used as an inventory material at risk value for the LLW that could be accumulated throughout WESF. LLW at WESF would contain significantly less radioactive material than this assumption (typically fractions of a curie)[188].

LLW is collected from areas throughout the facility and is typically placed into a waste container or moved to a conex box and stored until shipped from the facility for final disposal. Most of the material consists of gloves, paper, swipes, plastic, broken tools, etc. LLW originating from the hot cells typically consists of manipulator sleeves, swipes, failed equipment, etc. Hazardous and mixed waste produced at WESF consists primarily of maintenance waste (e.g., oily waste), batteries, fluorescent lamps, and miscellaneous waste from the use of chemical cleaning agents and will be recycled or disposed of as appropriate. The hazardous and mixed solid waste identified for disposal is packaged and shipped to the appropriate regulated waste storage or disposal facility. Nonregulated waste from activities such as

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184 [CHPRC-01371 (Rev0), Pg. 13]
185 [HNF-8758 (Rev9), Pg. 9-3]
186 [HNF-8758 (Rev9), Pg. 2-44]
187 [CHPRC-02203 (Rev0), Pg. B-21]
188 [HNF-8758 (Rev9), Pg. 3-80]

housekeeping will be recycled or disposed of as appropriate and consists of materials such as office waste, nonregulated aerosols, vegetation growth, and sewage from facilities.

Two liquid effluent streams evolve from WESF operations, the WESF liquid effluent stream and the WESF cooling water stream. The WESF liquid effluent stream is routed to the TEDF via "F" Line and consists of sanitary water, raw water from the compressed air heat exchanger, 282-B deep well testing, and storm water. The primary contributor to the waste stream is the raw water discharges from the compressed air heat exchanger in the 225-BC Building. Other sources contributing to the stream are batch discharges from Pool Cells 9 and 10, floor drains, filter backwash, and street drains. Pool Cells 9 and 10 collect sanitary and raw water discharges from the pool cell area. The WESF cooling water effluent stream is routed to TEDF via "E" Line and consists of water from the pool cell CLCS, the WESF deep well pumps during testing, and raw water used for single pass cooling in the pool cell heat exchangers. Discharge of the single pass cooling water from the pool cell heat exchangers will only occur if the CLCS fails.

During the site tour by the assigned CRESP team in mid-October 2014 – personal communication with the WESF managers and operators noted that the stainless steel liner of the pool for Pool Cells 5 and 10 are known to have small liner leaks. Pool cell water leakage was collected in a sump at a rate of approximately 12-15 liters every few months[189]. Collected water was then tested through the facility's testing equipment for beta-counts and resulting with no radioactive material within the collected water.

Facility Workers

The Cs and Sr capsules and contamination within the facility do not pose potential impacts during normal operating conditions to the facility workers directly involved with carrying out duties under the current authorized mission of safe storage. The initiating events that could cause the highest impact to the facility workers within the Hazards Analysis[190] are the following[191]:

- Loss of cooling/shielding water from the all pool cells (High Unmitigated Dose Consequence Category)
- Hydrogen explosion in Hot Cell G and the K3 duct (High Unmitigated Dose Consequence Category)
- Hydrogen explosion in the WESF Ion Exchange Modules (WIXM) (Medium Unmitigated Dose Consequence Category)

Co-located Person

The Cs and Sr capsules and contamination within the facility do not pose potential impacts during normal operating conditions to the persons co-located to the WESF complex under the current authorized mission of safe storage. The initiating events that could cause the highest impact to the co-located person within the WESF Documented Safety Analysis[192] and the Hazards Analysis[193] are the following:

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[189] [HNF-8758 (Rev9), Pg. 2-27] The quoted volumetric flow rate of the leak is 0.8 L/week.
[190] [CHPRC-01352 (Rev2)]
[191] The Beyond Design Basis Accident where contaminants from both the pool-stored capsules and the hot cell/connecting ducts combined produce the largest impact. The doses are listed in two places within [CHPRC-02047 (Rev0)] on pages [CHPRC-02407 (Rev0) Pg. 21] and [CHPRC-02407 (Rev0) Pg. 2A-7]. Within [CHPRC-02407 (Rev0) Pg. 21]: The doses listed are FW: 380 rem; CP: 0.53 rem; MOI: 0.24 rem. On page [CHPRC-02407 (Rev0) Pg. 2A-7], the doses are given as FW: 780 rem; CP: 1.0 rem; MOI: 0.42 rem. The higher values were used within this report. The Dose rates for the higher values are 4 rem/h 100 m from 225B Building and 40 rem/hr 5 m from external wall.
[192] [HNF-8758 (Rev9)]
[193] [CHPRC-01352 (Rev2)]

- Loss of cooling/shielding water from the all pool cells (277 rem)
- Hydrogen explosion in Hot Cell G and the K3 duct (102 rem)
- Hydrogen explosion in the WESF Ion Exchange Modules (WIXM) (71 rem)

Public

The Cs and Sr capsules and contamination within the facility do not pose potential impacts during normal operating conditions to the local populace outside of the Hanford site under the current authorized mission of safe storage. The initiating events that could cause the highest impact to the maximally-exposed offsite individual (MOI) within the WESF Documented Safety Analysis[194] and the Hazards Analysis[195] are the following:

- Loss of cooling/shielding water from the all pool cells (0.21 rem)
- Hydrogen explosion in Hot Cell G and the K3 duct (0.031 rem)
- Hydrogen explosion in the WESF Ion Exchange Modules (WIXM) (0.022 rem)

Groundwater

WESF contamination is confined and there are no vadose zone sources or current groundwater contamination associated with this EU. This leads to a ND rating.

Columbia River

The Columbia River will not be impacted by WESF due to the distance between the facility and the river. This leads a ND rating.

Ecological Resources

- No species of concern were observed either within the EU or in the immediate vicinity.
- The EU for WESF and adjacent landscape buffer consist of 0 level resources; that is, paved and graveled surfaces, buildings, infrastructure, and minor amounts of landscaping.
- Remediation of the WESF EU would not have any negative impacts on habitat connectivity.

Cultural Resources Setting

- There are no known recorded archaeological sites or TCPs located within the WESF EU.
- The WESF EU is located inside the 225 B Waste Encapsulation and Storage Facility, a contributing property within the Manhattan Project and Cold War Era Historic District with documentation required.

Archaeological sites and TCPs located within 500 meters of the EU:

- The 212 B Fission Products Load out Station (documentation required) is located nearby the WESF Evaluation Unit, also a contributing property within the Manhattan Project and Cold War Era Historic District. In accordance with the 1998 *Hanford Site Manhattan Project and Cold War Era Historic District Treatment Plan (*DOE/RL-97-56), all documentation requirements have been completed for this property.
- There are no known archaeological sites or TCPs located within 500 meters of the WESF EU.

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194 [HNF-8758 (Rev9)]
195 [CHPRC-01352 (Rev2)]

Recorded TCPs Visible from the EU

- There are two recorded TCPs associated with the Native American Precontact and Ethnographic Landscape that are visible from the WESF EU.

CLEANUP APPROACHES AND END-STATE CONCEPTUAL MODEL

Selected or Potential Cleanup Approaches

1. What is the range of potential remedial actions?

No cleanup decisions have been made for final disposition of the cesium/strontium capsules. Decisions have been deferred to future decision-making processes. The plausible alternatives are:

- Package and transport capsules from WESF to dry storage; store capsules pending final disposition; direct dispose of capsules at a geologic repository.
- Incorporate capsules into immobilized high-level waste glass at WTP.
- Store capsules at Hanford for 300 years (approximately 10 half-lives); after natural decay, direct dispose of capsules as mixed low-level radioactive waste.

It is unknown what the potential degree of disturbance of an area due to the uncertainty of the final disposition pathway for the Cs and Sr capsules.

2. What is the sequence of activities and duration of each phase?
   See Part IV (Unit Description and History) under "WESF Processes and Operations"

3. What is the magnitude of each activity (i.e., cubic yards of excavation, etc.)?

   Present Configuration: WET STORAGE: Waste generated at WESF includes radioactive and non-radioactive solids, liquids, and gases from decontamination activities, maintenance, and miscellaneous operations[196]. The DSA does not report the volume or mass of the wastes produced. The DSA does not report the spent resin volume or mass that is used during a specific operational time frame. The types of waste produced are Liquid Low-Level Waste[197] (LLLW), solid and compacted LLW in drums and metal crates, solid and uncompacted LLW in bags, and mixed LLW[198]. A bounding and extremely conservative assumption of 1,000 Ci of 90Sr was used as an inventory material at risk value for the LLW that could be accumulated throughout WESF. LLW at WESF would contain significantly less radioactive material than this assumption (typically fractions of a curie)[199].

   ***Near-Future Configuration: BUILDING UPGRADES*:** The types of waste estimated to be produced during this phase is the same as the current operations under the safe storage of Cs/Sr capsules mission. It is postulated that the amount of waste will increase relative to the current operational status due to increased activity.

   ***Longer-Term Future Configuration: CAPSULE DRY STORAGE, Limited D&D of 200E Area*:** The estimated waste quantity (reported as tons of material) was reported [200]:

   - 225BA: K1 Filter Pit Encapsulation Facility: 386 tons

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[196] [HNF-8758 (Rev9), Pg. 9-3]
[197] [HNF-8758 (Rev9), Pg. 2-44]
[198] [CHPRC-02203 (Rev0), Pg. B-21]
[199] [HNF-8758 (Rev9), Pg. 3-80]
[200] [DOE/RL-2010-102 (Rev0), Appendix A, pg. A1]

- 225BB: K3 Filter Pit Encapsulation Facility: 39 tons
- 225BF: WESF Tanker Loadout Station: 331 tons

The D4 activities are not described in detail for these individual facilities. There is information provided on the two filter pit encapsulation facilities which indicates some to some level the resultant tonnage from D4 operations[201]:

- 225BA and 225BB are considered "Typical Reinforced Structures". These structures are typically cast-in-place concrete beams or columns, and could include below-grade construction or basements. These buildings/structures normally have exterior walls that exceed 0.3048 mn (12 in.) in thickness, and are heavily reinforced on minimal centerline spacing. Interior walls will vary depending on bearing and nonbearing requirements. Floor and roof framing system consists of cast-in-place concrete slabs with concrete beams, one-way joists, two-way waffle joists, or flat slabs. Buildings that fall into this generic category include the following:
- 225BA K1 Filter Pit Encapsulation Facility. The 225BA Kl Filter Pit Encapsulation Facility is associated with the WESF ventilation system and is approximately 59 M2 (638 ft^2).
- 225BB K3 Filter Pit Encapsulation Facility. The 225BB K3 Filter Pit Encapsulation Facility is associated with the WESF ventilation system and is approximately 121 M2 (1,302 ft^2).

Contaminant Inventory Remaining at the Conclusion of Planned Active Cleanup Period

It is unknown what the potential contaminant inventory within or nearby WESF due to the uncertainty of the final disposition pathway for the Cs and Sr capsules.

Risks and Potential Impacts Associated with Cleanup

During the near-future phase of contamination stabilization and ventilation upgrades, there were identified risks of current operations to co-located persons that could be augmented due to the additional heavy equipment on site (e.g., cranes). The contaminant inventory would stay the same but the number of possible initiating events (e.g., crane load drops) would increase the risk during initial construction. After grouting and stabilization of contaminants in the hot cells and ventilation system occur, the likelihood of the grouted contaminant being released from the cemented matrix will be lowered greatly.

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

Facility Worker

The Hazards Analysis did not provide quantitative dose impact information for the facility workers directly involved with the WESF complex near-future operations. The qualitative risk ratings and potential consequence categories were provided and listed below:

- K3 filter housing hydrogen explosion
  - Potential Consequence Categories: (FW: high; CP: moderate/medium; MOI: low)
  - Qualitative Risk Ratings: (FW: I; CP: II; MOI: III)
- Design basis earthquake causes the ventilation stack to collapse and releases from the canyon, hot cells, and a limited number of capsules assumed to be stored in Hot Cell G

[201] [DOE/RL-2010-102 (Rev0), Appendix A, pg. A9]

  - Potential Consequence Categories: (FW: high; CP: moderate/medium; MOI: low)
  - Qualitative Risk Ratings: (FW: I; CP: II; MOI: III)
- A crane fall/heavy load drop causes releases from the canyon, hot cells, and a limited number of capsules assumed to be stored in Hot Cell G
  - Potential Consequence Categories: (FW: high; CP: moderate/medium; MOI: low)
  - Qualitative Risk Ratings: (FW: I; CP: II; MOI: III)

Co-located Person

The WESF Stabilization and Ventilation Project Hazards Analysis[202] evaluates a K3 filter housing hydrogen explosion resulting with the highest unmitigated dose consequences to the co-located person 100 meters from the WESF boundary. The impacts to a co-located person are considered moderate (58 rem) and low for the MOI (0.018 rem). The inventory assumed in the Hazards Analysis is significantly higher than expected for the new system because the new system will ventilate the canyon and G cell only and there would be an insignificant inventory available in the facility to accumulate on the filters. However, the new system will likely be used while the grouting operation is being performed and there may be some disturbances of the contamination in the hot cells. Therefore, the same moderate level consequence will be assumed for the co-located person and the same low level consequence will be assumed for the maximally-exposed offsite individual.

Public

The WESF Stabilization and Ventilation Project Hazards Analysis[203] evaluates a design-basis earthquake resulting with a collapse of the ventilation stack onto the WESF building resulting the highest impact to the MOI. Due to the stack collapse, damage to the hot cells, canyon, and limited number of capsules potentially stored in Hot Cell G is postulated to release radioactive contaminants causing concern to human health. The unmitigated dose consequence to the MOI is estimated to be 0.036 rem. The impacts to the maximally-exposed offsite individual are considered low and moderate for the co-located persons (46 rem). The new ventilation system will likely be used while the grouting operation is being performed and there may be some disturbances of the contamination in the hot cells. Therefore, the same moderate level consequence will be assumed for the co-located person and the same low level consequence will be assumed for the MOI.

Groundwater

WESF contamination is confined and there are no vadose zone sources or current groundwater contamination associated with this EU and none are expected over the next 50 years. This leads to a ND rating.

Columbia River

The Columbia River will not be impacted by WESF due to the distance between the facility and the river. This leads a ND rating.

Ecological Resources

Personnel, car, pick-up truck, truck traffic and heavy equipment through non-target and remediated areas will likely lead to permanent effects in areas of heavy equipment use. 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).

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[202] [CHPRC-02203 (Rev0)]
[203] [CHPRC-02203 (Rev0)]

Cultural Resources

Personnel, car, and truck traffic on paved roads as well as use of heavy equipment will not have any direct impact on archaeological resources because there is no disturbance to soil/ground or alteration to the landscape. Assuming heavy equipment locations 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 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 paved roads located on TCP, direct effects include visual, auditory and vibrational alterations to landscape/setting. Heavy equipment 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. 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, car, and truck traffic on paved roads as well as use of heavy equipment 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. Existing road causes no alteration to 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. 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

This is a multi-phase project and delay would have different impacts, depending on when it occurred. These will be addressed in chronological order.

1. Delay in completion of the Stabilization and Ventilation Modification Project – will results in a longer time period in which: (a) a substantial (~300,000 Ci) source term is available for potential dispersion during a beyond design basis event, and (b) the ventilation system at WESF is not compliance with requirement for confinement ventilation systems, thus increasing the potential for an inadequately filtered release from WESF.
2. The Waste Management EIS mentions two potential options for addressing the HLW present in the capsules at WESF: (a) designing and building a facility which would be an adjunct to the Waste Treatment and Immobilization Plant (WTP), which would allow the capsules to be opened, prepared and fed to the HLW vitrification melter; and (b) more recently, due to the age of WESF and schedule challenges at WTP, the retrieval of the capsules from the storage pool in WESF and placement in dry cask storage, similar to commercial spent nuclear fuel, to await disposition in a geologic repository. Both of these options require the design and construction of new facilities. Delay in either option results in extended storage of the capsules in the 40 year old WESF.

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

Populations and Resources at Risk or Potentially Impacted After Cleanup Actions (from residual contaminant inventory or long-term activities)

Table H.4-5. Population or Resource Risk/ Impact Rating

Population or Resource		Risk/Impact Rating	Comments
Human	Facility Worker	IS	
	Co-located Person	IS	
	Public	IS	
Environmental	Groundwater	ND	WESF contamination is confined and there are no vadose zone sources or current groundwater contamination associated with this EU and none are expected over the next 150 years.
	Columbia River	ND	The Columbia River will not be impacted by WESF due to the distance between the facility and the river.
	Ecological Resources*	ND	Few ecological resources now, and likely none in the future. If there is re-vegetation, then continued activity and monitoring could result in minor disturbance in EU.
Social	Cultural Resources*	**Native American:** Direct: Unknown Indirect: Unknown **Historic Pre-Hanford:** Direct: Unknown Indirect: Unknown **Manhattan/Cold War**: Direct: None Indirect: None	No expectations for impacts to known cultural resources.

*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. The abbreviation "IS" denotes insufficient information available to rate".

The determination of the disposition path of the Cs and Sr capsules, required by the Tri-Party Agreement (M-092-05) by June 2017, requires an understanding of the options that exist for safe storage while meeting other requirements directly related to the decontamination, deactivation, decommissioning, and demolition (D4) of the adjacent B Plant. The unit operations required for longer-term configuration include transferring capsules within an additional storage overpack and then placement into dry storage casks. The dry storage casks will be then transferred to a concrete pad on the Hanford site in the 200 East Area near WESF and B Plant. Limited D&D efforts are ongoing and to be determined. Risk drivers associated with longer-term future configuration are radioactive material contained in the capsules during movement into dry storage containers. Any D&D activities are tentative for WESF until plans for dry storage of capsules can be finalized.

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

Same as Near Term above.

PART VII. SUPPLEMENTAL INFORMATION AND CONSIDERATIONS

No supplemental information applicable.

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APPENDIX H.5

ENVIRONMENTAL RESTORATION DISPOSAL FACILITY (ERDF)
(CP-OP-6, CENTRAL PLATEAU)
EVALUATION UNIT SUMMARY TEMPLATE

Table of Contents

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PART I. EXECUTIVE SUMMARY

EU LOCATION

Environmental Restoration Disposal Facility, ERDF, between 200 East and 200 West Areas

RELATED EUS:

Other D&D Projects Providing Debris for Disposal

PRIMARY CONTAMINANTS, CONTAMINATED MEDIA, AND WASTES:

The Environmental Restoration Disposal Facility (ERDF) accepts waste from Hanford Site environmental restoration activities as defined in the ERDF ROD. All waste received at ERDF is tracked using the Waste Management Information System (WMIS). Quantitative estimates of specific radionuclide inventories have been compiled based on an ERDF WMIS summary in August 2010, which provides bounding estimates of the inventory (larger than likely exists). The current and final inventory is described in Table H.5-1 (data from WCH 520).

Table H.5-1. Current and anticipated final inventory of major radionuclides in ERDF.

Constituent	2014	Final
C-14	1.9 Ci	<45 kCi
Cs-137	14.6 kCi	<2000 kCi
Cl-36	0	0.3 kCi
H-3	7.8 kCi	<160 kCi
Ni-63	15.0 kCi	<110 kCi
Sr-90	11.4 kCi	< 1200 kCi
Tc-99	0.021 kCi	<0.86 kCi
U (T)	202 Mg	<870 Mg

BRIEF NARRATIVE DESCRIPTION:

ERDF is Subtitle C- style landfill that was constructed to permanently dispose of wastes generated by remediation at the Hanford site. Disposal of contaminated material at ERDF is the preferred remedy for much of the waste excavated from numerous Hanford waste sites. As of July 2013, approximately 13.6 million metric tons of waste has been disposed at ERDF since the facility started operations in July 1996 (an average of 800,000 metric tons/yr).

ERDF employs a modular design consisting of a series of disposal cells with separate sumps. The first eight disposal cells were built in two-cell pairs (four pairs total). The most recent cells combine the past two-cell pairs into one larger “supercell,” approximately the same size as each cell pair. Cells 1 through 4 have been filled; cells 5 through 8 are nearly filled; and supercells 9 and 10 are receiving waste. Each cell is lined with a RCRA Subtitle C double liner with a lower composite liner, leak detection between liners, and leachate collection. The entire disposal facility will be capped with a final cover combined of a water-balance cover underlain by a composite barrier (geomembrane over compacted soil barrier).

Waste disposal at ERDF consists primarily of high-volume slightly contaminated soils and debris that are delivered by truck from remediation sites. The soils are dumped, spread in a cell, and compaction to minimize void space and limit future waste volume subsidence. A limited volume of building debris and other non-soil wastes are also placed in ERDF. These wastes are grouted when necessary to fill void space.

Summary Tables of Risks and Potential Impacts to Receptors

Table H.5-2 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 ERDF; a co-located Person (CP) is an individual located 100 meters from the perimeter of the ERDF operation; and Public is an individual located at the closest point on the Hanford Site boundary not subject to DOE access control, which in this instance is the west bank of the Columbia River approximately 305 m (1,000 ft) east of the facility. The nuclear related risks to humans are based on unmitigated (unprotected or controlled conditions) dose exposures expressed in a range of from Non-Discernable (ND) to Very High. The estimated mitigated exposure that takes engineered and administrative controls and protections into consideration, is shown in parenthesis.

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 Non-Discernable (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: No risk ratings are provided for Cultural Resources. The Table 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.

Table H.5-2. Risk Rating Summary (for Human Health, unmitigated nuclear safety basis indicated, mitigated basis indicated in parenthesis (e.g., "Very High" (Low)).

Population or Resource		Evaluation Time Period — Active Cleanup (to 2064): **Current Condition:** Operating as Waste Site	Evaluation Time Period — Active Cleanup (to 2064): **From Cleanup Actions:** Final Closure
Human Health	Facility Worker	Medium (Low)	Medium (Low)
	Co-located Person	Low (ND to Low)	Low (ND to Low)
	Public	ND to Low (ND to Low)	ND to Low (ND to Low)
Environ-mental	Groundwater	ND	ND
	Columbia River	ND	ND
	Ecological Resources	Low to Medium	Low to High
Social	Cultural Resources	Native American: Direct: Unknown Indirect: Known Historic Pre-Hanford: Direct: Known Indirect: Unknown Manhattan/Cold War: Direct: Known Indirect: Known	Native American: Direct: Unknown Indirect: Known Historic Pre-Hanford: Direct: Known Indirect: Unknown Manhattan/Cold War: Direct: Known Indirect: Known

SUPPORT FOR RISK AND IMPACT RATINGS FOR EACH POPULATION OR RESOURCE

Human Health

<u>**Current**</u>

The risks at ERDF are associated with (i) radiation exposure by facility workers unloading trucks and placing waste within the disposal cell, (ii) physical accidents associated with trucks and machinery within or entering/exiting the ERDF area, and (iii) ground water contamination. The two scenarios that exist are:

- *C*ontact with waste of much higher activity than expected, resulting in up to high risk even with health and safety plans being followed; and
- Equipment accident that could cause severe injury or loss of life, but has low risk given implementation of the health and safety plan.

For the public, the engineered barrier systems provide a high level of containment, with ND to low risk associated with use of groundwater that might be contaminated from ERDF, as described in the ERDF Performance Assessment (WCH 520).

Unmitigated Risk: Facility Worker – Medium; Co-located person – Low; Public – ND to Low

Mitigation: All personnel at ERDF are required to follow the health and safety plans for waste disposal and equipment operations.

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

Risks and Potential Impacts from Selected or Potential Cleanup Approaches
Clean up actions involve closure of ERDF with a final cover. The closure activities are the same as those associated with the current operational condition, except radionuclide exposure is eliminated.

Unmitigated Risk: Facility Worker – Medium; Co-located person – Low; Public – ND to Low

Mitigation: The facility worker retains medium risk because of the potential for an equipment accident, but has low risk given implementation of the health and safety plan. For the public, the engineered barrier systems provide a high level of containment, with ND to low risk associated with use of groundwater that might be contaminated from ERDF, as described in the ERDF Performance Assessment (WCH 520).

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

Groundwater

It is assumed that the waste in ERDF is contained within a RCRA Subtitle C landfill. Any waste outside of the ERDF facility is assumed negligible. This leads to a ND rating.

Columbia River

The Columbia River will not be impacted by ERDF due to the distance between the facility and the river. It is assumed that the waste in ERDF is contained within a RCRA Subtitle C landfill. Any waste outside of the ERDF facility is assumed negligible. This leads to a ND rating.

Ecological Resources

Current
Levels of frequent disturbance can result in increases in invasive species, particularly to high quality habitat in buffer (80% is level 3-5 resources). ERDF is one of only 2 EUs in interim report with level 5 resources (about 9% of buffer is level 5 resources, 0 in EU).

Risks and Potential Impacts from Selected or Potential Cleanup Approaches
Because of high quality of resources in buffer area (7% level 3 resources in EU, 80% levels 3-5 in buffer), the potential for disturbance is medium, which could disrupt native communities in buffer, and result in increases in exotic species. Continued dust suppression changes available water levels, which could affect native species diversity and abundance.

Cultural Resources

Current
A few National Register ineligible archaeological sites and isolated finds were recorded before construction of ERDF within this EU. None are likely present due to construction of ERDF and were addressed under the National Historic Preservation Act, Section 106 Review completed prior to ERDF construction. A Manhattan Project/Cold War eligible site is recorded within 500 meters of ERDF as well as several other archaeological sites associated with various landscapes. Traditional cultural places are visible from this EU.

Risks and Potential Impacts from Selected or Potential Cleanup Approaches
The entire EU has been inventoried for archaeological resources on the surface. Because there are pockets of land where no disturbance has occurred, the potential for subsurface archaeological material

to be present in these areas is moderate. Indirect effects to the Manhattan Project/Cold War eligible archaeological site are possible.

Considerations for timing of the cleanup actions

ERDF is an operating facility and will continue to operate until remediation activities at Hanford are complete. Final cover will be placed once use of the disposal facility ceases. Thus, timing is not an issue for ERDF.

Near-Term, Post-Cleanup Risks and Potential Impacts

The near-term and post-clean up risks and impacts are the same as those from current (near term) and clean up cited above, as ERDF is an operating facility.

Because of low level of monitoring expected in the near-term post-cleanup period, the effect on ecological resources is expected to be ND. However, the risk will depend on the level of disturbance, which may adversely affect the 80% level 3-5 resources in buffer area.

Permanent indirect effects to cultural resources may be caused by alterations in the view shed due to placement of the final cover. The presence of permanent contamination from disposal of waste will have a low level impact on cultural resources.

PART II. ADMINISTRATIVE INFORMATION

OU AND/OR TSDF DESIGNATION(S)

CP-OP-6

COMMON NAME(S) FOR EU

Environmental Restoration and Disposal Facility (ERDF)

KEY WORDS

landfill, demolition debris

REGULATORY STATUS

Regulatory basis: ERDF is a mixed waste disposal facility operating under regulations stipulated in RCRA Subtitle C and DOE O 435.1. The disposal cells are designed, constructed, and operated to meet the technical requirements stipulated in 40 CFR 264, Subpart N.

Applicable regulatory documentation

Hanford Site remedial action RODs and action memoranda identify ERDF as the location for disposal of waste. The ERDF ROD was signed by the EPA, Ecology, and DOE (the Tri-Parties) in January 1995. An ESD was issued in August 1996. Four amendments to the ERDF ROD have also been issued. The first amendment was signed on September 30, 1997; the second was signed on March 23, 1999; the third was signed on January 31, 2002; and the fourth was signed on May 24, 2007. ERDF is authorized to accept waste from Hanford Site environmental restoration activities consistent with the ERDF ROD, the Explanation of Significant Difference (ESD), and ROD amendments (EPA/ROD/R10-95/100, EPA/ESD/R10-

96/145, EPA/AMD/R10-97/101, EPA/AMD/R10-99/038, EPA/AMD/R10-02/030,07-AMRC-0077, 09-AMRC-0179).

Applicable Consent Decree or TPA milestones

Not Applicable

Risk Review Evaluation Information

Completed: Revised January 19, 2015

Evaluated by: Craig Benson

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

PART III. SUMMARY DESCRIPTION

CURRENT LAND USE

DOE HANFORD INDUSTRIAL SITE AREA

DESIGNATED FUTURE LAND USE

INDUSTRIAL

PRIMARY EU SOURCE COMPONENTS

Legacy Source Sites

Not Applicable

High-Level Waste Tanks and Ancillary Equipment

Not Applicable

Groundwater Plumes

Not Applicable

Operating Facilities

Environmental Restoration and Disposal Facility

Location and Layout Maps

ERDF is located between the 200 East Area and 200 West Area as shown in Fig. 1.

Figure H.5-1. Location map of ERDF (yellow rectangle) at Hanford Site.

Figure H.5-2. EU Boundary Map

PART IV. UNIT DESCRIPTION AND HISTORY

EU Former/Current Use(s)

ERDF is a composite-lined waste disposal facility constructed to permanently dispose of all wastes generated by remediation of Hanford Site past-practice and CERCLA waste sites in an environmentally protective manner. As of July 2013, approximately 13.6 million metric tons of waste has been disposed at ERDF since the facility started operations in July 1996 (an average of 800,000 metric tons/yr). ERDF is on the Central Plateau portion of the Hanford Site between the 200 West and 200 East Areas and is constructed in a modular fashion so that additional disposal space can be built as needed. The first eight disposal cells were built in pairs located at the west end of ERDF. Waste disposal at ERDF predominantly consist of high-volume slightly contaminated soils and debris delivered by truck from remediation sites that are spreading in ERDF cells and compacted to minimize void space and limit future waste volume subsidence. However, other demolition wastes are also placed in ERDF, and when necessary, grouted to fill void space. Characteristics of ERDF that strongly affect contaminant release and transport through the vadose zone and into the unconfined aquifer are its location, engineered barriers, and the nature of the waste. The vadose zone (rock/soil zone above the water table) is approximately 80 to 100 m thick and provides the greatest possible distance to the water table compared to waste sites located elsewhere in the Hanford Site. In addition, because of its location in the middle of the Central Plateau it provides the largest contaminant migration distance possible to the Columbia River from the Hanford Site.

Legacy Source Sites

Not Applicable

High-Level Waste Tanks

Not Applicable

Groundwater Plumes

Not Applicable

D&D of Inactive Facilities

Not Applicable

Operating Facilities

ERDF was constructed is constructed in a modular fashion consistent of disposal cells (see Figure H.5-3). The first eight disposal cells were built in pairs located at the west end of ERDF. Each cell is approximately 152 m by 152 m at the bottom, approximately 21 m deep, and has a 3:1 (horizontal to vertical ratio) side slope that extends 64 m horizontally from the base of the cells. The latest cell construction toward the east (Supercells 9 and 10) combines the cell pairings into larger cells, approximately the same size as each two-cell pair. Since the beginning of operations in July 1996, cells 1 through 4 have been filled; cells 5 through 8 are nearly filled; and Supercells 9 and 10 are receiving waste. Using the lined, deep, single-trench configuration, the disturbed area needed for additional construction of ERDF (including the trench, container handling, material stockpile, and support facilities) will not exceed the maximum of 4.1 km^2 identified in the ERDF ROD.

Figure H.5-3. Layout of conventional cells (1-8) and supercells (9, 10) in ERDF.

Waste Disposal Criteria and Management. The waste disposal criteria for the ERDF are outlined in WCH-191, Environmental Restoration Disposal Facility Waste Acceptance Criteria. The ERDF is authorized to accept waste from Hanford Site environmental restoration activities consistent with the ERDF ROD, the Explanation of Significant Difference (ESD), and ROD amendments (EPA/ROD/R10-95/100, EPA/ESD/R10-96/145, EPA/AMD/R10-97/101, EPA/AMD/R10-99/038, EPA/AMD/R10-02/030, 07-AMRC-0077, 09-AMRC-0179). Inactive treatment, storage, and disposal; RCRA past practice; and decontamination and decommissioning waste may be placed in the ERDF through a remedial action ROD or removal action memorandum issued in accordance with CERCLA and the "Oil and Hazardous Substances Pollution National Contingency Plan" (40 CFR 300). On a case-by-case basis, other documents may be used to provide regulatory authority for disposal of waste at the ERDF. Waste that has not been subjected to the waste acceptance process defined in Section 3.0 of WCH-191 shall not be accepted for disposal at ERDF.

All waste received at ERDF is tracked using the Waste Management Information System (WMIS). Before waste is accepted into ERDF, a waste profile and a waste designation is developed and approved for each waste source in accordance with WMT-1, Waste Management and Transportation. Waste that is within the established profile, meets the Supplemental Waste Acceptance Criteria for the Environmental Restoration Disposal Facility (0000X-DC-W001), has been authorized for disposal by a regulator-approved CERCLA or RCRA past-practice decision document, and is accompanied by the appropriate documentation is disposed in accordance with the ERDF operation process.

Engineered Barriers –Liner System. A schematic of the ERDF multi-layer liner system is shown below. The ERDF sideslope liner comprises six layers: (1) a 0.9-m silty sand operations layer, (2) a primary geocomposite drainage layer, (3) a primary 1.5-mm high-density polyethylene (HDPE) geomembrane, (4) a secondary geocomposite drainage layer, (5) a secondary 1.5 mm HDPE geomembrane liner, and (6) a 0.9-m-thick compacted soil barrier with a hydraulic conductivity no more than $1x10^{-7}$ cm/s. The secondary geomembrane and underlying compacted soil barrier comprise a secondary composite liner.

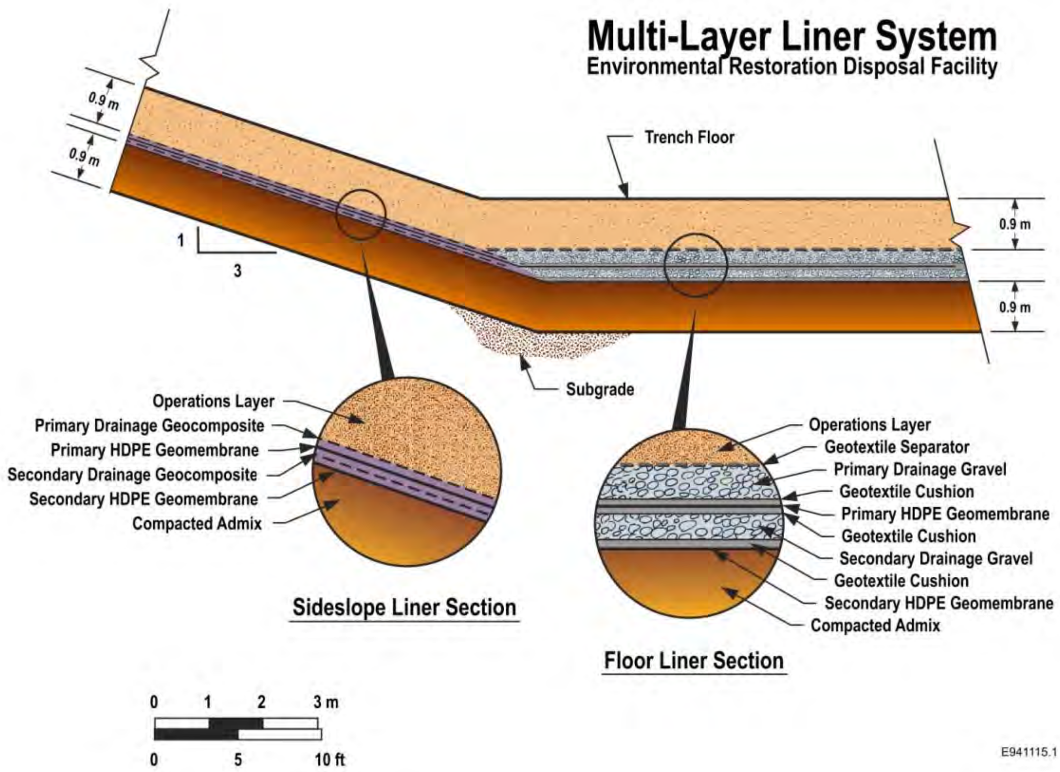

Figure H.5-4. Multilayer double liner system used at ERDF.

The ERDF floor liner has 10 layers: (1) a 0.9-m operations layer, (2) a geotextile separator, (3) a primary gravel drainage layer, (4) a geotextile cushion, (5) a primary 1.5-mm HDPE geomembrane liner, (6) a geotextile cushion, (7) a secondary gravel drainage layer, (8) a geotextile cushion, (9) a secondary 1.5-mm HDPE geomembrane liner, and (10) a 0.9-m-thick compacted soil barrier with a hydraulic conductivity no more than $1x10^{-7}$ cm/s. The secondary geomembrane and underlying compacted soil barrier comprise a secondary composite liner. Field data from similar systems reported by Bonaparte et al. (2002) indicates that the leakage rate is less than 0.1 mm/yr.

Engineered Barriers – Cover System. A schematic of the multi-layer cover system currently proposed for ERDF is shown below. The cover consists of a water balance design at the surface underlain by a composite barrier as described by the ERDF ROD (EPA/ROD/R10-95/100). The upper 50 cm (20 in.) of the soil cover system is composed of an admixture of silt and gravels that provides long-term resistance to erosion, which is underlain by 4.6 m of soil, geomembrane, clay, and sand and gravel. Prior to cover construction, closure cover designs will be evaluated and the most appropriate closure cover design will be selected for construction. The design will, at a minimum, comply with applicable RCRA requirements (WCH-520, 2013). Field monitoring of a similar cover system at the Monticello Uranium Mill Tailings Disposal facility, a more humid climate, has shown near zero percolation in the waste (Apiwantragoon et al. 2014). Even lower percolation rates should be expected at ERDF.

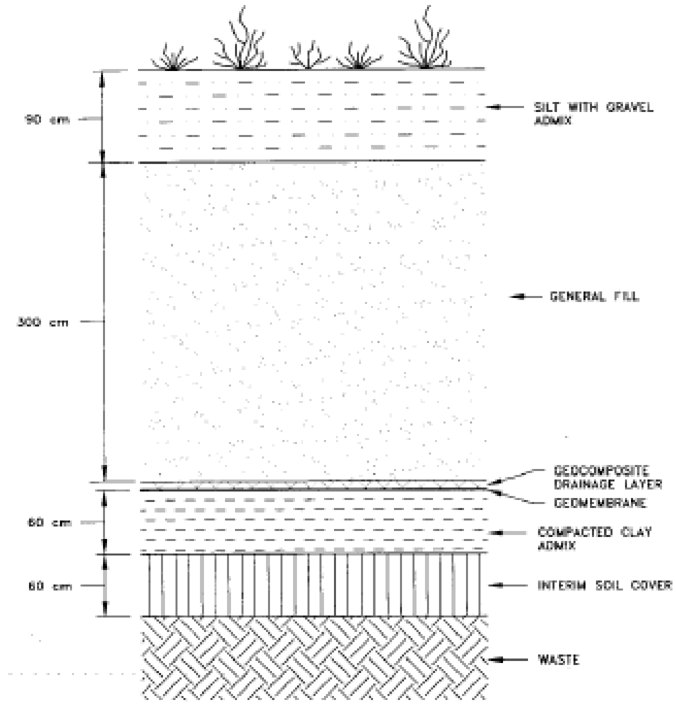

Figure H.5-5. Multilayer final cover proposed for ERDF.

A commercial low-level waste disposal facility also operates within the perimeter of the Hanford and in close proximity to ERDF. The facility is located just south of the tank farms in the 200 East Area on federal land leased to the State of Washington. The facility is operated by US Ecology Inc. under contract to the State of Washington. The inventory of major radionuclides for the commercial low-level waste disposal facility is summarized in Table H.5-3 (WDOH 2004).

Table H.5-3. Inventory at closure

Constituent	Inventory at Closure
C-14	18.4 Ci
Cs (ag)	137 kCi
H-3	1004 kCi
Ni (ag)	883 kCi
Sr-90	65.7 kCi
Tc-99	<0.07 kCi
U (ag)	1.8 Ci
Fe-55	278 kCi
Pu (ag)	14.5 kCi
Sb-125	4.2 kCi

ag = aggregated total of isotopes.

In contrast to the multi-layer double liner system employed at ERDF, the commercial LLW facility wastes in un-lined trenches. When the commercial facility ceases accepting wastes, a final cover will be installed that is similar to the cover proposed for ERDF, except the earthen layers above the composite barrier will be approximately one-half the thickness used for the final cover at ERDF.

ECOLOGICAL RESOURCES SETTING

Landscape Evaluation and Resource Classification

The amount of each category of biological resources at and near the ERDF EU was examined within a circular area radiating 2,123 m from the geometric center of the unit (equivalent to 3,499 acres). The majority of the area within the 424.2 acres of the EU is classified as level 0 (365.4 ac), with only 31.4 acres classified as level 3 or higher biological resources, whereas the adjacent landscape buffer contains substantial level 3 and higher resources (2,468 ac out of 3,075.1 ac). Overall, approximately 71.5 percent of the total combined area currently consists of level 3 or higher biological resources.

Field Survey

The EU associated with the ERDF facilities was surveyed in October 2014 by pedestrian and vehicle reconnaissance of disturbed areas and field measurement or visual survey of natural habitat areas. The majority of the EU consists of disturbed landfill cells, roads/ramps, buildings, parking lots, and associated facilities. Small areas of natural habitat remain along the EU perimeter. Based on visual surveys the natural habitat along the northern boundary (survey areas 4-01a and 4-01b) was classified as a composite of levels 1-3 and the natural habitat along the eastern boundary (survey area 3-09a) was classified as primarily level 2 to reflect current vegetation conditions. Two sanitation tile/drain fields are located within the EU: 1) part of the level 1 habitat resource in the northwest corner which was visually surveyed and 2) an area along the central southern boundary which could not be accessed during the field survey. Field measurements conducted in the natural habitat area located at the southwest corner (survey area 3-09b) of the EU confirmed the habitat to be resource level 3 with mature big sagebrush (*Artemisia tridentata*) in the overstory.

Wildlife observations included a side-blotched lizard (*Uta stansburiana*) and harvester ants in habitats near the northern boundary, signs of small mammals in habitats near the northern boundary and in the southwest corner, and a white-crowned sparrow (*Zonotrichia leucophrys*) in habitats near the eastern boundary.

CULTURAL RESOURCES SETTING

The entire ERDF EU has been inventoried for archaeological resources with limited findings. Specifically, there are two Native American Pre-contact and Ethnographic landscape associated archaeological sites/isolates and four pre-Hanford Early Settler/Farming sites/isolates. None of these resources are National Register-Eligible. No TCPs or Manhattan Project/Cold War Era Landscape resources are known within the ERDF EU.

Three archaeological isolates, one archaeological site representing the Native American Pre-contact and Ethnographic, and the Manhattan Project/Cold War landscapes are located within 500 meters of the ERDF EU. The Manhattan Project/Cold War Era Atmospheric Dispersion Grid archaeological site has been determined to be National Register-eligible. Additionally the 201W Instrument Building is a contributing property within the Manhattan Project/Cold War Landscapes.

While the geomorphologic composition suggest a potential for buried archaeological materials the great distance from a permanent water source as well as the extensive earthworks, evidence of ground disturbances, and inferences based on historic map data suggest that the potential for intact archaeological resources associated with all three landscapes to be present within the EU is low. 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 associated with these landscapes (e.g., East Benton Historical Society, Prosser Cemetery Association, Franklin County Historical Society, the Reach, and the B-Reactor Museum Association) may need to occur. Indirect effects are always possible when TCPs are located in the general vicinity. 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 inventory in ERDF is well characterized through the WMIS. The final disposition is expected to have the inventory summarized in Table H.5-4. (WCH 520).

CONTAMINATION WITHIN PRIMARY EU SOURCE COMPONENTS

Legacy Source Sites

Not Applicable

Vadose Zone Contamination

None from ERDF

Groundwater Plumes

None from ERDF

Facilities for D&D

Not applicable

Operating Facilities

See previous discussion in Part IV.

Detailed inventories are provided in Table H.5-4, Table H.5-5, and Table H.5-6. All values are to 2 significant figures. The source document should be consulted for greater precision data. The sum for each primary contaminant is shown in the first row. Table H.5-7 provides a summary of the evaluation of threats to groundwater as a protected resource from saturated zone and remaining vadose zone contamination associated with the evaluation unit.

Table H.5-4. Inventory of Primary Contaminants[a]

WIDS	Description	Decay Date	Ref	Am-241 (Ci)	C-14 (Ci)	Cl-36 (Ci)	Co-60 (Ci)	Cs-137 (Ci)	Eu-152 (Ci)	Eu-154 (Ci)	H-3 (Ci)	I-129 (Ci)
All	Sum			NP	1900	0	NP	15000	NP	NP	7800	0.019
600-148	Burial Ground	2011	WCH 520	NP	1900	0	NP	15000	NP	NP	7800	0.019

a. NP = Not present at significant quantities for indicated EU

Table H.5-5. Inventory of Primary Contaminants (cont)[a]

WIDS	Description	Decay Date	Ref	Ni-59 (Ci)	Ni-63 (Ci)	Pu (total) (Ci)	Sr-90 (Ci)	Tc-99 (Ci)	U (total) (Ci)
All	Sum			NP	15000	0.0048	11000	21	NP
600-148	Burial Ground	2011	WCH 520	NP	15000	0.0048	11000	21	NP

a. NP = Not present at significant quantities for indicated EU

Table H.5-6. Inventory of Primary Contaminants (cont)[a]

WIDS	Descrip-tion	Ref	CCl4 (kg)	CN (kg)	Cr (kg)	Cr-VI (kg)	Hg (kg)	NO3 (kg)	Pb (kg)	TBP (kg)	TCE (kg)	U (total) (kg)
All	Sum		NP	NP	NP	NP	NP	NP	NP	NP	NP	200000
600-148	Burial Ground	WCH 520	NP	NP	NP	NP	NP	NP	NP	NP	NP	200000

a. NP = Not present at significant quantities for indicated EU

Table H.5-7. Summary of the Evaluation of Threats to Groundwater as a Protected Resource from Saturated Zone (SZ) and Remaining Vadose Zone (VZ) Contamination associated with the Evaluation Unit

PC	Group	WQS	Porosity[a]	K_d (mL/g)[a]	ρ (kg/L)[a]	VZ Source M^{Source}	SZ Total M^{SZ}	Treated[c] M^{Treat}	VZ Remaining M^{Tot}	VZ GTM (Mm^3)	VZ Rating[d]
C-14	A	2000 pCi/L	0.23	0	1.84	---	---	---	---	---	ND
I-129	A	1 pCi/L	0.23	0.2	1.84	---	---	---	---	---	ND
Sr-90	B	8 pCi/L	0.23	22	1.84	---	---	---	---	---	ND
Tc-99	A	900 pCi/L	0.23	0	1.84	---	---	---	---	---	ND
CCl4	A	5 µg/L	0.23	0	1.84	---	---	---	---	---	ND
Cr	B	100 µg/L	0.23	0	1.84	---	---	---	---	---	ND
Cr-VI	A	48 µg/L[b]	0.23	0	1.84	---	---	---	---	---	ND
TCE	B	5 µg/L	0.23	2	1.84	---	---	---	---	---	ND
U(tot)	B	30 µg/L	0.23	0.8	1.84	---	---	---	---	---	ND

a. Parameters obtained from the analysis provided in Attachment 6-1 to Methodology Report.

b. “Model Toxics Control Act—Cleanup” (WAC 173-340) Method B groundwater cleanup level for hexavalent chromium.

c. Treatment amounts from the 2013 Hanford Annual Groundwater Report (DOE/RL-2014-32, Rev. 0).

d. Groundwater Threat Metric rating based on Table 6-3, Methodology Report. These contaminants are being treated using the 200-West Groundwater Treatment Facility.

PART VI. POTENTIAL RISK/IMPACT PATHWAYS AND EVENTS

CURRENT CONCEPTUAL MODEL

Pathways and Barriers: (1. description of institutional, natural and engineered barriers (including material characteristics) that currently mitigate or prevent risk or impacts, 2. Time scale from loss of each barrier to realization of risk or impacts)

The final cover and the composite liner are the primary barriers to contaminant migration from ERDF. The thick vadose zone beneath ERDF is a secondary barrier to contaminant migration. Leakage from ERDF is expected to be less than 0.5 mm/yr, and most likely will be much lower.

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

Soils placed over and around disposed debris provide active and passive shielding during operations. The final cover provides active and passive shielding after closure.

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

Soils placed over and around disposed debris provide active and passive shielding during operations. The final cover provides active and passive shielding after closure.

3. *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?*

The final cover and the composite liner are the primary barriers to contaminant migration from ERDF. The thick vadose zone beneath ERDF is a secondary barrier to contaminant migration. Leakage from ERDF is expected to be less than 0.5 mm/yr, and most likely will be much lower.

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

The liner system will degrade over time as antioxidants are depleted from the geomembrane, ultimately leading to stress cracking and potentially higher leakage rates. The geomembrane in the cover will also degrade due to antioxidant depletion, ultimately leading to higher percolation rates. The cover may also be degraded by catastrophic erosion events. Recent studies on geomembranes, however, indicate that degradation is unlikely to begin for at least 1000 yr after installation.

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

Contaminant migration to groundwater is the primary pathway for populations or resources at risk from ERDF.

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

Hundreds of years, if not longer.

7. *Are there current on-going releases to the environment or receptors?*

Not at this time

POPULATIONS AND RESOURCES CURRENTLY AT RISK OR POTENTIALLY IMPACTED

Facility Worker

Workers involved in unloading, distribution, compaction, and grouting are at risk during operations due to contact with the waste or physical accidents associated with operation of machinery.

Co-Located Person (CP)

CPs are not directly exposed to the disposal operations because they are located 100 meters away from the periphery of ERDF, thereby precluding contact with the waste being disposed.

Public

There is no direct risk to the public beyond those associated with impacts to groundwater that might ultimately be **used by the public.**

Groundwater

It is assumed that the waste in ERDF is contained within a RCRA Subtitle C landfill. Any waste outside of the ERDF facility is assumed negligible. This leads to a ND rating.

Columbia River

The Columbia River will not be impacted by EDRF due to the distance between the facility and the river. It is assumed that the waste in ERDF is contained within a RCRA Subtitle C landfill. Any waste outside of the ERDF facility is assumed negligible. This leads to a ND rating.

Ecological Resources:

- The majority of the area within the 424.2 acres of the ERDF EU is classified as level 0 (365.4 ac), with only 31.4 acres classified as level 3 or higher biological resources.
- Remediation actions undertaken within the ERDF EU boundary would result in no more than an approximate 1% (31.4 ac) reduction of level 3 or higher biological resources within a 2.1 km radius.
- Areas of habitat within the ERDF EU are located near its perimeter and are contiguous with surrounding habitats located in the adjacent landscape buffer; the removal of the small amount of habitat within the EU would not be expected to significantly affect habitat connectivity.
- Future plans to expand ERDF by adding new landfill cells have the potential to significantly affect those level 3 or higher biological resources immediately adjacent to the EU.

Cultural Resources:

- There are no known TCPs within the EU.
- Six cultural resources have been documented in the EU. These resources include archaeological sites and isolates representing the pre-contact, ethnographic, and historic era landscapes. Specifically, there are two Native American Pre-contact and Ethnographic landscape associated archaeological sites and four pre-Hanford Early Settler/Farming sites. Each of these six sites has been determined to be not eligible for listing on the NRHP.

Archaeological sites and TCPs located within 500 meters of the EU

- There are no known TCPs within 500 meters of the EU.
- Five additional cultural resources have been documented within 500-meters of the EU. These resources include archaeological sites and isolates representing the Native American Pre-contact and Ethnographic, and the Manhattan Project/Cold War landscapes.

- One contributing properties to the Manhattan Project and Cold War Era Landscape, the 201W Instrument Building (with no documentation required) is located within 500-meters of the ERDF Evaluation Unit:
- The Hanford Atmospheric Dispersion Test Facility is a National Register-eligible archaeological site, that is associated with the Manhattan Project and Cold War Era Landscape

Closest Recorded TCP

- There are 2 recorded TCPs that are known to be visible from the ERDF EU.

CLEANUP APPROACHES AND END-STATE CONCEPTUAL MODEL

Selected or Potential Cleanup Approaches

ERDF is intended for permanent disposal and isolation of wastes. No clean up approaches are needed after the facility is filled and the final cover is installed. The only "clean up" activity is installation of the final cover.

Contaminant Inventory Remaining at the Conclusion of Planned Active Cleanup Period

The inventory summarized in Table H.5-1 will remain when ERDF is closed and the final cover is installed.

Risks and Potential Impacts Associated with Cleanup

The risks during operations are the same as those currently existing at ERDF, which is an operating facility.

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

Workers (directly involved)

The worker risks are similar to those during operations, except radionuclide exposure is eliminated because of shielding provided by interim cover soil over waste.

Co-located (CW)

Same as worker. CW risk would be due to accident with machinery operating around ERDF.

Public

Same at risk as in existing condition (operating facility).

Groundwater

Same at risk as in existing condition (operating facility). It is assumed that the waste in ERDF is contained within a RCRA Subtitle C landfill. Any waste outside of the ERDF facility is assumed negligible. This leads to a ND rating.

Columbia River

Same at risk as in existing condition (operating facility). The Columbia River will not be impacted by ERDF due to the distance between the facility and the river. It is assumed that the waste in ERDF is contained within a RCRA Subtitle C landfill. Any waste outside of the ERDF facility is assumed negligible. This leads to a ND rating

Ecological Resources

Trucks, heavy equipment and drill rigs 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. Additional water from dust suppression could lead to more diverse and abundant vegetation in areas that receive water, which could encourage invasion of exotic species. The latter could displace native plant communities. Excessive dust suppression activities could lead to compaction, which can decrease plant growth in those areas, decrease abundance and diversity of soil invertebrates, and prevent fossorial snakes or mammals from using the area. Irrigation for re-vegetation requires a system of pumps and water, resulting in physical disturbance. Use of non-specific herbicides results in some mortality of native vegetation (especially native forbes), and allows exotic species to move in. It may change species composition of native communities, but it also could make it easier for native species to move in. Improved methods could result in positive results. Irrigation for re-vegetation requires a system of pumps and water, resulting in physical disturbance. This is used to re-establish native plant species. Repeated irrigation from the same locations could result in some soil compaction, which can decrease plant growth in those areas, decrease abundance and diversity of soil invertebrates, and prevent fossorial snakes or mammals from using the area. 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, car, and truck traffic on paved roads as well as use of heavy equipment will not have any direct impact on archaeological resources because there is no disturbance to soil/ground or alteration to the landscape. Assuming heavy equipment locations 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 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 paved roads located on TCP, direct effects include visual, auditory and vibrational alterations to landscape/setting. Heavy equipment 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. Construction of staging areas, caps 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 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 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. Otherwise, capping 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. 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, car, and truck traffic on paved roads as well as use of heavy equipment 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. Existing road causes no alteration to 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 construction, 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

None

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

ERDF is an operating facility that will operate until remediation is completed at Hanford. The near-term risks are the same as existing risks.

Populations and Resources at Risk or Potentially Impacted After Cleanup Actions (from residual contaminant inventory or long-term activities)

Facility Worker

None

Co-Located Person (CP)

None

Public

There is no direct risk to the public beyond those associated with impacts to groundwater that might ultimately be used by the public.

Groundwater

It is assumed that the waste in ERDF is contained within a RCRA Subtitle C landfill. Any waste outside of the ERDF facility is assumed negligible. This leads to a ND rating.

Columbia River

The Columbia River will not be impacted by ERDF due to the distance between the facility and the river. It is assumed that the waste in this EU is contained within a RCRA Subtitle C landfill. Any waste outside of the ERDF facility is assumed negligible. This leads to a ND rating.

Ecological Resources

Personnel, car, and pick-up truck traffic through non-target and remediated areas will likely no longer cause an effect on the ecological resources, unless heavy traffic caused ruts. If alien/exotic species became established during remediation, their presence could continue to affect the ecological resources.

Cultural Resources

Personnel, car and truck traffic on paved roads will likely have no direct effects on the cultural resources assuming the resources were not disturbed during remediation.

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

All waste disposed in ERDF will remain in place in perpetuity. The long-term risk is the same as the post-closure risk.

PART VII. SUPPLEMENTAL INFORMATION AND CONSIDERATIONS

None

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Bonaparte, R., Daniel, D., and Koerner, R. (2002), Assessment and Recommendations for Improving the Performance of Waste Containment Systems, National Risk Management Research Laboratory, US Environmental Protection Agency, Cincinnati, Ohio.

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Washington Closure Hanford 2010, Environmental Restoration Disposal Facility Operations Plan, WCH-179 Rev. 1, December 2010.

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APPENDIX I

SUMMARY OF NON-DOE FACILITIES

PACIFIC NORTHWEST NATIONAL LABORATORY

Pacific Northwest National Laboratory (PNNL), one of the U.S. Department of Energy (DOE) Office of Science's (SC's) 10 national laboratories, provides innovative science and technology development in the areas of energy and the environment, fundamental and computational science, and national security. DOE's Pacific Northwest Site Office (PNSO), which was established in 2003, is responsible for oversight of PNNL at its campus in Richland, Washington, and at its facilities in Sequim, Seattle, and North Bonneville, Washington, and Corvallis and Portland, Oregon.

In 1964, the federal government issued a request for contractors to bid to operate the Hanford Site laboratories to conduct research and development (R&D) activities related to nuclear energy and the non-destructive use of nuclear materials. In January 1965, Battelle Memorial Institute, a not-for-project, applied science and technology organization was awarded the Pacific Northwest Laboratory (PNL) contract and, as part of the successful proposal, was able to invest its own funds to construct facilities to conduct non-Hanford Site research to promote R&D around the Pacific Northwest. Battelle bought 93 ha (230 ac) of former Camp Hanford land from the City of Richland to build its facilities. Under the original contract, more than 2200 former General Electric Company employees joined the Battelle workforce.

In the late 1970s, research expanded into energy, health, environmental, and national security endeavors. With the expanded areas of research, PNL contributed to areas such as robotics, environmental monitoring, material coatings, veterinary medicine, and the formation of new plastics. In 1995, PNL was renamed Pacific Northwest National Laboratory. Throughout the ensuing years, PNNL researchers have developed versatile technologies, earning numerous R&D 100 awards, Federal Laboratory Consortium awards, and Innovation awards for their R&D work and contributions.

As of September 2013, PNNL employed 4344 staff members. PNNL's FY 2013 funding totaled $1.06 billion, with $936 million in total spending during the fiscal year. A total of 716 undergraduate students, graduate students, post-doctoral students, and faculty participated in post-secondary fellowships and intern programs at PNNL in FY 2013. PNNL's research activities in FY 2013 generated 264 invention disclosures, 60 patent filings, 36 patents granted, and 41 commercial and research license agreements issued. In addition, PNNL researchers had almost 1200 peer-reviewed, published articles (Scott and Niemeyer 2014).

The PNNL Richland campus is located in Benton County in southeastern Washington State, at the northern boundary of the City of Richland and south of the DOE-Richland Operations Office's (DOE-RL's) Hanford Site 300 Area. The PNNL campus covers approximately 247 ha (610 ac), encompassing the DOE-owned PNNL site, adjacent land and facilities owned by Battelle that are under an exclusive-use agreement with DOE, and leased facilities located on private land and the Washington State University Tri-Cities campus (Figure I-1, from Duncan et al. 2014). The area immediately south of the PNNL campus includes public and privately owned land, currently envisioned to be developed with office, laboratory, residential, and retail space as part of the Tri-Cities Research District.

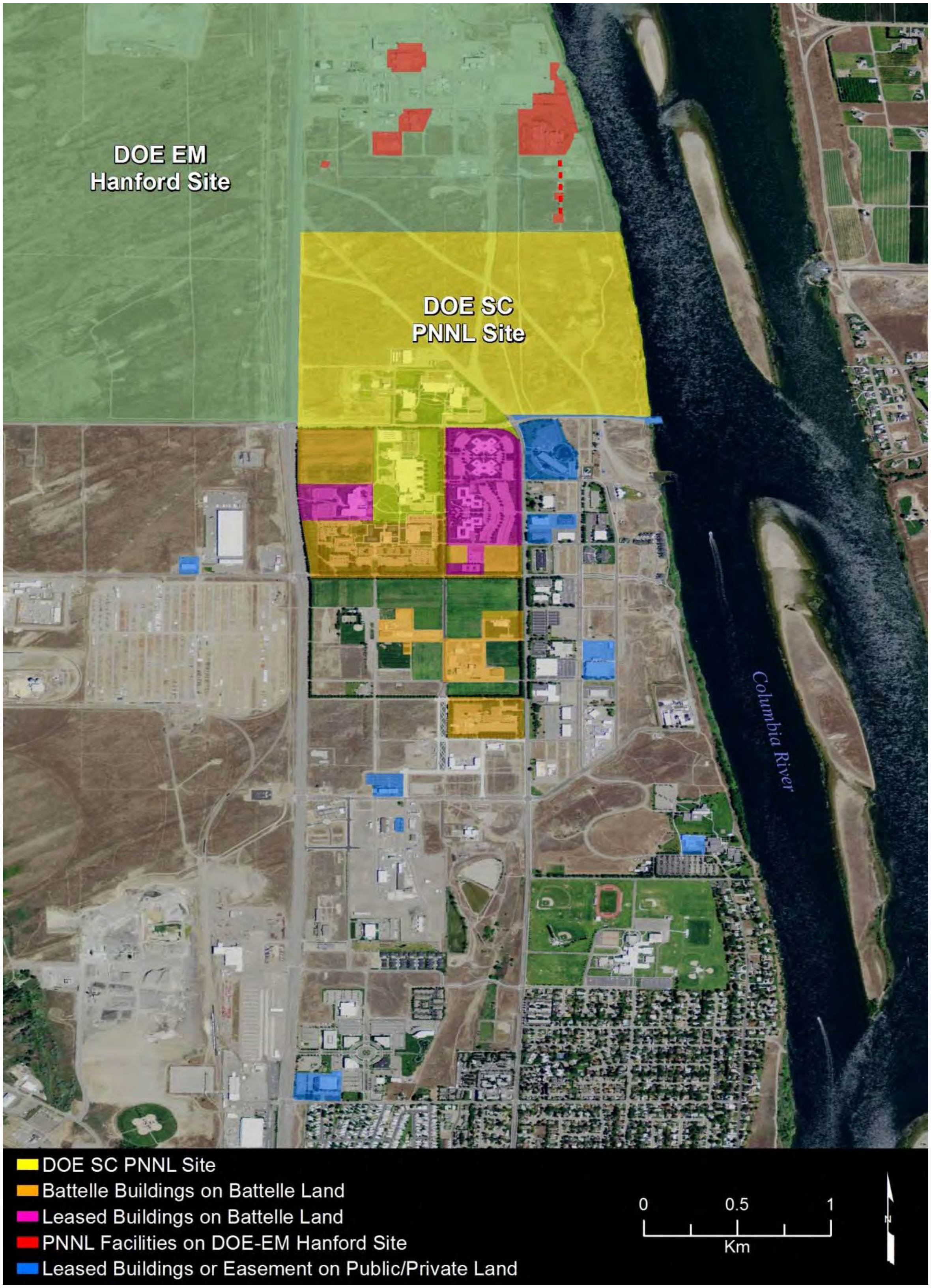

Figure I-1. Pacific Northwest National Laboratory campus and surrounding area.

In May, 2007, DOE-SC and the DOE Office of Environmental Management (EM) signed a memorandum of agreement (DOE 2007) allowing PNNL to continue to occupy four facility complexes in the 300 Area, including supporting utilities/structures solely dedicated to operation of the facilities until DOE-SC no longer needs these facilities. These facilities (shown in Figure I-2) provide core capabilities in applied nuclear science and technology and enable environmental, energy, and national security research involving higher-risk activities. At the end of occupancy of the retained facilities, DOE-SC will release the facilities to DOE-EM for demolition and cleanup pursuant to Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) requirements in effect as dictated by the Tri-Party Agreement.

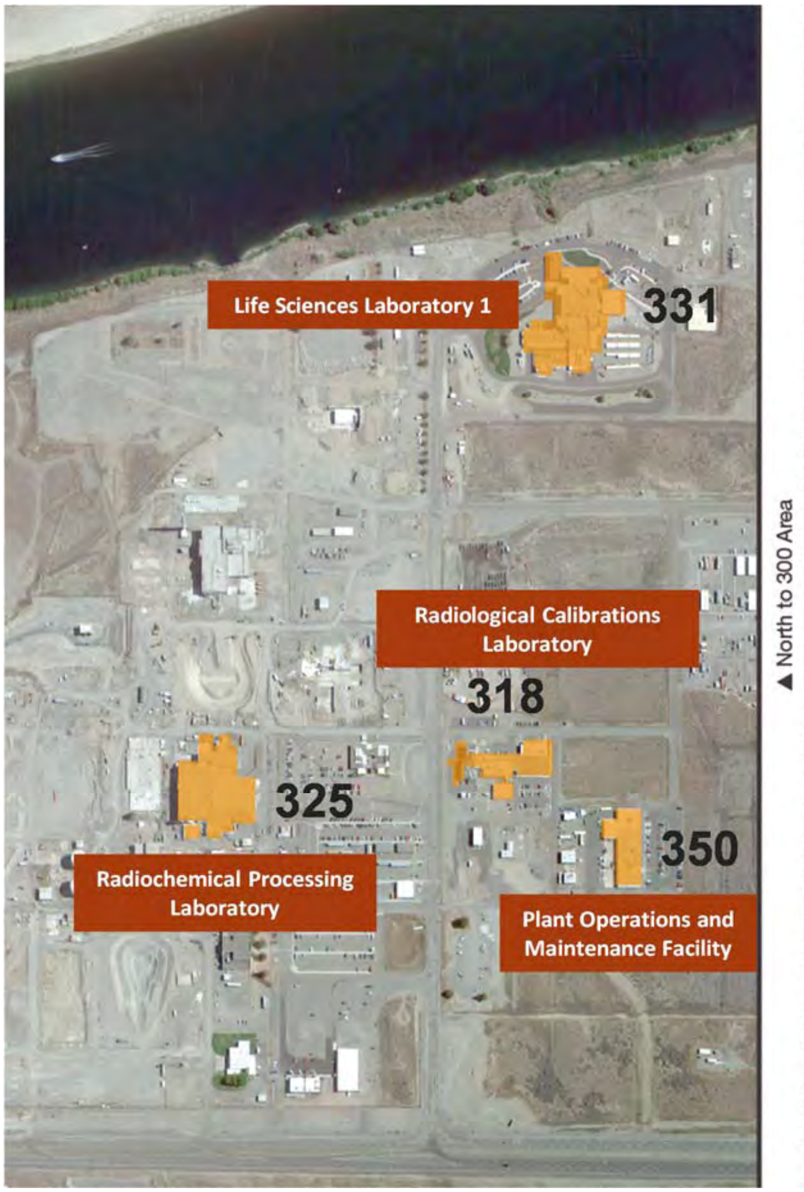

Figure I-2. Pacific Northwest National Laboratory 300 Area facilities.

PNNL's Annual Site Environmental Report for Calendar Year 2013 (Duncan et al. 2014) provides a synopsis of ongoing environmental management performance and compliance activities conducted at PNNL during 2013. It describes the location and background of each facility; addresses compliance with all applicable DOE, federal, state, and local regulations and site-specific permits; documents environmental monitoring efforts and status; presents potential radiation doses to staff and the public in the surrounding areas; and describes DOE-required data quality assurance methods used for data verification. PNNL is committed to complying with all applicable federal, state, and local laws and regulations and site-specific permits. In 2013, PNNL was in compliance with all applicable requirements.

References

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US Ecology

US Ecology, a commercial low-level waste disposal facility also operates within the perimeter of the Hanford and near the Environmental Restoration Disposal Facility (ERDF). The facility is located just south of the tank farms in the 200 East Area on federal land leased to the State of Washington. The facility is operated by US Ecology, Inc. under contract to the State of Washington. The inventory of major radionuclides for the commercial low-level waste disposal facility is summarized in Table I-1 (WDOH 2004).

Table I-1. Inventory at closure.

Constituent	Inventory at Closure
C-14	18.4 Ci
Cs (ag)	137 kCi
H-3	1004 kCi
Ni (ag)	883 kCi
Sr-90	65.7 kCi
Tc-99	<0.07 kCi
U (ag)	1.8 Ci
Fe-55	278 kCi
Pu (ag)	14.5 kCi
Sb-125	4.2 kCi

ag = aggregated total of isotopes.

In contrast to the multi-layer double liner system employed at ERDF, the commercial low-level waste facility stores wastes in unlined trenches. When the commercial facility ceases accepting wastes, a final cover will be installed that is similar to the cover proposed for ERDF, except the earthen layers above the composite barrier will be approximately one-half the thickness used for the final cover at ERDF.

Reference

WDOH (2004), Final Environmental Impact Statement, Commercial Low-Level Radioactive Waste Disposal Site, Richland, Washington, DOH Publication 320-031, State Of Washington Department Of Health.

VOLPENTEST HAZARDOUS MATERIALS MANAGEMENT AND EMERGENCY RESPONSE (HAMMER) FEDERAL TRAINING CENTER

The Volpentest HAMMER Federal Training Center is a safety and emergency response training center. HAMMER provides premier worker safety training. The Hanford Site originated through the WWII Manhattan Project and today is the largest and most complex nuclear cleanup site in the country. HAMMER offers the most realistic and comprehensive safety and emergency response training for those who need it most—nuclear waste cleanup workers and emergency response personnel. These workers benefit through expert instruction and from the most expansive selection of training props in the country.

HAMMER is located at the DOE Hanford Site in southeastern Washington State, and is owned by DOE and operated by Mission Support Alliance. HAMMER was dedicated in 1997 with the primary mission to train DOE Hanford workers and emergency responders on hazardous materials handling; environmental, health, and safety courses; and emergency response.

The concept of HAMMER began with a goal of having one Hanford Site central training facility that provided improved training for emergency responders and cleanup workers at Hanford. In a partnership that has become a model around the nation, management joined forces with organized labor to build the 88 acre campus that provides a state-of-the-art, hands-on training facility. An aerial view of the HAMMER campus is provided below. HAMMER is composed of modern classrooms, specialty-training areas, and numerous life-size training props that can be configured to create a variety of situations for industrial hazards: worksite scenarios, emergency response or incident command, and hazardous materials training.

Figure I-3. Aerial view of the Hammer campus.

HAMMER staff manages nationally recognized training and safety programs, including:

- Construction Worker Safety Training

- Worker-Trainer Program
- National Training Center Safety and Health Courses
- Energy Infrastructure Protection and Emergency Response Program
- Domestic and International Border Security Training
- Military Training

HAMMER is available to DOE and DOE-affiliated entities as well as the military, other authorized federal and state agencies, and local law enforcement and security personnel.

Columbia Generating Station (CGS)

The CGS is a single-unit nuclear power plant operated by Energy Northwest that began commercial operation in December 1984. The CGS site boundary encloses approximately 1089 ac (441 ha) leased to Energy Northwest by DOE. The most conspicuous structures on the CGS site include the reactor containment building, the turbine building, six cooling towers, and various buildings that house equipment and staff that support the operation of the reactor (NRC 2012).

CGS produces approximately 1170 megawatts of electricity, equivalent to about 10% of Washington's power and 4% of all the electric power used in the Pacific Northwest. All electrical energy produced at CGS is delivered to electrical distribution facilities owned and operated by Bonneville Power Administration (BPA) as part of the Federal Columbia River Power System (NRC 2012). Since initiating operation, CGS has moved approximately 531 metric tons of spent fuel into the fuel storage basins on the site (Alvarez 2011). CGS has spent fuel containing 134 million curies of radioactivity stored in the Independent Spent Fuel Storage Installation on site and an additional 134 million curies in the spent fuel pool (personal communication with Jeff Waddell, Energy Northwest; email received November 20, 2014).

CGS is located on the Hanford Site approximately 10 mi (19 km) northwest of Richland. The CGS site is bounded on the east by the Columbia River. Groundwater from deeper and/or uncontaminated portions of the aquifer system is withdrawn for backup fire and sanitary water supply at CGS (DOE-RL-2009-85, Rev 1). The 618-11 Burial Ground is just west of the CGS boundary. Figure I-4 shows the facility location and the relationship of the facility to the Columbia River, nearby waste sites, roads, and other facilities. (NRC 2012).

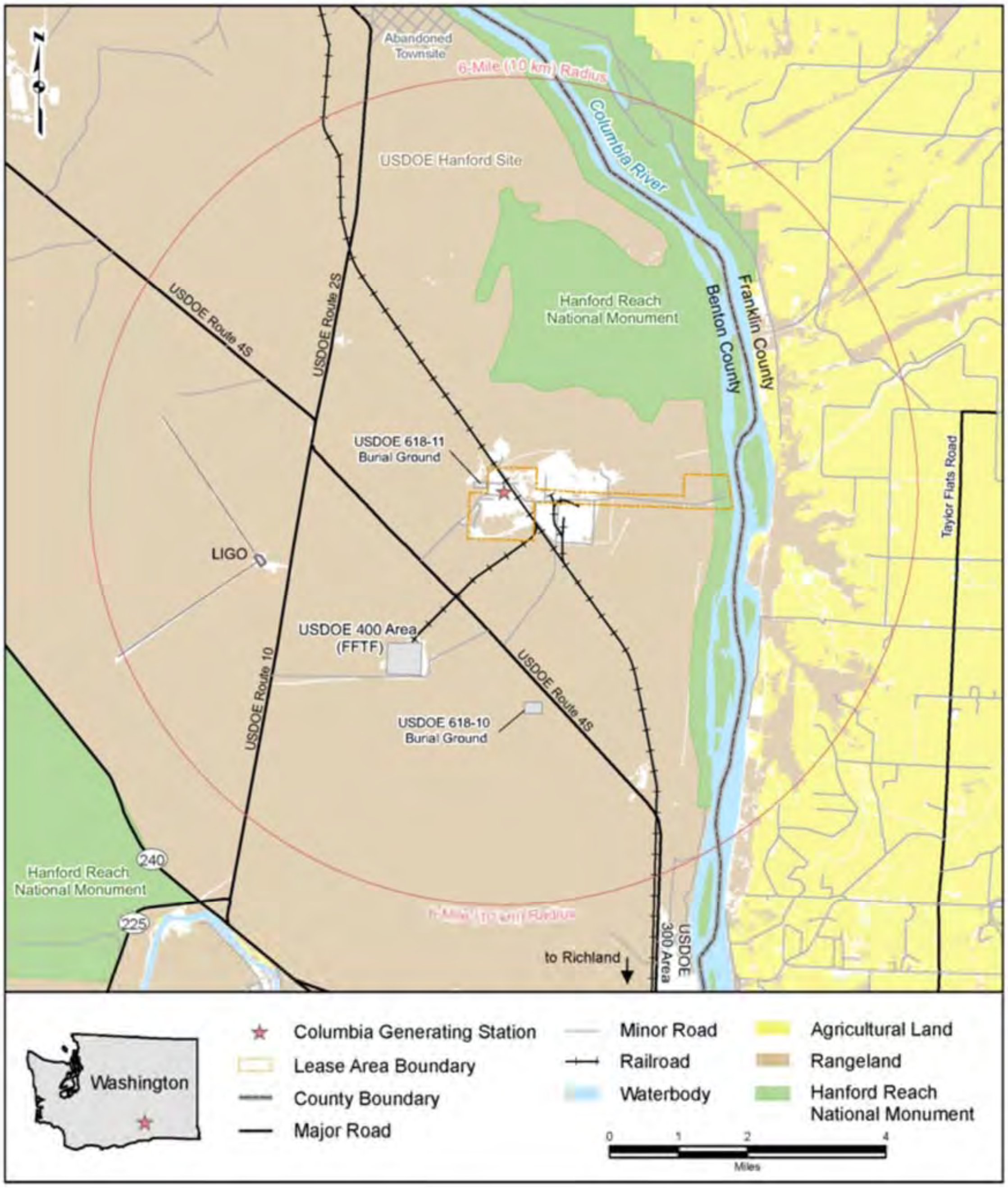

Figure I-4. Columbia Generating Station location.

REFERENCES

Alvarez, R. 2011. Spent Nuclear Fuel Pools in the U.S.: Reducing the Deadly Risks of Storage. Institute for Policy Studies. Washington, D.C.

DOE/RL-2009-85 Revision 1 2012. *Remedial Investigation Report for the 200-PO-1 Groundwater Operable Unit.* U.S. Department of Energy, Richland, Washington.

NRC. 2012. Generic Environmental Impact Statement for License Renewal of Nuclear Plants, Supplement 47, Regarding Columbia Generating Station. Office of Nuclear Reactor Regulation, Washington, D.C., NUREG-1437 Supplement 47, Vol. 1.

LASER INTERFEROMETER GRAVITATIONAL-WAVE OBSERVATORY (LIGO)

The LIGO facility is dedicated to the detection of cosmic gravitational waves and the measurement of these waves for scientific research. It consists of two widely separated installations within the United States, operated in unison as a single observatory. This observatory is available for use by the world scientific community, and is a vital member in a developing global network of gravitational wave observatories.

LIGO's mission is to observe gravitational waves of cosmic origin. LIGO searches for gravitational waves created in the supernova collapse of stellar cores to form neutron stars or black holes, the collisions and coalescences of neutron stars or black holes, the wobbly rotation of neutron stars with deformed crusts and the remnants of gravitational radiation created by the birth of the universe. LIGO is operated by the California Institute of Technology and the Massachusetts Institute of Technology for the National Science Foundation (NSF).

LIGO Observatory facilities in Hanford, WA (see photo below) and Livingston, LA house laser interferometers, consisting of mirrors suspended at each of the corners of a gigantic, L-shaped vacuum system, measuring 4 km (2-1/2 mi) on a side. Precision laser beams in the interferometers will sense small motions of the mirrors that are caused by a gravitational wave. Construction of the facilities was completed in 1999. Initial operation of the detectors began in 2001, with observing runs beginning in 2002. Groundwater from deeper and/or uncontaminated portions of the aquifer system is withdrawn for backup sanitary and potable water supply at LIGO (DOE-RL-2009-85, Rev 1). In 2008, the NSF approved funding Advanced LIGO. The Advanced LIGO program will place upgraded detector subsystems into the existing infrastructures at the sites, generating a ten-fold sensitivity improvement and yielding a thousand-fold increase in the volume of space that LIGO will survey.

Figure I-5. LIGO Observatory Facility.

Reference

DOE/RL-2009-85 Revision 1 2012. *Remedial Investigation Report for the 200-PO-1 Groundwater Operable Unit.* U.S. Department of Energy, Richland, Washington.

HANFORD REACH NATIONAL MONUMENT

The Hanford Reach National Monument, established in 2000 (65 FR 37253), totals 792.6 km^2 (306 mi^2) on lands which primarily served as a security buffer for the Hanford Site. The designation establishes the long-term protection and management of the lands. A separate memorandum allows for the incorporation of additional Hanford Site Lands into the monument as the land is remediated.

Areas within the monument include the Fitzner-Eberhardt Arid Lands Ecology Reserve, Saddle Mountain National Wildlife Refuge, McGee Ranch/Riverlands, Wahluke and Ringold. In addition land 0.40 km (0.25 mi) inland from the mean high-water mark on the south and west shores of the 82 km (51 mi)-long Hanford Reach of the Columbia River. It also includes the federally owned islands in the Hanford Reach > and the sand dune area northwest of the Energy Northwest site.

The U.S. Fish and Wildlife Service manages approximately 67,000 ha (166,000 ac) of monument lands as a unit of the National Wildlife Refuge System under permit from DOE. DOE manages the remainder of the monument. In August 2008, the U.S. Fish and Wildlife Service, as lead agency, issued the Hanford Reach National Monument Comprehensive Conservation Plan and Environmental Impact Statement which further describes management of the Hanford Reach National Monument.

References

65 FR 37253. Establishment of the Hanford Reach National Monument. Federal Register (June 9, 2000). Available at <http://www.gpoaccess.gov/cfr/index.html> [20 August 2015].

U.S. Fish & wildlife Service 2015, Hanford Reach National Monument, Washington. Available at: <ww.fws.gov/refuge/hanford_reach/> [20 August 2015].

OTHER HANFORD SITE LEASED FACILITIES

In addition to Energy Northwest's CGS, LIGO, HAMMER, the US Ecology commercial low-level waste burial ground, and PNNL, there are a few properties on the Hanford Site that are leased to other entities. These include:

- The Combined Community Communication Facility on Rattlesnake Mountain. This facility is owned by Energy Northwest and provides emergency response communication services.
- A maintenance shop on Rattlesnake that DOE quitclaimed to the U.S. Fish and Wildlife Service.
- Telecommunication towers and electrical utility lines and other utility system facilities that are leased to BPA.

Appendix J

Ecological Field Studies for Each Evaluation Unit

This appendix to the interim progress report (report) for the Hanford Site-Wide Risk Review Project contains the field evaluations for ecological resources. The evaluation of risk to ecological resources in the current, active cleanup, and near-term post-cleanup periods depends on the resource level in each evaluation unit (EU) and its buffer zone. While there have been some recent ecological inventories on the Hanford Site, many of the EUs have not been examined for resource level in many years. It was thus necessary to conduct on-the-ground evaluations of the current resource level on each EU with its associated buffer area (1X the largest diameter of the EU). To accomplish this, a field protocol was developed by the Consortium for Risk Evaluation with Stakeholder Participation (CRESP) in collaboration with Pacific Northwest National Laboratory (PNNL) personnel to assess current resource levels. Evaluations were made of each EU and its buffer area by trained professional PNNL ecologists, including the percent of the EU and buffer area that was composed of each resource level type (see Chapter 7 of the methodology document). The field reports completed by PNNL follow. Note that the field evaluations for the EUs in this report were conducted in the winter, which is not optimal because the vegetation is not green. Further, time constraints and access issues prevented evaluation of some parts of some EUs and buffer areas.

The field evaluations were used, in conjunction with the risk rating table (from Chapter 7 of the methodology document) and the disposition table (Appendix B) to rate the risk to ecological resources currently, during active cleanup, and in the near-term post-cleanup period. All rating evaluation results may be found in Chapter 3 of this report. A key indicator of risk used by the authors to evaluate the ecological resources is the summary of the percentage of each biological resource level within each evaluation unit (

Table J.1) and within the adjacent landscape buffer area (Table J.2).

There were five levels of ecological resources (DOE/RL-96-32 2013), described briefly below (see Chapter 7 of the methodology document for a full description).

Levels of Ecological Resources (DOE/RL-96-32 2013)

- Level 5 = Irreplaceable habitat or federal threatened and endangered species (including proposed species, and species that are new to science or unique to Washington State)
- Level 4 = Essential habitat for important species

Level 3 = Important habitat

Level 2 = Habitat with high potential for restoration (ecologically, not legally)

Level 1 = Industrial or developed

Level 0 = Non-native plants and animals

Three caveats should be noted: (1) many of these resources have not been evaluated for a decade or more (and so may have changed), (2) no invasive species inventory has been completed, and (3) while much of the site was evaluated for resource level, not all sites were evaluated—thus evaluations are valid where given, but if a site is blank on the resource map, it may not indicate lack of a value, but rather that the site was not surveyed.

Table of Contents

Table J.1. Percentage of each Biological Resource Level within each Evaluation Unit

Evaluation Unit*	Evaluation Unit Name*	Level 0	Level 1	Level 2	Level 3	Level 4	Level 5	Percentage of Resources Level 3 or Greater
RC-LS-1	618-11 Burial Ground	30.26%	8.41%	51.24%	10.09%	0.00%	0.00%	10.09%
RC-LS-2	K Area Waste Sites	86.94%	2.40%	2.62%	0.09%	7.95%	0.00%	8.04%
CP-LS-1	BC Cribs and Trenches	69.73%	0.00%	0.00%	11.31%	18.96%	0.00%	30.27%
CP-LS-2	Plutonium Contaminated Waste Sites	47.61%	16.25%	31.36%	4.77%	0.00%	0.00%	4.77%
CP-TF-1	T Tank Farm	89.34%	0.00%	9.80%	0.86%	0.00%	0.00%	0.86%
CP-TF-2	S-SX Tank Farms	86.19%	7.11%	6.69%	0.00%	0.00%	0.00%	0.00%
CP-TF-3	TX-TY Tank Farms	43.56%	19.31%	27.82%	9.31%	0.00%	0.00%	9.31%
CP-TF-4	U Tank Farm	63.40%	0.00%	18.56%	18.04%	0.00%	0.00%	18.04%
CP-TF-5	A-AX Tank Farms	41.12%	34.97%	2.57%	21.34%	0.00%	0.00%	21.34%
CP-TF-6	B-BX-BY Tank Farms	43.64%	25.36%	26.70%	4.31%	0.00%	0.00%	4.31%
CP-TF-7	C Tank Farm	99.44%	0.00%	0.56%	0.00%	0.00%	0.00%	0.00%
CP-TF-8	200-East Double Shell Tanks	100.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
CP-TF-9	200-West Double Shell Tanks	100.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
RC-DD-1	324 Building	100.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
RC-DD-2	KE/KW Reactors	100.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
CP-DD-1	PUREX	84.30%	0.00%	10.76%	4.93%	0.00%	0.00%	4.93%
RC-OP-1	K Basin Sludge	100.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
CP-OP-1	CWC	57.56%	2.15%	40.28%	0.00%	0.00%	0.00%	0.00%
CP-OP-3	WESF	100.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
CP-OP-6	ERDF	86.14%	2.29%	4.17%	7.02%	0.38%	0.00%	7.40%

*For RC-GW-1, -2, and -3 and CP-GW-1, the analysis only consisted of the interception of the groundwater plumes with the terrestrial environment (riparian areas). The riparian areas are all Level 4 and 5. CP-GW-2 does not have groundwater plumes that currently intercept the terrestrial environment; there is not an ecological resources evaluation for this groundwater EU.

Table J.2. Percentage of each Biological Resource Level within Adjacent Landscape Buffer Area

Evaluation Unit*	Evaluation Unit Name*	Level 0	Level 1	Level 2	Level 3	Level 4	Level 5
RC-LS-1	618-11 Burial Ground	21.62%	0.00%	14.27%	3.64%	60.48%	0.00%
RC-LS-2	K Area Waste Sites	1.17%	0.00%	20.94%	12.28%	65.53%	0.09%
CP-LS-1	BC Cribs and Trenches	13.21%	2.33%	7.31%	19.22%	57.92%	0.00%
CP-LS-2	Plutonium Contaminated Waste Sites	46.45%	11.26%	39.00%	3.29%	0.00%	0.00%
CP-TF-1	T Tank Farm	43.70%	6.91%	37.96%	11.43%	0.00%	0.00%
CP-TF-2	S-SX Tank Farms	16.23%	37.47%	39.99%	6.32%	0.00%	0.00%
CP-TF-3	TX-TY Tank Farms	65.81%	1.97%	28.18%	4.04%	0.00%	0.00%
CP-TF-4	U Tank Farm	26.89%	22.24%	34.54%	16.33%	0.00%	0.00%
CP-TF-5	A-AX Tank Farms	30.44%	28.14%	14.91%	18.97%	7.54%	0.00%
CP-TF-6	B-BX-BY Tank Farms	7.84%	6.18%	43.32%	11.23%	31.44%	0.00%
CP-TF-7	C Tank Farm	35.78%	33.76%	13.82%	16.21%	0.43%	0.00%
CP-TF-8	200-East Double Shell Tanks	66.55%	21.59%	7.35%	4.51%	0.00%	0.00%
CP-TF-9	200-West Double Shell Tanks	63.87%	4.01%	25.18%	6.93%	0.00%	0.00%
RC-DD-1	324 Building	100.00%	0.00%	0.00%	0.00%	0.00%	0.00%
RC-DD-2	KE/KW Reactors	93.17%	2.52%	0.00%	0.00%	4.32%	0.00%
CP-DD-1	PUREX	37.19%	15.95%	15.57%	19.95%	11.34%	0.00%
RC-OP-1	K Basin Sludge	93.17%	2.52%	0.00%	0.00%	4.32%	0.00%
CP-OP-1	CWC	30.89%	9.11%	58.10%	1.90%	0.00%	0.00%
CP-OP-3	WESF	100.00%	0.00%	0.00%	0.00%	0.00%	0.00%
CP-OP-6	ERDF	8.68%	2.63%	8.42%	43.04%	28.71%	8.51%

*For RC-GW-1, -2, and -3 and CP-GW-1, the analysis only consisted of the interception of the groundwater plumes with the terrestrial environment (riparian areas). The riparian areas are all Level 4 and 5. CP-GW-2 does not have groundwater plumes that currently intercept the terrestrial environment; there is not an ecological resources evaluation for this groundwater EU.

Evaluation Unit:	618-11 Burial Ground
ID:	RC-LS-1
Group:	Legacy Source
Operable Unit Cross-Walk:	300-FF-2
Related EU:	CP-GW-1
Sites & Facilities:	618-11 Burial Ground
Key Data Sources Docs:	WCH-542, Rev 0
	WCH-183, Rev 1
	WCH-459, Rev 1
	DOE/RL-96-32 2013
	PNNL ECAP Database[1]
Field Survey Date:	7/16/2014
Data Sheet prepared by:	JLD 10/5/2014

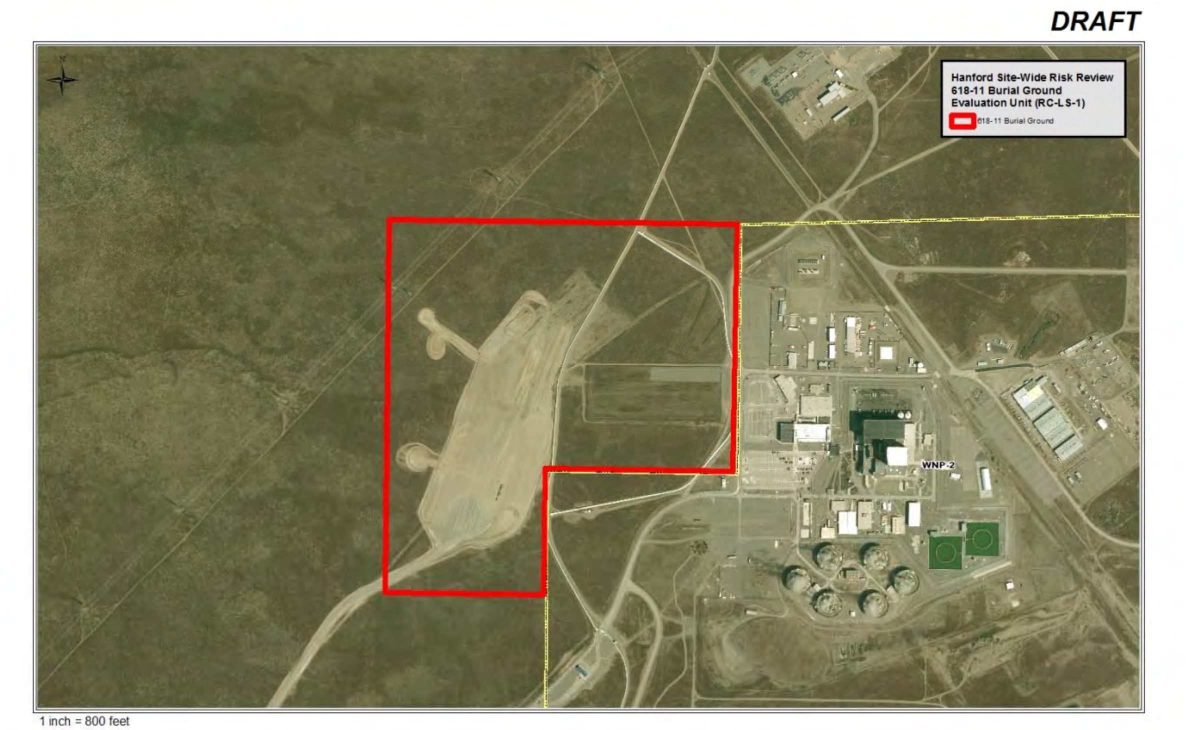

Figure J.1. Site Map with Evaluation Unit Boundaries

RC-LS-1: 618-11 Burial Grounds

Survey and Analysis Methods:

The evaluation process makes use of existing biological resource level maps (DOE/RL-96-32 2013), field surveys and measurement of current vegetation and habitat conditions, and wildlife observations to evaluate potential ecological impacts associated with cleanup activities at the evaluation unit (EU). Additional information used in the ecological evaluation includes the

[1] The Ecological Compliance and Assessment Project (ECAP) database is an evolving set of data that is maintained by Pacific Northwest National Laboratory (PNNL) and updated as new ecological assessments are completed.

current Endangered and Threatened Species (Federal and State) distribution data; priority habitats as defined by Washington Department of Fish and Wildlife; available current aerial imagery, locations of Hanford Unit waste sites and infrastructure spatial data; and available information about species of concern distribution and habitat use in the vicinity of the EUs including data previously collected by PNNL for DOE-RL. Definitions relevant to the methods and ecological survey results are provided at the end of this summary along with field data tables.

The following steps were taken to assess the EU associated with the 618-11 burial ground:

1. The EU boundary (polygon) is assumed to represent the estimated boundary or extent of potential habitat removal and direct disturbance due to remediation.
2. A visual survey was conducted within the EU boundary by experienced shrub-steppe ecologists. PNNL biologists also reviewed the observations and biological survey data available in the Ecological Compliance and Assessment Project (ECAP) database from the past 5 years for the EU to determine the status and resource level of the habitats within the EU and supplement the evaluation with previous wildlife or plant species observations.
3. A second boundary (polygon) outside the EU was established to evaluate indirect effects and assess the remediation in relation to adjacent landscape features. This polygon is centered on the EU and encompasses a circular area with a radius 1 times the maximum width of the EU and is referred to as the **adjacent landscape buffer**.
4. A reconnaissance survey of the boundary of the EU was conducted to confirm the validity of past mapping of biological resources. Aerial imagery from 2012 was reviewed to identify any significant changes in habitat and resource levels (such as new well pads, roads, or other ground disturbance not captured by the available biological resources mapping) within the EU and adjacent landscape buffer. Where significant change is evident from ground survey or imagery, the biological resource map was updated to reflect the change in resource level.
5. The spatial extent of habitat classified at each of 6 resource levels (0 – 5) (DOE/RL-96-32 2013; definitions at end of this summary) within the adjacent landscape buffer area and the EU were assessed and compared using a Geographic Information System (GIS) to examine potential indirect effects on habitat condition within the adjacent landscape. For purposes of assessing indirect effects on the adjacent landscape, this evaluation assumes the maximum potential change in biological resources—that is, all habitat within the EU is assumed to be lost to remediation and cleanup activities and resources in the EU are considered level 0.
6. PNNL biologists assembled the information from field survey, reconnaissance, and spatial analyses of resource availability to provide a subjective evaluation of potential effects on habitat connectivity in the vicinity of the EU.

Field Survey:

Vegetation on the area of the 618-11 Burial Ground within the EU was visually estimated to be composed of approximately 30% to 40% crested wheatgrass (*Agropyron cristatum*), an introduced perennial bunchgrass planted for erosion control, and approximately 10% to 20% Russian thistle (*Salsola tragus*).

Vegetation was measured in habitat patches to the north in a stand dominated by big sagebrush (*Artemisia tridentata*) and gray rabbitbrush (*Ericameria nauseosa*), in grasslands to the west, and south of the burial ground, as well as within the bladed laydown area visible in Figure J.1 to the far west of the burial ground. A summary of these data is provided in Table J.3 and data sheets for the site are included at the end of this summary.

No information was found documenting previous wildlife surveys of the 618-11 Burial Ground. Wildlife species (or their sign) observed during the 16 July 2014 survey include horned lark (*Eremophila alpestris*), loggerhead shrike (*Lanius ludovicianus*), western meadowlark (*Sturnella neglecta*), common raven (*Corvus corax*), unknown hawk (*Buteo* spp.), northern pocket gopher (*Thomomys talpoides*), coyote (*Canis latrans*), and American badger (*Taxidea taxus*).

Table J.3. Percent Canopy Cover and Surface Cover Measured at 618-11 Burial Ground

Vegetation/Surface Cover	618-11 South	618-11 West	618-11 North	Borrow/ Laydown Area
BARE	3.0	30.5	19.3	22.8
CRUST	2.5	4.5	17.6	5.5
LITTER	40.0	29.3	32.4	28.5
Introduced Forb	20.0	14.8	3.7	6.3
Introduced Grass	17.8	15.0	16.1	27.5
Native Forb	2.8	3.8	1.1	-
Native Grass	14.0	2.3	9.7	11.5
Climax Shrubs	-	-	9.6	-
Successional Shrubs	<1	< 1	.3	-

Landscape Evaluation and Resource Classification:

The spatial area of each level of biological resources was evaluated at two scales: 1) within the 618-11 Burial Grounds EU, and 2) within a circular area radiating 1164 m from the geometric center of the site (equivalent to 1052 acres)(Figure J.2).

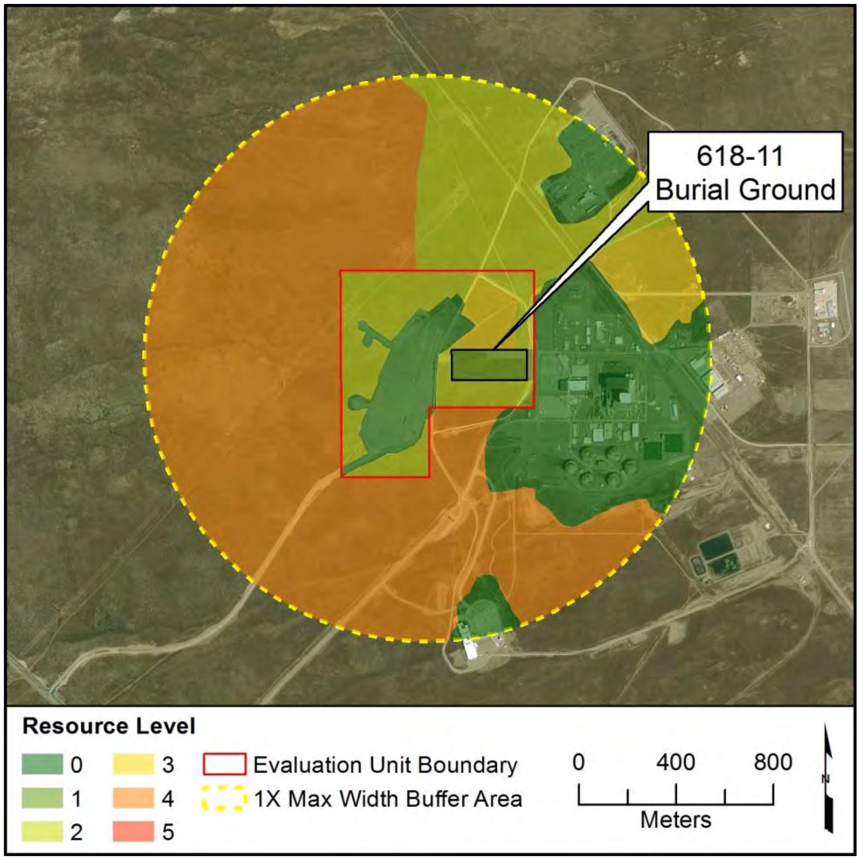

Figure J.2. Map of Biological Resource Level Classifications at the 618-11 Burial Grounds Evaluation Site (red boundary) and Landscape Buffer Area (yellow dashed line boundary)

The EU was originally characterized as containing habitats classified as levels 0, 2, and 4 (DOE/RL-96-32 2013). However, those areas of the EU that were originally classified as level 4 habitat were reclassified in this assessment as level 0 (bladed lay down area to west), and level 2 and 3 habitats based on field observations and data collected during the 16-July 2014 field visit. Resource levels within the landscape buffer area outside the EU were not re-classified for this assessment.

Table J.4 summarizes the areal extent of existing biological resources and potential changes or impacts due to clean-up activities within the landscape buffer area. All resources within the EU are assumed to be lost during cleanup and classified as 0 level habitat for evaluation of post-cleanup conditions.

Table J.4. Area and Proportion of Each Biological Resource Level Within the 618-11 Burial Ground Evaluation Unit in Relation to Adjacent Landscape and Potential Maximum Change in Resources

Resource Level[1]	Evaluation Unit Area (ac)	Adjacent Landscape Buffer (ac)	Combined Total Area (ac)	Percent of Resource Level in Combined Total Area	Percent of Resource Level in Combined Total Area After Cleanup[2]	Percent Difference at Landscape Scale After Cleanup[2]
0	41.4	197.9	239.4	22.7%	31.8%	9.1%
1	11.5	0.0	11.5	1.1%	0.0%	-1.1%
2	70.1	130.6	200.7	19.1%	12.4%	-6.7%
3	13.8	33.3	47.1	4.5%	3.2%	-1.3%
4	0.0	553.6	553.6	52.6%	52.6%	0.0%
5	0.0	0.0	0.0	0.0%	0.0%	0.0%
Total	136.8	915.4	1052.2	100.0%	100.0%	

1 Resource levels for the evaluation unit were reviewed in the field and via imagery during July 2014 and revised to reflect current habitats conditions.

2 Potential maximum change in area of a given resource level within the combined total area (Evaluation Unit + Adjacent Landscape Buffer) that would occur assuming that all habitat within the evaluation unit is destroyed by remediation activities and the resource level of the evaluation unit is level 0.

Assumptions and Uncertainty:

Due to project time constraints, the field surveys and reconnaissance of this EU were conducted in mid-July. By the time of the survey, the cool-season annual and perennial herbaceous plants that dominate shrub-steppe habitat had completed seasonal growth and senesced making identification and inventory difficult and most likely incomplete. Although no records for plant species of concern have been noted, the absence of species cannot be confirmed by surveys during this time of year.

By mid-July, most migratory birds have completed their nesting cycles, and surveys may not reflect their occupancy and use of habitat within the evaluation unit earlier in the season. Their absence cannot be confirmed by surveys in July after the nesting season is over. Further surveys during the nesting season would be required to fully assess the ecological impacts to nesting migratory birds.

Summary of Ecological Review:

- More than half of the EU consists of level 2 (mixed native and non-native grassland) resources. Approximately 13 acres of the EU contain a mixed sagebrush and rabbitbrush stand that qualifies as level 3 habitat, although it is degraded by invasion with non-native grasses and forbs. This area is also adjacent to another operable unit.
- The EU is adjacent and contiguous to a large industrial site— because this industrial area already affects habitat connectivity, cleanup activities inside the EU are not expected to impact habitat connectivity through loss of habitat or fragmentation.
- No species of concern were observed within or in the vicinity of the EU during the 16-July-2014 surveys.
- Approximately 56 % of the total landscape area evaluated (Figure J.2) is classified as level 3 or higher biological resources, which are not expected to be significantly impacted by cleanup actions within the EU.

References

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Definitions and Acronyms:

Adjacent Landscape Buffer – a circular area adjacent to and outside the EU boundary with the center of the circle at the centroid of the EU, and with a radius that is 1 times the maximum dimension (width or length—whichever is greatest). This circular buffer area is used to evaluate indirect effects and assess the remediation in relation to the landscape features and resources adjacent to the EU. This circular area is generally at least 3 times the area of the EU.

Biological Resource Levels (from DOE-RL-96-32-01)

- Level 5 resources include species that are listed or proposed-to-be listed under the *Endangered Species Act* and their critical habitat, as well as rare and irreplaceable habitats.
- Level 4 resources include federal candidate species; Washington State threatened or endangered species; habitat or exclusion buffers for federal candidates and Washington State threatened or endangered species; high-quality mature shrub steppe; wetlands and riparian areas; and buffer areas for bald eagles and ferruginous hawks.
- Level 3 resources include Washington State sensitive, candidate, and review species; Washington Department of Fish and Wildlife priority species; lower quality mature shrub-steppe—such as shrub stands that are less mature, have lower shrub density or canopy cover, and/or a greater proportion of cheatgrass in the understory than stands that qualify for Level 4. Level 3 also includes high-quality grasslands, conservation corridors, snake hibernacula, bat roosts, rookeries, burrowing owl buffer areas, and areas with significant quantities of culturally important species.
- Level 2 resources include migratory birds, state watch list plants and monitor list animals, recreationally and commercially important species, and lower quality steppe and shrub-steppe.
- Level 1 resources include individual common native plant and wildlife species, upland stands of non-native plants, and abandoned agricultural fields.

Evaluation Units (EUs) – groupings of sources, aggregated for evaluation as part of the Hanford Site-wide Risk Review Project. Sources may be aggregated into an EU based on potential impacts to a common set of receptors or receptor geographic area, common past waste management practices, or integration in the waste management process.

MBTA – Migratory Bird Treaty Act; referring to species listed and protected under the federal Act.

PNNL ECAP (Ecological Compliance and Assessment Project) Database – PNNL performed ecological reviews for individual projects and annually surveyed selected areas and buildings on the Hanford Site for DOE-RL under the DOE's Public Safety and Resource Protection Program until 2011. The data collected during those surveys is archived in the ECAP database, and is used to supplement ecological evaluations as available.

Priority Habitats – Priority habitats are habitat types or elements with unique or significant value to a diverse assemblage of species. A priority habitat may consist of a unique vegetation type (e.g., shrub-steppe) or dominant plant species (e.g., juniper savannah), a described successional stage (e.g., old-growth forest), or a specific habitat feature (e.g., cliffs).

Species of Concern or Species of Conservation Concern – An informal term that for the purpose of this assessment includes those species listed at the federal or state level as being threatened endangered, sensitive, or candidate, as well as those listed by the U.S. Fish and Wildlife Service as species of concern within the ecoregion.

Field Data Sheets for the 618-11 Burial Ground

Percent Canopy Cover Visually Estimated in 0.5 m2 quadrats (Q1-Q4)										
Site	Survey Area	Species	Origin & Class	Q1	Q2	Q3	Q4	sum	Mean Canopy Cover	Freq.
618-11	Around Laydown Area	BRTE	IG	18	42	40	10	110	27.5	1
618-11	Around Laydown Area	POSA	NG	14	10	4	18	46	11.5	1
618-11	Around Laydown Area	SAKA	IF	5	4	2	10	21	5.25	1
618-11	Around Laydown Area	TRDU	IF		4			4	1	0.25
618-11	Around Laydown Area	Litter	LITTER	10	30	42	32	114	28.5	1
618-11	Around Laydown Area	Crust	CRUST	4	0	0	18	22	5.5	0.5
618-11	Around Laydown Area	Bare	BARE	59	10	10	12	91	22.75	1
Quantification										
Visual Estimate from Outside Fence for Entire Area										
Site	Survey Area	Species	Origin & Class	Percent Canopy Cover						
618-11	Burial Ground	AGCR	IG	35						
618-11	Burial Ground	SAKA	IF	10						

Percent Canopy Cover Visually Estimated in 0.5 m2 quadrats (Q1-Q4)										
Site	Survey Area	Species	Origin & Class	Q1	Q2	Q3	Q4	sum	Mean canopy cover	Freq.
618-11	South of BG Fence	AGCR	IF					0	0	0
618-11	South of BG Fence	AMAC	NF					0	0	0
618-11	South of BG Fence	OEPA	NF					0	0	0
618-11	South of BG Fence	FEOC	NG					0	0	0
618-11	South of BG Fence	BRTE	IG		18	15	38	71	17.75	0.75
618-11	South of BG Fence	POSA	NG	12	6			18	4.5	0.5
618-11	South of BG Fence	BARE	BARE	7	4	1		12	3	0.75
618-11	South of BG Fence	SAKA	IF		32	40	8	80	20	0.75
618-11	South of BG Fence	MACA	NF					0	0	0
618-11	South of BG Fence	LITTER	LITTER	29	36	42	53	160	40	1
618-11	South of BG Fence	CRUST	CRUST	10				10	2.5	0.25
618-11	South of BG Fence	RUVE	NF	4	4	2	1	11	2.75	1
618-11	South of BG Fence	AMTE	NF					0	0	0
618-11	South of BG Fence	STCO	NG	38				38	9.5	0.25

Percent Canopy Cover Visually Estimated in 0.5 m2 quadrats (Q1-Q4)										
Site	Survey Area	Species	Origin & Class	Q1	Q2	Q3	Q4	sum	Mean Canopy Cover	Freq.
618-11	West of Burial Ground	AGCR	IF	14				14	3.5	0.25
618-11	West of Burial Ground	AMAC	NF	4				4	1	0.25
618-11	West of Burial Ground	OEPA	NF	2				2	0.5	0.25
618-11	West of Burial Ground	FEOC	NG	1				1	0.25	0.25
618-11	West of Burial Ground	BRTE	IG	4	10	32	14	60	15	1
618-11	West of Burial Ground	POSA	NG	1	3		4	8	2	0.75
618-11	West of Burial Ground	BARE	BARE	74	30	4	14	122	30.5	1
618-11	West of Burial Ground	SAKA	IF		10	16	19	45	11.25	0.75
618-11	West of Burial Ground	MACA	NF		3		1	4	1	0.5
618-11	West of Burial Ground	LITTER	LITTER		32	40	45	117	29.25	0.75
618-11	West of Burial Ground	CRUST	CRUST		12	4	2	18	4.5	0.75
618-11	West of Burial Ground	RUVE	NF			4		4	1	0.25
618-11	West of Burial Ground	AMTE	NF				1	1	0.25	0.25

Percent Canopy Cover Visually Estimated in 0.5 m2 quadrats (Q1-Q7)														
Site	PatchLoc	Species	Origin & Class	Q1	Q2	Q3	Q4	Q5	Q6	Q7	sum	Mean canopy cover	Freq.
618-11	N of Burial Ground	PLPA	NF	7							7	1.0	0.25
618-11	N of Burial Ground	BRTE	IG	6	30	20	20	35		2	113	16.1	1.5
618-11	N of Burial Ground	SAKA	IF	1	16			6	1	2	26	3.7	1.25
618-11	N of Burial Ground	POSA	NG	8		6	14	1	3	14	46	6.6	1.5
618-11	N of Burial Ground	Litter	LITTER	30	40	30	56	58	9	4	227	32.4	1.75
618-11	N of Burial Ground	Crust	CRUST	48	14	22	8		5	26	123	17.6	1.5
618-11	N of Burial Ground	STCO	NG			22					22	3.1	0.25
618-11	N of Burial Ground	Bare	BARE				2		82	51	135	19.3	0.75
618-11	N of Burial Ground	ERUI	NF							1	1	0.1	0.25

Line Intercept Measurement of Shrub Canopy Cover						
Site	Survey Area	Species	Transect distance (tota	Start	Stop	Dif
618-11	North Patch, West End of Burial Ground	Artr	100	2	3.55	1.55
618-11	North Patch, West End of Burial Ground	Artr	100	6.6	8	1.4
618-11	North Patch, West End of Burial Ground	Artr	100	16.15	16.7	0.55
618-11	North Patch, West End of Burial Ground	Artr	100	25.2	26.75	1.55
618-11	North Patch, West End of Burial Ground	Artr	100	71.8	74.3	2.5
618-11	North Patch, West End of Burial Ground	Artr	100	78.05	79.55	1.5
618-11	North Patch, West End of Burial Ground	Artr	100	88.3	88.85	0.55
618-11	North Patch, West End of Burial Ground	Chna	100	91.7	92	0.3
						9.9

Evaluation Unit:	K Area Waste Sites
ID:	RC-LS-2
Group:	Legacy Source
Operable Unit Cross-Walk:	100-KR-1 100-KR-2
Related EU:	RC-DD-2
Sites & Facilities:	Legacy waste sites within the fence at 100-K, where remediation is post-2015
Key Data Sources Docs:	DOE/RL-96-32 2013 PNNL ECAP Database[2]
Field Survey Date:	10/16/2014
Data Sheet Prepared By:	JLD, KBL, SAM, KDH; 10/23/2013

Figure J.3. Site Map with Evaluation Unit Boundaries

RC-LS-2: K Area Waste Sites

Survey and Analysis Methods:

The evaluation process makes use of existing biological resource level maps (DOE/RL-96-32 2013), field surveys and measurement of current vegetation and habitat conditions, and wildlife observations to evaluate potential ecological impacts associated with cleanup activities at the evaluation unit (EU). Additional information used in the ecological evaluation includes the current Endangered and Threatened Species (Federal and State) distribution data; priority

[2] The Ecological Compliance and Assessment Project (ECAP) database is an evolving set of data that is maintained by Pacific Northwest National Laboratory (PNNL) and updated as new ecological assessments are completed.

habitats as defined by Washington Department of Fish and Wildlife; available current aerial imagery, locations of Hanford Unit waste sites and infrastructure spatial data; and available information about species of concern distribution and habitat use in the vicinity of the EUs including data previously collected by PNNL for DOE-RL. Definitions relevant to the methods and ecological survey results are provided at the end of this summary along with field data tables.

The following steps were taken to assess the EU associated with the K Area Waste Sites:

1. The EU boundary (polygon) is assumed to represent the estimated boundary or extent of potential habitat removal and direct disturbance due to remediation.
2. A visual survey was conducted within the EU boundary by experienced shrub-steppe ecologists. Because the unit consists of primarily of unvegetated industrial and graveled surfaces and buildings, no field measurements of vegetation were taken, but canopy cover and surface condition were estimated visually in one level 2 resource area. PNNL biologists also reviewed the observations and biological survey data available in the Ecological Compliance and Assessment Project (ECAP) database from the past 5 years for the EU to determine the status and resource level of the habitats within the EU and supplement the evaluation with previous wildlife or plant species observations.
3. A second boundary (polygon) outside the EU was established to evaluate indirect effects and assess the remediation in relation to adjacent landscape features. This polygon is centered on the EU and encompasses a circular area with a radius 1 times the maximum width of the EU and is referred to as the **adjacent landscape buffer**.
4. A reconnaissance survey of the boundary of the EU was conducted to confirm the validity of past mapping of biological resources. Aerial imagery from 2012 was reviewed to identify any significant changes in habitat and resource levels (such as new well pads, roads, or other ground disturbance not captured by the available biological resources mapping) within the EU and adjacent landscape buffer. Where significant change is evident from ground survey or imagery, the biological resource map was updated to reflect the change in resource level.
5. The spatial extent of habitat classified at each of 6 resource levels (0 – 5) (DOE/RL-96-32 2013; definitions at end of this summary) within the adjacent landscape buffer area and the EU were assessed and compared using a Geographic Information System (GIS) to examine potential indirect effects on habitat condition within the adjacent landscape. For purposes of assessing indirect effects on the adjacent landscape, this evaluation assumes the maximum potential change in biological resources—that is, all habitat within the EU is assumed to be lost to remediation and cleanup activities and resources in the EU are considered level 0.
6. PNNL biologists assembled the information from field survey, reconnaissance, and spatial analyses of resource availability to provide a subjective evaluation of potential effects on habitat connectivity in the vicinity of the EU.

Field Survey:

Field evaluation of the 100-K Area Waste Sites EU revealed that most of the EU consists of built infrastructure, roads, parking lots, buildings, with small fragments of habitat to the north of the two reactors. Much of the surrounding area has been revegetated after cleanup of waste areas and trenches outside the 100-K fence lines. Installation of numerous pump and treat wells, well pads, buildings and transfer pipes has occurred both within and outside the EU.

No observations of wildlife were made during the October 16, 2014 survey of the EU. However, a PNNL ECAP review of the 100-K Area and buildings done in 2010 is included at the end of this summary. Numerous birds were noted in association with the buildings and structures that existed within the EU at that point in time. Since then, clean up and decommissioning activities may have removed much of the infrastructure that previously was used as nesting and perching habitat.

Table J.5. Percent Canopy Cover and Surface Cover Visually Estimated in Level 2 Resource Area within the K Area Waste Sites Evaluation Unit

Vegetation/Surface Cover	Slope to the North of Reactors (%)
Introduced Forb	2
Introduced Grass	5
Native Forb	<1
Native Grass	30
Successional Shrubs	15

Landscape Evaluation and Resource Classification:

Approximately 89% of the area within EU is classified as level 0 or level 1 biological resources (Table J.6, Figure J.4). A small hillslope north of the reactors is classified as level 2 resources (Figure J.5). The level 4 resources within the EU reflect a restricted use buffer area for the bald eagle (*Haliaeetus leucocephalus*) roosting site to the northwest of the 100-K Area along the river and do not consist of any habitat resources.

The amount and proximity of biological resources to the 100-K Waste Sites EU was examined within the adjacent landscape buffer area radiating 1,396 m from the geometric center of the EU (equivalent to 1,286 acres). Note that within the landscape buffer area, obvious areas where vegetation was cleared or removed were reclassified as level 0 resources. Numerous areas within the adjacent landscape buffer had been revegetated with varying degrees of success; these areas were not reclassified, but retain the original biological resource level assigned in DOE/RL-96-32 2013. The adjacent landscape buffer area extends across the Columbia River shoreline and into the riverine habitat. Level 4 resource patches along the river shoreline and in the river reflect the riparian habitat along the shoreline and a small patch of level 5 habitat in the river reflects a known spawning location for Fall Chinook salmon (*Oncorhynchus tshawytscha).*

Table J.6. Area and Proportion of Each Biological Resource Level Within the Evaluation Unit in Relation to Adjacent Landscape and Potential Maximum Change in Resources

Resource Level[1]	Evaluation Unit Area (ac)	Adjacent Landscape Buffer (ac)	Combined Total Area (ac)	Percent of Resource Level in Combined Total Area	Percent of Resource Level in Combined Total Area After Cleanup[2]	Percent Difference at Landscape Scale After Cleanup[2]
0	195.7	15.0	210.7	13.9%	15.9%	2.0%
1	5.4	0.0	5.4	0.4%	0.0%	-0.4%
2	5.9	269.3	275.2	18.2%	17.8%	-0.4%
3	0.2	158.0	158.2	10.5%	10.5%	0.0%
4	17.9	842.8	860.7	56.9%	55.8%	-1.2%
5	0.0	1.1	1.1	0.1%	0.1%	0.0%
Total	225.1	1286.2	1511.4	100.0%	100.0%	

1 Resource levels for the evaluation unit were reviewed in the field and via imagery during October 2014 and revised to reflect current habitats conditions.

2 Potential maximum change in area of a given resource level within the combined total area (Evaluation Unit + Adjacent Landscape Buffer) that would occur assuming that all habitat within the evaluation unit is destroyed by remediation activities and the resource level of the evaluation unit is level 0.

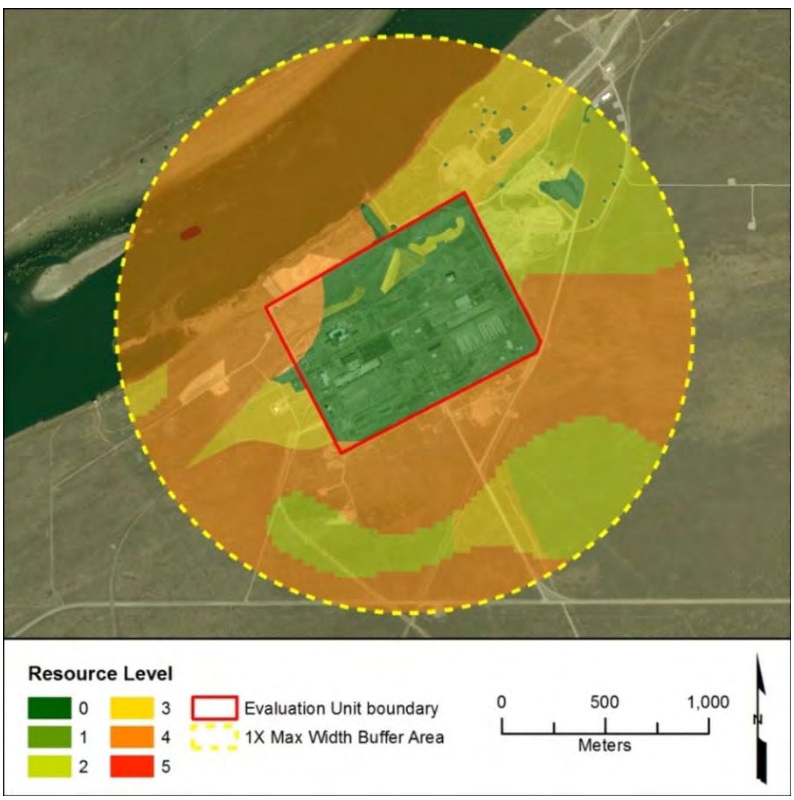

Figure J.4. Biological Resource Level Classifications Based on October 2014 Surveys for the K Area Waste Sites Evaluation Unit (red solid line) and the Adjacent Landscape Buffer (yellow dashed line)

Figure J.5. Condition of Landscape on the Slope North of the 100-K Area Reactors in October 2014

Assumptions and Uncertainty:

Due to project time constraints, the field surveys and reconnaissance of this EU were conducted in October. By the time of the survey, the cool-season annual and perennial herbaceous plants that dominate shrub-steppe habitat had completed seasonal growth and senesced making identification and inventory difficult and most likely incomplete. Although no records for plant species of concern have been noted, the absence of species cannot be confirmed by surveys during this time of year.

By October, migratory birds have completed their nesting cycles, and most have migrated out of the region. Surveys conducted in late fall will not reflect their occupancy and use of habitat within the EU earlier in the season. Their absence cannot be confirmed by surveys October after the nesting season is over. Further surveys during the nesting season would be required to fully assess the ecological impacts to nesting migratory birds.

Summary of Ecological Review:

- Most of the K Waste Sites EU (nearly 90% of the area) has been disturbed or consists of buildings, roadways, parking areas, and infrastructure that are classified as level 0 or level 1 habitat.
- Level 4 resources within the EU reflect the bald eagle roost site buffer area (~400 m diameter) that extends into the EU. Noise and construction activities associated with clean-up activities within 400 m of the roost site could potentially influence eagle use of the roost, during the seasonal use period when eagles are present along the river.
- Because most of the EU is disturbed, and remaining habitat within the unit is not contiguous with the adjacent landscape, the loss of habitat resources within the K Waste Sites evaluation unit would not be expected to negatively impact habitat connectivity at the landscape level.

References

DOE/RL-96-32. 2013. Hanford Site Biological Resources Management Plan, Revision 0.

U.S. Fish and Wildlife Service (USFWS). 2014. Birds Protected by the Migratory Bird Treaty Act. http://www.fws.gov/migratorybirds/RegulationsPolicies/mbta/mbtintro.html

U.S. Fish and Wildlife Service (USFWS). 2014. Environmental Conservation Online System, Listings and Occurrences for Washington. http://ecos.fws.gov/tess_public/pub/stateListingAndOccurrenceIndividual.jsp?state=WA&s8fid=112761032792&s8fid=112762573902

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Washington State Department of Natural Resources. 2014. Washington Natural Heritage Program Plant Ranks. http://www1.dnr.wa.gov/nhp/refdesk/lists/plantrnk.html

Definitions and Acronyms:

Adjacent Landscape Buffer – a circular area adjacent to and outside the EU boundary with the center of the circle at the centroid of the EU, and with a radius that is 1 times the maximum dimension (width or length—whichever is greatest). This circular buffer area is used to evaluate indirect effects and assess the remediation in relation to the landscape features and resources adjacent to the EU. This circular area is generally at least 3 times the area of the EU.

Biological Resource Levels (from DOE-RL-96-32-01) –

- Level 5 resources include species that are listed or proposed-to-be listed under the *Endangered Species Act* and their critical habitat, as well as rare and irreplaceable habitats.
- Level 4 resources include federal candidate species; Washington State threatened or endangered species; habitat or exclusion buffers for federal candidates and Washington State threatened or endangered species; high-quality mature shrub steppe; wetlands and riparian areas; and buffer areas for bald eagles and ferruginous hawks.
- Level 3 resources include Washington State sensitive, candidate, and review species; Washington Department of Fish and Wildlife priority species; lower quality mature shrub-steppe—such as shrub stands that are less mature, have lower shrub density or canopy cover, and/or a greater proportion of cheatgrass in the understory than stands that qualify for Level 4. Level 3 also includes high-quality grasslands, conservation corridors, snake hibernacula, bat roosts, rookeries, burrowing owl buffer areas, and areas with significant quantities of culturally important species.
- Level 2 resources include migratory birds, state watch list plants and monitor list animals, recreationally and commercially important species, and lower quality steppe and shrub-steppe.
- Level 1 resources include individual common native plant and wildlife species, upland stands of non-native plants, and abandoned agricultural fields.

Evaluation Units (EUs) – groupings of sources, aggregated for evaluation as part of the Hanford Site-wide Risk Review Project. Sources may be aggregated into an EU based on potential impacts to a common set of receptors or receptor geographic area, common past waste management practices, or integration in the waste management process.

MBTA – Migratory Bird Treaty Act; referring to species listed and protected under the federal Act.

PNNL ECAP (Ecological Compliance and Assessment Project) Database – PNNL performed ecological reviews for individual projects and annually surveyed selected areas and buildings on the Hanford Site for DOE-RL under the DOE's Public Safety and Resource Protection Program until 2011. The data collected during those surveys is archived in the ECAP database, and is used to supplement ecological evaluations as available.

Priority Habitats – Priority habitats are habitat types or elements with unique or significant value to a diverse assemblage of species. A priority habitat may consist of a unique vegetation type (e.g., shrub-steppe) or dominant plant species (e.g., juniper savannah), a described successional stage (e.g., old-growth forest), or a specific habitat feature (e.g., cliffs).

Species of Concern or Species of Conservation Concern – An informal term that for the purpose of this assessment includes those species listed at the federal or state level as being threatened endangered, sensitive, or candidate, as well as those listed by the U.S. Fish and Wildlife Service as species of concern within the ecoregion.

PNNL ECAP Review of the 100-K Buildings in 2010

Pacific Northwest
NATIONAL LABORATORY

Tel: (509) 371-7187
Fax: (509) 371-7160
michael.sackschewsky@pnl.gov

May 18, 2010

Mr. Brett Barnes
CH2M Hill Plateau Remediation
P.O. Box 1600, MSIN X4-01
Richland, WA 99352

Dear Mr. Barnes:

BLANKET BIOLOGICAL REVIEW OF100-K AREA MAINTENANCE AND OPERATION ACTIVITIES; 100-K AREA; ECR #2010-100-073

Project Description:

This blanket biological review covers all routine maintenance and operations activities for buildings and facilities within the fenced boundary of the 100-K Area. Also included is coverage for continued use of existing lay-down yards, debris/soil piles, and queues adjacent to the KW and KE Sedimentation Basins and overburden storage and queue areas in the north-central and northeast regions of the site (Figure 1). This review does not apply to the demolition/removal or construction/installation of buildings, except that ongoing demolition of 1706KE, 1706KEL, 1706KER, 183.1KW, and 183.7KW is allowed under this letter. This review does not apply to any work outside of the 100-K fence. This letter may be used as a reference for NEPA CX checklists and for support for excavation permits within the area of coverage.

Survey Objectives:

To determine the occurrence in the project area of plant and animal species protected under the Endangered Species Act (ESA), candidates for such protection, and species listed as threatened, endangered, candidate, sensitive, or monitor by the state of Washington, and species protected under the Migratory Bird Treaty Act (MBTA).

To evaluate and quantify the potential impacts of disturbance on priority habitats and protected plant and animal species identified in the survey.

Mr. Brett Barnes
2010-100-073
Page 2 of 6

Survey Methods:

Pedestrian and ocular reconnaissance of the 100-K area was conducted by K. Hand and M. Chamness on May 7, 2010.

Priority habitats and species of concern are documented in Washington Department of Fish and Wildlife (2009a, 2009b), and Washington State Department of Natural Resources (2009). Lists of animal and plant species considered Endangered, Threatened, Proposed, or Candidate by the U.S. Fish and Wildlife Service are maintained at 50 CFR 17.11 and 50 CFR 17.12; the list of birds protected under the MBTA is maintained at 50 CFR 10.13.

Survey Results:

Most of the area within the 100-K boundary fence is highly disturbed with substrate consisting primarily of compacted gravel. Vegetation consists primarily of widely scattered weedy species, with most of the area having essentially no vegetation. An exception is 116-KW-3 (an approximately 2.6 hectare area in the northwest corner of the site) which has been remediated and is characterized by Sandberg's bluegrass (*Poa secunda*), and bluebunch wheatgrass (*Pseudoroegneria spicata*).

The following migratory bird activity was observed. Nest sites active at the time of the survey are underlined.

- **105KE** -Two common ravens (*Corvus corax*) searching within the exposed north side.
  -One inactive common raven nest on a catwalk on the west side.
  -<u>One active Say's phoebe (*Sayornis saya*) nest inside a propped-open door at the southeast corner.</u>

- **105KW** -<u>One active house finch (*Carpodacus mexicanus*) nest behind the light above Door 607 on the north side.</u>
  -A pair of house finches perched on the west side.
  -One inactive western kingbird (*Tyrannus verticalis*) nest on a pipe bracket on the northeast corner.

- **115KE** -One Say's phoebe perched on the roof on the northeast corner.

- **142K** -Two inactive house finch nests; one on a pipe bracket on the west side and one behind an alarm box on the east side.

- **151KE (Substation)** -Two house finches perched within the structure.

Mr. Brett Barnes
2010-100-073
Page 3 of 6

- **151KW (Substation)** -One house finch perched within the structure.
- **1720K** -One American robin (*Turdus migratorius*) flushed from a dead tree at the southeast corner.
  -One western kingbird perched on the fence on the south side.
  -One killdeer (*Charadrius vociferous*) flying past the south side.
- **151K (Substation)** -A pair of house finches perched within the structure.
- **181KE** -One California quail (*Callipepla californica*) perched on the fence on the east side.
  -Ten inactive cliff swallow (*Hirundo pyrrhonota*) nests under building overhangs.
- **181KW** -One American robin perched on a nearby fence.
  -Two black-billed magpies (*Pica pica*) hunting among beams on the south side.
  -Several inactive cliff swallow nests under building overhangs.
  -One California quail near the building.
- **183KE** -Two inactive house finch nests under a wooden eave at the northwest corner.
- **183KE (Storage Conexes)** -One active house finch nest in a southeast conex corner.
  -Two Say's phoebes perched on a fence on the south side.
  -One western kingbird perched on a fence on the south side.
- **183.1KE** -One black-billed magpie perched adjacent to the tanks on the south side.
- **183.2KE & 183.3KE** -Over 30 active cliff swallow nests underneath walkways and beams throughout the structure.
  -Several barn swallows (*Hirundo rustica*) and probable nests underneath walkways and beams on the south side.
  -One common raven flying over the structure.
- **190KW** -Two black-billed magpies near the building.
- **MO-237** -One inactive house finch nest in a porch eave at the southwest corner.

- **MO-293** -One white-crowned sparrow (*Zonotrichia leucophrys*) on the ground near the building.

- An active bee hive was observed on vent pipe/catwalk on the west side of 105KW.

- No migratory birds or nests were observed at the time of the survey on the following buildings or structures:

  111KE (Bottle Dock), 115KW, 116KE, 116KW, 117KE, 117KW, 118KE, 118KW, 119KW, 142KA, 1506K1, 166KE, 166KE (Blue Shed), 166KW, 167K, 1705KE, 1713KW, 1714KW, 1717K, 1724K, 1724KA, 183.5KE, 183.6KE, 185K, 1908K, 1908KE, 190KE, MO-054, MO-079, MO-087, MO-236, MO-323, MO-442, MO-500, MO-506, MO-507, MO-806, MO-872, MO-880, MO-917, MO-955, MO-1101, MO-1102, MO-1103, MO-1104, MO-1105, MO-1106, MO-1107, MO-1108, MO-1109, MO-1110, MO-1111, MO-1112, MO-1115, MO-1301, MO-1302, MO-1303, and MO-1501

- Numerous European starling (*Sturnus vulgaris*), house sparrow (*Passer domesticus*) and rock pigeon (*Columba livia*) birds or nests were observed throughout the 100-K Area. These species are not protected under the MBTA.

Considerations and Recommendations:

No plant or animal species protected under the ESA, candidates for such protection, or species listed by the Washington state government as threatened or endangered were observed within the 100-K perimeter fence.

Several species of migratory birds were observed within the 100-K Area (as listed in the Survey Results section). These species are afforded protection under the MBTA, which makes it illegal to take, capture, or kill, as applicable, any migratory bird, or any part, nest or egg of such bird. In locations containing active nests work activities should be postponed until after the young have fledged. Specifically, it is recommended that the door at the southeast corner of 105KE be left propped open and undisturbed until the Say's phoebe nest has fledged. Please contact M. R. Sackschewsky at 371-7187 for assistance in determining nest status as necessary.

Although many buildings and structures had no nests or had inactive nests at the time of the survey, the breeding season of local migratory birds extends through mid-July and the status of nesting activity can change quickly. Gravel substrates common throughout the 100-K Area may provide potential nesting habitat for ground-nesting migratory birds (e.g., killdeer) and buildings may provide potential nesting habitat for numerous structure-nesting birds (e.g. American robin, barn swallow, black-billed magpie, cliff swallow, common raven, house finch, Say's phoebe, western kingbird).

Mr. Brett Barnes
2010-100-073
Page 5 of 6

Project staff should be advised to check for bird activity on ground surfaces and structures prior to initiating work tasks. If any active nests or birds exhibiting defensive behaviors (flying at workers, refusal to leave area, strident vocalizations) are encountered during work, please contact M. R. Sackschewsky for further consultation.

It is recommended that all entrances (e.g. doorways, window, holes, cracks) to buildings be maintained in a closed or sealed condition (except the 105KE southeast door) to prevent birds from entering and establishing nests in building interiors.

For non-routine activities such as excavation, building construction, and building demolition (except those buildings already exempted as listed in the Project Description section) or for activities within the re-vegetated 116-KW-3 area, please request support from the PNNL Ecological Monitoring and Compliance staff to initiate project-specific biological reviews.

Assuming compliance with the above recommendations, no adverse impacts to species or habitats are expected to occur from routine operation and maintenance activities within the 100-K Area.

This Ecological Compliance Review is valid until April 15, 2011.

Sincerely,

Mickie Chamness for

Michael R. Sackschewsky
Compliance Assessment Manager
Ecological Monitoring and Compliance Project

LB:mrs
kdh

Mr. Brett Barnes
2010-100-073
Page 6 of 6

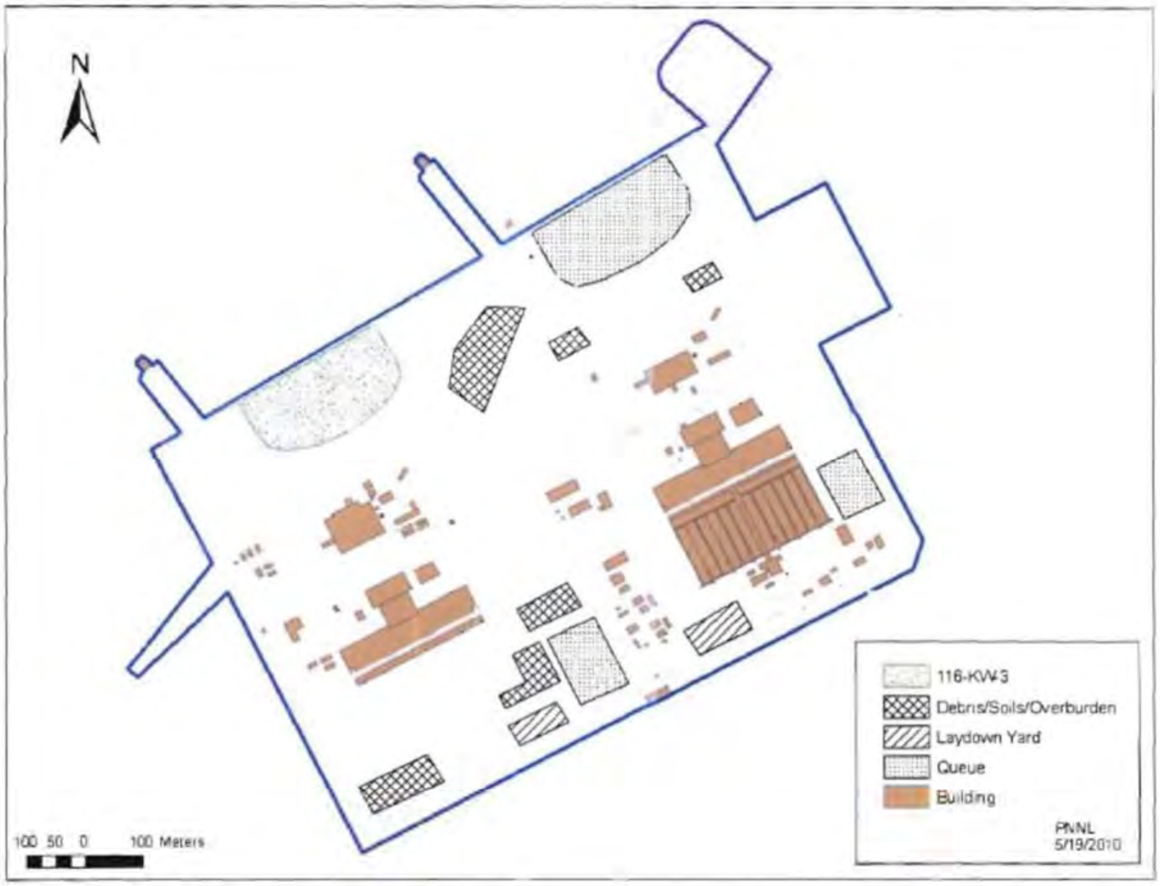


Figure 1. 100-K Area

REFERENCES

Washington Department of Fish and Wildlife. 2009a. Species of Concern in Washington State. http://wdfw.wa.gov/wlm/diversty/soc/soc.htm

Washington Department of Fish and Wildlife. 2009b. Priority Habitats and Species List. WDFW web site. http://wdfw.wa.gov/hab/phspage.htm

Washington Department of Natural Resources. 2009. Washington Natural Heritage Information System Plant Ranks. http://www1.dnr.wa.gov/nhp/refdesk/plants.html

Field Data Collected for 100-K Area Waste Sites EU on October 16, 2014

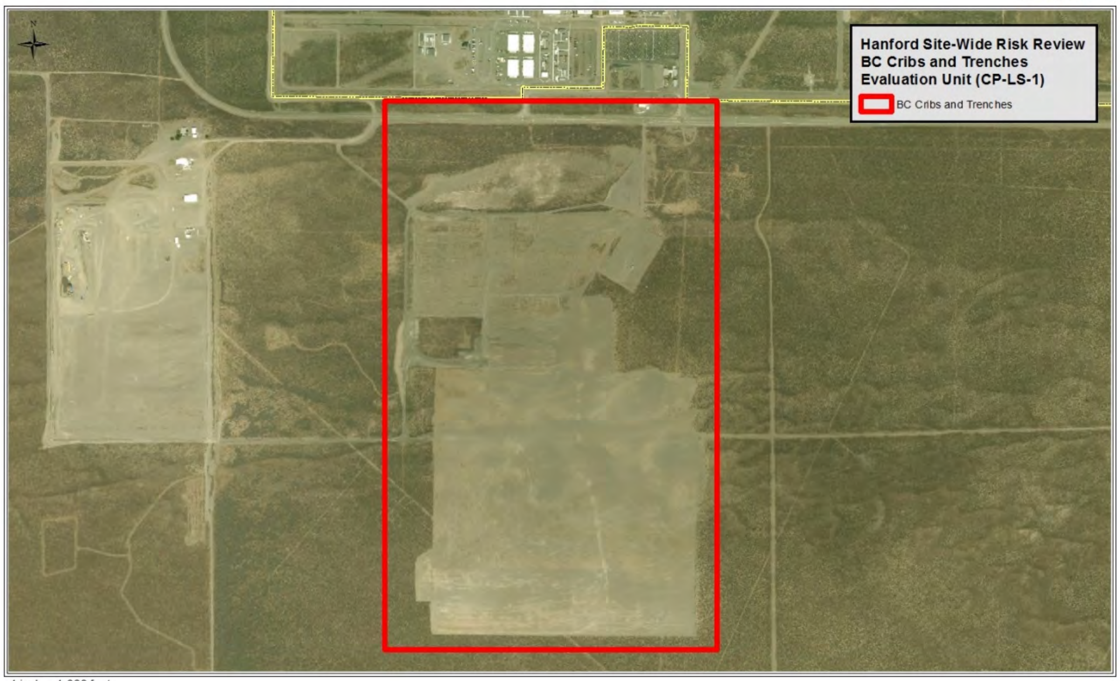
Percent Canopy Cover of Herbaceous Species Measured in 0.5 m2 quadrats

EU	Survey Area	Species	Origin & Class	Percent Cover
100K Waste Site	Hillside	AGSP/PSSP	NG	30
100K Waste Site	Hillside	CHNA	NS	15
100K Waste Site	Hillside	MACA	NF	<1
100K Waste Site	Hillside	BRTE	IG	5
100K Waste Site	Hillside	SATR	IF	2

Notes: Level 0 above Reactor. Photos 26 & 27 Reveg on East SATR & ARTR. Photo 28 Reveg to South of fence by main entrance. Photo 23 looki
and photo 25 from SE corner of fence looking North.

Evaluation Unit: BC Cribs and Trenches
ID: CP-LS-1
Group: Legacy Source
Operable Unit Cross-Walk: 200-BC-1
Related EU: CP-LS-17
CP-GW-1
Sites & Facilities: Cribs, trenches and tanks located to the south of the 200-E area
Key Data Sources Docs: DOE/RL-96-32 2013
PNNL ECAP Database[3]
Field Survey Date: 7/16/2014
Data Sheet prepared by: KBL 10/6/2014

DRAFT



1 inch = 1,000 feet

Figure J.6. Site Map with Evaluation Unit Boundaries

CP-LS-1: BC Cribs and Trenches

Survey and Analysis Methods:

The evaluation process makes use of existing biological resource level maps (DOE/RL-96-32 2013), field surveys and measurement of current vegetation and habitat conditions, and wildlife observations to evaluate potential ecological impacts associated with cleanup activities at the evaluation unit (EU). Additional information used in the ecological evaluation includes the current Endangered and Threatened Species (Federal and State) distribution data; priority

[3] The Ecological Compliance and Assessment Project (ECAP) database is an evolving set of data that is maintained by Pacific Northwest National Laboratory (PNNL) and updated as new ecological assessments are completed.

habitats as defined by Washington Department of Fish and Wildlife; available current aerial imagery, locations of Hanford Site waste sites and infrastructure spatial data; and available information about species of concern distribution and habitat use in the vicinity of the evaluation units including data previously collected by PNNL for DOE-RL. Definitions relevant to the methods and ecological survey results are provided at the end of this summary along with field data tables.

The following steps were taken to assess the evaluation unit associated with the BC-Cribs and Trenches:

1. The evaluation unit boundary (polygon) is assumed to represent the estimated boundary or extent of potential habitat removal and direct disturbance due to remediation.
2. A visual survey was conducted within the evaluation unit boundary by experienced shrub-steppe ecologists. Because the unit consists of disturbed and revegetated areas and graveled surfaces, no field measurements of vegetation were taken. PNNL biologists also reviewed the observations and biological survey data available in the (Ecological Compliance and Assessment Project) ECAP database from the past 5 years for the evaluation unit to determine the status and resource level of the habitats within the evaluation unit and supplement the evaluation with previous wildlife or plant species observations.
3. A second boundary (polygon) outside the evaluation unit was established to evaluate indirect effects and assess the remediation in relation to adjacent landscape features. This polygon is centered on the evaluation unit and encompasses a circular area with a radius 1 times the maximum width of the evaluation unit and is referred to as the **adjacent landscape buffer**.
4. A reconnaissance survey of the boundary of the evaluation unit was conducted to confirm the validity of past mapping of biological resources. Aerial imagery from 2012 was reviewed to identify any significant changes in habitat and resource levels (such as new well pads, roads, or other ground disturbance not captured by the available biological resources mapping) within the evaluation unit and adjacent landscape buffer. Where significant change is evident from ground survey or imagery, the biological resource map was updated to reflect the change in resource level.
5. The spatial extent of habitat classified at each of 6 resource levels (0 – 5) (DOE/RL-96-32 2013; definitions at end of this summary) within the adjacent landscape buffer area and the evaluation unit were assessed and compared using a Geographic Information System (GIS) to examine potential indirect effects on habitat condition within the adjacent landscape. For purposes of assessing indirect effects on the adjacent landscape, this evaluation assumes the maximum potential change in biological resources—that is, all habitat within the evaluation unit is assumed to be lost to remediation and cleanup activities and resources in the evaluation unit are considered level 0.

6. PNNL biologists assembled the information from field survey, reconnaissance, and spatial analyses of resource availability to provide a subjective evaluation of potential effects on habitat connectivity in the vicinity of the evaluation unit.

Field Survey:

Reconnaissance of the BC Cribs and Trenches evaluation unit indicated that most of the EU currently consists of non-vegetated areas, heavily disturbed or revegetated areas, and compacted gravel areas (i.e., level 0 resources; Table J.8). A portion of this area that was previously classified as level 3 and 4 (approximately 153 acres) was reclassified as level 0 for this assessment to reflect current vegetation conditions (Figure J.7 and Figure J.8). Habitat around the level 0 resources in the disturbed area of the evaluation unit consists of level 3 and 4 resources along the boundary of the evaluation unit. These patches are contiguous with the adjacent landscape, but no pedestrian surveys or field data collection were attempted in these areas because this waste site and evaluation unit lie within a radiological control area. A project review letter summarizing data collected within the evaluation unit boundary in 2008 and 2009 is included at the end of this summary to provide information on habitat quality in the remaining level 3 and level 4 resources.

Figure J.8 shows the condition of the area where revegetation was attempted and failed, resulting in scattered cover of Russian thistle (*Salsola tragus)* and scurf pea (*Psoralea lanceolata*) across the southern portion of the EU.

Table J.7. Percent Canopy Cover and Surface Cover Measured at BC Cribs and Trenches

No field measurements of vegetation were taken; visual and pedestrian survey of the evaluation unit consists mainly of graveled pads, disturbed and bare soils (cover > 80%) and scattered Russian thistle and scurf pea growing in failed revegetation areas.

Landscape Evaluation and Resource Classification:

The amount of each category of biological resources at the BC Cribs and Trenches EU was examined within a circular area radiating 1830 m from the geometric center of the unit (equivalent to 2598 acres). Approximately 71 percent of the total combined area (evaluation unit and associated adjacent landscape) is classified as level 3 or higher biological resources in the existing resource level map. However, the majority of the level 3 and level 4 resources lie to outside of the evaluation unit boundary (Figure J.7).

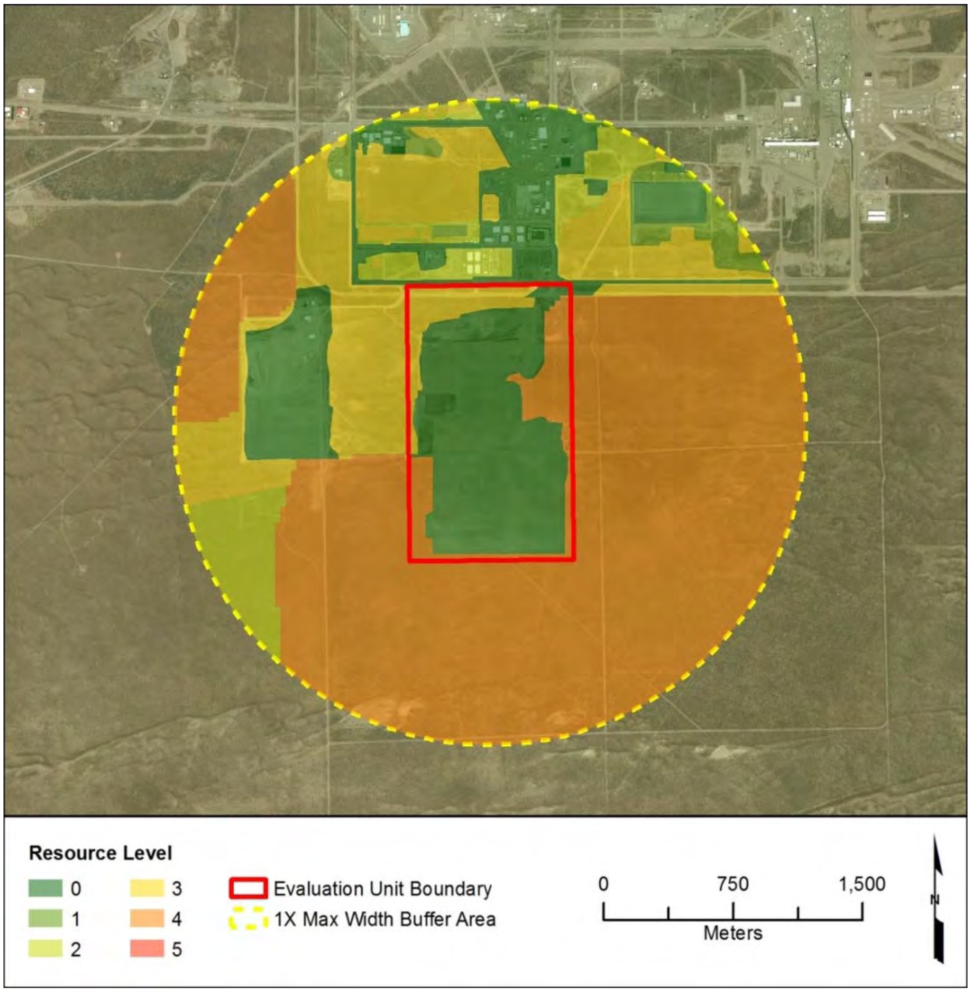


Figure J.7. Map of Biological Resource Level Classifications for the BC Cribs and Trenches Evaluation Unit Based on July 2014 Pedestrian and Vehicle Survey (red boundary) and Reconnaissance of the Adjacent Landscape Buffer (yellow dashed line)

Table J.8. Area and Proportion of Each Biological Resource Level Within the Evaluation Unit in Relation to Adjacent Landscape and Potential Maximum Change in Resources

Resource Level[1]	Evaluation Unit Area (ac)	Adjacent Landscape Buffer (ac)	Combined Total Area (ac)	Percent of Resource Level in Combined Total Area	Percent of Resource Level in Combined Total Area After Cleanup[2]	Percent Difference at Landscape Scale After Cleanup[2]
0	255.9	294.7	550.6	21.2%	25.5%	4.3%
1	0.0	52.1	52.1	2.0%	2.0%	0.0%
2	0.0	163.2	163.2	6.3%	6.3%	0.0%
3	41.5	429.0	470.5	18.1%	16.5%	-1.6%
4	69.6	1292.5	1362.1	52.4%	49.7%	-2.7%
5	0.0	0.0	0.0	0.0%	0.0%	0.0%
Total	367.0	2231.5	2598.5	100.0%	100.0%	-

[1] Resource levels for both the evaluation unit and adjacent landscape boundary were reviewed in the field and via imagery during July 2014 and revised to reflect current habitats conditions.

[2] Potential maximum change in area of a given resource level within the combined total area (Evaluation Unit + Adjacent Landscape Buffer) that would occur assuming that all habitat within the evaluation unit is destroyed by remediation activities and the resource level of the evaluation unit is level 0.

Figure J.8. Photograph of Disturbed/Revegetated Area within the BC Cribs and Trenches Evaluation Unit

Summary of Ecological Review:

- Most of the EU currently consists of non-vegetated areas, compacted gravel areas, and heavily disturbed or revegetated areas.
- Level 3 or higher biological resources exist near the perimeter of the BC Cribs and Trenches EU (Figure J.8); a previous review and habitat characterization (see

information for zone A in attached letter) was conducted in 2008 and 2009 indicating that the habitat within the evaluation unit is level 3 or higher.

- Excavation and blading within the evaluation unit would remove approximately 111 additional acres of level 3 or higher resources at the BC Cribs and Trenches EU (Table J.8). This represents a 4.3 percent reduction in the amount of level 3 or higher resources within a 1.8 km radius of the unit;
- Because these areas are contiguous with surrounding habitat near the perimeter of the evaluation unit (i.e., they are not considered distinct habitat patches), their removal would not be expected to significantly affect habitat connectivity.

Assumptions and Uncertainty:

Due to project time constraints, the field surveys and reconnaissance of this evaluation unit were conducted in mid-July. By the time of the survey, the cool-season annual and perennial herbaceous plants that dominate shrub-steppe habitat had completed seasonal growth and senesced making identification and inventory difficult and most likely incomplete. Although no records for plant species of concern have been noted, the absence of species cannot be confirmed by surveys during this time of year.

By mid-July, most migratory birds have completed their nesting cycles, and surveys may not reflect their occupancy and use of habitat within the evaluation unit earlier in the season. Their absence cannot be confirmed by surveys in July after the nesting season is over. Further surveys during the nesting season would be required to fully assess the ecological impacts to nesting migratory birds.

References

DOE/RL-96-32. 2013. Hanford Unit Biological Resources Management Plan, Revision 1.

PNNL. 2009. 300 Area Buildings Survey for 2009, Ecological Compliance and Assessment Project Database. Data collected by PNNL for DOE/RL under the Public Safety and Resource Protection Program.

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Definitions and Acronyms:

Adjacent Landscape Buffer – a circular area adjacent to and outside the evaluation unit boundary with the center of the circle at the centroid of the evaluation unit, and with a radius that is 1 times the maximum dimension (width or length—whichever is greatest). This circular buffer area is used to evaluate indirect effects and assess the remediation in relation to the landscape features and resouces adjacent to the evaluation unit. This circular area is generally at least 3 times the area of the evaluation unit.

Biological Resource Levels (from DOE-RL-96-32-01) –

- Level 5 resources include species that are listed or proposed-to-be listed under the *Endangered Species Act* and their critical habitat, as well as rare and irreplaceable habitats.
- Level 4 resources include federal candidate species; Washington State threatened or endangered species; habitat or exclusion buffers for federal candidates and Washington State threatened or endangered species; high-quality mature shrub steppe; wetlands and riparian areas; and buffer areas for bald eagles and ferruginous hawks.
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- Level 1 resources include individual common native plant and wildlife species, upland stands of non-native plants, and abandoned agricultural fields.

Evaluation Units (EUs) – groupings of sources, aggregated for evaluation as part of the Hanford Site-wide Risk Review Project. Sources may be aggregated into an EU based on potential impacts to a common set of receptors or receptor geographic area, common past waste management practices, or integration in the waste management process.

MBTA – Migratory Bird Treaty Act; referring to species listed and protected under the federal Act.

PNNL ECAP (Ecological Compliance and Assessment Project) Database – PNNL performed ecological reviews for individual projects and annually surveyed selected areas and buildings on the Hanford Site for DOE-RL under the DOE's Public Safety and Resource Protection Program until 2011. The data collected during those surveys is archived in the ECAP database, and is used to supplement ecological evaluations as available.

Priority Habitats – Priority habitats are habitat types or elements with unique or significant value to a diverse assemblage of species. A priority habitat may consist of a unique vegetation type (e.g., shrub-steppe) or dominant plant species (e.g., juniper savannah), a described successional stage (e.g., old-growth forest), or a specific habitat feature (e.g., cliffs).

Species of Concern or Species of Conservation Concern – An informal term that for the purpose of this assessment includes those species listed at the federal or state level as being threatened endangered, sensitive, or candidate, as well as those listed by the U.S. Fish and Wildlife Service as species of concern within the ecoregion.

PNNL ECAP Project Review Letter Describing Original Habitat within the BC-Cribs and Trenches Evaluation Unit:

Pacific Northwest
NATIONAL LABORATORY

Tel: (509) 371-7187
Fax: (509) 371-7160
MSIN: K6-85

July 14, 2009

Mr. Randy Hermann
CH2M Hill Plateau Remediation Company
P.O. Box 1600
Richland, WA 99352

Dear Mr. Hermann:

ECOLOGICAL REVIEW OF THE BC CONTROLLED AREA, 600 AREA, ECR #2008-600-006A, rev. 1

Project Background and Description:

Construction and remediation activities at the BC Controlled Area (BCCA) UPR-200-E-83 Waste Unit are scheduled to commence in August 2009 (Figure 1). This 12-mi^2 area has been split into three zones, A, B, and C, based on the levels and extent of contamination. Zone A consists of an area roughly 140 ac that is characterized by higher levels of radiological contamination. Remediation activities in Zone A will include large-scale grubbing of the top 6 to 12 inches of soil. Ecological reviews for Zone A will be covered under this ECR #2008-600-006A rev. 1.

Zone B contains spots of detectable contamination covering an area of about 6 mi^2. Because of the large area involved, work will commence in a phased approach (Figure 2). Review letters will be submitted based upon project schedule which indicates first the remediation and construction of the queue area followed by Phase 1 remediation of Zone B. Ecological reviews for Zone B will be covered under ECR #2008-600-006B.

Zone C remediation activities are not scheduled to begin in the near term but will be addressed under ECR #2008-600-006C at a later date.

<u>This letter reevaluates Zone A (originally surveyed in 2008).</u>

902 Battelle Boulevard | P.O. Box 999 | Richland, WA 99352 | 1-888-375-PNNL (7665) | inquiry@pnl.gov | www.pnl.gov

Survey Objectives:

Determine the occurrence in the project area of plant and animal species protected under the Endangered Species Act (ESA), candidates for such protection, and species listed as threatened, endangered, candidate, sensitive, or monitor by the state of Washington, and species protected under the Migratory Bird Treaty Act (MBTA).

Evaluate and quantify the potential impacts of disturbance on priority habitats and protected plant and animal species identified in the survey.

Survey Methods:

Pedestrian and visual reconnaissance of Zone A was performed by Robin Durham, on April 7 and 8, 2008, and again on June 9, 2009. Percent cover of dominant vegetation was visually estimated.

Priority habitats and species of concern are documented in: Washington Department of Fish and Wildlife (2008a, 2008b), and Washington State Department of Natural Resources (2008). Lists of animal and plant species considered Endangered, Threatened, Proposed, or Candidate by the U.S. Fish and Wildlife Service are maintained at 50 CFR 17.11 and 50 CFR 17.12; the list of birds protected under the MBTA is maintained at 50 CFR 10.13.

Survey Results:

Zone A (2009 Review):
Shrub cover within Zone A varied from 10 to 30 percent, with most of the cover provided by mature sagebrush (*Artemisia tridentata*). Spiny hopsage (*Grayia spinosa*) was present to a lesser degree, co-dominating the shrub layer on some portions of the zone. Antelope bitterbrush (*Purshia tridentata*) was found localized on stabilized dunes along the northern section of the zone. The understory was dominated by Sandberg's bluegrass (*Poa sandbergii*), cheatgrass (*Bromus tectorum*), and native forbs such as Carey's balsamroot (*Balsamorhiza careyana*), long-leaved phlox (*Phlox longifolia*), yarrow (*Achillea millefolium*), daisy fleabane (*Erigeron* spp.) and turpentine spring parsley (*Cymopterus terebinthinus*). Sage sparrows (*Amphispiza belli*), loggerhead shrikes (*Lanius ludovicianus*) and black-tailed jackrabbits (*Lepus californicus*) were observed in abundance across the site. Coyote (*Canis latrans*) sign were noted.

Considerations and Recommendations:

A number of loggerhead shrikes were observed in Zone A during surveys conducted in both years. This migratory bird is a state candidate and federal species of concern. Some individuals have been known to remain year round in eastern Washington but in general, loggerhead shrikes arrive in early March, and nest from late March through July. Fledging occurs in May, and by September most have departed for their migration south (DOE 2001, WDFW 2008b).

Two additional state species of concern, the sage sparrow and black-tailed jackrabbit, were observed in abundance across Zone A.

1) The sage sparrow is a migratory bird that arrives in mid February (DOE 2001), nests from March through June (Vander Haegen 2004) and migrates by mid August (DOE 2001).

2) Black-tailed jackrabbits breed from late February to mid-July (Flinders and Chapman 2003). Black-tailed jackrabbits are known to be relatively fast moving animals. Because these animals are highly mobile, it is anticipated that they will be able to move out of the way of earth-moving equipment. However, recently birthed young will likely be impacted.

It is unlawful, according to the MBTA, to take, capture or kill, as applicable, any migratory bird, or any part, nest or egg of such. To assure compliance with the MBTA, excavation activities in Zone A should be limited to the period between July 15 and March 1. This restriction will also reduce the impact of habitat removal during the breeding season of other state species of concern.

If nesting birds (if not a nest, a pair of birds of the same species or a single bird that will not leave the area when disturbed) are encountered, or bird defensive behaviors (flying at workers, refusal to leave area, strident vocalizations) are observed during project activities, please contact Mike Sackschewsky at 371-7187.

Lastly, Zone A contains a high-quality old-growth sagebrush-steppe community. This is considered a priority habitat by the state (WDFW 2008b) and regarded as a Level III resource at Hanford. Revegetation of Zone A with native grasses and sagebrush will help reduce the impacts of habitat fragmentation through the encouragement of successional development. In addition to revegetating the site of disturbance, some sort of compensatory mitigation will be required as stipulated under the Hanford Site

Biological Resources Management Plan (DOE 2001), and Hanford Site Biological Resources Mitigation Strategy (DOE 2003).

It will be necessary to draft a Mitigation Action Plan (MAP) to outline the methods you will use to mitigate for this Level III resource loss. We are available to assist you, if desired, with the development of this MAP, and to assist you in reaching your mitigation action goals.

This Ecological Compliance Review is valid until April 15, 2010.

Sincerely,

Michael R. Sackschewsky
Compliance Assessment Manager
Ecological Monitoring and Compliance Project

LB:mrs

Evaluation Unit:	Plutonium Contaminated Waste Sites
ID:	CP-LS-2
Group:	Legacy Source
Operable Unit Cross-Walk:	200-PW-1, 3, 6 200-CW-5
Related EU:	CP-DD-5 CP-GW-2
Sites & Facilities:	Plutonium (Pu) contaminated cribs and trenches associated with PFP in central part of 200-W area
Key Data Sources Docs:	DOE/RL-96-32 2013 PNNL ECAP Database[4]
Field Survey Date:	10/10/2014
Data Sheet Prepared By:	JLD, MAC, KBL, KDH, SAM; 10/08/2014

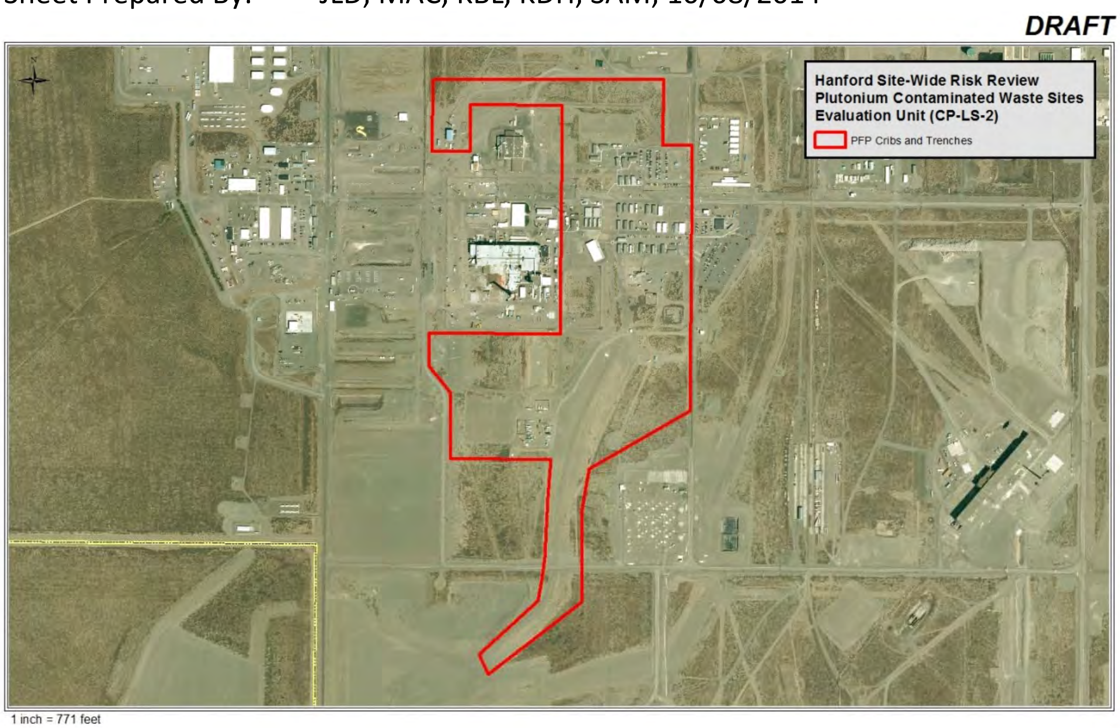

Figure J.9. Site Map with Evaluation Unit Boundaries

CP-LS-2: Plutonium Contaminated Waste Sites

Survey and Analysis Methods:

The evaluation process makes use of existing biological resource level maps (DOE/RL-96-32 2013), field surveys and measurement of current vegetation and habitat conditions, and wildlife observations to evaluate potential ecological impacts associated with cleanup activities at the evaluation unit (EU). Additional information used in the ecological evaluation includes the

[4] The Ecological Compliance and Assessment Project (ECAP) database is an evolving set of data that is maintained by Pacific Northwest National Laboratory (PNNL) and updated as new ecological assessments are completed.

current Endangered and Threatened Species (Federal and State) distribution data; priority habitats as defined by Washington Department of Fish and Wildlife; available current aerial imagery, locations of Hanford Site waste sites and infrastructure spatial data; and available information about species of concern distribution and habitat use in the vicinity of the EUs including data previously collected by PNNL for DOE-RL. Definitions relevant to the methods and ecological survey results are provided at the end of this summary along with field data tables.

The following steps were taken to assess the EU associated with the Plutonium Contaminated Waste Sites:

1. The EU boundary (polygon) is assumed to represent the estimated boundary or extent of potential habitat removal and direct disturbance due to remediation.
2. A visual and pedestrian survey was conducted within the EU boundary by experienced shrub-steppe ecologists. Vegetation was measured in the field in level 3 habitat resources. PNNL biologists also reviewed the observations and biological survey data available in the Ecological Compliance and Assessment Project (ECAP) database from the past 5 years for the EU to determine the status and resource level of the habitats within the EU and supplement the evaluation with previous wildlife or plant species observations.
3. A second boundary (polygon) outside the EU was established to evaluate indirect effects and assess the remediation in relation to adjacent landscape features. This polygon is centered on the EU and encompasses a circular area with a radius 1 times the maximum width of the EU and is referred to as the **adjacent landscape buffer**.
4. A reconnaissance survey of the boundary of the EU was conducted to confirm the validity of past mapping of biological resources. Aerial imagery from 2012 was reviewed to identify any significant changes in habitat and resource levels (such as new well pads, roads, or other ground disturbance not captured by the available biological resources mapping) within the EU and adjacent landscape buffer. Where significant change is evident from ground survey or imagery, the biological resource map was updated to reflect the change in resource level.
5. The spatial extent of habitat classified at each of 6 resource levels (0 – 5) (DOE/RL-96-32 2013; definitions at end of this summary) within the adjacent landscape buffer area and the EU were assessed and compared using a Geographic Information System (GIS) to examine potential indirect effects on habitat condition within the adjacent landscape. For purposes of assessing indirect effects on the adjacent landscape, this evaluation assumes the maximum potential change in biological resources—that is, all habitat within the EU is assumed to be lost to remediation and cleanup activities and resources in the EU are considered level 0.
6. PNNL biologists assembled the information from field survey, reconnaissance, and spatial analyses of resource availability to provide a subjective evaluation of potential effects on habitat connectivity in the vicinity of the EU.

Field Survey:

PNNL biologists conducted pedestrian and vehicle surveys throughout the EU. Canopy cover of species was estimated visually in level 2 resource areas, and measured along a transect in a level 3 resource area. Much of the EU has been previously disturbed by ongoing operations and the installation and operation of various pump-and-treat wells and remaining habitat occurs in strips and patches surrounded by roads and infrastructure. Vegetation measurements confirmed the status of resources within the EU. Two individual species occurrences of Piper's daisy (*Erigeron piperianus*) were previously noted in the EU, but were not relocated during October 2014 survey of the unit.

Some wildlife sign was observed during the October survey including small mammal tracks and burrows, coyote tracks (*Canis latrans*), unidentified lizards, rabbit tracks, and harvester ant hills. These observations match wildlife observations and sign noted previously by the PNNL ECAP surveys. PNNL ECAP surveys conducted in 2009 and 2010 recorded mountain cottontail (*Sylvilagus nutalli*), northern pocket gopher (*Thomomys talpoides*), side-blotched lizard (*Uta stansburiana*), western kingbird (*Tyrannus verticalis*), lark sparrow (*Chondestes grammacus*), rock dove (*Columba livia*), American robin (*Turdus migratorius*), American kestrel (*Falco sparverius*), and mourning dove (*Zenaida macroura*) within the multiple habitat patches in this EU (see attached records at end of this summary).

Table J.9. Percent Canopy Cover and Surface Cover Measured at the Plutonium Contaminated Waste Sites Evaluation Unit

Vegetation/Surface Cover	Survey Area 2-10 (%)	Survey Area 2-12 (%)	Survey Area 3-07 (%)
Bare Ground	-	30	44.4
Litter	-	25	36.0
Introduced Forb	5	25	16.3
Introduced Grass	-	-	8.7
Native Grass	11	1	45.5
Climax Shrubs	-	-	7.0
Successional Shrubs	25	20	4.7

Landscape Evaluation and Resource Classification:

More than 60% of the acreage in the Plutonium Contaminated Waste Sites EU is classified as level 0 or level 1 habitat and does not provide significant habitat resources (Table J.10, Figure J.10). The EU contains approximately 4.2 acres (less than 5%) of level 3 biological resources. The amount and proximity of the biological resources to the EU was examined within the adjacent landscape buffer area radiating 1,365 m from the geometric center of the EU (equivalent to 1,357 acres). More than half of the combined total area (EU and adjacent landscape buffer area) is classified as level 0 or 1 habitat, with level 2 habitat resources comprising 38.5% and level 3 and above resources comprising only 3.4% of the area at the landscape level. Some of the habitat patches within this EU are contiguous with habitat in the surrounding adjacent landscape buffer area, but the patches in the adjacent landscape buffer are not contiguous with habitat outside the 200-West industrial area and generally represent isolated habitat fragments.

Table J.10. Area and Proportion of Each Biological Resource Level Within the Plutonium Contaminated Waste Sites Evaluation Unit in Relation to Adjacent Landscape and Potential Maximum Change in Resources

Resource Level[1]	Evaluation Unit Area (ac)	Adjacent Landscape Buffer (ac)	Combined Total Area (ac)	Percent of Resource Level in Combined Total Area	Percent of Resource Level in Combined Total Area After Cleanup[2]	Percent Difference at Landscape Scale After Cleanup[2]
0	41.9	630.5	672.4	46.5%	49.7%	3.2%
1	14.3	152.8	167.1	11.6%	10.6%	-1.0%
2	27.6	529.3	556.9	38.5%	36.6%	-1.9%
3	4.2	44.7	48.9	3.4%	3.1%	-0.3%
4	0.0	0.0	0.0	0.0%	0.0%	0.0%
5	0.0	0.0	0.0	0.0%	0.0%	0.0%
Total	88.0	1357.3	1445.3	100.0%	100.0%	

1 Resource levels for both the evaluation unit and adjacent landscape boundary were reviewed in the field and via imagery during October 2014 and revised to reflect current habitats conditions.

2 Potential maximum change in area of a given resource level within the combined total area (Evaluation Unit + Adjacent Landscape Buffer) that would occur assuming that all habitat within the evaluation unit is destroyed by remediation activities and the resource level of the evaluation unit is level 0.

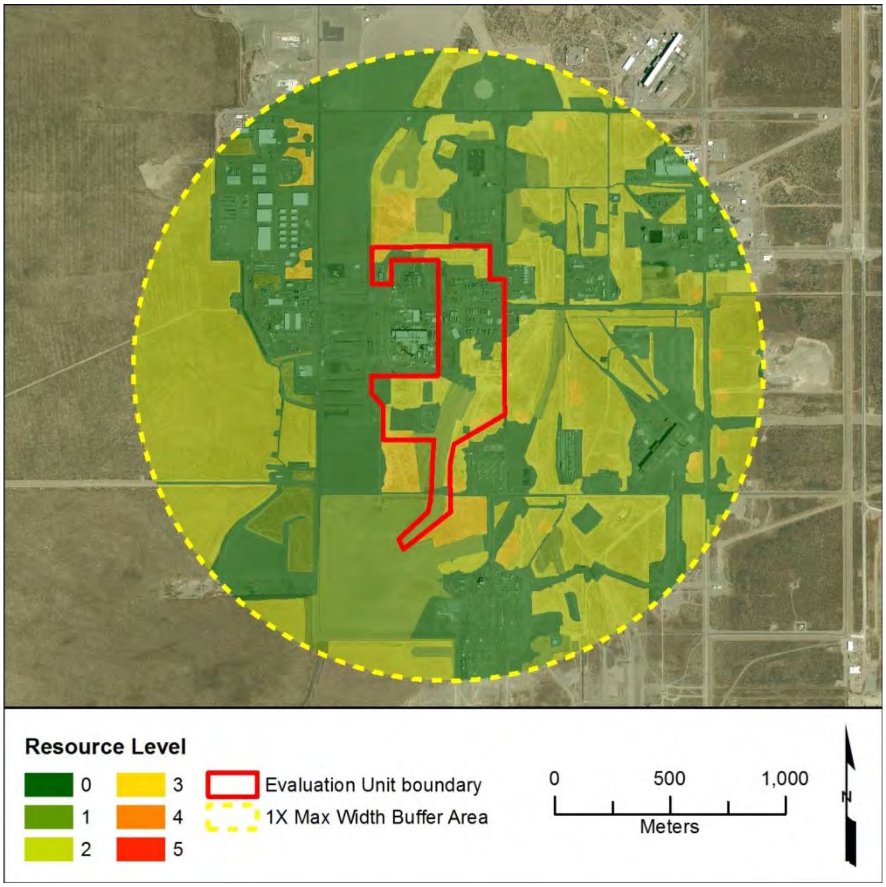

Figure J.10. Biological Resource Level Classifications Based on October 2014 Surveys for the Plutonium Contaminated Waste Sites Evaluation Unit (red solid line) and Adjacent Landscape Buffer (yellow dashed line)

Assumptions and Uncertainty:

Due to project time constraints, the field surveys and reconnaissance of this EU were conducted in October. By the time of the survey, the cool-season annual and perennial herbaceous plants that dominate shrub-steppe habitat had completed seasonal growth and senesced making identification and inventory difficult and most likely incomplete. Although no records for plant species of concern have been noted, the absence of species cannot be confirmed by surveys during this time of year.

By October, migratory birds have completed their nesting cycles, and most have migrated out of the region. Surveys conducted in late fall will not reflect their occupancy and use of habitat within the EU earlier in the season. Their absence cannot be confirmed by surveys October after the nesting season is over. Further surveys during the nesting season would be required to fully assess the ecological impacts to nesting migratory birds.

Summary of Ecological Review:

- More than 60% of the acreage in the Plutonium Contaminated Waste Sites EU is classified as level 0 or level 1 habitat and does not provide significant habitat resources

- Approximately 4 acres of level 3 habitat exist within the Plutonium Contaminated Waste Sites EU; total loss of this habitat would result in a change of 0.3% at the landscape level.
- The remaining level 2 and level 3 habitat within the EU are fragmented and isolated from habitat surrounding the 200-West Area.
- Individual species occurrences of Piper's daisy represent approximately 1 acre of level 3 resources within the EU. Loss of individual plants of this species is not likely to affect population viability for the Washington State sensitive species.
- Because remaining habitat within the EU and adjacent landscape buffer area is isolated from contiguous habitat outside the 200-West Area, any loss of habitat within the Plutonium Contaminated Waste Sites EU would not be expected to impact habitat connectivity at the landscape level.

References

DOE/RL-96-32. 2013. Hanford Site Biological Resources Management Plan, Revision 0.

U.S. Fish and Wildlife Service (USFWS). 2014. Birds Protected by the Migratory Bird Treaty Act. http://www.fws.gov/migratorybirds/RegulationsPolicies/mbta/mbtintro.html

U.S. Fish and Wildlife Service (USFWS). 2014. Environmental Conservation Online System, Listings and Occurrences for Washington. http://ecos.fws.gov/tess_public/pub/stateListingAndOccurrenceIndividual.jsp?state=WA&s8fid=112761032792&s8fid=112762573902

Washington Department of Fish and Wildlife. 2008. Washington State Priority Habitats and Species List. Olympia Washington. 174 pp. http://wdfw.wa.gov/conservation/phs/list/

Washington Department of Fish and Wildlife. 2014. Species of Concern in Washington. http://wdfw.wa.gov/conservation/endangered/

Washington Noxious Weed Control Board.2014. Noxious Weed List. http://www.nwcb.wa.gov/

Washington State Department of Natural Resources. 2014. Washington Natural Heritage Program Plant Ranks. http://www1.dnr.wa.gov/nhp/refdesk/lists/plantrnk.html

Definitions and Acronyms:

Adjacent Landscape Buffer – a circular area adjacent to and outside the EU boundary with the center of the circle at the centroid of the EU, and with a radius that is 1 times the maximum dimension (width or length—whichever is greatest). This circular buffer area is used to evaluate indirect effects and assess the remediation in relation to the landscape features and resources adjacent to the EU. This circular area is generally at least 3 times the area of the EU.

Biological Resource Levels (from DOE-RL-96-32-01) –

- Level 5 resources include species that are listed or proposed-to-be listed under the *Endangered Species Act* and their critical habitat, as well as rare and irreplaceable habitats.

- Level 4 resources include federal candidate species; Washington State threatened or endangered species; habitat or exclusion buffers for federal candidates and Washington State threatened or endangered species; high-quality mature shrub steppe; wetlands and riparian areas; and buffer areas for bald eagles and ferruginous hawks.
- Level 3 resources include Washington State sensitive, candidate, and review species; Washington Department of Fish and Wildlife priority species; lower quality mature shrub-steppe—such as shrub stands that are less mature, have lower shrub density or canopy cover, and/or a greater proportion of cheatgrass in the understory than stands that qualify for Level 4. Level 3 also includes high-quality grasslands, conservation corridors, snake hibernacula, bat roosts, rookeries, burrowing owl buffer areas, and areas with significant quantities of culturally important species.
- Level 2 resources include migratory birds, state watch list plants and monitor list animals, recreationally and commercially important species, and lower quality steppe and shrub-steppe.
- Level 1 resources include individual common native plant and wildlife species, upland stands of non-native plants, and abandoned agricultural fields.

Evaluation Units (EUs) – groupings of sources, aggregated for evaluation as part of the Hanford Site-wide Risk Review Project. Sources may be aggregated into an EU based on potential impacts to a common set of receptors or receptor geographic area, common past waste management practices, or integration in the waste management process.

MBTA – Migratory Bird Treaty Act; referring to species listed and protected under the federal Act.

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Priority Habitats – Priority habitats are habitat types or elements with unique or significant value to a diverse assemblage of species. A priority habitat may consist of a unique vegetation type (e.g., shrub-steppe) or dominant plant species (e.g., juniper savannah), a described successional stage (e.g., old-growth forest), or a specific habitat feature (e.g., cliffs).

Species of Concern or Species of Conservation Concern – An informal term that for the purpose of this assessment includes those species listed at the federal or state level as being threatened endangered, sensitive, or candidate, as well as those listed by the U.S. Fish and Wildlife Service as species of concern within the ecoregion.

Previous PNNL ECAP Survey Data

ECAP Database Query Results for W-026

Observer: *Chamness, Mickie* Date *7/7/2010*

Plant

Common Name	Latin Name	Abundance	Comments
Russian thistle	Salsola kali	25	Mostly sprayed wasteland
gray rabbitbrush	Chrysothamnus nauseosus	15	Can access big N part again
No vegetation present	No vegetation		40% Loose sand
cheatgrass	Bromus tectorum	1	
indian ricegrass	Oryzopsis hymenoides	1	
stiff wirelettuce	Stephanomeria paniculata		
needle-and-thread grass	Stipa comata		
Yellow salsify	Tragopogon dubius		

Mammal

Common Name	Latin Name	Abundance	Comments
unknown/unidentified small mammal	small mammal	Common	tracks, poop
coyote	Canis latrans	Present	Tracks
mountain cottontail	Sylvilagus nutalli	Present	Tracks

Herpt

Common Name	Latin Name	Abundance	Comments
Unidentified/Unlisted herpt	Unidentified/Unlisted herpt	Present	Snake track
side-blotched lizard	Uta stansburiana	Present	

Bird

Common Name	Latin Name	Abundance	Comments
killdeer	Charadrius vociferus	1	Flew over
western kingbird	Tyrannus verticalis	1	Flew over

Observer: *Simmons, Mary Ann* Date *7/7/2010*

Plant

Common Name	Latin Name	Abundance	Comments
gray rabbitbrush	Chrysothamnus nauseosus		
Russian thistle	Salsola kali		

Mammal

Common Name	Latin Name	Abundance	Comments
unknown/unidentified small mammal	small mammal	Present	tracks
mountain cottontail	Sylvilagus nutalli	Present	Pellets

Herpt

Common Name	Latin Name	Abundance	Comments
side-blotched lizard	Uta stansburiana	Present	

Wednesday, October 15, 2014 Page 1 of 1

ECAP Database Query Results for W-026a

Observer: *Simmons, Mary Ann* Date *7/7/2010*

Plant

Common Name	Latin Name	Abundance	Comments
No vegetation present	No vegetation	90	gravel
Russian thistle	Salsola kali		
needle-and-thread grass	Stipa comata		

Mammal

Common Name	Latin Name	Abundance	Comments
unknown/unidentified small mammal	small mammal	Present	Tracks; possible rabbit and snake

Bird

Common Name	Latin Name	Abundance	Comments
rock dove	Columba livia	3	Roosting

Wednesday, October 15, 2014 Page 1 of 1

ECAP Database Query Results for W-026b

Observer: *Simmons, Mary Ann* Date *7/7/2010*

Plant

Common Name	Latin Name	Abundance	Comments
No vegetation present	No vegetation	90	gravel
gray rabbitbrush	Chrysothamnus nauseosus		
Russian thistle	Salsola kali		

ECAP Database Query Results for W-028

Observer: *Chamness, Mickie* Date *7/7/2010*

Plant

Common Name	Latin Name	Abundance	Comments
big sagebrush	Artemisia tridentata	30	W edge overprayed? more dead shrb
prairie Junegrass	Koeleria cristata		Use % frm last yr
Sandberg's bluegrass	Poa sandbergii		Brte
Russian thistle	Salsola kali	15	Because its dom on W
crested wheatgrass	Agropyron cristatum		
bur ragweed	Ambrosia acanthicarpa		
Carey's balsamroot	Balsamorhiza careyana		
gray rabbitbrush	Chrysothamnus nauseosus		
green rabbitbrush	Chrysothamnus viscidiflorus		
bastard toadflax	Comandra umbellata		
turpentine springparsley	Cymopteris terebithimus		
western tansymustard	Descurainia pinnata		
flixweed	Descurainia sophia		
prickly lettuce	Lactuca serriola		
hoary aster	Machaeranthera canescens		
indian ricegrass	Oryzopsis hymenoides		
indian ricegrass	Oryzopsis hymenoides		
longleaf phlox	Phlox longifolia		
Jim Hill's tumblemustard	Sisymbrium altissimum		
bottlebrush grass	Sitanion hystrix		
needle-and-thread grass	Stipa comata		

Mammal

Common Name	Latin Name	Abundance	Comments
unknown/unidentified small mammal	small mammal	Abundant	tracks
mountain cottontail	Sylvilagus nutalli	Present	

Herpt

Common Name	Latin Name	Abundance	Comments
Unidentified/Unlisted herpt	Unidentified/Unlisted herpt	Common	Lizard tracks

Bird

Common Name	Latin Name	Abundance	Comments
No birds observed	No birds		

Observer: *Simmons, Mary Ann* Date *7/7/2010*

Plant

Common Name	Latin Name	Abundance	Comments
Sandberg's bluegrass	Poa sandbergii	5	
needle-and-thread grass	Stipa comata	5	

Wednesday, October 15, 2014 Page 1 of 2

ECAP Database Query Results for W-034

Observer: ***Chamness, Mickie*** Date ***7/7/2010***

Plant

Common Name	Latin Name	Abundance	Comments
Russian thistle	Salsola kali	5	
gray rabbitbrush	Chrysothamnus nauseosus	30	
Sandberg's bluegrass	Poa sandbergii	20	
cheatgrass	Bromus tectorum	10	
indian ricegrass	Oryzopsis hymenoides	1	
needle-and-thread grass	Stipa comata	1	
yarrow	Achillea millefolium		
crested wheatgrass	Agropyron cristatum		
big sagebrush	Artemisia tridentata		
stalked-pod milkvetch	Astragalus sclerocarpus		
green rabbitbrush	Chrysothamnus viscidiflorus		
Fendler's cryptantha	Cryptantha fendleri		
turpentine springparsley	Cymopteris terebithinus		
prairie Junegrass	Koeleria cristata		
hoary aster	Machaeranthera canescens		
pale evening primrose	Oenothera pallida		
threadleaf scorpionweed	Phacelia linearis		

Mammal

Common Name	Latin Name	Abundance	Comments
coyote	Canis latrans	Present	Tracks
northern pocket gopher	Thomomys talpoides	Present	Mnd
unknown/unidentified small mammal	small mammal	Common	Holes, tracks

Herpt

Common Name	Latin Name	Abundance	Comments
Unidentified/Unlisted herpt	Unidentified/Unlisted herpt	Present	Lizard trks

Bird

Common Name	Latin Name	Abundance	Comments
lark sparrow	Chondestes grammacus	2	On Chna
western kingbird	Tyrannus verticalis	2	Acrobatics

Observer: ***Simmons, Mary Ann*** Date ***7/7/2010***

Plant

Common Name	Latin Name	Abundance	Comments
cheatgrass	Bromus tectorum	25	
gray rabbitbrush	Chrysothamnus nauseosus	25	
indian ricegrass	Oryzopsis hymenoides	10	
needle-and-thread grass	Stipa comata	10	

Wednesday, October 15, 2014 Page 1 of 2

ECAP Database Query Results for W-034b

Observer: *Chamness, Mickie* Date *7/7/2010*

Plant

Common Name	Latin Name	Abundance	Comments
big sagebrush	Artemisia tridentata		1
cheatgrass	Bromus tectorum	40	
crested wheatgrass	Agropyron cristatum	20	
bur ragweed	Ambrosia acanthicarpa		
gray rabbitbrush	Chrysothamnus nauseosus		
matted cryptantha	Cryptantha circumscissa		
prickly lettuce	Lactuca serriola		
hoary aster	Machaeranthera canescens		
indian ricegrass	Oryzopsis hymenoides		
Sandberg's bluegrass	Poa sandbergii		
Russian thistle	Salsola kali		
needle-and-thread grass	Stipa comata		

Mammal

Common Name	Latin Name	Abundance	Comments
coyote	Canis latrans	Present	Tracks
mountain cottontail	Sylvilagus nuttalli	Present	Tracks
unknown/unidentified small mammal	small mammal	Common	Holes, tracks

Bird

Common Name	Latin Name	Abundance	Comments
western meadowlark	Sturnella neglecta	1	Sing E powerpole
mourning dove	Zenaida macroura	2	Flushed
cliff swallow	Hirundo pyrrhonota	1	Feeding

Observer: *Simmons, Mary Ann* Date *7/7/2010*

Plant

Common Name	Latin Name	Abundance	Comments
crested wheatgrass	Agropyron cristatum	15	
yarrow	Achillea millefolium		
cheatgrass	Bromus tectorum		
gray rabbitbrush	Chrysothamnus nauseosus		
green rabbitbrush	Chrysothamnus viscidiflorus		
slender sixweeks	Festuca octoflora		
prickly lettuce	Lactuca serriola		
hoary aster	Machaeranthera canescens		
indian ricegrass	Oryzopsis hymenoides		
Sandberg's bluegrass	Poa sandbergii		
Russian thistle	Salsola kali		

ECAP Database Query Results for W-034N

Observer: *Chamness, Mickie* Date *7/7/2010*

Plant

Common Name	Latin Name	Abundance	Comments
No vegetation present	No vegetation		50%
Russian thistle	Salsola kali	30	
gray rabbitbrush	Chrysothamnus nauseosus	20	
big sagebrush	Artemisia tridentata		
cheatgrass	Bromus tectorum		
green rabbitbrush	Chrysothamnus viscidiflorus		
indian ricegrass	Oryzopsis hymenoides		
stiff wirelettuce	Stephanomeria paniculata		

Mammal

Common Name	Latin Name	Abundance	Comments
mountain cottontail	Sylvilagus nuttalli	Present	Tracks, eaten all veg
coyote	Canis latrans	Present	Tracks
unknown/unidentified small mammal	small mammal	Common	Tracks

Bird

Common Name	Latin Name	Abundance	Comments
cliff swallow	Hirundo pyrrhonota	1	flew over. Losh nest not used

Observer: *Simmons, Mary Ann* Date *7/7/2010*

Plant

Common Name	Latin Name	Abundance	Comments
puncture vine	Tribulus terrestris		tackweed
gray rabbitbrush	Chrysothamnus nauseosus	25	
Russian thistle	Salsola kali	20	
bur ragweed	Ambrosia acanthicarpa		
big sagebrush	Artemisia tridentata		
cheatgrass	Bromus tectorum		
indian ricegrass	Oryzopsis hymenoides		
Yellow salsify	Tragopogon dubius		

Mammal

Common Name	Latin Name	Abundance	Comments
unknown/unidentified small mammal	small mammal	Present	Tracks
coyote	Canis latrans	Present	Scat
mountain cottontail	Sylvilagus nuttalli	Common	pellets

Herpt

Common Name	Latin Name	Abundance	Comments
side-blotched lizard	Uta stansburiana	Present	

Wednesday, October 15, 2014 Page 1 of 1

ECAP Database Query Results for W-102

Observer: ***Chamness, Mickie*** Date ***6/8/2010***

Bird

Common Name	Latin Name	Abundance	Comments
western kingbird	Tyrannus verticalis	2	Acrobatics

Observer: ***Freeman-Cadoret, Natalie*** Date ***6/21/2010***

Plant

Common Name	Latin Name	Abundance	Comments
cheatgrass	Bromus tectorum	15	
Sandberg's bluegrass	Poa sandbergii	15	
crested wheatgrass	Agropyron cristatum	10	
needle-and-thread grass	Stipa comata	+	
big sagebrush	Artemisia tridentata		
slender sixweeks	Festuca octoflora		
indian ricegrass	Oryzopsis hymenoides		
Russian thistle	Salsola kali		

Mammal

Common Name	Latin Name	Abundance	Comments
unknown/unidentified small mammal	small mammal	Present	

Bird

Common Name	Latin Name	Abundance	Comments
American kestrel	Falco sparverius	1	

ECAP Database Query Results for W-505

Observer: ***Chamness, Mickie*** Date ***4/29/2009***

Plant

Common Name	Latin Name	Abundance	Comments
No vegetation present	No vegetation		

Bird

Common Name	Latin Name	Abundance	Comments
American robin	Turdus migratorius	1	On grnd behind razor wire

Bird

Common Name	Latin Name	Abundance	Comments
western meadowlark	Sturnella neglecta	1	On powerline to E

Wednesday, October 15, 2014 Page 1 of 1

Field Data Collected During October 2014 Surveys

Percent Canopy Cover of Herbaceous Species Measured in 0.5 m2 quadrats																
EU	Survey Area	Species	Origin & Class	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10	sum	Mean Canopy Cover	Freq
PFP	3-07	ARTR	NS	100										100	100	0.1
PFP	3-07	SATR	IF	1	10		10		5			32	40	98	16.33333	0.6
PFP	3-07	BRTE	IG		1		20				5			26	8.666667	0.3
PFP	3-07	POSE	NG			1	10							11	5.5	0.2
PFP	3-07	LITTER	LITTER	20	50	9	50		25	65	10	35	60	324	36	0.9
PFP	3-07	BARE	BARE		40	90	10	60	70	10	85	25	10	400	44.44444	0.9
PFP	3-07	STCO	NG					40						40	40	0.1
PFP	3-07	CHNA	NS							25				25	25	0.1
Notes																

Shrub Canopy Measured by Line-Intercept Methods on 50m Transect

EU	Survey Area	Species	Transect Distance (total)	Start	Stop	Dif
PFP	3-07	CHVI	50	1.73	2.93	1.2
PFP	3-07	ARTR	50	3.41	5	1.59
PFP	3-07	ARTR	50	12.6	14.52	1.92
PFP	3-07	CHNA	50	19.31	19.94	0.63
PFP	3-07	CHNA	50	27.89	28.39	0.5
PFP	3-07	CHNA	50	34.06		0

Notes

Evaluation Unit: PFP	Observers: JLD, MAC
Patch ID: 2-10	Date: 10/10/2014

Wildlife Observations Recorded During Pedestrian or Vehicle Surveys	
Species	Observation
UTST	Lizard
Small mammal	Burrow
Coyote	Tracks
Harvester ants	
Notes	

Evaluation Unit: PFP	Observers: JLD, MAC
Patch ID: 2-12	Date: 10/10/2014

Wildlife Observations Recorded During Pedestrian or Vehicle Surveys	
Species	Observation
Small mammal	Tracks
Lizards	
Jack rabbit/Cotton tail	Tracks
Harvester ants	
Notes	

Evaluation Unit: PFP	Observers: MAC
Patch ID: 3-07	Date: 10/10/2014

Wildlife Observations Recorded During Pedestrian or Vehicle Surveys	
Species	Observation
Mouse	Tracks
CALA	Tracks
Lizard	
Harvester ants	
Notes	

Evaluation Unit:	T Tank Farm
ID:	CP-TF-1
Group:	Tank Farm
Operable Unit Cross-Walk:	200-DV-1 WMA T 200-WA-1
Related EU:	CP-LS-7 CP-GW-2
Sites & Facilities:	T tank farm, ancillary structures, associated liquid waste sites, and soils contamination.
Key Data Sources Docs:	DOE/RL-96-32 2013 PNNL ECAP Database[5]
Field Survey Date:	July 16, 2014
Data Sheet Prepared By:	JLD, 10/08/2014

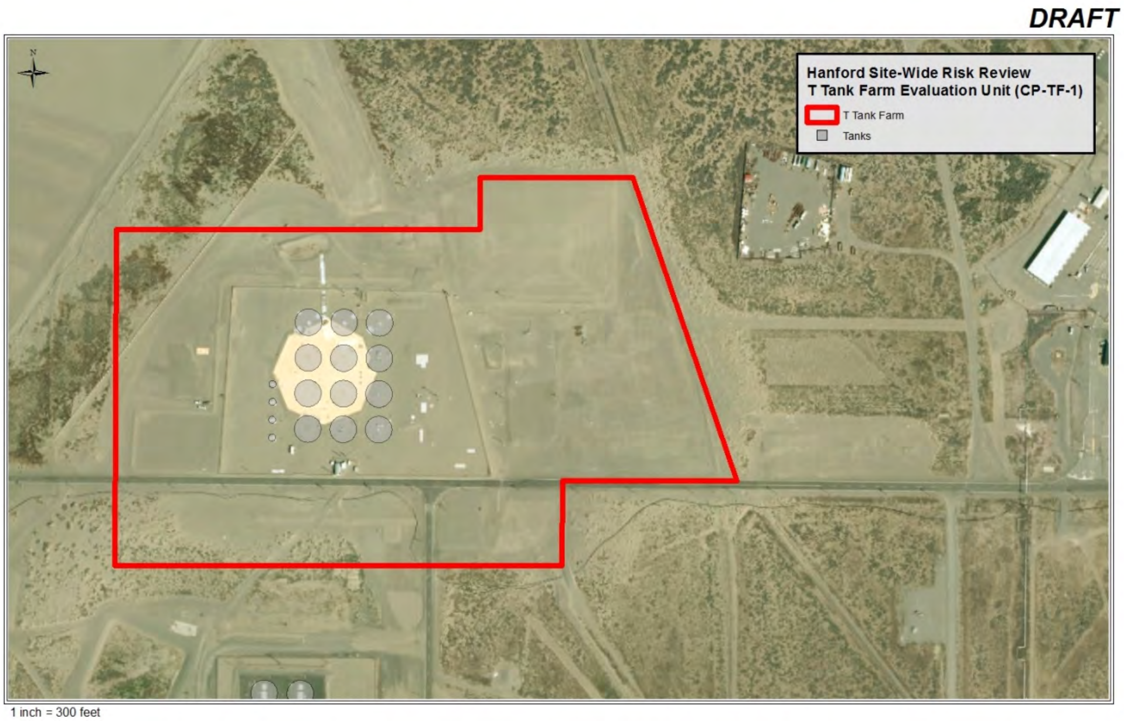

Figure J.11. Site Map with Evaluation Unit Boundaries and Tank Locations

CP-TF-1: T Tank Farm

Survey and Analysis Methods:

The evaluation process makes use of existing biological resource level maps (DOE/RL-96-32 2013), field surveys and measurement of current vegetation and habitat conditions, and wildlife observations to evaluate potential ecological impacts associated with cleanup activities at the

[5] The Ecological Compliance and Assessment Project (ECAP) database is an evolving set of data that is maintained by Pacific Northwest National Laboratory (PNNL) and updated as new ecological assessments are completed.

evaluation unit (EU). Additional information used in the ecological evaluation includes the current Endangered and Threatened Species (Federal and State) distribution data; priority habitats as defined by Washington Department of Fish and Wildlife; available current aerial imagery, locations of Hanford Site waste sites and infrastructure spatial data; and available information about species of concern distribution and habitat use in the vicinity of the EUs including data previously collected by PNNL for DOE-RL. Definitions relevant to the methods and ecological survey results are provided at the end of this summary along with field data tables.

The following steps were taken to assess the EU associated with the T Tank Farm:

1. The EU boundary (polygon) is assumed to represent the estimated boundary or extent of potential habitat removal and direct disturbance due to remediation.
2. A visual survey was conducted within the EU boundary by experienced shrub-steppe ecologists. Because the unit consists primarily of disturbed graveled/bare surfaces within the tank farm fence, and small patches of degraded shrub-steppe, no field measurements of vegetation were taken and no field data sheet is included in this summary. PNNL biologists also reviewed the observations and biological survey data available in the Ecological Compliance and Assessment Project (ECAP) database from the past 5 years for the EU to determine the status and resource level of the habitats within the EU and supplement the evaluation with previous wildlife or plant species observations.
3. A second boundary (polygon) outside the EU was established to evaluate indirect effects and assess the remediation in relation to adjacent landscape features. This polygon is centered on the EU and encompasses a circular area with a radius 1 times the maximum width of the EU and is referred to as the **adjacent landscape buffer**.
4. A reconnaissance survey of the boundary of the EU was conducted to confirm the validity of past mapping of biological resources. Aerial imagery from 2012 was reviewed to identify any significant changes in habitat and resource levels (such as new well pads, roads, or other ground disturbance not captured by the available biological resources mapping) within the EU and adjacent landscape buffer. Where significant change is evident from ground survey or imagery, the biological resource map was updated to reflect the change in resource level.
5. The spatial extent of habitat classified at each of 6 resource levels (0 – 5) (DOE/RL-96-32 2013; definitions at end of this summary) within the adjacent landscape buffer area and the EU were assessed and compared using a Geographic Information System (GIS) to examine potential indirect effects on habitat condition within the adjacent landscape. For purposes of assessing indirect effects on the adjacent landscape, this evaluation assumes the maximum potential change in biological resources—that is, all habitat within the EU is assumed to be lost to remediation and cleanup activities and resources in the EU are considered level 0.

6. PNNL biologists assembled the information from field survey, reconnaissance, and spatial analyses of resource availability to provide a subjective evaluation of potential effects on habitat connectivity in the vicinity of the EU.

Field Survey:

Approximately 90% of the T Tank Farm EU consists of graveled surfaces and paved areas. No vegetation measurements were taken in the areas adjacent to the actual tank farm, but previous information from PNNL ECAP surveys is included at the end of this summary. The existing resource level map indicates the presence of level 3 resources in the southwest corner of the EU to the south of the paved road associated with a point occurrence of a sensitive species (*Erigeron piperianus*) that has been observed at this location in past ECAP surveys but was not observed in 2010. No wildlife was observed in the area during a vehicle reconnaissance of the boundary, and in 2010, a previous PNNL ECAP survey of the habitat surrounding the tank farm noted only coyote (*Canis latrans*) tracks in the habitat to the west and northwest of the tank farm.

Table J.11. Percent Canopy Cover and Surface Cover Measured at T Tank Farm Evaluation Unit

Vegetation/Surface Cover	Inside Tank Farm Fence
BARE	100%

Landscape Evaluation and Resource Classification:

The amount and proximity of biological resources to the T Tank Farms EU was examined within the adjacent landscape buffer area radiating 574 m from the geometric center of the EU (equivalent to 256 acres). Approximately 44% of the adjacent landscape buffer area is classified as level 0 biological resources in the existing resource map (Table J.12, Figure J.12). The nearest level 3 resources within the buffer area are located south of the evaluation site (individual occurrences of sensitive plant species) and north and northeast of the evaluation site (Figure J.12). Review of historical ECAP data indicates the areas north and northwest of the EU contained shrub-steppe with a native climax big sagebrush (*Artemisia tridentata*) overstory with cheatgrass (*Bromus tectorum*) co-dominant in the understory with native bunchgrasses. These habitats have been degraded over the past 5 years with blowing sand and invasion by Russian thistle (*Salsola tragus*). No level 4 or 5 resources are present within the T tank farm adjacent landscape buffer.

Table J.12. Area and Proportion of Each Biological Resource Level Within the Evaluation Unit in Relation to Adjacent Landscape and Potential Maximum Change in Resources

Resource Level[1]	Evaluation Unit Area (ac)	Adjacent Landscape Buffer (ac)	Combined Total Area (ac)	Percent of Resource Level in Combined Total Area	Percent of Resource Level in Combined Total Area After Cleanup[2]	Percent Difference at Landscape Scale After Cleanup[2]
0	31.0	96.7	127.7	49.9%	51.3%	1.4%
1	0.0	15.3	15.3	6.0%	6.0%	0.0%
2	3.4	84.0	87.4	34.1%	32.8%	-1.3%
3	0.3	25.3	25.6	10.0%	9.9%	-0.1%
4	0.0	0.0	0.0	0.0%	0.0%	0.0%
5	0.0	0.0	0.0	0.0%	0.0%	0.0%
Total	34.7	221.3	256.1	100.0%	100.0%	

1 Resource levels for both the evaluation unit and adjacent landscape boundary were reviewed in the field and via imagery during July 2014 and revised to reflect current habitats conditions.

2 Potential maximum change in area of a given resource level within the combined total area (Evaluation Unit + Adjacent Landscape Buffer) that would occur assuming that all habitat within the evaluation unit is destroyed by remediation activities and the resource level of the evaluation unit is level 0.

Assumptions and Uncertainty:

Due to project time constraints, the field surveys and reconnaissance of this EU were conducted in mid-July. By the time of the survey, the cool-season annual and perennial herbaceous plants that dominate shrub-steppe habitat had completed seasonal growth and senesced making identification and inventory difficult and most likely incomplete. Although no records for plant species of concern have been noted, the absence of species cannot be confirmed by surveys during this time of year.

By mid-July, most migratory birds have completed their nesting cycles, and surveys may not reflect their occupancy and use of habitat within the EU earlier in the season. Their absence cannot be confirmed by surveys in July after the nesting season is over. Further surveys during the nesting season would be required to fully assess the ecological impacts to nesting migratory birds.

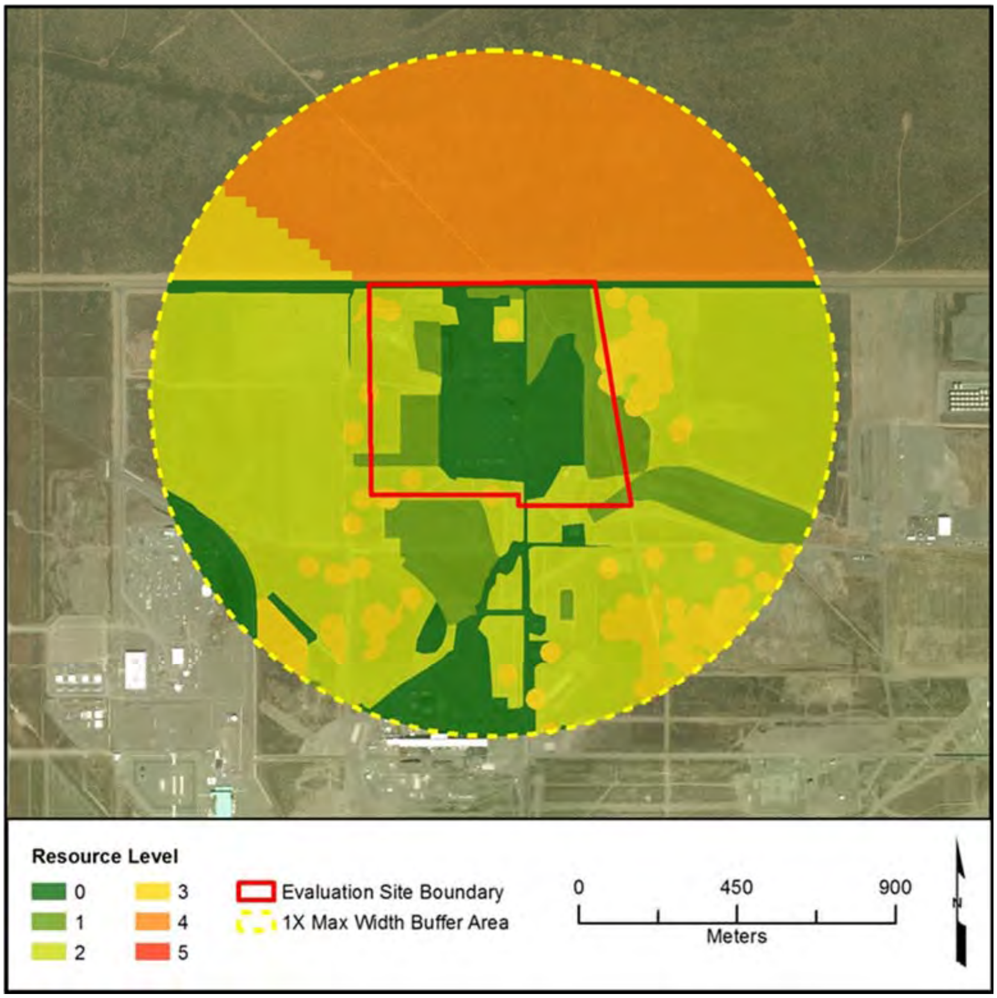

Figure J.12. Map of Biological Resource Level Classifications at the T Tank Farm Evaluation Unit (red boundary) and Adjacent Landscape Buffer Area (yellow dashed line boundary) Based on July 2014 Survey

Summary of Ecological Review:

- Approximately 90% of the T Tank Farm EU consists of graveled surfaces and paved areas.
- Individual occurrences of level 3 species have been previously documented at the T Tank Farm EU, however, no level 3 or greater habitat resources occur in patches greater than 0.5 ac within the EU.
- Loss of individual Piper's daisy plants would not be likely to affect the viability of populations of this species in the region.
- No wildlife was observed in the area during a vehicle reconnaissance of the boundary, and in 2010, a previous PNNL ECAP survey of the habitat surrounding the tank farm noted only coyote (*Canis latrans*) tracks in the habitat to the west and northwest of the tank farm.
- Cleanup activities would result in no net change in the amount of level 3 or higher resources within a 0.97 km radius.

- Because the EU is adjacent to paved roadways and multiple industrial areas and waste sites—no significant change in habitat connectivity would be expected if habitat resources within the EU are lost.

References:

DOE/RL-96-32. 2013. Hanford Site Biological Resources Management Plan, Revision 0.

U.S. Fish and Wildlife Service (USFWS). 2014. Birds Protected by the Migratory Bird Treaty Act. http://www.fws.gov/migratorybirds/RegulationsPolicies/mbta/mbtintro.html

U.S. Fish and Wildlife Service (USFWS). 2014. Environmental Conservation Online System, Listings and Occurrences for Washington. http://ecos.fws.gov/tess_public/pub/stateListingAndOccurrenceIndividual.jsp?state=WA&s8fid=112761032792&s8fid=112762573902

Washington Department of Fish and Wildlife. 2008. Washington State Priority Habitats and Species List. Olympia Washington. 174 pp. http://wdfw.wa.gov/conservation/phs/list/

Washington Department of Fish and Wildlife. 2014. Species of Concern in Washington. http://wdfw.wa.gov/conservation/endangered/

Washington Noxious Weed Control Board.2014. Noxious Weed List. http://www.nwcb.wa.gov/

Washington State Department of Natural Resources. 2014. Washington Natural Heritage Program Plant Ranks. http://www1.dnr.wa.gov/nhp/refdesk/lists/plantrnk.html

Definitions and Acronyms:

Adjacent Landscape Buffer – a circular area adjacent to and outside the EU boundary with the center of the circle at the centroid of the EU, and with a radius that is 1 times the maximum dimension (width or length—whichever is greatest). This circular buffer area is used to evaluate indirect effects and assess the remediation in relation to the landscape features and resources adjacent to the EU. This circular area is generally at least 3 times the area of the EU.

Biological Resource Levels (from DOE-RL-96-32-01) –

- Level 5 resources include species that are listed or proposed-to-be listed under the *Endangered Species Act* and their critical habitat, as well as rare and irreplaceable habitats.
- Level 4 resources include federal candidate species; Washington State threatened or endangered species; habitat or exclusion buffers for federal candidates and Washington State threatened or endangered species; high-quality mature shrub steppe; wetlands and riparian areas; and buffer areas for bald eagles and ferruginous hawks.
- Level 3 resources include Washington State sensitive, candidate, and review species; Washington Department of Fish and Wildlife priority species; lower quality mature shrub-steppe—such as shrub stands that are less mature, have lower shrub density or canopy cover, and/or a greater proportion of cheatgrass in the understory than stands that qualify for Level 4. Level 3 also includes high-quality grasslands, conservation corridors, snake hibernacula, bat roosts, rookeries, burrowing owl buffer areas, and areas with significant quantities of culturally important species.
- Level 2 resources include migratory birds, state watch list plants and monitor list animals, recreationally and commercially important species, and lower quality steppe and shrub-steppe.

- Level 1 resources include individual common native plant and wildlife species, upland stands of non-native plants, and abandoned agricultural fields.

Evaluation Units (EUs) – groupings of sources, aggregated for evaluation as part of the Hanford Site-wide Risk Review Project. Sources may be aggregated into an EU based on potential impacts to a common set of receptors or receptor geographic area, common past waste management practices, or integration in the waste management process.

MBTA – Migratory Bird Treaty Act; referring to species listed and protected under the federal Act.

PNNL ECAP (Ecological Compliance and Assessment Project) Database – PNNL performed ecological reviews for individual projects and annually surveyed selected areas and buildings on the Hanford Site for DOE-RL under the DOE's Public Safety and Resource Protection Program until 2011. The data collected during those surveys is archived in the ECAP database, and is used to supplement ecological evaluations as available.

Priority Habitats – Priority habitats are habitat types or elements with unique or significant value to a diverse assemblage of species. A priority habitat may consist of a unique vegetation type (e.g., shrub-steppe) or dominant plant species (e.g., juniper savannah), a described successional stage (e.g., old-growth forest), or a specific habitat feature (e.g., cliffs).

Species of Concern or Species of Conservation Concern – An informal term that for the purpose of this assessment includes those species listed at the federal or state level as being threatened endangered, sensitive, or candidate, as well as those listed by the U.S. Fish and Wildlife Service as species of concern within the ecoregion.

ECAP Database Query Results for W-051a

Observer: ***Hand, Kris*** Date ***7/28/2010***

Plant

Common Name	Latin Name	Abundance	Comments
big sagebrush	Artemisia tridentata		Remnant few N end
Sandberg's bluegrass	Poa sandbergii		N end w/ Artr
giant wildrye	Elymus cinereus		Lg grass
Russian thistle	Salsola kali	25	
gray rabbitbrush	Chrysothamnus nauseosus	1	
bur ragweed	Ambrosia acanthicarpa		
hoary aster	Machaeranthera canescens		
indian ricegrass	Oryzopsis hymenoides		

Mammal

Common Name	Latin Name	Abundance	Comments
coyote	Canis latrans	Present	Tracks

Bird

Common Name	Latin Name	Abundance	Comments
No birds observed	No birds		

Evaluation Unit:	S-SX Tank Farms
ID:	CP-TF-2
Group:	Tank Farm
Operable Unit Cross-Walk:	WMA S/SX 200-DV-1 200-WA-1
Related EU:	CP-LS-7 CP-TF-9 CP-GW-2
Sites & Facilities:	S-SX Tank Farms, ancillary structures, associated liquid waste sites, and soils contamination; includes 242-S Evaporator
Key Data Sources Docs:	DOE/RL-96-32 2013 PNNL ECAP Database[6]
Field Survey Date:	10/14/2014
Date Sheet Prepared By:	KDH, JLD, MAC, KBL, SAM; 10/23/2014

Figure J.13. Site Map of the S-SX Tank Farms Evaluation Unit Boundary and Tank Locations

CP-TF-2: S-SX Tank Farms

Survey and Analysis Methods:

The evaluation process makes use of existing biological resource level maps (DOE/RL-96-32 2013), field surveys and measurement of current vegetation and habitat conditions, and wildlife observations to evaluate potential ecological impacts associated with cleanup activities at the

[6] The Ecological Compliance and Assessment Project (ECAP) database is an evolving set of data that is maintained by Pacific Northwest National Laboratory (PNNL) and updated as new ecological assessments are completed.

evaluation unit (EU). Additional information used in the ecological evaluation includes the current Endangered and Threatened Species (Federal and State) distribution data; priority habitats as defined by Washington Department of Fish and Wildlife; available current aerial imagery, locations of Hanford Site waste sites and infrastructure spatial data; and available information about species of concern distribution and habitat use in the vicinity of the EUs including data previously collected by PNNL for DOE-RL. Definitions relevant to the methods and ecological survey results are provided at the end of this summary along with field data tables.

The following steps were taken to assess the EU associated with the S-SX Tank Farms:

1. The EU boundary (polygon) is assumed to represent the estimated boundary or extent of potential habitat removal and direct disturbance due to remediation.
2. A visual survey was conducted within the EU boundary by experienced shrub-steppe ecologists. Because the unit consists of disturbed and revegetated areas and graveled surfaces, no field measurements of vegetation were taken. PNNL biologists also reviewed the observations and biological survey data available in the Ecological Compliance and Assessment Project (ECAP) database from the past 5 years for the EU to determine the status and resource level of the habitats within the EU and supplement the evaluation with previous wildlife or plant species observations.
3. A second boundary (polygon) outside the EU was established to evaluate indirect effects and assess the remediation in relation to adjacent landscape features. This polygon is centered on the EU and encompasses a circular area with a radius 1 times the maximum width of the EU and is referred to as the **adjacent landscape buffer**.
4. A reconnaissance survey of the boundary of the EU was conducted to confirm the validity of past mapping of biological resources. Aerial imagery from 2012 was reviewed to identify any significant changes in habitat and resource levels (such as new well pads, roads, or other ground disturbance not captured by the available biological resources mapping) within the EU and adjacent landscape buffer. Where significant change is evident from ground survey or imagery, the biological resource map was updated to reflect the change in resource level.
5. The spatial extent of habitat classified at each of 6 resource levels (0 – 5) (DOE/RL-96-32 2013; definitions at end of this summary) within the adjacent landscape buffer area and the EU were assessed and compared using a Geographic Information System (GIS) to examine potential indirect effects on habitat condition within the adjacent landscape. For purposes of assessing indirect effects on the adjacent landscape, this evaluation assumes the maximum potential change in biological resources—that is, all habitat within the EU is assumed to be lost to remediation and cleanup activities and resources in the EU are considered level 0.
6. PNNL biologists assembled the information from field survey, reconnaissance, and spatial analyses of resource availability to provide a subjective evaluation of potential effects on habitat connectivity in the vicinity of the EU.

Field Survey:

PNNL biologists conducted a reconnaissance and visual survey of the S-SX Tank Farms EU on October 14, 2014. The major portion of the unit consists of graveled surfaces, buildings, parking areas, and infrastructure related to the tanks. Small areas of remnant shrub-steppe vegetation occur within the EU near the west and south boundaries. The canopy cover was visually evaluated in the field for these patches. In the overstory successional shrub (gray rabbitbrush, *Ericameria nauseosa*) cover was approximately 5%, with mixed native and alien grasses and forbs in the understory (Table J.13).

No wildlife were observed within the EU during the October reconnaissance, however, PNNL ECAP surveys conducted in 2009 and 2010 noted the following wildlife: an American kestrel (*Falco sparverius*) apparently nesting in a building at the north end of the EU, loggerhead shrike (*Lanius ludovicianus*), Say's phoebe (*Sayornis saya*), barn swallow (*Hirundo rustica*), white-crowned sparrow (*Zonotrichia leucophrys*), western meadowlark (*Sturnella neglecta*), and black-tailed jackrabbit (*Lepus californicus*). All the bird species noted are protected by the Migratory Bird Treaty Act and, additionally, the loggerhead shrike is listed as a Washington State Species of Concern. The black-tailed jackrabbit is listed as a Washington State Candidate Species.

Table J.13. Percent Canopy Cover and Surface Cover Measured at S-SX Tank Farms Evaluation Unit

Vegetation/Surface Cover	Survey Area 2-16 (%)
Introduced Forb	6
Introduced Grass	1
Native Grass	2
Successional Shrubs	5

Landscape Evaluation and Resource Classification:

The amount of each category of biological resources at and near the S-SX Tank Farms EU was examined within a circular area radiating 623 m from the geometric center of the unit (equivalent to 300.9 acres). The majority of the area within the 47.7 acres of the EU is classified as level 0 (41.2 ac) biological resources, with the remainder classified as level 1 and 2. The adjacent landscape buffer consists primarily of level 0, 1, and 2. Small patches of level 3 resources are located to the north and south of the EU, including several point occurrences of sensitive species (Figure J.14). Overall, approximately 5.3 percent of the total combined area currently consists of level 3 or higher biological resources (Figure J.14, Table J.14).

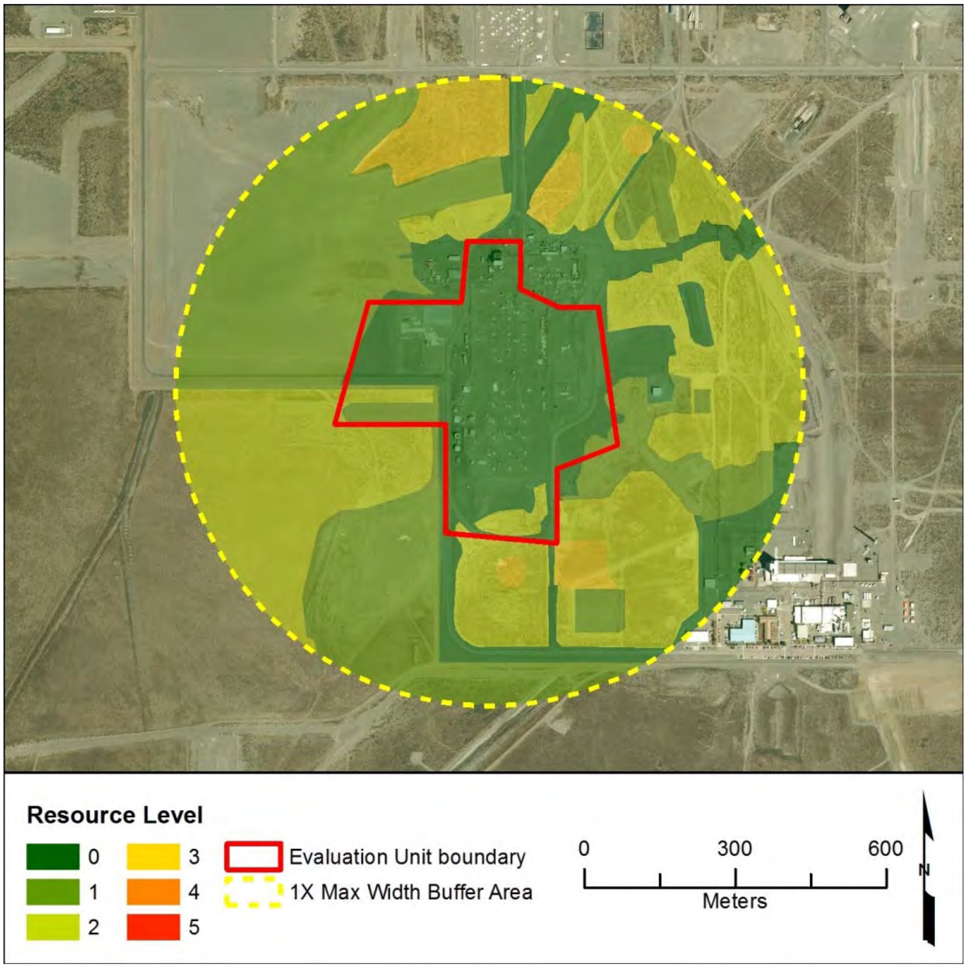

Figure J.14. Biological Resource Level Classifications Based on October 2014 Surveys for the S-SX Tank Farms Evaluation Unit (red solid line) and Adjacent Landscape Buffer (yellow dashed line)

Table J.14. Area and Proportion of Each Biological Resource Level Within the Evaluation Unit in Relation to Adjacent Landscape and Potential Maximum Change in Resources

Resource Level[1]	Evaluation Unit Area (ac)	Adjacent Landscape Buffer (ac)	Combined Total Area (ac)	Percent of Resource Level in Combined Total Area	Percent of Resource Level in Combined Total Area After Cleanup[2]	Percent Difference at Landscape Scale After Cleanup[2]
0	41.2	41.1	82.2	27.3%	29.5%	2.2%
1	3.4	94.9	98.3	32.7%	31.5%	-1.1%
2	3.2	101.3	104.4	34.7%	33.6%	-1.1%
3	0.0	16.0	16.0	5.3%	5.3%	0.0%
4	0.0	0.0	0.0	0.0%	0.0%	0.0%
5	0.0	0.0	0.0	0.0%	0.0%	0.0%
Total	47.8	253.3	300.9	100.0%	100.0%	

1 Resource levels for both the evaluation unit and adjacent landscape boundary were reviewed in the field and via imagery during October 2014 and revised to reflect current habitats conditions.

2 Potential maximum change in area of a given resource level within the combined total area (Evaluation Unit + Adjacent Landscape Buffer) that would occur assuming that all habitat within the evaluation unit is destroyed by remediation activities and the resource level of the evaluation unit is level 0.

Assumptions and Uncertainty:

Due to project time constraints, the field surveys and reconnaissance of this EU were conducted in mid-October. By the time of the survey, the cool-season annual and perennial herbaceous plants that dominate shrub-steppe habitat had completed seasonal growth and senesced making identification and inventory difficult, and most likely incomplete. Although no records for plant species of concern have been noted, the absence of such species cannot be confirmed by surveys during this time of year.

By mid-October, most migratory birds have completed their nesting cycles, and surveys may not reflect their occupancy and use of habitat within the EU earlier in the season. Their absence cannot be confirmed by surveys in October after the nesting season is over. Further surveys during the nesting season would be required to fully assess the ecological impacts to nesting migratory birds.

Summary of Ecological Review:

- The major portion of the unit (>85%) consists of graveled surfaces, buildings, parking areas, and infrastructure related to the tanks.
- No wildlife were observed within the EU during the October reconnaissance, however, 6 bird species as well as black tailed jackrabbit sign were noted in the vicinity during previous surveys.
- No level 3 or higher quality habitat patches occur within the S-SX Tank Farms EU.
- Cleanup activities undertaken within the EU boundary would result in no net change in the amount of level 3 or higher resources within a 0.6 km radius.

- Because the area is an industrial site, and is contiguous with adjacent tank farms and other industrial areas—no significant change in habitat connectivity would be expected if habitat resources within the EU are lost.

References

DOE/RL-96-32. 2013. Hanford Site Biological Resources Management Plan, Revision 0.

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Washington State Department of Natural Resources. 2014. Washington Natural Heritage Program Plant Ranks. http://www1.dnr.wa.gov/nhp/refdesk/lists/plantrnk.html

Definitions and Acronyms:

Adjacent Landscape Buffer – a circular area adjacent to and outside the EU boundary with the center of the circle at the centroid of the EU, and with a radius that is 1 times the maximum dimension (width or length—whichever is greatest). This circular buffer area is used to evaluate indirect effects and assess the remediation in relation to the landscape features and resources adjacent to the EU. This circular area is generally at least 3 times the area of the EU.

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- Level 5 resources include species that are listed or proposed-to-be listed under the *Endangered Species Act* and their critical habitat, as well as rare and irreplaceable habitats.
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- Level 3 resources include Washington State sensitive, candidate, and review species; Washington Department of Fish and Wildlife priority species; lower quality mature shrub-steppe—such as shrub stands that are less mature, have lower shrub density or canopy cover, and/or a greater proportion of cheatgrass in the understory than stands that qualify for Level 4. Level 3 also includes high-quality grasslands, conservation corridors, snake hibernacula, bat roosts, rookeries, burrowing owl buffer areas, and areas with significant quantities of culturally important species.

- Level 2 resources include migratory birds, state watch list plants and monitor list animals, recreationally and commercially important species, and lower quality steppe and shrub-steppe.
- Level 1 resources include individual common native plant and wildlife species, upland stands of non-native plants, and abandoned agricultural fields.

Evaluation Units (EUs) – groupings of sources, aggregated for evaluation as part of the Hanford Site-wide Risk Review Project. Sources may be aggregated into an EU based on potential impacts to a common set of receptors or receptor geographic area, common past waste management practices, or integration in the waste management process.

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Priority Habitats – Priority habitats are habitat types or elements with unique or significant value to a diverse assemblage of species. A priority habitat may consist of a unique vegetation type (e.g., shrub-steppe) or dominant plant species (e.g., juniper savannah), a described successional stage (e.g., old-growth forest), or a specific habitat feature (e.g., cliffs).

Species of Concern or Species of Conservation Concern – An informal term that for the purpose of this assessment includes those species listed at the federal or state level as being threatened endangered, sensitive, or candidate, as well as those listed by the U.S. Fish and Wildlife Service as species of concern within the ecoregion.

Field Data Sheets

Percent Canopy Cover of Herbaceous Species Surveyed Visually

EU	Survey Area	Species	Origin & Class	Percent Cover
S-SX Tank Farm	2-16	CHNA	NS	5
S-SX Tank Farm	2-16	ORHY	NG	<1
S-SX Tank Farm	2-16	STCO	NG	1
S-SX Tank Farm	2-16	SATR	IF	6
S-SX Tank Farm	2-16	BRTE	IG	1
S-SX Tank Farm	2-16	POSE	NG	<1

Notes: Level 0 is pretty much bare sand/gravel with a few SAKA. In this EU we alse changed resource level 1 area outside 200W fenceline to level 3 b high percentage of mature CHNA with some ARTR. There was no assigned patch_ID to begin with.

ECAP Database Query Results for W-503

Observer: ***Chamness, Mickie*** Date ***5/6/2009***

Bird

Common Name	Latin Name	Abundance	Comments
white-crowned sparrow	Zonotrichia leucophrys	6	On grnd
barn swallow	Hirundo rustica	1	Fly over
American kestrel	Falco sparverius	2	Flew to high light pole, nesting her or on 242-S
Say's phoebe	Sayornis saya	1	Collecting nest stuff

Bird

Common Name	Latin Name	Abundance	Comments
loggerhead shrike	Lanius ludovicianus	1	Flew to W powerline

Observer: ***Hand, Kris*** Date ***5/5/2009***

Plant

Common Name	Latin Name	Abundance	Comments
cheatgrass	Bromus tectorum		Saka

Wednesday, October 15, 2014 Page 1 of 1

ECAP Database Query Results for W-044

Observer: *Freeman-Cadoret, Natalie* Date *5/18/2010*

Plant

Common Name	Latin Name	Abundance	Comments
gray rabbitbrush	Chrysothamnus nauseosus	5	
Sandberg's bluegrass	Poa sandbergii	5	
cheatgrass	Bromus tectorum	30	
needle-and-thread grass	Stipa comata	1	
crested wheatgrass	Agropyron cristatum		
stalked-pod milkvetch	Astragalus sclerocarpus		
slender hawksbeard	Crepis atrabarba		
slender sixweeks	Festuca octoflora		
jagged chickweed	Holosteum umbellatum		
hoary aster	Machaeranthera canescens		
indian ricegrass	Oryzopsis hymenoides		
pine bluegrass	Poa scabrella		
Russian thistle	Salsola kali		

Mammal

Common Name	Latin Name	Abundance	Comments
black-tailed jackrabbit	Lepus californicus	Present	Saw the rabbit

Bird

Common Name	Latin Name	Abundance	Comments
western meadowlark	Sturnella neglecta	2	

Observer: *Simmons, Mary Ann* Date *5/18/2010*

Plant

Common Name	Latin Name	Abundance	Comments
cheatgrass	Bromus tectorum	60	
gray rabbitbrush	Chrysothamnus nauseosus	1	
Sandberg's bluegrass	Poa sandbergii	1	
stalked-pod milkvetch	Astragalus sclerocarpus		
sagebrush mariposa lily	Calochortus macrocarpus		
slender hawksbeard	Crepis atrabarba		
winged cryptantha	Cryptantha pterocarya		
turpentine springparsley	Cymopteris terebithinus		
hoary aster	Machaeranthera canescens		
pale evening primrose	Oenothera pallida		
indian ricegrass	Oryzopsis hymenoides		
pine bluegrass	Poa scabrella		
Jim Hill's tumblemustard	Sisymbrium altissimum		
needle-and-thread grass	Stipa comata		

ECAP Database Query Results for W-107d

Observer: ***Hand, Kris*** Date ***6/1/2010***

Plant

Common Name	Latin Name	Abundance	Comments
No vegetation present	No vegetation	80	gravel
Sandberg's bluegrass	Poa sandbergii	1	
Russian thistle	Salsola kali	1	
crested wheatgrass	Agropyron cristatum		
cheatgrass	Bromus tectorum		
gray rabbitbrush	Chrysothamnus nauseosus		

Bird

Common Name	Latin Name	Abundance	Comments
No birds observed	No birds		

Evaluation Unit: TX-TY Tank Farms
ID: CP-TF-3
Group: Tank Farm
Operable Unit Cross-Walk: WMA TX/TY
200-DV-1
200-WA-1
Related EU: CP-LS-7
CP-GW-2
Sites & Facilities: TX-TY tank farms, ancillary structures, associated liquid waste sites, and soils contamination; includes 242-T Evaporator
Key Data Sources Docs: DOE/RL-96-32 2013
PNNL ECAP Database[7]
Field Survey Date: 10/10/2014
Data Sheet Prepared By: JLD, MAC, KBL, KDH, SAM; 10/22/2014

DRAFT

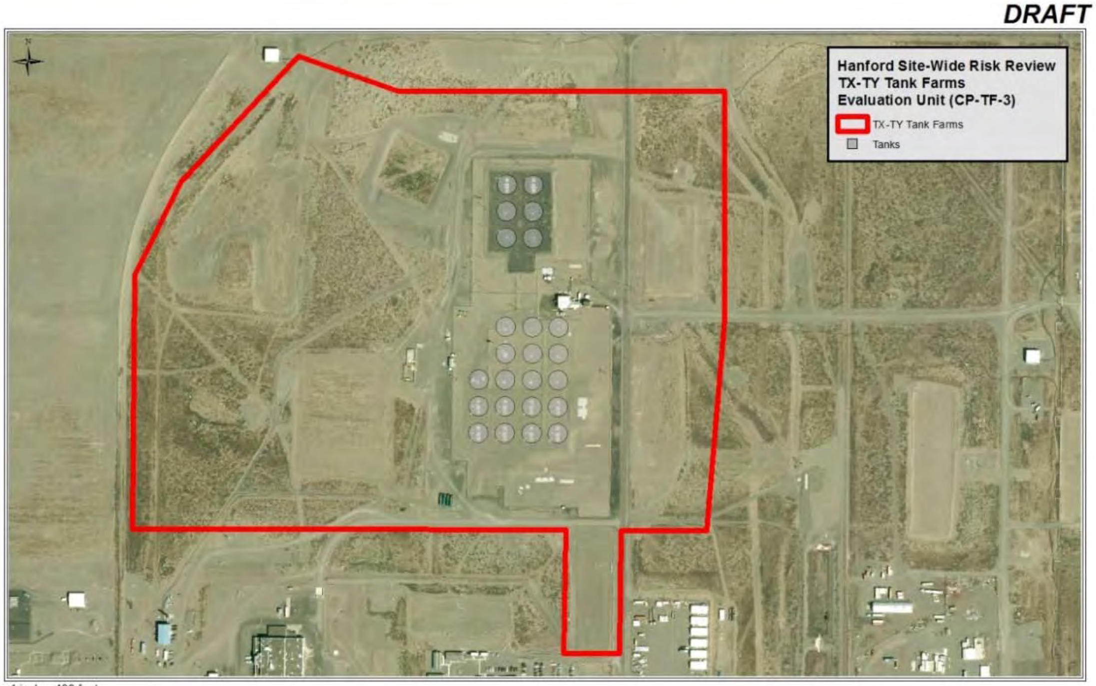

Figure J.15. Site Map with Evaluation Unit Boundaries and Tank Locations

CP-TF-3: TX-TY Tank Farms

Survey and Analysis Methods:

The evaluation process makes use of existing biological resource level maps (DOE/RL-96-32 2013), field surveys and measurement of current vegetation and habitat conditions, and wildlife observations to evaluate potential ecological impacts associated with cleanup activities at the

[7] The Ecological Compliance and Assessment Project (ECAP) database is an evolving set of data that is maintained by Pacific Northwest National Laboratory (PNNL) and updated as new ecological assessments are completed.

evaluation unit (EU). Additional information used in the ecological evaluation includes the current Endangered and Threatened Species (Federal and State) distribution data; priority habitats as defined by Washington Department of Fish and Wildlife; available current aerial imagery, locations of Hanford Site waste sites and infrastructure spatial data; and available information about species of concern distribution and habitat use in the vicinity of the EUs including data previously collected by PNNL for DOE-RL. Definitions relevant to the methods and ecological survey results are provided at the end of this summary along with field data tables.

The following steps were taken to assess the EU associated with the TX-TY Tank Farms:

1. The EU boundary (polygon) is assumed to represent the estimated boundary or extent of potential habitat removal and direct disturbance due to remediation.
2. A visual and pedestrian survey was conducted within the EU boundary by experienced shrub-steppe ecologists. Vegetation was measured in the field in level 3 habitat resources. PNNL biologists also reviewed the observations and biological survey data available in the Ecological Compliance and Assessment Project (ECAP) database from the past 5 years for the EU to determine the status and resource level of the habitats within the EU and supplement the evaluation with previous wildlife or plant species observations.
3. A second boundary (polygon) outside the EU was established to evaluate indirect effects and assess the remediation in relation to adjacent landscape features. This polygon is centered on the EU and encompasses a circular area with a radius 1 times the maximum width of the EU and is referred to as the **adjacent landscape buffer**.
4. A reconnaissance survey of the boundary of the EU was conducted to confirm the validity of past mapping of biological resources. Aerial imagery from 2012 was reviewed to identify any significant changes in habitat and resource levels (such as new well pads, roads, or other ground disturbance not captured by the available biological resources mapping) within the EU and adjacent landscape buffer. Where significant change is evident from ground survey or imagery, the biological resource map was updated to reflect the change in resource level.
5. The spatial extent of habitat classified at each of 6 resource levels (0 – 5) (DOE/RL-96-32 2013; definitions at end of this summary) within the adjacent landscape buffer area and the EU were assessed and compared using a Geographic Information System (GIS) to examine potential indirect effects on habitat condition within the adjacent landscape. For purposes of assessing indirect effects on the adjacent landscape, this evaluation assumes the maximum potential change in biological resources—that is, all habitat within the EU is assumed to be lost to remediation and cleanup activities and resources in the EU are considered level 0.
6. PNNL biologists assembled the information from field survey, reconnaissance, and spatial analyses of resource availability to provide a subjective evaluation of potential effects on habitat connectivity in the vicinity of the EU.

Field Survey:

PNNL biologists conducted pedestrian and vehicle surveys throughout the TX-TY Tank Farms EU. Canopy cover of species was estimated visually in level 2 resource areas, and measured along a transect in a level 3 resource area (Table J.15). Much of the EU (~55 acres) has been previously disturbed by ongoing operations and the installation and operation of various pump and treat wells and remaining habitat occurs in strips and patches surrounded by roads and infrastructure (Table J.16 and Figure J.16). Several areas have been revegetated with a mixture of crested wheatgrass (*Agropyron cristatum)* and shrubs. Vegetation measurements confirmed the status of level 2 and level 3 resources within the EU (Table J.15).

Wildlife signs observed during the October field survey included coyote (*Canis latrans*) tracks, rabbit tracks, small mammal burrows, and harvester ant hills. Previous PNNL ECAP surveys conducted in 2009 and 2010 identified the following wildlife in habitats within the EU: side-blotched lizard (*Uta stansburiana*), western meadowlark (*Sturnella neglecta*), rock dove (*Columba livia*), and northern pocket gopher (*Thomomys talpoides*).

Table J.15. Percent Canopy Cover and Surface Cover Measured at the TX-TY Tank Farms Evaluation Unit

Vegetation/Surface Cover	Survey Area 2-03	Survey Area 2-04a	Survey Area 2-04b	Survey Area 2-05	Survey Area 3-06
Bare Ground	-	-	-	-	35.9
Crust	-	-	-	-	7.0
Litter	-	-	-	-	24.1
Introduced Forb	5	3	1	30	4.0
Introduced Grass	1	1	1	-	6.0
Native Forb	-	-	-	-	9.0
Native Grass	45	41	43	18	34.5
Climax Shrubs	-	-	-	-	12.8
Successional Shrubs	5	1	-	10	2.2

Landscape Evaluation and Resource Classification:

More than 60% of the acreage in the TX-TY Tank Farms EU is classified as level 0 or level 1 habitat and does not provide significant habitat resources (Table J.16, Figure J.16). The EU contains approximately 8 acres of level 3 biological resources. The amount and proximity of the biological resources to the EU was examined within the adjacent landscape buffer area radiating approximately 864 m from the geometric center of the EU (equivalent to 579 acres). More than 60% of the combined total area (EU and adjacent landscape buffer area) is classified as level 0 or 1 habitat. One individual level 3 species occurrence lies within the adjacent landscape buffer—likely Piper's daisy (*Erigeron piperianus*).

Level 2 habitat on the eastern side of the EU is contiguous with larger patches of habitat within the adjacent landscape buffer area that are connected by narrow corridors to habitat outside the 200-West Area. These connections are bisected by various roadways. The level 3 habitat within the EU is isolated from any connections to habitats outside the 200-West Area, although it is contiguous with small amounts of level 3 or level 2 habitats to the south within the adjacent landscape buffer area. Habitats to the south fall within the EU for Plutonium Contaminated Waste Sites and may be affected by remediation actions taken for that unit.

Table J.16. Area and Proportion of Each Biological Resource Level Within the TX-TY Tank Farms Evaluation Unit in Relation to Adjacent Landscape and Potential Maximum Change in Resources

Resource Level[1]	Evaluation Unit Area (ac)	Adjacent Landscape Buffer (ac)	Combined Total Area (ac)	Percent of Resource Level in Combined Total Area	Percent of Resource Level in Combined Total Area After Cleanup[2]	Percent Difference at Landscape Scale After Cleanup[2]
0	37.9	323.9	361.8	62.5%	70.9%	8.5%
1	16.8	9.7	26.5	4.6%	1.7%	-2.9%
2	24.2	138.7	162.9	28.1%	23.9%	-4.2%
3	8.1	19.9	28.0	4.8%	3.4%	-1.4%
4	0.0	0.0	0.0	0.0%	0.0%	0.0%
5	0.0	0.0	0.0	0.0%	0.0%	0.0%
Total	87.0	492.2	579.2	100.0%	100.0%	

1 Resource levels for both the evaluation unit and adjacent landscape boundary were reviewed in the field and via imagery during October 2014 and revised to reflect current habitats conditions.

2 Potential maximum change in area of a given resource level within the combined total area (Evaluation Unit + Adjacent Landscape Buffer) that would occur assuming that all habitat within the evaluation unit is destroyed by remediation activities and the resource level of the evaluation unit is level 0.

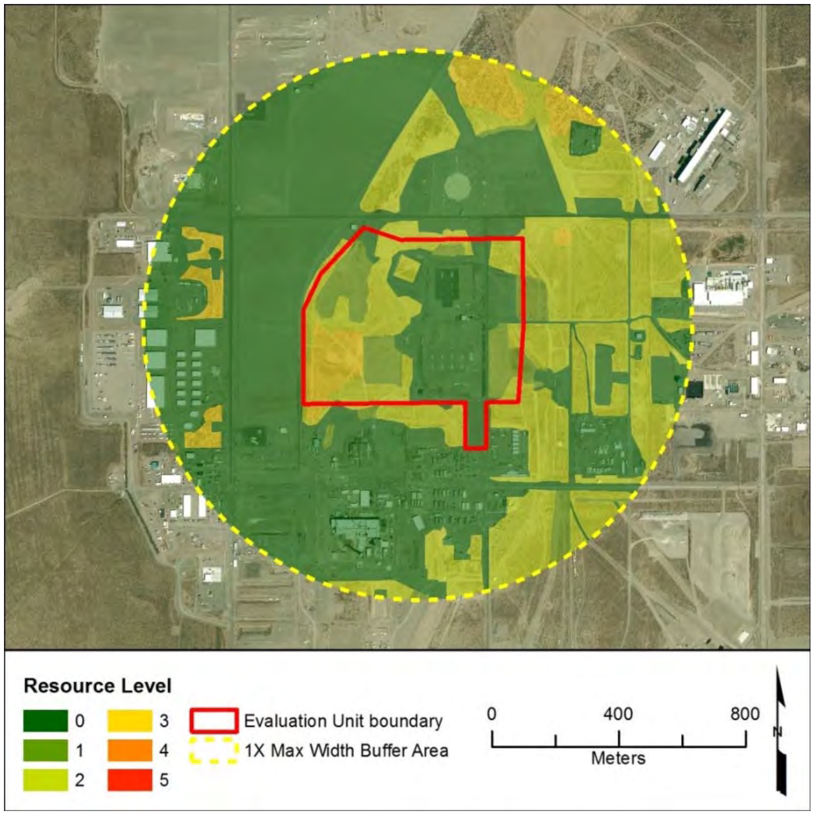

Figure J.16. Biological Resource Level Classifications at the TX-TY Tank Farms Evaluation Unit (red solid line) and Adjacent Landscape Buffer Area (yellow dashed line) Based on Surveys in October 2014

Assumptions and Uncertainty:

Due to project time constraints, the field surveys and reconnaissance of this EU were conducted in October. By the time of the survey, the cool-season annual and perennial herbaceous plants that dominate shrub-steppe habitat had completed seasonal growth and senesced making identification and inventory difficult and most likely incomplete. Although no records for plant species of concern have been noted, the absence of species cannot be confirmed by surveys during this time of year.

By October, migratory birds have completed their nesting cycles and many have migrated away from the region. Surveys conducted in late fall will not reflect migratory bird occupancy and use of habitat within the EU earlier in the season. Their absence cannot be confirmed by surveys after the nesting season is over. Further surveys during the nesting season would be required to fully assess the ecological impacts to nesting migratory birds.

Summary of Ecological Review:

- No species of concern were found within the EU.
- Much of the EU (~55 acres) is graveled, or has been previously disturbed by ongoing operations and the installation and operation of various pump-and-treat wells and remaining habitat occurs in strips and patches surrounded by roads and infrastructure.

- Wildlife signs observed during the October field survey included coyote tracks, rabbit tracks, small mammal burrows, and harvester ant hills; previous surveys identified side-blotched lizard, western meadowlark, rock dove, and northern pocket gopher in the vicinity.
- The TX-TY Tank Farms EU is adjacent and contiguous to other tank farms and waste site EUs.
- Level 3 habitat within the EU does not connect to any level 2 or level 3 habitat lying outside the 200-West Area. Potential loss of level 2 and level 3 habitats within the EU would not be likely to affect habitat connectivity at the landscape scale.

References

DOE/RL-96-32. 2013. Hanford Site Biological Resources Management Plan, Revision 0.

U.S. Fish and Wildlife Service (USFWS). 2014. Birds Protected by the Migratory Bird Treaty Act. http://www.fws.gov/migratorybirds/RegulationsPolicies/mbta/mbtintro.html

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PNNL ECAP Survey Data for the TX-TY Tank Farm

ECAP Database Query Results for W-065

Observer: *Simmons, Mary Ann* **Date** *7/14/2010*

Plant

Common Name	Latin Name	Abundance	Comments
gray rabbitbrush	Chrysothamnus nauseosus	30	
cheatgrass	Bromus tectorum	20	
Sandberg's bluegrass	Poa sandbergii	10	
crested wheatgrass	Agropyron cristatum		
big sagebrush	Artemisia tridentata		
hoary aster	Machaeranthera canescens		
indian ricegrass	Oryzopsis hymenoides		
Russian thistle	Salsola kali		

Mammal

Common Name	Latin Name	Abundance	Comments
unknown/unidentified small mammal	small mammal	Present	Tracks and holes
Unidentified/Unlisted mammal	Unidentified/Unlisted mammal	Present	rabbit pellets

Herpt

Common Name	Latin Name	Abundance	Comments
Unidentified/Unlisted herpt	Unidentified/Unlisted herpt	Common	snake tracks
side-blotched lizard	Uta stansburiana	Present	

Bird

Common Name	Latin Name	Abundance	Comments
mourning dove	Zenaida macroura	3	Landed in radiological buffer area within W-065

Observer: *Stegen, Amanda* **Date** *7/14/2010*

Plant

Common Name	Latin Name	Abundance	Comments
Russian thistle	Salsola kali	5	
gray rabbitbrush	Chrysothamnus nauseosus	15	
cheatgrass	Bromus tectorum	10	
crested wheatgrass	Agropyron cristatum		
stalked-pod milkvetch	Astragalus sclerocarpus		
matted cryptantha	Cryptantha circumscissa		
spring whitlowgrass	Draba verna		
hoary aster	Machaeranthera canescens		
indian ricegrass	Oryzopsis hymenoides		
Sandberg's bluegrass	Poa sandbergii		

Mammal

Common Name	Latin Name	Abundance	Comments
unknown/unidentified small mammal	small mammal	Present	Some holes

Wednesday, October 15, 2014 Page 1 of 2

ECAP Database Query Results for W-065a

Observer: *Chamness, Mickie* Date *5/6/2009*

Plant

Common Name	Latin Name	Abundance	Comments
No vegetation present	No vegetation		

Wednesday, October 15, 2014 Page 1 of 1

ECAP Database Query Results for W-069

Observer: *Simmons, Mary Ann* Date *7/14/2010*

Plant

Common Name	Latin Name	Abundance	Comments
Sandberg's bluegrass	Poa sandbergii	5	
big sagebrush	Artemisia tridentata	20	
cheatgrass	Bromus tectorum	15	
yarrow	Achillea millefolium		
crested wheatgrass	Agropyron cristatum		
gray rabbitbrush	Chrysothamnus nauseosus		
green rabbitbrush	Chrysothamnus viscidiflorus		
bastard toadflax	Comandra umbellata		
matted cryptantha	Cryptantha circumscissa		
turpentine springparsley	Cymopteris terebithinus		
slender sixweeks	Festuca octoflora		
prickly lettuce	Lactuca serriola		
hoary aster	Machaeranthera canescens		
flattop broomrape	Orobanche corymbosa		
indian ricegrass	Oryzopsis hymenoides		
Russian thistle	Salsola kali		

Mammal

Common Name	Latin Name	Abundance	Comments
unknown/unidentified small mammal	small mammal	Common	Tracks and holes
Unidentified/Unlisted mammal	Unidentified/Unlisted mammal	Present	rabbit pellets

Bird

Common Name	Latin Name	Abundance	Comments
western meadowlark	Sturnella neglecta	1	Singing
rock dove	Columba livia	13	Flushed

Observer: *Stegen, Amanda* Date *7/14/2010*

Plant

Common Name	Latin Name	Abundance	Comments
big sagebrush	Artemisia tridentata	20	
cheatgrass	Bromus tectorum	10	
gray rabbitbrush	Chrysothamnus nauseosus		
green rabbitbrush	Chrysothamnus viscidiflorus		
matted cryptantha	Cryptantha circumscissa		
turpentine springparsley	Cymopteris terebithinus		
spring whitlowgrass	Draba verna		
prickly lettuce	Lactuca serriola		
hoary aster	Machaeranthera canescens		

Wednesday, October 15, 2014 Page 1 of 2

ECAP Database Query Results for W-069b

Observer: *Chamness, Mickie* Date *6/10/2009*

Plant

Common Name	Latin Name	Abundance	Comments
cheatgrass	Bromus tectorum	10	
crested wheatgrass	Agropyron cristatum	1	
stalked-pod milkvetch	Astragalus sclerocarpus		
gray rabbitbrush	Chrysothamnus nauseosus		
indian ricegrass	Oryzopsis hymenoides		
bulbous bluegrass	Poa bulbosa		
Sandberg's bluegrass	Poa sandbergii		
Russian thistle	Salsola kali		

Mammal

Common Name	Latin Name	Abundance	Comments
coyote	Canis latrans	Present	Tracks

Observer: *Freeman-Cadoret, Natalie* Date *6/10/2009*

Plant

Common Name	Latin Name	Abundance	Comments
crested wheatgrass	Agropyron cristatum		
cheatgrass	Bromus tectorum		
gray rabbitbrush	Chrysothamnus nauseosus		
hoary aster	Machaeranthera canescens		
bulbous bluegrass	Poa bulbosa		
Sandberg's bluegrass	Poa sandbergii		
Russian thistle	Salsola kali		

Mammal

Common Name	Latin Name	Abundance	Comments
unknown/unidentified small mammal	small mammal	Present	

Observer: *Hand, Kris* Date *6/10/2009*

Plant

Common Name	Latin Name	Abundance	Comments
cheatgrass	Bromus tectorum	10	much bare sand/gravel in poly
gray rabbitbrush	Chrysothamnus nauseosus	1	
Russian thistle	Salsola kali	1	
indian ricegrass	Oryzopsis hymenoides	+	
crested wheatgrass	Agropyron cristatum		
thickspike wheatgrass	Agropyron dasytachyum		

Wednesday, October 15, 2014 Page 1 of 2

ECAP Database Query Results for W-071

Observer: *Simmons, Mary Ann* Date *7/14/2010*

Plant

Common Name	Latin Name	Abundance	Comments
cheatgrass	Bromus tectorum	5	
gray rabbitbrush	Chrysothamnus nauseosus	20	
crested wheatgrass	Agropyron cristatum		
bur ragweed	Ambrosia acanthicarpa		
big sagebrush	Artemisia tridentata		
green rabbitbrush	Chrysothamnus viscidiflorus		
hoary aster	Machaeranthera canescens		
pale evening primrose	Oenothera pallida		
indian ricegrass	Oryzopsis hymenoides		
Sandberg's bluegrass	Poa sandbergii		
Russian thistle	Salsola kali		
needle-and-thread grass	Stipa comata		

Herpt

Common Name	Latin Name	Abundance	Comments
side-blotched lizard	Uta stansburiana	Present	

Observer: *Stegen, Amanda* Date *7/14/2010*

Plant

Common Name	Latin Name	Abundance	Comments
cheatgrass	Bromus tectorum	20	
gray rabbitbrush	Chrysothamnus nauseosus	15	
Russian thistle	Salsola kali	10	
crested wheatgrass	Agropyron cristatum		
bur ragweed	Ambrosia acanthicarpa		
bur ragweed	Ambrosia acanthicarpa		
big sagebrush	Artemisia tridentata		
stalked-pod milkvetch	Astragalus sclerocarpus		
green rabbitbrush	Chrysothamnus viscidiflorus		
matted cryptantha	Cryptantha circumscissa		
spring whitlowgrass	Draba verna		
hoary aster	Machaeranthera canescens		
indian ricegrass	Oryzopsis hymenoides		
Sandberg's bluegrass	Poa sandbergii		

Mammal

Common Name	Latin Name	Abundance	Comments
unknown/unidentified small mammal	small mammal	Present	many holes

Wednesday, October 15, 2014 Page 1 of 1

ECAP Database Query Results for W-073a

Observer: *Chamness, Mickie* Date *7/1/2010*

Plant

Common Name	Latin Name	Abundance	Comments
No vegetation present	No vegetation		Bare 40%
crested wheatgrass	Agropyron cristatum	15	
gray rabbitbrush	Chrysothamnus nauseosus	+	
bur ragweed	Ambrosia acanthicarpa		
stalked-pod milkvetch	Astragalus sclerocarpus		
cheatgrass	Bromus tectorum		
prickly lettuce	Lactuca serriola		
hoary aster	Machaeranthera canescens		
whitestem stickleaf	Mentzelia albicaulis		
indian ricegrass	Oryzopsis hymenoides		
Sandberg's bluegrass	Poa sandbergii		
Russian thistle	Salsola kali		
stiff wirelettuce	Stephanomeria paniculata		

Mammal

Common Name	Latin Name	Abundance	Comments
northern pocket gopher	Thomomys talpoides	Present	Mnds
unknown/unidentified small mammal	small mammal	Common	Holes
coyote	Canis latrans	Common	dig, tracks

Wednesday, October 15, 2014 Page 1 of 1

ECAP Database Query Results for W-073b

Observer: *Chamness, Mickie* Date *7/1/2010*

Plant

Common Name	Latin Name	Abundance	Comments
No vegetation present	No vegetation		

Bird

Common Name	Latin Name	Abundance	Comments
No birds observed	No birds		

Wednesday, October 15, 2014 Page 1 of 1

ECAP Database Query Results for W-083

Observer: *Chamness, Mickie* Date *7/7/2010*

Plant

Common Name	Latin Name	Abundance	Comments
Sandberg's bluegrass	Poa sandbergii	25	
gray rabbitbrush	Chrysothamnus nauseosus	20	
Russian thistle	Salsola kali	20	
cheatgrass	Bromus tectorum	10	
crested wheatgrass	Agropyron cristatum		
big sagebrush	Artemisia tridentata		
stalked-pod milkvetch	Astragalus sclerocarpus		
hoary aster	Machaeranthera canescens		
indian ricegrass	Oryzopsis hymenoides		
bulbous bluegrass	Poa bulbosa		
needle-and-thread grass	Stipa comata		

Mammal

Common Name	Latin Name	Abundance	Comments
Unidentified/Unlisted mammal	Unidentified/Unlisted mammal	Present	Rabbit poop
northern pocket gopher	Thomomys talpoides	Present	Mnds
unknown/unidentified small mammal	small mammal	Present	Holes

Bird

Common Name	Latin Name	Abundance	Comments
western meadowlark	Sturnella neglecta	1	Call, N pwrline
No birds observed	No birds		

Observer: *Simmons, Mary Ann* Date *7/7/2010*

Plant

Common Name	Latin Name	Abundance	Comments
cheatgrass	Bromus tectorum		
gray rabbitbrush	Chrysothamnus nauseosus		
indian ricegrass	Oryzopsis hymenoides		
Sandberg's bluegrass	Poa sandbergii		
Russian thistle	Salsola kali		

Wednesday, October 15, 2014 Page 1 of 1

ECAP Database Query Results for W-087

Observer: *Chamness, Mickie* Date *7/1/2010*

Plant

Common Name	Latin Name	Abundance	Comments
gray rabbitbrush	Chrysothamnus nauseosus	5	
Russian thistle	Salsola kali	30	
Sandberg's bluegrass	Poa sandbergii	20	
cheatgrass	Bromus tectorum	15	
crested wheatgrass	Agropyron cristatum		
whitestem stickleaf	Mentzelia albicaulis		
indian ricegrass	Oryzopsis hymenoides		
stiff wirelettuce	Stephanomeria paniculata		

Mammal

Common Name	Latin Name	Abundance	Comments
coyote	Canis latrans	Present	Tracks
Unidentified/Unlisted mammal	Unidentified/Unlisted mammal	Present	Syzu? tracks
unknown/unidentified small mammal	small mammal	Present	Holes

Observer: *Simmons, Mary Ann* Date *7/1/2010*

Plant

Common Name	Latin Name	Abundance	Comments
Piper's daisy	Erigeron piperianus		1 plant; 2 seedlings
cheatgrass	Bromus tectorum	30	
gray rabbitbrush	Chrysothamnus nauseosus	15	
Sandberg's bluegrass	Poa sandbergii	10	
yarrow	Achillea millefolium		
crested wheatgrass	Agropyron cristatum		
big sagebrush	Artemisia tridentata		
asparagus	Asparagus officinalis		
buckwheat milkvetch	Astragalus caricinus		
prickly lettuce	Lactuca serriola		
hoary aster	Machaeranthera canescens		
whitestem stickleaf	Mentzelia albicaulis		
indian ricegrass	Oryzopsis hymenoides		
Russian thistle	Salsola kali		
sand dropseed	Sporobolus cryptandrus		
stiff wirelettuce	Stephanomeria paniculata		
needle-and-thread grass	Stipa comata		

Mammal

Common Name	Latin Name	Abundance	Comments
Unidentified/Unlisted mammal	Unidentified/Unlisted mammal	Present	tracks

Wednesday, October 15, 2014 Page 1 of 2

ECAP Database Query Results for W-104

Observer: *Simmons, Mary Ann* Date *7/14/2010*

Plant

Common Name	Latin Name	Abundance	Comments
cheatgrass	Bromus tectorum	5	
crested wheatgrass	Agropyron cristatum	20	
indian ricegrass	Oryzopsis hymenoides		
Sandberg's bluegrass	Poa sandbergii		
Russian thistle	Salsola kali		

Mammal

Common Name	Latin Name	Abundance	Comments
unknown/unidentified small mammal	small mammal	Present	Tracks and holes

Bird

Common Name	Latin Name	Abundance	Comments
No birds observed	No birds	0	

Field Data Collected at TX-TY Tank Farm EU on October 10, 2014

Percent Canopy Cover of Herbaceous Species Measured in 0.5 m2 quadrats

EU	Survey Area	Species	Origin & Class	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10	sum	Mean Canopy Cover	Freq
TX_TY Tank Farms	3-06	ORHY	NG	26	20		35	40			30			151	30.2	0.5
TX_TY Tank Farms	3-06	BRTE	IG	8		1	1	1	8	8	1	13	13	54	6.0	0.9
TX_TY Tank Farms	3-06	SATR	IF	6	1	1	5	1	14	3	1	3	5	40	4.0	1.0
TX_TY Tank Farms	3-06	CRCI	NF	1						1				2	1.0	0.2
TX_TY Tank Farms	3-06	MACA	NF		8									8	8.0	0.1
TX_TY Tank Farms	3-06	LITTER	LITTER	25	35	20	35	16	28	8	25	34	15	241	24.1	1.0
TX_TY Tank Farms	3-06	BARE	BARE	35	5	2	12	28	67	88		34	52	323	35.9	0.9
TX_TY Tank Farms	3-06	CHNA	NS		20									20	20.0	0.1
TX_TY Tank Farms	3-06	CRUST	CRUST		10		12	12	5	4	2	6	5	56	7.0	0.8
TX_TY Tank Farms	3-06	ARTR	NS			75					46	8	2	131	32.8	0.4
TX_TY Tank Farms	3-06	POSE	NG			2					6		2	10	3.3	0.3
TX_TY Tank Farms	3-06	FEOC	NG					1					1	2	1.0	0.2

Notes

Shrub Canopy Measured by Line-Intercept Methods on 50m Transect

EU	Survey Area	Species	Transect Distance (total)	Start	Stop	Dif
TX_TY Tank Farms	3-06	ARTR	50	1.4	1.9	0.5
TX_TY Tank Farms	3-06	ARTR	50	13.7	16.0	2.3
TX_TY Tank Farms	3-06	CHNA	50	28.2	28.7	0.5
TX_TY Tank Farms	3-06	CHNA	50	31.0	31.6	0.6
TX_TY Tank Farms	3-06	ARTR	50	31.7	32.5	0.8
TX_TY Tank Farms	3-06	ARTR	50	32.7	33.6	0.9
TX_TY Tank Farms	3-06	ARTR	50	40.8	41.7	0.9
TX_TY Tank Farms	3-06	ARTR	50	43.4	44.3	0.9
TX_TY Tank Farms	3-06	ARTR	50	46.4	46.5	0.1

Notes

Evaluation Unit: TX-TY Tank Farms	Observers: MAC, KDH
Patch ID: 2-03	Date: 10/14/2014

Wildlife Observations Recorded During Pedestrian or Vehicle Surveys	
Species	Observation
CALA	Tracks
Harvester Ants	
Notes	

Evaluation Unit: TX-TY Tank Farms	Observers: MAC, KDH
Patch ID: 2-04 A & B	Date: 10/14/2014

Wildlife Observations Recorded During Pedestrian or Vehicle Surveys	
Species	Observation
CALA	Tracks
Harvester Ants	
Notes	

Evaluation Unit: TX-TY Tank Farms	Observers: MAC, KDH
Patch ID: 2-05	Date: 10/13/2014

Wildlife Observations Recorded During Pedestrian or Vehicle Surveys	
Species	Observation
CALA	Tracks
Harvester Ants	mounds
Notes	

Evaluation Unit: TX-TY Tank Farms	Observers: JLD, MAC
Patch ID: 3-06	Date: 10/10/2014

Wildlife Observations Recorded During Pedestrian or Vehicle Surveys	
Species	Observation
Coyote	Tracks
Rabbitt	Tracks
Harverster ants	mound
Notes	

Evaluation Unit: U Tank Farm
ID: CP-TF-4
Group: Tank Farm
Operable Unit Cross-Walk: WMA U
200-WA-1
Related EU: CP-LS-7
CP-GW-2
Sites & Facilities: U tank farm, ancillary structures, associated liquid waste sites, and soils contamination
Key Data Sources Docs: DOE/RL-96-32 2013
PNNL ECAP Database[8]
Field Survey Date: 10/10/2014
Data Sheet Prepared By: JLD, MAC, SAM, KBL, KDH; 10/22/2014

Figure J.17. Site Map with Evaluation Unit Boundaries and Tank Locations

CP-TF-4: U Tank Farm

Survey and Analysis Methods:

The evaluation process makes use of existing biological resource level maps (DOE/RL-96-32 2013), field surveys and measurement of current vegetation and habitat conditions, and wildlife observations to evaluate potential ecological impacts associated with cleanup activities at the evaluation unit (EU). Additional information used in the ecological evaluation includes the current Endangered and Threatened Species (Federal and State) distribution data; priority

[8] The Ecological Compliance and Assessment Project (ECAP) database is an evolving set of data that is maintained by Pacific Northwest National Laboratory (PNNL) and updated as new ecological assessments are completed.

habitats as defined by Washington Department of Fish and Wildlife; available current aerial imagery, locations of Hanford Site waste sites and infrastructure spatial data; and available information about species of concern distribution and habitat use in the vicinity of the EUs including data previously collected by PNNL for DOE-RL. Definitions relevant to the methods and ecological survey results are provided at the end of this summary along with field data tables.

The following steps were taken to assess the EU associated with the U Tank Farm:

1. The EU boundary (polygon) is assumed to represent the estimated boundary or extent of potential habitat removal and direct disturbance due to remediation.
2. A pedestrian and vehicle survey was conducted within the EU boundary by experienced shrub-steppe ecologists. PNNL biologists also reviewed the observations and biological survey data available in the Ecological Compliance and Assessment Project (ECAP) database from the past 5 years for the EU to determine the status and resource level of the habitats within the EU and supplement the evaluation with previous wildlife or plant species observations.
3. A second boundary (polygon) outside the EU was established to evaluate indirect effects and assess the remediation in relation to adjacent landscape features. This polygon is centered on the EU and encompasses a circular area with a radius 1 times the maximum width of the EU and is referred to as the **adjacent landscape buffer**.
4. A reconnaissance survey of the boundary of the EU was conducted to confirm the validity of past mapping of biological resources. Aerial imagery from 2012 was reviewed to identify any significant changes in habitat and resource levels (such as new well pads, roads, or other ground disturbance not captured by the available biological resources mapping) within the EU and adjacent landscape buffer. Where significant change is evident from ground survey or imagery, the biological resource map was updated to reflect the change in resource level.
5. The spatial extent of habitat classified at each of 6 resource levels (0 – 5) (DOE/RL-96-32 2013; definitions at end of this summary) within the adjacent landscape buffer area and the EU were assessed and compared using a Geographic Information System (GIS) to examine potential indirect effects on habitat condition within the adjacent landscape. For purposes of assessing indirect effects on the adjacent landscape, this evaluation assumes the maximum potential change in biological resources—that is, all habitat within the EU is assumed to be lost to remediation and cleanup activities and resources in the EU are considered level 0.
6. PNNL biologists assembled the information from field survey, reconnaissance, and spatial analyses of resource availability to provide a subjective evaluation of potential effects on habitat connectivity in the vicinity of the EU.

Field Survey:

The fenced portion of the U Tank Farm consists of graveled surfaces and tank farm infrastructure. Some level 2 habitat resources remain at the perimeters of the EU outside the fenced area. Pedestrian surveys of the habitat areas were conducted, and the canopy cover of dominant vegetation was estimated visually (Table J.17).

Table J.17. Percent Canopy Cover and Surface Cover Visually Estimated at U Tank Farm

Vegetation/Surface Cover	Survey Area 2-13	Survey Area 2-14 (Level 2)	Survey Area 2-14 (Level 3)	Survey Area 2-15
Bare Ground	30	25	-	-
Introduced Forb	10	10	-	10
Introduced Grass	-	5	-	5
Native Forb	-	-	-	1
Native Grass	21	12	30	12
Successional Shrubs	15	20	23	15
Climax Shrubs	-	-	5	-

Based on the field surveys, two small patches of habitat within the EU were re-classified from level 2 to level 3 because the understory was primarily native bunchgrasses with a mix of climax and successional species in the shrub layer.

Wildlife observations made during the October survey within the habitat along the borders of the EU included coyote tracks (*Canis latrans*), small mammal burrows, and harvester ant hills. These observations agreed with a sign noted in previous PNNL ECAP surveys of habitat within and around the EU. Those surveys also identified side-blotch lizard (*Uta stansburiana*), northern pocket gopher (*Thomomys talpoides*), lark sparrow (*Chondestes grammacus*), western kingbird Tyrannus verticalis), Say's phoebe (*Sayornis saya*), American kestrel (*Falco sparverius*), western meadowlark (*Sturnella neglecta*), and mourning dove (*Zenaida macroura*).

Landscape Evaluation and Resource Classification:

Approximately 63% of the EU consists of level 0 habitat with graveled and bare surface conditions (Table J.18). Small areas of level 2 (3.6 acres) and level 3 habitat resources (3.5 acres) exist around the perimeter of the EU and are part of larger patches of habitat that extend into the adjacent landscape buffer area as seen in Figure J.18.

The amount and proximity of the biological resources to the EU was examined within the adjacent landscape buffer area radiating approximately 459 m from the geometric center of the EU (equivalent to 163.3 acres). About half of the combined total area (EU and adjacent landscape buffer area) is classified as level 0 or 1 habitat, with level 2 habitat resources comprising 32.6% and level 3 and above resources comprising 16.5% of the area at the landscape level.

Table J.18. Area and Proportion of Each Biological Resource Level Within the U Tank Farm Evaluation Unit in Relation to Adjacent Landscape and Potential Maximum Change in Resources

Resource Level[1]	Evaluation Unit Area (ac)	Adjacent Landscape Buffer (ac)	Combined Total Area (ac)	Percent of Resource Level in Combined Total Area	Percent of Resource Level in Combined Total Area After Cleanup[2]	Percent Difference at Landscape Scale After Cleanup[2]
0	12.3	38.7	51.0	31.3%	35.6%	4.3%
1	0.0	32.0	32.0	19.6%	19.6%	0.0%
2	3.6	49.7	53.3	32.6%	30.4%	-2.2%
3	3.5	23.5	27.0	16.5%	14.4%	-2.1%
4	0.0	0.0	0.0	0.0%	0.0%	0.0%
5	0.0	0.0	0.0	0.0%	0.0%	0.0%
Total	19.4	143.9	163.3	100.0%	100.0%	

1 Resource levels for both the evaluation unit and adjacent landscape boundary were reviewed in the field and via imagery during October 2014 and revised to reflect current habitats conditions.

2 Potential maximum change in area of a given resource level within the combined total area (Evaluation Unit + Adjacent Landscape Buffer) that would occur assuming that all habitat within the evaluation unit is destroyed by remediation activities and the resource level of the evaluation unit is level 0.

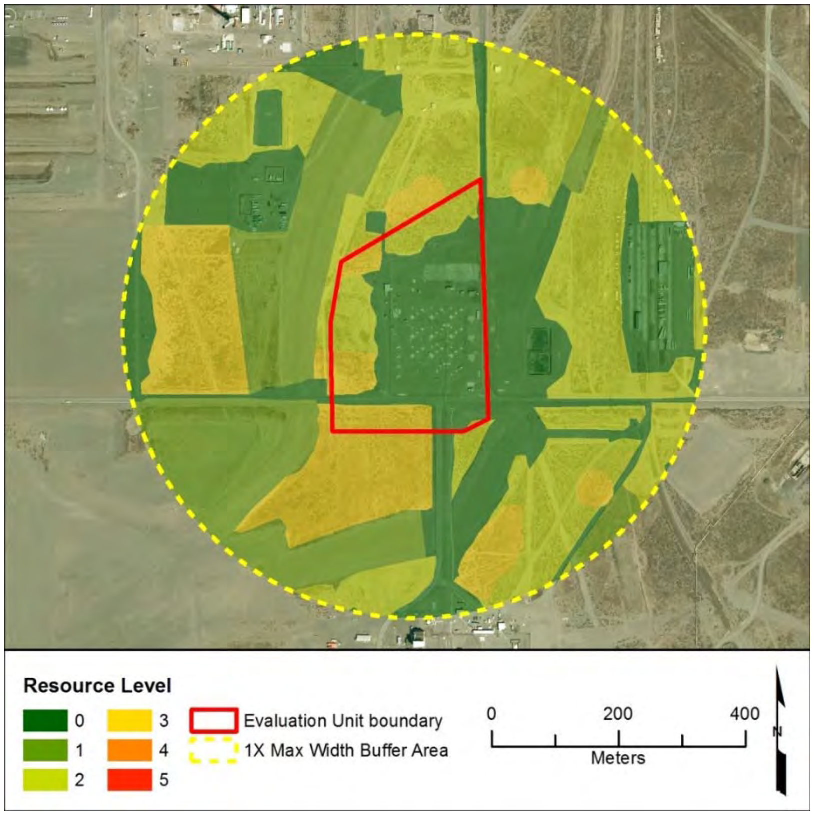

Figure J.18. Biological Resource Level Classifications at the U Tank Farm Evaluation Unit (red solid line) and Adjacent Landscape Buffer Area (yellow dashed line) Based on Surveys in October 2014

Assumptions and Uncertainty:

Due to project time constraints, the field surveys and reconnaissance of this EU were conducted in October. By the time of the survey, the cool-season annual and perennial herbaceous plants that dominate shrub-steppe habitat had completed seasonal growth and senesced making identification and inventory difficult and most likely incomplete. Although no records for plant species of concern have been noted, the absence of species cannot be confirmed by surveys during this time of year.

By October, migratory birds have completed their nesting cycles and many have migrated away from the region. Surveys conducted in late fall will not reflect migratory bird occupancy and use of habitat within the EU earlier in the season. Their absence cannot be confirmed by surveys after the nesting season is over. Further surveys during the nesting season would be required to fully assess the ecological impacts to nesting migratory birds.

Summary of Ecological Review:

- The fenced portion of the U Tank Farm consists of graveled surfaces and tank farm infrastructure (>60%). Level 2 and level 3 habitat resources remain at the perimeters of the EU outside the fenced area (~18% each).

- Wildlife observations made during the October survey within the habitat along the borders of the EU included coyote tracks, small mammal burrows, and harvester ant hills, which were also observed in previous surveys along with northern pocket gopher signs, side-blotched lizards, and 6 migratory bird species.
- Approximately 3.5 acres of level 3 habitat exist within the U Tank Farm EU; total loss of this habitat within the EU would result in a change of approximately 2% at the landscape level evaluated for this unit.
- The remaining level 2 and level 3 habitats within the EU are fragmented and isolated from habitat surrounding the 200-West Area.
- Individual species occurrences of Piper's daisy lie just outside the perimeter of the EU, but would not be expected to be impacted by clean up actions for U-Tank Farm.
- Loss of level 2 and level 3 habitat within the U Tank Farm EU would not be expected to affect habitat connectivity outside the 200-West Area.

References

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Washington Department of Fish and Wildlife. 2008. Washington State Priority Habitats and Species List. Olympia Washington. 174 pp. http://wdfw.wa.gov/conservation/phs/list/

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Definitions and Acronyms:

Adjacent Landscape Buffer – a circular area adjacent to and outside the EU boundary with the center of the circle at the centroid of the EU, and with a radius that is 1 times the maximum dimension (width or length—whichever is greatest). This circular buffer area is used to evaluate indirect effects and assess the remediation in relation to the landscape features and resources adjacent to the EU. This circular area is generally at least 3 times the area of the EU.

Biological Resource Levels (from DOE-RL-96-32-01) –

- Level 5 resources include species that are listed or proposed-to-be listed under the *Endangered Species Act* and their critical habitat, as well as rare and irreplaceable habitats.

- Level 4 resources include federal candidate species; Washington State threatened or endangered species; habitat or exclusion buffers for federal candidates and Washington State threatened or endangered species; high-quality mature shrub steppe; wetlands and riparian areas; and buffer areas for bald eagles and ferruginous hawks.
- Level 3 resources include Washington State sensitive, candidate, and review species; Washington Department of Fish and Wildlife priority species; lower quality mature shrub-steppe—such as shrub stands that are less mature, have lower shrub density or canopy cover, and/or a greater proportion of cheatgrass in the understory than stands that qualify for Level 4. Level 3 also includes high-quality grasslands, conservation corridors, snake hibernacula, bat roosts, rookeries, burrowing owl buffer areas, and areas with significant quantities of culturally important species.
- Level 2 resources include migratory birds, state watch list plants and monitor list animals, recreationally and commercially important species, and lower quality steppe and shrub-steppe.
- Level 1 resources include individual common native plant and wildlife species, upland stands of non-native plants, and abandoned agricultural fields.

Evaluation Units (EUs) – groupings of sources, aggregated for evaluation as part of the Hanford Site-wide Risk Review Project. Sources may be aggregated into an EU based on potential impacts to a common set of receptors or receptor geographic area, common past waste management practices, or integration in the waste management process.

MBTA – Migratory Bird Treaty Act; referring to species listed and protected under the federal Act.

PNNL ECAP (Ecological Compliance and Assessment Project) Database – PNNL performed ecological reviews for individual projects and annually surveyed selected areas and buildings on the Hanford Site for DOE-RL under the DOE's Public Safety and Resource Protection Program until 2011. The data collected during those surveys is archived in the ECAP database, and is used to supplement ecological evaluations as available.

Priority Habitats – Priority habitats are habitat types or elements with unique or significant value to a diverse assemblage of species. A priority habitat may consist of a unique vegetation type (e.g., shrub-steppe) or dominant plant species (e.g., juniper savannah), a described successional stage (e.g., old-growth forest), or a specific habitat feature (e.g., cliffs).

Species of Concern or Species of Conservation Concern – An informal term that for the purpose of this assessment includes those species listed at the federal or state level as being threatened endangered, sensitive, or candidate, as well as those listed by the U.S. Fish and Wildlife Service as species of concern within the ecoregion.

PNNL ECAP Data for U-Tank Farm

ECAP Database Query Results for W-034

Observer: *Chamness, Mickie* Date *7/7/2010*

Plant

Common Name	Latin Name	Abundance	Comments
Russian thistle	Salsola kali	5	
gray rabbitbrush	Chrysothamnus nauseosus	30	
Sandberg's bluegrass	Poa sandbergii	20	
cheatgrass	Bromus tectorum	10	
indian ricegrass	Oryzopsis hymenoides	1	
needle-and-thread grass	Stipa comata	1	
yarrow	Achillea millefolium		
crested wheatgrass	Agropyron cristatum		
big sagebrush	Artemisia tridentata		
stalked-pod milkvetch	Astragalus sclerocarpus		
green rabbitbrush	Chrysothamnus viscidiflorus		
Fendler's cryptantha	Cryptantha fendleri		
turpentine springparsley	Cymopteris terebithinus		
prairie Junegrass	Koeleria cristata		
hoary aster	Machaeranthera canescens		
pale evening primrose	Oenothera pallida		
threadleaf scorpionweed	Phacelia linearis		

Mammal

Common Name	Latin Name	Abundance	Comments
coyote	Canis latrans	Present	Tracks
northern pocket gopher	Thomomys talpoides	Present	Mnd
unknown/unidentified small mammal	small mammal	Common	Holes, tracks

Herpt

Common Name	Latin Name	Abundance	Comments
Unidentified/Unlisted herpt	Unidentified/Unlisted herpt	Present	Lizard trks

Bird

Common Name	Latin Name	Abundance	Comments
lark sparrow	Chondestes grammacus	2	On Chna
western kingbird	Tyrannus verticalis	2	Acrobatics

Observer: *Simmons, Mary Ann* Date *7/7/2010*

Plant

Common Name	Latin Name	Abundance	Comments
cheatgrass	Bromus tectorum	25	
gray rabbitbrush	Chrysothamnus nauseosus	25	
indian ricegrass	Oryzopsis hymenoides	10	
needle-and-thread grass	Stipa comata	10	

Wednesday, October 15, 2014 Page 1 of 2

ECAP Database Query Results for W-054c

Observer: *Chamness, Mickie* Date *6/8/2010*

Plant

Common Name	Latin Name	Abundance	Comments
Sandberg's bluegrass	Poa sandbergii	25	
gray rabbitbrush	Chrysothamnus nauseosus	20	
Russian thistle	Salsola kali	10	
cheatgrass	Bromus tectorum	1	
bur ragweed	Ambrosia acanthicarpa		
big sagebrush	Artemisia tridentata		
matted cryptantha	Cryptantha circumscissa		
hoary aster	Machaeranthera canescens		
whitestem stickleaf	Mentzelia albicaulis		
indian ricegrass	Oryzopsis hymenoides		
Jim Hill's tumblemustard	Sisymbrium altissimum		

Mammal

Common Name	Latin Name	Abundance	Comments
unknown/unidentified small mammal	small mammal	Common	holes

Herpt

Common Name	Latin Name	Abundance	Comments
side-blotched lizard	Uta stansburiana	Present	Hiding

Wednesday, October 15, 2014 Page 1 of 1

Observer: *Simmons, Mary Ann* Date *6/8/2010*

Plant

Common Name	Latin Name	Abundance	Comments
gray rabbitbrush	Chrysothamnus nauseosus	15	
Sandberg's bluegrass	Poa sandbergii	10	
yarrow	Achillea millefolium		
bur ragweed	Ambrosia acanthicarpa		
big sagebrush	Artemisia tridentata		
stalked-pod milkvetch	Astragalus sclerocarpus		
sagebrush mariposa lily	Calochortus macrocarpus		
green rabbitbrush	Chrysothamnus viscidiflorus		
matted cryptantha	Cryptantha circumscissa		
Fendler's cryptantha	Cryptantha fendleri		
turpentine springparsley	Cymopterus terebithinus		
hoary aster	Machaeranthera canescens		
pale evening primrose	Oenothera pallida		
indian ricegrass	Oryzopsis hymenoides		
threadleaf scorpionweed	Phacelia linearis		
Russian thistle	Salsola kali		
Jim Hill's tumblemustard	Sisymbrium altissimum		
needle-and-thread grass	Stipa comata		

Mammal

Common Name	Latin Name	Abundance	Comments
unknown/unidentified small mammal	small mammal	Present	Holes

Bird

Common Name	Latin Name	Abundance	Comments
western meadowlark	Sturnella neglecta	1	Singing
mourning dove	Zenaida macroura	2	Flushed

Wednesday, October 15, 2014 Page 2 of 2

ECAP Database Query Results for W-508

Observer: ***Hand, Kris*** Date ***5/6/2009***

Plant

Common Name	Latin Name	Abundance	Comments
No vegetation present	No vegetation		

Bird

Common Name	Latin Name	Abundance	Comments
European starling	Sturnus vulgaris		

Field Data Collected at the U Tank Farm EU on October 10, 2014

Evaluation Unit: U Tank Farm	Observers: JLD, MAC
Patch ID: 2-13, 2-14, 2-15	Date: 10/10/2014

Wildlife Observations Recorded During Pedestrian or Vehicle Surveys	
Species	Observation
Coyote	Tracks
Harvester ants	Mound
Small mammal	Burrows
Notes	

Percent Canopy Cover of Herbaceous Species Surveyed Visually

EU	Survey Area	Species	Origin & Class	Percent Cover
U Tank Farm	2-13	CHNA	NS	15
U Tank Farm	2-13	POSE	NG	20
U Tank Farm	2-13	SATR	IF	10
U Tank Farm	2-13	BARE	BARE	30
U Tank Farm	2-13	ORHY	NG	1
U Tank Farm	2-13	BRTE	IG	

Notes: Harvester ant, small mammal burrow, habitat contiguous to N outside EU. Coyote tracks.

Percent Canopy Cover of Herbaceous Species Surveyed Visually

EU	Survey Area	Species	Origin & Class	Percent Cover	Comments			
U Tank Farm	2-14	CHNA	NS	20	Level 3			
U Tank Farm	2-14	CHVI	NS	3	Level 3			
U Tank Farm	2-14	ORHY	NG	15	Level 3			
U Tank Farm	2-14	STCO	NG	15	Level 3			
U Tank Farm	2-14	CHNA	NS	20	Level 2			
U Tank Farm	2-14	POSE	NG	10	Level 2			
U Tank Farm	2-14	STCO	NG	2	Level 2			
U Tank Farm	2-14	BARE	BARE	25	Level 2			
U Tank Farm	2-14	BRTE	IG	5	Level 2			
U Tank Farm	2-14	SATR	IF	10	Level 2			

Notes: Harvester ants, coyote tracks, small mammal burrows. N slope of hill at S end of polygon would likely

Percent Canopy Cover of Herbaceous Species Surveyed Visually

EU	Survey Area	Species	Origin & Class	Percent Cover
U Tank Farm	2-15	CHNA	NS	15
U Tank Farm	2-15	BRTE	IG	5
U Tank Farm	2-15	SATR	IF	10
U Tank Farm	2-15	POSE	NG	10
U Tank Farm	2-15	ORHY	NG	2
U Tank Farm	2-15	MACA	NF	1

Notes: All SAKA less than 10cm. Small mammall burrows. West end has ORHY. Coyote tracks. Contiguous to S w/at least some level 3 resources i patch-see map.

Evaluation Unit:	A-AX Tank Farms
ID:	CP-TF-5
Group:	Tank Farm
Operable Unit Cross-Walk:	WMA A/AX 200-EA-1 200-PW-3
Related EU:	CP-LS-7 CP-TF-8 CP-GW-1
Sites & Facilities:	A-AX tank farm, ancillary structures, associated liquid waste sites, and soils contamination
Key Data Sources Docs:	DOE/RL-96-32 2013 PNNL ECAP Database[9]
Field Survey Date:	10/08/2014
Data Sheet Prepared By:	JLD, MAC, KDH, SAM, KBL 10/20/2014

Figure J.19. Site Map with Evaluation Unit Boundaries and Tank Locations

CP-TF-5: A-AX Tank Farms

Survey and Analysis Methods:

The evaluation process makes use of existing biological resource level maps (DOE/RL-96-32 2013), field surveys and measurement of current vegetation and habitat conditions, and wildlife observations to evaluate potential ecological impacts associated with cleanup activities at the

[9] The Ecological Compliance and Assessment Project (ECAP) database is an evolving set of data that is maintained by Pacific Northwest National Laboratory (PNNL) and updated as new ecological assessments are completed.

evaluation unit (EU). Additional information used in the ecological evaluation includes the current Endangered and Threatened Species (Federal and State) distribution data; priority habitats as defined by Washington Department of Fish and Wildlife; available current aerial imagery, locations of Hanford Unit waste sites and infrastructure spatial data; and available information about species of concern distribution and habitat use in the vicinity of the EUs including data previously collected by PNNL for DOE-RL. Definitions relevant to the methods and ecological survey results are provided at the end of this summary along with field data tables.

The following steps were taken to assess the EU associated with the A-AX Tank Farms:

1. The EU boundary (polygon) is assumed to represent the estimated boundary or extent of potential habitat removal and direct disturbance due to remediation.
2. A visual survey was conducted within the EU boundary of unvegetated industrial and graveled surfaces and buildings as well as field measurement and pedestrian surveys of habitat areas by experienced shrub-steppe ecologists. PNNL biologists also reviewed the observations and biological survey data available in the Ecological Compliance and Assessment Project (ECAP) database from the past 5 years for the EU to determine the status and resource level of the habitats within the EU and supplement the evaluation with previous wildlife or plant species observations.
3. A second boundary (polygon) outside the EU was established to evaluate indirect effects and assess the remediation in relation to adjacent landscape features. This polygon is centered on the EU and encompasses a circular area with a radius 1 times the maximum width of the EU and is referred to as the **adjacent landscape buffer**.
4. A reconnaissance survey of the boundary of the EU was conducted to confirm the validity of past mapping of biological resources. Aerial imagery from 2012 was reviewed to identify any significant changes in habitat and resource levels (such as new well pads, roads, or other ground disturbance not captured by the available biological resources mapping) within the EU and adjacent landscape buffer. Where significant change is evident from ground survey or imagery, the biological resource map was updated to reflect the change in resource level.
5. The spatial extent of habitat classified at each of 6 resource levels (0 – 5) (DOE/RL-96-32 2013; definitions at end of this summary) within the adjacent landscape buffer area and the EU were assessed and compared using a Geographic Information System (GIS) to examine potential indirect effects on habitat condition within the adjacent landscape. For purposes of assessing indirect effects on the adjacent landscape, this evaluation assumes the maximum potential change in biological resources—that is, all habitat within the EU is assumed to be lost to remediation and cleanup activities and resources in the EU are considered level 0.
6. PNNL biologists assembled the information from field survey, reconnaissance, and spatial analyses of resource availability to provide a subjective evaluation of potential effects on habitat connectivity in the vicinity of the EU.

Field Survey:

Field measurements and visual surveys were conducted in October 2014 in two habitat areas: one resource level 2 area (visual survey) and one resource level 3 area (two transects) (Table J.19). The field data confirmed the resource levels shown in Figure J.20. Previous ECAP survey data taken in 2010 noted an occurrence of Piper's daisy in the level 2 habitat in the southwest corner of the EU.

Wildlife observations within the level 3 habitat areas on the east side of the EU included harvester ant hills, small mammal burrows, coyote (*Canis latrans*) tracks, and an unidentified lizard. Previous ECAP survey data collected in 2010 for polygons within the EU also noted white-crowned sparrow (*Zonotrichia leucophrys*), western meadowlark (*Sturnella neglecta*), and house finch (*Carpodacus mexicanus*), as well as northern pocket gopher mounds (*Thomomys talpoides*).

Table J.19. Percent Canopy Cover and Surface Cover Measured at A-AX Tank Farms

Vegetation/Surface Cover	Survey Area 2-01 (%)	Survey Area 3-02a (%)	Survey Area 3-02b (%)
Bare Ground	-	15.3	23.6
Crust	25	12.3	36.6
Litter	-	40.4	51.6
Introduced Forb	5	8.4	1.4
Introduced Grass	8	10.9	5.8
Native Forb	-	7.0	2.5
Native Grass	16	32.0	7.6
Climax Shrubs	-	7.4	19.1
Successional Shrubs	25	1.0	-

Landscape Evaluation and Resource Classification:

Approximately 75% of the A-AX Tank Farms EU has been previously disturbed, or consists of graveled surfaces, buildings, industrial areas and tank farm infrastructure (levels 0 and 1 from Table J.20). Several large fragments of level 3 habitat remain within the eastern side of the EU (Figure J.20).

The amount of each biological resource category was examined in a circular buffer area radiating 1,386 m from the center of the EU (equivalent to 1,490.5 acres). Approximately 26% of the total combined area (EU and associated adjacent landscape) is classified as level 3 or greater habitat. Areas classified as level 4 resources lie outside the 200-East Area fence and were not reviewed as part of this survey.

Table J.20. Area and Proportion of Each Biological Resource Level Within the Evaluation Unit in Relation to Adjacent Landscape and Potential Maximum Change in Resources

Resource Level[1]	Evaluation Unit Area (ac)	Adjacent Landscape Buffer (ac)	Combined Total Area (ac)	Percent of Resource Level in Combined Total Area	Percent of Resource Level in Combined Total Area After Cleanup[2]	Percent Difference at Landscape Scale After Cleanup[2]
0	52.8	414.6	467.4	31.4%	36.4%	5.1%
1	44.9	383.3	428.2	28.7%	25.7%	-3.0%
2	3.3	203.1	206.4	13.8%	13.6%	-0.2%
3	27.4	258.4	285.8	19.2%	17.3%	-1.8%
4	0.0	102.7	102.7	6.9%	6.9%	0.0%
5	0.0	0.0	0.0	0.0%	0.0%	0.0%
Total	128.4	1362.1	1490.5	100.0%	100.0%	

1 Resource levels for the evaluation unit were reviewed in the field and via imagery during October 2014 and revised to reflect current habitats conditions.

2 Potential maximum change in area of a given resource level within the combined total area (Evaluation Unit + Adjacent Landscape Buffer) that would occur assuming that all habitat within the evaluation unit is destroyed by remediation activities and the resource level of the evaluation unit is level 0.

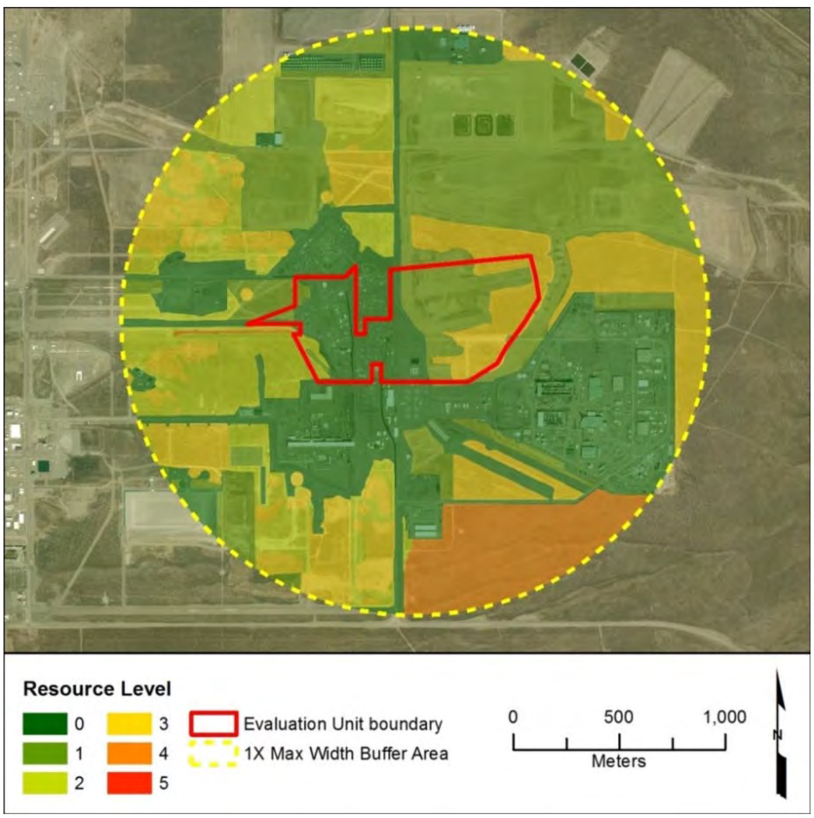

Figure J.20. Biological Resource Level Classifications Based on October 2014 Surveys for the A-AX Tank Farms Evaluation Unit (red solid line) and Adjacent Landscape Buffer (yellow dashed line)

Assumptions and Uncertainty:

Due to project time constraints, the field surveys and reconnaissance of this EU were conducted in October. By the time of the survey, the cool-season annual and perennial herbaceous plants that dominate shrub-steppe habitat had completed seasonal growth and senesced making identification and inventory difficult and most likely incomplete. Although no records for plant species of concern have been noted, the absence of species cannot be confirmed by surveys during this time of year.

By October, most migratory birds have completed their nesting cycles many have migrated away from the region. Surveys conducted in late fall will not reflect migratory bird occupancy and use of habitat within the EU earlier in the season. Their absence cannot be confirmed by surveys in October after the nesting season is over. Further surveys during the nesting season would be required to fully assess the ecological impacts to nesting migratory birds.

Summary of Ecological Review:

- More than 75% of the EU consists of level 0 and level 1 habitat resources.
- Up to 27 acres of level 3 habitat may be lost if remediation actions were to result in clearing the entire EU. This would represent a loss of 1.8% of this habitat level at the landscape scale considered for this EU.
- Wildlife observations within the level 3 habitat areas on the east side of the EU included harvester ant hills, small mammal burrows, coyote tracks, and an unidentified lizard; previous surveys noted 3 migratory bird species and northern pocket gopher mounds.
- One individual occurrence of a sensitive plant species (Piper's daisy) has been previously noted within the EU boundary, but was not relocated during the October 2014 survey. Loss of individual sensitive plant occurrences is unlikely to affect population viability for this species.
- The A-AX Tank Farms EU is surrounded by additional industrial and operations areas inside the 200-East Area. Loss of level 3 resources from within the EU would not be expected to significantly impact habitat connectivity.

References:

DOE/RL-96-32. 2013. Hanford Site Biological Resources Management Plan, Revision 0.

U.S. Fish and Wildlife Service (USFWS). 2014. Birds Protected by the Migratory Bird Treaty Act. http://www.fws.gov/migratorybirds/RegulationsPolicies/mbta/mbtintro.html

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Washington Department of Fish and Wildlife. 2008. Washington State Priority Habitats and Species List. Olympia Washington. 174 pp. http://wdfw.wa.gov/conservation/phs/list/

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Washington Noxious Weed Control Board.2014. Noxious Weed List. http://www.nwcb.wa.gov/

Washington State Department of Natural Resources. 2014. Washington Natural Heritage Program Plant Ranks. http://www1.dnr.wa.gov/nhp/refdesk/lists/plantrnk.html

Definitions and Acronyms:

Adjacent Landscape Buffer – a circular area adjacent to and outside the EU boundary with the center of the circle at the centroid of the EU, and with a radius that is 1 times the maximum dimension (width or length—whichever is greatest). This circular buffer area is used to evaluate indirect effects and assess the remediation in relation to the landscape features and resources adjacent to the EU. This circular area is generally at least 3 times the area of the EU.

Biological Resource Levels (from DOE-RL-96-32-01) –

- Level 5 resources include species that are listed or proposed-to-be listed under the *Endangered Species Act* and their critical habitat, as well as rare and irreplaceable habitats.
- Level 4 resources include federal candidate species; Washington State threatened or endangered species; habitat or exclusion buffers for federal candidates and Washington State threatened or endangered species; high-quality mature shrub steppe; wetlands and riparian areas; and buffer areas for bald eagles and ferruginous hawks.
- Level 3 resources include Washington State sensitive, candidate, and review species; Washington Department of Fish and Wildlife priority species; lower quality mature shrub-steppe—such as shrub stands that are less mature, have lower shrub density or canopy cover, and/or a greater proportion of cheatgrass in the understory than stands that qualify for Level 4. Level 3 also includes high-quality grasslands, conservation corridors, snake hibernacula, bat roosts, rookeries, burrowing owl buffer areas, and areas with significant quantities of culturally important species.
- Level 2 resources include migratory birds, state watch list plants and monitor list animals, recreationally and commercially important species, and lower quality steppe and shrub-steppe.
- Level 1 resources include individual common native plant and wildlife species, upland stands of non-native plants, and abandoned agricultural fields.

Evaluation Units (EUs) – groupings of sources, aggregated for evaluation as part of the Hanford Site-wide Risk Review Project. Sources may be aggregated into an EU based on potential impacts to a common set of receptors or receptor geographic area, common past waste management practices, or integration in the waste management process.

MBTA – Migratory Bird Treaty Act; referring to species listed and protected under the federal Act.

PNNL ECAP (Ecological Compliance and Assessment Project) Database – PNNL performed ecological reviews for individual projects and annually surveyed selected areas and buildings on the Hanford Site for DOE-RL under the DOE's Public Safety and Resource Protection Program until 2011. The data collected during those surveys is archived in the ECAP database, and is used to supplement ecological evaluations as available.

Priority Habitats – Priority habitats are habitat types or elements with unique or significant value to a diverse assemblage of species. A priority habitat may consist of a unique vegetation type (e.g., shrub-steppe) or dominant plant species (e.g., juniper savannah), a described successional stage (e.g., old-growth forest), or a specific habitat feature (e.g., cliffs).

Species of Concern or Species of Conservation Concern – An informal term that for the purpose of this assessment includes those species listed at the federal or state level as being threatened endangered, sensitive, or candidate, as well as those listed by the U.S. Fish and Wildlife Service as species of concern within the ecoregion.

ECAP Database Query Results for E-019a

Observer: *Chamness, Mickie* Date *4/29/2010*

Plant

Common Name	Latin Name	Abundance	Comments
Piper's daisy	Erigeron piperianus		took GPS
rush skeletonweed	Chondrilla juncea		Seedlings
hoary aster	Machaeranthera canescens	5	
Sandberg's bluegrass	Poa sandbergii	40	
cheatgrass	Bromus tectorum	30	
gray rabbitbrush	Chrysothamnus nauseosus	20	
crested wheatgrass	Agropyron cristatum		
fiddleneck	Amsinckia lycopsoides		
big sagebrush	Artemisia tridentata		
spring whitlowgrass	Draba verna		
storksbill	Erodium cicutarium		
jagged chickweed	Holosteum umbellatum		
bulbous bluegrass	Poa bulbosa		
Russian thistle	Salsola kali		
Jim Hill's tumblemustard	Sisymbrium altissimum		

Mammal

Common Name	Latin Name	Abundance	Comments
coyote	Canis latrans	Present	Scat
Unidentified/Unlisted mammal	Unidentified/Unlisted mammal	Present	Lg mammal digs
unknown/unidentified small mammal	small mammal	Present	Holes

Bird

Common Name	Latin Name	Abundance	Comments
white-crowned sparrow	Zonotrichia leucophrys	3	Flitting

Observer: *Simmons, Mary Ann* Date *4/29/2010*

Plant

Common Name	Latin Name	Abundance	Comments
cheatgrass	Bromus tectorum	60	
gray rabbitbrush	Chrysothamnus nauseosus	20	
Sandberg's bluegrass	Poa sandbergii	20	
big sagebrush	Artemisia tridentata	+	
crested wheatgrass	Agropyron cristatum		
buckwheat milkvetch	Astragalus caricinus		
Piper's daisy	Erigeron piperianus		
storksbill	Erodium cicutarium		
jagged chickweed	Holosteum umbellatum		
hoary aster	Machaeranthera canescens		

ECAP Database Query Results for E-019b

Observer: *Chamness, Mickie* Date *4/29/2010*

Plant

Common Name	Latin Name	Abundance	Comments
crested wheatgrass	Agropyron cristatum	40	
cheatgrass	Bromus tectorum	10	
Sandberg's bluegrass	Poa sandbergii	10	
slender sixweeks	Festuca octoflora		
bulbous bluegrass	Poa bulbosa		

Mammal

Common Name	Latin Name	Abundance	Comments
unknown/unidentified small mammal	small mammal	Present	Holes

Bird

Common Name	Latin Name	Abundance	Comments
No birds observed	No birds		

ECAP Database Query Results for E-021g

Observer: *Chamness, Mickie* Date *4/30/2010*

Plant

Common Name	Latin Name	Abundance	Comments
crested wheatgrass	Agropyron cristatum	40	Crust devel.
cheatgrass	Bromus tectorum	10	
bulbous bluegrass	Poa bulbosa	10	
Sandberg's bluegrass	Poa sandbergii	10	
yarrow	Achillea millefolium		
fiddleneck	Amsinckia lycopsoides		
buckwheat milkvetch	Astragalus caricinus		
gray rabbitbrush	Chrysothamnus nauseosus		
hoary aster	Machaeranthera canescens		
indian ricegrass	Oryzopsis hymenoides		
Russian thistle	Salsola kali		
Jim Hill's tumblemustard	Sisymbrium altissimum		
sand dropseed	Sporobolus cryptandrus		

Mammal

Common Name	Latin Name	Abundance	Comments
northern pocket gopher	Thomomys talpoides	Present	Mnds
unknown/unidentified small mammal	small mammal	Present	Holes

Herpt

Common Name	Latin Name	Abundance	Comments
Unidentified/Unlisted herpt	Unidentified/Unlisted herpt	Present	Lizard ran under Saka

Bird

Common Name	Latin Name	Abundance	Comments
western meadowlark	Sturnella neglecta	2	up from grnd
white-crowned sparrow	Zonotrichia leucophrys	1	On Saka

Observer: *Freeman-Cadoret, Natalie* Date *4/30/2010*

Plant

Common Name	Latin Name	Abundance	Comments
yarrow	Achillea millefolium		
yarrow	Achillea millefolium		
crested wheatgrass	Agropyron cristatum		
bur ragweed	Ambrosia acanthicarpa		
fiddleneck	Amsinckia lycopsoides		
buckwheat milkvetch	Astragalus caricinus		
cheatgrass	Bromus tectorum		
gray rabbitbrush	Chrysothamnus nauseosus		
jagged chickweed	Holosteum umbellatum		

Friday, October 17, 2014 Page 1 of 2

ECAP Database Query Results for E-046

Observer: ***Hand, Kris*** Date ***5/1/2009***

Plant

Common Name	Latin Name	Abundance	Comments
cheatgrass	Bromus tectorum		
Russian thistle	Salsola kali		

ECAP Database Query Results for E-508

Observer: ***Chamness, Mickie*** Date ***5/1/2009***

Bird

Common Name	Latin Name	Abundance	Comments
white-crowned sparrow	Zonotrichia leucophrys	1	On grnd in AY farm
house finch	Carpodacus mexicanus	3	On fence, 2 nesting

Friday, October 17, 2014 Page 1 of 1

Percent Canopy Cover of Herbaceous Species Surveyed Visually

EU	Survey Area	Species	Origin & Class	Percent Cover							
A-AX Tank Farms	2-01	CHNA	NS	25							
A-AX Tank Farms	2-01	POSE/POBU	NG	15							
A-AX Tank Farms	2-01	BRTE	IG	8							
A-AX Tank Farms	2-01	ARTR	NS	2							
A-AX Tank Farms	2-01	CRUST	CRUST	25							
A-AX Tank Farms	2-01	SATR	IF	5							
A-AX Tank Farms	2-01	SPCR	NG	1							

Notes

Percent Canopy Cover of Herbaceous Species Measured in 0.5 m2 quadrats

EU	Survey Area	Species	Origin & Class	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10	sum	Mean Canopy Cover	Freq
A-AX Tank Farms	3-02	STCO	NG	20								18		38	19.0	0.2
A-AX Tank Farms	3-02	ARTR	NS	2	100						50	14	18	184	36.8	0.5
A-AX Tank Farms	3-02	POSE	NG	4					17	12	12	20		65	13.0	0.5
A-AX Tank Farms	3-02	SATR	IF	7	1	16		12	3	15			5	59	8.4	0.7
A-AX Tank Farms	3-02	BRTE	IG	4		10		30	10	10	4		8	76	10.9	0.7
A-AX Tank Farms	3-02	CRUST	CRUST	25		2			10	7		14	16	74	12.3	0.6
A-AX Tank Farms	3-02	LITTER	LITTER	14	25	60	100	60	15	60	40	10	20	404	40.4	1
A-AX Tank Farms	3-02	BARE	BARE	20		12			20	4	2		34	92	15.3	0.6
A-AX Tank Farms	3-02	CHNA	NS						25					25	25.0	0.1
A-AX Tank Farms	3-02	OERA	NF									2		2	2.0	0.1
A-AX Tank Farms	3-02	COUM	NF									4		4	4.0	0.1
A-AX Tank Farms	3-02	MACA	NF									1		1	1.0	0.1
A-AX Tank Farms	3-02	PHLO	NF													
A-AX Tank Farms	3-02	ORHY	NG													
A-AX Tank Farms	3-02	PTTE	NF													
A-AX Tank Farms	3-02	CAMA	NF													
A-AX Tank Farms	3-02	CRCI	NF													

Notes: No birds seen, amcr head, pocket gopher mounds, small mammal holes, unid lizard. Not contigous dead branches of artr as part of shrub cover, * litter includes standing dead

Shrub Canopy Measured by Line-Intercept Methods on 50m Transect

EU	Survey Area	Species	Transect distance (total)	Start	Stop	Dif
A-AX Tank Farms	3-02	ARTR	50	4.8	6.4	1.6
A-AX Tank Farms	3-02	CHNA	50	25.4	25.9	0.5
A-AX Tank Farms	3-02	ARTR	50	34.7	35.4	0.7
A-AX Tank Farms	3-02	ARTR	50	40	40.7	0.7
A-AX Tank Farms	3-02	ARTR	50	44.6	45.2	0.6
A-AX Tank Farms	3-02	ARTR	50	48.9	49	0.1

Notes: No birds seen, amcr head, pocket gopher mounds, small mammal holes, unid lizard. Not contigous dead branches of artr as part of shrub cover, * includes standing dead

Percent Canopy Cover of Herbaceous Species Measured in 0.5 m2 quadrats

EU	Survey Area	Species	Origin & Class	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10	sum	Mean Canopy Cover	Freq
A-AX Tank Farms	3-02	BARE	BARE	10	4	38	40	5	3	12	16	10	98	236	23.6	1
A-AX Tank Farms	3-02	CRUST	CRUST	50	60	44	35	65	14	20		5		293	36.625	0.8
A-AX Tank Farms	3-02	LITTER	LITTER	45	60	24	35	*65	90	70	*85	85	4	413	51.625	0.8
A-AX Tank Farms	3-02	POSE	NG	2	10		1	16				9		38	7.6	0.5
A-AX Tank Farms	3-02	SATR	IF	1		1			1	1	3	2	1	10	1.428571	0.7
A-AX Tank Farms	3-02	BRTE	IG	1	2	1	1	5	4	15	3	25	1	58	5.8	1
A-AX Tank Farms	3-02	ARTR	NS		22	18	36	4	12	10	10			112	16	0.7
A-AX Tank Farms	3-02	ASCA	NF			1	2							3	1.5	0.2
A-AX Tank Farms	3-02	COUM	NF					1					1	2	1	0.2

Notes: No birds seen, amcr head, pocket gopher mounds, small mammal holes, unid lizard. Not contigous dead branches of artr as part of shrub cover, * litter includes standing dead

Shrub Canopy Measured by Line-Intercept Methods on 50m Transect

EU	Survey Area	Species	Transect distance (total)	Start	Stop	Dif
A-AX Tank Farms	3-02	ARTR	50	41	41.85	0.85
A-AX Tank Farms	3-02	ARTR	50	39	39.8	0.8
A-AX Tank Farms	3-02	ARTR	50	32.6	33.5	0.9
A-AX Tank Farms	3-02	ARTR	50	30.1	30.7	0.6
A-AX Tank Farms	3-02	ARTR	50	27.1	28.2	1.1
A-AX Tank Farms	3-02	ARTR	50	24.8	25.2	0.4
A-AX Tank Farms	3-02	ARTR	50	23.65	24	0.35
A-AX Tank Farms	3-02	ARTR	50	22.5	23.1	0.6
A-AX Tank Farms	3-02	ARTR	50	18.5	19.15	0.65
A-AX Tank Farms	3-02	ARTR	50	17.95	18.3	0.35
A-AX Tank Farms	3-02	ARTR	50	14.85	15.1	0.25
A-AX Tank Farms	3-02	ARTR	50	13.4	13.8	0.4
A-AX Tank Farms	3-02	ARTR	50	11.5	12.3	0.8
A-AX Tank Farms	3-02	ARTR	50	8.6	9.2	0.6
A-AX Tank Farms	3-02	ARTR	50	3.6	4.5	0.9

Notes

Evaluation Unit: B-BX-BY Tank Farms
ID: CP-TF-6
Group: Tank Farm
Operable Unit Cross-Walk: WMA B/BX/BY
200-DV-1
200-EA-1
Related EU: CP-LS-7
CP-GW-1
Sites & Facilities: B-BX-BY tank farms, ancillary structures, associated liquid waste sites, and associated soils contamination
Key Data Sources Docs: DOE/RL-96-32 2013
PNNL ECAP Database[10]
Field Survey Date: 7/16/2014
Data Sheet Prepared By: JLD 10/10/2014

Figure J.21. Site Map with Evaluation Unit Boundaries and Tank Locations

CP-TF-6: B-BX-BY Tank Farms

Survey and Analysis Methods:

The evaluation process makes use of existing biological resource level maps (DOE/RL-96-32 2013), field surveys and measurement of current vegetation and habitat conditions, and wildlife observations to evaluate potential ecological impacts associated with cleanup activities at the evaluation unit (EU). Additional information used in the ecological evaluation includes the

[10] The Ecological Compliance and Assessment Project (ECAP) database is an evolving set of data that is maintained by Pacific Northwest National Laboratory (PNNL) and updated as new ecological assessments are completed.

current Endangered and Threatened Species (Federal and State) distribution data; priority habitats as defined by Washington Department of Fish and Wildlife; available current aerial imagery, locations of Hanford Site waste sites and infrastructure spatial data; and available information about species of concern distribution and habitat use in the vicinity of the EUs including data previously collected by PNNL for DOE-RL. Definitions relevant to the methods and ecological survey results are provided at the end of this summary along with field data tables.

The following steps were taken to assess the EU associated with the B-BX-BY Tank Farms:

1. The EU boundary (polygon) is assumed to represent the estimated boundary or extent of potential habitat removal and direct disturbance due to remediation.
2. A visual survey was conducted within the EU boundary by experienced shrub-steppe ecologists. Because the unit consists primarily of unvegetated industrial and graveled surfaces and structures, and revegetated areas, field measurements of vegetation were taken in only a single habitat patch. PNNL biologists also reviewed the observations and biological survey data available in the Ecological Compliance and Assessment Project (ECAP) database from the past 5 years for the EU to determine the status and resource level of the habitats within the EU and supplement the evaluation with previous wildlife or plant species observations.
3. A second boundary (polygon) outside the EU was established to evaluate indirect effects and assess the remediation in relation to adjacent landscape features. This polygon is centered on the EU and encompasses a circular area with a radius 1 times the maximum width of the EU and is referred to as the **adjacent landscape buffer**.
4. A reconnaissance survey of the boundary of the EU was conducted to confirm the validity of past mapping of biological resources. Aerial imagery from 2012 was reviewed to identify any significant changes in habitat and resource levels (such as new well pads, roads, or other ground disturbance not captured by the available biological resources mapping) within the EU and adjacent landscape buffer. Where significant change is evident from ground survey or imagery, the biological resource map was updated to reflect the change in resource level.
5. The spatial extent of habitat classified at each of 6 resource levels (0 – 5) (DOE/RL-96-32 2013; definitions at end of this summary) within the adjacent landscape buffer area and the EU were assessed and compared using a Geographic Information System (GIS) to examine potential indirect effects on habitat condition within the adjacent landscape. For purposes of assessing indirect effects on the adjacent landscape, this evaluation assumes the maximum potential change in biological resources—that is, all habitat within the EU is assumed to be lost to remediation and cleanup activities and resources in the EU are considered level 0.
6. PNNL biologists assembled the information from field survey, reconnaissance, and spatial analyses of resource availability to provide a subjective evaluation of potential effects on habitat connectivity in the vicinity of the EU.

Field Survey:

The B-BX-BY Tank Farms evaluation site includes levels 0, 1, 2, and 3 biological resources as classified in the existing resource level map (DOE/RL-96-32 2013) (Table J.21; Figure J.22). Most of the areas previously classified as level 3 have been degraded by activities within the EU. Several areas have been revegetated. Areas of level 3 resources within the evaluation site are associated with individual occurrences of sensitive species noted in previous ECAP surveys. Piper's daisy (*Erigeron piperianus*), a Washington state sensitive species, was observed in the southwest corner of the site during the 16 July 2014 survey, and has been observed near that location in past ECAP surveys. Field measurements were taken in the southwest corner of B-BX-BY EU (Table J.21).

Animal species (or their sign) observed during the 16 July 2014 survey include horned lark (*Eremophila alpestris*), northern pocket gopher (*Thomomys talpoides*), coyote (*Canis latrans*), and black-tailed jackrabbit (*Lepus californicus*). The black-tailed jackrabbit sign (very old scat) was observed in the southwest corner of the evaluation site. No other sign of recent presence (e.g., runs, fresh scat, animals) was observed. The black-tailed jackrabbit is a Federal Species of Concern and Washington State Candidate species.

Table J.21. Percent Canopy Cover and Surface Cover Measured at B-BX-BY Tank Farms

Vegetation/Surface Cover	CP-TF-6 SW Corner
BARE	10.7%
CRUST	0%
LITTER	31.0%
Introduced Forb	7.0%
Introduced Grass	0.5%
Native Forb	1.8%
Native Grass	15.0%
Climax Shrubs	7.0
Successional Shrubs	10.6%

Landscape Evaluation and Resource Classification:

The B-BX-BY Tank Farms EU has been heavily disturbed throughout and primarily contains level 0 and 1 resources. The existing resource level map (DOE/RL-96-32 2013) also shows areas of level 2 and 3 biological resources (Table J.22, Figure J.22). Areas of level 3 resources within the evaluation site are associated with point occurrences of sensitive species noted in previous ECAP surveys. Piper's daisy (*Erigeron piperianus*), a Washington state sensitive species, was observed in the southwest corner of the site during the 16 July 2014 survey, and has been observed near that location in past ECAP surveys. However, an occurrence of a sensitive species does not constitute a habitat "patch" as considered in this assessment, but field survey of the southwest corner of B-BX-BY EU confirmed the surrounding habitat is should be classified as level 2 resources. Climax shrubs (big sagebrush; *Artemisia tridentata*) are limited to a small patch in the center and the majority of the habitat patch is dominated by gray rabbitbrush (*Ericameria nauseosa*) (Figure J.23).

The amount and proximity of biological resources to the B-BX-BY Tank Farms EU was examined within the adjacent buffer area, which extends 974 m from the geometric center of the site (equivalent to 736 acres) to encompass a circle. Approximately 43% of the adjacent buffer area is classified as level 3 or higher biological resource in the existing resource classification. The level 3 habitat within the 200-East Area represents multiple locations where Piper's daisy has been found. This species is often found in disturbed and gravelly areas on the 200-Area Plateau. The majority of the level 3 and level 4 resources are found across the paved road to the north, outside the 200-East boundary fence (Figure J.22).

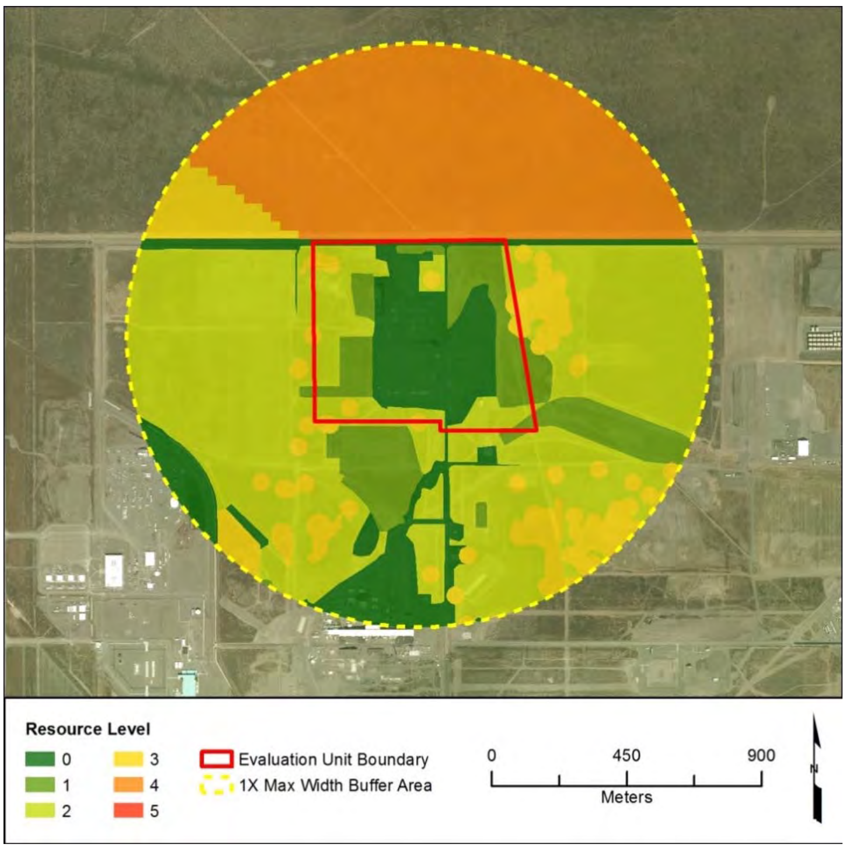

Figure J.22. Map of Biological Resource Level Classifications for the B-BX-BY Tank Farm Evaluation Unit Based on July 2014 Pedestrian and Vehicle Survey (red boundary) and Reconnaissance Survey of the Adjacent Landscape Buffer (yellow boundary)

Table J.22. Area and Proportion of Each Biological Resource Level Within the B-BX-BY Tank Farm Evaluation Unit in Relation to Adjacent Landscape and Potential Maximum Change in Resources

Resource Level[1]	Evaluation Unit Area (ac)	Adjacent Landscape Buffer (ac)	Combined Total Area (ac)	Percent of Resource Level in Combined Total Area	Percent of Resource Level in Combined Total Area After Cleanup[2]	Percent Difference at Landscape Scale After Cleanup[2]
0.0	45.6	49.5	95.1	12.9%	20.9%	8.0%
1.0	26.5	39.0	65.5	8.9%	5.3%	-3.6%
2.0	27.9	273.5	301.4	41.0%	37.2%	-3.8%
3.0	4.5	70.9	75.4	10.2%	9.6%	-0.6%
4.0	0.0	198.5	198.5	27.0%	27.0%	0.0%
5.0	0.0	0.0	0.0	0.0%	0.0%	0.0%
Total	104.4	631.4	735.8	100.0%	100.0%	

1 Resource levels for both the evaluation unit and adjacent landscape boundary were reviewed in the field and via imagery during July 2014 and revised to reflect current habitats conditions.

2 Potential maximum change in area of a given resource level within the combined total area (Evaluation Unit + Adjacent Landscape Buffer) that would occur assuming that all habitat within the evaluation unit is destroyed by remediation activities and the resource level of the evaluation unit is level 0.

Figure J.23. Photograph of Habitat in Southwest Corner of Evaluation Unit Showing Small Patch of Sagebrush in Foreground and Rabbitbrush Throughout the Unit

Assumptions and Uncertainty:

Due to project time constraints, the field surveys and reconnaissance of this EU were conducted in mid-July. By the time of the survey, the cool-season annual and perennial herbaceous plants that dominate shrub-steppe habitat had completed seasonal growth and senesced making identification and inventory difficult and most likely incomplete. The absence of species cannot be confirmed by surveys during this time of year.

By mid-July, most migratory birds have completed their nesting cycles, and surveys may not reflect their occupancy and use of habitat within the EU earlier in the season. Their absence cannot be confirmed by surveys in July after the nesting season is over. Further surveys during the nesting season would be required to fully assess the ecological impacts to nesting migratory birds.

Summary of Ecological Review:

- Animal species (or their sign) observed during July 2014 survey include horned lark, northern pocket gopher, coyote, and black-tailed jackrabbit.
- Almost 70% of the EU consists of level 0 and level 1 habitat; level 2 habitats within the EU are fragmented by roadways, buildings, and infrastructure.
- Individual occurrences of level 3 resources associated with the sensitive plant species Piper's daisy have been previously documented at the B-BX-BY evaluation site and a single occurrence of Piper's daisy was noted within the EU during the survey. However, there are no patches of level 3 or higher habitat greater than 0.5 ac within the evaluation site;
- Cleanup activities would result in no net change in the amount of level 3 or higher habitats within a 0.97 km radius;
- Loss of individual Piper's daisy (level 3 species) from within the EU would not be expected to affect population viability for this species.
- Habitats within the B-X-BY Tank Farm are highly fragmented and lie within the 200-East Area. Loss of remaining level 2 or level 3 habitat associated with remediation actions would not be expected to significantly alter habitat connectivity outside the 200-East Area.

References

DOE/RL-96-32. 2013. Hanford Site Biological Resources Management Plan, Revision 0.

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Washington State Department of Natural Resources. 2014. Washington Natural Heritage Program Plant Ranks. http://www1.dnr.wa.gov/nhp/refdesk/lists/plantrnk.html

Definitions and Acronyms:

Adjacent Landscape Buffer – a circular area adjacent to and outside the EU boundary with the center of the circle at the centroid of the EU, and with a radius that is 1 times the maximum dimension (width or length—whichever is greatest). This circular buffer area is used to evaluate indirect effects and assess the remediation in relation to the landscape features and resources adjacent to the EU. This circular area is generally at least 3 times the area of the EU.

Biological Resource Levels (from DOE-RL-96-32-01) –

- Level 5 resources include species that are listed or proposed-to-be listed under the *Endangered Species Act* and their critical habitat, as well as rare and irreplaceable habitats.
- Level 4 resources include federal candidate species; Washington State threatened or endangered species; habitat or exclusion buffers for federal candidates and Washington State threatened or endangered species; high-quality mature shrub steppe; wetlands and riparian areas; and buffer areas for bald eagles and ferruginous hawks.
- Level 3 resources include Washington State sensitive, candidate, and review species; Washington Department of Fish and Wildlife priority species; lower quality mature shrub-steppe—such as shrub stands that are less mature, have lower shrub density or canopy cover, and/or a greater proportion of cheatgrass in the understory than stands that qualify for Level 4. Level 3 also includes high-quality grasslands, conservation corridors, snake hibernacula, bat roosts, rookeries, burrowing owl buffer areas, and areas with significant quantities of culturally important species.
- Level 2 resources include migratory birds, state watch list plants and monitor list animals, recreationally and commercially important species, and lower quality steppe and shrub-steppe.
- Level 1 resources include individual common native plant and wildlife species, upland stands of non-native plants, and abandoned agricultural fields.

Evaluation Units (EUs) – groupings of sources, aggregated for evaluation as part of the Hanford Site-wide Risk Review Project. Sources may be aggregated into an EU based on potential impacts to a common set of receptors or receptor geographic area, common past waste management practices, or integration in the waste management process.

MBTA – Migratory Bird Treaty Act; referring to species listed and protected under the federal Act.

PNNL ECAP (Ecological Compliance and Assessment Project) Database – PNNL performed ecological reviews for individual projects and annually surveyed selected areas and buildings on the Hanford Site for DOE-RL under the DOE's Public Safety and Resource Protection Program until 2011. The data collected during those surveys is archived in the ECAP database, and is used to supplement ecological evaluations as available.

Priority Habitats – Priority habitats are habitat types or elements with unique or significant value to a diverse assemblage of species. A priority habitat may consist of a unique vegetation type (e.g., shrub-steppe) or dominant plant species (e.g., juniper savannah), a described successional stage (e.g., old-growth forest), or a specific habitat feature (e.g., cliffs).

Species of Concern or Species of Conservation Concern – An informal term that for the purpose of this assessment includes those species listed at the federal or state level as being threatened endangered, sensitive, or candidate, as well as those listed by the U.S. Fish and Wildlife Service as species of concern within the ecoregion.

Previous PNNL ECAP Field Survey Data Collected in the B-BX-BY Tank Farms EU

ECAP Database Query Results for E-021a

Observer: *Chamness, Mickie* Date *5/27/2010*

Plant

Common Name	Latin Name	Abundance	Comments
wheat	Triticum aestivum	30	
Sandberg's bluegrass	Poa sandbergii	10	
gray rabbitbrush	Chrysothamnus nauseosus		
Russian thistle	Salsola kali		

Mammal

Common Name	Latin Name	Abundance	Comments
unknown/unidentified small mammal	small mammal	Present	Holes

Bird

Common Name	Latin Name	Abundance	Comments
horned lark	Eremophila alpestris	2	Or more sing
mourning dove	Zenaida macroura	2	Flew by

Observer: *Simmons, Mary Ann* Date *5/27/2010*

Plant

Common Name	Latin Name	Abundance	Comments
cheatgrass	Bromus tectorum	5	
Sandberg's bluegrass	Poa sandbergii	5	
crested wheatgrass	Agropyron cristatum	30	
Russian thistle	Salsola kali		
Russian thistle	Salsola kali		

Mammal

Common Name	Latin Name	Abundance	Comments
northern pocket gopher	Thomomys talpoides	Present	Mounds
unknown/unidentified small mammal	small mammal	Present	Holes old

Bird

Common Name	Latin Name	Abundance	Comments
mourning dove	Zenaida macroura	3	Flushed
horned lark	Eremophila alpestris	2	

ECAP Database Query Results for E-029

Observer: *Chamness, Mickie* Date *5/27/2010*

Plant

Common Name	Latin Name	Abundance	Comments
crouching milkvetch	Astragalus succumbens		Lots
Sandberg's bluegrass	Poa sandbergii	40	
cheatgrass	Bromus tectorum	20	
gray rabbitbrush	Chrysothamnus nauseosus	20	
big sagebrush	Artemisia tridentata	1	
buckwheat milkvetch	Astragalus caricinus	1	
fiddleneck	Amsinckia lycopsoides		
sagebrush mariposa lily	Calochortus macrocarpus		
hoary falseyarrow	Chaenactis douglasii		
threadleaf fleabane	Erigeron filifolius		
Piper's daisy	Erigeron piperianus		
shaggy fleabane	Erigeron pumilis		
prickly lettuce	Lactuca serriola		
hoary aster	Machaeranthera canescens		
Russian thistle	Salsola kali		
Jim Hill's tumblemustard	Sisymbrium altissimum		
sand dropseed	Sporobolus cryptandrus		
Yellow salsify	Tragopogon dubius		
wheat	Triticum aestivum		

Mammal

Common Name	Latin Name	Abundance	Comments
northern pocket gopher	Thomomys talpoides	Present	old Mnds
unknown/unidentified small mammal	small mammal	Present	Holes

Bird

Common Name	Latin Name	Abundance	Comments
lark sparrow	Chondestes grammacus	1	Squawked to Chna
western meadowlark	Sturnella neglecta	2	Sing
western kingbird	Tyrannus verticalis	1	On chain
American robin	Turdus migratorius	2	On Artr
barn swallow	Hirundo rustica	1	Fly over
mourning dove	Zenaida macroura	1	Fly over
Say's phoebe	Sayornis saya	5	Calling from Chna

Observer: *Simmons, Mary Ann* Date *5/27/2010*

Plant

Common Name	Latin Name	Abundance	Comments
Sandberg's bluegrass	Poa sandbergii	25	

Sunday, July 20, 2014 Page 1 of 2

ECAP Database Query Results for E-514a

Observer: ***Hand, Kris*** Date ***5/6/2010***

Plant

Common Name	Latin Name	Abundance	Comments
Munro's globemallow	Sphaeralcea munroana		Spmu?,test site,photo 1449
big sagebrush	Artemisia tridentata	10	Planted in test site,E side
bluebunch wheatgrass	Agropyron spicatum	10	Planted
cheatgrass	Bromus tectorum	20	
gray rabbitbrush	Chrysothamnus nauseosus	15	
buckwheat milkvetch	Astragalus caricinus		
tumble knapweed	Centaurea diffusa		
storksbill	Erodium cicutarium		
hoary aster	Machaeranthera canescens		
Russian thistle	Salsola kali		
Jim Hill's tumblemustard	Sisymbrium altissimum		

Mammal

Common Name	Latin Name	Abundance	Comments
mountain cottontail	Sylvilagus nutalli	Uncommon	Poop

Sunday, July 20, 2014 Page 1 of 1

ECAP Database Query Results for E-027a

Observer: ***Hand, Kris*** Date ***5/6/2010***

Plant

Common Name	Latin Name	Abundance	Comments
gray rabbitbrush	Chrysothamnus nauseosus		Sprayed
Russian thistle	Salsola kali	15	
Sandberg's bluegrass	Poa sandbergii	10	
hoary aster	Machaeranthera canescens		

Sunday, July 20, 2014 Page 1 of 1

Evaluation Unit: C Tank Farm
ID: CP-TF-7
Group: Tank Farm
Operable Unit Cross-Walk: WMA C
Related EU: CP-LS-7
CP-GW-1
Sites & Facilities: C tank farm, ancillary structures, associated liquid waste sites, and soils contamination
Key Data Sources Docs: DOE/RL-96-32 2013
PNNL ECAP Database[11]
Field Survey Date: 10/7/2014
Data Sheet Prepared By: JLD, MAC, KDH; 10/20/2014

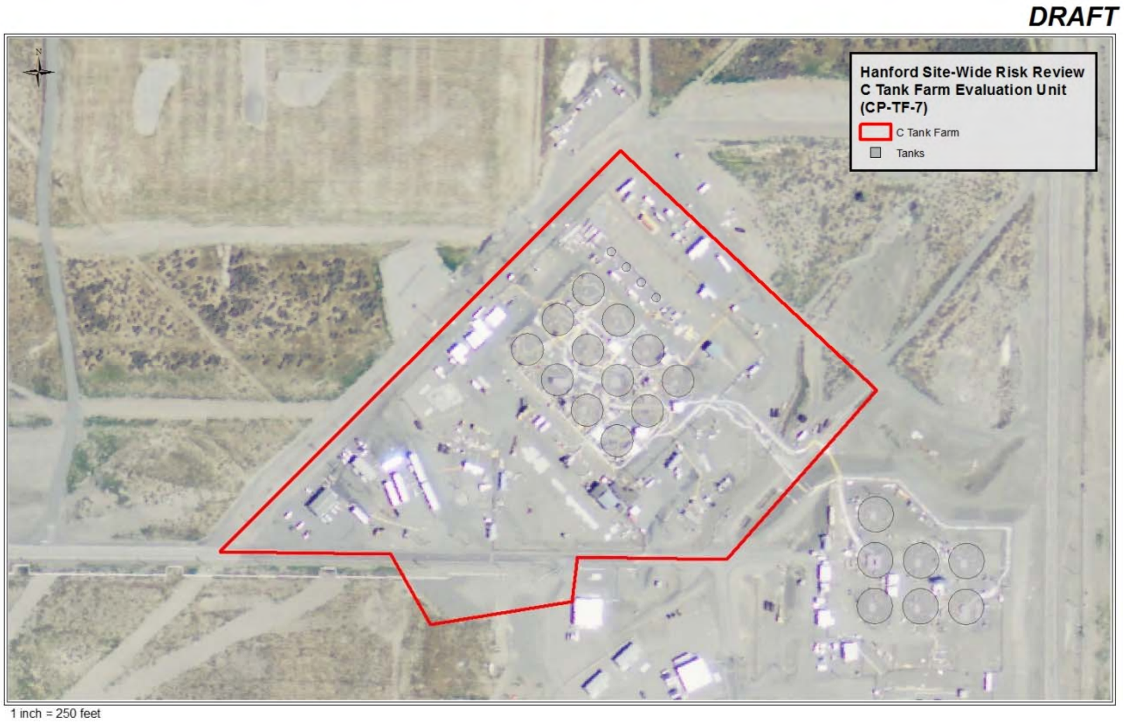

Figure J.24. Site Map with Evaluation Unit Boundaries and Tank Locations

CP-TF-7: C Tank Farm

Survey and Analysis Methods:

The evaluation process makes use of existing biological resource level maps (DOE/RL-96-32 2013), field surveys and measurement of current vegetation and habitat conditions, and wildlife observations to evaluate potential ecological impacts associated with cleanup activities at the evaluation unit (EU). Additional information used in the ecological evaluation includes the current Endangered and Threatened Species (Federal and State) distribution data; priority

[11] The Ecological Compliance and Assessment Project (ECAP) database is an evolving set of data that is maintained by Pacific Northwest National Laboratory (PNNL) and updated as new ecological assessments are completed.

habitats as defined by Washington Department of Fish and Wildlife; available current aerial imagery, locations of Hanford Unit waste sites and infrastructure spatial data; and available information about species of concern distribution and habitat use in the vicinity of the EUs including data previously collected by PNNL for DOE-RL. Definitions relevant to the methods and ecological survey results are provided at the end of this summary along with field data tables.

The following steps were taken to assess the EU associated with the C Tank Farm:

1. The EU boundary (polygon) is assumed to represent the estimated boundary or extent of potential habitat removal and direct disturbance due to remediation.
2. A visual survey was conducted within the EU boundary by experienced shrub-steppe ecologists. Because the unit consists of unvegetated industrial and graveled surfaces and buildings, no field measurements of vegetation were taken. PNNL biologists also reviewed the observations and biological survey data available in the Ecological Compliance and Assessment Project (ECAP) database from the past 5 years for the EU to determine the status and resource level of the habitats within the EU and supplement the evaluation with previous wildlife or plant species observations.
3. A second boundary (polygon) outside the EU was established to evaluate indirect effects and assess the remediation in relation to adjacent landscape features. This polygon is centered on the EU and encompasses a circular area with a radius 1 times the maximum width of the EU and is referred to as the **adjacent landscape buffer**.
4. A reconnaissance survey of the boundary of the EU was conducted to confirm the validity of past mapping of biological resources. Aerial imagery from 2012 was reviewed to identify any significant changes in habitat and resource levels (such as new well pads, roads, or other ground disturbance not captured by the available biological resources mapping) within the EU and adjacent landscape buffer. Where significant change is evident from ground survey or imagery, the biological resource map was updated to reflect the change in resource level.
5. The spatial extent of habitat classified at each of 6 resource levels (0 – 5) (DOE/RL-96-32 2013; definitions at end of this summary) within the adjacent landscape buffer area and the EU were assessed and compared using a Geographic Information System (GIS) to examine potential indirect effects on habitat condition within the adjacent landscape. For purposes of assessing indirect effects on the adjacent landscape, this evaluation assumes the maximum potential change in biological resources—that is, all habitat within the EU is assumed to be lost to remediation and cleanup activities and resources in the EU are considered level 0.
6. PNNL biologists assembled the information from field survey, reconnaissance, and spatial analyses of resource availability to provide a subjective evaluation of potential effects on habitat connectivity in the vicinity of the EU.

Field Survey:

Visual survey and vehicle reconnaissance of the C Tank Farm EU confirmed that the area is primarily level 0 habitat (Figure J.25) with disturbed and graveled surfaces as shown in Figure J.26. Because the site is primarily industrial, no field measurements of vegetation were recorded and no field data sheet is included. No wildlife were observed within the EU during the October survey. Previous ECAP surveys in 2010 noted the presence of mountain cottontail (*Sylvilagus nuttallii*) in the area.

Table J.23. Percent Canopy Cover and Surface Cover Estimated Visually at C Tank Farm

Vegetation/Surface Cover	C Tank Farm EU
Bare Ground	95%
Successional Shrubs	5%

Landscape Evaluation and Resource Classification:

The EU for C-Tank Farm consists of level 0 habitat except for a very small area (0.1 acre) of level 2 habitat. The amount and proximity of biological resources to the C Tank Farms EU was examined within the adjacent landscape buffer area radiating 483 m from the geometric center of the EU (equivalent to 181 acres). No level 3 or greater habitat occurs within the EU. If remediation actions result in the loss of level 2 habitat within the EU, this change would only represent a 0.1% difference in available level 2 habitat resources at the landscape level. A little more than 15% of the combined total area (EU plus adjacent landscape buffer area) consists of level 3 or greater habitats. Some of the level 3 resources in the combined total area are individual occurrences of sensitive plant species (likely Piper’s daisy, *Erigeron piperianus*).

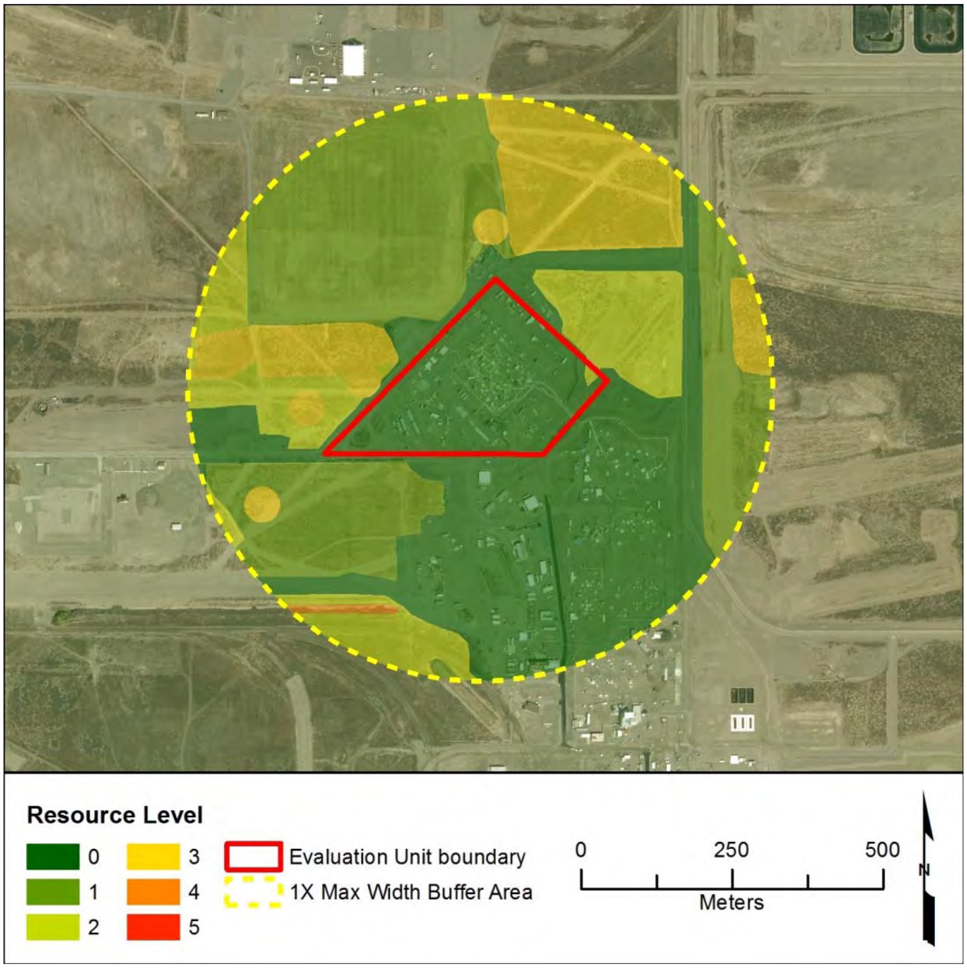

Figure J.25. Biological Resource Level Classifications for the C Tank Farm Evaluation Unit Based on October 2014 Pedestrian and Vehicle Survey (red boundary) and Reconnaissance of the Adjacent Landscape Buffer (yellow dashed line)

Assumptions and Uncertainty:

Due to project time constraints, the field surveys and reconnaissance of this EU were conducted in October. By the time of the survey, the cool-season annual and perennial herbaceous plants that dominate shrub-steppe habitat had completed seasonal growth and senesced making identification and inventory difficult and most likely incomplete. Although no records for plant species of concern have been noted, the absence of species cannot be confirmed by surveys during this time of year.

Table J.24. Area and Proportion of Each Biological Resource Level Within the Evaluation Unit in Relation to Adjacent Landscape and Potential Maximum Change in Resources

Resource Level[1]	Evaluation Unit Area (ac)	Adjacent Landscape Buffer (ac)	Combined Total Area (ac)	Percent of Resource Level in Combined Total Area	Percent of Resource Level in Combined Total Area After Cleanup[2]	Percent Difference at Landscape Scale After Cleanup[2]
0	17.8	58.5	76.3	42.1%	42.1%	0.1%
1	0.0	55.2	55.2	30.5%	30.4%	0.0%
2	0.1	22.6	22.7	12.5%	12.5%	-0.1%
3	0.0	26.5	26.5	14.6%	14.6%	0.0%
4	0.0	0.7	0.7	0.4%	0.4%	0.0%
5	0.0	0.0	0.0	0.0%	0.0%	0.0%
Total	17.9	163.5	181.4	100.0%	100.0%	

1 Resource levels for the evaluation unit were reviewed in the field and via imagery during October 2014 and revised to reflect current habitats conditions.

2 Potential maximum change in area of a given resource level within the combined total area (Evaluation Unit + Adjacent Landscape Buffer) that would occur assuming that all habitat within the evaluation unit is destroyed by remediation activities and the resource level of the evaluation unit is level 0.

Figure J.26. Surface Conditions at the C-Tank Farm Evaluation Unit in October 2014

By October, migratory birds have completed their nesting cycles, and most have migrated out of the region. Surveys conducted in late fall will not reflect their occupancy and use of habitat within the EU earlier in the season. Their absence cannot be confirmed by surveys in October after the nesting season is over. Further surveys during the nesting season would be required to fully assess the ecological impacts to nesting migratory birds.

Summary of Ecological Review:

- The EU for C-Tank Farm consists almost entirely of level 0 resources, and remediation actions will not have any negative effects on habitat resources within the EU.
- The EU is contiguous with the A-AX Tank Farms and 200-East Double Shell Tanks, but does adjoin small patches of level 2 and level 3 habitat to the west. However, disturbance to habitats within the EU would not have any effect on habitat connectivity.
- No wildlife were observed in the vicinity during the October survey.
- Individual occurrences of sensitive plant species are located within the landscape buffer area, but would be unlikely to be affected by any remediation action within the evaluation unit.

References:

DOE/RL-96-32. 2013. Hanford Site Biological Resources Management Plan, Revision 0.

U.S. Fish and Wildlife Service (USFWS). 2014. Birds Protected by the Migratory Bird Treaty Act. http://www.fws.gov/migratorybirds/RegulationsPolicies/mbta/mbtintro.html

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Definitions and Acronyms:

Adjacent Landscape Buffer – a circular area adjacent to and outside the EU boundary with the center of the circle at the centroid of the EU, and with a radius that is 1 times the maximum dimension (width or length—whichever is greatest). This circular buffer area is used to evaluate indirect effects and assess the remediation in relation to the landscape features and resources adjacent to the EU. This circular area is generally at least 3 times the area of the EU.

Biological Resource Levels (from DOE-RL-96-32-01) –

- Level 5 resources include species that are listed or proposed-to-be listed under the *Endangered Species Act* and their critical habitat, as well as rare and irreplaceable habitats.
- Level 4 resources include federal candidate species; Washington State threatened or endangered species; habitat or exclusion buffers for federal candidates and Washington State threatened or endangered species; high-quality mature shrub steppe; wetlands and riparian areas; and buffer areas for bald eagles and ferruginous hawks.
- Level 3 resources include Washington State sensitive, candidate, and review species; Washington Department of Fish and Wildlife priority species; lower quality mature shrub-steppe—such as shrub stands that are less mature, have lower shrub density or canopy cover, and/or a greater proportion of cheatgrass in the understory than stands that qualify for Level 4. Level 3 also includes high-quality grasslands, conservation corridors, snake hibernacula, bat roosts, rookeries, burrowing owl buffer areas, and areas with significant quantities of culturally important species.
- Level 2 resources include migratory birds, state watch list plants and monitor list animals, recreationally and commercially important species, and lower quality steppe and shrub-steppe.
- Level 1 resources include individual common native plant and wildlife species, upland stands of non-native plants, and abandoned agricultural fields.

Evaluation Units (EUs) – groupings of sources, aggregated for evaluation as part of the Hanford Site-wide Risk Review Project. Sources may be aggregated into an EU based on potential impacts to a common set of receptors or receptor geographic area, common past waste management practices, or integration in the waste management process.

MBTA – Migratory Bird Treaty Act; referring to species listed and protected under the federal Act.

PNNL ECAP (Ecological Compliance and Assessment Project) Database – PNNL performed ecological reviews for individual projects and annually surveyed selected areas and buildings on the Hanford Site for DOE-RL under the DOE’s Public Safety and Resource Protection Program until 2011. The data collected during those surveys is archived in the ECAP database, and is used to supplement ecological evaluations as available.

Priority Habitats – Priority habitats are habitat types or elements with unique or significant value to a diverse assemblage of species. A priority habitat may consist of a unique vegetation type (e.g., shrub-steppe) or dominant plant species (e.g., juniper savannah), a described successional stage (e.g., old-growth forest), or a specific habitat feature (e.g., cliffs).

Species of Concern or Species of Conservation Concern – An informal term that for the purpose of this assessment includes those species listed at the federal or state level as being threatened endangered, sensitive, or candidate, as well as those listed by the U.S. Fish and Wildlife Service as species of concern within the ecoregion.

PNNL ECAP Survey Data

ECAP Database Query Results for E-512

Observer: *Chamness, Mickie* Date *5/1/2009*

Mammal

Common Name	Latin Name	Abundance	Comments
mountain cottontail	Sylvilagus nuttalli	Common	Lots of poop N end

Bird

Common Name	Latin Name	Abundance	Comments
cliff swallow	Hirundo pyrrhonota	1	Flew over

Friday, October 17, 2014 Page 1 of 1

Evaluation Unit: 200-East DSTs
ID: CP-TF-8
Group: Tank Farm
Operable Unit Cross-Walk: NA
Related EU: CP-LS-7
CP-TF-5
Sites & Facilities: AN, AP, AW, AY, AZ tank farms, ancillary structures, associated liquid waste sites, and soils contamination
Key Data Sources Docs: DOE/RL-96-32 2013
PNNL ECAP Database[12]
Field Survey Date: 10/08/2014
Data Sheet Prepared By: JLD, KDH, MAC, SAM, KBL; 10/20/2014

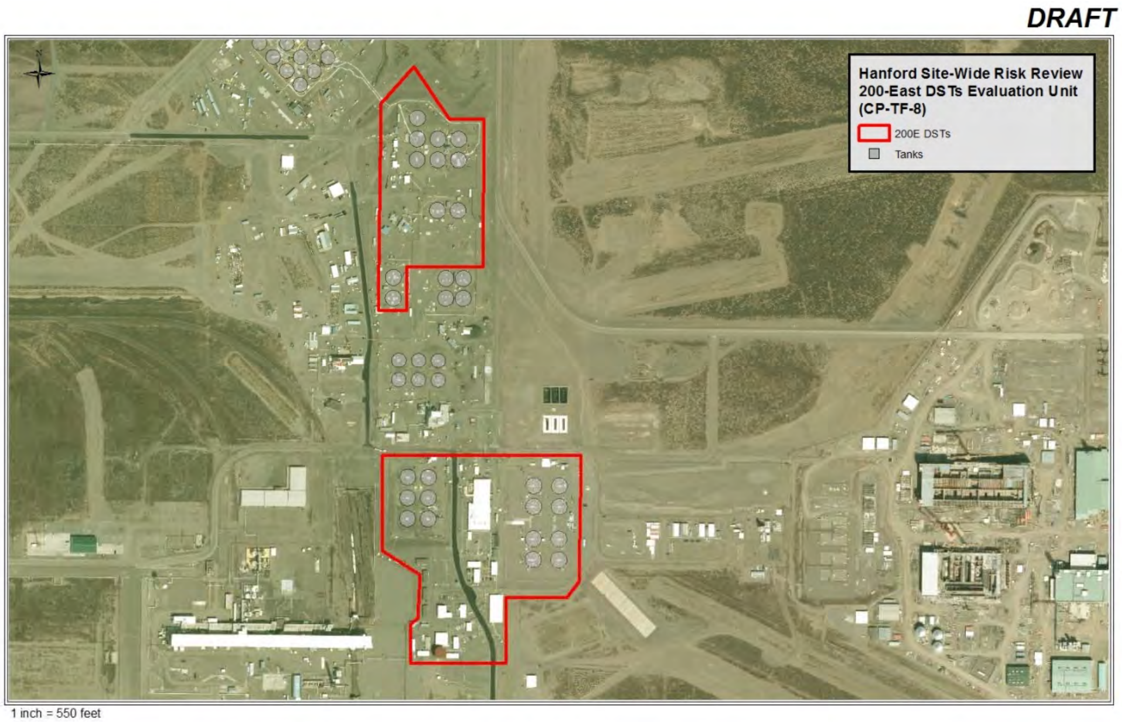

Figure J.27. Site Map with Evaluation Unit Boundaries and Tank Locations

CP-TF-8: 200-East Double Shell Tanks

Survey and Analysis Methods:

The evaluation process makes use of existing biological resource level maps (DOE/RL-96-32 2013), field surveys and measurement of current vegetation and habitat conditions, and wildlife observations to evaluate potential ecological impacts associated with cleanup activities at the evaluation unit (EU). Additional information used in the ecological evaluation includes the current Endangered and Threatened Species (Federal and State) distribution data; priority

[12] The Ecological Compliance and Assessment Project (ECAP) database is an evolving set of data that is maintained by Pacific Northwest National Laboratory (PNNL) and updated as new ecological assessments are completed.

habitats as defined by Washington Department of Fish and Wildlife; available current aerial imagery, locations of Hanford Site waste sites and infrastructure spatial data; and available information about species of concern distribution and habitat use in the vicinity of the EUs including data previously collected by PNNL for DOE-RL. Definitions relevant to the methods and ecological survey results are provided at the end of this summary along with field data tables.

The following steps were taken to assess the EU associated with the 200-East Double Shell Tanks:

1. The EU boundary (polygon) is assumed to represent the estimated boundary or extent of potential habitat removal and direct disturbance due to remediation.
2. A visual survey was conducted within the EU boundary by experienced shrub-steppe ecologists. Because the unit consists of disturbed areas and graveled surfaces, no field measurements of vegetation were taken. PNNL biologists also reviewed the observations and biological survey data available in the Ecological Compliance and Assessment Project (ECAP) database from the past 5 years for the EU to determine the status and resource level of the habitats within or around the EU and supplement the evaluation with previous wildlife or plant species observations.
3. A second boundary (polygon) outside the EU was established to evaluate indirect effects and assess the remediation in relation to adjacent landscape features. This polygon is centered on the EU and encompasses a circular area with a radius 1 times the maximum width of the EU and is referred to as the **adjacent landscape buffer**.
4. A reconnaissance survey of the boundary of the EU was conducted to confirm the validity of past mapping of biological resources. Aerial imagery from 2012 was reviewed to identify any significant changes in habitat and resource levels (such as new well pads, roads, or other ground disturbance not captured by the available biological resources mapping) within the EU and adjacent landscape buffer. Where significant change is evident from ground survey or imagery, the biological resource map was updated to reflect the change in resource level.
5. The spatial extent of habitat classified at each of 6 resource levels (0 – 5) (DOE/RL-96-32 2013; definitions at end of this summary) within the adjacent landscape buffer area and the EU were assessed and compared using a Geographic Information System (GIS) to examine potential indirect effects on habitat condition within the adjacent landscape. For purposes of assessing indirect effects on the adjacent landscape, this evaluation assumes the maximum potential change in biological resources—that is, all habitat within the EU is assumed to be lost to remediation and cleanup activities and resources in the EU are considered level 0.
6. PNNL biologists assembled the information from field survey, reconnaissance, and spatial analyses of resource availability to provide a subjective evaluation of potential effects on habitat connectivity in the vicinity of the EU.

Field Survey:

Field surveys conducted in October 2014 confirmed that the majority of the 200-East Double Shell Tanks EU consists of buildings, parking areas, graveled surfaces, and infrastructure related to the tanks. No vegetation measurements were taken and no field data sheets are included. Table J.25 documents the surface conditions of the EU. No wildlife was observed within the EU during the October 2014 survey; however, PNNL ECAP surveys conducted in 2009 noted the following wildlife on/near the buildings: house finch (*Carpodacus mexicanus*), Brewer's blackbird (*Euphagus byanocephalus*), black-billed magpie (*Pica pica*), and western kingbird (*Tyrannus verticalis*).

Table J.25. Percent Canopy Cover and Surface Cover Measured at 200-East Double Shell Tanks Evaluation Unit

Vegetation/Surface Cover	Inside Tank Farm Fence
Bare Ground/Gravel	100%

Landscape Evaluation and Resource Classification:

The amount and proximity of the biological resources to the EUs were examined within the adjacent landscape buffer areas radiating approximately 386 m (northern polygon) and 420 m (southern polygon) from the geometric centers of the EU (equivalent to 228.6 acres combined). The major portion—that is, nearly 90%—of the 200-East Double Shell Tanks EU and adjacent landscape buffer is comprised of level 0 and level 1 habitat resources (Figure J.28 and Figure J.29, Table J.26). Small patches of level 2 habitat are located close to, but not contiguous with the northern and southern extents of the two EU polygons. A small patch (approximately 2 to 3 acres of level 3 habitat is located to the east of the two polygons (300 to 700 feet away from EU boundaries), and individual occurrences of level 3 plant species, Piper's daisy (*Erigeron piperianus*) are located to the south.

Table J.26. Area and Proportion of Each Biological Resource Level Within the 200-East Double Shell Tanks Evaluation Unit in Relation to Adjacent Landscape and Potential Maximum Change in Resources

Resource Level[1]	Evaluation Unit Area (ac)	Adjacent Landscape Buffer (ac)	Combined Total Area (ac)	Percent of Resource Level in Combined Total Area	Percent of Resource Level in Combined Total Area After Cleanup[2]	Percent Difference at Landscape Scale After Cleanup[2]
0	31.4	131.3	162.7	71.2%	71.2%	0.0%
1	0.0	42.6	42.6	18.6%	18.6%	0.0%
2	0.0	14.5	14.5	6.3%	6.3%	0.0%
3	0.0	8.9	8.9	3.9%	3.9%	0.0%
4	0.0	0.0	0.0	0.0%	0.0%	0.0%
5	0.0	0.0	0.0	0.0%	0.0%	0.0%
Total	31.4	197.3	228.6	100.0%	100.0%	

1 Resource levels for both the evaluation unit and adjacent landscape boundary were reviewed in the field and via imagery during October 2014 and revised to reflect current habitats conditions.

2 Potential maximum change in area of a given resource level within the combined total area (Evaluation Unit + Adjacent Landscape Buffer) that would occur assuming that all habitat within the evaluation unit is destroyed by remediation activities and the resource level of the evaluation unit is level 0.

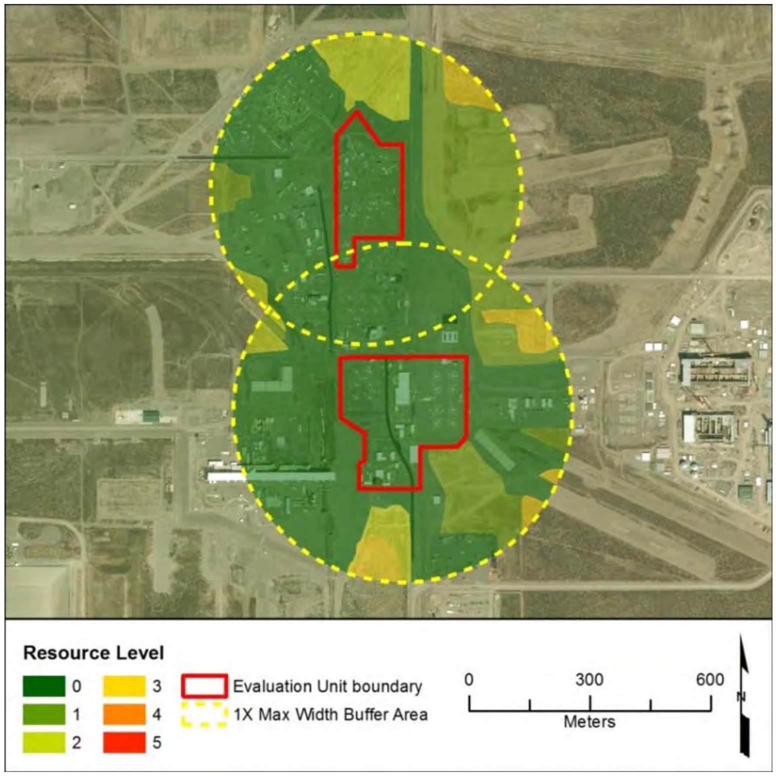

Figure J.28. Biological Resource Level Classifications for the 200-East Double Shell Tanks Evaluation Unit (red solid line) and Adjacent Landscape Buffer Area (yellow dashed line) Based on October 2014 Survey

Figure J.29. Surface Conditions of the 200-East Double Shell Tanks Evaluation Unit during October 2014 Survey

Assumptions and Uncertainty:

Due to project time constraints, the field surveys and reconnaissance of this EU were conducted in October. By the time of the survey, the cool-season annual and perennial herbaceous plants that dominate shrub-steppe habitat had completed seasonal growth and senesced making identification and inventory difficult and most likely incomplete. Although no records for plant species of concern have been noted, the absence of species cannot be confirmed by surveys during this time of year.

By October, migratory birds have completed their nesting cycles, and most have migrated out of the region. Surveys conducted in late fall will not reflect their occupancy and use of habitat within the EU earlier in the season. Their absence cannot be confirmed by surveys in October after the nesting season is over. Further surveys during the nesting season would be required to fully assess the ecological impacts to nesting migratory birds.

Summary of Ecological Review:

- The EU is level 0 habitat, and no level 3 or greater resources exist within the 200-East Double Shell Tank EU boundaries.
- No wildlife were observed using the disturbed habitats within the EU boundaries.
- Because the area is an industrial site, and is contiguous with adjacent tank farms and other industrial areas—no significant change in habitat connectivity would be expected to result from remediation actions taken within the EU.

References

DOE/RL-96-32. 2013. Hanford Site Biological Resources Management Plan, Revision 0.

U.S. Fish and Wildlife Service (USFWS). 2014. Birds Protected by the Migratory Bird Treaty Act. http://www.fws.gov/migratorybirds/RegulationsPolicies/mbta/mbtintro.html

U.S. Fish and Wildlife Service (USFWS). 2014. Environmental Conservation Online System, Listings and Occurrences for Washington. http://ecos.fws.gov/tess_public/pub/stateListingAndOccurrenceIndividual.jsp?state=WA&s8fid=112761032792&s8fid=112762573902

Washington Department of Fish and Wildlife. 2008. Washington State Priority Habitats and Species List. Olympia Washington. 174 pp. http://wdfw.wa.gov/conservation/phs/list/

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Washington Noxious Weed Control Board.2014. Noxious Weed List. http://www.nwcb.wa.gov/

Washington State Department of Natural Resources. 2014. Washington Natural Heritage Program Plant Ranks. http://www1.dnr.wa.gov/nhp/refdesk/lists/plantrnk.html

Definitions and Acronyms:

Adjacent Landscape Buffer – a circular area adjacent to and outside the EU boundary with the center of the circle at the centroid of the EU, and with a radius that is 1 times the maximum dimension (width or length—whichever is greatest). This circular buffer area is used to evaluate indirect effects and assess the remediation in relation to the landscape features and resources adjacent to the EU. This circular area is generally at least 3 times the area of the EU.

Biological Resource Levels (from DOE-RL-96-32-01) –

- Level 5 resources include species that are listed or proposed-to-be listed under the *Endangered Species Act* and their critical habitat, as well as rare and irreplaceable habitats.
- Level 4 resources include federal candidate species; Washington State threatened or endangered species; habitat or exclusion buffers for federal candidates and Washington State threatened or endangered species; high-quality mature shrub steppe; wetlands and riparian areas; and buffer areas for bald eagles and ferruginous hawks.
- Level 3 resources include Washington State sensitive, candidate, and review species; Washington Department of Fish and Wildlife priority species; lower quality mature shrub-steppe—such as shrub stands that are less mature, have lower shrub density or canopy cover, and/or a greater proportion of cheatgrass in the understory than stands that qualify for Level 4. Level 3 also includes high-quality grasslands, conservation corridors, snake hibernacula, bat roosts, rookeries, burrowing owl buffer areas, and areas with significant quantities of culturally important species.
- Level 2 resources include migratory birds, state watch list plants and monitor list animals, recreationally and commercially important species, and lower quality steppe and shrub-steppe.
- Level 1 resources include individual common native plant and wildlife species, upland stands of non-native plants, and abandoned agricultural fields.

Evaluation Units (EUs) – groupings of sources, aggregated for evaluation as part of the Hanford Site-wide Risk Review Project. Sources may be aggregated into an EU based on potential impacts to a common set of receptors or receptor geographic area, common past waste management practices, or integration in the waste management process.

MBTA – Migratory Bird Treaty Act; referring to species listed and protected under the federal Act.

PNNL ECAP (Ecological Compliance and Assessment Project) Database – PNNL performed ecological reviews for individual projects and annually surveyed selected areas and buildings on the Hanford Site for DOE-RL under the DOE's Public Safety and Resource Protection Program until 2011. The data collected during those surveys is archived in the ECAP database, and is used to supplement ecological evaluations as available.

Priority Habitats – Priority habitats are habitat types or elements with unique or significant value to a diverse assemblage of species. A priority habitat may consist of a unique vegetation type (e.g., shrub-steppe) or dominant plant species (e.g., juniper savannah), a described successional stage (e.g., old-growth forest), or a specific habitat feature (e.g., cliffs).

Species of Concern or Species of Conservation Concern – An informal term that for the purpose of this assessment includes those species listed at the federal or state level as being threatened endangered, sensitive, or candidate, as well as those listed by the U.S. Fish and Wildlife Service as species of concern within the ecoregion.

Previous PNNL ECAP Survey Data

ECAP Database Query Results for 200E Tank Farms

Observer: *Hand, Kris* Date: *5/1/2009*

SelectBldg	BldgFaunaCode	BldgFaunaName	BldgObs	BldgNestStatus	Abundance	BldgAspect	BldgDetail	BldgComments
274-AW	Hofi	finch, house: Carpodacus mexicanus	Critter		1	SE	Perch fence,sing	
274-AW	Hofi	finch, house: Carpodacus mexicanus	Critter		1	E	Perch wire,sing	
MO-267	Brbl	blackbird, Brewer's: Euphagus cyanocephalus	Nest	Inactive	1	W	Pine shrub	
MO-268	Brbl	blackbird, Brewer's: Euphagus cyanocephalus	Nest	Inactive	1	S	Juniper	
MO-268	Bbma	magpie, black-billed: Pica pica	Critter		1	S	Flush juniper	No nest visible
MO-268	Weki	kingbird, western: Tyrannus verticalis	Critter		2	W	Perch powerline	1 flew W
272-AW	Hofi	finch, house: Carpodacus mexicanus	Critter		1	SW	Perch powerline	

Friday, October 24, 2014 Page 1 of 1

Evaluation Unit: 200-West DSTs
ID: CP-TF-9
Group: Tank Farm
Operable Unit Cross-Walk: WMA S/SX
Related EU: CP-LS-7
CP-TF-2
Sites & Facilities: SY tank farm, ancillary structures, associated liquid waste sites, and soils contamination
Key Data Sources Docs: DOE/RL-96-32 2013
Field Survey Date: 10/10/2014
Data Sheet Prepared By: KDH, JLD, MAC, KBL, SAM; 10/22/2014

Figure J.30. Site Map of the 200-West Double Shell Tanks Evaluation Unit Boundary and Tank Locations

CP-TF-9: 200-West Double Shell Tanks

Survey and Analysis Methods:

The evaluation process makes use of existing biological resource level maps (DOE/RL-96-32 2013), field surveys and measurement of current vegetation and habitat conditions, and wildlife observations to evaluate potential ecological impacts associated with cleanup activities at the evaluation unit (EU). Additional information used in the ecological evaluation includes the current Endangered and Threatened Species (Federal and State) distribution data; priority habitats as defined by Washington Department of Fish and Wildlife; available current aerial imagery, locations of Hanford Site waste sites and infrastructure spatial data; and available information about species of concern distribution and habitat use in the vicinity of the EUs including data previously collected by PNNL for DOE-RL. Definitions relevant to the methods and ecological survey results are provided at the end of this summary along with field data tables.

The following steps were taken to assess the EU associated with the 200-West Double Shell Tanks:

1. The EU boundary (polygon) is assumed to represent the estimated boundary or extent of potential habitat removal and direct disturbance due to remediation.
2. A visual survey was conducted within the EU boundary by experienced shrub-steppe ecologists. Because the unit consists of unvegetated industrial and graveled surfaces and buildings, no field measurements of vegetation were taken. PNNL biologists also reviewed the observations and biological survey data available in the Ecological Compliance and Assessment Project (ECAP) database from the past 5 years for the EU to determine the status and resource level of the habitats within the EU and supplement the evaluation with previous wildlife or plant species observations.
3. A second boundary (polygon) outside the EU was established to evaluate indirect effects and assess the remediation in relation to adjacent landscape features. This polygon is centered on the EU and encompasses a circular area with a radius 1 times the maximum width of the EU and is referred to as the **adjacent landscape buffer**.
4. A reconnaissance survey of the boundary of the EU was conducted to confirm the validity of past mapping of biological resources. Aerial imagery from 2012 was reviewed to identify any significant changes in habitat and resource levels (such as new well pads, roads, or other ground disturbance not captured by the available biological resources mapping) within the EU and adjacent landscape buffer. Where significant change is evident from ground survey or imagery, the biological resource map was updated to reflect the change in resource level.
5. The spatial extent of habitat classified at each of 6 resource levels (0 – 5) (DOE/RL-96-32 2013; definitions at end of this summary) within the adjacent landscape buffer area and the EU were assessed and compared using a Geographic Information System (GIS) to examine potential indirect effects on habitat condition within the adjacent landscape. For purposes of assessing indirect effects on the adjacent landscape, this evaluation assumes the maximum potential change in biological resources—that is, all habitat within the EU is assumed to be lost to remediation and cleanup activities and resources in the EU are considered level 0.
6. PNNL biologists assembled the information from field surveys, reconnaissance, and spatial analyses of resource availability to provide a subjective evaluation of potential effects on habitat connectivity in the vicinity of the EU.

Field Survey:

PNNL biologists conducted a reconnaissance and visual survey of the 200-West Double Shell Tanks EU on October 14, 2014. This field survey confirmed that nearly the entire EU consists of graveled surfaces, buildings, parking areas, and infrastructure related to the tanks. Only sparse vegetation, consisting of alien grasses and forbs, occurs along roadside margins outside the tank farm fence. No vegetation measurements were taken and no field data sheets are included. Table J.27 documents the surface conditions of the EU.

No wildlife were observed within the EU during the October reconnaissance, however, PNNL ECAP surveys conducted in 2009 noted the following birds: an American kestrel (*Falco sparverius*) apparently nesting in a light pole or nearby building, Say's phoebe (*Sayornis saya*), barn swallow (*Hirundo rustica*), and white-crowned sparrow (*Zonotrichia leucophrys*).

Table J.27. Percent Surface Cover Estimated Visually at the 200-West DSTs EU

Vegetation/Surface Cover	200-West DSTs EU
Bare Ground	100%

Landscape Evaluation and Resource Classification:

The amount of each category of biological resources at and near the 200-West Double Shell Tanks EU was examined within a circular area radiating 204 m from the geometric center of the unit (equivalent to 32.2 acres). The entire EU (4.7 ac) is comprised of level 0 biological resources (Table J.28). The major portion (18.6 ac, 67.6%) of the adjacent landscape buffer is made up of level 0 and 1 resources, with the remainder comprised of several small patches of level 2 (6.9 ac, 25.1%) located north and east of the EU and a single patch of level 3 (1.9 ac, 6.9%) located north of the EU (Figure J.31, Table J.28). Overall, only six percent of the total combined area currently consists of higher quality (level 3 or above) biological resources based on habitat.

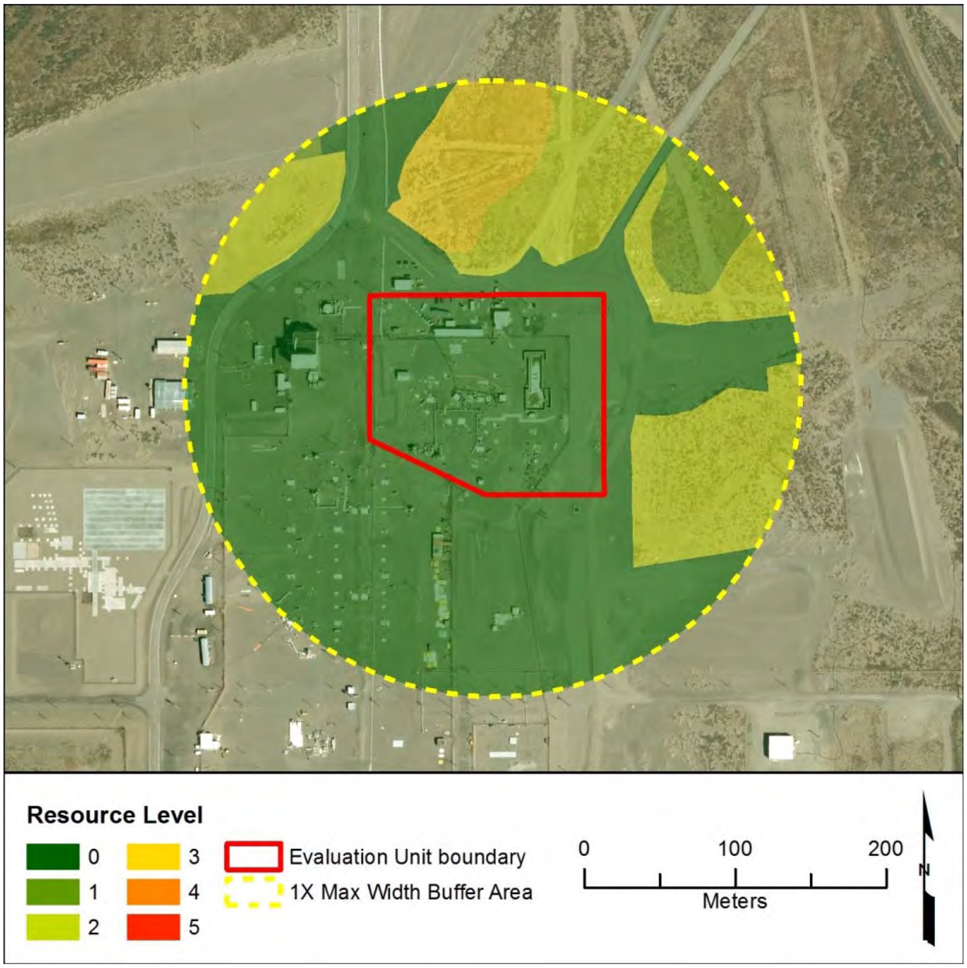

Figure J.31. Biological Resource Level Classifications Based on October 2014 Surveys for the 200-West Double Shell Tanks Evaluation Unit (red solid line) and Adjacent Landscape Buffer (yellow dashed line)

Table J.28. Area and Proportion of Each Biological Resource Level Within the Evaluation Unit in Relation to Adjacent Landscape and Potential Maximum Change in Resources

Resource Level[1]	Evaluation Unit Area (ac)	Adjacent Landscape Buffer (ac)	Combined Total Area (ac)	Percent of Resource Level in Combined Total Area	Percent of Resource Level in Combined Total Area After Cleanup[2]	Percent Difference at Landscape Scale After Cleanup[2]
0	4.7	17.5	22.2	69.2%	69.2%	0.0%
1	0.0	1.1	1.1	3.4%	3.4%	0.0%
2	0.0	6.9	6.9	21.4%	21.4%	0.0%
3	0.0	1.9	1.9	6.0%	6.0%	0.0%
4	0.0	0.0	0.0	0.0%	0.0%	0.0%
5	0.0	0.0	0.0	0.0%	0.0%	0.0%
Total	4.7	27.4	32.2	100.0%	100.0%	

1 Resource levels for the evaluation unit were reviewed in the field and via imagery during October 2014 and revised to reflect current habitats conditions.

2 Potential maximum change in area of a given resource level within the combined total area (Evaluation Unit + Adjacent Landscape Buffer) that would occur assuming that all habitat within the evaluation unit is destroyed by remediation activities and the resource level of the evaluation unit is level 0.

Assumptions and Uncertainty:

Due to project time constraints, the field surveys and reconnaissance of this EU were conducted in mid-October. By the time of the survey, the cool-season annual and perennial herbaceous plants that dominate shrub-steppe habitat had completed seasonal growth and senesced making identification and inventory difficult, and most likely incomplete. Although no records for plant species of concern have been noted, the absence of such species cannot be confirmed by surveys during this time of year.

By mid-October, most migratory birds have completed their nesting cycles, and surveys may not reflect their occupancy and use of habitat within the EU earlier in the season. Their absence cannot be confirmed by surveys in October after the nesting season is over. Further surveys during the nesting season would be required to fully assess the ecological impacts to nesting migratory birds.

Summary of Ecological Review:

- The EU for the 200-West DSTs consists entirely of level 0 habitat resources.
- No wildlife or signs were observed during the October survey of the EU.
- Remediation actions undertaken within the 200-West DSTs EU boundary would result in no net change in biological resources within a 2.1 km radius.
- Because the area is an industrial site, and is contiguous with adjacent tank farms and other industrial areas—no significant change in habitat connectivity would be expected if habitat resources within the EU are lost.

References

DOE/RL-96-32. 2013. Hanford Site Biological Resources Management Plan, Revision 0.

U.S. Fish and Wildlife Service (USFWS). 2014. Birds Protected by the Migratory Bird Treaty Act. http://www.fws.gov/migratorybirds/RegulationsPolicies/mbta/mbtintro.html

U.S. Fish and Wildlife Service (USFWS). 2014. Environmental Conservation Online System, Listings and Occurrences for Washington. http://ecos.fws.gov/tess_public/pub/stateListingAndOccurrenceIndividual.jsp?state=WA&s8fid=112761032792&s8fid=112762573902

Washington Department of Fish and Wildlife. 2008. Washington State Priority Habitats and Species List. Olympia Washington. 174 pp. http://wdfw.wa.gov/conservation/phs/list/

Washington Department of Fish and Wildlife. 2014. Species of Concern in Washington. http://wdfw.wa.gov/conservation/endangered/

Washington Noxious Weed Control Board.2014. Noxious Weed List. http://www.nwcb.wa.gov/

Washington State Department of Natural Resources. 2014. Washington Natural Heritage Program Plant Ranks. http://www1.dnr.wa.gov/nhp/refdesk/lists/plantrnk.html

Definitions and Acronyms:

Adjacent Landscape Buffer – a circular area adjacent to and outside the EU boundary with the center of the circle at the centroid of the EU, and with a radius that is 1 times the maximum dimension (width or length—whichever is greatest). This circular buffer area is used to evaluate indirect effects and assess the remediation in relation to the landscape features and resources adjacent to the EU. This circular area is generally at least 3 times the area of the EU.

Biological Resource Levels (from DOE-RL-96-32-01) –

- Level 5 resources include species that are listed or proposed-to-be listed under the *Endangered Species Act* and their critical habitat, as well as rare and irreplaceable habitats.
- Level 4 resources include federal candidate species; Washington State threatened or endangered species; habitat or exclusion buffers for federal candidates and Washington State threatened or endangered species; high-quality mature shrub steppe; wetlands and riparian areas; and buffer areas for bald eagles and ferruginous hawks.
- Level 3 resources include Washington State sensitive, candidate, and review species; Washington Department of Fish and Wildlife priority species; lower quality mature shrub-steppe—such as shrub stands that are less mature, have lower shrub density or canopy cover, and/or a greater proportion of cheatgrass in the understory than stands that qualify for Level 4. Level 3 also includes high-quality grasslands, conservation corridors, snake hibernacula, bat roosts, rookeries, burrowing owl buffer areas, and areas with significant quantities of culturally important species.
- Level 2 resources include migratory birds, state watch list plants and monitor list animals, recreationally and commercially important species, and lower quality steppe and shrub-steppe.
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Evaluation Units (EUs) – groupings of sources, aggregated for evaluation as part of the Hanford Site-wide Risk Review Project. Sources may be aggregated into an EU based on potential impacts to a common set of receptors or receptor geographic area, common past waste management practices, or integration in the waste management process.

MBTA – Migratory Bird Treaty Act; referring to species listed and protected under the federal Act.

PNNL ECAP (Ecological Compliance and Assessment Project) Database – PNNL performed ecological reviews for individual projects and annually surveyed selected areas and buildings on the Hanford Site for DOE-RL under the DOE's Public Safety and Resource Protection Program until 2011. The data collected during those surveys is archived in the ECAP database, and is used to supplement ecological evaluations as available.

Priority Habitats – Priority habitats are habitat types or elements with unique or significant value to a diverse assemblage of species. A priority habitat may consist of a unique vegetation type (e.g., shrub-steppe) or dominant plant species (e.g., juniper savannah), a described successional stage (e.g., old-growth forest), or a specific habitat feature (e.g., cliffs).

Species of Concern or Species of Conservation Concern – An informal term that for the purpose of this assessment includes those species listed at the federal or state level as being threatened endangered, sensitive, or candidate, as well as those listed by the U.S. Fish and Wildlife Service as species of concern within the ecoregion.

Field Data Sheets Embedded

ECAP Database Query Results for W-503

Observer: *Chamness, Mickie* Date *5/6/2009*

Bird

Common Name	Latin Name	Abundance	Comments
white-crowned sparrow	Zonotrichia leucophrys	6	On grnd
barn swallow	Hirundo rustica	1	Fly over
American kestrel	Falco sparverius	2	Flew to high light pole, nesting her or on 242-S
Say's phoebe	Sayornis saya	1	Collecting nest stuff

Bird

Common Name	Latin Name	Abundance	Comments
loggerhead shrike	Lanius ludovicianus	1	Flew to W powerline

Observer: *Hand, Kris* Date *5/5/2009*

Plant

Common Name	Latin Name	Abundance	Comments
cheatgrass	Bromus tectorum		Saka

Friday, October 17, 2014 Page 1 of 1

ECAP Database Query Results for W-046ac

Observer: ***Chamness, Mickie*** Date ***6/8/2010***

Plant

Common Name	Latin Name	Abundance	Comments
No vegetation present	No vegetation		W of paved rd

Observer: ***Simmons, Mary Ann*** Date ***6/8/2010***

Plant

Common Name	Latin Name	Abundance	Comments
No vegetation present	No vegetation	95	gravel
crested wheatgrass	Agropyron cristatum	+	
whitestem stickleaf	Mentzelia albicaulis		
indian ricegrass	Oryzopsis hymenoides		
Sandberg's bluegrass	Poa sandbergii		
Russian thistle	Salsola kali		

Friday, October 17, 2014 Page 1 of 1

ECAP Database Query Results for W-107d

Observer: ***Hand, Kris*** Date ***6/1/2010***

Plant

Common Name	Latin Name	Abundance	Comments
No vegetation present	No vegetation	80	gravel
Sandberg's bluegrass	Poa sandbergii	1	
Russian thistle	Salsola kali	1	
crested wheatgrass	Agropyron cristatum		
cheatgrass	Bromus tectorum		
gray rabbitbrush	Chrysothamnus nauseosus		

Bird

Common Name	Latin Name	Abundance	Comments
No birds observed	No birds		

Evaluation Unit: 300 Area Groundwater Plumes
ID: RC-GW-1
Group: Groundwater
Operable Unit Cross-Walk: 300-FF-5
Related EU: RC-DD-1
Sites & Facilities: 300 Area uranium and associated contaminant plumes
Key Data Sources Docs: N/A

Figure J.32. Site Map with Evaluation Unit Boundaries

RC-GW-1: 300 Area GW Plumes

Survey and Analysis Methods:

The approach developed to assess potential impacts to ecological resources within the individual groundwater evaluation units includes consideration of the extent of potential direct and indirect interactions of ecological receptors and resources with the groundwater plume and remediation activities. The potential for 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). In general, the depth to groundwater at Hanford is much greater than 15 feet, and it would be very unlikely that ecological receptors would be affected by the presence of the plume below ground except for areas where the groundwater approaches the surface. Along the shoreline adjacent to where groundwater plumes intercept and enter the river, the groundwater may not be as deep below the surface. In such areas, there could be mixing of river bank storage and groundwater at shallower depths accessible to biota, and plant roots and burrowing animals could potentially interact with portions of the groundwater plume.

For purposes of this assessment, we delineated the areas where the mapped riparian zone along the river shoreline intersects the estimated contours for the groundwater plume. 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 with separate contaminant plumes are provided in Table J.29 and indicate the extent of biological resources that could potentially be affected by the groundwater plumes. In total for the four groundwater evaluation units with plumes that are estimated to intersect the Columbia River, there are approximately 109.5 acres of riparian habitat and resources along the river shoreline that could potentially be affected.

In addition to consideration of the area where ecological resources might be directly affected by the contaminant groundwater plumes, the direct and indirect effects of potential remediation actions should be taken into account. Remediation actions taken to reduce the contaminated groundwater plumes may have indirect effects on terrestrial ecological resources. Subsurface remediation actions such as pump and treat activities or development of subsurface chemical barriers to contaminant transport may indirectly affect ecological resources through several mechanisms:

- Injection and pumping wells might alter the hydrology in the vadose zone, and change soil water availability for plants.
- Injection of barrier constituents might alter soil chemistry and nutrient availability depending on rate or distance of migration of those constituents and whether the constituents interact with soils within the rooting zone
- Well pad and road construction may disturb the surface, degrade available habitat, and impact ecological resources/receptors
- Pedestrian and vehicle traffic during construction, maintenance, monitoring, and decommission 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. Removal of the treatment plant species at conclusion of the remediation action would also be likely to cause surface and noise disturbance as well as dust and transport of potentially contaminated plant materials as waste. 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.

Table J.29. Areal Extent (Acres) of Riparian Zone Intersected by 2013 Groundwater Plumes Within Each Groundwater Operable Unit

Evaluation Unit Groundwater Operable Unit COPC	Reference Value	RC-GW-3 100-BC-5	RC-GW-3 100-KR-4	RC-GW-2 100-NR-2	RC-GW-3 100-HR-3	CP-GW-1 200-PO-1	RC-GW-1 300-FF-5	Total Area
Carbon-14	2,000 pCi/L[a]	-	-	-	-	-	-	-
Cyanide	200 µg/L[a]	-	-	-	-	-	-	-
Chromium	10 µg/L[b]	7.61	2.78	0.04	29.90	-	-	40.32
Carbon Tetrachloride	5 µg/L[a]	-	-	-	-	-	-	-
Iodine-129	1 pCi/L[a]	-	-	-	-	-	-	-
Nitrate	45 mg/L[a]	-	-	0.38	-	-	0.61	0.99
Strontium-90	8 pCi/L[a]	2.00	-	1.14	0.14	-	-	3.28
Technetium-99	900 pCi/L[a]	-	-	-	-	-	-	-
Trichloroethylene	5 µg/L[a]	-	0.73	-	-	-	0.66	1.39
TPH-D	200 µg/L[c]	-	-	0.10	-	-	-	0.10
Tritium	20,000 pCi/L[a]	-	-	0.11	-	52.84	-	52.94
Uranium	30 µg/L[a]	-	-	-	-	-	3.21	3.21
Total Extent of Plumes[d]	-	7.61	3.55	1.54	30.51	52.84	4.20	100.25
Total Riparian Area[e]	-	491.52	78.04	11.38	792.84	357.37	208.42	2660.78

(a) EPA and/or DOH Drinking Water Standard

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

(c) EPA and/or DOH Secondary Drinking Water Standard for Total Dissolved Solids. Secondary drinking water standards are not associated with health effects, but associated with taste, odor, staining, or other aesthetic qualities.

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

(e) The Total Riparian Area is the based on the areal extent of mapped riparian vegetation along the Benton County shoreline of the Hanford Site. The total riparian area listed (2660.78 ac) includes riparian area within 100-FR-3 (721.2 ac), which is part of the Hanford Reach but is not listed in other parts of the table because there is no plume intersection with the riparian zone.

Notes:

1. All groundwater plumes were generated by CH2M HILL Plateau Remediation Company for the 2013 Hanford Site Groundwater Monitoring Report (DOE/RL-2014-32).
2. Riparian cover type was documented in the Hanford Site Environmental Report for Calendar Year 2004 (PNNL-15222).
3. The impacted riparian zone corresponds to the areal extent of the plume above the corresponding reference value listed for each COPC. Riparian cover type in 200-East Area was not included because those plants are not removing groundwater; groundwater is more than 100 ft deep in 200-East Area.

These data depict the areal intersection between mapped riparian vegetation and estimated contaminated groundwater plumes on the U.S. Department of Energy Hanford Site in southcentral Washington State. Riparian spatial data was obtained from a map of plant community types of the Hanford Site, which has been updated periodically since 1993 (PNL-8942; Soll et al. 1999; PNNL-13688; PNNL-15222). Additional updates to the plant community map have been made to reflect changes due to wildfires that occurred between 2000 and 2011 (unpublished data). Spatial data for groundwater plumes was obtained from CH2M HILL Plateau Remediation Company and can be found in the 2013 Hanford Site Groundwater Monitoring Report (DOE/RL-2014-32). Plumes are based on spatial interpolation of contaminant concentrations as measured at monitoring wells. Riparian cover type in 200 East Area was not included because those plants are not removing groundwater; groundwater is more than 100 ft deep in 200 East Area.

References

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Downs JL, WH Rickard, CA Brandt, LL Cadwell, CE Cushing, DR Geist, RM Mazaika, DA Neitzel, LE Rogers, MR Sackschewsky, and JJ Nugent. PNL-8942. 1993. Habitat Types on the Hanford Site: Wildlife and Plant Species of Concern. Pacific Northwest Laboratory, Richland, Washington.

Sackschewsky MR and JL Downs. 2001. Vascular Plants of the Hanford Site. PNNL-13688. Pacific Northwest National Laboratory, Richland, Washington.

Soll J, JA Hall, R Pabst, and C Soper (eds.). 1999. Biodiversity Inventory and Analysis of the Hanford Site – Final Report 1994-1999. The Nature Conservancy of Washington, Seattle, Washington.

Evaluation Unit:	100-N GW Plume
ID:	RC-GW-2
Group:	Groundwater
Operable Unit Cross-Walk:	100-NR-2
Related EU:	NA
Sites & Facilities:	100-N strontium and associated contaminant plumes
Key Data Sources Docs:	NA

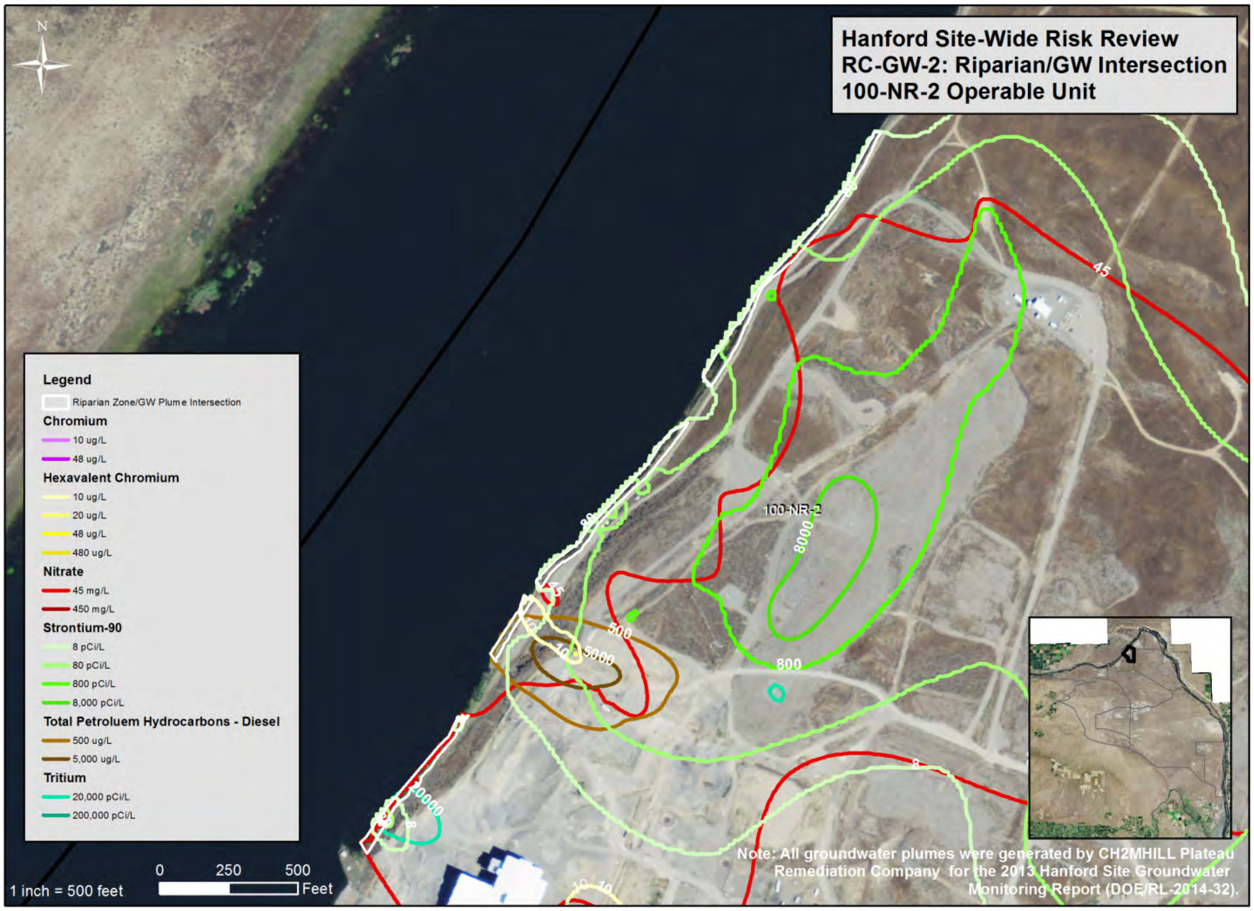

Figure J.33. Site Map with Evaluation Unit Boundaries

RC-GW-2: 100-N GW Plume

See discussion for RC-GW-1.

Evaluation Unit:	100-B/D/H/F/K Area GW Plumes
ID:	RC-GW-3
Group:	Groundwater
Operable Unit Cross-Walk:	100-BC-5 100-KR-4 100-HR-3 (100-FR-3 is not included because the groundwater plumes are not currently intercepting the riparian areas)
Related EU:	NA
Sites & Facilities:	100-B/D/H/F/K Area Chromium and associated contaminant plumes. Includes pump and treat systems
Key Data Sources Docs:	SGW-40938, Rev 0

NOTE: There is no discussion of riparian areas for 100-FR-3 because the groundwater plumes in that Operable Unit are not currently intercepting the riparian areas.

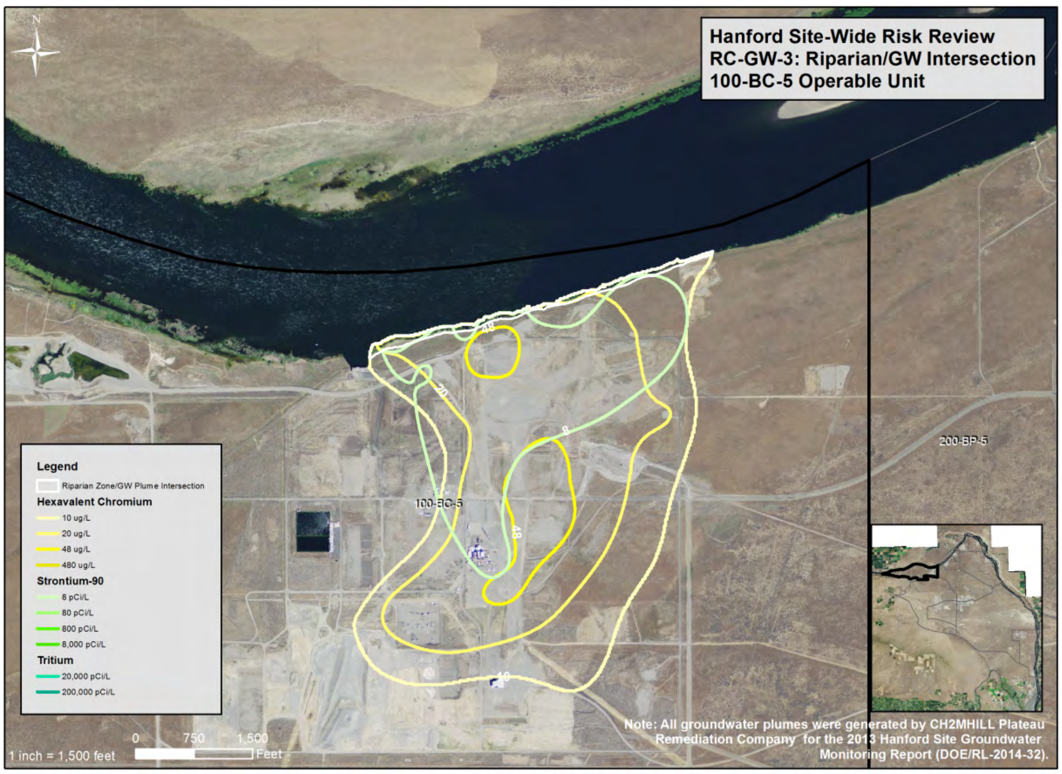

Figure J.34. Groundwater Plumes Intercepting the Riparian Areas Around 100-BC-5

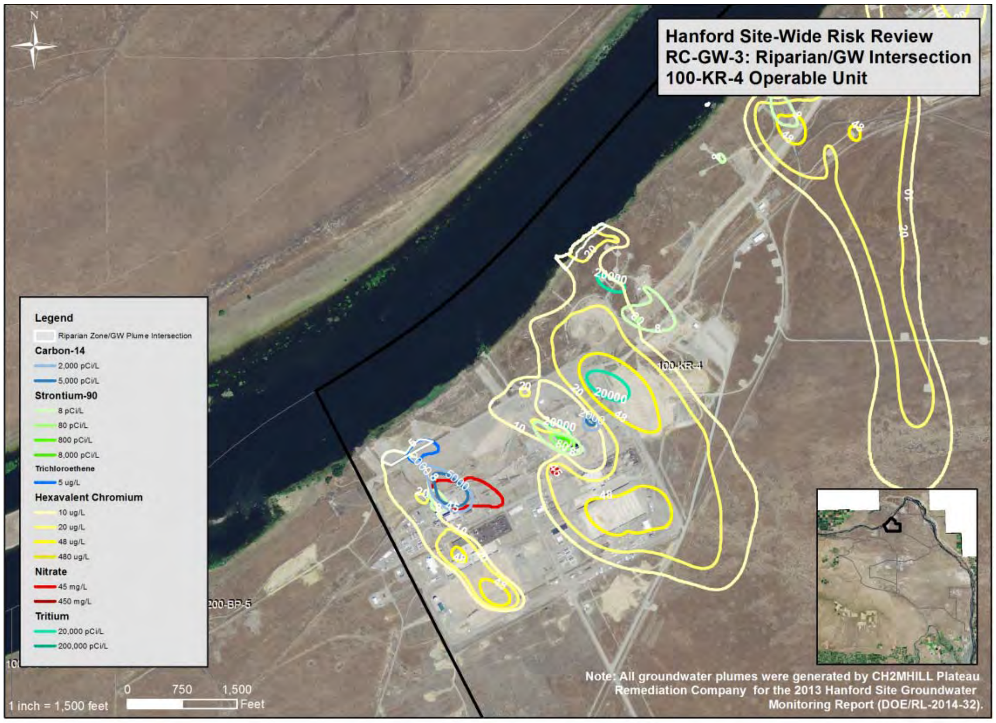

Figure J.35. Groundwater Plumes Intercepting the Riparian Areas Around 100-KR-4

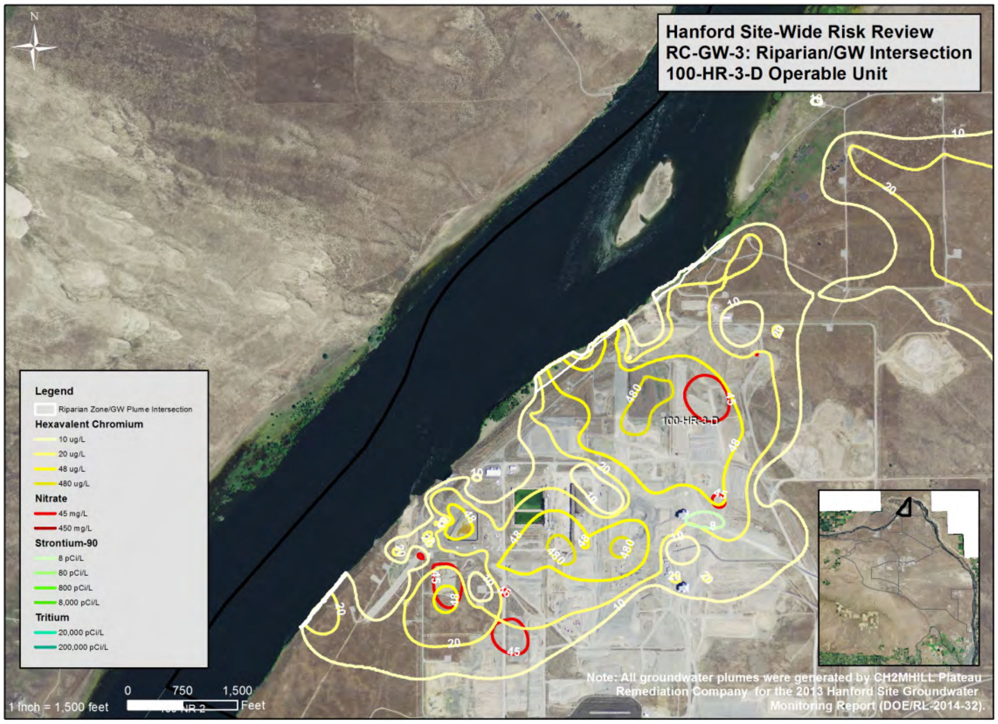

Figure J.36. Groundwater Plumes Intercepting the Riparian Areas on the Western Portion of 100-HR-3

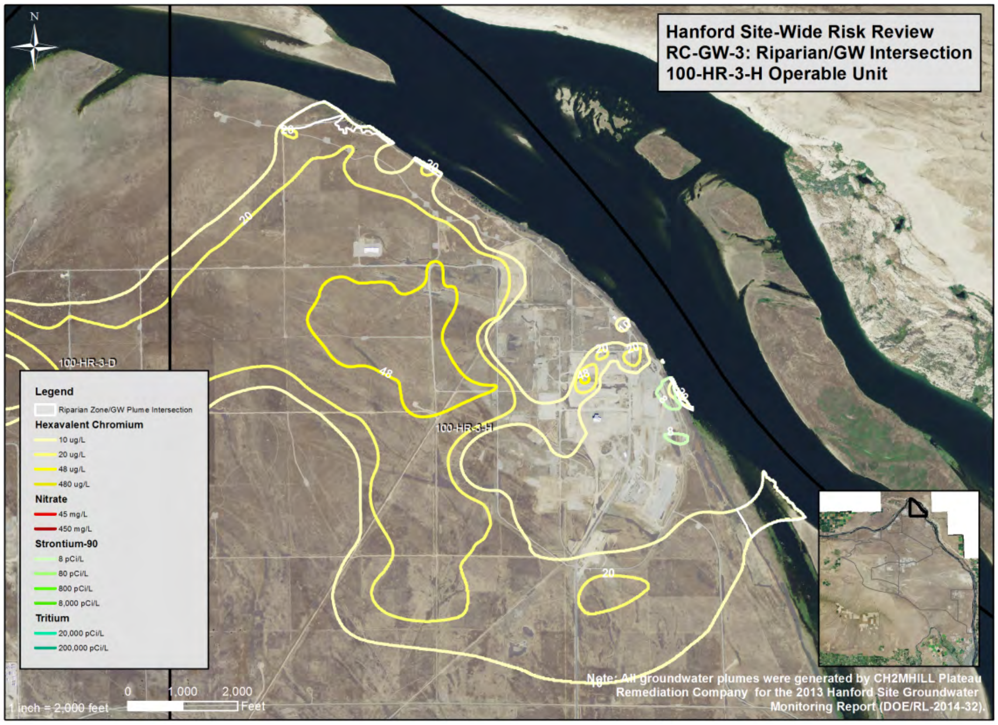

Figure J.37. Groundwater Plumes Intercepting the Riparian Areas on the Eastern Portion of 100-HR-3

RC-GW-3: 100-B/D/H/F/K Area GW Plumes

See discussion for RC-GW-1.

Evaluation Unit:	200-East Groundwater
ID:	CP-GW-1
Group:	Groundwater
Operable Unit Cross-Walk:	200-BP-5 200-PO-1
Related EU:	CP-LS-1, 8, 9, 10, 11; CP-TF-5, 6, 7
Sites & Facilities:	Existing groundwater plumes emanating from the 200-East area
Key Data Sources Docs:	NA

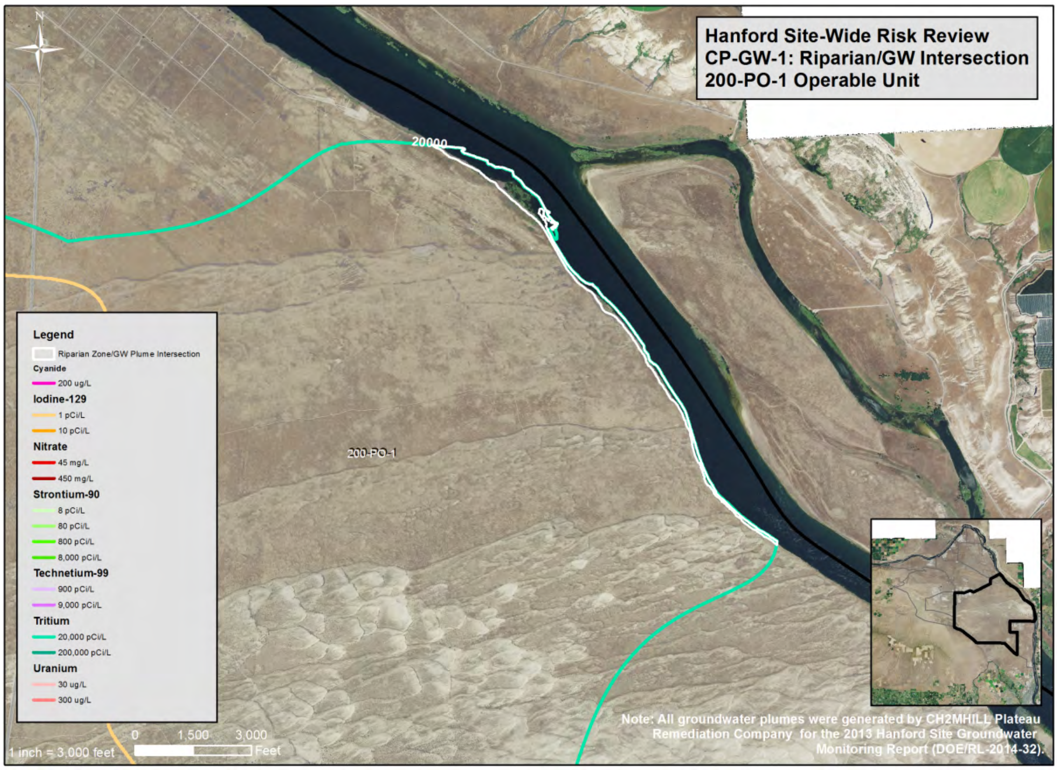

Figure J.38. 200-East Groundwater Plumes Intercepting the Riparian Areas

CP-GW-1: 200-East Groundwater

See discussion for RC-GW-1.

Evaluation Unit: 200-West Groundwater
ID: CP-GW-2
Group: Groundwater
Operable Unit Cross-Walk: 200-ZP-5
200-UP-1
Related EU: CP-LS-2, 3, 4, 5, 6
CP-TF-1, 2, 3, 4
Sites & Facilities: Existing groundwater plumes emanating from the 200-West Area. Includes pump and treat systems.
Key Data Sources Docs: NA

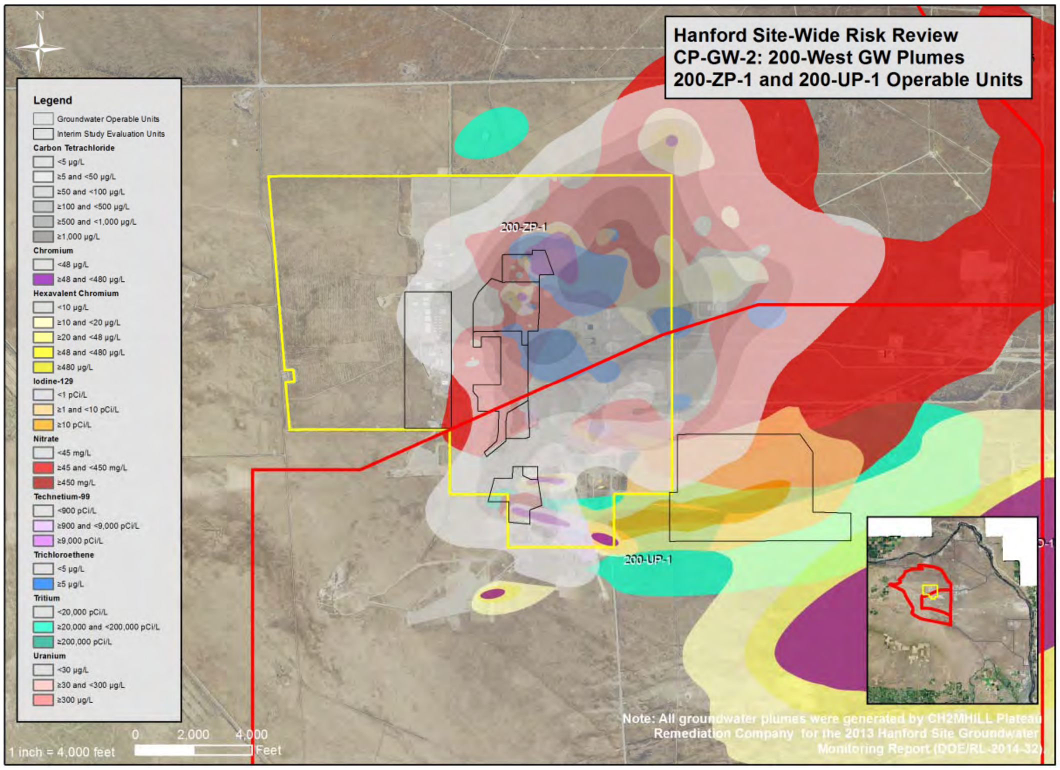

Figure J.39. Site Map with Evaluation Unit Boundaries

CP-GW-1: 200-West Groundwater

This review is limited to the region of the evaluation units where groundwater intercepts the riparian vegetation. In CP-GW-2, there is no area where groundwater intercepts riparian vegetation, so no additional information is included at this time.

Evaluation Unit:	324 Building
ID:	RC-DD-1
Group:	D&D
Operable Unit Cross-Walk:	300-FF-2
Related EU:	RC-GW-1
Units & Facilities:	324 Building and associated soils contamination under the building
Key Data Sources Docs:	DOE/RL-96-32 2013 PNNL ECAP Database[13]
Field Survey Date:	7/16/2014
Data Sheet prepared by:	JLD 10/5/2014

Figure J.40. Unit Map with Evaluation Unit Boundaries

RC-DD-1: 324 Building

Survey and Analysis Methods:

The evaluation process makes use of existing biological resource level maps (DOE/RL-96-32 2013), field surveys and measurement of current vegetation and habitat conditions, and wildlife observations to evaluate potential ecological impacts associated with cleanup activities at the evaluation unit (EU). Additional information used in the ecological evaluation includes the current Endangered and Threatened Species (Federal and State) distribution data; priority habitats as defined by Washington Department of Fish and Wildlife; available current aerial imagery, locations of Hanford Site waste sites and infrastructure spatial data; and available

[13] The Ecological Compliance and Assessment Project (ECAP) database is an evolving set of data that is maintained by Pacific Northwest National Laboratory (PNNL) and updated as new ecological assessments are completed.

information about species of concern distribution and habitat use in the vicinity of the EUs including data previously collected by PNNL for DOE-RL. Definitions relevant to the methods and ecological survey results are provided at the end of this summary along with field data tables.

The following steps were taken to assess the EU associated with the 324 building:

1. The EU boundary (polygon) is assumed to represent the estimated boundary or extent of potential habitat removal and direct disturbance due to remediation.
2. A visual survey was conducted within the EU boundary by experienced shrub-steppe ecologists. Because the unit consists of unvegetated industrial and graveled surfaces and buildings, no field measurements of vegetation were taken. PNNL biologists also reviewed the observations and biological survey data available in the Ecological Compliance and Assessment Project (ECAP) database from the past 5 years for the EU to determine the status and resource level of the habitats within the EU and supplement the evaluation with previous wildlife or plant species observations.
3. A second boundary (polygon) outside the EU was established to evaluate indirect effects and assess the remediation in relation to adjacent landscape features. This polygon is centered on the EU and encompasses a circular area with a radius 1 times the maximum width of the EU and is referred to as the **adjacent landscape buffer**.
4. A reconnaissance survey of the boundary of the EU was conducted to confirm the validity of past mapping of biological resources. Aerial imagery from 2012 was reviewed to identify any significant changes in habitat and resource levels (such as new well pads, roads, or other ground disturbance not captured by the available biological resources mapping) within the EU and adjacent landscape buffer. Where significant change is evident from ground survey or imagery, the biological resource map was updated to reflect the change in resource level.
5. The spatial extent of habitat classified at each of 6 resource levels (0 – 5) (DOE/RL-96-32 2013; definitions at end of this summary) within the adjacent landscape buffer area and the EU were assessed and compared using a Geographic Information System (GIS) to examine potential indirect effects on habitat condition within the adjacent landscape. For purposes of assessing indirect effects on the adjacent landscape, this evaluation assumes the maximum potential change in biological resources—that is, all habitat within the EU is assumed to be lost to remediation and cleanup activities and resources in the EU are considered level 0.
6. PNNL biologists assembled the information from field survey, reconnaissance, and spatial analyses of resource availability to provide a subjective evaluation of potential effects on habitat connectivity in the vicinity of the EU.

Field Survey:

Reconnaissance and visual survey of the 324 Building EU indicated the unit consists entirely of non-vegetated areas, paved, concrete, and compacted gravel areas (i.e., level 0 resources), and no field measurements of vegetation abundance were collected during the July 2014 survey. Some weedy species such as cheatgrass and Russian thistle were sparsely established around the road edges and parking lot boundaries. No wildlife were observed within the EU. Previous ECAP building survey data indicated that the starling (*Sturnus vulgaris*), which is not protected by the Migratory Bird Treaty Act (MBTA), was the only bird species observed nesting on the building as recently as 2009.

Table J.30. Percent Canopy Cover and Surface Cover Measured at 324 Building

No field measurements of vegetation were taken; the EU consists entirely of graveled surfaces (parking areas and roadways), sidewalks, building, and disturbed bare ground.

Landscape Evaluation and Resource Classification:

The amount of each category of biological resources was evaluated at two scales: 1) within the 324 Building EU and 2) within a circular area radiating 231 m from the geometric center of the unit (equivalent to 41.5 acres) (Figure J.41). The EU and buffer area north, south, and east of the unit were previously classified as level 3 because it is within 0.25 miles of the Columbia River. These areas were reclassified for this assessment to level 0 to reflect current habitat conditions (Table J.31).

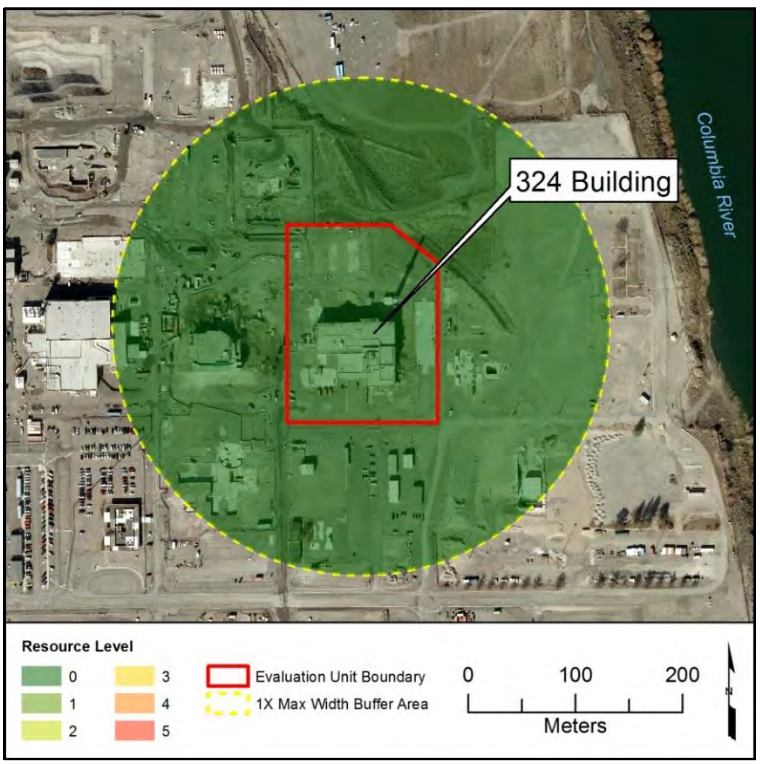

Figure J.41. Map of Biological Resource Level Classifications for the 324 Building Evaluation Unit Based on July 2014 Pedestrian and Vehicle Survey (red boundary) and Reconnaissance Survey of the Adjacent Landscape Buffer (yellow boundary)

Table J.31. Area and Proportion of Each Biological Resource Level Within the 324 Building Evaluation Unit in Relation to Adjacent Landscape and Potential Maximum Change in Resources

Resource Level[1]	Evaluation Unit Area (ac)	Adjacent Landscape Buffer (ac)	Combined Total Area (ac)	Percent of Resource Level in Combined Total Area	Percent of Resource Level in Combined Total Area After Cleanup[2]	Percent Difference at Landscape Scale After Cleanup[2]
0	6.2	35.3	41.5	100.0%	100.0%	0.0%
1	0.0	0.0	0.0	0.0%	0.0%	0.0%
2	0.0	0.0	0.0	0.0%	0.0%	0.0%
3	0.0	0.0	0.0	0.0%	0.0%	0.0%
4	0.0	0.0	0.0	0.0%	0.0%	0.0%
5	0.0	0.0	0.0	0.0%	0.0%	0.0%
Total	6.2	35.3	41.5	100.0%	100.0%	

1 Resource levels for both the evaluation unit and adjacent landscape boundary were reviewed in the field and via imagery during July 2014 and revised to reflect current habitats conditions.

2 Potential maximum change in area of a given resource level within the combined total area (Evaluation Unit + Adjacent Landscape Buffer) that would occur assuming that all habitat within the evaluation unit is destroyed by remediation activities and the resource level of the evaluation unit is level 0.

Assumptions and Uncertainty:

Due to project time constraints, the field surveys and reconnaissance of this EU were conducted in mid-July. By the time of the survey, the cool-season annual and perennial herbaceous plants that dominate shrub-steppe habitat had completed seasonal growth and senesced making identification and inventory difficult and most likely incomplete. Although no plant species of concern have been noted during previous surveys of the area, and presence of species of concern is very unlikely in graveled industrial areas, the absence of species cannot be confirmed by surveys during this time of year.

By mid-July, most migratory birds have completed their nesting cycles, and surveys may not reflect their occupancy and use of habitat within the evaluation unit earlier in the season. Previous survey data gathered by the ECAP project in 2009 did not indicate use of the 324 building by any MBTA species and although the likelihood is low that MBTA species nested within the EU during the current year, their absence cannot be confirmed by surveys in July after the nesting season is over.

Summary of Ecological Review:

- The EU consists entirely of level 0 resources (Table J.31; Figure J.41);
- No species listed by the US Fish and Wildlife Service or listed by Washington State as species of conservation concern were observed within or in the vicinity of the EU;
- No level 3 or higher habitat resources exist within a 231 m radius of the unit;
- Because the EU lies within and adjacent to a highly disturbed industrial area, the cleanup activities associated with the 324 building would not be expected to impact habitat connectivity.

References

DOE/RL-96-32. 2013. Hanford Unit Biological Resources Management Plan, Revision 1.

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Washington Noxious Weed Control Board. 2014. Noxious Weed List. Available on line at http://www.nwcb.wa.gov/

Washington State Department of Natural Resources. 2014. Washington Natural Heritage Program Plant Ranks. http://www1.dnr.wa.gov/nhp/refdesk/lists/plantrnk.html

Definitions and Acronyms:

Adjacent Landscape Buffer – a circular area adjacent to and outside the EU boundary with the center of the circle at the centroid of the EU, and with a radius that is 1 times the maximum dimension (width or length—whichever is greatest). This circular buffer area is used to evaluate indirect effects and assess the remediation in relation to the landscape features and resources adjacent to the EU. This circular area is generally at least 3 times the area of the EU.

Biological Resource Levels (from DOE-RL-96-32-01) –

- Level 5 resources include species that are listed or proposed-to-be listed under the *Endangered Species Act* and their critical habitat, as well as rare and irreplaceable habitats.

- Level 4 resources include federal candidate species; Washington State threatened or endangered species; habitat or exclusion buffers for federal candidates and Washington State threatened or endangered species; high-quality mature shrub steppe; wetlands and riparian areas; and buffer areas for bald eagles and ferruginous hawks.
- Level 3 resources include Washington State sensitive, candidate, and review species; Washington Department of Fish and Wildlife priority species; lower quality mature shrub-steppe—such as shrub stands that are less mature, have lower shrub density or canopy cover, and/or a greater proportion of cheatgrass in the understory than stands that qualify for Level 4. Level 3 also includes high-quality grasslands, conservation corridors, snake hibernacula, bat roosts, rookeries, burrowing owl buffer areas, and areas with significant quantities of culturally important species.
- Level 2 resources include migratory birds, state watch list plants and monitor list animals, recreationally and commercially important species, and lower quality steppe and shrub-steppe.
- Level 1 resources include individual common native plant and wildlife species, upland stands of non-native plants, and abandoned agricultural fields.

Evaluation Units (EUs) – groupings of sources, aggregated for evaluation as part of the Hanford Site-wide Risk Review Project. Sources may be aggregated into an EU based on potential impacts to a common set of receptors or receptor geographic area, common past waste management practices, or integration in the waste management process.

MBTA – Migratory Bird Treaty Act; referring to species listed and protected under the federal Act.

PNNL ECAP (Ecological Compliance and Assessment Project) Database – PNNL performed ecological reviews for individual projects and annually surveyed selected areas and buildings on the Hanford Site for DOE-RL under the DOE's Public Safety and Resource Protection Program until 2011. The data collected during those surveys is archived in the ECAP database, and is used to supplement ecological evaluations as available.

Priority Habitats – Priority habitats are habitat types or elements with unique or significant value to a diverse assemblage of species. A priority habitat may consist of a unique vegetation type (e.g., shrub-steppe) or dominant plant species (e.g., juniper savannah), a described successional stage (e.g., old-growth forest), or a specific habitat feature (e.g., cliffs).

Species of Concern or Species of Conservation Concern – An informal term that for the purpose of this assessment includes those species listed at the federal or state level as being threatened endangered, sensitive, or candidate, as well as those listed by the U.S. Fish and Wildlife Service as species of concern within the ecoregion.

Previous Field Observations for the 324 Building

ECAP Database Query Results for 324

Observer: *Chamness, Mickie* Date *6/14/2009*

Bird

Common Name	Latin Name	Abundance	Comments
European starling	Sturnus vulgaris		Nest/Active/W/In duct/

Monday, October 06, 2014 Page 1 of 1

Evaluation Unit:	KE/KW Reactors
ID:	RC-DD-2
Group:	D&D
Operable Unit Cross-Walk:	100-KR-1 100-KR-2
Related EU:	RC-LS-2 RC-GW-3
Sites & Facilities:	KE/KW reactors, basin, ancillary buildings, sludge, and associated soils contamination
Key Data Sources Docs:	DOE/RL-96-32 2013 PNNL ECAP Database[14]
Field Survey Date:	10/16/2014
Data Sheet Prepared By:	JLD, KBL, SAM; 10/23/2014

Figure J.42. Site Map with Evaluation Unit Boundaries

RC-DD-2: KE/KW Reactors

Survey and Analysis Methods:

The evaluation process makes use of existing biological resource level maps (DOE/RL-96-32 2013), field surveys and measurement of current vegetation and habitat conditions, and wildlife observations to evaluate potential ecological impacts associated with cleanup activities at the evaluation unit (EU). Additional information used in the ecological evaluation includes the

[14] The Ecological Compliance and Assessment Project (ECAP) database is an evolving set of data that is maintained by Pacific Northwest National Laboratory (PNNL) and updated as new ecological assessments are completed.

current Endangered and Threatened Species (Federal and State) distribution data; priority habitats as defined by Washington Department of Fish and Wildlife; available current aerial imagery, locations of Hanford Unit waste sites and infrastructure spatial data; and available information about species of concern distribution and habitat use in the vicinity of the EUs including data previously collected by PNNL for DOE-RL. Definitions relevant to the methods and ecological survey results are provided at the end of this summary along with field data tables.

The following steps were taken to assess the EU associated with the 618-11 burial ground:

1. The EU boundary (polygon) is assumed to represent the estimated boundary or extent of potential habitat removal and direct disturbance due to remediation.
2. A visual survey was conducted within the EU boundary by experienced shrub-steppe ecologists. Because the unit consists of unvegetated industrial and graveled surfaces and buildings, no field measurements of vegetation were taken. PNNL biologists also reviewed the observations and biological survey data available in the Ecological Compliance and Assessment Project (ECAP) database from the past 5 years for the EU to determine the status and resource level of the habitats within the EU and supplement the evaluation with previous wildlife or plant species observations.
3. A second boundary (polygon) outside the EU was established to evaluate indirect effects and assess the remediation in relation to adjacent landscape features. This polygon is centered on the EU and encompasses a circular area with a radius 1 times the maximum width of the EU and is referred to as the **adjacent landscape buffer**.
4. A reconnaissance survey of the boundary of the EU was conducted to confirm the validity of past mapping of biological resources. Aerial imagery from 2012 was reviewed to identify any significant changes in habitat and resource levels (such as new well pads, roads, or other ground disturbance not captured by the available biological resources mapping) within the EU and adjacent landscape buffer. Where significant change is evident from ground survey or imagery, the biological resource map was updated to reflect the change in resource level.
5. The spatial extent of habitat classified at each of 6 resource levels (0 – 5) (DOE/RL-96-32 2013; definitions at end of this summary) within the adjacent landscape buffer area and the EU were assessed and compared using a Geographic Information System (GIS) to examine potential indirect effects on habitat condition within the adjacent landscape. For purposes of assessing indirect effects on the adjacent landscape, this evaluation assumes the maximum potential change in biological resources—that is, all habitat within the EU is assumed to be lost to remediation and cleanup activities and resources in the EU are considered level 0.
6. PNNL biologists assembled the information from field survey, reconnaissance, and spatial analyses of resource availability to provide a subjective evaluation of potential effects on habitat connectivity in the vicinity of the EU.

Field Survey:

The 100-K East and West Reactors EU and adjacent habitat were evaluated by vehicle and pedestrian surveys on October 16, 2014. The EU consists entirely of built structures and graveled and concrete surfaces and no field measurements of vegetation were made. Some sparse Russian thistle (*Salsola tragus*) was noted around the periphery of parking areas and graveled slopes (Table J.32). No wildlife was observed at the reactors during the October survey. Data collected during an ECAP survey of 100-K Area buildings is included at the end of this summary and notes various bird species using the reactors buildings at that time. Much of the infrastructure around the reactors has been removed since that survey was completed, and the available nesting/perching areas that were used by birds likely no longer exist.

Table J.32. Percent Canopy Cover and Surface Cover Visually Estimated at the KE/KW Reactors Evaluation Unit

Vegetation/Surface Cover	Survey Location
Bare Ground	95%
Introduced Forb	5%

Landscape Evaluation and Resource Classification:

The amount and proximity of biological resources to the two reactors in the EU was examined within two adjacent landscape buffer areas; each landscape buffer area is defined by a circle radiating approximately 146 m from the geometric center of each reactor (equivalent to 27.8 acres for the two buffer zones combined) (Figure J.43). Most of the EU the adjacent landscape buffer areas consist of level 0 biological resources—94.2% of the combined total area (Table J.33, Figure J.43 and Figure J.44). The adjacent landscape buffer area includes a small area designated as resource level 4. The level 4 area is a species resource and is considered a level 4 resource because it intersects a designated buffer zone for a bald eagle (*Haliaeetus leucocephalus*) roosting area at the river's edge close to the northwest corner of the 100-K Area.

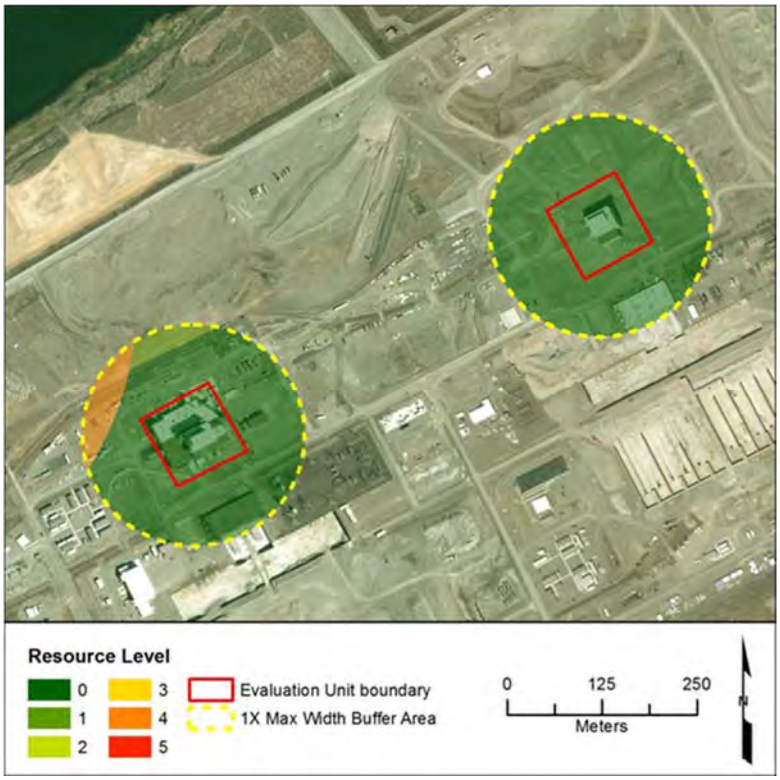

Figure J.43. Biological Resource Level Classifications Based on October 2014 Surveys for the KE/KW Reactors Evaluation Unit (red solid line) and Adjacent Landscape Buffer (yellow dashed line)

Figure J.44. Condition of Landscape around the 100-K East Reactor in October 2014

Table J.33. Area and Proportion of Each Biological Resource Level Within the Evaluation Unit in Relation to Adjacent Landscape and Potential Maximum Change in Resources

Resource Level[1]	Evaluation Unit Area (ac)	Adjacent Landscape Buffer (ac)	Combined Total Area (ac)	Percent of Resource Level in Combined Total Area	Percent of Resource Level in Combined Total Area After Cleanup[2]	Percent Difference at Landscape Scale After Cleanup[2]
0	5.2	25.9	31.1	94.2%	94.2%	0.0%
1	0.0	0.7	0.7	2.1%	2.1%	0.0%
2	0.0	0.0	0.0	0.0%	0.0%	0.0%
3	0.0	0.0	0.0	0.0%	0.0%	0.0%
4	0.0	1.2	1.2	3.6%	3.6%	0.0%
5	0.0	0.0	0.0	0.0%	0.0%	0.0%
Total	5.2	27.8	33.0	100.0%	100.0%	

1 Resource levels for the evaluation unit were reviewed in the field and via imagery during October 2014 and revised to reflect current habitats conditions.

2 Potential maximum change in area of a given resource level within the combined total area (Evaluation Unit + Adjacent Landscape Buffer) that would occur assuming that all habitat within the evaluation unit is destroyed by remediation activities and the resource level of the evaluation unit is level 0.

Assumptions and Uncertainty:

Due to project time constraints, the field surveys and reconnaissance of this EU were conducted in October. By the time of the survey, the cool-season annual and perennial herbaceous plants that dominate shrub-steppe habitat had completed seasonal growth and senesced making identification and inventory difficult and most likely incomplete. Although no records for plant species of concern have been noted, the absence of species cannot be confirmed by surveys during this time of year.

By October, migratory birds have completed their nesting cycles, and most have migrated out of the region. Surveys conducted in late fall will not reflect their occupancy and use of habitat within the EU earlier in the season. Their absence cannot be confirmed by surveys October after the nesting season is over. Further surveys during the nesting season would be required to fully assess the ecological impacts to nesting migratory birds.

Summary of Ecological Review:

- Deconstruction and decommissioning of the KE/KW reactors would not be expected to result in loss of any additional habitat at the EU. All habitat resources are level 0.
- Previous surveys noted nesting birds associated with the reactor buildings; however it is not evident that the infrastructure and building features that supported nesting are still in existence.
- Remediation actions taken for this EU are not expected to impact habitat connectivity within the adjacent landscape.

- A portion of the adjacent landscape buffer area for the 100-K west reactor is relatively near (within 400 meters) an active bald eagle roost site. Noise and construction activities associated with deconstruction and decommissioning could potentially influence eagle use of the roost.

References:

DOE/RL-96-32. 2013. Hanford Site Biological Resources Management Plan, Revision 0.

U.S. Fish and Wildlife Service (USFWS). 2014. Birds Protected by the Migratory Bird Treaty Act. http://www.fws.gov/migratorybirds/RegulationsPolicies/mbta/mbtintro.html

U.S. Fish and Wildlife Service (USFWS). 2014. Environmental Conservation Online System, Listings and Occurrences for Washington. http://ecos.fws.gov/tess_public/pub/stateListingAndOccurrenceIndividual.jsp?state=WA&s8fid=112761032792&s8fid=112762573902

Washington Department of Fish and Wildlife. 2008. Washington State Priority Habitats and Species List. Olympia Washington. 174 pp. http://wdfw.wa.gov/conservation/phs/list/

Washington Department of Fish and Wildlife. 2014. Species of Concern in Washington. http://wdfw.wa.gov/conservation/endangered/

Washington Noxious Weed Control Board.2014. Noxious Weed List. http://www.nwcb.wa.gov/

Washington State Department of Natural Resources. 2014. Washington Natural Heritage Program Plant Ranks. http://www1.dnr.wa.gov/nhp/refdesk/lists/plantrnk.html

Definitions and Acronyms:

Adjacent Landscape Buffer – a circular area adjacent to and outside the EU boundary with the center of the circle at the centroid of the EU, and with a radius that is 1 times the maximum dimension (width or length—whichever is greatest). This circular buffer area is used to evaluate indirect effects and assess the remediation in relation to the landscape features and resources adjacent to the EU. This circular area is generally at least 3 times the area of the EU.

Biological Resource Levels (from DOE-RL-96-32-01) –

- Level 5 resources include species that are listed or proposed-to-be listed under the *Endangered Species Act* and their critical habitat, as well as rare and irreplaceable habitats.
- Level 4 resources include federal candidate species; Washington State threatened or endangered species; habitat or exclusion buffers for federal candidates and Washington State threatened or endangered species; high-quality mature shrub steppe; wetlands and riparian areas; and buffer areas for bald eagles and ferruginous hawks.
- Level 3 resources include Washington State sensitive, candidate, and review species; Washington Department of Fish and Wildlife priority species; lower quality mature shrub-steppe—such as shrub stands that are less mature, have lower shrub density or canopy cover, and/or a greater proportion of cheatgrass in the understory than stands that qualify for Level 4. Level 3 also includes high-quality grasslands, conservation corridors, snake hibernacula, bat roosts, rookeries, burrowing owl buffer areas, and areas with significant quantities of culturally important species.

- Level 2 resources include migratory birds, state watch list plants and monitor list animals, recreationally and commercially important species, and lower quality steppe and shrub-steppe.
- Level 1 resources include individual common native plant and wildlife species, upland stands of non-native plants, and abandoned agricultural fields.

Evaluation Units (EUs) – groupings of sources, aggregated for evaluation as part of the Hanford Site-wide Risk Review Project. Sources may be aggregated into an EU based on potential impacts to a common set of receptors or receptor geographic area, common past waste management practices, or integration in the waste management process.

MBTA – Migratory Bird Treaty Act; referring to species listed and protected under the federal Act.

PNNL ECAP (Ecological Compliance and Assessment Project) Database – PNNL performed ecological reviews for individual projects and annually surveyed selected areas and buildings on the Hanford Site for DOE-RL under the DOE's Public Safety and Resource Protection Program until 2011. The data collected during those surveys is archived in the ECAP database, and is used to supplement ecological evaluations as available.

Priority Habitats – Priority habitats are habitat types or elements with unique or significant value to a diverse assemblage of species. A priority habitat may consist of a unique vegetation type (e.g., shrub-steppe) or dominant plant species (e.g., juniper savannah), a described successional stage (e.g., old-growth forest), or a specific habitat feature (e.g., cliffs).

Species of Concern or Species of Conservation Concern – An informal term that for the purpose of this assessment includes those species listed at the federal or state level as being threatened endangered, sensitive, or candidate, as well as those listed by the U.S. Fish and Wildlife Service as species of concern within the ecoregion.

Excerpt from ECAP Survey 2010-100-073; 105 KE includes the east reactor building and 105 KW includes the west reactor building

BLANKET BIOLOGICAL REVIEW OF100-K AREA MAINTENANCE AND OPERATION ACTIVITIES; 100-KAREA; ECR#2010-100-073

Survey Results:

Most of the area within the 100-K boundary fence is highly disturbed with substrate consisting primarily of compacted gravel. Vegetation consists primarily of widely scattered weedy species, with most of the area having essentially no vegetation. An exception is 116-KW-3 (an approximately 2.6 hectare area in the northwest corner of the site) which has been remediated and is characterized by Sandberg's bluegrass *(Poa secunda),* and bluebunch wheatgrass *(Pseudoroegneria spicata).*

The following migratory bird activity was observed. Nest sites active at the time of the survey are underlined.

105KE -Two common ravens *(Corvus corax)* searching within the exposed north side.

-One inactive common raven nest on a catwalk on the west side.

-One active Say's phoebe *(Sayornis saya)* nest inside a propped-open door at the southeast corner.

105KW -One active house finch *(Carpodacus mexicanus)* nest behind the light above Door 607on the north side.

-A pair of house finches perched on the west side.

-One inactive western kingbird *(Tyrannus verticalis)* nest on a pipe bracket on the northeast corner.

Evaluation Unit:	PUREX
ID:	CP-DD-1
Group:	D&D
Operable Unit Cross-Walk:	200-CP-1
Related EU:	CP-LS-9
Sites & Facilities:	PUREX canyon, tunnels, ancillary building, structures, and associated near-surface contaminated soils
Key Data Sources Docs:	DOE/RL-96-32 2013 PNNL ECAP database[15]
Field Survey Date:	10/7/2014
Data Sheet Prepared By:	JLD, KDH, MAC, KBL, SAM 10/20/2014

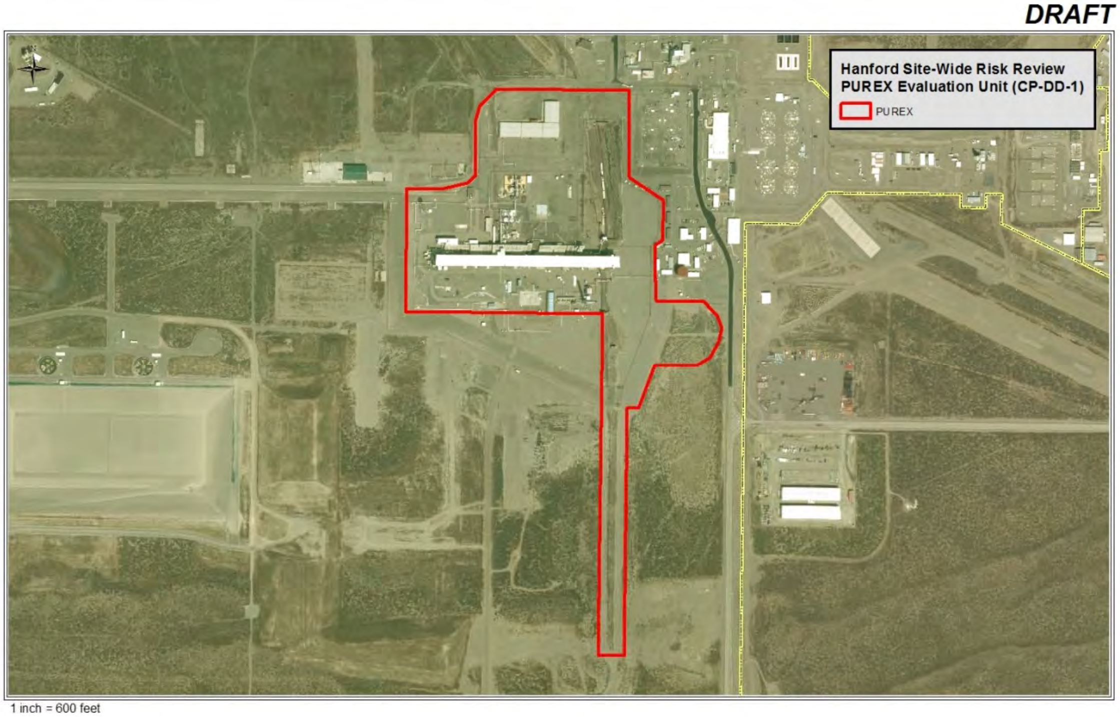

Figure J.45. Site Map with Evaluation Unit Boundaries

CP-DD-1: PUREX

Survey and Analysis Methods:

The evaluation process makes use of existing biological resource level maps (DOE/RL-96-32 2013), field surveys and measurement of current vegetation and habitat conditions, and wildlife observations to evaluate potential ecological impacts associated with cleanup activities at the evaluation unit (EU). Additional information used in the ecological evaluation includes the current Endangered and Threatened Species (Federal and State) distribution data; priority habitats as defined by Washington Department of Fish and Wildlife; available current aerial

[15] The Ecological Compliance and Assessment Project (ECAP) database is an evolving set of data that is maintained by Pacific Northwest National Laboratory (PNNL) and updated as new ecological assessments are completed.

imagery, locations of Hanford Site waste sites and infrastructure spatial data; and available information about species of concern distribution and habitat use in the vicinity of the EUs including data previously collected by PNNL for DOE-RL. Definitions relevant to the methods and ecological survey results are provided at the end of this summary along with field data tables.

The following steps were taken to assess the EU associated with PUREX:

1. The EU boundary (polygon) is assumed to represent the estimated boundary or extent of potential habitat removal and direct disturbance due to remediation.
2. A visual survey was conducted within the EU boundary by experienced shrub-steppe ecologists. PNNL biologists also reviewed the observations and biological survey data available in the Ecological Compliance and Assessment Project (ECAP) database from the past 5 years for the EU to determine the status and resource level of the habitats within the EU and supplement the evaluation with previous wildlife or plant species observations.
3. A second boundary (polygon) outside the EU was established to evaluate indirect effects and assess the remediation in relation to adjacent landscape features. This polygon is centered on the EU and encompasses a circular area with a radius 1 times the maximum width of the EU and is referred to as the **adjacent landscape buffer**.
4. A reconnaissance survey of the boundary of the EU was conducted to confirm the validity of past mapping of biological resources. Aerial imagery from 2012 was reviewed to identify any significant changes in habitat and resource levels (such as new well pads, roads, or other ground disturbance not captured by the available biological resources mapping) within the EU and adjacent landscape buffer. Where significant change is evident from ground survey or imagery, the biological resource map was updated to reflect the change in resource level.
5. The spatial extent of habitat classified at each of 6 resource levels (0 – 5) (DOE/RL-96-32 2013; definitions at end of this summary) within the adjacent landscape buffer area and the EU were assessed and compared using a Geographic Information System (GIS) to examine potential indirect effects on habitat condition within the adjacent landscape. For purposes of assessing indirect effects on the adjacent landscape, this evaluation assumes the maximum potential change in biological resources—that is, all habitat within the EU is assumed to be lost to remediation and cleanup activities and resources in the EU are considered level 0.
6. PNNL biologists assembled the information from field survey, reconnaissance, and spatial analyses of resource availability to provide a subjective evaluation of potential effects on habitat connectivity in the vicinity of the EU.

Field Survey:

The EU associated with the PUREX facilities was surveyed by pedestrian and vehicle reconnaissance and field measurement of remaining habitat on the southeast side of the area in October 2014. The majority of the EU consists of buildings, disturbed areas, parking lots, and facilities, except for the extension of the unit to the south and a small area just south of the parking lot on the east side of the unit. Field measurements in the southeast habitat (Table J.34) confirmed that the area consisted of level 2 habitat resources. Patches of level 3 resources within the EU are associated with individual occurrences of sensitive plant species; Piper's daisy (*Erigeron piperianus*) had been noted in previous ECAP surveys and an *Erigeron* spp. was noted in the field survey, but could not be verified as Piper's daisy.

Wildlife observations within the level 2 habitat included several side-blotched lizards (*Uta stansburiana*), small mammal burrows and trails, coyote (*Canis latrans*) tracks, and a common raven (*Corvus corax*) flying overhead. No wildlife were observed within the fenced area around PUREX facilities.

Landscape Evaluation and Resource Classification:

The amount of each category of biological resources at the PUREX EU was examined within a circular area radiating approximately 995 m from the geometric center of the unit (equivalent to 768 acres). Within the 44.6 acres of the EU, only 2.2 acres are classified as level 3 habitat, but these consist of fragmented and narrow patches (Table J.35, Figure J.46). Approximately 31% of the total combined area (EU plus adjacent landscape buffer) consists of level 3 or greater resources.

Table J.34. Percent Canopy Cover and Surface Cover Measured at the PUREX Evaluation Unit

Vegetation/Surface Cover	Southeast Side of EU
Bare Ground	19.8
Crust	51.6
Litter	25.8
Introduced Forb	1.0
Introduced Grass	1.0
Native Forb	11.0
Native Grass	8.2
Climax Shrubs	2.4
Successional Shrubs	14.3

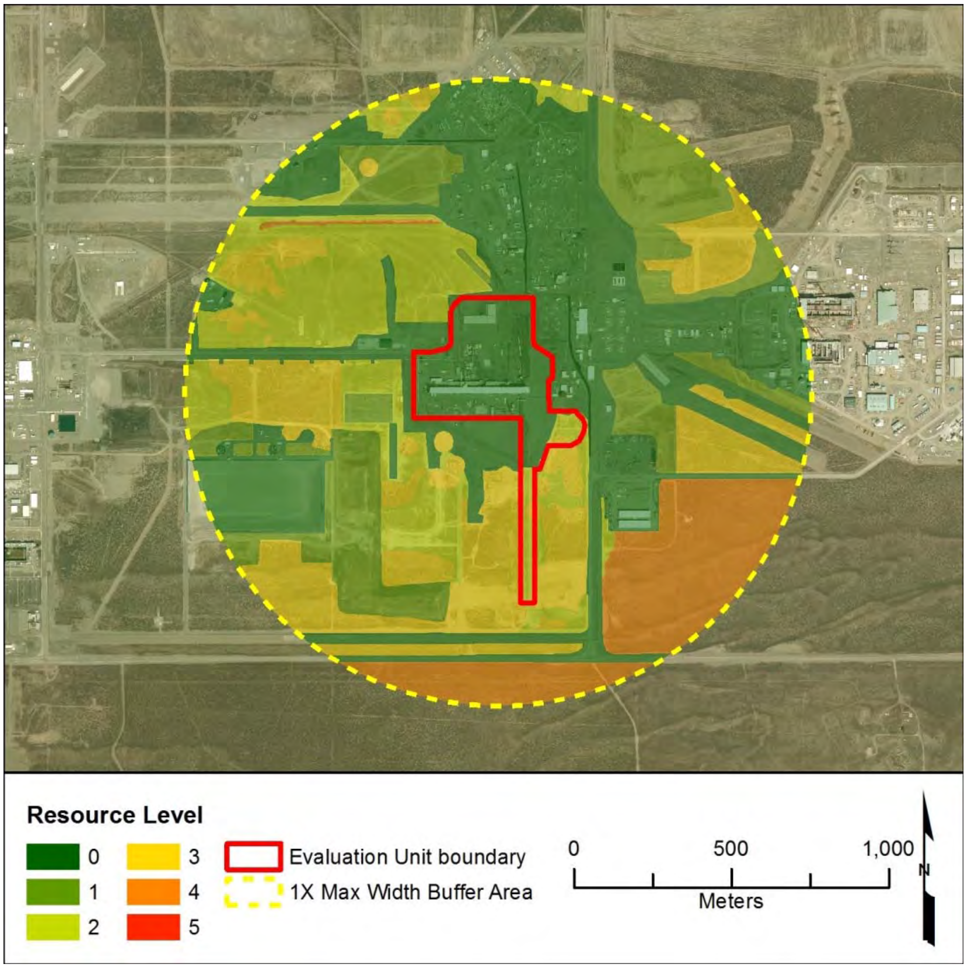

Figure J.46. Biological Resource Level Classifications Based on October 2014 Surveys at the PUREX Evaluation Unit (red solid line) and Adjacent Landscape Buffer Area (yellow dashed line)

Table J.35. Area and Proportion of Each Biological Resource Level Within the Evaluation Unit in Relation to Adjacent Landscape and Potential Maximum Change in Resources

Resource Level[1]	Evaluation Unit Area (ac)	Adjacent Landscape Buffer (ac)	Combined Total Area (ac)	Percent of Resource Level in Combined Total Area	Percent of Resource Level in Combined Total Area After Cleanup[2]	Percent Difference at Landscape Scale After Cleanup[2]
0	37.6	269.0	306.6	39.9%	40.8%	0.9%
1	0.0	115.4	115.4	15.0%	15.0%	0.0%
2	4.8	112.6	117.4	15.3%	14.7%	-0.6%
3	2.2	144.3	146.5	19.1%	18.8%	-0.3%
4	0.0	82.0	82.0	10.7%	10.7%	0.0%
5	0.0	0.0	0.0	0.0%	0.0%	0.0%
Total	44.6	723.3	767.9	100.0%	100.0%	

1 Resource levels for both the evaluation unit and adjacent landscape boundary were reviewed in the field and via imagery during October 2014 and revised to reflect current habitats conditions.

2 Potential maximum change in area of a given resource level within the combined total area (Evaluation Unit + Adjacent Landscape Buffer) that would occur assuming that all habitat within the evaluation unit is destroyed by remediation activities and the resource level of the evaluation unit is level 0.

Assumptions and Uncertainty:

Due to project time constraints, the field surveys and reconnaissance of this EU were conducted in October. By the time of the survey, the cool-season annual and perennial herbaceous plants that dominate shrub-steppe habitat had completed seasonal growth and senesced making identification and inventory difficult and most likely incomplete. Although no records for plant species of concern have been noted, the absence of species cannot be confirmed by surveys during this time of year.

By October, migratory birds have completed their nesting cycles and many have migrated away from the region. Surveys conducted in the late fall will not reflect migratory bird occupancy and use of habitat within the EU earlier in the season. Their absence cannot be confirmed by surveys in October after the nesting season is over. Further surveys during the nesting season would be required to fully assess the ecological impacts to nesting migratory birds.

Summary of Ecological Review:

- The majority of the EU consists of buildings, disturbed areas, parking lots, and facilities.
- Patches of level 3 resources within the EU are associated with individual occurrences of sensitive plant species, Piper's daisy.
- Removal or loss of individual occurrences of the sensitive plant species, Piper's daisy, would be unlikely to alter population viability for this species.
- Remediation actions would result in only a 0.3% change in level 3 and above biological resources at the landscape scale.

- Because the PUREX facilities are adjacent to and contiguous with other disturbed and industrial areas within the 200-East Area, the loss of habitat that could potentially occur within this EU would not be expected to impact habitat connectivity on the 200 Area plateau.

References:

DOE/RL-96-32. 2013. Hanford Site Biological Resources Management Plan, Revision 0.

U.S. Fish and Wildlife Service (USFWS). 2014. Birds Protected by the Migratory Bird Treaty Act. http://www.fws.gov/migratorybirds/RegulationsPolicies/mbta/mbtintro.html

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Washington Department of Fish and Wildlife. 2008. Washington State Priority Habitats and Species List. Olympia Washington. 174 pp. http://wdfw.wa.gov/conservation/phs/list/

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Species of Concern or Species of Conservation Concern – An informal term that for the purpose of this assessment includes those species listed at the federal or state level as being threatened endangered, sensitive, or candidate, as well as those listed by the U.S. Fish and Wildlife Service as species of concern within the ecoregion.

Previous ECAP Survey Data

ECAP Database Query Results for E-006

Observer: *Freeman-Cadoret, Natalie* Date *5/24/2010*

Plant

Common Name	Latin Name	Abundance	Comments
Piper's daisy	Erigeron piperianus		small plant 20+ flowers
Piper's daisy	Erigeron piperianus		16 flowers on plant
gray rabbitbrush	Chrysothamnus nauseosus	5	
Sandberg's bluegrass	Poa sandbergii	15	
big sagebrush	Artemisia tridentata	10	
buckwheat milkvetch	Astragalus caricinus	1	
yarrow	Achillea millefolium		
bur ragweed	Ambrosia acanthicarpa		
cheatgrass	Bromus tectorum		
green rabbitbrush	Chrysothamnus viscidiflorus		
matted cryptantha	Cryptantha circumscissa		
matted cryptantha	Cryptantha circumscissa		
turpentine springparsley	Cymopteris terebithinus		
western tansymustard	Descurainia pinnata		
threadleaf fleabane	Erigeron filifolius		
Piper's daisy	Erigeron piperianus		
shaggy fleabane	Erigeron pumilis		
storksbill	Erodium cicutarium		
spiny hopsage	Grayia spinosa		
prickly lettuce	Lactuca serriola		
hoary aster	Machaeranthera canescens		
indian ricegrass	Oryzopsis hymenoides		
longleaf phlox	Phlox longifolia		
Russian thistle	Salsola kali		
Jim Hill's tumblemustard	Sisymbrium altissimum		
needle-and-thread grass	Stipa comata		

Mammal

Common Name	Latin Name	Abundance	Comments
black-tailed jackrabbit	Lepus californicus	Present	Old pellets
unknown/unidentified small mammal	small mammal	Present	

Herpt

Common Name	Latin Name	Abundance	Comments
Unidentified/Unlisted herpt	Unidentified/Unlisted herpt	Present	lizard

Observer: *Simmons, Mary Ann* Date *5/24/2010*

Plant

Common Name	Latin Name	Abundance	Comments

Wednesday, October 15, 2014 Page 1 of 2

ECAP Database Query Results for E-510

Observer: ***Hand, Kris*** Date ***6/18/2009***

Plant

Common Name	Latin Name	Abundance	Comments
No vegetation present	No vegetation	90	
Russian thistle	Salsola kali	1	
cheatgrass	Bromus tectorum	+	
gray rabbitbrush	Chrysothamnus nauseosus		
hoary aster	Machaeranthera canescens		
sand dropseed	Sporobolus cryptandrus		

Wednesday, October 15, 2014 Page 1 of 1

Field Data Sheets

Percent Canopy Cover of Herbaceous Species Measured in 0.5 m2 quadrats																
EU	Survey Area	Species	Origin & Class	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10	sum	Mean Canopy Cover	Freq
PUREX	2-02	BARE	BARE	75	25	20	10	32	8	2		2	4	178	19.8	0.9
PUREX	2-02	CRUST	CRUST	15	4	12	15	45	84	93	94	68	86	516	51.6	1.0
PUREX	2-02	LITTER	LITTER	10	70	55	64	16	8	5	6	20	4	258	25.8	1.0
PUREX	2-02	CHNA	NS	2		1	65		9	7		64	9	157	22.4	0.7
PUREX	2-02	ASCA	NF	1	1	25		6		9	12			54	9.0	0.6
PUREX	2-02	SATR	IF	1	1	1		1	1		1		1	7	1.0	0.7
PUREX	2-02	BRTE	IG	1		1		1	1		1	1		6	1.0	0.6
PUREX	2-02	ARTR	NS		22									22	22.0	0.1
PUREX	2-02	POSE	NG					8	2	10	3	15	11	49	8.2	0.6
PUREX	2-02	DEPI	NF								1			1	1.0	0.1
PUREX	2-02	ERCI	NF										1	1	1.0	0.1

Notes: UTST common within Evaluation Unit. Small mammal holes, ant mounds, and rabbit droppings present. AMCO flying overhead. Cover taken on left side of transect, starting at 5m-6m.

Shrub Canopy Measured by Line-Intercept Methods on 50m Transect

EU	Survey Area	Species	Transect distance (total)	Start	Stop	Dif
PUREX	2-02	CHNA	50	0.8	1.6	0.8
PUREX	2-02	ARTR	50	8.1	8.2	0.1
PUREX	2-02	CHNA	50	8.1	8.7	0.6
PUREX	2-02	ARTR	50	10.4	11.1	0.7
PUREX	2-02	ARTR	50	11.7	12.1	0.4
PUREX	2-02	CHNA	50	12.2	13.0	0.8
PUREX	2-02	CHNA	50	14.3	15.1	0.8
PUREX	2-02	CHNA	50	15.2	15.4	0.2
PUREX	2-02	CHNA	50	16.6	17.3	0.7
PUREX	2-02	CHNA	50	18.0	19.4	1.4
PUREX	2-02	CHNA	50	21.8	22.0	0.1
PUREX	2-02	CHNA	50	33.6	33.9	0.3
PUREX	2-02	CHNA	50	38.9	39.3	0.4
PUREX	2-02	CHNA	50	41.2	41.6	0.4
PUREX	2-02	CHNA	50	45.0	45.7	0.7

Notes: Saw Erigeron species southwest of transect within Evaluation Unit. Lizard and small mammal burrows present. Saw lizards within Evaluation U
well.

Evaluation Unit: PUREX	Observers: HAND, CHAMNESS
Patch ID: 2-02	Date: 10/7/2014

Wildlife Observations Recorded During Pedestrian or Vehicle Surveys

Species	Observation
UTST	Common within EU
CORA	Flying overhead

Notes

Evaluation Unit:	K Basin Sludge
ID:	RC-OP-1
Group:	Operations
Operable Unit Cross-Walk:	100-KR-2
Related EU:	RC-LS-2 RC-DD-2 RC-GW-3
Sites & Facilities:	KE/KW fuel basin
Key Data Sources Docs:	BHI-01172, Rev 2 CHPRC–DD-50769 Rev 1a (OUO) DD-49394, Rev 2 DD-49580, Rev 1 DD-49581, Rev 1 DD-53484, Rev 0 DD-53838, Rev 0 DD-54878, Rev 0 DOE/RL-2005-26, Rev 1 DOE/RL-2010-43, Rev 0 DOE/RL-96-17, Rev 6 HNF-24274, Rev 6 HNF-40475, Rev 4 HNF-41051, Rev 6 HNF-5356, Rev 15 HNF-SD-SNF-TI-015, Rev 14, Vol 2 HNF-SD-SNF-TI-015, Rev 14A, Vol 2 HNF-SD-WM-SAR-062, Rev 15Ca (OUO) KBC-36585, Rev 1A KBC-39764a (OUO) KBC-43475, Rev 2 KBC-43809, Rev 0 KBC-46856, Rev 1 PRC-STP-00012, Rev 0 PRC-STP-00109, Rev 0 PRC-STP-00467, Rev 2 (Interim) PRC-STP-00473, Rev 2 PRC-STP-00497, Rev 0 PRC-STP-00615, Rev 0 PRC-STP-00687, Rev 1 PRC-STP-00697, Rev 3 PRC-STP-00718, Rev 0 PRC-STP-00720, Rev 1 PRC-STP-00731, Rev 2 PRC-STP-00834, Rev 0 SNF-8163, Rev 5 SNF-10823, Rev 1 - 1E SGW-40938, Rev 0 PRC-STP-00702, Rev 3 ALARA 4QTR13 Presentation
Field Survey Date:	10/16/2014

Figure J.47. Site Map with Evaluation Unit Boundaries

RC-OP-1: K Basin Sludge

Survey and Analysis Methods:

The evaluation process makes use of existing biological resource level maps (DOE/RL-96-32 2013), field surveys and measurement of current vegetation and habitat conditions, and wildlife observations to evaluate potential ecological impacts associated with cleanup activities at the evaluation unit (EU). Additional information used in the ecological evaluation includes the current Endangered and Threatened Species (Federal and State) distribution data; priority habitats as defined by Washington Department of Fish and Wildlife; available current aerial imagery, locations of Hanford Unit waste sites and infrastructure spatial data; and available information about species of concern distribution and habitat use in the vicinity of the EUs including data previously collected by PNNL for DOE-RL. Definitions relevant to the methods and ecological survey results are provided at the end of this summary along with field data tables.

The following steps were taken to assess the EU associated with the K Basin Sludge facilities (in conjunction with the KE and KW Reactors EU):

1. The EU boundary (polygon) is assumed to represent the estimated boundary or extent of potential habitat removal and direct disturbance due to remediation.

2. A visual survey was conducted within the EU boundary by experienced shrub-steppe ecologists. Because the unit consists of unvegetated industrial and graveled surfaces and buildings, no field measurements of vegetation were taken. PNNL biologists also reviewed the observations and biological survey data available in the Ecological Compliance and Assessment Project (ECAP) database from the past 5 years for the EU to determine the status and resource level of the habitats within the EU and supplement the evaluation with previous wildlife or plant species observations.
3. A second boundary (polygon) outside the EU was established to evaluate indirect effects and assess the remediation in relation to adjacent landscape features. This polygon is centered on the EU and encompasses a circular area with a radius 1 times the maximum width of the EU and is referred to as the **adjacent landscape buffer**.
4. A reconnaissance survey of the boundary of the EU was conducted to confirm the validity of past mapping of biological resources. Aerial imagery from 2012 was reviewed to identify any significant changes in habitat and resource levels (such as new well pads, roads, or other ground disturbance not captured by the available biological resources mapping) within the EU and adjacent landscape buffer. Where significant change is evident from ground survey or imagery, the biological resource map was updated to reflect the change in resource level.
5. The spatial extent of habitat classified at each of 6 resource levels (0 – 5) (DOE/RL-96-32 2013; definitions at end of this summary) within the adjacent landscape buffer area and the EU were assessed and compared using a Geographic Information System (GIS) to examine potential indirect effects on habitat condition within the adjacent landscape. For purposes of assessing indirect effects on the adjacent landscape, this evaluation assumes the maximum potential change in biological resources—that is, all habitat within the EU is assumed to be lost to remediation and cleanup activities and resources in the EU are considered level 0.
6. PNNL biologists assembled the information from field survey, reconnaissance, and spatial analyses of resource availability to provide a subjective evaluation of potential effects on habitat connectivity in the vicinity of the EU.

Field Survey:

The K Basin Sludge EU, along with the KE and KW Reactors EU, and the adjacent habitat were evaluated by vehicle and pedestrian surveys on October 16, 2014. The EU consists entirely of built structures and graveled and concrete surfaces and no field measurements of vegetation were made. Some sparse Russian thistle (*Salsola tragus*) was noted around the periphery of parking areas and graveled slopes (Table J.36). No wildlife was observed at the K basins during the October survey. Data collected during an ECAP survey of 100-K Area buildings is included at the end of this summary and notes various bird species using the reactors buildings at that time. Much of the infrastructure around the reactors has been removed since that survey was completed, and the available nesting/perching areas that were used by birds likely no longer exist.

Table J.36. Percent Canopy Cover and Surface Cover Visually Estimated at the K Basin Sludge Evaluation Unit

Vegetation/Surface Cover	Survey Location
Bare Ground	95%
Introduced Forb	5%

Landscape Evaluation and Resource Classification:

The amount and proximity of biological resources to the K Basins in the EU was examined within two adjacent landscape buffer areas; each landscape buffer area is defined by a circle radiating approximately 146 m from the geometric center of the KE and KW Reactor buildings (equivalent to 27.8 acres for the two buffer zones combined) (Figure J.48). Most of the EU the adjacent landscape buffer areas consist of level 0 biological resources—94.2% of the combined total area (Table J.37, Figure J.48 and Figure J.49). The adjacent landscape buffer area includes a small area designated as resource level 4. The level 4 area is a species resource and is considered a level 4 resource because it intersects a designated buffer zone for a bald eagle (*Haliaeetus leucocephalus*) roosting area at the river's edge close to the northwest corner of the 100-K Area.

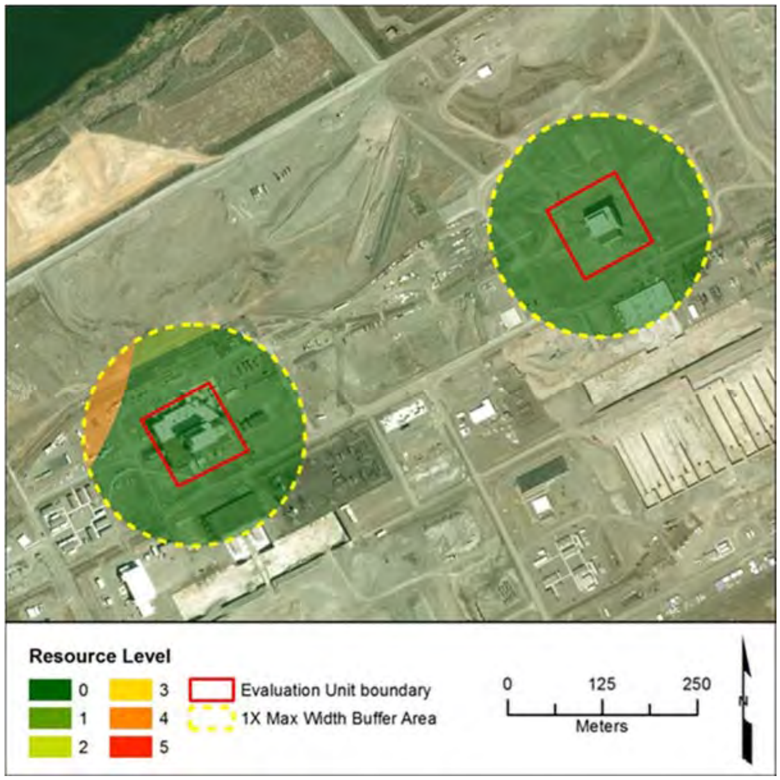

Figure J.48. Biological Resource Level Classifications Based on October 2014 Surveys for the K Basin Sludge Evaluation Unit (red solid line) and Adjacent Landscape Buffer (yellow dashed line)

Figure J.49. Condition of Landscape around the 100-K East Reactor in October 2014

Table J.37. Area and Proportion of Each Biological Resource Level Within the Evaluation Unit in Relation to Adjacent Landscape and Potential Maximum Change in Resources

Resource Level[1]	Evaluation Unit Area (ac)	Adjacent Landscape Buffer (ac)	Combined Total Area (ac)	Percent of Resource Level in Combined Total Area	Percent of Resource Level in Combined Total Area After Cleanup[2]	Percent Difference at Landscape Scale After Cleanup[2]
0	5.2	25.9	31.1	94.2%	94.2%	0.0%
1	0.0	0.7	0.7	2.1%	2.1%	0.0%
2	0.0	0.0	0.0	0.0%	0.0%	0.0%
3	0.0	0.0	0.0	0.0%	0.0%	0.0%
4	0.0	1.2	1.2	3.6%	3.6%	0.0%
5	0.0	0.0	0.0	0.0%	0.0%	0.0%
Total	5.2	27.8	33.0	100.0%	100.0%	

1 Resource levels for the evaluation unit were reviewed in the field and via imagery during October 2014 and revised to reflect current habitats conditions.

2 Potential maximum change in area of a given resource level within the combined total area (Evaluation Unit + Adjacent Landscape Buffer) that would occur assuming that all habitat within the evaluation unit is destroyed by remediation activities and the resource level of the evaluation unit is level 0.

Assumptions and Uncertainty:

Due to project time constraints, the field surveys and reconnaissance of this EU were conducted in October. By the time of the survey, the cool-season annual and perennial herbaceous plants that dominate shrub-steppe habitat had completed seasonal growth and senesced making identification and inventory difficult and most likely incomplete. Although no records for plant species of concern have been noted, the absence of species cannot be confirmed by surveys during this time of year.

By October, migratory birds have completed their nesting cycles, and most have migrated out of the region. Surveys conducted in late fall will not reflect their occupancy and use of habitat within the EU earlier in the season. Their absence cannot be confirmed by surveys October after the nesting season is over. Further surveys during the nesting season would be required to fully assess the ecological impacts to nesting migratory birds.

Summary of Ecological Review:

- Deconstruction and decommissioning of the KE/KW reactors (with basins) would not be expected to result in loss of any additional habitat at the EU. All habitat resources are level 0.
- Previous surveys noted nesting birds associated with the KE and KW Reactor buildings; however it is not evident that the infrastructure and building features that supported nesting are still in existence.
- Remediation actions taken for this EU are not expected to impact habitat connectivity within the adjacent landscape.

- A portion of the adjacent landscape buffer area for the KW reactor is relatively near (within 400 meters) an active bald eagle roost site. Noise and construction activities associated with deconstruction and decommissioning could potentially influence eagle use of the roost.

References:

DOE/RL-96-32. 2013. Hanford Site Biological Resources Management Plan, Revision 0.

U.S. Fish and Wildlife Service (USFWS). 2014. Birds Protected by the Migratory Bird Treaty Act. http://www.fws.gov/migratorybirds/RegulationsPolicies/mbta/mbtintro.html

U.S. Fish and Wildlife Service (USFWS). 2014. Environmental Conservation Online System, Listings and Occurrences for Washington. http://ecos.fws.gov/tess_public/pub/stateListingAndOccurrenceIndividual.jsp?state=WA&s8fid=112761032792&s8fid=112762573902

Washington Department of Fish and Wildlife. 2008. Washington State Priority Habitats and Species List. Olympia Washington. 174 pp. http://wdfw.wa.gov/conservation/phs/list/

Washington Department of Fish and Wildlife. 2014. Species of Concern in Washington. http://wdfw.wa.gov/conservation/endangered/

Washington Noxious Weed Control Board.2014. Noxious Weed List. http://www.nwcb.wa.gov/

Washington State Department of Natural Resources. 2014. Washington Natural Heritage Program Plant Ranks. http://www1.dnr.wa.gov/nhp/refdesk/lists/plantrnk.html

Definitions and Acronyms:

Adjacent Landscape Buffer – a circular area adjacent to and outside the EU boundary with the center of the circle at the centroid of the EU, and with a radius that is 1 times the maximum dimension (width or length—whichever is greatest). This circular buffer area is used to evaluate indirect effects and assess the remediation in relation to the landscape features and resources adjacent to the EU. This circular area is generally at least 3 times the area of the EU.

Biological Resource Levels (from DOE-RL-96-32-01) –

- Level 5 resources include species that are listed or proposed-to-be listed under the *Endangered Species Act* and their critical habitat, as well as rare and irreplaceable habitats.
- Level 4 resources include federal candidate species; Washington State threatened or endangered species; habitat or exclusion buffers for federal candidates and Washington State threatened or endangered species; high-quality mature shrub steppe; wetlands and riparian areas; and buffer areas for bald eagles and ferruginous hawks.
- Level 3 resources include Washington State sensitive, candidate, and review species; Washington Department of Fish and Wildlife priority species; lower quality mature shrub-steppe—such as shrub stands that are less mature, have lower shrub density or canopy cover, and/or a greater proportion of cheatgrass in the understory than stands that qualify for Level 4. Level 3 also includes high-quality grasslands, conservation corridors, snake hibernacula, bat roosts, rookeries, burrowing owl buffer areas, and areas with significant quantities of culturally important species.

- Level 2 resources include migratory birds, state watch list plants and monitor list animals, recreationally and commercially important species, and lower quality steppe and shrub-steppe.
- Level 1 resources include individual common native plant and wildlife species, upland stands of non-native plants, and abandoned agricultural fields.

Evaluation Units (EUs) – groupings of sources, aggregated for evaluation as part of the Hanford Site-wide Risk Review Project. Sources may be aggregated into an EU based on potential impacts to a common set of receptors or receptor geographic area, common past waste management practices, or integration in the waste management process.

MBTA – Migratory Bird Treaty Act; referring to species listed and protected under the federal Act.

PNNL ECAP (Ecological Compliance and Assessment Project) Database – PNNL performed ecological reviews for individual projects and annually surveyed selected areas and buildings on the Hanford Site for DOE-RL under the DOE's Public Safety and Resource Protection Program until 2011. The data collected during those surveys is archived in the ECAP database, and is used to supplement ecological evaluations as available.

Priority Habitats – Priority habitats are habitat types or elements with unique or significant value to a diverse assemblage of species. A priority habitat may consist of a unique vegetation type (e.g., shrub-steppe) or dominant plant species (e.g., juniper savannah), a described successional stage (e.g., old-growth forest), or a specific habitat feature (e.g., cliffs).

Species of Concern or Species of Conservation Concern – An informal term that for the purpose of this assessment includes those species listed at the federal or state level as being threatened endangered, sensitive, or candidate, as well as those listed by the U.S. Fish and Wildlife Service as species of concern within the ecoregion.

Excerpt from ECAP Survey 2010-100-073; 105 KE includes the east reactor building and 105 KW includes the west reactor building

BLANKET BIOLOGICAL REVIEW OF100-K AREA MAINTENANCE AND OPERATION ACTIVITIES; 100-K AREA; ECR #2010-100-073

Survey Results:

Most of the area within the 100-K boundary fence is highly disturbed with substrate consisting primarily of compacted gravel. Vegetation consists primarily of widely scattered weedy species, with most of the area having essentially no vegetation. An exception is 116-KW-3 (an approximately 2.6 hectare area in the northwest corner of the site) which has been remediated and is characterized by Sandberg's bluegrass *(Poa secunda),* and bluebunch wheatgrass *(Pseudoroegneria spicata).*

The following migratory bird activity was observed. Nest sites active at the time of the survey are underlined.

- **105KE** -Two common ravens *(Corvus corax)* searching within the exposed north side.

  -One inactive common raven nest on a catwalk on the west side.

  -One <u>active Say's phoebe *(Sayornis saya)* nest</u> inside a propped-open door at the southeast corner.

- **105KW** -One <u>active house finch *(Carpodacus mexicanus)* nest</u> behind the light above Door 607 on the north side.

  -A pair of house finches perched on the west side.

  -One inactive western kingbird *(Tyrannus verticalis)* nest on a pipe bracket on the northeast corner.

Evaluation Unit: CWC
ID: CP-OP-1
Group: Operations
Operable Unit Cross-Walk: NA
Related EU: NA
Sites & Facilities: Central Waste Complex (CWC) operations, closure, and D&D
Key Data Sources Docs: DOE/RL-96-32 2013
PNNL ECAP Database[16]
Field Survey Date: 7/16/2014
Data Sheet prepared by: JLD 10/6/2014

Figure J.50. Site Map with Evaluation Unit Boundaries

CP-OP-1: CWC

Survey and Analysis Methods:

The evaluation process makes use of existing biological resource level maps (DOE/RL-96-32 2013), field surveys and measurement of current vegetation and habitat conditions, and wildlife observations to evaluate potential ecological impacts associated with cleanup activities at the evaluation unit (EU). Additional information used in the ecological evaluation includes the current Endangered and Threatened Species (Federal and State) distribution data; priority habitats as defined by Washington Department of Fish and Wildlife; available current aerial imagery, locations of Hanford Site waste sites and infrastructure spatial data; and available

[16] The Ecological Compliance and Assessment Project (ECAP) database is an evolving set of data that is maintained by Pacific Northwest National Laboratory (PNNL) and updated as new ecological assessments are completed.

information about species of concern distribution and habitat use in the vicinity of the EUs including data previously collected by PNNL for DOE-RL. Definitions relevant to the methods and ecological survey results are provided at the end of this summary along with field data tables.

The following steps were taken to assess the EU associated with the CWC:

1. The EU boundary (polygon) is assumed to represent the estimated boundary or extent of potential habitat removal and direct disturbance due to remediation.
2. A visual survey was conducted within the EU boundary by experienced shrub-steppe ecologists. Because the unit consists of disturbed and revegetated areas and graveled surfaces, no field measurements of vegetation were taken. PNNL biologists also reviewed the observations and biological survey data available in the Ecological Compliance and Assessment Project (ECAP) database from the past 5 years for the EU to determine the status and resource level of the habitats within the EU and supplement the evaluation with previous wildlife or plant species observations.
3. A second boundary (polygon) outside the EU was established to evaluate indirect effects and assess the remediation in relation to adjacent landscape features. This polygon is centered on the EU and encompasses a circular area with a radius 1 times the maximum width of the EU and is referred to as the **adjacent landscape buffer**.
4. A reconnaissance survey of the boundary of the EU was conducted to confirm the validity of past mapping of biological resources. Aerial imagery from 2012 was reviewed to identify any significant changes in habitat and resource levels (such as new well pads, roads, or other ground disturbance not captured by the available biological resources mapping) within the EU and adjacent landscape buffer. Where significant change is evident from ground survey or imagery, the biological resource map was updated to reflect the change in resource level.
5. The spatial extent of habitat classified at each of 6 resource levels (0 – 5) (DOE/RL-96-32 2013; definitions at end of this summary) within the adjacent landscape buffer area and the EU were assessed and compared using a Geographic Information System (GIS) to examine potential indirect effects on habitat condition within the adjacent landscape. For purposes of assessing indirect effects on the adjacent landscape, this evaluation assumes the maximum potential change in biological resources—that is, all habitat within the EU is assumed to be lost to remediation and cleanup activities and resources in the EU are considered level 0.
6. PNNL biologists assembled the information from field survey, reconnaissance, and spatial analyses of resource availability to provide a subjective evaluation of potential effects on habitat connectivity in the vicinity of the EU.

Field Survey:

PNNL biologists conducted a reconnaissance and pedestrian survey of the EU. Much of the unit consists of buildings and parking areas with some scattered shrubs bordering the graveled areas. Some small patches of remnant shrub-steppe vegetation occur in between buildings, and canopy cover was visually evaluated, but not physically measured in the field; therefore, no data sheet is included in this summary. The patches between buildings contain some scattered big sagebrush (*Artemisia tridentata*) with mixed native and alien grass understory. Cheatgrass (*Bromus tectorum*) cover ranged from 30% to 50%. The canopy cover of dominant vegetation in the revegetated area that occurs to the west and south of the buildings and parking areas was primarily crested wheatgrass (*Agropyron cristatum*) along with sparse shrubs (*Artemisia tridentata and Atriplex canescens*) (Table J.38).

No wildlife were observed within the unit during the July reconnaissance, however, PNNL ECAP surveys done in 2010 noted the following wildlife or wildlife signs: side-blotched lizard (*Uta stansburiana*), coyote (*Canis latrans*), mountain cottontail (*Sylvilagus nutalli*), and old scat from black-tailed jackrabbit (*Lepus californicus*).

Table J.38. Percent Canopy Cover of Vegetation Estimated Visually at the CWC Evaluation Unit

Vegetation/Surface Cover	West Revegetation	Scattered Habitat Between Buildings
BARE	10	NM
CRUST	NM	NM
LITTER	10	NM
Introduced Forb	10	10
Introduced Grass	25	35
Native Forb	2	1
Native Grass	-	5
Climax Shrubs	1	5
Successional Shrubs	<1	<1
Non-native Shrub	1	-

NM = Not measured or estimated

Landscape Evaluation and Resource Classification:

The CWC EU includes levels 0, 1, 2, and 3 resources as classified in the existing resource level map (DOE/RL-96-32 2013). However, two locations classified as level 3 resources in the existing resource map have become degraded and were reclassified as level 2 for this assessment. Central and western portions of the EU have been converted into industrial areas and were reclassified as level 0 resources. The majority of the CWC site is characterized by level 0 (i.e., industrial sites, paved and compacted gravel areas) and level 2 resources (i.e., small patches with sparse climax or successional shrub overstory and non-native understory) (Table J.39; Figure J.51). Much of the area on the west side of the EU was reclassified as level 2 because it had burned previously, and was revegetatated with non-native and native species.

Table J.39. Area and Proportion of Each Biological Resource Level Within the Evaluation Unit in Relation to Adjacent Landscape and Potential Maximum Change in Resources

Resource Level[1]	Evaluation Unit Area (ac)	Adjacent Landscape Buffer (ac)	Combined Total Area (ac)	Percent of Resource Level in Combined Total Area	Percent of Resource Level in Combined Total Area After Cleanup[2]	Percent Difference at Landscape Scale After Cleanup[2]
0	93.6	491.9	585.5	33.4%	37.3%	3.9%
1	3.5	145.1	148.6	8.5%	8.3%	-0.2%
2	65.5	925.2	990.7	56.5%	52.7%	-3.7%
3	0.0	30.2	30.2	1.7%	1.7 %	0.0%
4	0.0	0.0	0.0	0.0%	0.0%	0.0%
5	0.0	0.0	0.0	0.0%	0.0%	0.0%
Total	162.6	1592.4	1755.0	100.0%	100.0%	

1 Resource levels for both the evaluation unit and adjacent landscape boundary were reviewed in the field and via imagery during July 2014 and revised to reflect current habitats conditions.

2 Potential maximum change in area of a given resource level within the combined total area (Evaluation Unit + Adjacent Landscape Buffer) that would occur assuming that all habitat within the evaluation unit is destroyed by remediation activities and the resource level of the evaluation unit is level 0.

The amount and proximity of biological resources to the CWC EU was evaluated within the adjacent landscape buffer area radiating 1504 m from the geometric center of the site (equivalent to 1755 acres). Small patches of level 3 resources (ranging from 1.9 to 11.5 acres) are located to the east and southeast of the EU, including several point occurrences of sensitive species (Figure J.51).

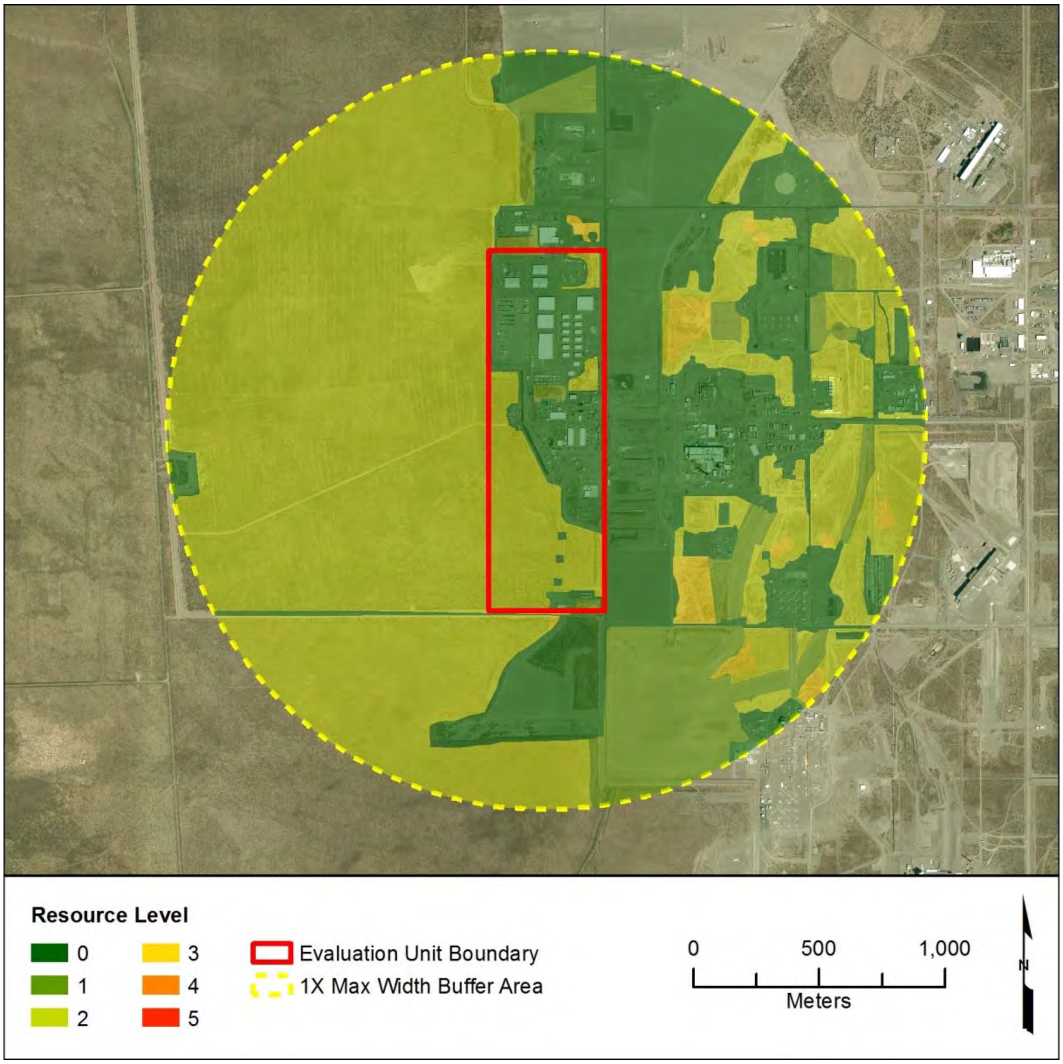

Figure J.51. Map of Biological Resource Level Classifications at the Central Waste Complex Evaluation Unit (red boundary) and Adjacent Landscape Buffer Area (yellow dashed line boundary) Based on July 2014 Survey

Assumptions and Uncertainty:

Due to project time constraints, the field surveys and reconnaissance of this EU were conducted in mid-July. By the time of the survey, the cool-season annual and perennial herbaceous plants that dominate shrub-steppe habitat had completed seasonal growth and senesced making identification and inventory difficult and most likely incomplete. Although no records for plant species of concern have been noted, the absence of species cannot be confirmed by surveys during this time of year.

By mid-July, most migratory birds have completed their nesting cycles, and surveys may not reflect their occupancy and use of habitat within the EU earlier in the season. Their absence cannot be confirmed by surveys in July after the nesting season is over. Further surveys during the nesting season would be required to fully assess the ecological impacts to nesting migratory birds.

Summary of Ecological Review:

- No level 3 or higher quality habitat patches occur within the CWC EU (Table J.39; Figure J.51).
- Cleanup activities would result in no net change in the amount of level 3 or higher resources within a 1.5 km radius.
- The CWC EU is adjacent and contiguous to multiple industrial sites—no significant change in habitat connectivity would be expected if habitat resources within the EU are lost.

References:

DOE/RL-96-32. 2013. Hanford Unit Biological Resources Management Plan, Revision 1.

PNNL. 2009. 300 Area Buildings Survey for 2009, Ecological Compliance and Assessment Project Database. Data collected by PNNL for DOE/RL under the Public Safety and Resource Protection Program.

U.S. Fish and Wildlife Service (USFWS). 2014. Environmental Conservation Online System, Listings and Occurrences for Washington. http://ecos.fws.gov/tess_public/pub/stateListingAndOccurrenceIndividual.jsp?state=WA&s8fid=112761032792&s8fid=112762573902

U.S. Fish and Wildlife Service (USFWS). 2014. Birds Protected by the Migratory Bird Treaty Act. http://www.fws.gov/migratorybirds/RegulationsPolicies/mbta/mbtintro.html

Washington Department of Fish and Wildlife. 2008. Washington State Priority Habitats and Species List. Olympia Washington. 174 pp. Available at: http://wdfw.wa.gov/conservation/phs/list/

Washington Department of Fish and Wildlife. 2014. Species of Concern in Washington. http://wdfw.wa.gov/conservation/endangered/

Washington Noxious Weed Control Board. 2014. Noxious Weed List. Available on line at http://www.nwcb.wa.gov/

Washington State Department of Natural Resources. 2014. Washington Natural Heritage Program Plant Ranks. http://www1.dnr.wa.gov/nhp/refdesk/lists/plantrnk.html

Definitions and Acronyms:

Adjacent Landscape Buffer – a circular area adjacent to and outside the EU boundary with the center of the circle at the centroid of the EU, and with a radius that is 1 times the maximum dimension (width or length—whichever is greatest). This circular buffer area is used to evaluate indirect effects and assess the remediation in relation to the landscape features and resources adjacent to the EU. This circular area is generally at least 3 times the area of the EU.

Biological Resource Levels (from DOE-RL-96-32-01) –

- Level 5 resources include species that are listed or proposed-to-be listed under the *Endangered Species Act* and their critical habitat, as well as rare and irreplaceable habitats.
- Level 4 resources include federal candidate species; Washington State threatened or endangered species; habitat or exclusion buffers for federal candidates and Washington State threatened or endangered species; high-quality mature shrub steppe; wetlands and riparian areas; and buffer areas for bald eagles and ferruginous hawks.
- Level 3 resources include Washington State sensitive, candidate, and review species; Washington Department of Fish and Wildlife priority species; lower quality mature shrub-steppe—such as shrub stands that are less mature, have lower shrub density or canopy cover, and/or a greater proportion of cheatgrass in the understory than stands that qualify for Level 4. Level 3 also includes high-quality grasslands, conservation corridors, snake hibernacula, bat roosts, rookeries, burrowing owl buffer areas, and areas with significant quantities of culturally important species.
- Level 2 resources include migratory birds, state watch list plants and monitor list animals, recreationally and commercially important species, and lower quality steppe and shrub-steppe.
- Level 1 resources include individual common native plant and wildlife species, upland stands of non-native plants, and abandoned agricultural fields.

Evaluation Units (EUs) – groupings of sources, aggregated for evaluation as part of the Hanford Site-wide Risk Review Project. Sources may be aggregated into an EU based on potential impacts to a common set of receptors or receptor geographic area, common past waste management practices, or integration in the waste management process.

MBTA – Migratory Bird Treaty Act; referring to species listed and protected under the federal Act.

PNNL ECAP (Ecological Compliance and Assessment Project) Database – PNNL performed ecological reviews for individual projects and annually surveyed selected areas and buildings on the Hanford Site for DOE-RL under the DOE’s Public Safety and Resource Protection Program until 2011. The data collected during those surveys is archived in the ECAP database, and is used to supplement ecological evaluations as available.

Priority Habitats – Priority habitats are habitat types or elements with unique or significant value to a diverse assemblage of species. A priority habitat may consist of a unique vegetation type (e.g., shrub-steppe) or dominant plant species (e.g., juniper savannah), a described successional stage (e.g., old-growth forest), or a specific habitat feature (e.g., cliffs).

Species of Concern or Species of Conservation Concern – An informal term that for the purpose of this assessment includes those species listed at the federal or state level as being threatened endangered, sensitive, or candidate, as well as those listed by the U.S. Fish and Wildlife Service as species of concern within the ecoregion.

Previous PNNL ECAP Field Survey Data Collected within the CWC EU:

ECAP Database Query Results for W-125

Observer: *Freeman-Cadoret, Natalie* Date *6/21/2010*

Plant

Common Name	Latin Name	Abundance	Comments
cheatgrass	Bromus tectorum	50	
big sagebrush	Artemisia tridentata	5	
fiddleneck	Amsinckia lycopsoides	20	
Russian thistle	Salsola kali	10	
crested wheatgrass	Agropyron cristatum		
bur ragweed	Ambrosia acanthicarpa		
green rabbitbrush	Chrysothamnus viscidiflorus		
flixweed	Descurainia sophia		
hoary aster	Machaeranthera canescens		
flattop broomrape	Orobanche corymbosa		
indian ricegrass	Oryzopsis hymenoides		
Sandberg's bluegrass	Poa sandbergii		
Jim Hill's tumblemustard	Sisymbrium altissimum		

Mammal

Common Name	Latin Name	Abundance	Comments
black-tailed jackrabbit	Lepus californicus	Present	Pellets
unknown/unidentified small mammal	small mammal	Present	

Observer: *Simmons, Mary Ann* Date *6/21/2010*

Plant

Common Name	Latin Name	Abundance	Comments
cheatgrass	Bromus tectorum	40	
Russian thistle	Salsola kali	20	
big sagebrush	Artemisia tridentata	1	
bur ragweed	Ambrosia acanthicarpa		
gray rabbitbrush	Chrysothamnus nauseosus		
green rabbitbrush	Chrysothamnus viscidiflorus		
western tansymustard	Descurainia pinnata		
prickly lettuce	Lactuca serriola		
hoary aster	Machaeranthera canescens		
flattop broomrape	Orobanche corymbosa		
indian ricegrass	Oryzopsis hymenoides		
Sandberg's bluegrass	Poa sandbergii		
Jim Hill's tumblemustard	Sisymbrium altissimum		

Mammal

Common Name	Latin Name	Abundance	Comments
northern pocket gopher	Thomomys talpoides	Present	Mounds

Monday, October 13, 2014 Page 1 of 2

ECAP Database Query Results for W-080a

Observer: *Freeman-Cadoret, Natalie* Date *6/21/2010*

Plant

Common Name	Latin Name	Abundance	Comments
cheatgrass	Bromus tectorum	30	
big sagebrush	Artemisia tridentata	25	
gray rabbitbrush	Chrysothamnus nauseosus	1	
green rabbitbrush	Chrysothamnus viscidiflorus	1	
crested wheatgrass	Agropyron cristatum		
bur ragweed	Ambrosia acanthicarpa		
turpentine springparsley	Cymopteris terebithinus		
flixweed	Descurainia sophia		
slender sixweeks	Festuca octoflora		
hoary aster	Machaeranthera canescens		
flattop broomrape	Orobanche corymbosa		
indian ricegrass	Oryzopsis hymenoides		
Sandberg's bluegrass	Poa sandbergii		
pine bluegrass	Poa scabrella		
Russian thistle	Salsola kali		
Jim Hill's tumblemustard	Sisymbrium altissimum		
stiff wirelettuce	Stephanomeria paniculata		

Mammal

Common Name	Latin Name	Abundance	Comments
black-tailed jackrabbit	Lepus californicus	Present	Pellets
unknown/unidentified small mammal	small mammal	Present	

Herpt

Common Name	Latin Name	Abundance	Comments
side-blotched lizard	Uta stansburiana	Present	

Observer: *Simmons, Mary Ann* Date *6/21/2010*

Plant

Common Name	Latin Name	Abundance	Comments
big sagebrush	Artemisia tridentata	5	
cheatgrass	Bromus tectorum	40	
crested wheatgrass	Agropyron cristatum		
bur ragweed	Ambrosia acanthicarpa		
gray rabbitbrush	Chrysothamnus nauseosus		
green rabbitbrush	Chrysothamnus viscidiflorus		
turpentine springparsley	Cymopteris terebithinus		
western tansymustard	Descurainia pinnata		
prickly lettuce	Lactuca serriola		

ECAP Database Query Results for W-126

Observer: ***Hand, Kris*** Date *7/28/2010*

Plant

Common Name	Latin Name	Abundance	Comments
cheatgrass	Bromus tectorum	50	
Russian thistle	Salsola kali	10	
Jim Hill's tumblemustard	Sisymbrium altissimum	10	
crested wheatgrass	Agropyron cristatum		
bur ragweed	Ambrosia acanthicarpa		
green rabbitbrush	Chrysothamnus viscidiflorus		
prickly lettuce	Lactuca serriola		
hoary aster	Machaeranthera canescens		

Mammal

Common Name	Latin Name	Abundance	Comments
mountain cottontail	Sylvilagus nutalli	Present	Poop

Bird

Common Name	Latin Name	Abundance	Comments
No birds observed	No birds		

Monday, October 13, 2014 Page 1 of 1

ECAP Database Query Results for W-080d

Observer: ***Hand, Kris*** Date *7/28/2010*

Plant

Common Name	Latin Name	Abundance	Comments
big sagebrush	Artemisia tridentata	25	Well pad now w/in poly
Russian thistle	Salsola kali	30	
flixweed	Descurainia sophia	1	
cheatgrass	Bromus tectorum		
green rabbitbrush	Chrysothamnus viscidiflorus		

Mammal

Common Name	Latin Name	Abundance	Comments
coyote	Canis latrans	Present	Tracks
mountain cottontail	Sylvilagus nutalli	Present	Poop

Herpt

Common Name	Latin Name	Abundance	Comments
side-blotched lizard	Uta stansburiana	Present	Critter

Bird

Common Name	Latin Name	Abundance	Comments
No birds observed	No birds		

Monday, October 13, 2014 Page 1 of 1

Evaluation Unit:	WESF
ID:	CP-OP-3
Group:	Operations
Operable Unit Cross-Walk:	NA
Related EU:	CP-DD-2
Sites & Facilities:	Waste Encapsulation and Storage Facility (WESF) – Evaluate for the storage and removal of Cs/SR capsules. D&D included with B Plant EU.
Key Data Sources Docs:	DOE/RL-96-32 2013 PNNL ECAP Database[17]
Field Survey Date:	10/8/2014
Data Sheet Prepared By:	JLD, MAC, KDH, KBL, SAM; 10/08/2014

Figure J.52. Site Map with Evaluation Unit Boundaries

CP-OP-3: WESF

Survey and Analysis Methods:

The evaluation process makes use of existing biological resource level maps (DOE/RL-96-32 2013), field surveys and measurement of current vegetation and habitat conditions, and wildlife observations to evaluate potential ecological impacts associated with cleanup activities at the evaluation unit (EU). Additional information used in the ecological evaluation includes the current Endangered and Threatened Species (Federal and State) distribution data; priority habitats as defined by Washington Department of Fish and Wildlife; available current aerial

[17] The Ecological Compliance and Assessment Project (ECAP) database is an evolving set of data that is maintained by Pacific Northwest National Laboratory (PNNL) and updated as new ecological assessments are completed.

imagery, locations of Hanford Site waste sites and infrastructure spatial data; and available information about species of concern distribution and habitat use in the vicinity of the EUs including data previously collected by PNNL for DOE-RL. Definitions relevant to the methods and ecological survey results are provided at the end of this summary along with field data tables.

The following steps were taken to assess the EU associated with WESF:

1. The EU boundary (polygon) is assumed to represent the estimated boundary or extent of potential habitat removal and direct disturbance due to remediation.
2. A visual survey was conducted within the EU boundary by experienced shrub-steppe ecologists. Because the unit consists of unvegetated industrial and graveled surfaces and buildings, no field measurements of vegetation were taken. PNNL biologists also reviewed the observations and biological survey data available in the ECAP database from the past 5 years for the EU to determine the status and resource level of the habitats within the EU and supplement the evaluation with previous wildlife or plant species observations.
3. A second boundary (polygon) outside the EU was established to evaluate indirect effects and assess the remediation in relation to adjacent landscape features. This polygon is centered on the EU and encompasses a circular area with a radius 1 times the maximum width of the EU and is referred to as the **adjacent landscape buffer**.
4. A reconnaissance survey of the boundary of the EU was conducted to confirm the validity of past mapping of biological resources. Aerial imagery from 2012 was reviewed to identify any significant changes in habitat and resource levels (such as new well pads, roads, or other ground disturbance not captured by the available biological resources mapping) within the EU and adjacent landscape buffer. Where significant change is evident from ground survey or imagery, the biological resource map was updated to reflect the change in resource level.
5. The spatial extent of habitat classified at each of 6 resource levels (0 – 5) (DOE/RL-96-32 2013; definitions at end of this summary) within the adjacent landscape buffer area and the EU were assessed and compared using a Geographic Information System (GIS) to examine potential indirect effects on habitat condition within the adjacent landscape. For purposes of assessing indirect effects on the adjacent landscape, this evaluation assumes the maximum potential change in biological resources—that is, all habitat within the EU is assumed to be lost to remediation and cleanup activities and resources in the EU are considered level 0.
6. PNNL biologists assembled the information from field survey, reconnaissance, and spatial analyses of resource availability to provide a subjective evaluation of potential effects on habitat connectivity in the vicinity of the EU.

Field Survey:

A visual survey of the EU for WESF confirmed that the EU consists entirely of built structures and paved, graveled, or landscaped surfaces. No wildlife were observed. No field data sheets were generated. PNNL ECAP surveys conducted in 2009 for the WESF area indicated the following wildlife around the buildings: American robin (*Turdus migratorius*), lark sparrow (*Chondestes grammacus*), killdeer (*Charadrius vociferous*), barn swallow (*Hirundo rustica*), and mourning dove (*Zenaida macroura*).

Table J.40. Percent Canopy Cover and Surface Cover Observed at WESF

Vegetation/Surface Cover	Survey Area
Bare Ground/Building	100%

Landscape Evaluation and Resource Classification:

The amount and proximity of the biological resources to the EU were examined within the adjacent landscape buffer area radiating approximately 64 m from the geometric center of the EU (equivalent to 3.2 acres). The WESF EU and surrounding adjacent landscape buffer area consist entirely of level 0 resources; that is, paved, graveled surfaces and buildings with some landscaping around them.

Table J.41. Area and Proportion of Each Biological Resource Level Within the WESF Evaluation Unit in Relation to Adjacent Landscape and Potential Maximum Change in Resources

Resource Level[1]	Evaluation Unit Area (ac)	Adjacent Landscape Buffer (ac)	Combined Total Area (ac)	Percent of Resource Level in Combined Total Area	Percent of Resource Level in Combined Total Area After Cleanup[2]	Percent Difference at Landscape Scale After Cleanup[2]
0	0.5	2.7	3.2	100%	100%	0%
1	0.0	0.0	0.0	0%	0%	0%
2	0.0	0.0	0.0	0%	0%	0%
3	0.0	0.0	0.0	0%	0%	0%
4	0.0	0.0	0.0	0%	0%	0%
5	0.0	0.0	0.0	0%	0%	0%
Total	0.5	2.7	3.2	100%	100%	0%

1 Resource levels for both the evaluation unit and adjacent landscape boundary were reviewed in the field and via imagery during October 2014 and revised to reflect current habitats conditions.

2 Potential maximum change in area of a given resource level within the combined total area (Evaluation Unit + Adjacent Landscape Buffer) that would occur assuming that all habitat within the evaluation unit is destroyed by remediation activities and the resource level of the evaluation unit is level 0.

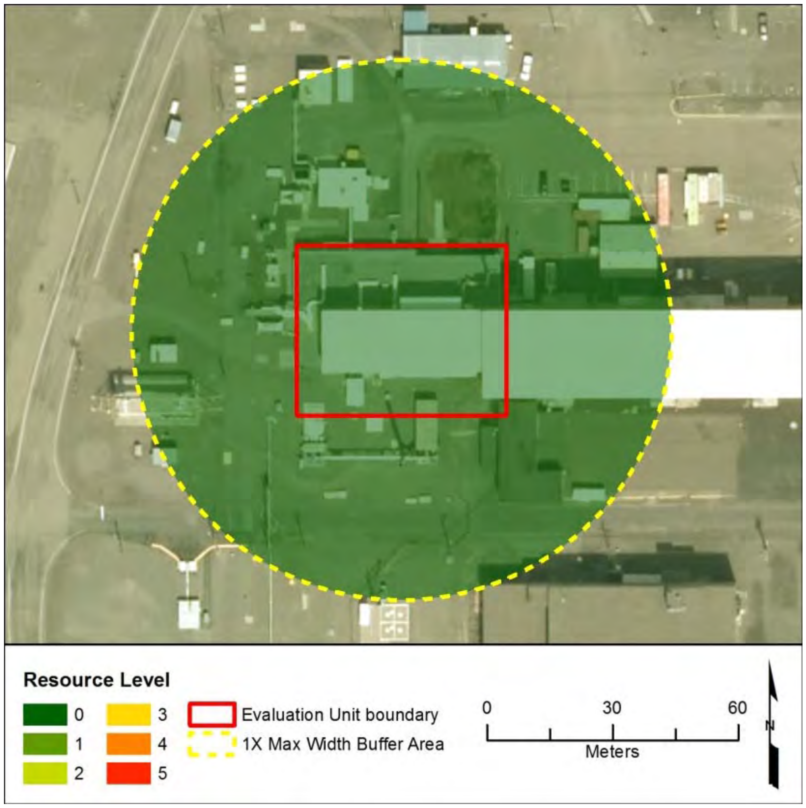

Figure J.53. Biological Resource Level Classifications Based on October 2014 Surveys at the WESF Evaluation Unit (red solid line) and Adjacent Landscape Buffer Area (yellow dashed line).

Assumptions and Uncertainty:

Due to project time constraints, the field surveys and reconnaissance of this EU were conducted in October. By the time of the survey, the cool-season annual and perennial herbaceous plants that dominate shrub-steppe habitat had completed seasonal growth and senesced making identification and inventory difficult and most likely incomplete. Although no records for plant species of concern have been noted, the absence of species cannot be confirmed by surveys during this time of year.

By October, migratory birds have completed their nesting cycles, and most have migrated out of the region. Surveys conducted in late fall will not reflect their occupancy and use of habitat within the EU earlier in the season. Their absence cannot be confirmed by surveys October after the nesting season is over. Further surveys during the nesting season would be required to fully assess the ecological impacts to nesting migratory birds.

Summary of Ecological Review:

- No species of concern were observed either within the EU or in the immediate vicinity.
- The EU for WESF and adjacent landscape buffer consist of 0 level resources; that is, paved and graveled surfaces, buildings, infrastructure, and minor amounts of landscaping.

- Remediation of the WESF EU would not have any negative impacts on habitat connectivity.

References

DOE/RL-96-32. 2013. Hanford Site Biological Resources Management Plan, Revision 0.

U.S. Fish and Wildlife Service (USFWS). 2014. Birds Protected by the Migratory Bird Treaty Act. http://www.fws.gov/migratorybirds/RegulationsPolicies/mbta/mbtintro.html

U.S. Fish and Wildlife Service (USFWS). 2014. Environmental Conservation Online System, Listings and Occurrences for Washington. http://ecos.fws.gov/tess_public/pub/stateListingAndOccurrenceIndividual.jsp?state=WA&s8fid=112761032792&s8fid=112762573902

Washington Department of Fish and Wildlife. 2008. Washington State Priority Habitats and Species List. Olympia Washington. 174 pp. http://wdfw.wa.gov/conservation/phs/list/

Washington Department of Fish and Wildlife. 2014. Species of Concern in Washington. http://wdfw.wa.gov/conservation/endangered/

Washington Noxious Weed Control Board.2014. Noxious Weed List. http://www.nwcb.wa.gov/

Washington State Department of Natural Resources. 2014. Washington Natural Heritage Program Plant Ranks. http://www1.dnr.wa.gov/nhp/refdesk/lists/plantrnk.html

Definitions and Acronyms:

Adjacent Landscape Buffer – a circular area adjacent to and outside the EU boundary with the center of the circle at the centroid of the EU, and with a radius that is 1 times the maximum dimension (width or length—whichever is greatest). This circular buffer area is used to evaluate indirect effects and assess the remediation in relation to the landscape features and resouces adjacent to the EU. This circular area is generally at least 3 times the area of the EU.

Biological Resource Levels (from DOE-RL-96-32-01) –

- Level 5 resources include species that are listed or proposed-to-be listed under the *Endangered Species Act* and their critical habitat, as well as rare and irreplaceable habitats.
- Level 4 resources include federal candidate species; Washington State threatened or endangered species; habitat or exclusion buffers for federal candidates and Washington State threatened or endangered species; high-quality mature shrub steppe; wetlands and riparian areas; and buffer areas for bald eagles and ferruginous hawks.
- Level 3 resources include Washington State sensitive, candidate, and review species; Washington Department of Fish and Wildlife priority species; lower quality mature shrub-steppe—such as shrub stands that are less mature, have lower shrub density or canopy cover, and/or a greater proportion of cheatgrass in the understory than stands that qualify for Level 4. Level 3 also includes high-quality grasslands, conservation corridors, snake hibernacula, bat roosts, rookeries, burrowing owl buffer areas, and areas with significant quantities of culturally important species.
- Level 2 resources include migratory birds, state watch list plants and monitor list animals, recreationally and commercially important species, and lower quality steppe and shrub-steppe.

- Level 1 resources include individual common native plant and wildlife species, upland stands of non-native plants, and abandoned agricultural fields.

Evaluation Units (EUs) – groupings of sources, aggregated for evaluation as part of the Hanford Site-wide Risk Review Project. Sources may be aggregated into an EU based on potential impacts to a common set of receptors or receptor geographic area, common past waste management practices, or integration in the waste management process.

MBTA – Migratory Bird Treaty Act; referring to species listed and protected under the federal Act.

PNNL ECAP (Ecological Compliance and Assessment Project) Database – PNNL performed ecological reviews for individual projects and annually surveyed selected areas and buildings on the Hanford Site for DOE-RL under the DOE's Public Safety and Resource Protection Program until 2011. The data collected during those surveys is archived in the ECAP database, and is used to supplement ecological evaluations as available.

Priority Habitats – Priority habitats are habitat types or elements with unique or significant value to a diverse assemblage of species. A priority habitat may consist of a unique vegetation type (e.g., shrub-steppe) or dominant plant species (e.g., juniper savannah), a described successional stage (e.g., old-growth forest), or a specific habitat feature (e.g., cliffs).

Species of Concern or Species of Conservation Concern – An informal term that for the purpose of this assessment includes those species listed at the federal or state level as being threatened endangered, sensitive, or candidate, as well as those listed by the USFWS as species of concern within the ecoregion.

Previous ECAP Survey Data for the WESF EU

ECAP Database Query Results for E-501

Observer: ***Chamness, Mickie*** Date ***6/26/2009***

Plant

Common Name	Latin Name	Abundance	Comments
Russian thistle	Salsola kali	+	Mostly gravel

Bird

Common Name	Latin Name	Abundance	Comments
American robin	Turdus migratorius	1	S powerline
lark sparrow	Chondestes grammacus	1	N power line by railroad
killdeer	Charadrius vociferus	2	N parking lot
barn swallow	Hirundo rustica	2	Foraging
mourning dove	Zenaida macroura	1	Flew over

Evaluation Unit:	ERDF
ID:	CP-OP-6
Group:	Operations
Operable Unit Cross-Walk:	NA
Related EU:	NA
Sites & Facilities:	Environmental Restoration Disposal Facility operations and closure
Key Data Sources Docs:	DOE/RL-96-32 2013
Field Survey Date:	10/13/2014
Data Sheet Prepared By:	KDH, JLD, MAC, KBL, SAM; 10/22/2014

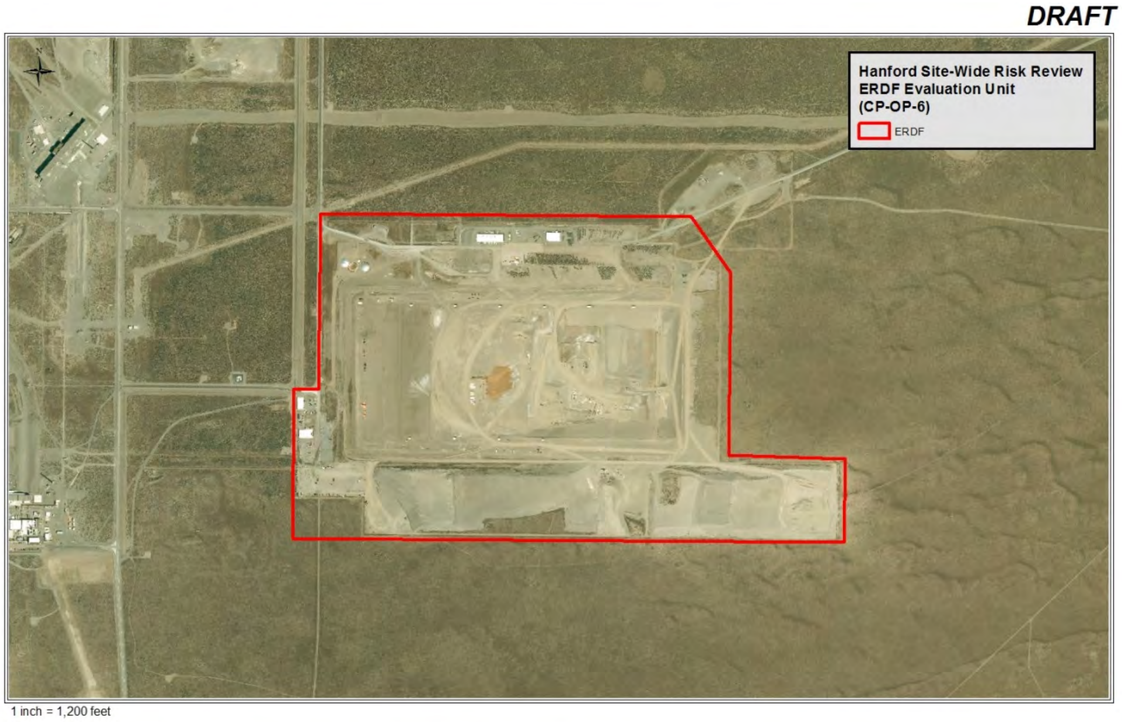

Figure J.54. Site Map of the ERDF Evaluation Unit Boundary

CP-OP-6: ERDF

Survey and Analysis Methods:

The evaluation process makes use of existing biological resource level maps (DOE/RL-96-32 2013), field surveys and measurement of current vegetation and habitat conditions, and wildlife observations to evaluate potential ecological impacts associated with cleanup activities at the evaluation unit (EU). Additional information used in the ecological evaluation includes the current Endangered and Threatened Species (Federal and State) distribution data; priority habitats as defined by Washington Department of Fish and Wildlife; available current aerial imagery, locations of Hanford Unit waste sites and infrastructure spatial data; and available information about species of concern distribution and habitat use in the vicinity of the EUs including data previously collected by PNNL for DOE-RL. Definitions relevant to the methods and ecological survey results are provided at the end of this summary along with field data tables.

The following steps were taken to assess the EU associated with the Environmental Restoration Disposal Facility:

1. The EU boundary (polygon) is assumed to represent the estimated boundary or extent of potential habitat removal and direct disturbance due to remediation.
2. A vehicle and field survey was conducted within the EU boundary by experienced shrub-steppe ecologists. Field measurements of vegetation were taken in selected habitats. No PNNL Ecological Compliance and Assessment Project (ECAP) data were available for this area.
3. A second boundary (polygon) outside the EU was established to evaluate indirect effects and assess the remediation in relation to adjacent landscape features. This polygon is centered on the EU and encompasses a circular area with a radius 1 times the maximum width of the EU and is referred to as the **adjacent landscape buffer**.
4. A reconnaissance survey of the boundary of the EU was conducted to confirm the validity of past mapping of biological resources. Aerial imagery from 2012 was reviewed to identify any significant changes in habitat and resource levels (such as new well pads, roads, or other ground disturbance not captured by the available biological resources mapping) within the EU and adjacent landscape buffer. Where significant change is evident from ground survey or imagery, the biological resource map was updated to reflect the change in resource level.
5. The spatial extent of habitat classified at each of 6 resource levels (0 – 5) (DOE/RL-96-32 2013; definitions at end of this summary) within the adjacent landscape buffer area and the EU were assessed and compared using a Geographic Information System (GIS) to examine potential indirect effects on habitat condition within the adjacent landscape. For purposes of assessing indirect effects on the adjacent landscape, this evaluation assumes the maximum potential change in biological resources—that is, all habitat within the EU is assumed to be lost to remediation and cleanup activities and resources in the EU are considered level 0.
6. PNNL biologists assembled the information from field survey, reconnaissance, and spatial analyses of resource availability to provide a subjective evaluation of potential effects on habitat connectivity in the vicinity of the EU.

Field Survey:

The EU associated with the ERDF facilities was surveyed in October 2014 by pedestrian and vehicle reconnaissance of disturbed areas and field measurement or visual survey of natural habitat areas. The majority of the EU consists of disturbed landfill cells, roads/ramps, buildings, parking lots, and associated facilities. Small areas of natural habitat remain along the EU perimeter. Based on visual surveys the natural habitat along the northern boundary (survey areas 4-01a and 4-01b, Table J.42) was classified as a composite of levels 1-3 and the natural habitat along the eastern boundary (survey area 3-09a, Table J.42) was classified as primarily level 2 to reflect current vegetation conditions (Figure J.55). Two sanitation tile/drain fields are located within the EU: 1) part of the level 1 habitat resource in the northwest corner which was visually surveyed and 2) an area along the central southern boundary which could not be accessed during the field survey. Field measurements conducted in the natural habitat area located at the southwest corner (survey area 3-09b, Table J.42) of the EU confirmed the habitat to be resource level 3 (Figure J.55) with mature big sagebrush (*Artemisia tridentata*) in the overstory.

Wildlife observations included a side-blotched lizard (*Uta stansburiana*) and harvester ants in habitats near the northern boundary, signs of small mammals in habitats near the northern boundary and in the southwest corner, and a white-crowned sparrow (*Zonotrichia leucophrys*) in habitats near the eastern boundary.

Table J.42. Percent Canopy Cover and Surface Cover Measured at the ERDF Evaluation Unit

Vegetation/Surface Cover	Survey Area 3-09a (%)	Survey Area 3-09b (%)	Survey Area 4-01a (%)	Survey Area 4-01b (%)
Bare Ground	-	33.4	-	-
Crust	-	8.3	-	-
Litter	-	44.0	-	-
Introduced Forb	15	3.8	35	10
Introduced Grass	20	5.2	10	15
Native Forb	-	23.0	-	3
Native Grass	3	22.9	2	-
Climax Shrubs	1	1.5	-	-
Successional Shrubs	-	-	-	1

Landscape Evaluation and Resource Classification:

The amount of each category of biological resources at and near the ERDF EU was examined within a circular area radiating 2,123 m from the geometric center of the unit (equivalent to 3,499 acres). The majority of the area within the 424.2 acres of the EU is classified as level 0 (365.4 ac), with only 31.4 acres classified as level 3 or higher biological resources, whereas the adjacent landscape buffer contains substantial level 3 and higher resources (2,468 ac out of 3,075.1 ac). Overall, approximately 71.5 percent of the total combined area currently consists of level 3 or higher biological resources (Figure J.55, Table J.43).

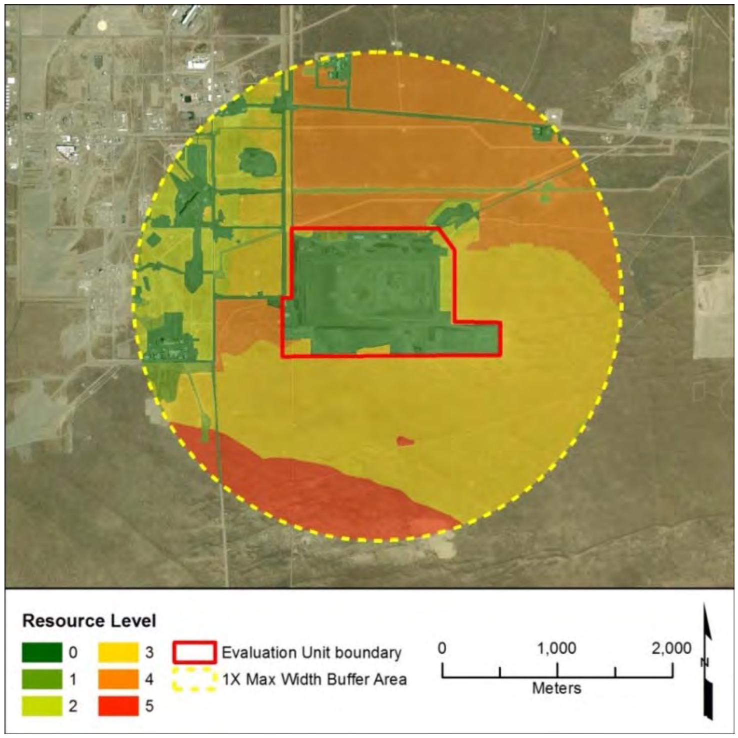

Figure J.55. Map of Biological Resource Level Classifications Based on October 2014 Surveys for the ERDF Evaluation Unit (red solid line) and Adjacent Landscape Buffer (yellow dashed line)

Table J.43. Area and Proportion of Each Biological Resource Level Within the Evaluation Unit in Relation to Adjacent Landscape and Potential Maximum Change in Resources

Resource Level[1]	Evaluation Unit Area (ac)	Adjacent Landscape Buffer (ac)	Combined Total Area (ac)	Percent of Resource Level in Combined Total Area	Percent of Resource Level in Combined Total Area After Cleanup[2]	Percent Difference at Landscape Scale After Cleanup[2]
0	365.4	267.0	632.4	18.1%	19.8%	1.7%
1	9.7	81.0	90.7	2.6%	2.3%	-0.3%
2	17.7	259.0	276.7	7.9%	7.4%	-0.5%
3	29.8	1323.5	1353.3	38.7%	37.8%	-0.9%
4	1.6	882.8	884.5	25.3%	25.2%	0.1%
5	0.0	261.7	261.7	7.5%	7.5%	0.0%
Total	424.2	3075.0	3499.3	100.0%	100.0%	

1 Resource levels for the evaluation unit were reviewed in the field and via imagery during October 2014 and revised to reflect current habitats conditions.

2 Potential maximum change in area of a given resource level within the combined total area (Evaluation Unit + Adjacent Landscape Buffer) that would occur assuming that all habitat within the evaluation unit is destroyed by remediation activities and the resource level of the evaluation unit is level 0.

Assumptions and Uncertainty:

Due to project time constraints, the field surveys and reconnaissance of this EU were conducted in mid-October. By the time of the survey, the cool-season annual and perennial herbaceous plants that dominate shrub-steppe habitat had completed seasonal growth and senesced making identification and inventory difficult, and most likely incomplete. Although no records for plant species of concern have been noted, the absence of such species cannot be confirmed by surveys during this time of year.

By mid-October, most migratory birds have completed their nesting cycles, and surveys may not reflect their occupancy and use of habitat within the EU earlier in the season. Their absence cannot be confirmed by surveys in October after the nesting season is over. Further surveys during the nesting season would be required to fully assess the ecological impacts to nesting migratory birds.

Summary of Ecological Review:

- The majority of the area within the 424.2 acres of the ERDF EU is classified as level 0 (365.4 ac), with only 31.4 acres classified as level 3 or higher biological resources.
- Remediation actions undertaken within the ERDF EU boundary would result in no more than an approximate 1% (31.4 ac) reduction of level 3 or higher biological resources within a 2.1 km radius.
- Areas of habitat within the ERDF EU are located near its perimeter and are contiguous with surrounding habitats located in the adjacent landscape buffer; the removal of the small amount of habitat within the EU would not be expected to significantly affect habitat connectivity.
- Future plans to expand ERDF by adding new landfill cells have the potential to significantly affect those level 3 or higher biological resources immediately adjacent to the EU.

References

DOE/RL-96-32. 2013. Hanford Site Biological Resources Management Plan, Revision 0.

U.S. Fish and Wildlife Service (USFWS). 2014. Birds Protected by the Migratory Bird Treaty Act. http://www.fws.gov/migratorybirds/RegulationsPolicies/mbta/mbtintro.html

U.S. Fish and Wildlife Service (USFWS). 2014. Environmental Conservation Online System, Listings and Occurrences for Washington. http://ecos.fws.gov/tess_public/pub/stateListingAndOccurrenceIndividual.jsp?state=WA&s8fid=112761032792&s8fid=112762573902

Washington Department of Fish and Wildlife. 2008. Washington State Priority Habitats and Species List. Olympia Washington. 174 pp. http://wdfw.wa.gov/conservation/phs/list/

Washington Department of Fish and Wildlife. 2014. Species of Concern in Washington. http://wdfw.wa.gov/conservation/endangered/

Washington Noxious Weed Control Board.2014. Noxious Weed List. http://www.nwcb.wa.gov/

Washington State Department of Natural Resources. 2014. Washington Natural Heritage Program Plant Ranks. http://www1.dnr.wa.gov/nhp/refdesk/lists/plantrnk.html

Definitions and Acronyms:

Adjacent Landscape Buffer – a circular area adjacent to and outside the EU boundary with the center of the circle at the centroid of the EU, and with a radius that is 1 times the maximum dimension (width or length—whichever is greatest). This circular buffer area is used to evaluate indirect effects and assess the remediation in relation to the landscape features and resources adjacent to the EU. This circular area is generally at least 3 times the area of the EU.

Biological Resource Levels (from DOE-RL-96-32-01) –

- Level 5 resources include species that are listed or proposed-to-be listed under the *Endangered Species Act* and their critical habitat, as well as rare and irreplaceable habitats.
- Level 4 resources include federal candidate species; Washington State threatened or endangered species; habitat or exclusion buffers for federal candidates and Washington State threatened or endangered species; high-quality mature shrub steppe; wetlands and riparian areas; and buffer areas for bald eagles and ferruginous hawks.
- Level 3 resources include Washington State sensitive, candidate, and review species; Washington Department of Fish and Wildlife priority species; lower quality mature shrub-steppe—such as shrub stands that are less mature, have lower shrub density or canopy cover, and/or a greater proportion of cheatgrass in the understory than stands that qualify for Level 4. Level 3 also includes high-quality grasslands, conservation corridors, snake hibernacula, bat roosts, rookeries, burrowing owl buffer areas, and areas with significant quantities of culturally important species.
- Level 2 resources include migratory birds, state watch list plants and monitor list animals, recreationally and commercially important species, and lower quality steppe and shrub-steppe.
- Level 1 resources include individual common native plant and wildlife species, upland stands of non-native plants, and abandoned agricultural fields.

Evaluation Units (EUs) – groupings of sources, aggregated for evaluation as part of the Hanford Site-wide Risk Review Project. Sources may be aggregated into an EU based on potential impacts to a common set of receptors or receptor geographic area, common past waste management practices, or integration in the waste management process.

MBTA – Migratory Bird Treaty Act; referring to species listed and protected under the federal Act.

PNNL ECAP (Ecological Compliance and Assessment Project) Database – PNNL performed ecological reviews for individual projects and annually surveyed selected areas and buildings on the Hanford Site for DOE-RL under the DOE's Public Safety and Resource Protection Program until 2011. The data collected during those surveys is archived in the ECAP database, and is used to supplement ecological evaluations as available.

Priority Habitats – Priority habitats are habitat types or elements with unique or significant value to a diverse assemblage of species. A priority habitat may consist of a unique vegetation type (e.g., shrub-steppe) or dominant plant species (e.g., juniper savannah), a described successional stage (e.g., old-growth forest), or a specific habitat feature (e.g., cliffs).

Species of Concern or Species of Conservation Concern – An informal term that for the purpose of this assessment includes those species listed at the federal or state level as being threatened endangered, sensitive, or candidate, as well as those listed by the U.S. Fish and Wildlife Service as species of concern within the ecoregion.

Field Data Collected at ERDF on October 13, 2014

Percent Canopy Cover of Herbaceous Species Surveyed Visually

EU	Survey Area	Species	Origin & Class	Percent Cover									
ERDF	3-09 A	ARTR	NS	1									
ERDF	3-09 A	POSE	NG	3									
ERDF	3-09 A	BRTE	IG	20									
ERDF	3-09 A	SATR	IF	15									
ERDF	3-09 A	CHNA	NS										
ERDF	3-09 A	CRAT	NF										
ERDF	3-09 A	CYTE	NF										
ERDF	3-09 A	ACMI	NF										

Notes: Outside EU notes: This area E of 3-09 will be the next cell dug for ERDF. A few mature ARTR, some MACA, tiny bit of POSE, mostly SATR/BRTE around edges in the middle are a few more species w/the SATR, like CYTE, CRCI, ORHY, and ACMI. Small mammal holes (none looked active) and tracks. Old large mammal dig.

Percent Canopy Cover of Herbaceous Species Measured in 0.5 m2 quadrats

EU	Survey Area	Species	Origin & Class	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10	sum	Mean Canopy Cover	Freq
ERDF	3-09 B	ARTR	NS	45										45	45.0	0.1
ERDF	3-09 B	POSE	NG	17		2			12	13	7	7		58	9.7	0.6
ERDF	3-09 B	BRTE	IG	2	12	2	14	7	5	1	2	2		47	5.2	0.9
ERDF	3-09 B	SATR	IF	1	3	15	2	3	3	1	4	2		34	3.8	0.9
ERDF	3-09 B	CRUST	CRUST	16		3		7	8	1	3	20		58	8.3	0.7
ERDF	3-09 B	LITTER	LITTER	38	70	26	66	33	65	8	50	40		396	44.0	0.9
ERDF	3-09 B	BARE	BARE	44	4	40	18	55	15	75	20	30		301	33.4	0.9
ERDF	3-09 B	STCO	NG		14			14		21	9	8		66	13.2	0.5
ERDF	3-09 B	BACA	NF			4								4	4.0	0.1
ERDF	3-09 B	COUM	NF				7				1			8	4.0	0.2
ERDF	3-09 B	PHLO	NF							1				1	1.0	0.1
ERDF	3-09 B	MACA	NF								14			14	14.0	0.1

Notes: Mature ARTR/CHNA

Shrub Canopy Measured by Line-Intercept Methods on 50m Transect

EU	Survey Area	Species	Transect distance (total)	Start	Stop	Dif						
ERDF	3-09 B	ARTR	50	5.72	6.45	0.73						

Notes

Percent Canopy Cover of Herbaceous Species Surveyed Visually

EU	Survey Area	Species	Class & Origin	Percent Cover
ERDF	4-01 A	SATR	IF	35
ERDF	4-01 A	ORHY	NG	2
ERDF	4-01 A	CHNA	NS	
ERDF	4-01 A	MACA	NF	
ERDF	4-01 A	AMAC	NF	
ERDF	4-01 A	OEPA	NF	
ERDF	4-01 A	CRCI	NF	
ERDF	4-01 A	BRTE	IG	10
ERDF	4-01 A	STCO	NG	
ERDF	4-01 A	SIAL	IF	

Notes: CHNA only on edges. In buffer area: E end near trailers patch of young and mature ARTR. The rest was cleared and is SATR/BRTE.

Percent Canopy Cover of Herbaceous Species Surveyed Visually

EU	Survey Area	Species	Class & Origin	Percent Cover
ERDF	4-01 B	OEPA	NF	1
ERDF	4-01 B	CHNA	NS	1
ERDF	4-01 B	COCA	NF	1
ERDF	4-01 B	SATR	IF	10
ERDF	4-01 B	CYTE	NF	1
ERDF	4-01 B	BRTE	IG	15
ERDF	4-01 B	MACA	NF	

Notes: Level 1 East of parking pad except on road shoulder. Small mammal holes and tracks. Harvester ants. More shrubs and native grasses along road edges.

Evaluation Unit: ERDF	Observers: MAC, KDH
Patch ID: 3-09 A	Date: 10/13/14

Wildlife Observations Recorded During Pedestrian or Vehicle Surveys	
Species	Observation
Small mammal	Holes and tracks
Wcsp	bird perched in shrub
Notes	

Evaluation Unit: ERDF	Observers: MAC, KDH
Patch ID: 3-09 B	Date: 10/13/14

Wildlife Observations Recorded During Pedestrian or Vehicle Surveys	
Species	Observation
Small mammal	Holes and tracks
Notes	

Evaluation Unit: ERDF	Observers: MAC, KDH
Patch ID: 4-01 A	Date: 10/13/14

Wildlife Observations Recorded During Pedestrian or Vehicle Surveys	
Species	Observation
Small mammal	Holes and tracks
Utst	1 lizard just north of fence
Notes	

Evaluation Unit: ERDF	Observers: MAC, KDH
Patch ID: 4-01 B	Date: 10/13/14

Wildlife Observations Recorded During Pedestrian or Vehicle Surveys	
Species	Observation
Small mammal	Holes and tracks
Harvester ants	
Notes	

Appendix K

Cultural Resource Literature Reviews for Each Evaluation Unit

This appendix to the interim progress report (report) for the Hanford Site-Wide Risk Review Project contains the cultural resources literature reviews (literature reviews) for the 25 evaluation units (EUs) evaluated for this report. Professional archaeologists at Pacific Northwest National Laboratory developed the methodology for the literature reviews at the request and approval of the Consortium for Risk Evaluation with Stakeholder Participation (see also Chapter 8 of the methodology report for the Risk Review Project).

The results of the literature review were used to evaluate each of the 25 EUs that are part of the Risk Review Project and described in this report. Evaluations made for the 25 EUs followed the approach described in Chapter 8 of the methodology report. All evaluation results may found in Chapter 3 of this report.

Table of Contents

Evaluation Unit: 618-11 Burial Ground
ID: RC-LS-1
Group: Legacy Source
Operable Unit Cross-Walk: 300-FF-2
Related EU: CP-GW-1
Sites & Facilities: 618-11 Burial Ground
Key Data Sources Docs: WCH-542, Rev 0
WCH-183, Rev 1
WCH-459, Rev 1

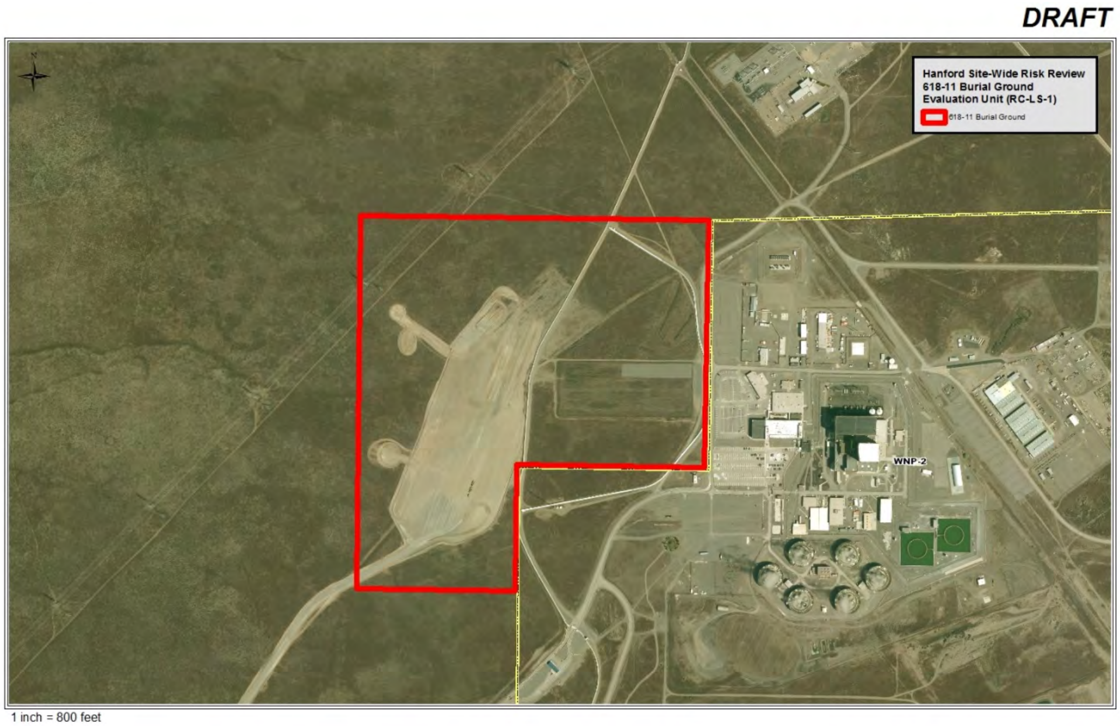

Figure K.1. Site Map with Evaluation Unit Boundaries

RC-LS-1: 618-11 Burial Ground

Cultural Resource Literature Reviews and Inventories

Most of the 618-11 EU has been inventoried for cultural resources under 628A (Smith et. al. 1977), HCRC#2002-600-021(Prendergast 2002), HCRC#2004-600-023 (Prendergast 2004), HCRC#2011-600-029 (Sharpe andDemaris 2011), HCRC#2013-600-020 (Sharpe and DeMaris 2013) and HCRC#2013-600-012A (Sheldon et.al. 2013) with negative findings. Closure and remediation of the 618-11 has been addressed in an NHPA Section 106 review completed under HCRC#2004-600-023 (Prendergast-Kennedy 2004), HCRC#2011-600-029 (Sharpe and Demaris 2011), and HCRC#2013-600-020 (Sharpe and DeMaris 2013). There is a possibility that intact archaeological material is present in the small areas that have not been inventoried for archaeological resources (both on the surface and in the subsurface), particularly where undisturbed soil deposits exist within 618-11 EU.

Archaeological sites, buildings and traditional cultural properties (TCPs) located within the EU[1]

- There are no known recorded archaeological sites, buildings or TCPs located within the 618-11 EU.

Archaeological sites and TCPs located within 500 meters of the EU

- The Hanford Site Plant Railroad a contributing property within the Manhattan Project/Cold War era Landscape with documentation required is located within 500 meters of the 618-11 EU. In accordance with the 1998 *Hanford Site Manhattan Project and Cold War Era Historic District Treatment Plan (*DOE/RL-97-56), all documentation requirements have been completed for this property.

Recorded TCPs Visible from the EU

- TCPs associated with the Native American Precontact and Ethnographic Landscape may be visible from the 618-11 EU.

Historic Map and Aerial Photograph Indicators

A review of 1916 historic United States Geological Survey (USGS) maps depicts no structures, roads, or any other indication of historic settlement to be present within the 618-11 EU. Ownership information provided on 1943 Hanford Engineer Works Real Estate maps state that the lands contained within the 618-10 EU were owned by the U.S. Government and the Thos. Cartstens Investment Co. in 1943. (The 1943 Hanford Engineer Works Real Estate maps contain land ownership information on the Hanford Site just prior to the land being acquired by the US Government for the Manhattan Project in 1943). 1943 aerials further confirm a lack of land use or development in this area with the exception of two roads; one trending road to the northeast and one to the northwest, both likely associated with the early stages of Manhattan Project construction suggesting there is some potential for Manhattan Project/Cold War era archaeological resources to be present in the 618-11 EU. This information indicates a low potential for archaeological resources associated with the Pre-Hanford Early Settlers/Farming landscape to be present within the 618-11 EU.

Geomorphology Indicators

The geomorphology within the 618-11 EU consists mostly of Pleistocene outburst flood deposits with a band of Holocene sand dune deposits running through the middle of the EU. Given the presence of the Pleistocene outburst flood deposits this suggests there is a low

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[1] Traditional cultural property has been defined by the National Park Service as “a property, a place, that is eligible for inclusion on the National Register of Historic Places because of its association with cultural practices and beliefs that are (1) rooted in the history of a community, and (2) are important to maintaining the continuity of that community’s traditional beliefs and practices” (Parker and King 1998).

potential for Native American Precontact and Ethnographic associated archaeological resources to be present where these soils overlap with undisturbed portions of the subsurface component of this EU. Given the presence of Holocene sand dune deposits, the potential for archaeological resources to be present is higher especially where these soils overlap with undisturbed soils.

Ground Disturbance Indicators

Examination of 2012 aerial imagery of the EU indicates that portions of the EU are heavily disturbed by the presence of the 618-11 solid waste site, well pads, staging areas and roads. A large part of the 618-11 EU appears to have minimal disturbance. In the areas that are extensively disturbed to both surface and subsurface soils, it is unlikely intact archaeological resources are present where these disturbed soils exist within the 618-11 EU. Because there are areas that appear to be minimally disturbed, it is possible for archaeological resources to be present both on the surface and within the subsurface. It also still possible for pockets of undisturbed soils to exist within the heavily disturbed areas.

Summary of Cultural Resources Review

Most of the 618-11 EU has been inventoried for archaeological sites with negative findings. There is a possibility that intact archaeological material is present in the areas that have not been inventoried for archaeological resources (both on the surface and in the subsurface), particularly if undisturbed soil deposits exist within 618-11 EU. Closure and remediation of the 618-11 has been addressed in an NHPA Section 106 review completed. The Hanford Site Plant Railroad a contributing property within the Manhattan Project/Cold War era Landscape with documentation required is located within 500 meters of the 618-11 EU. In accordance with the 1998 *Hanford Site Manhattan Project and Cold War Era Historic District Treatment Plan (*DOE/RL-97-56), all documentation requirements have been completed for this property.

Historic maps indicate that there is no evidence of historic-era land use within the 618-11 EU. Given the presence of roads on 1943 aerial photographs, the potential for Manhattan Project/Cold War archaeological resources to be present in the 618-11 EU is slightly higher but still low. Varying geomorphology and ground disturbance indicators suggests a range of potential for the presence of intact archaeological resources associated with all three landscapes to be present depending on the location of these soils within the 618-11 EU. Because none of the 618-11 EU has been investigated for subsurface for archaeological sites especially where Holocene deposits and pockets of undisturbed soil exist, it may be appropriate to conduct surface and subsurface archaeological investigations in these areas prior to initiating a remediation activity. 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 associated with these landscapes (e.g. East Benton Historical Society, Prosser Cemetery Association, Franklin County Historical Society, the Reach, and the B-Reactor Museum Association) may need to occur. Indirect effects are always possible when TCPs are visible from the 618-11 EU. Consultation with Hanford Tribes may also 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.

References[2]

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(HCRL#628a), Washington Archaeological Research Center, Washington State University, Pullman, Washington.

U.S. War Department. 1943. *Real Estate Engineer Works 1943 (maps).* Washington D.C.

USGS Topographic maps. 1916. Coyote Rapid Quadrangle.

[2] References with "**" are available to qualified individuals at the Washington State Department of Archaeology and Historic Preservation

Evaluation Unit: K Area Waste Sites
ID: RC-LS-2
Group: Legacy Source
Operable Unit Cross-Walk: 100-KR-1
100-KR-2
Related EU: RC-DD-2
Sites & Facilities: Legacy waste sites within the fence at 100-K, where remediation is post-2015
Key Data Sources Docs: DOE/RL-96-17

Figure K.2. Site Map with Evaluation Unit Boundaries

RC-LS-1: K Area Waste Sites

Cultural Resource Literature Reviews and Inventories of EU

The K Area Wastes Sites EU is located near the Columbia River on the Hanford Site, in an area generally known to have high potential to contain Native American Pre-contact and Ethnographic archaeological resources and Pre-Hanford Early Settlers/Farming eras resources. Portions of the EU have been inventoried for cultural resources by several surveys in the past under HCRC#2005-600-030 (Prendergast-Kennedy 2005), HCRC#2006-100-016 (Kennedy 2006), HCRC#2010-100-107 (Gutzeit and Willis 2011), HCRC#2010-100-116 (Gutzeit and Kennedy 2010a), HCRC#2010-100-116a (Gutzeit and Kennedy 2010b), and HCRC#2012-100-020 (Mendez and Clark with Wright 2012). Remediation of waste sites within the K Area Waste Sites

Evaluation Unit has been addressed by two NHPA Section 106 reviews under HCRC#2011-100-013 and HCRC#2011-100-015 (Mendez 2011a, Mendez 2011b). There is a possibility that intact archaeological material are present in the small areas that have not been inventoried for archaeological resources (both on the surface and in the subsurface), particularly where undisturbed soil deposits exist within the EU.

Archaeological sites, buildings and TCPs[3] located within the EU

Sensitive Cultural Resources:

- There are no known TCPs within the EU.
- A National Register-eligible irrigation canal associated with the Pre-Hanford Early Settlers/Farming Landscape is located within this EU. This large linear historic resource has been extensively documented and contains miles of main canal and dozens of miles of laterals. It is eligible for the National Register of Historic Places (NRHP). However, within the EU, visible evidence of the canal is minimal; within the EU the canal has been destroyed by 100-K Area Hanford construction and remediation activities.
- Segments of the National Register-eligible Hanford Site Plant Railroad a contributing property within the Manhattan Project and Cold War Era Historic District, with documentation required, are located within the EU. In accordance with the 1998 *Hanford Site Manhattan Project and Cold War Era Historic District Treatment Plan* (DOE/RL-97-56), all documentation requirements have been completed for this property.
- In addition to the Hanford Site Railroad, there are 23 Manhattan Project and Cold War Era buildings (see Table K.1) located within the Evaluation Unit (9 with individual documentation required, 12 with no individual documentation required). Mitigation for contributing buildings/structures have been completed as per the *Hanford Site Manhattan Project and Cold War Era Historic District Treatment Plan* (DOE/RL-97-56) and building demolition is ongoing.

[3] Traditional Cultural Property (TCP) is defined as, "a property that is eligible for inclusion in the National Register because of its association with cultural practices or beliefs of a living community that (a) are rooted in the community's history, and (b) are important in maintaining the continuing cultural identity of the community" (Parker and King 1998).

Table K.1. Manhattan Project and Cold War Era Buildings Located within the K Area Waste Sites EU

Building #	Building Name	Treatment Plan (DOE-RL 1998) Table Number	National Register Eligibility	Documentation Completed/Type
115-KE	Gas Recirculation Building	A.6	Contributing Property w/ no additional documentation requirements	HPIF
115-KW	Gas Recirculation Building	A.6	Contributing Property w/ no additional documentation requirements	HPIF
116-KE	Reactor Exhaust Stack	A.6	Contributing Property w/ no additional documentation requirements	HPIF
117-KE	Exhaust Air Filter Building	A.6	Contributing Property w/ no additional documentation requirements	HPIF
117-KW	Exhaust Air Filter Building	A.5	Buildings/Structures recommended for Mitigation	HPIF
165-KE	Power Control Building	A.6	Contributing Property w/ no additional documentation requirements	HPIF
165-KW	Power Control Building	A.6	Contributing Property w/ no additional documentation requirements	HPIF
167-K	Cross-tie Tunnel Building	A.6	Contributing Property w/ no additional documentation requirements	HPIF
1706-KE	Rad Con Count Lab Facility	A.5	Buildings/Structures recommended for Mitigation	HPIF
1706-KER	Water studies Recirculation Building	A.5	Buildings/Structures recommended for Mitigation	HPIF
1713-KER	Shop Building	A.6	Contributing Property w/ no additional documentation requirements	HPIF

Building #	Building Name	Treatment Plan (DOE-RL 1998) Table Number	National Register Eligibility	Documentation Completed/Type
1717-K	Maintenance Transportation	A.5	Buildings/Structures recommended for Mitigation	HPIF
1720-K	Administration Office Building	A.5	Buildings/Structures recommended for Mitigation	HPIF
1724-K	Maintenance Shop	A.6	Contributing Property w/ no additional documentation requirements	N/A
181-KE	River Pump House	A.6	Contributing Property w/ no additional documentation requirements	HPIF
181-KW	River Pump House	A.5	Buildings/Structures recommended for Mitigation	HPIF
182-K	Emergency Water Reservoir Pump House	A.6	Contributing Property w/ no additional documentation requirements	HPIF
183-KE	Complex	A.6	Contributing Property w/ no additional documentation requirements	HPIF
183-KW	Complex	A.5	Buildings/Structures recommended for Mitigation	HPIF
1908-K	Outfall Structure	A.6	Contributing Property w/ no additional documentation requirements	HPIF
1908-KE	Outfall Structure	A.5	Buildings/Structures recommended for Mitigation	HPIF
190-KE	Main Pump House	A.6	Contributing Property w/ no additional documentation requirements	HPIF
190-KW	Main Pump House	A.5	Buildings/Structures recommended for Mitigation	HPIF

Archaeological sites and TCPs located within 500 meters of the EU

- There are no documented TCPs located within 500 meters of the EU.
- Fourteen additional archaeological sites have been documented within 500-meters of the EU.
    - Seven archaeological sites (3 eligible and 4 unevaluated) and two isolates (2 not eligible) represent the Native American Precontact and Ethnographic landscape.
    - 3 archaeological sites (1 not eligible and 2 unevaluated) and 2 isolates (2 not eligible) represent the Manhattan Project and Cold War era landscape.

Closest Recorded TCP

- There are known TCPs exist in the vicinity of the EU.

Historic Map and Aerial Photograph Indicators

A review of 1916 United States Geological Survey (USGS) shows the Chicago Milwaukie and St Paul Hanford Branch Railroad, the Hanford Irrigation Canal, a road, and two trails (or unimproved roads) are present within the 100-K Waste Sites EU. The 1943 aerial imagery clearly shows the Hanford Irrigation Canal running parallel to the north edge of the EU. North of the canal are agricultural fields. Several trails, roads, or linear utilities are also evident within the EU on the 1943 imagery. However, the southern 2/3 of the EU is nearly devoid of cultural features in the imagery. Ownership information provided on 1943 Hanford Engineer Works Real Estate maps depicting land ownership information on the Hanford Site just prior to the land being acquired by the US Government for the Manhattan Project state that the lands contained within the K-Area Waste Sites EU were owned by several development companies: the Priest Rapids Irrigation District, the New Hampshire Real Estate Co, the Agathon Land Co (Jake Miller) and the Trustees of the Milwaukee, Saint Paul, & Pacific Railway Co. A small northern portion of the EU was owned by Delia Allard. In addition small parcels were owned by W.L. Steward and Mary Nelson in 1943. Collectively, this information suggests a low potential for archaeological resources associated with the Pre-Hanford Early Settlers/Farming landscape to be present within the southern 2/3 of the EU, while historic resources may be present in the northern 1/3 of the EU, paralleling the river, where agricultural activities took place. A higher potential for such resources is present just outside of the EU to the north.

Geomorphology Indicators

Surface geology of the EU consists of sedimentary Pleistocene flood deposits and gravels, with an overburden of Holocene loess and a narrow area of Quaternary alluvium in the northwest corner of the EU. This geomorphological environment suggests low to medium potential for Native American Pre-contact and Ethnographic associated archaeological resources within the subsurface component of this EU. Areas outside of the EU immediately adjacent to the north along the Columbia River shoreline have a particularly high likelihood for containing subsurface archaeological deposits.

Ground Disturbance Indicators

Examination of 2012 aerial imagery of the EU indicates that 100% of the EU has undergone extensive ground disturbances. The depth of these disturbances is not known, so there is a potential for intact archaeological resources to exist if any pockets of undisturbed soils exist.

However, it is highly unlikely that archaeological resources would be present on or near the ground surface within the EU.

Summary of Cultural Resources Review

Cultural resources documented within the K Area Waste Sites EU include 2 historic era linear resources (1 representing the Pre-Hanford Early Settlers/Farming Landscape and 1 representing the Manhattan Project and Cold War era), 23 contributing resources to the NRHP Eligible Manhattan Project and Cold War era historic district (9 with individual documentation required, 12 with no individual documentation required), and no precontact archaeological resources. No TCPs are known within the EU. In accordance with the 1998 *Hanford Site Manhattan Project and Cold War Era Historic District Treatment Plan (*DOE/RL-97-56), all documentation requirements have been completed for properties contributing to the Manhattan Project and Cold War era historic district.

Portions of the EU have been inventoried for cultural resources by several surveys in the past. Remediation of waste sites within the K Area Waste Sites Evaluation Unit has been addressed by two NHPA Section 106 reviews. There are 14 archaeological sites within 500 meters of the EU; 7 archaeological sites (3 eligible and 4 unevaluated) and 2 isolates (2 not eligible) represent the Native American Precontact and Ethnographic landscape, 3 archaeological sites (1 not eligible, and 2 unevaluated) and 2 isolates (2 not eligible) represent the Manhattan Project/Cold War landscape.

The geomorphologic composition of the EU and historic map data suggest some subsurface potential for cultural resources presence within the north 1/3 of the EU. However, the large earthworks disturbances shown in modern aerial imagery within the entire EU indicate that discovery of surface or near-surface cultural resources is not likely within the EU. 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) may need to occur. Consultation with Hanford Tribes may also 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.

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Department of Energy. 1998. *Hanford Site Manhattan Project and Cold War Era Historic District Treatment Plan (*DOE/RL-97-56). Richland, Washington.

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Mendez, K. 2011b. *Field Remediation of Waste Sites in the 100-K Reactor Area (HCRC#2011-100-015). CH2M Hill. Richland, Washington.*

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Parker, P. and T. King. 1998. *National Register Bulletin: Guidelines for Evaluating and Documenting Traditional Cultural Properties.* U.S. Department of the Interior, National Park Service. Washington, D. C.

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Evaluation Unit: BC Cribs and Trenches
ID: CP-LS-1
Group: Legacy Source
Operable Unit Cross-Walk: 200-BC-1
Related EU: CP-LS-17
CP-GW-1
Sites & Facilities: Cribs, trenches and tanks located to the south of the 200-E area
Key Data Sources Docs: DOE/RL-2010-49, Draft A

Figure K.3. Site Map with Evaluation Unit Boundaries

CP-LS-1: BC Cribs and Trenches

Cultural Resource Literature Reviews and Inventories

The BC Cribs and Trenches EU is located south of the 200-East Area of the Hanford Site. Most of the BC Cribs and Trenches EU has been inventoried for archaeological resources (surface) under HCRC# 89-600-010 (Chatters, 1990), HCRC# 93-600-005A (Crist and Wright 1993), HCRC# 2008-600-006 (Kennedy 2008a), HCRC# 2008-600-006A (Kennedy 2008b), HCRC# 2008-600-006B (Sharpe 2009) covering most of the area. Two archaeological finds were identified and recorded by these inventories. Remediation of the BC Cribs and Trenches EU has been addressed by an NHPA Section 106 review under HCRC# 2008-600-006, 006A, and 006B). There is a possibility that intact archaeological material is present in the small areas that have not been inventoried for archaeological resources (both on the surface and in the subsurface), particularly where undisturbed soil deposits exist within the BC Cribs and Trenches EU.

Archaeological sites, buildings and traditional cultural properties (TCPs) located within the EU[5]

- One archaeological site and one isolated find associated with the Native American Precontact and Ethnographic Landscape have been recorded within the BC Cribs and Trenches EU. The site has been unevaluated for National Register eligibility and the isolate is considered to not be National Register-eligible.
- The BC Cribs are a contributing property within the Manhattan Project and Cold War Era Historic District, with documentation required. In accordance with the 1998 *Hanford Site Manhattan Project and Cold War Era Historic District Treatment Plan (*DOE/RL-97-56), all documentation requirements have been completed for this property.
- There are no known recorded TCPs located within the EU.

Archaeological sites and TCPs located within 500 meters of the EU

- The 2101M Machine Shop/Office and 2750E Office Building are contributing properties within the Manhattan Project and Cold War Era Historic District, with documentation required, that are located within 500 meters of the BC Cribs and Trenches EU. In accordance with the 1998 *Hanford Site Manhattan Project and Cold War Era Historic District Treatment Plan (*DOE/RL-97-56), all documentation requirements have been completed for these properties.
- The 2751E, 2752E and 2753E Office Buildings are contributing properties within the Manhattan Project and Cold War Era Historic District, with no documentation required, that are located within 500 meters of the BC Cribs and Trenches EU. In accordance with the 1998 *Hanford Site Manhattan Project and Cold War Era Historic District Treatment Plan (*DOE/RL-97-56), all documentation requirements have been completed for these properties.

Recorded TCPs Visible from the EU

There are two known and recorded TCPs associated with the Native American Precontact and Ethnographic Landscape that are visible from the BC Cribs and Trenches EU.

Historic Map and Aerial Photograph Indicators

A review of 1916 United States Geological Survey (USGS) shows no indications of historic land use such as roads or buildings within the BC Cribs and Trenches EU. Ownership information provided on 1943 Hanford Engineer Works Real Estate maps depicting land ownership information on the Hanford Site just prior to the land being acquired by the US Government for the Manhattan Project state that the lands contained within the BC Cribs and Trenches EU were owned by the United States and the J.M. Coleman Company in 1943. This information indicates

[5] Traditional cultural property has been defined by the National Park Service as "a property, a place, that is eligible for inclusion on the National Register of Historic Places because of its association with cultural practices and beliefs that are (1) rooted in the history of a community, and (2) are important to maintaining the continuity of that community's traditional beliefs and practices"(Parker and King 1998).

a low to potential for archaeological resources associated with the Pre-Hanford Early Settlers/Farming landscape to be present within the BC Cribs and Trenches EU. 1943 aerials further confirm a lack of land use or development in this area with the exception of an east-to-west trending road, likely associated with the early stages of Manhattan Project construction suggesting there is some potential for Manhattan Project/Cold War era archaeological resources to be present in the BC Cribs and Trenches EU.

Geomorphology Indicators

The geomorphology within the BC Cribs and Trenches EU consists of Pleistocene outburst flood deposits to the south suggesting a low potential for Native American Precontact and Ethnographic associated archaeological resources to be present where these soils overlap with disturbed portions of the subsurface component of this EU. To the north, the soils are comprised of Holocene sand dune deposits where the potential for Native American Precontact and Ethnographic archaeological resources to be present is higher especially where these soils overlap with undisturbed soils.

Ground Disturbance Indicators

Examination of 2012 aerial imagery of the BC Cribs and Trenches EU depict paved roads, two-track dirt roads, crib and trench related disturbance, grubbed and cleared areas as well as areas with minimal disturbance. In the areas that are extensively disturbed to both surface and subsurface soils, it is unlikely that intact archaeological resources are present within the BC Cribs and Trenches EU. Because there are areas that appear to be minimally disturbed, it is possible for archaeological resources to be present both on the surface and within the subsurface. It also still possible for pockets of undisturbed soils to exist and therefore intact archaeological material to exist within the heavily disturbed areas.

Summary of Cultural Resources Review

Cultural resources known to be recorded within the BC Cribs and Trenches EU are limited to the archaeological finds associated with the Native American Precontact and Ethnographic Landscape (an isolated find and a site). The site has been unevaluated for National Register eligibility and the isolate is considered to not be National Register-eligible. Additionally, the BC Cribs are contributing properties within the Manhattan Project and Cold War Era Historic District, with documentation required. In accordance with the 1998 *Hanford Site Manhattan Project and Cold War Era Historic District Treatment Plan (*DOE/RL-97-56), all documentation requirements have been completed for this property.

A little over half of the BC Cribs and Trenches EU has been inventoried for archaeological resources and Remediation of the BC Cribs and Trenches EU has been addressed by an NHPA Section 106 review. There is a possibility that intact archaeological material is present in the areas that have not been inventoried for archaeological resources (both on the surface and in the subsurface), particularly if undisturbed soil deposits exist within the BC Cribs and Trenches EU. There are two National Register-eligible buildings that are contributing properties within the Manhattan Project /Cold War Era District with documentation required (2101M Machine Shop/Office and 2750E Office Building) and three National Register-eligible contributing buildings within the Manhattan Project /Cold War Era District with no documentation required

(2751E, 2752E and 2753E Office Buildings. In accordance with the 1998 *Hanford Site Manhattan Project and Cold War Era Historic District Treatment Plan (*DOE/RL-97-56), all documentation requirements have been completed for these properties.

Geomorphology, ground disturbance, historic maps, and the presence of archaeological resources associated with the Native American Precontact and Ethnographic landscape located within the BC Cribs and Trenches EU all suggest that the potential exists for additional archaeological resources associated with the Native American Precontact and Ethnographic landscape to be present on the surface or within the subsurface within the EU. The potential for intact archaeological resources associated with the Pre-Hanford Early Settlers/Farming Landscape and the Manhattan Project associated archaeological resources is also possible. Because some BC Cribs and Trenches EU has not been investigated for archaeological sites and pockets of undisturbed soil likely exist, it may be appropriate to conduct surface and subsurface archaeological investigations in these areas prior to initiating a remediation activity. 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 associated with these landscapes (e.g. East Benton Historical Society, Prosser Cemetery Association, Franklin County Historical Society, the Reach, and the B-Reactor Museum Association) may need to occur. Indirect effects are always possible when TCPs are known to be located in the general vicinity. Consultation with Hanford Tribes may also 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.

References[6]

Department of Energy. 1998. *Hanford Site Manhattan Project and Cold War Era Historic District Treatment Plan (*DOE/RL-97-56). Richland, Washington.

Chatters, JC. 1990. *Cultural Resources Review of the Project L-006 Route 3/4S Intersection Safety Improvements.* Pacific Northwest Laboratory. Richland, Washington.**

Crist, ME and MK Wright. 1993. *Cultural Resources Review of the L-102 Primary Highway Route North of the Wye Barricade –Location Change HCRC #93-600-005.* Pacific Northwest Laboratories. Richland, Washington.**

Kennedy, EP. 2008a. *Cultural Resources Inventory and Review for Phase I of the Comprehensive Response, Compensation and Liability Act Treatability Test, Remediation of the 200-BC-1 Operable Unit, Hanford Site HCRC#2008-600-006).* Pacific Northwest National Laboratory. Richland, Washington. **

Kennedy, EP. 2008b . *Cultural Resources Review for Remediation of Zone A of the BC Control Area Waste Site UPR-200-E-83, Operable Unit 200-UR-1, at the 600 Area of the Hanford Site (HCRC# 2008-600-006A).* Pacific Northwest National Laboratory. Richland, Washington. **

[6] **References available to qualified individuals at the Washington State Department of Archaeology and Historic Preservation

Parker, P. and T. King. 1998. *National Register Bulletin: Guidelines for Evaluating and Documenting Traditional Cultural Properties.* U.S. Department of the Interior, National Park Service. Washington, D. C.

Sharpe, JJ. 2009. *Cultural Resources Review and Inventory for the BC Controlled Area Northern Zone of the U.S. Department of Energy's Hanford Site. Benton County, Washington, HCRC3 2008-600-006B).* CH2MHill. Richland, Washington.**

U.S. War Department. 1943. *Real Estate Engineer Works 1943 (maps).* Washington D.C.

United States Geological Survey Topographic maps. 1916. Coyote Rapid Quadrangle.

Evaluation Unit:	Plutonium Contaminated Waste Sites
ID:	CP-LS-2
Group:	Legacy Source
Operable Unit Cross-Walk:	200-PW-1, 3, 6 200-CW-5
Related EU:	CP-DD-5 CP-GW-2
Sites & Facilities:	Plutonium (Pu) contaminated cribs and trenches associated with PFP in central part of 200-W area
Key Data Sources Docs:	ROD PW CW

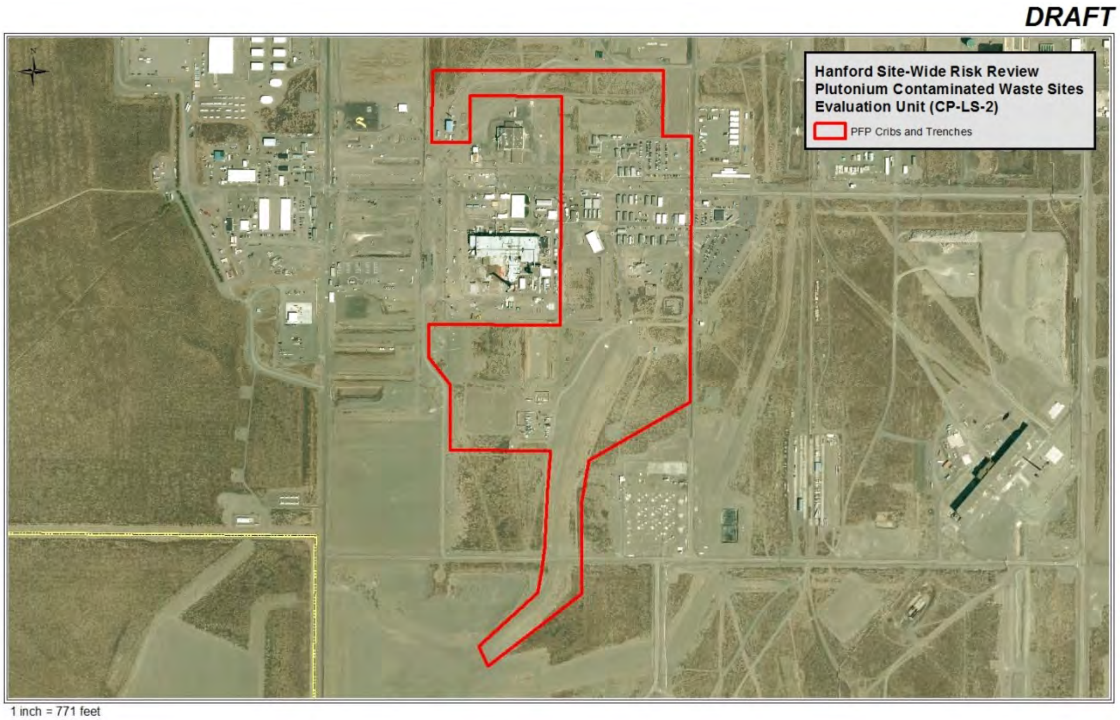

Figure K.4. Site Map with Evaluation Unit Boundaries

CP-LS-2: Plutonium Contaminated Waste Sites

Cultural Resource Literature Reviews, Inventories and Potential for Cultural Resources

The Plutonium Contaminated Waste Sites EU is located within the 200-West Area of the Hanford Site, an area known to have low potential to contain Native American Precontact and Ethnographic archaeological resources and Pre-Hanford Early Settlers/Farming resources. Much of the 200 Areas were addressed in a cultural resources report entitled *Archaeological Survey of the 200 East and 200 West Areas, Hanford Site* (Chatters and Cadoret 1990). The focus of this archaeological survey was on inventorying all undisturbed portions of the 200-East and 200-West Areas. This report concluded that much of the 200-East and 200-West Areas can be considered areas of low archaeological potential with the exception of intact portions of an historic/ethnohistoric trail/ road corridor which runs through the 200-West Area not far from the Plutonium Contaminated Waste Sites EU.

Much of the Plutonium Contaminated Waste Sites EU has not been inventoried for archaeological resources and it is unknown if an NHPA Section 106 review has been completed for remediation of the Plutonium Contaminated Waste Sites EU as one was not located. One small archaeological survey was completed under HCRC# 87-200-014 with negative findings (Chatters and Cadoret 1987). It is unlikely that intact archaeological material is present in the areas that have not been inventoried for archaeological resources (both on the surface and in the subsurface), particularly because the soils in the Plutonium Contaminated Waste Sites EU appear to be heavily disturbed.

Archaeological sites, buildings and Traditional Cultural Properties (TCPs) located within the EU[7]

- Segments of the National Register-eligible Hanford Site Plant Railroad, a contributing property within the Manhattan Project and Cold War Era Historic District, with documentation required, are located within the Plutonium Contaminated Waste Sites EU. In accordance with the 1998 *Hanford Site Manhattan Project and Cold War Era Historic District Treatment Plan (*DOE/RL-97-56), all documentation requirements have been completed for this property.
- There are several National Register-eligible buildings that are contributing properties within the Manhattan Project and Cold War Era Historic District, with documentation required, that are located adjacent to the Plutonium Contaminated Waste Sites EU as given in Table K.2. In accordance with the 1998 *Hanford Site Manhattan Project and Cold War Era Historic District Treatment Plan (*DOE/RL-97-56), all documentation requirements have been completed for these properties.

[7] Traditional cultural property has been defined by the National Park Service as "a property, a place, that is eligible for inclusion on the National Register of Historic Places because of its association with cultural practices and beliefs that are (1) rooted in the history of a community, and (2) are important to maintaining the continuity of that community's traditional beliefs and practices" (Parker and King 1998).

Table K.2. National Register-Eligible Buildings Located Adjacent to the Plutonium Contaminated Waste Sites EU

Building #	Building Name
242Z	WASTE TREATMENT FACILITY
234-5ZA	PFP MICON, ACES, AND MASK FIT STATIONS
231Z	MATERIALS ENGINEERING LABORATORY
234-5Z	PLUTONIUM FABRICATION FACILITY
2736Z	PLUTONIUM STORAGE BUILDING
2736ZB	PLUTONIUM STORAGE SUPPORT FACILITY
291Z	EXHAUST AIR FILTER STACK BUILDING
236Z	PLUTONIUM RECLAMATION FACILITY
2736ZA	PLUTONIUM STORAGE VENTILATION STRUCTURE

Archaeological sites and TCPs located within 500 meters of the EU

- A non-contributing segment of the National Register-eligible historic/ethnohistoric Trail/Road is located within 100 meters of the Plutonium Contaminated Waste Sites EU.
- There are one archaeological site, likely associated with the Pre-Hanford Early Settlers/Farming Landscapes, and two isolated finds (one associated with the Native American Precontact and Ethnographic Landscape and one associated with the Pre-Hanford Early Settlers/Farming Landscape) that have also been identified. None of these resources is considered to be National Register-eligible.
- The 270Z PFP support building is a National Register-eligible contributing property within the Manhattan Project and Cold War Era Historic District, with no documentation required, located adjacent to the Plutonium Contaminated Waste Sites EU.

Closest Recorded TCP

There are two recorded TCPs associated with the Native American Precontact and Ethnographic Landscape that are visible from the Plutonium Contaminated Waste Sites EU.

Historic Map and Aerial Photograph Indicators

A review of 1916 historic United States Geological Survey (USGS) maps depicts the historic/ethnohistoric Trail/Road running near the Plutonium Contaminated Waste Sites EU suggesting a moderate potential for archaeological resources associated with the Native American Precontact and Ethnographic Pre-Hanford Early Settlers/Farming landscapes to be present given the trail's relative proximity to this EU. Ownership information provided on 1943 Hanford Engineer Works Real Estate maps state that the lands contained within the Plutonium Contaminated Waste Sites EU were owned by the United States and Benton County in 1943. (The 1943 Hanford Engineer Works Real Estate maps contain land ownership information on the Hanford Site just prior to the land being acquired by the US Government for the Manhattan Project in 1943). 1943 aerial photographs further confirm the nearby presence of the White Bluffs Road.

Geomorphology Indicators

The geomorphology within the Plutonium Contaminated Waste Sites EU is primarily Pleistocene outburst flood deposits with a small pocket of Holocene dune sands to the south suggesting a moderate potential for Native American Precontact landscape associated archaeological resources to be present within the surface subsurface component of this EU where the Holocene Dune Sands are present and if pockets of undisturbed soils exist.

Ground Disturbance Indicators

Examination of 2012 aerial imagery of the EU indicates that the EU is heavily disturbed by building construction, buried pipelines, surface grading, roads and waste sites. This disturbance suggests low potential for intact archaeological resources to be present. It is possible but unlikely that pockets of undisturbed soils exist.

Summary of Cultural Resources Review

Cultural resources known to be recorded within the Plutonium EU are limited to the National Register-eligible buildings associated with the Manhattan Project/Cold War Era Landscape with documentation required. These include the Hanford Site Plant Railroad and the seven buildings listed in Table K.3.

Table K.3. National Register-Eligible Buildings Located within the Plutonium Contaminated Waste Sites EU

Building #	Building Name
242Z	WASTE TREATMENT FACILITY
234-5ZA	PFP MICON, ACES, AND MASK FIT STATIONS
231Z	MATERIALS ENGINEERING LABORATORY
234-5Z	PLUTONIUM FABRICATION FACILITY
2736Z	PLUTONIUM STORAGE BUILDING
2736ZB	PLUTONIUM STORAGE SUPPORT FACILITY
291Z	EXHAUST AIR FILTER STACK BUILDING
236Z	PLUTONIUM RECLAMATION FACILITY
2736ZA	PLUTONIUM STORAGE VENTILATION STRUCTURE

All National-Register-eligible Manhattan Project and Cold War Era buildings been documented as described in the *Hanford Site Manhattan Project and Cold War Era Historic District Treatment Plan* (DOE/RL-97-56).

Much of the Plutonium Contaminated Waste Sites EU has not been inventoried for archaeological resources and it is unknown if an NHPA Section 106 review has been completed for remediation of the Plutonium Contaminated Waste Sites EU as one was not located. One small archaeological survey was completed with negative findings. It is unlikely that intact archaeological material is present in the areas that have not been inventoried for archaeological resources (both on the surface and in the subsurface), because the soils in the EU are extensively disturbed.

There are 2 archaeological sites identified within 500 meters of the Plutonium EU: a non-contributing segment of a National Register-eligible historic/ethnohistoric Trail/Road associated with the Pre-Hanford Early Settlers/Farming and Native American Precontact and Ethnographic Landscapes and a site likely associated with the Pre-Hanford Early Settlers/Farming Landscape. Additionally two isolated finds, one associated with the Native American Precontact and Ethnographic Landscape, and one associated with the Pre-Hanford Early Settlers/Farming Landscape have also been identified. None of these resources is considered to be National Register-eligible.

Historic maps and cultural resources surveys indicate there is evidence of historic and ethnohistoric land use associated with transportation and travel through the area as a historic/ethnohistoric Trail/Road is located within close proximity to the Plutonium Contaminated Waste Sites EU. Geomorphology indicates a moderate potential for the presence of Native American Precontact and Ethnographic cultural resources to be present subsurface within the small pocket of Holocene Dune Sands deposits contained within the Plutonium Contaminated Waste Sites EU. Extensive ground disturbance within the entire EU however, may negate this moderate potential. Because the historic/ethnohistoric Trail/Road is located in such close proximity to the Plutonium Contaminated Waste Sites EU, mitigation for indirect impacts may need to be considered as part of the remediation efforts including measures undertaken to avoid and protect this area. 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 associated with these landscapes (e.g. East Benton Historical Society, the Franklin County Historical Society and the Prosser Cemetery Association, the Reach, and the B-Reactor Museum Association) may need to occur. Indirect effects are always possible when TCPs are known to be located in the general vicinity. Consultation with Hanford Tribes may also 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.

References[8]

Department of Energy. 1998. *Hanford Site Manhattan Project and Cold War Era Historic District Treatment Plan (*DOE/RL-97-56). Richland, Washington.

Chatters, JC and NA Cadoret. 1987. *Cultural Resources Survey of the Proposed 200- West Area Plutonium Finishing Plant Parking Lot Improvements.* Pacific Northwest Laboratory. Richland, Washington.**

Chatters JC and NA Cadoret 1990. *Archaeological Survey of the 200 East and 200 West Areas, Hanford Site.* Pacific Northwest Laboratory, Richland, Washington. **

[8] **References available to qualified individuals at the Washington State Department of Archaeology and Historic Preservation

Parker, P. and T. King. 1998. *National Register Bulletin: Guidelines for Evaluating and Documenting Traditional Cultural Properties.* U.S. Department of the Interior, National Park Service. Washington, D. C.

U.S. War Department. 1943. *Real Estate Engineer Works 1943 (maps).* Washington D.C.

USGS Topographic maps. 1916. Coyote Rapid Quadrangle.

Evaluation Unit:	T Tank Farm
ID:	CP-TF-1
Group:	Tank Farm
Operable Unit Cross-Walk:	200-DV-1 WMA T 200-WA-1
Related EU:	CP-LS-7 CP-GW-2
Sites & Facilities:	T tank farm, ancillary structures, associated liquid waste sites, and soils contamination.
Key Data Sources Docs:	RPP-13303 RPP-23405 RPP-23752 RPP-40545 RPP-PLAN-40145 RPP-10435

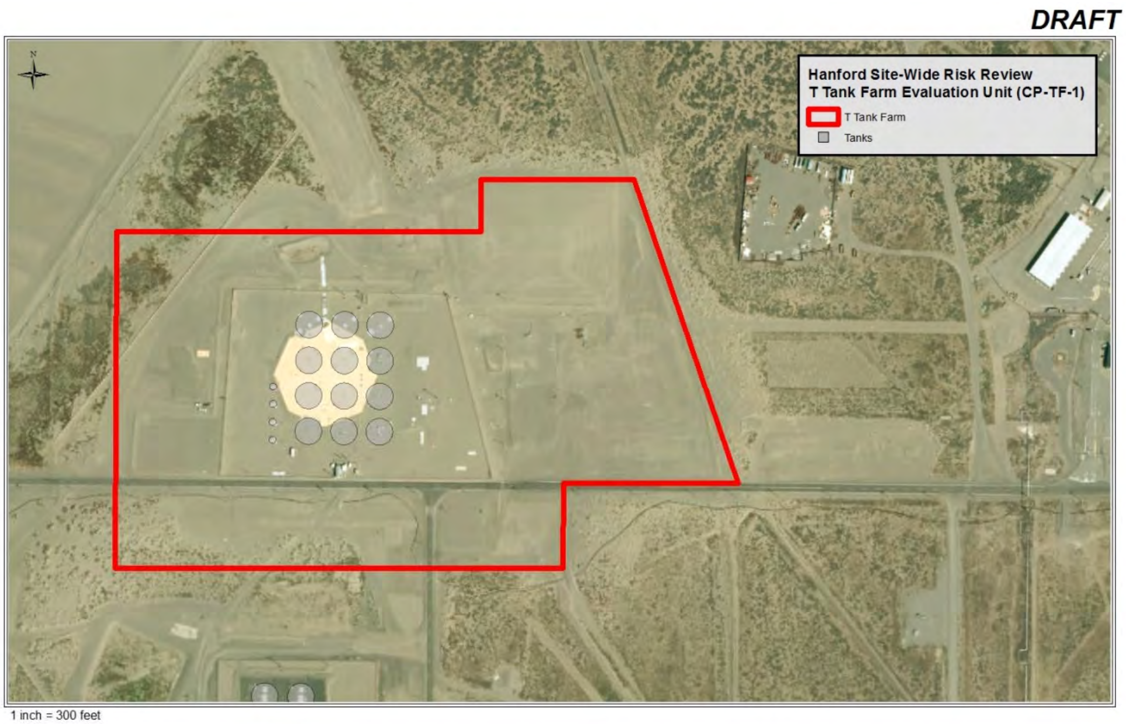

Figure K.5. Site Map with Evaluation Unit Boundaries and Tank Locations

CP-TF-1: T Tank Farm

Cultural Resource Literature Reviews and Inventories

The T Tank Farm EU is located in the 200-West Area of the Hanford Site, an area known to have low potential to contain Native American Precontact and Ethnographic archaeological resources and Pre-Hanford Early Settlers/Farming resources. Much of the 200 Areas were addressed in a cultural resources report entitled *Archaeological Survey of the 200 East and 200 West Areas, Hanford Site* (Chatters and Cadoret 1990). The focus of this archaeological survey was on inventorying all undisturbed portions of the 200-East and 200-West Areas. This report concluded that much of the 200-East and 200-West Areas can be considered areas of low archaeological potential with the exception of intact portions of an historic/ethnohistoric Trail/Road corridor which runs through the T Tank Farm EU. A non-contributing and un-intact segment of this trail/road runs through the T Tank Farm EU.

None of the T Tank Farm EU has been inventoried for archaeological resources (surface or subsurface). Closure and remediation of the tank farms located within the T Tank Farm EU has been addressed in an NHPA Section 106 review completed under HCRC#2003-200-044 (Prendergast-Kennedy and Harvey 2003). Given the extensive disturbance within the T-Tank Farm EU, this is unlikely, but there is a possibility that intact archaeological material is present in the areas that have not been inventoried for archaeological resources (both on the surface and in the subsurface), particularly if undisturbed soil deposits exist within the T Tank Farm EU and given the fact that an historic/ethnohistoric Trail/Road corridor runs through the T Tank Farm EU.

Archaeological sites, buildings and traditional cultural properties (TCPs) located within the EU[9]

- Segment C, a non-contributing un-intact segment of the National Register-eligible historic/ethnohistoric Road/Trail runs through the T Tank Farm EU.
- The 241T Tank Farm a contributing property within the Manhattan Project and Cold War Era Historic District, with documentation required, that is located within the T Tank Farm EU. In accordance with the 1998 *Hanford Site Manhattan Project and Cold War Era Historic District Treatment Plan (*DOE/RL-97-56), all documentation requirements have been completed for this property.

Archaeological sites and TCPs located within 500 meters of the EU

- The Hanford Site Plant Railroad, a contributing property within the Manhattan Project and Cold War Era Historic District, with documentation required, is located within 500 meters of the T Tank Farm EU. In accordance with the 1998 *Hanford Site Manhattan Project and Cold War Era Historic District Treatment Plan (*DOE/RL-97-56), all documentation requirements have been completed for this property.

[9] Traditional cultural property has been defined by the National Park Service as "a property, a place, that is eligible for inclusion on the National Register of Historic Places because of its association with cultural practices and beliefs that are (1) rooted in the history of a community, and (2) are important to maintaining the continuity of that community's traditional beliefs and practices" (Parker and King 1998).

Recorded TCPs Visible from the EU

There two recorded TCPs associated with the Native American Precontact and Ethnographic Landscape that are visible from the T Tank Farm EU.

Historic Map and Aerial Photograph Indicators

A review of 1916 United States Geological Survey (USGS) depicts an historic/ethnohistoric Trail/Road running through the T Tank Farm EU. Ownership information provided on 1943 Hanford Engineer Works Real Estate maps state that the lands contained within the T Tank Farm EU were owned by Benton County in 1943 (The 1943 Hanford Engineer Works Real Estate maps contain land ownership information on the Hanford Site just prior to the land being acquired by the US Government for the Manhattan Project in 1943). 1943 aerial photographs further confirm the presence of historic/ethnohistoric Trail/Road. This information indicates a moderate potential for archaeological resources associated with the Native American Precontact and Ethnographic and Pre-Hanford Early Settlers/Farming landscape to be present within the T Tank Farm EU.

Geomorphology Indicators

The geomorphology within the T Tank Farm EU consists of Pleistocene outburst flood deposits suggesting a low potential for Native American Precontact and Ethnographic associated archaeological resources to be present within undisturbed portions of the subsurface component of this EU.

Ground Disturbance Indicators

Examination of 2012 aerial imagery of the T Tank Farm EU depicts tank farms, buildings, roads as well as grubbed and cleared areas. It is also known that the T Tank Farm EU contains buried pipelines, sewer lines, tanks and miscellaneous waste sites. This extensive disturbance to both surface and subsurface soils suggests low potential for intact archaeological resources to be present within the T Tank Farm EU. Although unlikely, it is still possible however, for pockets of undisturbed soils to exist within the T Tank Farm EU.

Summary of Cultural Resources Review

Cultural resources known to be recorded within the T Tank Farm EU are limited to the National Register-eligible 241T Tank Farm associated with the Manhattan Project and Cold War Era Historic District, with documentation required. All National-Register-eligible Manhattan Project and Cold War Era buildings been documented as described in the *Hanford Site Manhattan Project and Cold War Era Historic District Treatment Plan* (DOE/RL-97-56). Additionally, the non-contributing/ineligible portion of the National Register-eligible White Bluffs Trail/Road which is associated with both the Native American Precontact and Ethnographic and the Pre-Hanford Early Settlers/Farming Landscapes, passes through the T Tank Farm EU.

None of the T Tank Farm EU has been inventoried for archaeological resources and closure and remediation of the tank farms located within the T Tank Farm EU has been addressed in an NHPA Section 106 review. There is a possibility that intact archaeological material is present in the T Tank Farm EU because it has not have not been inventoried for archaeological resources (both on the surface and in the subsurface) and particularly if undisturbed soil deposits exist within the T Tank Farm EU. Given the extensive disturbance this is unlikely. The National Register-eligible Hanford Site Plant Railroad, associated with the Manhattan Project/Cold War era Historic District with documentation required is the closest recorded cultural resource located within 500 meters of the T Tank Farm EU. All National-Register-eligible Manhattan Project and Cold War Era buildings been documented as described in the *Hanford Site Manhattan Project and Cold War Era Historic District Treatment Plan* (DOE/RL-97-56).

Despite there being no physical evidence of an historic/ethnohistoric trail/road within the T Tank Farm EU, historic maps reveal that this trail existed prior to excavation for the T-Tank Farm. Given the extensive ground disturbance within the entire EU and the geomorphology in the area, overall the potential for the presence of intact archaeological resources to be present subsurface within the T Tank Farm EU is unlikely.

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 associated with these landscapes (e.g. East Benton Historical Society, the Franklin County Historical Society and the Prosser Cemetery Association, the Reach and B-Reactor Museum Association) may need to occur. Indirect effects are always possible when TCPs are known to be located in the general vicinity. Consultation with Hanford Tribes may also 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.

References[10]

Department of Energy. 1998. *Hanford Site Manhattan Project and Cold War Era Historic District Treatment Plan (*DOE/RL-97-56). Richland, Washington.

Chatters JC and NA Cadoret 1990. *Archaeological Survey of the 200 East and 200 West Areas, Hanford Site.* Pacific Northwest Laboratory, Richland, Washington.**

Parker, P. and T. King. 1998. *National Register Bulletin: Guidelines for Evaluating and Documenting Traditional Cultural Properties.* U.S. Department of the Interior, National Park Service. Washington, D. C.

Prendergast-Kennedy, E. and DW Harvey. 2003. *Cultural Resources Review of Retrieval, Treatment and Disposal of Tank Waste and Closure of Single Shell Tanks (Tank Closure) Environmental Impact Statement (EIS) (HCRC# 2003-200-044).* Letter to Charlotte Johnson Science Applications International Corporation. Pacific Northwest National Laboratory, Richland, Washington.**

U.S. War Department. 1943. *Real Estate Engineer Works 1943 (maps).* Washington D.C.

United States Geological Survey Topographic maps. 1916. Coyote Rapid Quadrangle.

[10] **References available to qualified individuals at the Washington State Department of Archaeology and Historic Preservation

Evaluation Unit:	S-SX Tank Farms
ID:	CP-TF-2
Group:	Tank Farm
Operable Unit Cross-Walk:	WMA S/SX 200-DV-1 200-WA-1
Related EU:	CP-LS-7 CP-TF-9 CP-GW-2
Sites & Facilities:	S-SX Tank Farms, ancillary structures, associated liquid waste sites, and soils contamination, includes 242-S Evaporator
Key Data Sources Docs:	RPP-13033 RPP-40545 RPP-PLAN-40145 RPP-10435

DRAFT

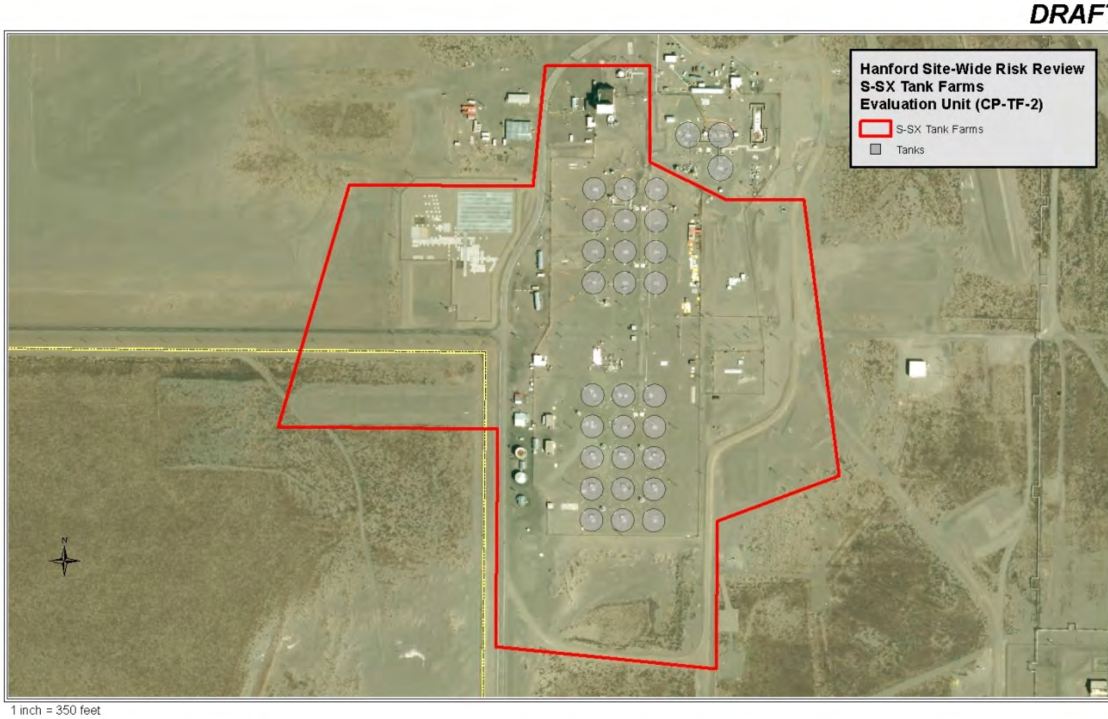

Figure K.6. Site Map with Evaluation Unit Boundaries and Tank Locations

CP-TF-2: S-SX Tank Farms

Cultural Resource Literature Reviews, Inventories and Potential for Cultural Resources

The S-SX Tank Farms EU is located within the 200-West Area of the Hanford Site, an area known to have low potential to contain Native American Precontact and Ethnographic archaeological resources and Pre-Hanford Early Settlers/Farming resources. Much of the 200 Areas were addressed in a cultural resources report entitled *Archaeological Survey of the 200 East and 200 West Areas, Hanford Site* (Chatters and Cadoret 1990). The focus of this archaeological survey was on inventorying all undisturbed portions of the 200-East and 200-West Areas. This report concluded that much of the 200-East and 200-West Areas can be considered areas of low archaeological potential with the exception of intact portions of an historic/ethnohistoric Trail/Road corridor which runs through the 200-West Area not far from the S-SX Tank Farms EU. Much of the S-SX Tank Farms EU has not been inventoried for archaeological resources. A very small area of the within the S-SX Tank Farms EU has been inventoried under HCRC#95-200-013 with negative findings (Stapp and Woodruff 1995). Although unlikely given the extensive disturbance in the S-SX Tank Farms EU, there is a possibility that intact archaeological material is present in the areas that have not been inventoried for archaeological resources (both on the surface and in the subsurface), particularly if undisturbed soil deposits exist within the S-SX Tank Farms EU. Closure and remediation of the tank farms located within the S-SX Tank Farms EU has been addressed in an NHPA Section 106 review completed under HCRC#2003-200-044 (Prendergast-Kennedy and Harvey 2003).

Archaeological sites, buildings and Traditional Cultural Properties (TCPs) located within the EU[11]

- There are no archaeological sites known to be located within the S-SX Tank Farms EU.
- The 242S Evaporator Facility a contributing property within the Manhattan Project and Cold War Era Historic District, with no documentation required is located within the S-SX Tank Farms EU.

Archaeological sites and TCPs located within 500 meters of the EU

- The 272S Maintenance Shop also a contributing property within the Manhattan Project and Cold War Era Historic District, with no documentation required is located adjacent to the S-SX Tank Farms EU.
- The Hanford Site Plant Railroad, a contributing property within the Manhattan Project and Cold War Era Historic District, with documentation required is located in the vicinity of the S-SX Tank Farms EU.
- An historic isolate likely associated with the Pre-Hanford Early Settlers/Farming Landscape is located in the vicinity of the S-SX Tank Farms EU. This isolated find is not considered to be eligible to the National Register of Historic Places.

Closest Recorded TCP

There are two recorded TCPs associated with the Native American Precontact and Ethnographic Landscape that are visible from the S-SX Tank Farms EU.

[11] Traditional cultural property has been defined by the National Park Service as "a property, a place, that is eligible for inclusion on the National Register of Historic Places because of its association with cultural practices and beliefs that are (1) rooted in the history of a community, and (2) are important to maintaining the continuity of that community's traditional beliefs and practices" (Parker and King 1998).

Historic Map and Aerial Photograph Indicators

A review of 1916 historic United States Geological Survey (USGS) maps depicts no structures, roads, or any other indication of historic settlement. Ownership information provided on 1943 Hanford Engineer Works Real Estate maps state that the lands contained within the SX Tank Farms EU were owned by the U.S. Government in 1943. (The 1943 Hanford Engineer Works Real Estate maps contain land ownership information on the Hanford Site just prior to the land being acquired by the U.S. Government for the Manhattan Project in 1943). 1943 aerial photographs further confirm the absence of historic settlement in the area. This information indicates a low potential for archaeological resources associated with the Pre-Hanford Early Settlers/Farming Landscape to be present within the S-SX Tank Farms EU.

Geomorphology Indicators

The geomorphology within the S-SX Tank Farms EU is all Pleistocene outburst flood deposits suggesting a low potential for Native American Precontact and Ethnographic associated archaeological resources to be present within the subsurface component of the S-SX Tank Farms EU.

Ground Disturbance Indicators

Examination of 2012 aerial imagery of the S-SX Tank Farms EU indicates that the S-SX Tank Farms EU is heavily disturbed by tank farm construction, buildings, buried pipelines, surface grading, roads and waste sites. This disturbance indicates that there is a very low potential for intact archaeological resources to be present. It is still possible however, for pockets of undisturbed soils to exist within the S-SX Tank Farms EU.

Summary of Cultural Resources Review

Cultural resources known to be recorded within the S-SX Tank Farms EU are limited to one National Register-eligible building; the 242S Evaporator Facility, associated with the Manhattan Project/Cold War Era Landscape with no documentation required. All have been documented as described in the *Hanford Site Manhattan Project and Cold War Era Historic District Treatment Plan* (DOE/RL-97-56).

Much of the S-SX Tank Farms EU has not been inventoried for archaeological resources with the exception of a very small area with negative findings. Closure and remediation of the tank farms located within the S-SX Tank Farms EU has been addressed in an NHPA Section 106 review completed. There are no archaeological sites or TCPs known to have been recorded or identified within the S-SX Tank Farms EU. Although unlikely given the presence of heavy disturbance, there is a possibility that intact archaeological material is present in the areas that have not been inventoried for archaeological resources (both on the surface and in the subsurface), particularly if undisturbed soil deposits exist within the S-SX Tank Farms EU.

One isolated archaeological find associated with the Pre-Hanford Early Settlers/Farming Landscape has been identified within 500 meters of the S-SX Tank Farms EU. Additionally, the National Register-eligible Hanford Site Plant Railroad and the 272S Maintenance Shop both of which are associated with the Manhattan Project and Cold War Era landscape with documentation required are located within 500 meters of the S-SX Tank Farms EU. Both have been documented as described in the *Hanford Site Manhattan Project and Cold War Era Historic District Treatment Plan* (DOE/RL-97-56).

Historic maps indicate that there is no evidence of historic settlement in or near the S-SX Tank Farms EU. Geomorphology and extensive ground disturbance further indicates a low potential for the presence of intact archaeological sites associated with all three landscapes to be present subsurface within the S-SX Tank Farms EU. Because none of the S-SX Tank Farms EU has been investigated for archaeological sites and pockets of undisturbed soil may exist, it may be appropriate to conduct surface and subsurface archaeological investigations in these areas prior to initiating a remediation activity. 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 associated with these landscapes (e.g. East Benton Historical Society, the Franklin County Historical Society, Prosser Cemetery Association, the Reach and B-Reactor Museum Association) may need to occur. Indirect effects are always possible when TCPs are known to be located in the general vicinity. Consultation with Hanford Tribes may also 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.

References[12]

Department of Energy. 1998. *Hanford Site Manhattan Project and Cold War Era Historic District Treatment Plan (*DOE/RL-97-56). Richland, Washington.

Chatters JC and NA Cadoret 1990. *Archaeological Survey of the 200 East and 200 West Areas, Hanford Site.* Pacific Northwest Laboratory, Richland, Washington.**

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Stapp DC and JK Woodruff. 1995. *Cultural Resoruces Review of the 200-UP-1 Characterization Drilling HCRC# 95-200-013).* CH2M Hill Hanford, Inc. Richland, Washington.**

U.S. War Department. 1943. *Real Estate Engineer Works 1943 (maps).* Washington D.C.

USGS Topographic maps. 1916. Coyote Rapid Quadrangle.

[12] **References available to qualified individuals at the Washington State Department of Archaeology and Historic Preservation

Evaluation Unit:	TX-TY Tank Farms
ID:	CP-TF-3
Group:	Tank Farm
Operable Unit Cross-Walk:	WMA TX/TY 200-DV-1 200-WA-1
Related EU:	CP-LS-7 CP-GW-2
Sites & Facilities:	TX-TY tank farms, ancillary structures, associated liquid waste sites, and soils contamination, includes 242-T Evaporator
Key Data Sources Docs:	RPP-13033 RPP-23405 RPP-23752 RPP-40545 RPP-PLAN-40145

DRAFT

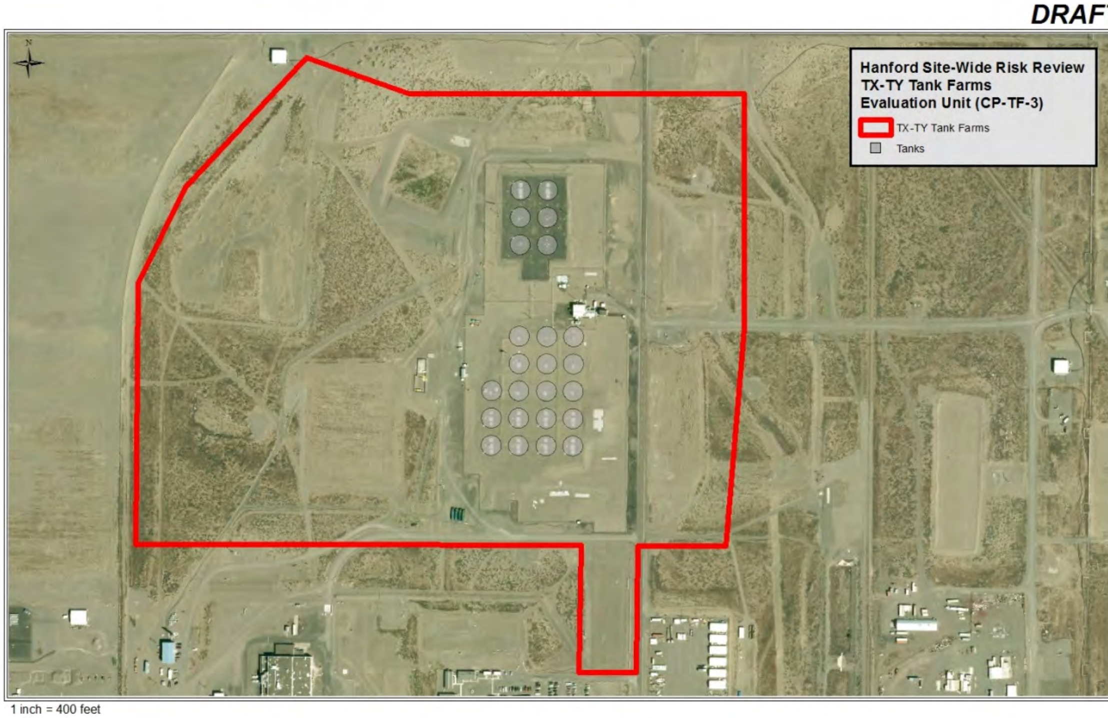

Figure K.7. Site Map with Evaluation Unit Boundaries and Tank Locations

CP-TF-3: TX-TY Tank Farms

Cultural Resource Literature Reviews, Inventories and Potential for Cultural Resources

The TX-TY Tank Farms Sites EU is located within the 200-West Area of the Hanford Site, an area known to have low potential to contain Native American pre-contact and ethnographic archaeological resources and Pre-Hanford Farming resources. Much of the 200 Areas were addressed in a cultural resources report entitled *Archaeological Survey of the 200 East and 200 West Areas, Hanford Site* (Chatters and Cadoret 1990). The focus of this archaeological survey was on inventorying all undisturbed portions of the 200-East and 200-West Areas. This report concluded that much of the 200-East and 200-West Areas can be considered areas of low archaeological potential with the exception of intact portions of an historic/ethnohistoric trail/Road corridor which runs through the 200-West Area through the TX-TY Tank Farms EU. A non-contributing/un-intact segment of this historic/ethnohistoric Trail/Road corridor runs through the TX-TY Tank Farms EU. Much of the TX-TY Tank Farms EU has not been inventoried (surface or subsurface) for archaeological resources with the exception of only a very small portion under HCRC#2013-600-010 with negative findings (Mendez et. al. 2013). Closure and remediation of the TX-TY tank farms however, has been addressed in an NHPA Section 106 review completed under HCRC#2003-200-044 (Prendergast-Kennedy and Harvey 2003). Although it is unlikely given the extensive disturbance in the TX-TY Tank Farms EU, there is a possibility that intact archaeological material is present in the areas that have not been inventoried for archaeological resources (both on the surface and in the subsurface), particularly if undisturbed soil deposits exist within the TX-TY Tank Farms EU.

Archaeological sites, buildings and traditional cultural properties (TCPs) located within the EU[13]

- The 241 TY and 241 TX Waste Disposal Tank Farm are contributing properties within the Manhattan Project and Cold War Era Historic District, with documentation required, are located within the TX/TY Tank Farms EU.
- Segment C, a non-contributing portion of a National Register-eligible historic/ethnohistoric Trail/Road passes through the TX/TY Tank Farms EU.
- Portions of the Hanford Site Plant Railroad, a contributing property within the Manhattan Project and Cold War Era Historic District, with documentation required are located inside the TX/TY Tank Farms EU.

Archaeological sites and TCPs located within 500 meters of the EU

- One isolated find and one site associated with the Pre-Hanford Farming Landscape and one isolated find associated with the Native American Precontact and Ethnohistoric Landscape are located within 500 meters of the TX/TY Tank Farms EU. None of these items are considered to be eligible to the National Register of Historic Places.

Closest Recorded TCP

There are two TCPs that have been recorded that are associated with the Native American Precontact and Ethnohistoric Landscape that are visible form the TX/TY Tank Farms EU.

Historic Map and Aerial Photograph Indicators

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[13] Traditional cultural property has been defined by the National Park Service as “a property, a place, that is eligible for inclusion on the National Register of Historic Places because of its association with cultural practices and beliefs that are (1) rooted in the history of a community, and (2) are important to maintaining the continuity of that community’s traditional beliefs and practices” (Parker and King 1998).

A review of 1916 historic United States Geological Survey (USGS) maps depicts an historic/ethnohistoric Trail/Road running through the TX/TY Tank Farms EU. Ownership information provided on 1943 Hanford Engineer Works Real Estate maps state that the lands contained within the TX/TY Tank Farms EU were owned by Benton County. (The 1943 Hanford Engineer Works Real Estate maps contain land ownership information on the Hanford Site just prior to the land being acquired by the US Government for the Manhattan Project in 1943). 1943 aerial photographs further confirm the presence of an historic/ethnohistoric Trail/Road. This information indicates a moderate potential for archaeological resources associated with the Native American Precontact and Ethnographic and Pre-Hanford Early Settlers Farming landscape to be present within the TX/TY Tank Farms EU

Geomorphology Indicators

The geomorphology within the TX/TY Tank Farms EU is all Pleistocene outburst flood deposits suggesting a low potential for Native American Precontact and Ethnographic associated archaeological resources to be present within the subsurface component of the TX/TY Tank Farms EU.

Ground Disturbance Indicators

Examination of 2013 aerial imagery of the TX/TY Tank Farms EU indicates that the EU is heavily disturbed by tank farm construction, buried pipelines, surface grading, roads and waste sites. This disturbance indicates that it is unlikely that intact archaeological resources to be present. It is still possible however, for pockets of undisturbed soils to exist within the TX/TY Tank Farms EU.

Summary of Cultural Resources Review

Cultural resources known to be recorded within the TX/TY Tank Farms EU are limited to three Manhattan Project/Cold War Era Landscape National Register-eligible sites with documentation required; two tank farms (241 TY and 241 TX Waste Disposal Tank Farm) and one railroad (the Hanford Site Plant Railroad). All have been documented as described in the *Hanford Site Manhattan Project and Cold War Era Historic District Treatment Plan* (DOE/RL-97-56). Additionally, a non-contributing/ineligible portion of a National Register-eligible historic/ethnohistoric Trail/Road which is associated with both the Native American Precontact and Ethnographic and the Pre-Hanford Early Settlers/Farming Landscapes, passes through the TX/TY Tank Farms EU.

Much of the TX-TY Tank Farms EU has not been inventoried for archaeological resources with the exception of a very small portion with negative findings. Closure and remediation of the tank farms located within TX/TY Tank Farms EU has been addressed in an NHPA Section 106 review completed. Given the extensive disturbance, it is unlikely but there is a possibility that intact archaeological material is present in the areas that have not been inventoried for archaeological resources (both on the surface and in the subsurface), particularly where the undisturbed soil deposits exist within the TX-TY Tank Farms EU.

One isolated find and one site associated with the Pre-Hanford Farming Landscape and one isolated find associated with the Native American Precontact and Ethnohistoric Landscape are located within 500 meters of the TX/TY Tank Farms EU. None of these items are considered to be eligible to the National Register of Historic Places.

Historic maps reveal that an historic/ethnohistoric/Trail Road ran through the TX-TY Tank Farms EU indicating that there was a presence of Native American and Pre-Hanford Farming Landscape cultural resources associated with transportation and travel through the area. Given the extensive ground disturbance within the entire EU and the geomorphology in the area however, overall it is unlikely that intact archaeological resources are present on the surface or in the subsurface within the TX/TY Tank Farms EU. Pockets of undisturbed soil may exist, it may be appropriate to conduct surface and subsurface archaeological investigations in these areas prior to initiating a remediation activity. 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 associated with these landscapes (e.g. East Benton Historical Society, the Franklin County Historical Society and the Prosser Cemetery Association, the Reach, and B-Reactor Museum Association) may need to occur. Indirect effects are always possible when TCPs are known to be located in the general vicinity. Consultation with Hanford Tribes may also 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.

References[14]

Department of Energy. 1998. *Hanford Site Manhattan Project and Cold War Era Historic District Treatment Plan (*DOE/RL-97-56). Richland, Washington.

Chatters JC and NA Cadoret 1990. *Archaeological Survey of the 200 East and 200 West Areas, Hanford Site.* Pacific Northwest Laboratory, Richland, Washington.**

Mendez, Keith, H. Hay, S. Sexton, and K. Clark. 2013. *Cultural Resource Review for Probabilistic Seismic Hazard Analysis of the Hanford Site and the Hanford Reach National Monument, Benton County, Washington (HCRC#2013-600-010).* CH2M Hill. Richland, Washington.**

Parker, P. and T. King. 1998. *National Register Bulletin: Guidelines for Evaluating and Documenting Traditional Cultural Properties.* U.S. Department of the Interior, National Park Service. Washington, D. C.

Prendergast-Kennedy, E. and DW Harvey. 2003. *Cultural Resources Review of Retrieval, Treatment and Disposal of Tank Waste and Closure of Single Shell Tanks (Tank Closure) Environmental Impact Statement (EIS) (HCRC# 2003-200-044).* Letter to Charlotte Johnson Science Applications International Corporation. Pacific Northwest National Laboratory, Richland, Washington.**

U.S. War Department. 1943. *Real Estate Engineer Works 1943 (maps).* Washington D.C.

USGS Topographic maps. 1916. Coyote Rapid Quadrangle.

[14] **References available to qualified individuals at the Washington State Department of Archaeology and Historic Preservation

Evaluation Unit:	U Tank Farm
ID:	CP-TF-4
Group:	Tank Farm
Operable Unit Cross-Walk:	WMA U 200-WA-1
Related EU:	CP-LS-7 CP-GW-2
Sites & Facilities:	U tank farm, ancillary structures, associated liquid waste sites, and soils contamination
Key Data Sources Docs:	RPP-13033 RPP-23405 RPP-40545 RPP-PLAN-40145 RPP-10435

Figure K.8. Site Map with Evaluation Unit Boundaries and Tank Locations

CP-TF-4: U Tank Farm

Cultural Resource Literature Reviews and Inventories

The U Tank Farms EU is located within the 200-West Area of the Hanford Site, an area known to have low potential to contain Native American Precontact and Ethnographic archaeological resources and Pre-Hanford Early Settlers/Farming resources. Much of the 200 Areas were addressed in a cultural resources report entitled *Archaeological Survey of the 200 East and 200*

West Areas, Hanford Site (Chatters and Cadoret 1990). The focus of this archaeological survey was on inventorying all undisturbed portions of the 200-East and 200-West Areas. This report concluded that much of the 200-East and 200-West Areas can be considered areas of low archaeological potential with the exception of intact portions of an historic/ethnohistoric Road/Trail corridor which runs through the 200-West Area located over in the vicinity of the U Tank Farms. None of the U Tank Farms EU has been inventoried for archaeological resources. Closure and remediation of the tank farms located within the U Tank Farms EU has been addressed in an NHPA Section 106 review completed under HCRC#2003-200-044 (Prendergast-Kennedy and Harvey 2003). Although it is unlikely given the extensive disturbance within the U Tank Farms EU, there is a possibility that intact archaeological material is present in the areas that have not been inventoried for archaeological resources (both on the surface and in the subsurface), particularly if undisturbed soil deposits exist within U Tank Farms EU.

Archaeological sites, buildings and traditional cultural properties (TCPs) located within the EU[15]

- There are no known recorded archaeological sites or TCPs located within the U Tank Farms EU.
- The 244UR Waste Disposal Vault a contributing property within the Manhattan Project and Cold War Era Historic District, with documentation required, is located within the U Tank Farms EU.

Archaeological sites and TCPs located within 500 meters of the EU

- The 2727WA Sodium Storage Building and the 2727W also a Sodium Storage Building contributing properties within the Manhattan Project and Cold War Era Historic District, with no documentation required are located within the vicinity of the U-Tanks Farms Evaluation Unit.
- The Hanford Site Plant Railroad, a contributing property within the Manhattan Project and Cold War Era Historic District, with documentation required is located in the vicinity of the U-Tanks Farms Evaluation Unit.

Recorded TCPs Visible from the EU

- There are two recorded TCPs associated with the Native American Precontact and Ethnographic Landscape that are visible from the U Tank Farms EU.

Historic Map and Aerial Photograph Indicators

A review of 1916 historic United States Geological Survey (USGS) maps depicts no structures, roads, or any other indication of historic settlement. Ownership information provided on 1943 Hanford Engineer Works Real Estate maps state that the lands contained within the U Tank Farms EU were owned by the U.S. Government in 1943. (The 1943 Hanford Engineer Works

[15] Traditional cultural property has been defined by the National Park Service as “a property, a place, that is eligible for inclusion on the National Register of Historic Places because of its association with cultural practices and beliefs that are (1) rooted in the history of a community, and (2) are important to maintaining the continuity of that community’s traditional beliefs and practices” (Parker and King 1998).

Real Estate maps contain land ownership information on the Hanford Site just prior to the land being acquired by the US Government for the Manhattan Project in 1943). 1943 aerial photographs further confirm the absence of the historic settlement in the area. This information indicates a low potential for archaeological resources associated with the Native American Precontact and Ethnographic and Pre-Hanford Early Settlers/Farming landscape to be present within U Tank Farms EU.

Geomorphology Indicators

The geomorphology within the U Tank Farms EU is all Pleistocene outburst flood deposits suggesting a low potential for Native American Precontact and Ethnographic associated archaeological resources to be present within the subsurface component of the U Tank Farms EU.

Ground Disturbance Indicators

Examination of 2012 aerial imagery of the EU indicates that the EU is heavily disturbed by tank farm construction, buried pipelines, surface grading, roads and waste sites. There are some areas that appear to be only surface graded. This disturbance indicates that there is a very low potential for intact archaeological resources to be present. It is still possible however, for pockets of undisturbed soils to exist within the U Tank Farms EU.

Summary of Cultural Resources Review

Cultural resources that are located in the U Tank Farms EU are limited to the National Register-eligible 244UR Waste Disposal Vault a contributing property within the Manhattan Project and Cold War Era. All documentation has been addressed as described in the *Hanford Site Manhattan Project and Cold War Era Historic District Treatment Plan* (DOE/RL-97-56). None of the U Tank Farms EU has been inventoried for archaeological resources. Closure and remediation of the tank farms located within the 200-West DSTs has been addressed in an NHPA Section 106 review completed. There is a possibility that intact archaeological material is present in the areas that have not been inventoried for archaeological resources (both on the surface and in the subsurface), particularly if undisturbed soil deposits exist within U Tank Farms EU.

Three National Register-eligible properties associated with the Manhattan Project/Cold War Era Landscape (Hanford Site Plant Railroad with documentation required and the 2727WA Sodium Storage Building and the 2727W also a Sodium Storage Building both with no documentation required are located within 500 meters of the U Tank Farms EU. All three have also been documented as described in the *Hanford Site Manhattan Project and Cold War Era Historic District Treatment Plan* (DOE/RL-97-56).

Historic maps indicate that there is no evidence of historic settlement in the U Tank Farms EU. Geomorphology and extensive ground disturbance further indicates a low potential for the presence of intact archaeological sites associated with all three landscapes to be present subsurface within the U Tank Farms EU. Because none of the U Tank Farms EU has been investigated for archaeological sites and pockets of undisturbed soil may exist, it may be appropriate to conduct surface and subsurface archaeological investigations in these areas prior to initiating a remediation activity. 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 associated with these landscapes (e.g. East Benton Historical Society, the Franklin County Historical Society, Prosser Cemetery Association, the Reach and B-Reactor Museum Association) may need to occur. Indirect effects are always possible when TCPs are known to be located in the general vicinity. Consultation with Hanford Tribes may also 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.

References[16]

Department of Energy. 1998. *Hanford Site Manhattan Project and Cold War Era Historic District Treatment Plan (*DOE/RL-97-56). Richland, Washington.

Chatters JC and NA Cadoret 1990. *Archaeological Survey of the 200 East and 200 West Areas, Hanford Site.* Pacific Northwest Laboratory, Richland, Washington.**

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U.S. War Department. 1943. *Real Estate Engineer Works 1943 (maps).* Washington D.C.

USGS Topographic maps. 1916. Coyote Rapid Quadrangle.

[16] **References available to qualified individuals at the Washington State Department of Archaeology and Historic Preservation

Evaluation Unit:	A-AX Tank Farms
ID:	CP-TF-5
Group:	Tank Farm
Operable Unit Cross-Walk:	WMA A/AX 200-EA-1 200-PW-3
Related EU:	CP-LS-7 CP-TF-8 CP-GW-1
Sites & Facilities:	A-AX tank farm, ancillary structures, associated liquid waste sites, and soils contamination
Key Data Sources Docs:	RPP-13033 RPP-23405 RPP-40545 RPP-PLAN-40145 RPP-10435

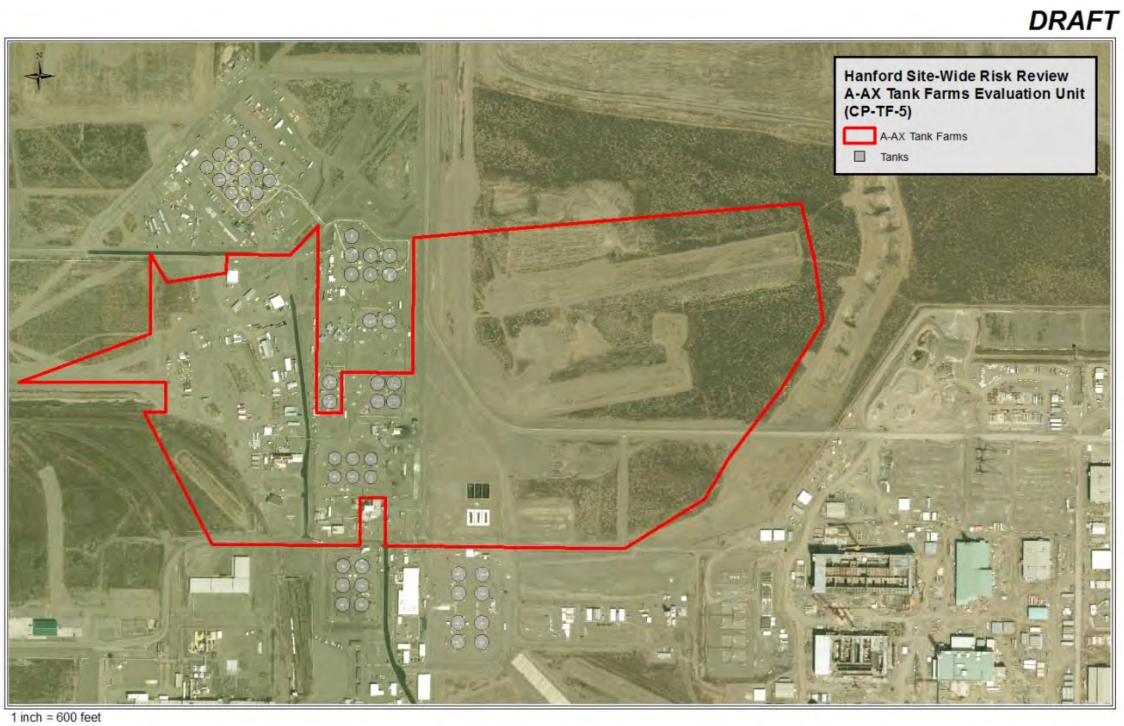

Figure K.9. Site Map with Evaluation Unit Boundaries and Tank Locations

CP-TF-5: A-AX Tank Farms

Cultural Resource Literature Reviews, Inventories and Potential for Cultural Resources

The A-AX Tank Farms EU is located within the 200-East Area of the Hanford Site, an area known to have low potential to contain Native American Precontact and Ethnographic archaeological resources and Pre-Hanford Early/Settlers Farming archaeological resources. Much of the 200 Areas were addressed in a cultural resources report entitled *Archaeological Survey of the 200 East and 200 West Areas, Hanford Site* (Chatters and Cadoret 1990). The focus of this archaeological survey was on inventorying all undisturbed portions of the 200-East and 200-West Areas. This report concluded that much of the 200-East and 200-West Areas can be considered areas of low archaeological potential with the exception of intact portions of an historic/ethnohistoric trail/road corridor which runs through the 200-West Area located over 5 kilometers from the A-AX Tank Farms EU. Portions of the A-AX Tank Farms Evaluation Unit has been inventoried for cultural resources under HRC# 87-200-002 (Chatters, 1987), HCRC# 96-200-109 (Cadoret and Nickens 1996), 2003-200-044 (Prendergast-Kennedy and Harvey 2003), HCRC# 88-200-015 (Hoover and Chatters 1988) and HCRC# 2008-200-017 (Kennedy 2008). No archaeological sites were located by these surveys. There is a possibility that intact archaeological material is present in the areas that have not been inventoried for archaeological resources (both on the surface and in the subsurface), particularly if undisturbed soil deposits exist within the A-AX Tank Farms EU. Closure and remediation of the tank farms located within the A-AX Tank Farms EU has been addressed in an NHPA Section 106 review completed under HCRC#2003-200-044 (Prendergast-Kennedy and Harvey 2003).

Archaeological sites, buildings and Traditional Cultural Properties (TCPs) located within the EU[17]

- The Hanford Site Plant Railroad and 2707AR Sludge Vault Change House contributing properties within the Manhattan Project and Cold War Era Historic District, with documentation required are located within the A-AX Tank Farms EU.
- The 244 AR Vault Facility and Canyon and 242BA (242-A Boiler Annex) are contributing properties within the Manhattan Project and Cold War Era Historic District with no documentation required are located within the A-AX Tank Farms EU.
- There are no archaeological sites or TCPs known to be located within the A-AX Tank Farms Evaluation Unit.

Archaeological sites and TCPs located within 500 meters of the EU

- The 241 AW Underground Liquid Tank Farm are contributing properties within the Manhattan Project and Cold War Era Historic District with documentation required are located within close proximity to the A-AX Tank Farms EU.
- The 271 CR Service and Office Building is a contributing property within the Manhattan Project and Cold War Era Historic District with no documentation required is located within close proximity to the A-AX Tank Farms EU.

[17]Traditional cultural property has been defined by the National Park Service as “a property, a place, that is eligible for inclusion on the National Register of Historic Places because of its association with cultural practices and beliefs that are (1) rooted in the history of a community, and (2) are important to maintaining the continuity of that community’s traditional beliefs and practices” (Parker and King 1998).

- All of the Manhattan Project and Cold War era contributing properties both with documentation and no documentation requirements that are listed as being located within the PUREX Evaluation Unit are also located in close proximity to the A-AX Tank Farms EU.

Closest Recorded TCP

There are two recorded TCPs associated with the Native American Precontact and Ethnographic Landscape that are visible from the A-AX Tank Farms EU.

Historic Map and Aerial Photograph Indicators

A review of 1916 historic United States Geological Survey (USGS) maps depicts no structures, roads, or any other indication of historic settlement. Ownership information provided on 1943 Hanford Engineer Works Real Estate maps state that the lands contained within the A-AX Tank Farms EU were owned by the U.S. Government and Benton County in 1943. (The 1943 Hanford Engineer Works Real Estate maps contain land ownership information on the Hanford Site just prior to the land being acquired by the US Government for the Manhattan Project in 1943). 1943 aerial photographs further confirm the absence of the historic settlement in the area. This information indicates a low potential for archaeological resources associated with the Native American Precontact and Ethnographic to be present within the A-AX Tank Farms EU.

Geomorphology Indicators

The geomorphology within the A-AX Tank Farms EU is comprised mostly of Pleistocene outburst flood deposits suggesting a low potential for Native American Precontact and Ethnographic associated archaeological resources to be present within the subsurface component of the A-AX Tank Farms EU. There is a large pocket of Holocene Dune sand along the eastern edge of the A-AX Tank Farms EU indicating there is a higher potential for archaeological resources to be present within these deposits.

Ground Disturbance Indicators

Examination of 2012 aerial imagery of the EU indicates that most of the A-AX Tank Farms EU is heavily disturbed by tank farm construction, buried pipelines, surface grading, roads and waste sites. This disturbance indicates that there is a very low potential for intact archaeological resources to be present in these areas. However the area to the east appears to have had only surface disturbance. Because this correlates with the Holocene deposits, the potential of archaeological resources to be present where these areas of surface disturbance overlap with the Holocene deposits exists. It is still possible also, but unlikely for additional pockets of undisturbed soils to exist within the more disturbed areas in the A-AX Tank Farms EU.

Summary of Cultural Resources Review

Cultural resources known to be located within the A-AX Tank Farms EU are limited to the Hanford Site Plant Railroad and the 2707AR Sludge Vault Change both contributing properties within the Manhattan Project/Cold War Era Landscape with documentation required and the 244 AR Vault Facility and Canyon and 242BA (242-A Boiler Annex) contributing properties within the Manhattan Project and Cold War Era Historic District with no documentation required. All documentation has been addressed as described in the *Hanford Site Manhattan Project and Cold War Era Historic District Treatment Plan* (DOE RL-97-56). There are no known archaeological sites, or TCPs known to be recorded within the A-AX Tank Farms EU. Portions of the A-AX Tank Farms Evaluation Unit have been inventoried for archaeological resources. No archaeological sites were located by these surveys. There is a possibility that intact archaeological material is present in the areas that have not been inventoried for archaeological resources (both on the surface and in the subsurface), particularly where pockets of undisturbed soil deposits exist within the A-AX Tank Farms EU.

Several National Register-eligible properties associated with the Manhattan Project/Cold War Era Landscape both with documentation required (241 AW Underground Liquid Tank Farm) and no documentation required (271 CR Service and Office Building) are located within 500 meters of the A-AX Tank Farms EU. Also see the list of Manhattan Project/Cold War Era buildings located within the PUREX Evaluation Unit which is located in adjacent to the A-AX Tank Farms EU. All have been documented as described in the *Hanford Site Manhattan Project and Cold War Era Historic District Treatment Plan* (DOE/RL-97-56).

Historic maps indicate that there is no evidence of historic-era settlement in or near the A-AX Tank Farms EU. The eastern most portion of the A-AX Tank Farms EU where Holocene deposits overlap with areas that have only surface disturbance present a moderate potential for the presence of intact archaeological resources associated with all three landscapes to be present subsurface within these areas within A-AX Tank Farms EU. Geomorphology throughout the rest of the A-AX Tank Farms EU and extensive ground disturbance suggest a low potential for the presence of intact archaeological resources be present subsurface within these areas within the A-AX Tank Farms EU. Where pockets of undisturbed soil may exist, it may be appropriate to conduct surface and subsurface archaeological investigations in these areas prior to initiating a remediation activity. 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 associated with these landscapes (e.g. East Benton Historical Society, the Franklin County Historical Society, Prosser Cemetery Association, the Reach and B-Reactor Museum) may need to occur. Indirect effects are always possible when TCPs are known to be located in the general vicinity. Consultation with Hanford Tribes may also 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.

References[18]

Cadoret, NA and PR Nickens. 1996. *Cultural Resources Review of the TWRS Privatization Phase I Site Development Project HCRC #96-200-109*. Letter to Mr. P.C. Miller, Westingthouse. Pacific Northwest National Laboratory, Richland, Washington.**

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[18] **References available to qualified individuals at the Washington State Department of Archaeology and Historic Preservation

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Hoover, KA and JC Chatters. 1988. *Cultural Resources Review of the Proposed 216-A -8 Crib Topsoil Borrow Pit HCRC# 88-200-015.* Letter to Mr. D.B. Herb, Westinghouse. Pacific Northwest National Laboratory, Richland, Washington.**

Kennedy, EP. 2008. *Cultural Resources Review and Inventory for Interim Pretreatment System Facilitv to Support Treatmen of Hanford Tank Waste and the Waste Treatment Plant. 200 East Area of the Hanford Site (HCRC#2008-200-017).* Pacific Northwest National Laboratory. Richland, Washington.**

Parker, P. and T. King. 1998. *National Register Bulletin: Guidelines for Evaluating and Documenting Traditional Cultural Properties.* U.S. Department of the Interior, National Park Service. Washington, D. C.

Prendergast-Kennedy, E. and DW Harvey. 2003. *Cultural Resources Review of Retrieval, Treatment and Disposal of Tank Waste and Closure of Single Shell Tanks (Tank Closure) Environmental Impact Statement (EIS) (HCRC# 2003-200-044).* Letter to Charlotte Johnson Science Applications International Corporation. Pacific Northwest National Laboratory, Richland, Washington.**

U.S. War Department. 1943. *Real Estate Engineer Works 1943 (maps).* Washington D.C.

USGS Topographic maps. 1916. Coyote Rapid Quadrangle.

Evaluation Unit: B-BX-BY Tank Farms
ID: CP-TF-6
Group: Tank Farm
Operable Unit Cross-Walk: WMA B/BX/BY
200-DV-1
200-EA-1
Related EU: CP-LS-7
CP-GW-1
Sites & Facilities: B-BX-BY tank farms, ancillary structures, associated liquid waste sites, and associated soils contamination.
Key Data Sources Docs: RPP-13033
RPP-23405
RPP-40545
RPP-PLAN-40145
RPP-10435

Figure K.10. Site Map with Evaluation Unit Boundaries and Tank Locations

CP-TF-6: B-BX-BY Tank Farms

Cultural Resource Literature Reviews and Inventories

The B-BX-BY Tank Farms EU is located in the north central part of the 200-East Area of the Hanford Site, an area known to have low potential to contain Native American Precontact and Ethnographic archaeological resources and Pre-Hanford Early Settlers/Farming resources. Much of the 200 Areas were addressed in a cultural resources report entitled *Archaeological Survey of the 200 East and 200 West Areas, Hanford Site* (Chatters and Cadoret 1990). The focus of this archaeological survey was on inventorying all undisturbed portions of the 200-East and 200-West Areas. This report concluded that much of the 200-East and 200-West Areas can be considered areas of low archaeological potential with the exception of intact portions of an historic/ethnohistoric Trail/Road corridor which runs through the 200-West Area located over 5km from the 200-East Area

None of the B-BX-BY Tank Farms EU has been inventoried for archaeological resources (surface or subsurface). Closure and remediation of the tank farms located within the B-BX-BY Tank Farms EU has been addressed in an NHPA Section 106 review completed under HCRC#2003-200-044 (Prendergast-Kennedy and Harvey 2003). There is a possibility that intact archaeological material is present in the areas that have not been inventoried for archaeological resources (both on the surface and in the subsurface), particularly if undisturbed soil deposits exist within the B-BX-BY Tank Farms EU.

Archaeological sites, buildings and traditional cultural properties (TCPs) located within the EU[19]

- There are no known recorded archaeological sites or TCPs located within the EU.
- The 242B Building Radioactive Particle Research Laboratory is a contributing property within the Manhattan Project and Cold War Era Historic District, with no documentation required, that is located within the B-BX-BY Tank Farms EU. In accordance with the 1998 *Hanford Site Manhattan Project and Cold War Era Historic District Treatment Plan (*DOE/RL-97-56), all documentation requirements have been completed for these properties.

Archaeological sites and TCPs located within 500 meters of the EU

- Two isolated finds and one small site which may be associated with the Pre-Hanford Landscape are located within 500 meters of the B-BX-BY Tank Farms EU. All three are considered to be National Register ineligible.
- The Hanford Site Plant Railroad, a contributing property within the Manhattan Project and Cold War Era Historic District, with documentation required is located within 500 meters of the B-BX-BY Tank Farms EU. In accordance with the 1998 *Hanford Site Manhattan Project and Cold War Era Historic District Treatment Plan (*DOE/RL-97-56), all documentation requirements have been completed for these properties.

Recorded TCPs Visible from the EU

[19] Traditional cultural property has been defined by the National Park Service as "a property, a place, that is eligible for inclusion on the National Register of Historic Places because of its association with cultural practices and beliefs that are (1) rooted in the history of a community, and (2) are important to maintaining the continuity of that community's traditional beliefs and practices" (Parker and King 1998).

There are two recorded TCPs associated with the Native American Precontact and Ethnographic Landscape that are visible from the BX-BY Tank Farms EU.

Historic Map and Aerial Photograph Indicators

A review of 1916 United States Geological Survey (USGS) shows no indications of historic land use such as roads or buildings within the B-BX-BY Tank Farms EU. Ownership information provided on 1943 Hanford Engineer Works Real Estate maps depicting land ownership information on the Hanford Site just prior to the land being acquired by the US Government for the Manhattan Project state that the lands contained within the B-BX-BY Tank Farms EU were owned by the United States and the Northern Pacific Railroad Company in 1943. (The 1943 Hanford Engineer Works Real Estate maps contain land ownership information on the Hanford Site just prior to the land being acquired by the US Government for the Manhattan Project in 1943). 1943 aerials further confirm a lack of land use or development in this area. This information further indicates a low potential for archaeological resources associated with the Pre-Hanford Early Settlers/Farming landscape to be present within the BX-BY Tank Farms EU

Geomorphology Indicators

The geomorphology within the BX-BY Tank Farms EU consists of Pleistocene outburst flood deposits suggesting a low potential for Native American Precontact and Ethnographic associated archaeological resources to be present within undisturbed portions of the subsurface component of this EU.

Ground Disturbance Indicators

Examination of 2012 aerial imagery of the BX-BY Tank Farms EU depicts tank farms, buildings, roads as well as grubbed and cleared areas. It is also known that the BX-BY Tank Farms EU contains buried pipelines, sewer lines, tanks and miscellaneous waste sites. This extensive disturbance to both surface and subsurface soils suggests low potential for intact archaeological resources to be present within the BX-BY Tank Farms EU. It is still possible however, for pockets of undisturbed soils to exist within the BX-BY Tank Farms EU particularly to the west where the ground appears have been minimally disturbed.

Summary of Cultural Resources Review

Cultural resources known to be recorded within the BX-BY Tank Farms EU are limited to the National Register-eligible 242B Building Radioactive Particle Research Laboratory associated with the Manhattan Project/Cold War Era Landscape with no documentation required. All National-Register-eligible Manhattan Project and Cold War Era buildings been documented as described in the *Hanford Site Manhattan Project and Cold War Era Historic District Treatment Plan* (DOE/RL-97-56).

None of the BX-BY Tank Farms EU has been inventoried for archaeological resources and closure and remediation of the tank farms located within the B-BX-BY Tank Farms EU has been addressed in an NHPA Section 106 review. There is a possibility that intact archaeological material is present in the BX-BY Tank Farms EU because it has not have not been inventoried for archaeological resources (both on the surface and in the subsurface) and particularly where undisturbed soil deposits exist within the BX-BY Tank Farms EU to the west. Within the other extensively disturbed areas, this is unlikely. The closest recorded archaeological site, located within 500 meters of the BX-BY Tank Farms EU consists of two historic-era isolated finds and one historic-era site likely associated with the Pre-Hanford Early Settlers/Farming Landscape and are not considered to be National Register-eligible. Additionally, the Hanford Site Plant Railroad, a contributing property within the Manhattan Project and Cold War Era Historic District, with documentation required is located within 500 meters of the B-BX-BY Tank Farms EU. In accordance with the 1998 *Hanford Site Manhattan Project and Cold War Era Historic District Treatment Plan (*DOE/RL-97-56), all documentation requirements have been completed for these properties

Geomorphology, ground disturbance, historic maps, and the lack of cultural resources located within and in the vicinity of BX-BY Tank Farms EU all suggest that the potential for archaeological resources associated with all three landscapes to be present on the surface or within the subsurface within the EU is very low. Because none of the BX-BY Tank Farms EU has been investigated for archaeological sites and pockets of undisturbed soil may exist, it may be appropriate to conduct surface and subsurface archaeological investigations in these areas prior to initiating a remediation activity. 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 associated with these landscapes (e.g. East Benton Historical Society, the Franklin County Historical Society, Prosser Cemetery Association, the Reach and B-Reactor Museum Association) may need to occur. Indirect effects are always possible when TCPs are known to be located in the general vicinity. Consultation with Hanford Tribes may also 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.

References[20]

Department of Energy. 1998. *Hanford Site Manhattan Project and Cold War Era Historic District Treatment Plan (*DOE/RL-97-56). Richland, Washington.

Chatters JC and NA Cadoret 1990. *Archaeological Survey of the 200 East and 200 West Areas, Hanford Site.* Pacific Northwest Laboratory, Richland, Washington.**

Parker, P. and T. King. 1998. *National Register Bulletin: Guidelines for Evaluating and Documenting Traditional Cultural Properties.* U.S. Department of the Interior, National Park Service. Washington, D. C.

Prendergast-Kennedy, E. and DW Harvey. 2003. *Cultural Resources Review of Retrieval, Treatment and Disposal of Tank Waste and Closure of Single Shell Tanks (Tank Closure) Environmental Impact Statement (EIS) (HCRC# 2003-200-044).* Letter to Charlotte Johnson Science Applications International Corporation. Pacific Northwest National Laboratory, Richland, Washington.**

U.S. War Department. 1943. *Real Estate Engineer Works 1943 (maps).* Washington D.C.

[20] **References available to qualified individuals at the Washington State Department of Archaeology and Historic Preservation

United States Geological Survey Topographic maps. 1916. Coyote Rapid Quadrangle.

Evaluation Unit:	C Tank Farm
ID:	CP-TF-7
Group:	Tank Farm
Operable Unit Cross-Walk:	WMA C
Related EU:	CP-LS-7 CP-GW-1
Sites & Facilities:	C tank farm, ancillary structures, associated liquid waste sites, and soils contamination
Key Data Sources Docs:	RPP-13033 RPP-23405 RPP-40545 RPP-PLAN-40145 RPP-10435

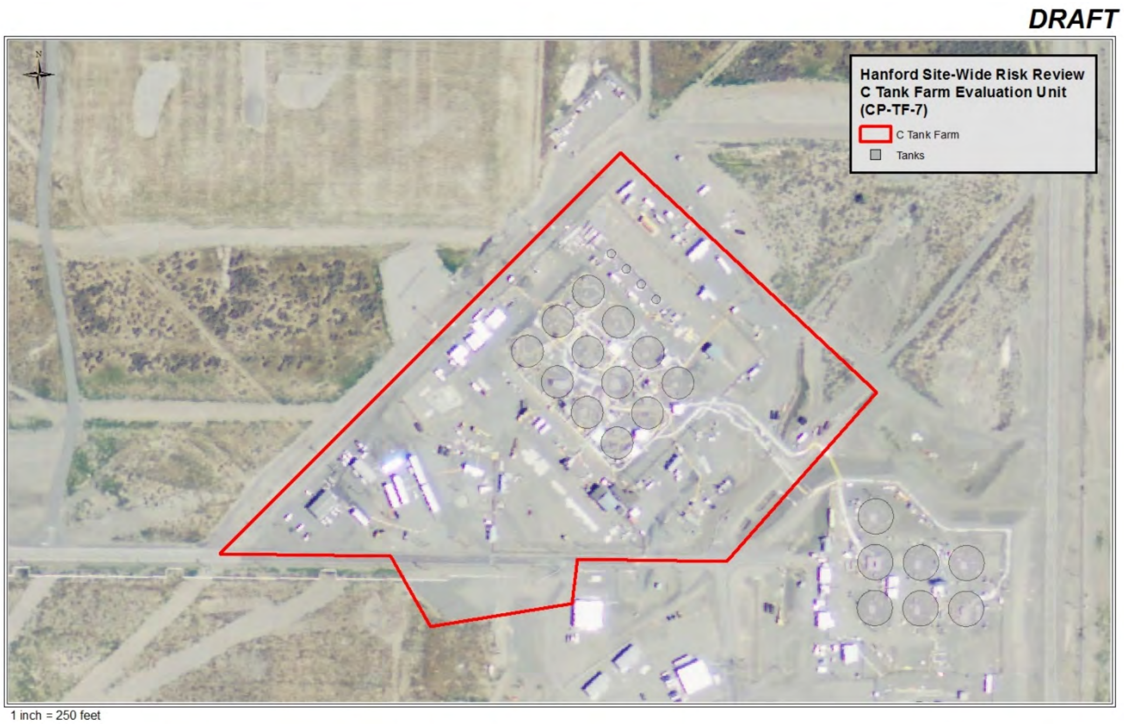

Figure K.11. Site Map with Evaluation Unit Boundaries and Tank Locations

CP-TF-7: C Tank Farm

Cultural Resource Literature Reviews, Inventories and Potential for Cultural Resources

The C Tank Farm EU is located within the 200-East Area of the Hanford Site, an area known to have low potential to contain Native American Precontact and Ethnographic archaeological resources and Pre-Hanford Early Settlers/Farming resources. Much of the 200 Areas were addressed in a cultural resources report entitled *Archaeological Survey of the 200 East and 200 West Areas, Hanford Site* (Chatters and Cadoret 1990). The focus of this archaeological survey was on inventorying all undisturbed portions of the 200-East and 200-West Areas. This report concluded that much of the 200-East and 200-West Areas can be considered areas of low archaeological potential with the exception of intact portions of an historic/ethnohistoric trail/road corridor which runs through the 200-West Area located over 5 kilometers from the C Tank Farm EU. None of the C Tank Farm EU has been inventoried for archaeological resources. Closure and remediation of the tank farms located within the C Tank Farm EU has been addressed in an NHPA Section 106 review completed under HCRC#2003-200-044 (Prendergast-Kennedy and Harvey 2003). Given the extensive ground disturbance in the C Tank Farm EU, it is unlikely but there is a possibility that intact archaeological material is present in the areas that have not been inventoried for archaeological resources (both on the surface and in the subsurface), particularly if undisturbed soil deposits exist within the C Tank Farm EU.

Archaeological sites, buildings and traditional cultural properties (TCPs) located within the EU[21]

- The 271-CR Service and Office Building, contributing property within the Manhattan Project/Cold War Era Historic District with no documentation required is located within the C Tank Farm EU.
- There are no archaeological sites or TCPs known to be located or recorded within the C Tank Farm EU.

Archaeological sites and TCPs located within 500 meters of the EU

- An isolated find associated with the Native American Precontact and Ethnographic Landscape consisting has been located within close proximity to the C-Tank Farm Evaluation Unit.
- The Hanford Site Plant Railroad and 2707AR Sludge Vault Change House are contributing properties within the Manhattan Project and Cold War Era Historic District with documentation required are located within close proximity to the C-Tank Farms Evaluation Unit.

Recorded TCPs Visible from the EU

- There are two recorded TCPs associated with the Native American Precontact and Ethnographic Landscape that are visible from the BX-BY Tank Farms EU.

Historic Map and Aerial Photograph Indicators

A review of 1916 historic United States Geological Survey (USGS) maps depicts no structures, roads, or any other indication of historic settlement within the C-Tank Farms EU. Ownership information provided on 1943 Hanford Engineer Works Real Estate maps state that the lands contained within the C-Tank Farms EU were owned by the U.S. Government in 1943. (The 1943 Hanford Engineer Works Real Estate maps contain land ownership information on the Hanford

[21] Traditional cultural property has been defined by the National Park Service as “a property, a place, that is eligible for inclusion on the National Register of Historic Places because of its association with cultural practices and beliefs that are (1) rooted in the history of a community, and (2) are important to maintaining the continuity of that community’s traditional beliefs and practices” (Parker and King 1998).

Site just prior to the land being acquired by the US Government for the Manhattan Project in 1943). 1943 aerial photographs further confirm the absence of the historic settlement in the area. This information indicates a low potential for archaeological resources associated with the Pre-Hanford Early Settlers/Farming landscape to be present within the C-Tank Farms EU.

Geomorphology Indicators

The geomorphology within the C-Tank Farms EU is all Pleistocene outburst flood deposits suggesting a low potential for archaeological resources to be present within the subsurface component of the C Tank Farm EU.

Ground Disturbance Indicators

Examination of 2012 aerial imagery of the EU indicates that the EU is heavily disturbed by tank farm construction, buried pipelines, surface grading, roads and waste sites. This disturbance indicates that there is a very low potential for intact archaeological resources to be present. It is still possible however, although unlikely, for pockets of undisturbed soils to exist within the C Tank Farm EU.

Summary of Cultural Resources Review

Cultural resources known to be located within the C Tank Farms EU are limited to the 271-CR Service and Office Building a contributing property within the Manhattan Project/Cold War Era Landscape with no documentation required. All documentation has been addressed as described in the *Hanford Site Manhattan Project and Cold War Era Historic District Treatment Plan* (DOE RL-97-56). There are no known archaeological sites, or TCPs known to be recorded within the C Tank Farms EU. None of the C Tank Farm EU has been inventoried for archaeological resources. Closure and remediation of the tank farms located within the C Tank Farm EU has been addressed in an NHPA Section 106 review. Given the extensive ground disturbance within the C- Tank Farm EU, it is unlikely but there is a possibility that intact archaeological material is present in the C Tank Farms EU because it has not have not been inventoried for archaeological resources (both on the surface and in the subsurface) and particularly if undisturbed soil deposits exist within the C Tank Farms EU.

Two National Register-eligible properties associated with the Manhattan Project/Cold War Era Landscape with documentation required (Hanford Site Plant Railroad and the 2707AR Sludge Vault Change House) are located within 500 meters of the C Tank Farms EU. Both have been documented as described in the *Hanford Site Manhattan Project and Cold War Era Historic District Treatment Plan* (DOE.RL-97-56). Additionally one isolated find associated with the Native American Precontact and Ethnographic Landscape has been located within 500 meters of the C Tank Farms EU. This isolated find is not considered to be eligible for the National Register of Historic Places.

Historic maps indicate that there is no evidence of historic settlement in or near the C Tank Farms EU. Geomorphology and extensive ground disturbance further indicates a low potential for the presence of intact archaeological resources associated with all three landscapes to be present subsurface within the C Tank Farms EU. Because none of the C Tank Farms EU has been investigated for archaeological sites and it is possible but unlikely that pockets of undisturbed soil exist, it may be appropriate to conduct surface and subsurface archaeological investigations in these areas prior to initiating a remediation activity. 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 associated with these landscapes (e.g. East Benton Historical Society, the Franklin County Historical Society, Prosser Cemetery Association, the Reach and B-Reactor Museum Association) may need to occur. Indirect effects are always possible when TCPs are known to be located in the general vicinity. Consultation with Hanford Tribes may also 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.

References[22]

Department of Energy. 1998. *Hanford Site Manhattan Project and Cold War Era Historic District Treatment Plan (*DOE/RL-97-56). Richland, Washington.

Chatters JC and NA Cadoret 1990. *Archaeological Survey of the 200 East and 200 West Areas, Hanford Site.* Pacific Northwest Laboratory, Richland, Washington.**

Parker, P. and T. King. 1998. *National Register Bulletin: Guidelines for Evaluating and Documenting Traditional Cultural Properties.* U.S. Department of the Interior, National Park Service. Washington, D. C.

Prendergast-Kennedy, E. and DW Harvey. 2003. *Cultural Resources Review of Retrieval, Treatment and Disposal of Tank Waste and Closure of Single Shell Tanks (Tank Closure) Environmental Impact Statement (EIS) (HCRC# 2003-200-044).* Letter to Charlotte Johnson Science Applications International Corporation. Pacific Northwest National Laboratory, Richland, Washington.**

U.S. War Department. 1943. *Real Estate Engineer Works 1943 (maps).* Washington D.C.

USGS Topographic maps. 1916. Coyote Rapid Quadrangle.

[22] **References available to qualified individuals at the Washington State Department of Archaeology and Historic Preservation

Evaluation Unit: 200-East DSTs
ID: CP-TF-8
Group: Tank Farm
Operable Unit Cross-Walk: NA
Related EU: CP-LS-7
CP-TF-5
Sites & Facilities: AN, AP, AW, AY, AZ tank farms, ancillary structures, associated liquid waste sites, and soils contamination
Key Data Sources Docs: RPP-13033
RPP-23405

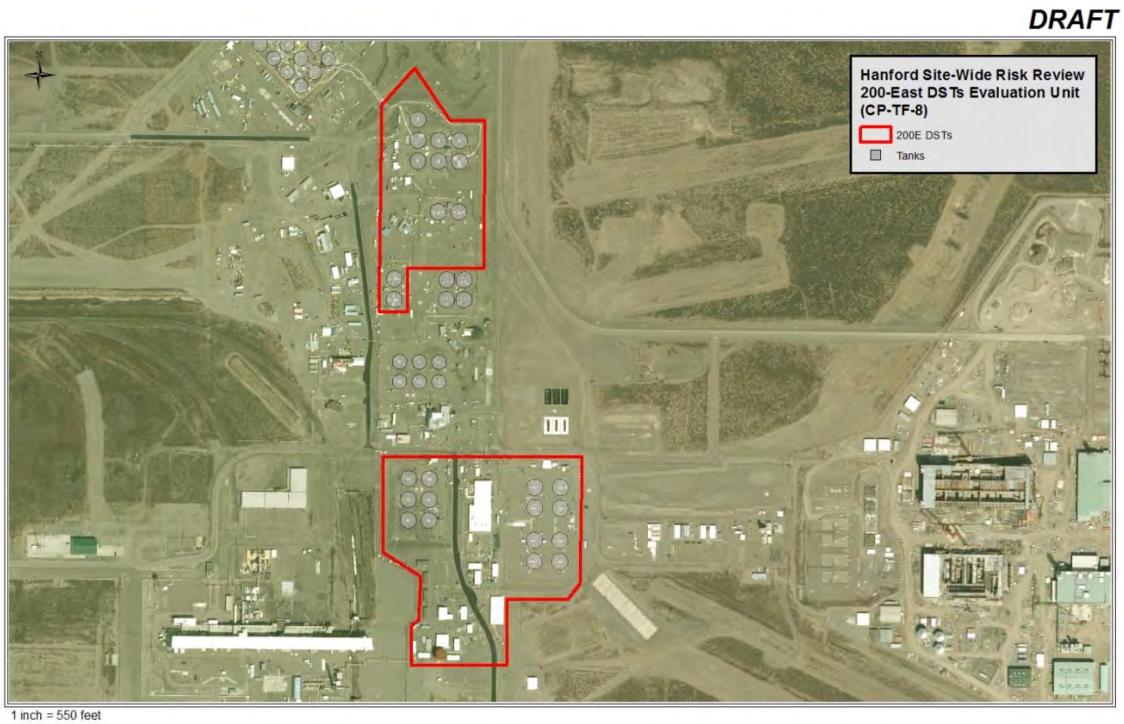

Figure K.12. Site Map with Evaluation Unit Boundaries and Tank Locations

CP-TF-8: 200-East Double Shell Tanks

Cultural Resource Reviews, Inventories and Potential for Cultural Resources

The 200-East DSTs EU is located within the 200-East Area of the Hanford Site, an area known to have low potential to contain Native American Precontact and Ethnographic archaeological resources and Pre-Hanford Early Settlers/Farming resources. Much of the 200 Areas were addressed in a cultural resources report entitled *Archaeological Survey of the 200 East and 200 West Areas, Hanford Site* (Chatters and Cadoret 1990). The focus of this archaeological survey was on inventorying all undisturbed portions of the 200-East and 200-West Areas. This report concluded that much of the 200-East and 200-West Areas can be considered areas of low archaeological potential with the exception of intact portions of an historic/ethnohistoric trail/road corridor which runs through the 200-West Area located over 5 kilometers from the 200-East DSTs EU. A very small portion of the 200-East DSTs EU has been inventoried for archaeological resources under HCRC# 87-200-002 (Chatters 1987).

Closure and remediation of the tank farms located within the 200-East DSTs EU has been addressed in an NHPA Section 106 review completed under HCRC#2003-200-044 (Prendergast-Kennedy and Harvey 2003). Given the extensive disturbance within the 200-East DSTs EU, it is unlikely, but there is a possibility that intact archaeological material is present in the areas that have not been inventoried for archaeological resources (both on the surface and in the subsurface), particularly if undisturbed soil deposits exist within the 200-East DSTs EU.

Archaeological sites, buildings and Traditional Cultural Properties (TCPs) located within the EU[23]

- The 241 AW Underground Liquid Waste Tanks Farm, a contributing property within the Manhattan Project and Cold War Era Historic District, with documentation required, is located within the 200-East DSTs EU.
- There are no archaeological sites or TCPs known to be located within the 200-East DSTs EU.

Archaeological sites and TCPs located within 500 meters of the EU

- An isolated find associated with the Native American Precontact and Ethnographic Landscape has been located within close proximity to the 200-East DSTs EU.
- The Hanford Site Plant Railroad and the 2707AR Sludge Vault Change House a contributing property within the Manhattan Project and Cold War Era Historic District with documentation required is located within close proximity to the 200-East DSTs EU.
- The 244 AR Vault Facility and Canyon and 242BA 242-A Boiler Annex are contributing properties within the Manhattan Project and Cold War Era Historic District with no documentation required are located within close proximity to the 200-East DSTs EU.
- All of the Manhattan Project/Cold War Era buildings located within the PUREX Evaluation Unit are also located in close proximity to the 200-East DST EU.

Closest Recorded TCP

There are two recorded TCPs associated with the Native American Precontact and Ethnographic Landscape that are visible from 200-East DST EU.

Historic Map and Aerial Photograph Indicators

A review of 1916 historic United States Geological Survey (USGS) maps depicts no structures, roads, or any other indication of historic settlement within the 200-East DST EU. Ownership information provided on 1943 Hanford Engineer Works Real Estate maps state that the lands

[23] Traditional cultural property has been defined by the National Park Service as "a property, a place, that is eligible for inclusion on the National Register of Historic Places because of its association with cultural practices and beliefs that are (1) rooted in the history of a community, and (2) are important to maintaining the continuity of that community's traditional beliefs and practices" (Parker and King 1998).

contained within the 200-East DST EU were owned by the U.S. Government and Benton County in 1943. (The 1943 Hanford Engineer Works Real Estate maps contain land ownership information on the Hanford Site just prior to the land being acquired by the US Government for the Manhattan Project in 1943). 1943 aerial photographs further confirm the absence of the historic settlement in the area. This information indicates a low potential for archaeological resources associated with Pre-Hanford Early Settlers/Farming landscape to be present within the 200-East DST EU.

Geomorphology Indicators

The geomorphology within the 200-East DST EU is comprised mostly of Pleistocene outburst flood deposits suggesting a low potential for Native American Precontact and Ethnographic associated archaeological resources to be present within the subsurface component of the 200-East DST EU. There is a small pocket of Holocene Dune sand along the southeastern corner of the southern-most 200-East DST EU indicating there is a higher potential for archaeological resources to be present within the subsurface component in the southeastern portion of the southern-most 200-East DST EU.

Ground Disturbance Indicators

Examination of 2012 aerial imagery of the EU indicates that the EU is heavily disturbed by tank farm construction, buried pipelines, surface grading, roads and waste sites. This disturbance indicates that there is a very low potential for intact archaeological resources to be present.

Summary of Cultural Resources Review

Cultural resources known to be located within the 200-East DST EU are limited to the 241 AW Underground Liquid Waste Tank Farm, a contributing property within the Manhattan Project/Cold War Era Landscape with no documentation required. All documentation has been addressed as described in the *Hanford Site Manhattan Project and Cold War Era Historic District Treatment Plan* (DOE RL-97-56). There are no known archaeological sites, or TCPs known to be recorded within the 200-East DSTs EU. None of the 200-East DSTs EU has been inventoried for archaeological resources with the exception of a very small portion. No archeological resources were located by this inventory in the 200-East DST EU. There is a possibility, but unlikely given the extensive disturbance in the 200-East DSTs EU, that intact archaeological material is present in the areas that have not been inventoried for archaeological resources (both on the surface and in the subsurface), particularly if undisturbed soil deposits exist within the 200-East DSTs EU. Closure and remediation of the tank farms located within the 200-East DST EU has been addressed in an NHPA Section 106 review completed.

Several National Register-eligible properties associated with the Manhattan Project/Cold War Era Landscape both with documentation required (Hanford Site Plant Railroad and the 2707AR Sludge Vault Change House) and no documentation required (244 AR Vault Facility and Canyon and 242BA 242-A Boiler Annex)are located within 500 meters of the 200-East DSTs EU. Also see the list of Manhattan Project/Cold War Era buildings located within the PUREX Evaluation Unit which is located in adjacent to the 200-East DST EU. All have been documented as described in the *Hanford Site Manhattan Project and Cold War Era Historic District Treatment Plan* (DOE.RL-97-56).

Historic maps indicate that there are no evidence of historic settlement in or near the 200-East DST EU. Geomorphology throughout most of the 200-East DST EU (with the exception of the eastern portion of the southern-most area of the 200-East DST EU) and extensive ground disturbance further suggest a low potential for intact archaeological resources associated with all three landscapes to be present subsurface within the 200-East DST EU. Pockets of undisturbed soil may exist, it may be appropriate to conduct surface and subsurface archaeological investigations in these areas prior to initiating a remediation activity. 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 associated with these landscapes (e.g. East Benton Historical Society, the Franklin County Historical Society, Prosser Cemetery Association, the Reach, and B-Reactor Museum Association) may need to occur. Indirect effects are always possible when TCPs are known to be located in the general vicinity. Consultation with Hanford Tribes may also 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.

References[24]

Department of Energy. 1998. *Hanford Site Manhattan Project and Cold War Era Historic District Treatment Plan (*DOE/RL-97-56). Richland, Washington.

Chatters, JC. 1987. *Cultural Resources Survey of the Proposed Near-Surface Disposal Site at Hanford, Washington HCRC# 87-200-002.* Pacific Northwest Laboratory. Richland, Washington.**

Chatters JC and NA Cadoret 1990. *Archaeological Survey of the 200 East and 200 West Areas, Hanford Site.* Pacific Northwest Laboratory, Richland, Washington.**

Parker, P. and T. King. 1998. *National Register Bulletin: Guidelines for Evaluating and Documenting Traditional Cultural Properties.* U.S. Department of the Interior, National Park Service. Washington, D. C.

Prendergast-Kennedy, E. and DW Harvey. 2003. *Cultural Resources Review of Retrieval, Treatment and Disposal of Tank Waste and Closure of Single Shell Tanks (Tank Closure) Environmental Impact Statement (EIS) (HCRC# 2003-200-044).* Letter to Charlotte Johnson Science Applications International Corporation. Pacific Northwest National Laboratory, Richland, Washington.**

U.S. War Department. 1943. *Real Estate Engineer Works 1943 (maps).* Washington D.C.

USGS Topographic maps. 1916. Coyote Rapid Quadrangle.

[24] **References available to qualified individuals at the Washington State Department of Archaeology and Historic Preservation

Evaluation Unit: 200-West DSTs
ID: CP-TF-9
Group: Tank Farm
Operable Unit Cross-Walk: WMA S/SX
Related EU: CP-LS-7
CP-TF-2
Sites & Facilities: SY tank farm, ancillary structures, associated liquid waste sites, and soils contamination
Key Data Sources Docs: RPP-13033
RPP-23405

Figure K.13. Site Map with Evaluation Unit Boundaries and Tank Locations

CP-TF-9: 200-West Double Shell Tanks

Cultural Resource Reviews, Inventories and Potential for Cultural Resources

The 200-West DSTs EU is located within the 200-West Area of the Hanford Site, an area known to have low potential to contain Native American Precontact and Ethnographic and Pre-Hanford Early Settlers/Farming archaeological resources. Much of the 200 Areas were addressed in a cultural resources report entitled *Archaeological Survey of the 200 East and 200 West Areas, Hanford Site* (Chatters and Cadoret 1990). The focus of this archaeological survey was on inventorying all undisturbed portions of the 200-East and 200-West Areas. This report concluded that much of the 200-East and 200-West Areas can be considered areas of low archaeological potential with the exception of intact portions of than historic/ethnohistoric

Trail/Rad corridor which runs through the 200-West Area located over 1 kilometer from the 200-West DSTs EU. None of the 200-West DSTs EU has been inventoried for archaeological resources. Given the extensive disturbance in the 200-West DSTs EU, it is unlikely but there is a possibility that intact archaeological material is present in the areas that have not been inventoried for archaeological resources (both on the surface and in the subsurface), particularly if undisturbed soil deposits exist within the 200-West DSTs EU. Closure and remediation of the tank farms located within the 200-West DSTs has been addressed in an NHPA Section 106 review completed under HCRC#2003-200-044 (Prendergast-Kennedy and Harvey 2003).

Archaeological sites, buildings and Traditional Cultural Properties (TCPs) located within the EU[25]

- There are no cultural resources known to be located within the 200-West DST.

Archaeological sites and TCPs located within 500 meters of the EU

- The 242S Evaporator Facility a contributing property within the Manhattan Project and Cold War Era Historic District, with no documentation required is located adjacent to the 200-West DST Evaluation Unit.
- The Hanford Site Plant Railroad, a contributing property within the Manhattan Project and Cold War Era Historic District, with documentation required is located in the vicinity of the 200-West DST Evaluation Unit.

Closest Recorded TCP

There are two recorded TCPs associated with the Native American Precontact and Ethnographic Landscape that are visible from the 200-West DST EU.

Historic Map and Aerial Photograph Indicators

A review of 1916 historic United States Geological Survey (USGS) maps depicts no structures, roads, or any other indication of historic settlement within the 200-West DST EU. Ownership information provided on 1943 Hanford Engineer Works Real Estate maps state that the lands contained within the 200-West DST EU were owned by the U.S. Government in 1943. (The 1943 Hanford Engineer Works Real Estate maps contain land ownership information on the Hanford Site just prior to the land being acquired by the US Government for the Manhattan Project in 1943). 1943 aerial photographs further confirm the absence of the historic settlement in the area. This information indicates a low potential for archaeological resources associated with the Pre-Hanford Early Settlers/Farming Landscape to be present within the 200-West DST EU.

[25] Traditional cultural property has been defined by the National Park Service as "a property, a place, that is eligible for inclusion on the National Register of Historic Places because of its association with cultural practices and beliefs that are (1) rooted in the history of a community, and (2) are important to maintaining the continuity of that community's traditional beliefs and practices" (Parker and King 1998).

Geomorphology Indicators

The geomorphology within the 200-West DST EU is all Pleistocene outburst flood deposits suggesting a low potential for Native American Precontact and Ethnographic archaeological resources to be present within the subsurface component of the 200-West DST EU.

Ground Disturbance Indicators

Examination of 2012 aerial imagery of the EU indicates that the EU is heavily disturbed by tank farm construction, buried pipelines, surface grading, roads and waste sites. This disturbance indicates that there is a very low potential for intact archaeological resources to be present. It is still possible however, for pockets of undisturbed soils to exist within the 200-West DST EU.

Summary of Cultural Resources Review

There are no known archaeological sites, buildings or TCPs known to be recorded within the 200-West DSTs EU. None of the 200-West DSTs EU has been inventoried for archaeological resources. Given the extensive disturbance within the 200-West DSTs EU, it is unlikely, but there is a possibility that intact archaeological material is present in the areas that have not been inventoried for archaeological resources (both on the surface and in the subsurface), particularly if undisturbed soil deposits exist within the 200-West DSTs EU. Closure and remediation of the tank farms located within the 200-West DSTs has been addressed in an NHPA Section 106 review.

Two National Register-eligible properties associated with the Manhattan Project/Cold War Era Landscape (Hanford Site Plant Railroad with documentation required and the 242S Evaporator Facility with no documentation required) are located within 500 meters of the 200-West DST EU. Both have been documented as described in the *Hanford Site Manhattan Project and Cold War Era Historic District Treatment Plan* (DOE.RL-97-56).

Historic maps indicate that there is no evidence of historic-era settlement in or near the 200-West DST EU. Geomorphology and extensive ground disturbance further indicates a low potential for the presence of intact archaeological resources associated with all three landscape to be present subsurface within the 200-West DST EU. Pockets of undisturbed soil may exist, it may be appropriate to conduct surface and subsurface archaeological investigations in these areas prior to initiating a remediation activity. 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 associated with these landscapes (e.g. East Benton Historical Society, the Franklin County Historical Society, Prosser Cemetery Association, the Reach and B-Reactor Museum Association) may need to occur. Indirect effects are always possible when TCPs are known to be located in the general vicinity. Consultation with Hanford Tribes may also 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.

References[26]

Department of Energy. 1998. *Hanford Site Manhattan Project and Cold War Era Historic District Treatment Plan (*DOE/RL-97-56). Richland, Washington.

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Parker, P. and T. King. 1998. *National Register Bulletin: Guidelines for Evaluating and Documenting Traditional Cultural Properties.* U.S. Department of the Interior, National Park Service. Washington, D. C.

Prendergast-Kennedy, E. and DW Harvey. 2003. *Cultural Resources Review of Retrieval, Treatment and Disposal of Tank Waste and Closure of Single Shell Tanks (Tank Closure) Environmental Impact Statement (EIS) (HCRC# 2003-200-044).* Letter to Charlotte Johnson Science Applications International Corporation. Pacific Northwest National Laboratory, Richland, Washington.**

U.S. War Department. 1943. *Real Estate Engineer Works 1943 (maps).* Washington D.C.

USGS Topographic maps. 1916. Coyote Rapid Quadrangle.

[26] **References available to qualified individuals at the Washington State Department of Archaeology and Historic Preservation

Evaluation Unit: 300 Area Groundwater Plumes
ID: RC-GW-1
Group: Groundwater
Operable Unit Cross-Walk: 300-FF-5
Related EU: RC-DD-1
Sites & Facilities: 300 Area uranium and associated contaminant plumes
Key Data Sources Docs: N/A

NOTE: Due to time constraints, a full literature review was not possible. Given more time, a more in depth analysis with an added level of detail for these areas is possible.

Figure K.14. Site Map with Evaluation Unit Boundaries

RC-GW-1: 300 Area Groundwater Plumes

This literature review is limited to the region of the evaluation unit where groundwater intercepts the riparian vegetation. The approach developed to assess potential impacts to cultural resources within the individual groundwater evaluation units aligns with the evaluation of ecological resources. The potential for 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). Along the shoreline adjacent to where groundwater plumes intercept and enter the river, the groundwater may not be as deep below the surface. In such areas, there could be mixing of river bank storage and groundwater at shallower depths accessible to biota, and plant roots and burrowing animals could potentially interact with portions of the groundwater plume. The shoreline of the Columbia River is very important to people in the region, and the focus of this review is on the shoreline where the groundwater intercepts the rooting zone for the riparian vegetation. Figure K.14 shows the riparian area for RC-GW-1, and Table K.4 includes the contaminants of concern exceeding accepted reference values and the area of the riparian vegetation intercepting the contaminated groundwater.

There are characterization, monitoring and remediation activities for the groundwater evaluation unit. These activities lead to soil disturbances that might impact cultural resources. Such activities are not evaluated here. Each activity has been reviewed in accordance with the cultural resources review process for DOE’s Richland Operations Offices and the Office of River Protection. 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.

Table K.4. Areal Extent (Acres) of Riparian Zone Intersected by 2013 Groundwater Plumes Within Each Groundwater Operable Unit

Evaluation Unit Groundwater Operable Unit COPC	Reference Value	RC-GW-3 100-BC-5	RC-GW-3 100-KR-4	RC-GW-2 100-NR-2	RC-GW-3 100-HR-3	CP-GW-1 200-PO-1	RC-GW-1 300-FF-5	Total Area
Carbon-14	2,000 pCi/L[a]	-	-	-	-	-	-	-
Cyanide	200 µg/L[a]	-	-	-	-	-	-	-
Chromium	10 µg/L[b]	7.61	2.78	0.04	29.90	-	-	40.32
Carbon Tetrachloride	5 µg/L[a]	-	-	-	-	-	-	-
Iodine-129	1 pCi/L[a]	-	-	-	-	-	-	-
Nitrate	45 mg/L[a]	-	-	0.38	-	-	0.61	0.99
Strontium-90	8 pCi/L[a]	2.00	-	1.14	0.14	-	-	3.28
Technetium-99	900 pCi/L[a]	-	-	-	-	-	-	-
Trichloroethylene	5 µg/L[a]	-	0.73	-	-	-	0.66	1.39
TPH-D	200 µg/L[c]	-	-	0.10	-	-	-	0.10
Tritium	20,000 pCi/L[a]	-	-	0.11	-	52.84	-	52.94
Uranium	30 µg/L[a]	-	-	-	-	-	3.21	3.21
Total Extent of Plumes[d]	-	7.61	3.55	1.54	30.51	52.84	4.20	100.25
Total Riparian Area[e]	-	491.52	78.04	11.38	792.84	357.37	208.42	2660.78

(a) EPA and/or DOH Drinking Water Standard

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

(c) EPA and/or DOH Secondary Drinking Water Standard for Total Dissolved Solids. Secondary drinking water standards are not associated with health effects, but associated with taste, odor, staining, or other aesthetic qualities.

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

(e) The Total Riparian Area is the based on the areal extent of mapped riparian vegetation along the Benton County shoreline of the Hanford Site. The total riparian area listed (2660.78 ac) includes riparian area within 100-FR-3 (721.2 ac), which is part of the Hanford Reach but is not listed in other parts of the table because there is no plume intersection with the riparian zone.

Notes:

1. All groundwater plumes were generated by CH2M HILL Plateau Remediation Company for the 2013 Hanford Site Groundwater Monitoring Report (DOE/RL-2014-32).
2. Riparian cover type was documented in the Hanford Site Environmental Report for Calendar Year 2004 (PNNL-15222).
3. The impacted riparian zone corresponds to the areal extent of the plume above the corresponding reference value listed for each COPC. Riparian cover type in 200-East Area was not included because those plants are not removing groundwater; groundwater is more than 100 ft deep in 200-East Area.

Cultural Resource Literature Reviews and Inventories

Surface archaeological inventories of the entire RC-GW-1 Riparian/Groundwater Plume Intersection EU have been previously completed in conjunction with various cultural resources compliance activities dating from 1987-present. While additional information needs to be gathered on the extent of subsurface investigations in these areas, it is apparent that the riparian area falls outside of defined operation areas, and as such contains little evidence of surface disturbance. Given the limited disturbance within the area, and the proximity to the Columbia River, it is highly likely that intact archaeological material is present both on the surface and in the subsurface throughout the riparian area. This is exhibited in the known cultural resources associated with the Native American Precontact and Ethnographic Landscape as well as the historic, Pre-Hanford Early Settlers/Farming Landscape, located within these riparian areas.

Archaeological sites, buildings and traditional cultural properties (TCPs) located within the EU[27]

- While there are no known TCPs within the riparian area, a highly culturally sensitive area associated with the Native American Precontact and Ethnographic Landscape is known to exist within the riparian area.
- There four known archaeological sites dating to the Native American Precontact and Ethnographic Landscape located within the riparian area. Three of these sites are included as part of a Washington Heritage Register listed Archaeological District. Additionally, there is one site within the riparian area that has been determined eligible for listing in the National Register of Historic Places.
- There is one archaeological site dating to the Pre-Hanford Early Settlers/Farming Landscape.

Archaeological sites, buildings and TCPs located within 500 meters of the EU

- No recorded TCPs are known to be located within 500 meters of the riparian area. As stated above, a highly culturally sensitive area exists within the general vicinity and within the riparian areas.
- Numerous archaeological resources associated with the Native American Precontact and Ethnographic Landscape, as well as the historic, Pre-Hanford Early Settlers/Farming Landscape area located within 500 meters of the riparian area.
- A total of 7 buildings within 500 meters of the riparian area were found to be contributing properties within the Manhattan Project/Cold War Era Landscape with documentation required. In accordance with the 1998 *Hanford Site Manhattan Project and Cold War Era Historic District Treatment Plan* (DOE/RL-97-56), all documentation requirements have been completed for these properties.

[27] Traditional cultural property has been defined by the National Park Service as "a property, a place, that is eligible for inclusion on the National Register of Historic Places because of its association with cultural practices and beliefs that are (1) rooted in the history of a community, and (2) are important to maintaining the continuity of that community's traditional beliefs and practices" (Parker and King 1998).

- A total of 7 buildings within 500 meters of the riparian area were found to be contributing properties within the Manhattan Project/Cold War Era Landscape with no documentation required. In accordance with the 1998 *Hanford Site Manhattan Project and Cold War Era Historic District Treatment Plan* (DOE/RL-97-56), all documentation requirements have been completed for these properties.
- Segments of the National Register-eligible Hanford Site Plant Railroad a contributing property within the Manhattan Project and Cold War Era Historic District, with documentation required, are located within 500 meters of the riparian area. In accordance with the 1998 *Hanford Site Manhattan Project and Cold War Era Historic District Treatment Plan* (DOE/RL-97-56), all documentation requirements have been completed for this property.

Recorded TCPs Visible from the EU

- There are 2 recorded TCPS (including the 1 mentioned above) known to be visible from the riparian area or within the immediate vicinity.

Historic Map and Aerial Photograph Indicators

A review of 1916, 1917 and 1924 historic United States Geological Survey (USGS) maps depict evidence of historic land use within the riparian area, mostly in the form of various primary and secondary roadways associated with the developing farming communities in these areas, such as Allard in the vicinity of the 100-K Area and the town of White Bluffs on the eastern side of the Columbia River horn. Information provided on 1943 Hanford Engineer Works Real Estate maps in conjunction with 1943 aerial imagery similarly show historic roadways running through and in close proximity to the riparian areas. (The 1943 Hanford Engineer Works Real Estate maps contain land ownership information on the Hanford Site just prior to the land being acquired by the US Government for the Manhattan Project in 1943). In addition, aerial imagery shows some agricultural development within and adjacent to the riparian areas, along with water control features, such as irrigation canals. Land ownership information indicates that areas within the riparian zone were both private and publicly owned (depending on the specific location). The information collected from historic maps and aerial imagery (in conjunction with known and recorded resources) indicate a high potential for archaeological resources associated with the Pre-Hanford Early Settlers/Farming landscape to be present within these areas.

Geomorphology Indicators

The geomorphology within the riparian areas is characterized by Quaternary (Pleistocene) outburst flood deposits (gravels and sands) and Quaternary alluvial deposits, consisting of clays, silts, sands and gravels/cobbles. The geomorphology of the area suggests a high potential for the presence of Native American Precontact and Ethnographic landscape associated archaeological resources to be present within the surface and subsurface component of these riparian areas.

Ground Disturbance Indicators

Examination of 2012 and 2013 aerial imagery of the riparian areas indicates that there has been minimal disturbance within the riparian areas with the exception of a few small pockets of disturbance associated with Hanford Site operations, remedial actions and related activities. The general undisturbed nature of these riparian areas indicates that there is a very high potential for intact archaeological resources to be present within these riparian zones (which is evidenced by the existence of numerous cultural resources both within and in close proximity to these defined areas).

Summary of Cultural Resources Review

Most of the riparian areas have been inventoried for archaeological resources, with numerous archaeological sites/isolates recorded both within and adjacent to these areas. There are numerous archaeological resources recorded within the riparian area, representing all three of the cultural landscapes present on the Hanford Site (the Native American Precontact and Ethnographic Landscape, Pre-Hanford Early Settlers/Farming Landscape and Manhattan Project/Cold War Era Landscape). While further research is needed to understand the extent of sub-surface investigations in these areas, it is apparent that there is a high probability for intact buried archaeological materials/deposits in these areas.

There are numerous cultural resources associated with all three landscapes within 500 meters of the riparian areas. These resources include archaeological sites, isolates, districts, features and structures.

Historic maps and aerial imagery indicate past land use associated with the Pre-Hanford Early Settlers/Farming Landscape within the riparian areas. Evidence of historic land use in this area is tied to many of the developing farming/agricultural communities within the current Hanford Site boundary. This, coupled with the presence of recorded historic resources within and adjacent to the riparian areas, suggest a high potential for the presence of archaeological materials from this landscape. Geomorphology indicators, along with known cultural resources data, suggests a high potential for the presence of archaeological resources associated with the Native American Precontact and Ethnographic landscape to be present within the riparian zone. Additionally, because there is little evidence of surface disturbance, it is likely that these deposits remain intact. This is further evidenced by the sheer number of archaeological resources (sites, isolates, districts and TCPs) recorded within and adjacent to these areas. With our understanding of these areas, archaeological monitoring may be appropriate as well as surface and subsurface archaeological investigations in these areas prior to initiating any remediation activity. 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) may need to occur. Consultation with Hanford Tribes would 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.

References

CH2MHill Plateau Remediation Company 2014, *Hanford Site groundwater monitoring report for 2013*, DOE/RL-2014-32, Rev. 0, CH2MHill, Richland, Wash.

Department of Energy. 1998. *Hanford Site Manhattan Project and Cold War Era Historic District Treatment Plan (*DOE/RL-97-56). Richland, Washington.

Hanf RW, JR, LF Morasch, TM Poston, and RL Dirkes. 2005. *Summary of the Hanford Site Environmental Report for Calendar Year 2004*. PNNL-15222 SUM. Pacific Northwest National Laboratory, Richland, WA.

Parker, P. and T. King. 1998. *National Register Bulletin: Guidelines for Evaluating and Documenting Traditional Cultural Properties.* U.S. Department of the Interior, National Park Service. Washington, D. C.

U.S. War Department. 1943. *Real Estate Engineer Works 1943 (maps).* Washington D.C.

USGS Topographic maps. 1916. Coyote Rapids, WA Quadrangle.

USGS Topographic maps. 1917. Pasco, WA Quadrangle.

USGS Topographic maps. 1924. Hanford, WA Quadrangle.

Evaluation Unit:	100-N GW Plume
ID:	RC-GW-2
Group:	Groundwater
Operable Unit Cross-Walk:	100-NR-2
Related EU:	NA
Sites & Facilities:	100-N strontium and associated contaminant plumes
Key Data Sources Docs:	NA

NOTE: Due to time constraints, a full literature review was not possible. Given more time, a more in depth analysis with an added level of detail for these areas is possible.

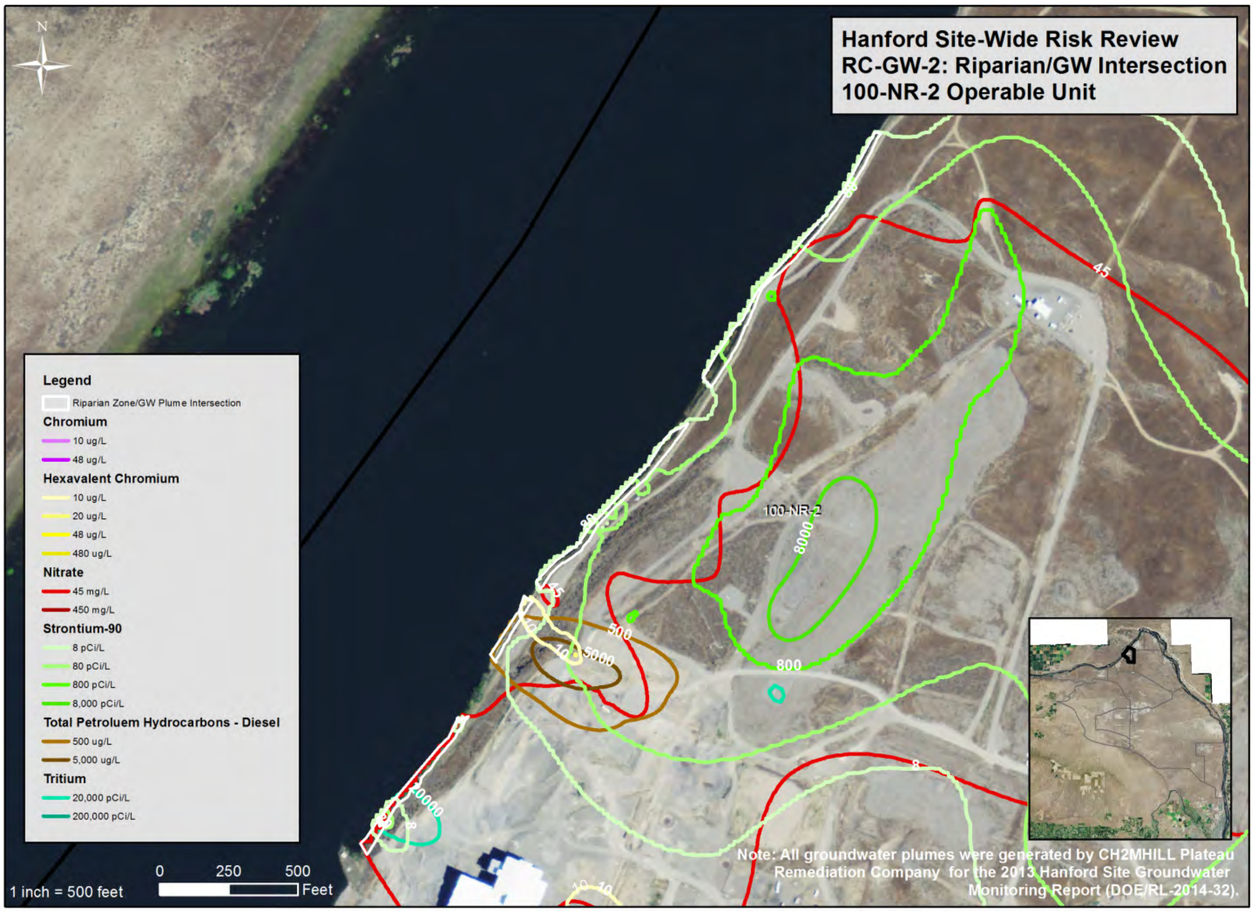

Figure K.15. Site Map with Evaluation Unit Boundaries

RC-GW-2: 100-N Groundwater Plumes

This literature review is limited to the region of the evaluation unit where groundwater intercepts the riparian vegetation. The approach developed to assess potential impacts to cultural resources within the individual groundwater evaluation units aligns with the evaluation of ecological resources. The potential for 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). Along the shoreline adjacent to where groundwater plumes intercept and enter the river, the groundwater may not be as deep below the surface. In such areas, there could be mixing of river bank storage and groundwater at shallower depths accessible to biota, and plant roots and burrowing animals could potentially interact with portions of the groundwater plume. The shoreline of the Columbia River is very important to people in the region, and the focus of this review is on the shoreline where the groundwater intercepts the rooting zone for the riparian vegetation. Figure K.15 shows the riparian area for CP-GW-1, and Table K.5 includes the contaminants of concern exceeding accepted reference values and the area of the riparian vegetation intercepting the contaminated groundwater.

There are characterization, monitoring and remediation activities for the groundwater evaluation unit. These activities lead to soil disturbances that might impact cultural resources. Such activities are not evaluated here. Each activity has been reviewed in accordance with the cultural resources review process for DOE's Richland Operations Offices and the Office of River Protection. 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.

Table K.5. Areal Extent (Acres) of Riparian Zone Intersected by 2013 Groundwater Plumes Within Each Groundwater Operable Unit

Evaluation Unit Groundwater Operable Unit COPC	Reference Value	RC-GW-3 100-BC-5	RC-GW-3 100-KR-4	RC-GW-2 100-NR-2	RC-GW-3 100-HR-3	CP-GW-1 200-PO-1	RC-GW-1 300-FF-5	Total Area
Carbon-14	2,000 pCi/L[a]	-	-	-	-	-	-	-
Cyanide	200 µg/L[a]	-	-	-	-	-	-	-
Chromium	10 µg/L[b]	7.61	2.78	0.04	29.90	-	-	40.32
Carbon Tetrachloride	5 µg/L[a]	-	-	-	-	-	-	-
Iodine-129	1 pCi/L[a]	-	-	-	-	-	-	-
Nitrate	45 mg/L[a]	-	-	0.38	-	-	0.61	0.99
Strontium-90	8 pCi/L[a]	2.00	-	1.14	0.14	-	-	3.28
Technetium-99	900 pCi/L[a]	-	-	-	-	-	-	-
Trichloroethylene	5 µg/L[a]	-	0.73	-	-	-	0.66	1.39
TPH-D	200 µg/L[c]	-	-	0.10	-	-	-	0.10
Tritium	20,000 pCi/L[a]	-	-	0.11	-	52.84	-	52.94
Uranium	30 µg/L[a]	-	-	-	-	-	3.21	3.21
Total Extent of Plumes[d]	-	7.61	3.55	1.54	30.51	52.84	4.20	100.25
Total Riparian Area[e]	-	491.52	78.04	11.38	792.84	357.37	208.42	2660.78

(a) EPA and/or DOH Drinking Water Standard
(b) Criteria for chronic exposure in fresh water, WAC 173-201A-240. "Water Quality Standards for Surface Waters of the State of Washington," "Toxic Substances," Table 240(3).
(c) EPA and/or DOH Secondary Drinking Water Standard for Total Dissolved Solids. Secondary drinking water standards are not associated with health effects, but associated with taste, odor, staining, or other aesthetic qualities.
(d) The Total Extent of Plumes for a given Operable Unit is not equal the sum of individual COPC plume areas because some plumes overlap; i.e., the total represents the combined 2-dimensional extent of individual COPC plumes.
(e) The Total Riparian Area is the based on the areal extent of mapped riparian vegetation along the Benton County shoreline of the Hanford Site. The total riparian area listed (2660.78 ac) includes riparian area within 100-FR-3 (721.2 ac), which is part of the Hanford Reach but is not listed in other parts of the table because there is no plume intersection with the riparian zone.

Notes:

1. All groundwater plumes were generated by CH2M HILL Plateau Remediation Company for the 2013 Hanford Site Groundwater Monitoring Report (DOE/RL-2014-32).
2. Riparian cover type was documented in the Hanford Site Environmental Report for Calendar Year 2004 (PNNL-15222).
3. The impacted riparian zone corresponds to the areal extent of the plume above the corresponding reference value listed for each COPC. Riparian cover type in 200-East Area was not included because those plants are not removing groundwater; groundwater is more than 100 ft deep in 200-East Area.

Cultural Resource Literature Reviews and Inventories

Surface archaeological surveys of most of the CP-GW-2 Riparian/Groundwater Plume Intersection EU have been previously completed in conjunction with various cultural resources compliance activities dating from 1992-2002. While additional information needs to be gathered on the extent of subsurface investigations in these areas, it is apparent that the riparian zone falls outside of defined operation areas, and as such contains little evidence of surface disturbance. Given the limited disturbance within the area, and the proximity to the Columbia River, it is highly likely that intact archaeological material is present both on the surface and in the subsurface throughout the riparian area. A review of existing cultural resources data and historic records indicate a high potential for archaeological resources associated with the Native American Precontact and Ethnographic Landscape as well as the historic, Pre-Hanford Early Settlers/Farming Landscape within these riparian areas.

Archaeological sites, buildings and traditional cultural properties (TCPs) located within the EU[28]

- One recorded/known TCP falls within the riparian area for this EU. This TCP is associated with the Native American Precontact and Ethnographic Landscape and has been determined eligible for the National Register of Historic Places.

Archaeological sites, buildings and TCPs located within 500 meters of the EU

- Aside from the TCP mentioned above, no additional recorded TCPs are located within 500 meters of the riparian area.
- Three archaeological sites associated with the Native American Precontact and Ethnographic Landscape are located within 500 meters of the riparian area. None of these recorded resources have been formerly evaluated for listing in the National Register of Historic Places.
- A total of 4 buildings within 500 meters of the riparian area were found to be contributing properties within the Manhattan Project/Cold War Era Landscape with documentation required. In accordance with the 1998 *Hanford Site Manhattan Project and Cold War Era Historic District Treatment Plan* (DOE/RL-97-56), all documentation requirements have been completed for these properties.
- A total of one building within 500 meters of the riparian area was found to be contributing properties within the Manhattan Project/Cold War Era Landscape with no documentation required. In accordance with the 1998 *Hanford Site Manhattan Project and Cold War Era Historic District Treatment Plan* (DOE/RL-97-56), all documentation requirements have been completed for these properties.
- Segments of the National Register-eligible Hanford Site Plant Railroad a contributing property within the Manhattan Project and Cold War Era Historic District, with documentation required, are located within 500 meters of the riparian area. In

[28] Traditional cultural property has been defined by the National Park Service as "a property, a place, that is eligible for inclusion on the National Register of Historic Places because of its association with cultural practices and beliefs that are (1) rooted in the history of a community, and (2) are important to maintaining the continuity of that community's traditional beliefs and practices" (Parker and King 1998).

accordance with the 1998 *Hanford Site Manhattan Project and Cold War Era Historic District Treatment Plan* (DOE/RL-97-56), all documentation requirements have been completed for this property.

Recorded TCPs Visible from the EU

- There is one recorded TCP known to be visible from the riparian area or within the immediate vicinity (the same as the one mentioned above).

Historic Map and Aerial Photograph Indicators

A review of 1916 historic United States Geological Survey (USGS) maps depicts some evidence of historic land use in the general vicinity of these riparian areas, mostly in the form of roadways with some structures present within the general area. Ownership information provided on 1943 Hanford Engineer Works Real Estate maps state that the lands contained within riparian areas were owned by the State of Washington in 1943. (The 1943 Hanford Engineer Works Real Estate maps contain land ownership information on the Hanford Site just prior to the land being acquired by the US Government for the Manhattan Project in 1943). 1943 aerial photographs confirm evidence of historic land use, mostly in the form of various roadways. This information indicates a potential for archaeological resources associated with the Pre-Hanford Early Settlers/Farming landscape to be present within the riparian areas.

Geomorphology Indicators

The geomorphology within the riparian areas is combination of Quaternary alluvium and Pleistocene outburst gravels with a thin layer of Holocene deposits, suggesting a high potential for Native American Precontact and Ethnographic landscape associated archaeological resources to be present within the surface and subsurface component of the riparian areas.

Ground Disturbance Indicators

Examination of 2012 and 2013 aerial imagery of the riparian areas indicates that there has been minimal disturbance within the riparian zone with the exception of a few roads. The general undisturbed nature of the riparian areas indicates that there is a very high potential for intact archaeological resources to be present within these riparian areas. Note that the monitoring wells for the in-situ permeable reactive barrier for removal of strontium-90 in the groundwater is not within the riparian vegetation area, and not included in this EU (Figure K.16).

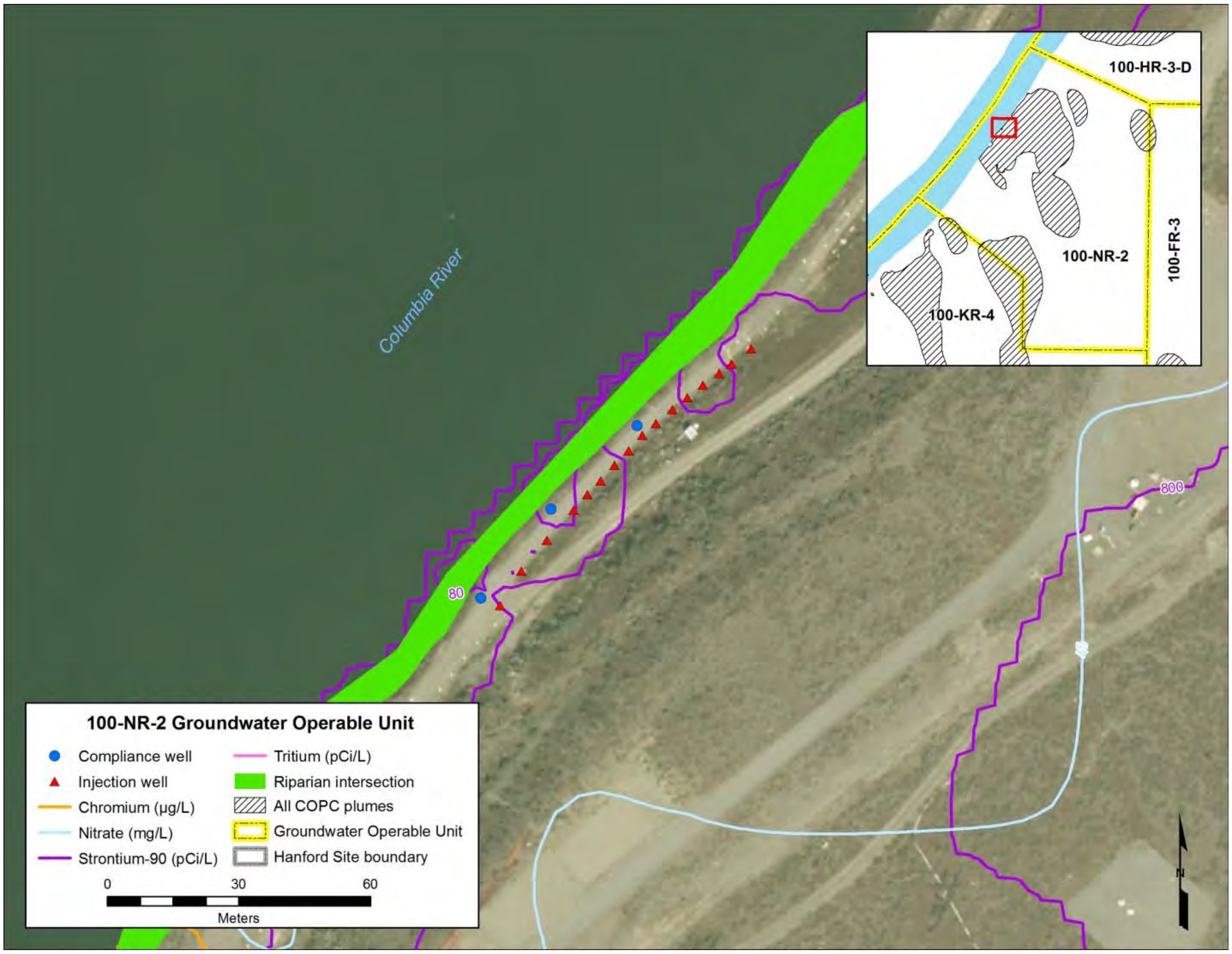

Figure K.16. In-situ Permeable Reactive Barrier Wells in Relationship to the Riparian Zone/Groundwater Plume Intersection Area

Summary of Cultural Resources Review

The entire riparian zone has been inventoried for archaeological resources. These inventories have resulted in the recordation of archaeological resources both within, and adjacent to these areas. One TCP related to the Native American Precontact and Ethnographic landscape is currently recorded within the riparian area. This property has also been determined eligible for listing in the National Register of Historic Places. While further research is needed to understand the extent of sub-surface investigations in these areas, it is apparent that there is the potential for intact buried archaeological materials/deposits in these areas.

There are numerous cultural resources associated with the Pre Contact Native American and Ethnographic Landscape as well as the Manhattan Project/Cold War Era Landscape located within 500 meters of the riparian areas including archaeological isolates, sites, features and buildings.

Historic maps indicate historic land use within and adjacent to the riparian areas, associated with the Pre-Hanford Early Settlers/Farming and the Manhattan Project and Cold War era. This evidence of historic land use suggests the potential for resources from these two landscapes to exist both within and adjacent to the riparian areas. Geomorphology indicators, along with our knowledge of cultural resources in these areas also suggests the potential for the presence of archaeological resources associated with the Native American Precontact and Ethnographic landscape within these riparian areas. Additionally, because there is little evidence of surface disturbance, it is likely that these soil deposits remain intact. With our understanding of these areas along with our knowledge of the presence of culturally sensitive areas within and adjacent to these riparian zones, archaeological monitoring may be appropriate as well as surface and subsurface archaeological investigations in these areas prior to initiating any remediation activity. 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) may need to occur. Consultation with Hanford Tribes would also be necessary to provide input on indirect effects to both recorded and potentially unrecorded TCPs in the area and other cultural resource issues of concern.

References

CH2MHill Plateau Remediation Company 2014, *Hanford Site groundwater monitoring report for 2013*, DOE/RL-2014-32, Rev. 0, CH2MHill, Richland, Wash.

Department of Energy. 1998. *Hanford Site Manhattan Project and Cold War Era Historic District Treatment Plan (*DOE/RL-97-56). Richland, Washington.

Hanf RW, JR, LF Morasch, TM Poston, and RL Dirkes. 2005. *Summary of the Hanford Site Environmental Report for Calendar Year 2004*. PNNL-15222 SUM. Pacific Northwest National Laboratory, Richland, WA.

Parker, P. and T. King. 1998. *National Register Bulletin: Guidelines for Evaluating and Documenting Traditional Cultural Properties.* U.S. Department of the Interior, National Park Service. Washington, D. C.

U.S. War Department. 1943. *Real Estate Engineer Works 1943 (maps).* Washington D.C.

USGS Topographic maps. 1916. Coyote Rapid Quadrangle.

Evaluation Unit:	100-B/D/H/F/K Area GW Plumes
ID:	RC-GW-3
Group:	Groundwater
Operable Unit Cross-Walk:	100-BC-5 100-KR-4 100-HR-3 (100-FR-3 is not included because the groundwater plumes are not currently intercepting the riparian areas)
Related EU:	NA
Sites & Facilities:	100-B/D/H/F/K Area Chromium and associated contaminant plumes. Includes pump and treat systems
Key Data Sources Docs:	SGW-40938, Rev 0

NOTE: Due to time constraints, a full literature review was not possible. Given more time, a more in depth analysis with an added level of detail for these areas is possible. There is no discussion of riparian areas for 100-FR-3 because the groundwater plumes in that Operable Unit are not currently intercepting the riparian areas.

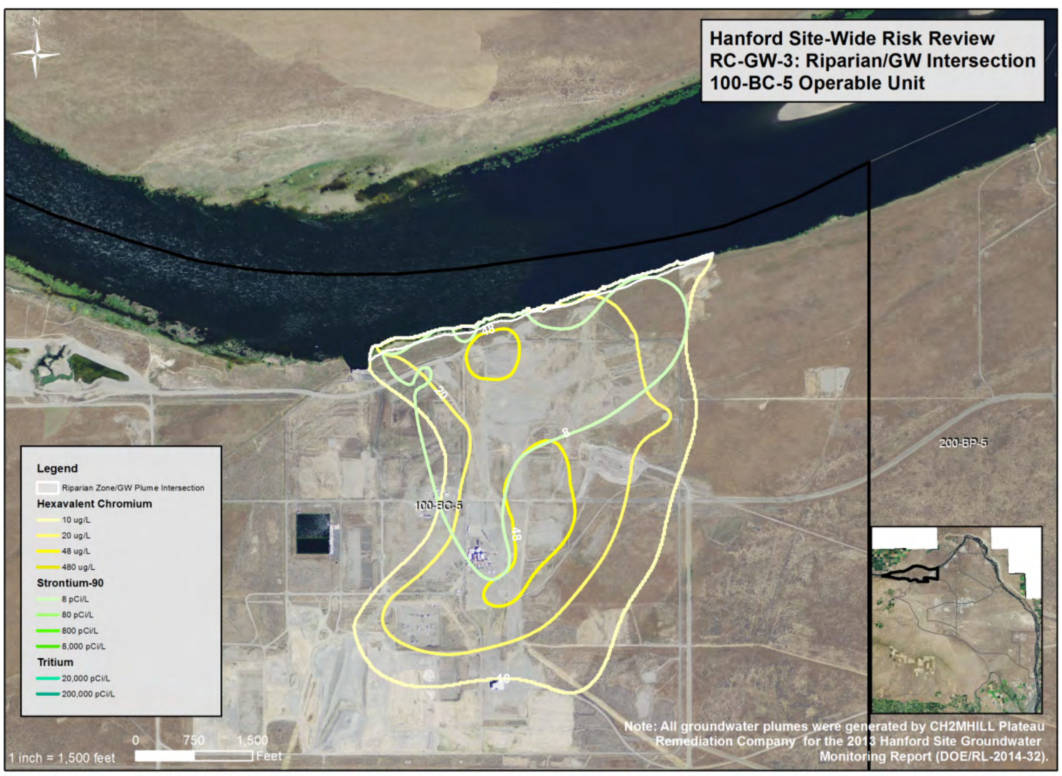

Figure K.17. Groundwater Plumes Intercepting the Riparian Areas Around 100-BC-5

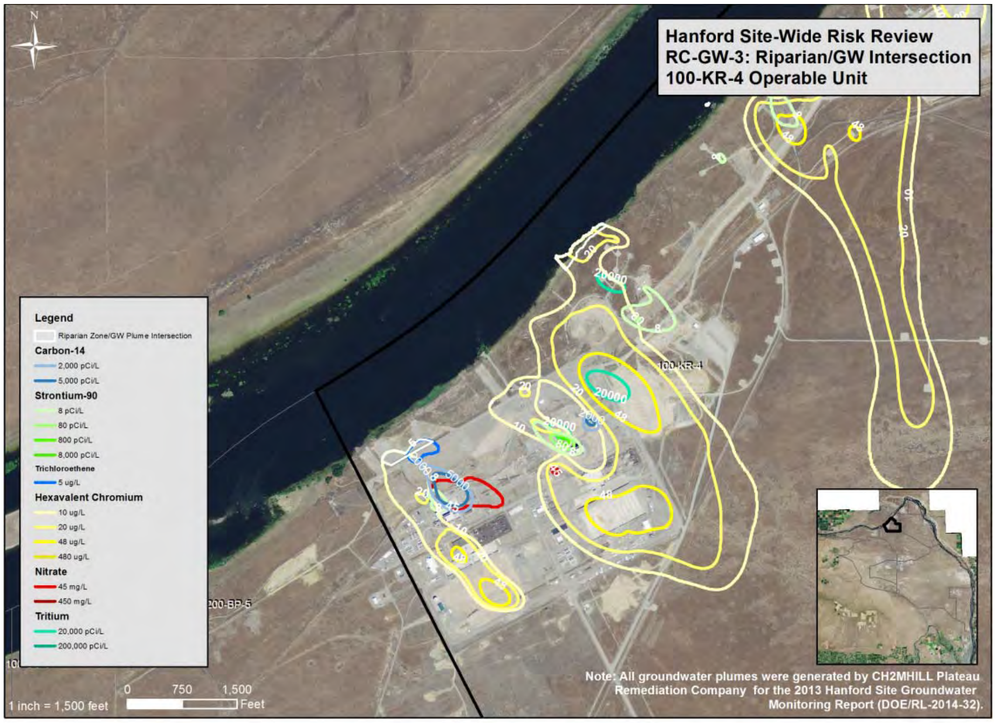

Figure K.18. Groundwater Plumes Intercepting the Riparian Areas Around 100-KR-4

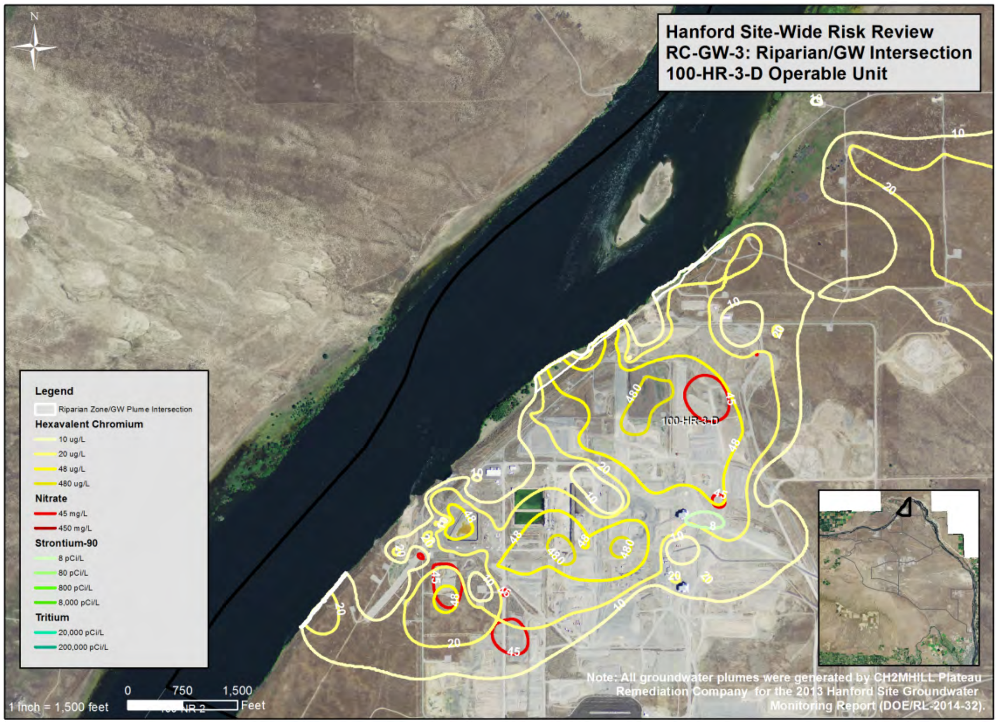

Figure K.19. Groundwater Plumes Intercepting the Riparian Areas on the Western Portion of 100-HR-3

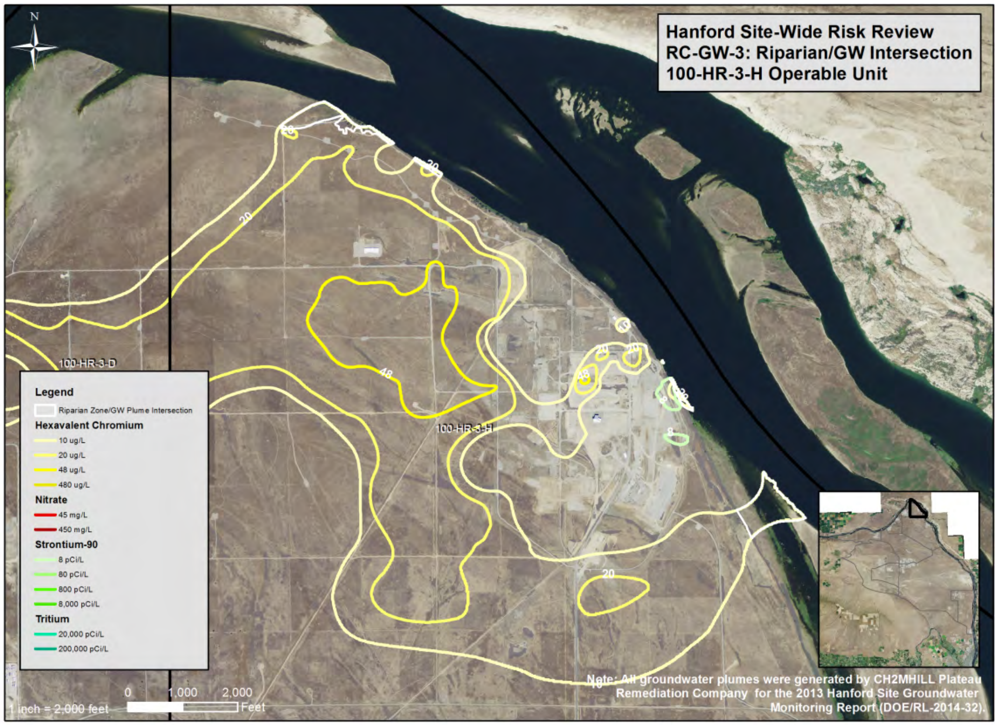

Figure K.20. Groundwater Plumes Intercepting the Riparian Areas on the Eastern Portion of 100-HR-3

RC-GW-3: 100-B/D/H/F/K Area Groundwater Plumes

This literature review is limited to the region of the evaluation unit where groundwater intercepts the riparian vegetation. The approach developed to assess potential impacts to cultural resources within the individual groundwater evaluation units aligns with the evaluation of ecological resources. The potential for 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). Along the shoreline adjacent to where groundwater plumes intercept and enter the river, the groundwater may not be as deep below the surface. In such areas, there could be mixing of river bank storage and groundwater at shallower depths accessible to biota, and plant roots and burrowing animals could potentially interact with portions of the groundwater plume. The shoreline of the Columbia River is very important to people in the region, and the focus of this review is on the shoreline where the groundwater intercepts the rooting zone for the riparian vegetation. Figure K.17 through Figure K.20 show the riparian area for RC-GW-3, and Table K.6 includes the contaminants of concern exceeding accepted reference values and the area of the riparian vegetation intercepting the contaminated groundwater.

There are characterization, monitoring and remediation activities for the groundwater evaluation unit. These activities lead to soil disturbances that might impact cultural resources.

Such activities are not evaluated here. Each activity has been reviewed in accordance with the cultural resources review process for DOE's Richland Operations Offices and the Office of River Protection. 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.

Table K.6. Areal Extent (Acres) of Riparian Zone Intersected by 2013 Groundwater Plumes Within Each Groundwater Operable Unit

Evaluation Unit Groundwater Operable Unit COPC	Reference Value	RC-GW-3 100-BC-5	RC-GW-3 100-KR-4	RC-GW-2 100-NR-2	RC-GW-3 100-HR-3	CP-GW-1 200-PO-1	RC-GW-1 300-FF-5	Total Area
Carbon-14	2,000 pCi/L[a]	-	-	-	-	-	-	-
Cyanide	200 µg/L[a]	-	-	-	-	-	-	-
Chromium	10 µg/L[b]	7.61	2.78	0.04	29.90	-	-	40.32
Carbon Tetrachloride	5 µg/L[a]	-	-	-	-	-	-	-
Iodine-129	1 pCi/L[a]	-	-	-	-	-	-	-
Nitrate	45 mg/L[a]	-	-	0.38	-	-	0.61	0.99
Strontium-90	8 pCi/L[a]	2.00	-	1.14	0.14	-	-	3.28
Technetium-99	900 pCi/L[a]	-	-	-	-	-	-	-
Trichloroethylene	5 µg/L[a]	-	0.73	-	-	-	0.66	1.39
TPH-D	200 µg/L[c]	-	-	0.10	-	-	-	0.10
Tritium	20,000 pCi/L[a]	-	-	0.11	-	52.84	-	52.94
Uranium	30 µg/L[a]	-	-	-	-	-	3.21	3.21
Total Extent of Plumes[d]	-	7.61	3.55	1.54	30.51	52.84	4.20	100.25
Total Riparian Area[e]	-	491.52	78.04	11.38	792.84	357.37	208.42	2660.78

(a) EPA and/or DOH Drinking Water Standard

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

(c) EPA and/or DOH Secondary Drinking Water Standard for Total Dissolved Solids. Secondary drinking water standards are not associated with health effects, but associated with taste, odor, staining, or other aesthetic qualities.

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

(e) The Total Riparian Area is the based on the areal extent of mapped riparian vegetation along the Benton County shoreline of the Hanford Site. The total riparian area listed (2660.78 ac) includes riparian area within 100-FR-3 (721.2 ac), which is part of the Hanford Reach but is not listed in other parts of the table because there is no plume intersection with the riparian zone.

Notes:

1. All groundwater plumes were generated by CH2M HILL Plateau Remediation Company for the 2013 Hanford Site Groundwater Monitoring Report (DOE/RL-2014-32).
2. Riparian cover type was documented in the Hanford Site Environmental Report for Calendar Year 2004 (PNNL-15222).

3. The impacted riparian zone corresponds to the areal extent of the plume above the corresponding reference value listed for each COPC. Riparian cover type in 200-East Area was not included because those plants are not removing groundwater; groundwater is more than 100 ft deep in 200-East Area.

Cultural Resource Literature Reviews and Inventories

Surface archaeological surveys of most of the RC-GW-3 Riparian/Groundwater Plume Intersection EU have been previously completed in conjunction with various cultural resources compliance activities dating from 1991-2011. While additional information needs to be gathered on the extent of subsurface investigations in these areas, it is apparent that the riparian zone falls outside of defined operation areas, and as such contains little evidence of surface disturbance. Given the limited disturbance within the area, and the proximity to the Columbia River, it is highly likely that intact archaeological material is present both on the surface and in the subsurface throughout the riparian areas. A review of existing cultural resources data and historic records indicate a high potential for archaeological resources associated with all three landscapes (the Native American Precontact and Ethnographic Landscape, Pre-Hanford Early Settlers/Farming Landscape and Manhattan Project/Cold War Era Landscape) within these riparian areas.

Archaeological sites, buildings and traditional cultural properties (TCPs) located within the EU[29]

- There is one known recorded TCP within the riparian area.
- There are ten known archaeological sites dating to the Native American Precontact and Ethnographic landscape located within the riparian areas. Two of these sites are included in as part of a Washington Heritage Register listed archaeological district. One additional site is included as part of a National Register listed archaeological district. Four of these sites have been determined eligible for listing in the National Register of Historic Places. The remaining three sites have not been evaluated for listing in the National Register of Historic Places.
- The boundary of one additional National Register listed archaeological district intersects with the riparian area.
- There are three known archaeological sites dating to the Pre-Hanford Early Settlers/Farming Landscape within the riparian area. All three sites have been determined not eligible for listing in the National Register of Historic Places.
- There is one known archaeological site dating to the Manhattan Project/Cold War Era Landscape within the riparian area. This site has been determined not eligible for listing in the National Register of Historic Places.

[29] Traditional cultural property has been defined by the National Park Service as "a property, a place, that is eligible for inclusion on the National Register of Historic Places because of its association with cultural practices and beliefs that are (1) rooted in the history of a community, and (2) are important to maintaining the continuity of that community's traditional beliefs and practices" (Parker and King 1998).

Archaeological sites, buildings and TCPs located within 500 meters of the EU

- No additional recorded TCPs (aside from the one mentioned above) are located within 500 meters of the riparian area.
- Numerous archaeological resources (sites, isolates and features) associated with the Native American Precontact and Ethnographic Landscape, as well as the historic, Pre-Hanford Early Settlers/Farming Landscape area located within 500 meters of the riparian area.
- There are two recorded, Washington State Register listed archaeological districts within 500 meters of the riparian areas. Both of these districts are associated with the Native American Precontact and Ethnographic Landscape.
- A total of 17 buildings within 500 meters of the riparian area were found to be contributing properties within the Manhattan Project/Cold War Era Landscape with documentation required. In accordance with the 1998 *Hanford Site Manhattan Project and Cold War Era Historic District Treatment Plan* (DOE/RL-97-56), all documentation requirements have been completed for these properties.
- A total of 19 buildings within 500 meters of the riparian area were found to be contributing properties within the Manhattan Project/Cold War Era Landscape with no documentation required. In accordance with the 1998 *Hanford Site Manhattan Project and Cold War Era Historic District Treatment Plan* (DOE/RL-97-56), all documentation requirements have been completed for these properties.
- Segments of the National Register-eligible Hanford Site Plant Railroad a contributing property within the Manhattan Project and Cold War Era Historic District, with documentation required, are located within 500 meters of the riparian area. In accordance with the 1998 *Hanford Site Manhattan Project and Cold War Era Historic District Treatment Plan* (DOE/RL-97-56), all documentation requirements have been completed for this property.

Recorded TCPs Visible from the EU

- There are 2 recorded TCPS known to be visible from the riparian area or within the immediate vicinity.

Historic Map and Aerial Photograph Indicators

A review of 1916, 1917 and 1924 historic United States Geological Survey (USGS) maps depict evidence of historic land use within the riparian area, mostly in the form of various primary and secondary roadways associated with the developing farming communities in these areas, such as Allard in the vicinity of the 100-K Area and the town of White Bluffs on the eastern side of the Columbia River horn. Information provided on 1943 Hanford Engineer Works Real Estate maps in conjunction with 1943 aerial imagery similarly show historic roadways running through and in close proximity to the riparian areas. (The 1943 Hanford Engineer Works Real Estate maps contain land ownership information on the Hanford Site just prior to the land being acquired by the US Government for the Manhattan Project in 1943). In addition, aerial imagery shows some agricultural development within and adjacent to the riparian areas, along with water control features, such as irrigation canals. Land ownership information indicates that areas within the riparian zone were both private and publicly owned (depending on the specific location). The information collected from historic maps and aerial imagery (in conjunction with known and recorded resources) indicate a high potential for archaeological resources associated with the Pre-Hanford Early Settlers/Farming landscape to be present within these areas.

Geomorphology Indicators

The geomorphology within the riparian areas is characterized by Quaternary (Pleistocene) outburst flood deposits (gravels and sands) and Quaternary alluvial deposits, consisting of clays, silts, sands and gravels/cobbles. The geomorphology of the area suggests a high potential for the presence of Native American Precontact and Ethnographic landscape associated archaeological resources to be present within the surface and subsurface component of these riparian areas.

Ground Disturbance Indicators

Examination of 2012 and 2013 aerial imagery of the riparian areas indicates that there has been minimal disturbance within the riparian areas with the exception of a few small pockets of disturbance associated with Hanford Site operations, remedial actions and related activities. The general undisturbed nature of these riparian areas indicates that there is a very high potential for intact archaeological resources to be present within these riparian zones (which is evidenced by the existence of numerous cultural resources both within and in close proximity to these defined areas).

Summary of Cultural Resources Review

Most of the riparian areas have been inventoried for cultural resources, with numerous archaeological sites/isolates recorded both within and adjacent to these areas. Various cultural resources reviews have been conducted to inventory these areas as part of ongoing Hanford operations, and to address potential impacts from those activities to these existing resources. There are numerous archaeological resources recorded within the riparian area, representing all three of the cultural landscapes present on the Hanford Site (the Native American Precontact and Ethnographic Landscape, Pre-Hanford Early Settlers/Farming Landscape and Manhattan Project/Cold War Era Landscape). While further research is needed to understand the extent of sub-surface investigations in these areas, it is apparent that there is a high probability for intact buried archaeological materials/deposits in these areas.

There are numerous cultural resources associated with all three landscapes within 500 meters of the riparian areas. These resources include archaeological sites, isolates, districts, features and structures.

Historic maps and aerial imagery indicate past land use associated with the Pre-Hanford Early Settlers/Farming Landscape within the riparian areas. Evidence of historic land use in this area is tied to many of the developing farming/agricultural communities within the current Hanford Site boundary. This, coupled with the presence of recorded historic resources within and adjacent to the riparian areas, suggest a high potential for the presence of archaeological materials from this landscape. Geomorphology indicators, along with known cultural resources data, suggests a high potential for the presence of archaeological resources associated with the Native American Precontact and Ethnographic landscape to be present within the riparian zone. Additionally, because there is little evidence of surface disturbance, it is likely that these deposits remain intact. This is further evidenced by the sheer number of archaeological resources (sites, isolates, districts and TCPs) recorded within and adjacent to these areas. With our understanding of these areas, archaeological monitoring may be appropriate as well as surface and subsurface archaeological investigations in these areas prior to initiating any remediation activity. 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) may need to occur. Consultation with Hanford Tribes would 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.

References

CH2MHill Plateau Remediation Company 2014, *Hanford Site groundwater monitoring report for 2013*, DOE/RL-2014-32, Rev. 0, CH2MHill, Richland, Wash.

Department of Energy. 1998. *Hanford Site Manhattan Project and Cold War Era Historic District Treatment Plan (*DOE/RL-97-56). Richland, Washington.

Hanf RW, JR, LF Morasch, TM Poston, and RL Dirkes. 2005. *Summary of the Hanford Site Environmental Report for Calendar Year 2004*. PNNL-15222 SUM. Pacific Northwest National Laboratory, Richland, WA.

Parker, P. and T. King. 1998. *National Register Bulletin: Guidelines for Evaluating and Documenting Traditional Cultural Properties.* U.S. Department of the Interior, National Park Service. Washington, D. C.

U.S. War Department. 1943. *Real Estate Engineer Works 1943 (maps).* Washington D.C.

USGS Topographic maps. 1916. Coyote Rapids, WA Quadrangle.

USGS Topographic maps. 1917. Pasco, WA Quadrangle.

USGS Topographic maps. 1924. Hanford, WA Quadrangle.

Evaluation Unit:	200-East Groundwater
ID:	CP-GW-1
Group:	Groundwater
Operable Unit Cross-Walk:	200-BP-5 200-PO-1
Related EU:	CP-LS-1, 8, 9, 10, 11; CP-TF-5, 6, 7
Sites & Facilities:	Existing groundwater plumes emanating from the 200-East area
Key Data Sources Docs:	NA

NOTE: Due to time constraints, a full literature review was not possible. Given more time, a more in depth analysis with an added level of detail for these areas is possible.

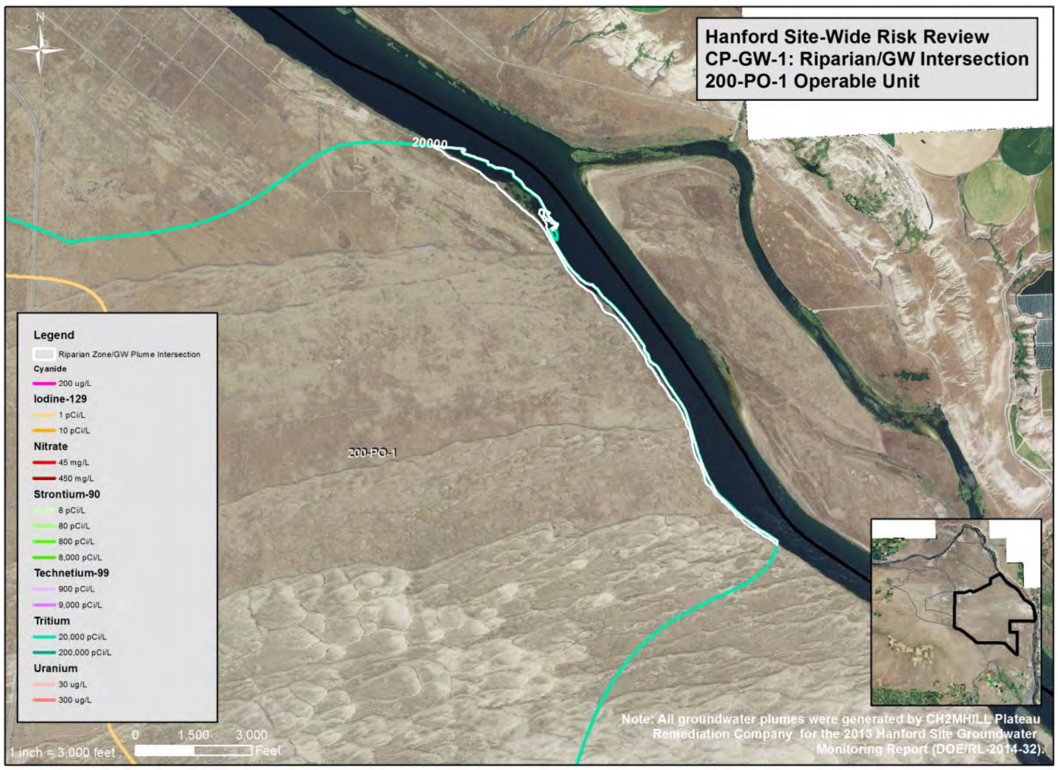

Figure K.21. 200-East Groundwater Plumes Intercepting the Riparian Areas

CP-GW-1: 200-East Groundwater Plumes

This review is limited to the region of the evaluation unit where groundwater intercepts the riparian vegetation. The approach developed to assess potential impacts to cultural resources within the individual groundwater evaluation units aligns with the evaluation of ecological resources. The potential for 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). Along the shoreline adjacent to where groundwater plumes intercept and enter the river, the groundwater may not be as deep below the surface. In such areas, there could be mixing of river bank storage and groundwater at shallower depths accessible to biota, and plant roots and burrowing animals could potentially interact with portions of the groundwater plume. The shoreline of the Columbia River is very important to people in the region, and the focus of this review is on the shoreline where the groundwater intercepts the rooting zone for the riparian vegetation. Figure K.21 shows the riparian area for CP-GW-1, and Table K.7 includes the contaminants of concern exceeding accepted reference values and the area of the riparian vegetation intercepting the contaminated groundwater.

There are characterization, monitoring and remediation activities for the groundwater evaluation unit. These activities lead to soil disturbances that might impact cultural resources. Such activities are not evaluated here. Each activity has been reviewed in accordance with the cultural resources review process for DOE's Richland Operations Offices and the Office of River Protection. 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.

Table K.7. Areal Extent (Acres) of Riparian Zone Intersected by 2013 Groundwater Plumes Within Each Groundwater Operable Unit

Evaluation Unit Groundwater Operable Unit COPC	Reference Value	RC-GW-3 100-BC-5	RC-GW-3 100-KR-4	RC-GW-2 100-NR-2	RC-GW-3 100-HR-3	CP-GW-1 200-PO-1	RC-GW-1 300-FF-5	Total Area
Carbon-14	2,000 pCi/L[a]	-	-	-	-	-	-	-
Cyanide	200 µg/L[a]	-	-	-	-	-	-	-
Chromium	10 µg/L[b]	7.61	2.78	0.04	29.90	-	-	40.32
Carbon Tetrachloride	5 µg/L[a]	-	-	-	-	-	-	-
Iodine-129	1 pCi/L[a]	-	-	-	-	-	-	-
Nitrate	45 mg/L[a]	-	-	0.38	-	-	0.61	0.99
Strontium-90	8 pCi/L[a]	2.00	-	1.14	0.14	-	-	3.28
Technetium-99	900 pCi/L[a]	-	-	-	-	-	-	-
Trichloroethylene	5 µg/L[a]	-	0.73	-	-	-	0.66	1.39
TPH-D	200 µg/L[c]	-	-	0.10	-	-	-	0.10
Tritium	20,000 pCi/L[a]	-	-	0.11	-	52.84	-	52.94
Uranium	30 µg/L[a]	-	-	-	-	-	3.21	3.21
Total Extent of Plumes[d]	-	7.61	3.55	1.54	30.51	52.84	4.20	100.25
Total Riparian Area[e]	-	491.52	78.04	11.38	792.84	357.37	208.42	2660.78

(a) EPA and/or DOH Drinking Water Standard

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

(c) EPA and/or DOH Secondary Drinking Water Standard for Total Dissolved Solids. Secondary drinking water standards are not associated with health effects, but associated with taste, odor, staining, or other aesthetic qualities.

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

(e) The Total Riparian Area is the based on the areal extent of mapped riparian vegetation along the Benton County shoreline of the Hanford Site. The total riparian area listed (2660.78 ac) includes riparian area within 100-FR-3 (721.2 ac), which is part of the Hanford Reach but is not listed in other parts of the table because there is no plume intersection with the riparian zone.

Notes:

1. All groundwater plumes were generated by CH2M HILL Plateau Remediation Company for the 2013 Hanford Site Groundwater Monitoring Report (DOE/RL-2014-32).
2. Riparian cover type was documented in the Hanford Site Environmental Report for Calendar Year 2004 (PNNL-15222).
3. The impacted riparian zone corresponds to the areal extent of the plume above the corresponding reference value listed for each COPC. Riparian cover type in 200-East Area was not included because those plants are not removing groundwater; groundwater is more than 100 ft deep in 200-East Area.

Cultural Resource Literature Reviews and Inventories

Surface surveys of most of the CP-GW-1 Riparian/Groundwater Plume Intersection EU have been previously completed in conjunction with various NHPA reviews and projects dating from 1992-2002. While additional information needs to be gathered on the extent of subsurface investigations in these areas, it is apparent that the riparian zone falls outside of defined operation areas, and as such contains little evidence of surface disturbance. Given the limited disturbance within the area, and the proximity to the Columbia River, it is highly likely that intact archaeological material is present both on the surface and in the subsurface throughout the riparian area. A review of existing cultural resources data and historic records indicate a high potential for archaeological resources associated with the Native American Precontact and Ethnographic Landscape as well as the historic, Pre-Hanford Early Settlers/Farming Landscape within these riparian areas.

Archaeological sites, buildings and traditional cultural properties (TCPs) located within the EU[30]

- There are no known recorded TCPs within the riparian area.
- There are four known archaeological sites dating to the Native American Precontact and Ethnographic landscape located within the riparian area. Two of these sites are included as part of a National Register and Washington Heritage Register listed archaeological district.

Archaeological sites, buildings and TCPs located within 500 meters of the EU

- No recorded TCPs are known to be located within 500 meters of the riparian area.
- Numerous archaeological resources (both sites and isolates) associated with the Native American Precontact and Ethnographic Landscape, as well as the historic, Pre-Hanford Early Settlers/Farming Landscape area located within 500 meters of the riparian area.

Recorded TCPs Visible from the EU

- There are no recorded TCPS known to be visible from the riparian area or within the immediate vicinity.

Historic Map and Aerial Photograph Indicators

A review of 1924 historic United States Geological Survey (USGS) maps depicts evidence of historic land use mostly in the form of historic roadways within the riparian area. The visible historic roadways extend from the former Hanford townsite, which is located northwest of the riparian area. Information provided on 1943 Hanford Engineer Works Real Estate maps similarly show historic roadways running through and in close proximity to the riparian areas. (The 1943 Hanford Engineer Works Real Estate maps contain land ownership information on the Hanford Site just prior to the land being acquired by the US Government for the Manhattan Project in

[30] Traditional cultural property has been defined by the National Park Service as “a property, a place, that is eligible for inclusion on the National Register of Historic Places because of its association with cultural practices and beliefs that are (1) rooted in the history of a community, and (2) are important to maintaining the continuity of that community’s traditional beliefs and practices” (Parker and King 1998).

1943). 1943 aerial photographs confirm the historic land use mentioned above, through the depiction of various roadways. The former Hanford townsite is located in close proximity to this riparian zone, and this information indicates a high potential for archaeological resources associated with the Pre-Hanford Early Settlers/Farming landscape to be present within these areas.

Geomorphology Indicators

The geomorphology within the riparian areas is characterized by a small pocket of Pleistocene outburst gravels and large swaths of Holocene dune/stabilized dune deposits suggesting a high potential for Native American Precontact and Ethnographic landscape (and likely Pre-Hanford Early-Settlers/Farming Landscape) associated archaeological resources to be present within the surface and subsurface component of these riparian areas.

Ground Disturbance Indicators

Examination of 2012 and 2013 aerial imagery of the riparian areas indicates that there has been minimal disturbance within the riparian areas with the exception of a few dirt roads. The general undisturbed nature of these riparian areas indicates that there is a very high potential for intact archaeological resources to be present within these riparian zones (which is evidenced by the existence of numerous cultural resources both within and in close proximity to these defined areas).

Summary of Cultural Resources Review

Large portions of the riparian areas have been inventoried for archaeological resources, with numerous archaeological sites/isolates recorded both within and adjacent to these areas. There are several archaeological resources recorded within the riparian area, two of which are currently listed on National Register of Historic Places and Washington Heritage Register as part of an archaeological district. While further research is needed to understand the extent of sub-surface investigations in these areas, it is apparent that there is a high probability for intact buried archaeological materials/deposits in these areas.

There are numerous cultural resources associated with the Native American Precontact and Ethnographic Landscape, as well as the Pre-Hanford Early Settlers/Farming Landscape within 500 meters of the riparian areas including archaeological isolates and sites.

Historic maps and aerial imagery indicate past land use associated with the Pre-Hanford Early Settlers/Farming Landscape timeframe. This, coupled with the presence of the Hanford townsite just northwest of the riparian area, suggest a high potential for the presence of archaeological materials associated with this landscape in these riparian areas. Geomorphology indicators, along with known cultural resources data, suggests a high potential for the presence of archaeological resources associated with the Native American Precontact and Ethnographic landscape to be present within these riparian areas. Additionally, because there is little evidence of surface disturbance, it is likely that these deposits remain intact. With our understanding of these areas, archaeological monitoring may be appropriate as well as surface and subsurface archaeological investigations in these areas prior to initiating any remediation activity. 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) may need to occur. Consultation with Hanford Tribes may also 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.

References

CH2MHill Plateau Remediation Company 2014, *Hanford Site groundwater monitoring report for 2013*, DOE/RL-2014-32, Rev. 0, CH2MHill, Richland, Wash.

Department of Energy. 1998. *Hanford Site Manhattan Project and Cold War Era Historic District Treatment Plan (*DOE/RL-97-56). Richland, Washington.

Hanf RW, JR, LF Morasch, TM Poston, and RL Dirkes. 2005. *Summary of the Hanford Site Environmental Report for Calendar Year 2004*. PNNL-15222 SUM. Pacific Northwest National Laboratory, Richland, WA.

Parker, P. and T. King. 1998. *National Register Bulletin: Guidelines for Evaluating and Documenting Traditional Cultural Properties.* U.S. Department of the Interior, National Park Service. Washington, D. C.

U.S. War Department. 1943. *Real Estate Engineer Works 1943 (maps).* Washington D.C.

USGS Topographic maps. 1924. Hanford, WA Quadrangle.

Evaluation Unit:	200-West Groundwater
ID:	CP-GW-2
Group:	Groundwater
Operable Unit Cross-Walk:	200-ZP-5 200-UP-1
Related EU:	CP-LS-2, 3, 4, 5, 6 CP-TF-1, 2, 3, 4
Sites & Facilities:	Existing groundwater plumes emanating from the 200-West Area. Includes pump and treat systems.
Key Data Sources Docs:	NA

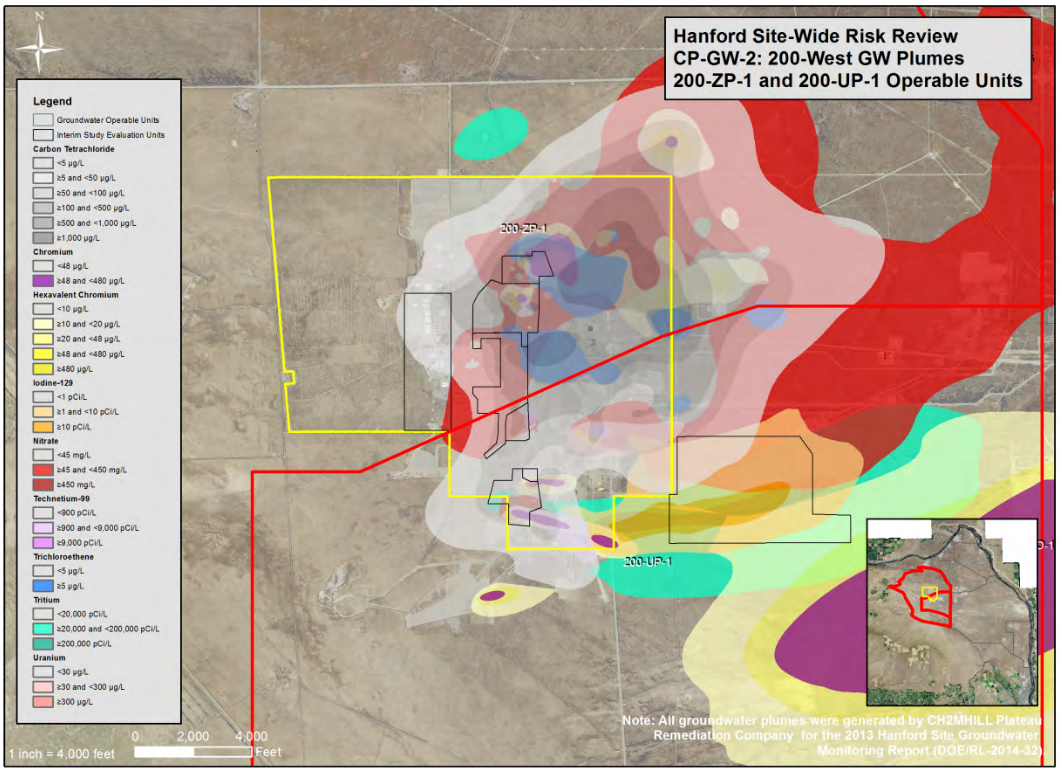

Figure K.22. Site Map with Evaluation Unit Boundaries

CP-GW-2: 200-West Groundwater Plumes

This review is limited to the region of the evaluation units where groundwater intercepts the riparian vegetation. In CP-GW-2, there is no area where groundwater intercepts riparian vegetation, so no additional information is included at this time.

Evaluation Unit:	324 Building
ID:	RC-DD-1
Group:	D&D
Operable Unit Cross-Walk:	300-FF-2
Related EU:	RC-GW-1
Sites & Facilities:	324 Building and associated soils contamination under the building
Key Data Sources Docs:	300-FF-2 ROD WCH-140, Rev 4 WCH-503, Rev 0

Figure K.23. Site Map with Evaluation Unit Boundaries

RC-DD-1: 324 Building

Cultural Resource Literature Reviews and Inventories

Most of the 324 Building EU has been inventoried for cultural resources under HCRC# 2011-300-024 (Purtzer 2011), HCRC# 2011-300-046 (Sharpe et al 2012), and HCRC# 2012-300-009b (Mendez et. al 2012) with negative findings. Demolition and remediation activities within the 324 Building EU have been addressed in an NHPA Section 106 under HCRC# 2011-300-0024 (Purtzer 2011). Given the extensive disturbance within the 324 Building EU, it is unlikely, but it is possible that intact archaeological material is present in the areas that have not been inventoried for archaeological resources (both on the surface and in the subsurface), particularly if undisturbed soil deposits exist within the 324 Building EU. There are important cultural resources associated with the Native American Precontact and Ethnographic Landscape located in close vicinity to the 324 Building EU

Archaeological sites, buildings and traditional cultural properties (TCPs) located within the EU[31]

- There are no known recorded archaeological sites or TCPs located within the 324 Building EU.
- The 324 Building a contributing property within the Manhattan Project/Cold War era Landscape with documentation required is located within the 324 Building EU. In accordance with the 1998 *Hanford Site Manhattan Project and Cold War Era Historic District Treatment Plan (*DOE/RL-97-56), all documentation requirements have been completed for this property.

Archaeological sites, buildings and TCPs located within 500 meters of the EU

- The Hanford Site Plant Railroad and the buildings listed in Table K.8 are all contributing properties within the Manhattan Project/Cold War Era Landscape with documentation required and are within 500 meters of the 324 building EU. In accordance with the 1998 *Hanford Site Manhattan Project and Cold War Era Historic District Treatment Plan (*DOE/RL-97-56), all documentation requirements have been completed for these properties.

[31] Traditional cultural property has been defined by the National Park Service as “a property, a place, that is eligible for inclusion on the National Register of Historic Places because of its association with cultural practices and beliefs that are (1) rooted in the history of a community, and (2) are important to maintaining the continuity of that community’s traditional beliefs and practices” (Parker and King 1998).

Table K.8. Manhattan Project and Cold War Era Landscape Buildings with Documentation Required within 500 meters of the 324 Building EU

Building #	Building Name
340A	WASTE RETENTION BUILDING
382	PUMP HOUSE BUILDING
320	PHYSICAL SCIENCES LABORATORY
309	SP-100 GES TEST FACILITY
308A	FUELS DEVELOMENT LABORATORY
340	WASTE NEUTRALIZATION FACILITY
340B	WASTE LOADOUT BUILDING
326	MATERIALS SCIENCES LABORATORY
329	CHEMICAL SCIENCES LABORATORY
3760	3760 OFFICE BUILDING
3709A	300 AREA FIRE STATION
3790	Badging Office
308	FUELS DEVELOPMENT LABORATORY
325A	CESIUM RECOVERY FACILITY PART OF 325
325	RADIOCHEMICAL PROCESSING LABORATORY (RPL)
318	RADIOLOGICAL CALIBRATIONS LABORATORY
3614A	RIVER MONITORING STATION

- The buildings listed in Table K.9 are all contributing properties within the Manhattan Project/Cold War Era Landscape with no documentation required and are within 500 meters of the 324 building EU. In accordance with the 1998 *Hanford Site Manhattan Project and Cold War Era Historic District Treatment Plan (*DOE/RL-97-56), all documentation requirements have been completed for these properties.

Table K.9. Manhattan Project and Cold War Era Landscape Buildings with No Documentation Required within 500 meters of the 324 Building EU

Building #	Building Name
331	LIFE SCIENCES LABORATORY
324	CHEMICAL ENGINEERING BUILDING
339A	COMPUTER FACILITY
350	PLANT OPERATIONS AND MAINTENANCE FACILITY
3707F	RADIATION MONITORING BUILDING
3714	SOILS LABORATORY
3730	GAMMA IRRADIATION FACILITY
3766	OFFICE BUILDING

- There are five archaeological sites located within 500 meters of the 324 Building EU. These include one isolated find, three National Register-eligible sites, and a state-Registered archaeological district associated with the Native American Precontact and Ethnographic Landscape and one isolated find associated with the Pre-Hanford Early Settlers and Farming Landscape.

Recorded TCPs Visible from the EU

- There are no known recorded TCPS known to be visible from the 324 Building EU or within the immediate vicinity.

Historic Map and Aerial Photograph Indicators

A review of 1916 historic United States Geological Survey (USGS) maps depicts evidence of historic land associated with the community of Fruitvale school, within the 324 Building EU. Ownership information provided on 1943 Hanford Engineer Works Real Estate maps state that the lands contained within the 324 Building EU were designated as part of the plat of Fruitvale in 1943. (The 1943 Hanford Engineer Works Real Estate maps contain land ownership information on the Hanford Site just prior to the land being acquired by the US Government for the Manhattan Project in 1943). 1943 aerial photographs confirm additional evidence of historic land use including various roads. This information indicates a high potential for archaeological resources associated with the Pre-Hanford Early Settlers/Farming landscape to be present within the 324 Building EU.

Geomorphology Indicators

The geomorphology within the 324 Building EU is combination of Pleistocene outburst gravels with a thin layer of Holocene deposits suggesting a high potential for Native American Precontact and Ethnographic landscape associated archaeological resources to be present within the surface and subsurface component of the 324 Building EU depending upon the location of these soils within the 324 Building EU.

Ground Disturbance Indicators

Examination of 2012 aerial imagery of the EU indicates that the EU is heavily disturbed by the presence of the 324 Building, various waste sites, staging areas, and roads. This disturbance indicates that there is a very low potential for intact archaeological resources to be present within the 324 Building EU.

Summary of Cultural Resources Review

Most of the 324 Building EU has been inventoried for cultural resources with negative findings. Demolition and remediation activities within the 324 Building EU have been addressed in an NHPA Section 106 cultural resources review. There are no cultural resources (archaeological, buildings or TCPs) known to be located within the 324 Building EU. It is very unlikely that intact archaeological material is present in the areas that have not been inventoried for archaeological resources (both on the surface and in the subsurface) given the extensive disturbance present within the 324 Building EU.

There are several cultural resources associated with all three landscapes located within 500 meters of the 324 building EU. These include the following:

- The Hanford Site Plant Railroad and the buildings listed in Table K.10 are all contributing properties within the Manhattan Project/Cold War Era Landscape with documentation required and are within 500 meters of the 324 building EU. In accordance with the 1998 *Hanford Site Manhattan Project and Cold War Era Historic District Treatment Plan (*DOE/RL-97-56), all documentation requirements have been completed for these properties.

Table K.10. Manhattan Project and Cold War Era Landscape Buildings with Documentation Required within 500 meters of the 324 Building EU

Building #	Building Name
340A	WASTE RETENTION BUILDING
382	PUMP HOUSE BUILDING
320	PHYSICAL SCIENCES LABORATORY
309	SP-100 GES TEST FACILITY
308A	FUELS DEVELOMENT LABORATORY
340	WASTE NEUTRALIZATION FACILITY
340B	WASTE LOADOUT BUILDING
326	MATERIALS SCIENCES LABORATORY
329	CHEMICAL SCIENCES LABORATORY
3760	3760 OFFICE BUILDING
3709A	300 AREA FIRE STATION
3790	BADGING OFFICE
308	FUELS DEVELOPMENT LABORATORY
325A	CESIUM RECOVERY FACILITY PART OF 325
325	RADIOCHEMICAL PROCESSING LABORATORY (RPL)
318	RADIOLOGICAL CALIBRATIONS LABORATORY
3614A	RIVER MONITORING STATION

- The buildings listed in Table K.11 are all contributing properties within the Manhattan Project/Cold War Era Landscape with no documentation required and are within 500 meters of the 324 building EU. In accordance with the 1998 *Hanford Site Manhattan Project and Cold War Era Historic District Treatment Plan (*DOE/RL-97-56), all documentation requirements have been completed for these properties.

Table K.11 Manhattan Project and Cold War Era Landscape Buildings with No Documentation Required within 500 meters of the 324 Building EU

Building #	Building Name
331	LIFE SCIENCES LABORATORY
324	CHEMICAL ENGINEERING BUILDING
339A	COMPUTER FACILITY
350	PLANT OPERATIONS AND MAINTENANCE FACILITY
3707F	RADIATION MONITORING BUILDING
3714	SOILS LABORATORY
3730	GAMMA IRRADIATION FACILITY
3766	OFFICE BUILDING

- There are five archaeological sites located within 500 meters of the 324 Building EU. These include one isolated find, three National Register-eligible sites, and a state-Registered archaeological district associated with the Native American Precontact and Ethnographic Landscape and one isolated find associated with the Pre-Hanford Early Settlers and Farming Landscape.

Historic maps indicate that historic land use was occurring within the Pre-Hanford Early Settlers/Farming and the Manhattan Project and Cold War era. Geomorphology indicators suggests potential for the presence of archaeological resources associated with the Native American Precontact and Ethnographic landscape to be present depending on the location of these soils within the 324 Building EU. However because of the extensive disturbance within the 324 Building EU, it is unlikely any archaeological material remains intact. It is always possible for pockets of undisturbed deposits to exist and archaeological monitoring may be appropriate as well as surface and subsurface archaeological investigations in these areas prior to initiating a remediation activity. 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) may need to occur.. Consultation with Hanford Tribes may also 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.

References[32]

Department of Energy. 1998. *Hanford Site Manhattan Project and Cold War Era Historic District Treatment Plan (*DOE/RL-97-56). Richland, Washington.

[32] **References available to qualified individuals at the Washington State Department of Archaeology and Historic Preservation

Mendez, K., H. Hay, and K. Clark. 2012. *Cultural Resource Review for the City of Richland 300 Area Electrical Service to the 324 Building, Hanford Site, Richland, Washington (HCRC#2012-300-009b)*. CH2M Hill. Richland, Washington. **

Parker, P. and T. King. 1998. *National Register Bulletin: Guidelines for Evaluating and Documenting Traditional Cultural Properties.* U.S. Department of the Interior, National Park Service. Washington, D. C.

Purtzer, L. 2011. *Remediation of 316-3 Waste Site (307 Disposal Trenches) in the 300 Area of the Hanford Site, Benton County, Washington. (HCRC# 2011-300-024).* Washington Closure Hanford. Richland, Washington. **

Sharpe, J.J., R. DeMaris, H. Hay, D. Sheldon, and S.N. Harrison. 2012. *Remedial Actions, Decommission, Deactivation, Decontamination, Demolition, Support Infrastructure, Removal and Related Activities of Waste Sites, Orphan Sites, Buildings, Miscellaneous Restoration, and Housekeeping Debris in the 300 Area of the Hanford Site, Benton County, Washington. HCRC#2011-300-046.* Washington Closure Hanford, Richland, Washington.**

U.S. War Department. 1943. *Real Estate Engineer Works 1943 (maps).* Washington D.C.

USGS Topographic maps. 1916. Coyote Rapid Quadrangle.

Evaluation Unit:	KE/KW Reactors
ID:	RC-DD-2
Group:	D&D
Operable Unit Cross-Walk:	100-KR-1 100-KR-2
Related EU:	RC-LS-2 RC-GW-3
Sites & Facilities:	KE/KW reactors, basin, ancillary buildings, sludge, and associated soils contamination
Key Data Sources Docs:	DOE/RL-96-17 DOE/RL-2005-26, Rev 1 BHI-01172, Rev 2

Figure K.24. Site Map with Evaluation Unit Boundaries

RC-DD-2: KE/KW Reactors

Cultural Resource Literature Reviews and Inventories

The K Area Reactors EU is located near the Columbia River on the Hanford Site, in an area generally known to have high potential to contain cultural resources associated with all three landscapes (Native American Pre-contact and Ethnographic Landscape, Pre-Hanford Early Settlers/Farming Landscape and the Manhattan Project/Cold War Landscape). A portion of the EU has been inventoried for cultural resources during a sludge treatment project in 2012 under HCRC#2012-100-020, (Mendez and Clark with Wright 2012). Remediation of waste sites within the K Area Waste Sites Evaluation Unit has been addressed by a NHPA Section 106 review under HCRC#2011-100-015 (Mendez 2011). There is a possibility that intact archaeological material is present in the small areas that have not been inventoried for archaeological resources (both on the surface and in the subsurface), particularly where undisturbed soil deposits exist within the EU.

Archaeological sites, buildings and TCPs[33] located within the EU

Sensitive Cultural Resources:

- There are no known TCPs within the EU.
- No archaeological resources have been documented in the EU.
- Five Manhattan Project/Cold War Era resources (Table K.12) are located within the Evaluation Unit (4 with individual documentation required, 1 with no individual documentation required). Mitigation for contributing buildings/structures has been completed as per the *Hanford Site Manhattan Project and Cold War Era Historic District Treatment Plan* (DOE/RL-97-56) and building demolition is ongoing.

Table K.12. Manhattan Project/Cold War Era resources are located within the Evaluation Unit

Building #	Building Name	Treatment Plan (DOE-RL 1998) Table Number	National Register Eligibility	Documentation Completed/Type
105KE	Reactor Building	A.6	Contributing Property w/ no additional documentation requirements	HPIF
105KW	Reactor Building and Process Water Tunnels	A.5	Buildings/Structures recommended for Mitigation	HPIF
107KW	Effluent Water Retention Basin	A.5	Buildings/Structures recommended for Mitigation	HPIF
116KW	Reactor Exhaust Stack	A.5	Buildings/Structures recommended for Mitigation	HPIF
119KW	Exhaust Air Sampling Building	A.5	Buildings/Structures recommended for Mitigation	HPIF

Archaeological sites and TCPs located within 500 meters of the EU

[33] Traditional Cultural Property (TCP) is defined as, "a property that is eligible for inclusion in the National Register because of its association with cultural practices or beliefs of a living community that (a) are rooted in the community's history, and (b) are important in maintaining the continuing cultural identity of the community" (Parker and King 1998).

- There are no documented TCPs located within 500 meters of the EU.
- Ten additional cultural resources have been documented within 500-meters of the EU. These resources include archaeological sites and isolates representing the Native American Pre-contact and Ethnographic, Pre-Hanford Early Settlers/Farming and Manhattan Project/Cold War era cultural landscapes.
  - Four archaeological sites (3 eligible and 1 unevaluated) represent the Native American Pre-contact and Ethnographic landscape.
  - One archaeological site (eligible) represents the Pre-Hanford Early Settlers/Farming landscape.
  - Three archaeological sites (1 eligible, 1 not eligible and 1 unevaluated) and 2 isolates (2 not eligible) represent the Manhattan Project/Cold War era landscape.

Closest Recorded TCP

- Known TCPs exist in the vicinity of the EU.

Historic Map and Aerial Photograph Indicators

A review of 1916 United States Geological Survey (USGS) shows no indications of historic land use such as roads or buildings within the 100-K Reactors EU. The 1943 aerial imagery does not indicate any historic use of the EU, except for a small road or trail traversing the northeast corner. North of the EU, historic land use included an irrigation canal, agricultural fields, and several trails, roads, or linear utilities. Ownership information provided on 1943 Hanford Engineer Works Real Estate maps depicting land ownership information on the Hanford Site just prior to the land being acquired by the US Government for the Manhattan Project state that the lands contained within the EU were owned by the State of Washington, Benton County, and the Chicago, Milwaukee, St. Paul, and Pacific Railroad company in 1943. Collectively, this information suggests a low potential for archaeological resources associated with the Pre-Hanford Early Settlers/Farming landscape to be present within the EU.

Geomorphology Indicators

Surface geology of the EU consists of sedimentary Pleistocene flood deposits and gravels. This geomorphological environment suggests low to medium potential for Native American Pre-contact/Ethnographic associated archaeological resources within the subsurface component of this EU. Areas outside of the EU immediately adjacent to the north along the Columbia River shoreline have a particularly high likelihood for containing subsurface archaeological deposits.

Ground Disturbance Indicators

Examination of 2012 aerial imagery of the EU indicates that 100% of the EU has undergone extensive ground disturbances. The depth of these disturbances is not known. However, it is highly unlikely that cultural resources would be present on or near the ground surface within the EU.

Summary of Cultural Resources Review

Cultural resources documented within the K Area Reactors EU include five Manhattan Project/Cold War Era Landscape resources (4 with individual documentation required, 1 with no individual documentation required). In accordance with the 1998 *Hanford Site Manhattan Project and Cold War Era Historic District Treatment Plan (*DOE/RL-97-56), all documentation requirements have been completed for properties contributing to the Manhattan Project and Cold War era historic district. No other archaeological resources or TCPs are known to be recorded within the EU.

A small portion of the K Area Reactors EU has been inventoried for archaeological resources. Remediation of waste sites within the K Area Waste Sites Evaluation Unit has been addressed by a NHPA Section 106 review. There are 10 archaeological sites within 500 meters of the EU: 4 archaeological sites (3 eligible and 1 unevaluated) represent the Native American Pre-contact and Ethnographic landscape; 1 archaeological site (eligible) represents the Pre-Hanford Early Settlers/Farming landscape, 3 archaeological sites (1 eligible, 1 not eligible, and 1 unevaluated); and 2 isolates (2 not eligible) represent the Manhattan Project/Cold War era landscape.

The geomorphologic composition of the EU, historic map, and modern aerial imagery all suggest low potential for subsurface intact archaeological resources in EU. 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) may need to occur.. Consultation with Hanford Tribes may also 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.

References[34]

Department of Energy. 1998. *Hanford Site Manhattan Project and Cold War Era Historic District Treatment Plan (*DOE/RL-97-56). Richland, Washington.

Mendez, K. 2011. *Field Remediation of Waste Sites in the 100-K Reactor Area (HCRC#2011-100-015). CH2M Hill. Richland, Washington.*

Mendez, K and C Clark with M Wright. 2012. *Construction and Demolition of the 105-KW Annex Temporary Facility to Support the Sludge Treatment Project at the 100-K Area of the Hanford Site, Benton County, Washington (HCRC#2012-100-020).* CH2M HILL. Richland, Washington.

Parker, P. and T. King. 1998. *National Register Bulletin: Guidelines for Evaluating and Documenting Traditional Cultural Properties.* U.S. Department of the Interior, National Park Service. Washington, D. C.

[34] **References available to qualified individuals at the Washington State Department of Archaeology and Historic Preservation

Evaluation Unit:	PUREX
ID:	CP-DD-1
Group:	D&D
Operable Unit Cross-Walk:	200-CP-1
Related EU:	CP-LS-9
Sites & Facilities:	PUREX canyon, tunnels, ancillary building, structures, and associated near-surface contaminated soils
Key Data Sources Docs:	M-85-12-02 CP-14977, Rev 6 HNF-SD-CP-HIE-002 HNF-SD-CP-HIE-004 HNF-14579 DOE/RL-98-35, Rev 3 DOE/RL-2010-102, Rev0 WA7890008967

Figure K.25. Site Map with Evaluation Unit Boundaries

CP-DD-1: PUREX

Cultural Resource Literature Reviews and Inventories

The PUREX EU is located within the 200-East Area of the Hanford Site, an area known to have low potential to contain Native American Precontact and Ethnographic archaeological resources and Pre-Hanford Early Settlers/Farming resources. Much of the 200 Areas were addressed in a cultural resources report entitled *Archaeological Survey of the 200 East and 200 West Areas, Hanford Site* (Chatters and Cadoret 1990). The focus of this archaeological survey was on inventorying all undisturbed portions of the 200-East and 200-West Areas. This report concluded that much of the 200-East and 200-West Areas can be considered areas of low archaeological potential with the exception of intact portions of an historic/ethnohistoric Trail/Road corridor which runs through the 200-West Area (well-away from the 200-East Area).

Much of the PUREX EU has not been inventoried (surface or subsurface) for archaeological resources and it is unknown if an NHPA Section 106 review has been completed for remediation of the PUREX EU as one was not located. A large archaeological survey with negative findings was completed under HCRC# 87-200-046 (Chatters 1988a), in the vicinity of the PUREX EU and overlaps the area in two places (Chatters 1988b) Two surveys were completed adjacent to the PUREX EU under HCRC#87-200-001 (Chatters 1987) and HCRC# 2012-600-031a (Gilmour et. al. 2013). Although it is unlikely given the heavy disturbance in the PUREX EU, there is a possibility that intact archaeological material is present in the areas (both on the surface and in the subsurface) that have not been inventoried for archaeological resources, particularly if undisturbed soil deposits exist within the PUREX EU.

Archaeological sites, buildings and traditional cultural properties (TCPs) located within the EU[35]

- There are no known recorded archaeological sites or TCPs located within the EU.
- Segments of the National Register-eligible Hanford Site Plant Railroad a contributing property within the Manhattan Project and Cold War Era Historic District, with documentation required, are located within the PUREX EU. In accordance with the 1998 *Hanford Site Manhattan Project and Cold War Era Historic District Treatment Plan (*DOE/RL-97-56), all documentation requirements have been completed for this property.
- There are several National Register-eligible buildings (Table K.13) that are contributing properties within the Manhattan Project and Cold War Era Historic District, with documentation required, that are located within the PUREX EU. In accordance with the 1998 *Hanford Site Manhattan Project and Cold War Era Historic District Treatment Plan (*DOE/RL-97-56), all documentation requirements have been completed for these properties. These include:

[35] Traditional cultural property has been defined by the National Park Service as “a property, a place, that is eligible for inclusion on the National Register of Historic Places because of its association with cultural practices and beliefs that are (1) rooted in the history of a community, and (2) are important to maintaining the continuity of that community’s traditional beliefs and practices” (Parker and King 1998).

Table K.13. National Register-Eligible Buildings with Documentation Required Located within the PUREX EU

Building #	Building Name
202A	PUREX Canyon and Service Facility
2701AB	PUREX Badge House
294A	Offgas Treatment Monitoring Station
293A	Offgas Treatment Facility

- The 218-E-14 and 218-E-15 Burial Grounds are also contributing properties within the Manhattan Project and Cold War Era Historic District, with documentation required, that are located within the PUREX EU.
- The 212A Fission Product Load Monitoring Station, 275EA Storage Warehouse at 202A, and the 291A PUREX Maintenance Exhaust System, are National Register-eligible contributing properties within the Manhattan Project and Cold War Era Historic District, with no documentation required located within the PUREX EU.

Archaeological sites and TCPs located within 500 meters of the EU

- An isolated find associated with the Pre-Hanford Early Settlers/Farming Landscape is located within 500 meters of the PUREX Evaluation Unit is ineligible for the National Register.

Recorded TCPs Visible from the EU

Two recorded TCPs associated with the Native American Precontact and Ethnographic Landscape are visible from the PUREX EU.

Historic Map and Aerial Photograph Indicators

A review of 1916 United States Geological Survey (USGS) maps shows no indications of historic land use such as roads or buildings within the PUREX EU. Ownership information provided on 1943 Hanford Engineer Works Real Estate maps depicting land ownership information on the Hanford Site just prior to the land being acquired by the US Government for the Manhattan Project state that the lands contained within the PUREX EU were owned by the United States and the J.M. Coleman Company in 1943. This information further indicates a low potential for archaeological resources associated with the Pre-Hanford Early Settlers/Farming landscape to be present within the PUREX EU. 1943 aerials further confirm a lack of land use or development in this area.

Geomorphology Indicators

The geomorphology within the PUREX EU is primarily Pleistocene outburst flood deposits with a small pocket of Holocene dune sands to the south suggesting a low potential for Native American Precontact and Ethnographic associated archaeological resources to be present within undisturbed portions of the subsurface component of this EU.

Ground Disturbance Indicators

Examination of 2012 aerial imagery of the PUREX EU depicts roads, parking lots, buildings as well as grubbed and cleared areas. It is also known that the PUREX EU contains buried pipelines, sewer lines, tanks and miscellaneous waste sites. This extensive disturbance to both surface and subsurface soils suggests low potential for intact archaeological resources to be present within the PUREX EU. Although unlikely, it is still possible however, for pockets of undisturbed soils to exist within the PUREX EU.

Summary of Cultural Resources Review

Cultural resources known to be recorded within the PUREX EU are limited to the National Register-eligible buildings associated with the Manhattan Project/Cold War Era Landscape some with documentation required and some without documentation requirements. Those with documentation required include the Hanford Site Plant Railroad, 202A (PUREX Canyon and Service Facility), 2701AB (PUREX Badge House), 294A (Offgas Treatment Monitoring Station), and 293A (Offgas Treatment Facility), and the 218-E-14 and 218-E-15 Burial Grounds. Those with no documentation required include the 212A Fission Product Load Monitoring Station, 275EA Storage Warehouse at 202A, and the 291A PUREX Maintenance Exhaust System.

All National-Register-eligible Manhattan Project and Cold War Era buildings have been mitigated (e.g. documented as described in the *Hanford Site Manhattan Project and Cold War Era Historic District Treatment Plan* (DOE.RL-97-56).

Most of the PUREX EU has not been inventoried for archaeological resources and it is unknown if an NHPA Section 106 review has been completed for remediation of the PUREX EU as one was not located. A few archaeological surveys with negative findings have been completed in the PUREX EU. No archaeological sites have been located by any of these surveys within the PUREX EU or near it. There is a slight possibility that intact archaeological material is present in the areas that have not been inventoried for archaeological resources (both on the surface and in the subsurface), particularly if undisturbed soil deposits exist within the PUREX EU. Given the extensive ground disturbance in the PUREX EU however, this is unlikely. The closest recorded archaeological site, located within 500 meters of the PUREX EU is an historic-era isolated find likely associated with the Pre-Hanford Early Settlers/Farming Landscape and is not considered to be National Register-eligible.

Geomorphology, ground disturbance, historic maps, and the lack of cultural resources located within and in the vicinity of PUREX EU all suggest that the potential for archaeological resources associated with the all three landscapes to be present on the surface or within the subsurface areas within the EU is very low. Because large areas have not been investigated for archaeological sites and pockets of undisturbed soil may exist, it may be appropriate to conduct subsurface archaeological investigations in these areas prior to initiating a remediation activity.

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 associated with these landscapes (e.g. East Benton Historical Society, the Franklin County Historical Society, Prosser Cemetery Association, B-Reactor Museum Association and the Reach) may need to occur. Indirect effects are always possible when TCPs are known to be located in the general vicinity. Consultation with Hanford Tribes may also 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.

References[36]

Department of Energy. 1998. *Hanford Site Manhattan Project and Cold War Era Historic District Treatment Plan (*DOE/RL-97-56). Richland, Washington.

Chatters JC 1987. *Cultural Resources Survey of Proposed PFM Construction Site Hanford Reservation, Washington.* Pacific National Laboratory. Richland, Washington.**

Chatters JC 1988a. *Cultural Resources Survey of the Proposed B-503 Decontamination Laundry Facility HCRC# 87-200-046.* Pacific Northwest Laboratory, Richland, Washington.**

Chatters JC. 1988b. *Report of Cultural Resource Site Review #87-200-046*, *The Decontamination Laundry Facility*. Pacific Northwest Laboratory, Richland, Washington.**

Chatters JC and NA Cadoret 1990. *Archaeological Survey of the 200 East and 200 West Areas, Hanford Site.* Pacific Northwest Laboratory, Richland, Washington.**

Gilmour DM, PS Salimano and MA Daniels. 2013. *Cultural Resources Survey Report for the U.S. Department of Energy's Proposed Esquatzel Route for the Cascade Natural Gas Pipeline Project in Benton and Franklin Counties, Washington (HCRC#2012-600-031a).* Willamette Cultural Resources Associates, Ltd. Portland, Oregon.**

Parker, P. and T. King. 1998. *National Register Bulletin: Guidelines for Evaluating and Documenting Traditional Cultural Properties.* U.S. Department of the Interior, National Park Service. Washington, D. C.

U.S. War Department. 1943. *Real Estate Engineer Works 1943 (maps).* Washington D.C.

USGS Topographic maps. 1916. Coyote Rapid Quadrangle.

[36] **References available to qualified individuals at the Washington State Department of Archaeology and Historic Preservation

Evaluation Unit:	K Basin Sludge
ID:	RC-OP-1
Group:	Operations
Operable Unit Cross-Walk:	100-KR-2
Related EU:	RC-LS-2 RC-DD-2 RC-GW-3
Sites & Facilities:	KE/KW fuel basin
Key Data Sources Docs:	BHI-01172, Rev 2 *CHPRC–DD-50769 Rev a (OUO)* DD-49394, Rev 2 DD-49580, Rev 1 DD-49581, Rev 1 DD-53484, Rev 0 DD-53838, Rev 0 DD-54878, Rev 0 DOE/RL-2005-26, Rev 1 DOE/RL-2010-43, Rev 0 DOE/RL-96-17, Rev 6 HNF-24274, Rev 6 HNF-40475, Rev 4 HNF-41051, Rev 6 HNF-5356, Rev 15 HNF-SD-SNF-TI-015, Rev 14, Vol 2 HNF-SD-SNF-TI-015, Rev 14A, Vol 2 *HNF-SD-WM-SAR-062, Rev 15C a (OUO)* KBC-36585, Rev 1A *KBC-39764 a (OUO)* KBC-43475, Rev 2 KBC-43809, Rev 0 KBC-46856, Rev 1 PRC-STP-00012, Rev 0 PRC-STP-00109, Rev 0 PRC-STP-00467, Rev 2 (Interim) PRC-STP-00473, Rev 2 PRC-STP-00497, Rev 0 PRC-STP-00615, Rev 0 PRC-STP-00687, Rev 1 PRC-STP-00697, Rev 3 PRC-STP-00718, Rev 0 PRC-STP-00720, Rev 1 PRC-STP-00731, Rev 2 PRC-STP-00834, Rev 0 SNF-8163, Rev 5 SNF-10823, Rev 1 - 1E SGW-40938, Rev 0 PRC-STP-00702, Rev 3 ALARA 4QTR13 Presentation

Figure K.26. Site Map with Evaluation Unit Boundaries

RC-OP-1: K Basin Sludge

Cultural Resource Literature Reviews and Inventories

The K Basin Sludge EU is located near the Columbia River on the Hanford Site, in an area generally known to have high potential to contain cultural resources associated with all three landscapes (Native American Pre-contact and Ethnographic Landscape, Pre-Hanford Early Settlers/Farming Landscape and the Manhattan Project/Cold War Landscape). This EU is essentially in the same location as RC-DD-2, the KE and KW Reactors, and thus the cultural resources are similar. A portion of the EU has been inventoried for cultural resources during a sludge treatment project in 2012 under HCRC#2012-100-020, (Mendez and Clark with Wright 2012). Remediation of waste sites within the K Area Waste Sites Evaluation Unit has been addressed by a NHPA Section 106 review under HCRC#2011-100-015 (Mendez 2011). There is a possibility that intact archaeological material is present in the small areas that have not been inventoried for archaeological resources (both on the surface and in the subsurface), particularly where undisturbed soil deposits exist within the EU.

Archaeological sites, buildings and TCPs[37] located within the EU

Sensitive Cultural Resources:

- There are no known TCPs within the EU.
- No archaeological resources have been documented in the EU.
- Two Manhattan Project/Cold War Era resources are located within the Evaluation Unit as given in Table K.14. Mitigation for contributing buildings/structures has been completed as per the *Hanford Site Manhattan Project and Cold War Era Historic District Treatment Plan* (DOE/RL-97-56) and building demolition is ongoing.

Table K.14. Manhattan Project/Cold War Era Resources Located within the K Basin Sludge EU

Building #	Building Name	Treatment Plan (DOE-RL 1998) Table Number	National Register Eligibility	Documentation Completed/Type
105KE	Reactor Building	A.6	Contributing Property w/ no additional documentation requirements	HPIF
105KW	Reactor Building and Process Water Tunnels	A.5	Buildings/Structures recommended for Mitigation	HPIF

Archaeological sites and TCPs located within 500 meters of the EU

- There are no documented TCPs located within 500 meters of the EU.
- Ten additional cultural resources have been documented within 500-meters of the EU. These resources include archaeological sites and isolates representing the Native American Pre-contact and Ethnographic, Pre-Hanford Early Settlers/Farming and Manhattan Project/Cold War era cultural landscapes.
  - Four archaeological sites (3 eligible and 1 unevaluated) represent the Native American Pre-contact and Ethnographic landscape.
  - One archaeological site (eligible) represents the Pre-Hanford Early Settlers/Farming landscape.
  - Three archaeological sites (1 eligible, 1 not eligible and 1 unevaluated) and 2 isolates (2 not eligible) represent the Manhattan Project/Cold War era landscape.

[37] Traditional Cultural Property (TCP) is defined as, "a property that is eligible for inclusion in the National Register because of its association with cultural practices or beliefs of a living community that (a) are rooted in the community's history, and (b) are important in maintaining the continuing cultural identity of the community" (Parker and King 1998).

Closest Recorded TCP

- Known TCPs exist in the vicinity of the EU.

Historic Map and Aerial Photograph Indicators

A review of 1916 United States Geological Survey (USGS) shows no indications of historic land use such as roads or buildings within the K Basin Sludge EU. The 1943 aerial imagery does not indicate any historic use of the EU, except for a small road or trail traversing the northeast corner. North of the EU, historic land use included an irrigation canal, agricultural fields, and several trails, roads, or linear utilities. Ownership information provided on 1943 Hanford Engineer Works Real Estate maps depicting land ownership information on the Hanford Site just prior to the land being acquired by the US Government for the Manhattan Project state that the lands contained within the EU were owned by the State of Washington, Benton County, and the Chicago, Milwaukee, St. Paul, and Pacific Railroad company in 1943. Collectively, this information suggests a low potential for archaeological resources associated with the Pre-Hanford Early Settlers/Farming landscape to be present within the EU.

Geomorphology Indicators

Surface geology of the EU consists of sedimentary Pleistocene flood deposits and gravels. This geomorphological environment suggests low to medium potential for Native American Pre-contact/Ethnographic associated archaeological resources within the subsurface component of this EU. Areas outside of the EU immediately adjacent to the north along the Columbia River shoreline have a particularly high likelihood for containing subsurface archaeological deposits.

Ground Disturbance Indicators

Examination of 2012 aerial imagery of the EU indicates that 100% of the EU has undergone extensive ground disturbances. The depth of these disturbances is not known. However, it is highly unlikely that cultural resources would be present on or near the ground surface within the EU.

Summary of Cultural Resources Review

Cultural resources documented within the K Basin Sludge EU include two Manhattan Project/Cold War Era Landscape resources. In accordance with the 1998 *Hanford Site Manhattan Project and Cold War Era Historic District Treatment Plan (*DOE/RL-97-56), all documentation requirements have been completed for properties contributing to the Manhattan Project and Cold War era historic district. No other archaeological resources or TCPs are known to be recorded within the EU.

A small portion of the K Basin Sludge EU has been inventoried for archaeological resources. Remediation of waste sites within the K Area Waste Sites Evaluation Unit has been addressed by a NHPA Section 106 review. There are 10 archaeological sites within 500 meters of the EU: 4 archaeological sites (3 eligible and 1 unevaluated) represent the Native American Pre-contact and Ethnographic landscape; 1 archaeological site (eligible) represents the Pre-Hanford Early Settlers/Farming landscape, 3 archaeological sites (1 eligible, 1 not eligible, and 1 unevaluated); and 2 isolates (2 not eligible) represent the Manhattan Project/Cold War era landscape.

The geomorphologic composition of the EU, historic map, and modern aerial imagery all suggest low potential for subsurface intact archaeological resources in EU. 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) may need to occur. Consultation with Hanford Tribes may also 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.

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Mendez, K. 2011. *Field Remediation of Waste Sites in the 100-K Reactor Area (HCRC#2011-100-015). CH2M Hill. Richland, Washington.*

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Parker, P. and T. King. 1998. *National Register Bulletin: Guidelines for Evaluating and Documenting Traditional Cultural Properties.* U.S. Department of the Interior, National Park Service. Washington, D. C.

[38] **References available to qualified individuals at the Washington State Department of Archaeology and Historic Preservation

Evaluation Unit:	CWC
ID:	CP-OP-1
Group:	Operations
Operable Unit Cross-Walk:	NA
Related EU:	NA
Sites & Facilities:	Central Waste Complex (CWC) operations, closure, and D&D
Key Data Sources Docs:	HNF-14741
	HNF-EP-0063, Rev 18
	HNF-15589, Rev8
	WA7890008967, Part III
	DOE/EIS-022-F
	DOE-RL-98-10

Figure K.27 Site Map with Evaluation Unit Boundaries

CP-OP-1: CWC

Cultural Resource Literature Reviews and Inventories

The CWC EU is located in the 200-West Area of the Hanford Site, an area known to have low potential to contain Native American Pre-contact and Ethnographic archaeological resources and Pre-Hanford Early Settlers Farming resources. Much of the 200 Areas were addressed in a cultural resources report entitled *Archaeological Survey of the 200 East and 200 West Areas, Hanford Site* (Chatters and Cadoret 1990). The focus of this archaeological survey was on inventorying all undisturbed portions of the 200-East and 200-West Areas. This report concluded that much of the 200-East and 200-West Areas can be considered areas of low archaeological potential with the exception of intact portions of an historic/ethnohistoric Trail/Road corridor which runs through the CWC EU. Both contributing/intact segments and non-contributing/un-intact segments of the historic/ethnohistoric Trail/Road corridor run through the CWC EU.

Almost all of the CWC EU has been surface-inventoried for archaeological resources under HCRC#88-200-038 (Chatters and Cadoret 1990), HCRC# 2000-600-023 (Hale 2000), HCRC# 88-200-005 (Chatters 1988), HCRC# 87-200-021 (Cadoret and Chatters 1988), HCRC# 2012-200-028 (Hay et. al). There is a possibility that intact archaeological material is present in the areas that have not been inventoried for archaeological resources (both on the surface and in the subsurface), particularly where undisturbed soil deposits exist within the CWC EU.

Archaeological sites, buildings and traditional cultural properties (TCPs) located within the EU[39]

- Segment B of a National Register-eligible historic/ethnohistoric Trail/Road Corridor runs through the CWC EU. Both non-contributing and contributing portions of segment B are contained within the CWC EU. Previous cultural resources reviews have recommended a 60-foot easement of avoidance on either side of the historic/ethnohistoric Bluffs Trail/Road Corridor through this area.
- One historic-archaeological site and one historic isolated find both likely associated with the Pre-Hanford Early Settlers/Farming Landscape and one prehistoric isolated find (lithic flake) associated with the Native American Precontact and Ethnographic Landscape are located within the CWC EU. None of these resources are considered to be eligible to the National Register of Historic Places.
- There are no known recorded TCPs located within the EU.
- There are no Manhattan Project/Cold War era buildings located within the CWC EU.

Archaeological sites and TCPs located within 500 meters of the EU

- Four isolated finds consisting of one associated with the Native American Precontact and Ethnographic Landscape and three historic-era finds associated with the Pre-Hanford Early Settlers/Farming Landscape are located within 500 meters of the CWC EU. All four are considered to be National Register ineligible.

Recorded TCPs Visible from the EU

There are two recorded TCPs associated with the Native American Precontact and Ethnographic Landscape that are visible from the CWC EU.

[39] Traditional cultural property has been defined by the National Park Service as “a property, a place, that is eligible for inclusion on the National Register of Historic Places because of its association with cultural practices and beliefs that are (1) rooted in the history of a community, and (2) are important to maintaining the continuity of that community’s traditional beliefs and practices” (Parker and King 1998).

Historic Map and Aerial Photograph Indicators

A review of 1916 United States Geological Survey (USGS) depicts the historic/ethnohistoric Trail/Road running through the CWC EU. Ownership information provided on 1943 Hanford Engineer Works Real Estate maps state that the lands contained within the CWC EU were owned by the United States and Benton County in 1943 (The 1943 Hanford Engineer Works Real Estate maps contain land ownership information on the Hanford Site just prior to the land being acquired by the US Government for the Manhattan Project in 1943). 1943 aerial photographs further confirm the presence of the historic/ethnohistoric Trail/Road.

Geomorphology Indicators

The geomorphology within the CWC EU is evenly dispersed with both Pleistocene outburst flood deposits and Holocene dune sands suggesting a moderate potential for Native American Pre-contact and Ethnographic associated archaeological resources to be present within undisturbed portions of both the surface and subsurface components of this EU.

Ground Disturbance Indicators

Examination of 2012 aerial imagery of the CWC EU depicts buildings, roads, parking lots as well as grubbed and cleared areas. It also contains areas that appear to have been undisturbed by ground-clearing activities. In areas where there is extensive disturbance to both surface and subsurface soil, there is a low potential for intact archaeological resources to be present within the CWC EU. Within the areas of undisturbed soils the potential for intact archaeological resources to be present within the CWC EU is moderate.

Summary of Cultural Resources Review

Cultural resources known to be recorded within the CWC EU consists of both contributing and noncontributing segments of a National register-eligible T historic/ethnohistoric trail/Road corridor associated with the Native American Precontact/Ethnographic and Pre-Hanford Early Settlers/Farming Landscapes as well as a historic site, likely associated with the Pre-Hanford Early Settlers/Farming Landscape. Additionally two isolated finds; one associated with the Native American Precontact and Ethnohistoric Landscape and one associated with the Pre-Hanford Early Settlers/Farming Landscape have also been identified. With the exception of the contributing portion of an historic/ethnohistoric Trail/Road, none of these resources is considered to be National Register-eligible. Previous cultural resources reviews have recommended a 60-foot easement of avoidance on either side of the contributing segment of the White Bluffs Trail/Road Corridor through this area.

Almost all of the CWC EU has been inventoried for archaeological resources. In addition to the archaeological resources already identified within the CWC EU, there is a possibility that intact archaeological material is present in the areas that have not been inventoried for archaeological resources (both on the surface and in the subsurface), particularly where the undisturbed soil deposits exist within the CWC EU.

The closest recorded archaeological sites, located within 500 meters of the CWC EU, consist of four isolated finds; one associated with the Native American and Ethnographic Landscape and three historic-era isolated finds that may be associated with the Pre-Hanford Early Settlers/Farming Landscape. All four are considered to be National Register ineligible.

The physical evidence of an historic/ethnohistoric Trail/Road within the CWC EU indicates evidence of historic and ethnohistoric land use through the CWC EU. The geomorphology and presence of undisturbed soils suggests that there is a moderate potential for the presence of archaeological resources associated with all three landscapes to be present both in the surface and subsurface within the CWC EU. Pockets of undisturbed soil exist, it may be appropriate to conduct surface and subsurface archaeological investigations in these areas prior to initiating a remediation activity.

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 associated with these landscapes (e.g. East Benton Historical Society, the Franklin County Historical Society and the Prosser Cemetery Association, the Reach, and B-Reactor Museum Association) may need to occur. Indirect effects are always possible when TCPs are known to be located in the general vicinity. Consultation with Hanford Tribes may also 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.

References[40]

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Hale, LL. 2000. *Cultural Resources Report Narrative-The White Bluffs Road Archaeological Survey, HCRC# 2000-600-023.* Pacific Northwest National Laboratory. Richland, Washington.

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U.S. War Department. 1943. *Real Estate Engineer Works 1943 (maps).* Washington D.C.

[40] **References available to qualified individuals at the Washington State Department of Archaeology and Historic Preservation

United States Geological Survey Topographic maps. 1916. Coyote Rapid Quadrangle.

Evaluation Unit:	WESF
ID:	CP-OP-3
Group:	Operations
Operable Unit Cross-Walk:	NA
Related EU:	CP-DD-2
Sites & Facilities:	Waste Encapsulation and Storage Facility (WESF) – Evaluate for the storage and removal of Cs/SR capsules. D&D included with B Plant EU.
Key Data Sources Docs:	HNF-8758 WA7890008967 DOE/RL-2010-102

Figure K.28. Site Map with Evaluation Unit Boundaries

CP-OP-3: WESF

Cultural Resource Literature Reviews, Inventories and Potential for Cultural Resources

The WESF EU is located within the 200-East Area of the Hanford Site, an area known to have low potential to contain Native American Precontact and Ethnographic archaeological resources and Pre-Hanford Early Settlers/Farming resources. Much of the 200 Areas were addressed in a cultural resources report entitled *Archaeological Survey of the 200 East and 200 West Areas, Hanford Site* (Chatters and Cadoret 1990). The focus of this archaeological survey was on inventorying all undisturbed portions of the 200-East and 200-West Areas. This report concluded that much of the 200-East and 200-West Areas can be considered areas of low archaeological potential with the exception of intact portions of an historic/ethnohistoric Road/Trail corridor which runs through the 200-West Area located over 5 kilometers from the WESF EU. None of the WESF Evaluation Unit has been inventoried for archaeological resources because it is located inside the 225 B Waste Encapsulation and Storage Facility.

Archaeological sites, buildings and traditional cultural properties (TCPs) located within the EU[41]

- There are no known recorded archaeological sites or TCPs located within the WESF EU.
- The WESF Evaluation Unit is located inside the 225 B Waste Encapsulation and Storage Facility, a contributing property within the Manhattan Project and Cold War Era Historic District with documentation required.

Archaeological sites and TCPs located within 500 meters of the EU

- The 212 B Fission Products Load out Station (documentation required) is located nearby the WESF Evaluation Unit, also a contributing property within the Manhattan Project and Cold War Era Historic District. In accordance with the 1998 *Hanford Site Manhattan Project and Cold War Era Historic District Treatment Plan (*DOE/RL-97-56), all documentation requirements have been completed for this property.
- There are no known archaeological sites or TCPs located within 500 meters of the WESF EU.

Recorded TCPs Visible from the EU

There are two recorded TCPs associated with the Native American Precontact and Ethnographic Landscape that are visible from the WESF EU.

Historic Map and Aerial Photograph Indicators

A review of 1916 historic United States Geological Survey USGS maps depicts no structures, roads, or any other indication of historic settlement. Ownership information provided on 1943 Hanford Engineer Works Real Estate maps state that the lands contained within the WESF EU were owned by Benton County in 1943. (The 1943 Hanford Engineer Works Real Estate maps contain land ownership information on the Hanford Site just prior to the land being acquired by the US Government for the Manhattan Project in 1943). This information indicates a low potential for archaeological resources associated with the Pre-Hanford Early Settlers/Farming landscape to be present within WESF EU. 1943 aerial photographs further confirm the absence of the historic settlement in the area.

Geomorphology Indicators

The geomorphology within the WESF EU is all Pleistocene outburst flood deposits suggesting a low potential for Native American Precontact and Ethnographic associated archaeological resources to be present within the subsurface component of the WESF EU.

[41] Traditional cultural property has been defined by the National Park Service as “a property, a place, that is eligible for inclusion on the National Register of Historic Places because of its association with cultural practices and beliefs that are (1) rooted in the history of a community, and (2) are important to maintaining the continuity of that community’s traditional beliefs and practices” (Parker and King 1998).

Ground Disturbance Indicators

Examination of 2012 aerial imagery of the EU indicates that the WESF EU is heavily disturbed because it is located inside the 225 B Waste Encapsulation and Storage Facility.

Summary of Cultural Resources Review

Cultural resources that are located in the WESF EU are limited to the National Register-eligible 225 B Waste Encapsulation and Storage Facility, a contributing property within the Manhattan Project and Cold War Era Historic District with documentation required. All documentation has been addressed as described in the *Hanford Site Manhattan Project and Cold War Era Historic District Treatment Plan* (DOE.RL-97-56). None of the WESF EU has been inventoried for archaeological resources and none are known to be located there.

The 212 B Fission Products Load out Station (documentation required) is located within 500 meters of the WESF Evaluation Unit, also a contributing property within the Manhattan Project and Cold War Era Historic District. It has also been documented as described in the *Hanford Site Manhattan Project and Cold War Era Historic District Treatment Plan* (DOE/RL-97-56).

Historic maps indicate that there is no evidence of historic settlement in or near the WESF EU. Geomorphology and extensive ground disturbance further indicates a low potential for the presence of intact archaeological resources associated with all three landscapes to be present subsurface within the WESF EU. 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 associated with these landscapes (e.g. East Benton Historical Society, the Franklin County Historical Society and the Prosser Cemetery Association, the Reach and B-Reactor Museum Association) may need to occur. Indirect effects are always possible when are known to be located in the general vicinity. Consultation with Hanford Tribes may also 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.

References

Chatters JC and NA Cadoret 1990. *Archaeological Survey of the 200 East and 200 West Areas, Hanford Site.* Pacific Northwest Laboratory, Richland, Washington.**

Department of Energy. 1998. *Hanford Site Manhattan Project and Cold War Era Historic District Treatment Plan (*DOE/RL-97-56). Richland, Washington.

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U.S. War Department. 1943. *Real Estate Engineer Works 1943 (maps).* Washington D.C.

USGS Topographic maps. 1916. Coyote Rapid Quadrangle.

Evaluation Unit:	ERDF
ID:	CP-OP-6
Group:	Operations
Operable Unit Cross-Walk:	NA
Related EU:	NA
Sites & Facilities:	Environmental Restoration Disposal Facility (ERDF) operations and closure
Key Data Sources Docs:	WCH-174, Rev 2 WCH-179 WCH-191, Rev 3 ROD ERDF

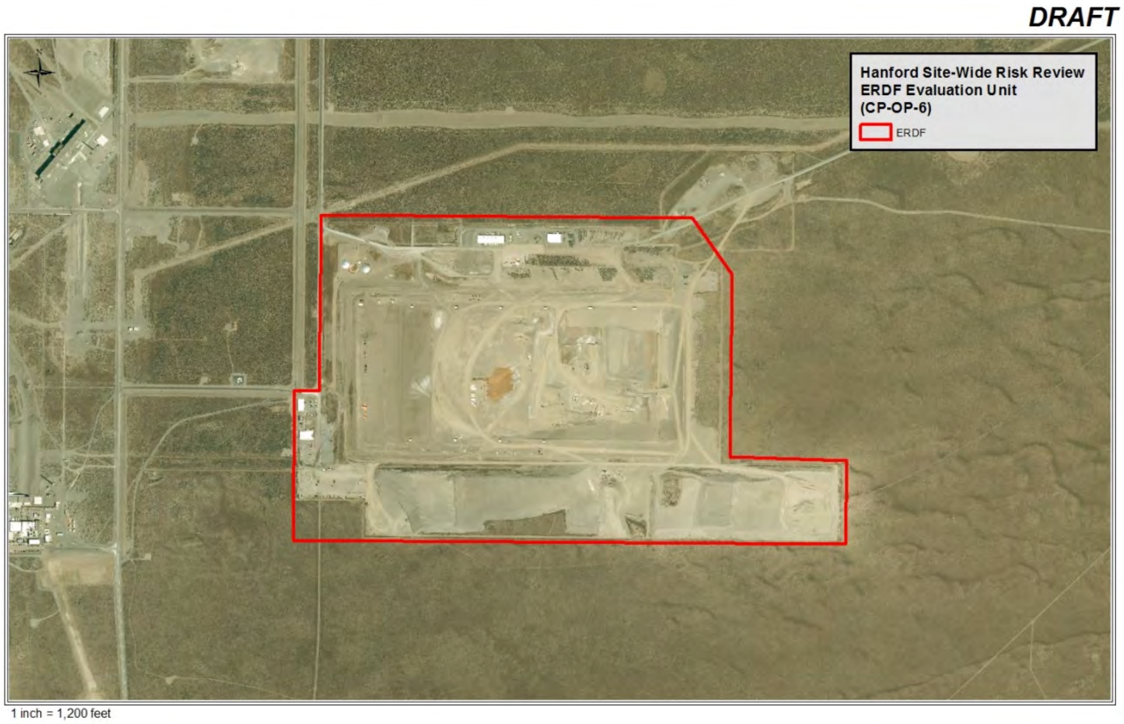

Figure K.29. Site Map with Evaluation Unit Boundaries

CP-OP-6: ERDF

Cultural Resource Literature Reviews and Inventories

The ERDF EU is located between the 200-West and 200-East Areas of the Hanford Site, an area generally known to have low potential to contain Native American Pre-contact and Ethnographic archaeological resources and Pre-Hanford Early Settlers/Farming resources. Construction and operation of the ERDF was addressed by an NHPA Section 106 Review under HCRC#93-200-001. All of the ERDF Evaluation Unit has been inventoried for cultural resources by several cultural resources surveys in the past. These include HCRC#89-200-023 (Minthorn 1990) HCRC#93-200-001 (Cadoret and Wright, 1994), HCRC#93-600-005 (Meyers and McIntire

1993), HCRC#93-600-038 (Crist and Longenecker 1994), HCRC#95-200-013 (Stapp and Woodruff 1994), HCRC#2008-600-006 (Kennedy 2008), HCRC#2011-600-015 (Hughes et. al. 2011), and HCRC#2012-600-035c (Hay et. al. 2013). There is a possibility that intact archaeological material is present in the small areas that have not been inventoried for archaeological resources (both on the surface and in the subsurface), particularly where undisturbed soil deposits exist within the ERDF boundary.

Archaeological sites, buildings and TCPs[42] located within the EU

Sensitive Cultural Resources:

- There are no known TCPs within the EU.
- Six cultural resources have been documented in the EU. These resources include archaeological sites and isolates representing the pre-contact, ethnographic, and historic era landscapes. Specifically, there are two Native American Pre-contact and Ethnographic landscape associated archaeological sites and four pre-Hanford Early Settler/Farming sites. Each of these six sites have been determined to be not eligible for listing on the NRHP.

Archaeological sites and TCPs located within 500 meters of the EU

- There are no known TCPs within 500 meters of the EU.
- Five additional cultural resources have been documented within 500-meters of the EU. These resources include archaeological sites and isolates representing the Native American Pre-contact and Ethnographic, and the Manhattan Project/Cold War landscapes.
- One contributing properties to the Manhattan Project and Cold War Era Landscape, the 201W Instrument Building (with no documentation required) is located within 500-meters of the ERDF Evaluation Unit:
- The Hanford Atmospheric Dispersion Test Facility is a National Register-eligible archaeological site, that is associated with the Manhattan Project and Cold War Era Landscape

Closest Recorded TCP

- There are 2 recorded TCPs that are known to be visible from the ERDF EU.

Historic Map and Aerial Photograph Indicators

A review of 1916 United States Geological Survey (USGS) shows no indications of historic land use such as roads or buildings within the ERDF EU. The 1943 aerial imagery show a faint trail or road running from the southwest to the northeast of the EU. No other land use or development

[42] Traditional cultural property has been defined by the National Park Service as “a property, a place, that is eligible for inclusion on the National Register of Historic Places because of its association with cultural practices and beliefs that are (1) rooted in the history of a community, and (2) are important to maintaining the continuity of that community’s traditional beliefs and practices” (Parker and King 1998).

is shown in the EU on this imagery. Ownership information provided on 1943 Hanford Engineer Works Real Estate maps depicting land ownership information on the Hanford Site just prior to the land being acquired by the US Government for the Manhattan Project state that the lands contained within the ERDF EU were owned by the United States Government, and Benton County in 1943. Collectively, this information suggests a low potential for archaeological resources associated with the Pre-Hanford Early Settlers/Farming landscape to be present within the ERDF EU.

Geomorphology Indicators

Surface geology of the EU consists of sedimentary Holocene stabilized sand dune deposits. Due to the age and deposition rate of this type of deposit this geomorphological environment suggests a potential for Native American Pre-contact and Ethnographic associated archaeological resources to be present within the subsurface component of this EU, especially in undisturbed soils.

Ground Disturbance Indicators

Examination of 2012 aerial imagery of the EU indicates that the EU is almost entirely disturbed by massive earthworks operations at ERDF. Some relatively undisturbed lands appear to be present around the EU perimeter, particularly at the southwest corner and south margin of the EU. The large scale disturbances within the EU suggest very low potential for intact archaeological resources to be present on the surface or within the subsurface. Because there are small areas that appear to be minimally disturbed, it is possible for archaeological resources to be present both on the surface and within the subsurface. It is possible for pockets of undisturbed soils to exist and therefore intact archaeological material to exist within the heavily disturbed areas.

Summary of Cultural Resources Review

The entire ERDF EU has been inventoried for archaeological resources with limited findings. Specifically, there are two Native American Pre-contact and Ethnographic landscape associated archaeological sites/isolates and four pre-Hanford Early Settler/Farming sites/isolates. None of these resources are National Register-Eligible. No TCPs or Manhattan Project/Cold War Era Landscape resources are known within the ERDF EU.

Three archaeological isolates, one archaeological site representing the Native American Pre-contact and Ethnographic, and the Manhattan Project/Cold War landscapes are located within 500 meters of the ERDF EU. The Manhattan Project/Cold War Era Atmospheric Dispersion Grid archaeological site has been determined to be National Register-eligible. Additionally the 201W Instrument Building is a contributing property within the Manhattan Project/Cold War Landscapes.

While the geomorphologic composition suggest a potential for buried archaeological materials the great distance from a permanent water source as well as the extensive earthworks, evidence of ground disturbances, and inferences based on historic map data suggest that the potential for intact archaeological resources associated with all three landscapes to be present within the EU is low. 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 associated with these landscapes (e.g., East Benton Historical Society, Prosser Cemetery Association, Franklin County Historical Society, the Reach, and the B-Reactor Museum Association) may need to occur. Indirect effects are always possible when TCPs are located in the general vicinity. 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.

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[43] **References available to qualified individuals at the Washington State Department of Archaeology and Historic Preservation