APPENDIX G.2

618-11 BURIAL GROUND (RC-LS-1, RIVER CORRIDOR)

EVALUATION UNIT SUMMARY TEMPLATE

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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. Transuranic (TRU) nuclides include ^{241}Am, ^{238}Pu, ^{240}Pu, ^{237}Np, ^{239}Pu, and ^{241}Pu. There is also N-Reactor fuel, enriched to 0.95 to 1.25% ^{235}U.
- Hazardous constituents include, lead shielding, ignitable metal turnings, thorium 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), ^{239}Pu (132 Ci), ^{241}Pu (639 Ci) and Beryllium (330 kg)[1]. The Tank Closure and Waste Management (TC&WM) EIS (DOE/EIS-0391, 2012) identified ^{90}Sr (1000 Ci), ^{137}Cs (1000 Ci), and $^{239\text{-}240}$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

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[1] The *Inventory Data Package for Hanford Assessments* (Kincaid et al., 2006) gave lower estimates for Sr-90 (11 Ci) and Cs-137 (12 Ci) in 618-11 than the above values. The tritium (^{3}H) inventory in CY 2000 was also estimated to be 2200 Ci, which decays to 1660 Ci in CY 2005. No nitrate inventory is provided in the presentation and reports.

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 Not Discernible (ND) to High. The estimated mitigated exposure that takes engineered and administrative controls and protections into consideration is shown in parentheses.

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

Ecological Resources[2]: 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[2]: 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.

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

Table G.2-1. Risk Rating Summary (for Human Health, unmitigated nuclear safety basis indicated, mitigated basis indicated in parentheses (e.g., “Very High” (Low)).

		Evaluation Time Periods	
		Active Cleanup (to 2064)	
Population or Resource		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 from vadose zone[(a)]	C: *Medium* (H-3, NO_3) A&B: *ND* (Sr-90)[(c)]	C: *Low* (H-3, NO_3) A&B: *ND* (Sr-90)[(c)]
	Columbia River from vadose zone[(a)]	ND	ND
	Ecological Resources[(b)]	ND	Low to Medium
Social	Cultural Resources[(b)]	**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

a. Threat to groundwater or the Columbia River is typically related to Group A and B primary contaminants (PCs) (Table 6-1, (CRESP, 2015)) remaining in the vadose zone. However, in the case of 618-11, there are current plumes for tritium (^3H) and nitrate (NO_3) linked directly to 618-11 that exceed the Group C PC threshold of 0.10 km^2 for a current *Medium* rating (Figure 6-9, (CRESP, 2015)). However, the ratings for ^3H and NO_3 are deemed to be *Low* during the remainder of the Active Cleanup period because of radioactive decay (^3H) and dispersion (both) as described in **Part I**.

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. Ecological ratings are described in Table 4-11 of the Final Report.

c. These ratings are for PCs with reported inventories (Table G.2-3 through Table G.2-5). (See **Part I** for additional details.) The Sr-90 disposed of in the 618-11 Burial Ground EU would translate to a *Very High* rating; however, there is no current Sr-90 plume in the vicinity of the EU, 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 (**Part I**). The Sr-90 rating after the Active Cleanup period is also *ND* because remedial actions will include vadose zone treatment.

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 ($\geq$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 (DOE VPP 2012).

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.

<u>*Caisson Waste Penetration*</u>: 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

<u>*Caisson Penetration with Fire:*</u> 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 they reach a public receptor.

There is no known plume associated with Sr-90 (Group A and B) from this EU; however, there are current plumes for Group C primary contaminants (PCs) (tritium (^3H) and nitrate (NO_3)) linked to the 618-11 Burial Ground EU (DOE/RL, 2016). The current tritium and nitrate plume areas exceed the 0.10 km^2 threshold (Figure 6-9, (CRESP, 2015)) for Group C PCs and thus are given *Medium* ratings. However, decay and dispersion of these contaminants has caused the maximum concentrations and plume areas to generally decrease over the last few years (DOE/RL, 2016), which is expected to continue into the future. Thus the tritium and nitrate ratings are *Low* for the remainder of the Active Cleanup period. Because decay will reduce the tritium inventory by over 97% by the end of the Active Cleanup period, the rating is *Not Discernible* (*ND*) for the Near-term, Post-Cleanup period. Because nitrate will continue to disperse (without decay) and 618-11 has insufficient known nitrate-bearing wastes to support a plume over the long-term, its rating is also *ND* for this period. Based on the transport and decay properties of Sr-90, Sr-90 is not expected to impact groundwater (or thus the Columbia River). Thus, an *ND* rating is given for the Active Cleanup period and, because remedial actions will treat the vadose zone, a rating of *ND* is also used afterwards.

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 tritium, nitrate, and Sr-90, no plumes are expected to reach the Columbia River in the next 50 years. This leads to a ND ratings during the Active Cleanup period. Furthermore, the conceptual model for the tritium plume evolution over time, indicates that tritium concentrations will be below the cleanup level when the plume reaches the Columbia River (DOE/RL, 2016). For the nitrate plume, sources outside of the 618-11 Burial Ground EU are the primary sources for nitrate plumes in the 300-FF groundwater interest area (GWIA); these impacts are evaluated in Appendix D.2.

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[3]

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[3]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

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[4]

TPA Milestone M-016-00B was changed to remove the 618-11 burial ground from its description and a new Milestone created.

M-016-86: Complete remedial actions for 618-11 Burial Ground in accordance with RD/RA Work Plan for 300-EF-2 Soils (DOE/RL-2014-13-ADD1).

Due date September 30, 2021

RISK REVIEW EVALUATION INFORMATION:

Completed: January 15, 2015, revised on August 26, 2016 and March 12, 2017

Evaluated by: Kathryn A. Higley, Craig H. Benson, and Kevin Brown

Reviewed by: H. Mayer and Kevin Brown

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

[4] *Final Approval Package for the Tentative Agreement on Hanford Federal Facility Agreement and Consent Order Revisions for Central Plateau Cleanup,* U.S. Department of Energy, U.S. Environmental Protection Agency, and the Washington State Department of Ecology, May 2016

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 tritium and nitrate groundwater plume that originate from sources within the 618-11 Burial Ground EU (DOE/RL, 2016).

LOCATION AND LAYOUT MAPS

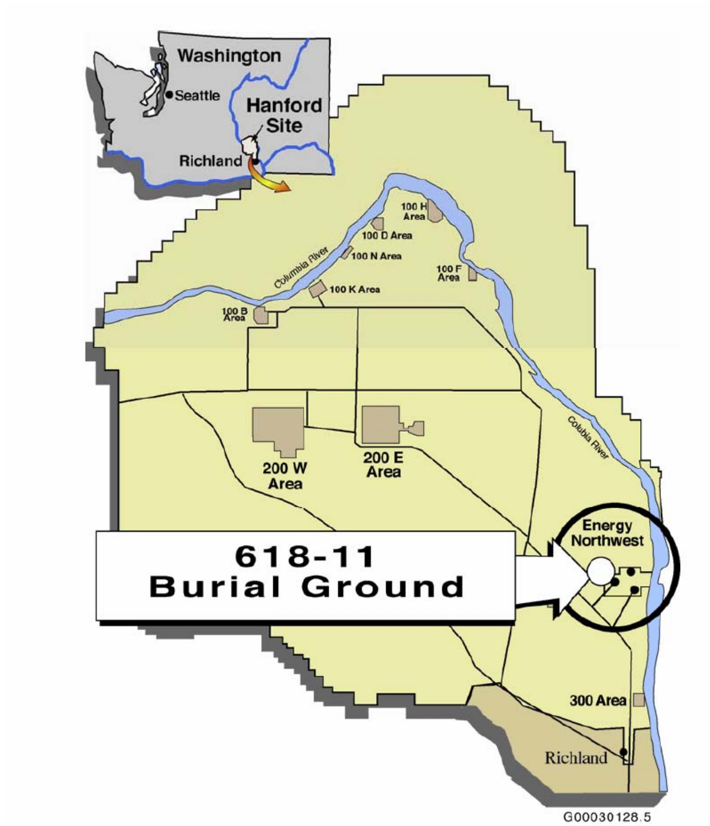


Figure G.2-1. Location of 618-11 Solid Waste Burial Ground on Hanford Site.

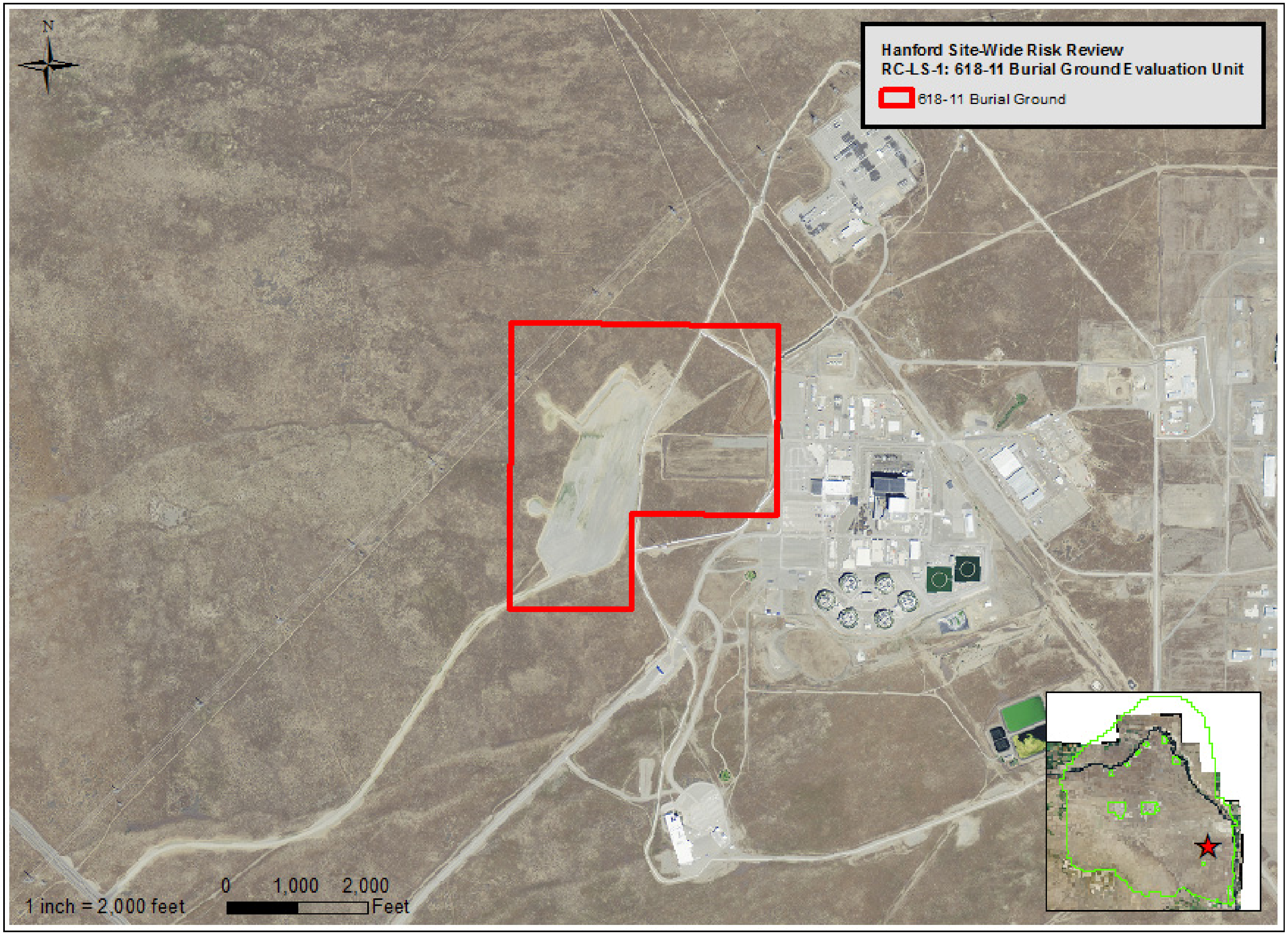


Figure G.2-2. 618-11 Burial Ground

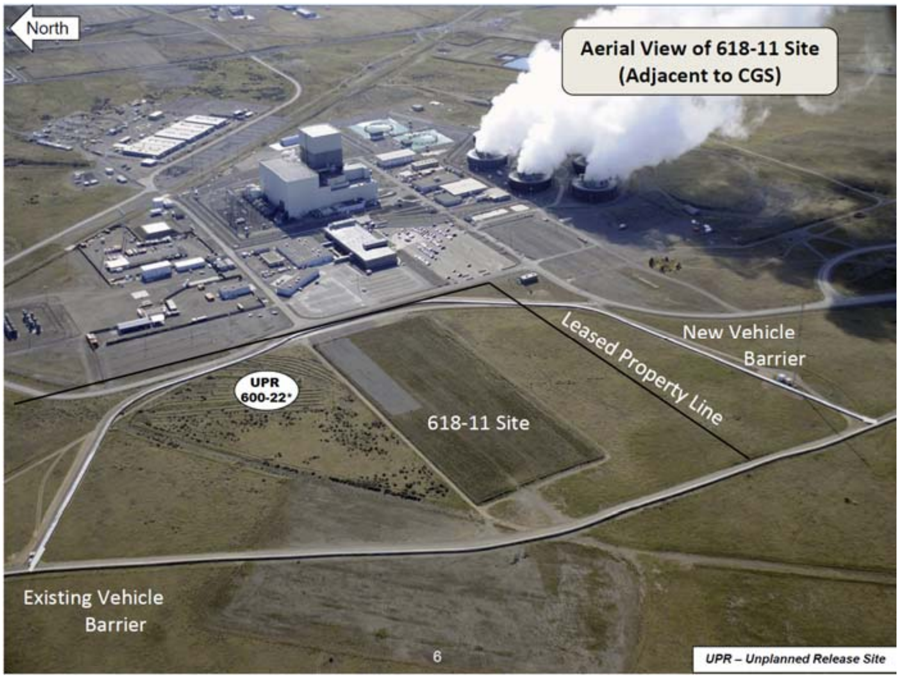


Figure G.2-3. Aerial photograph of 618-11 Solid Waste Burial Ground (rectangular area directly west of plant) adjacent to Energy Northwest plant.

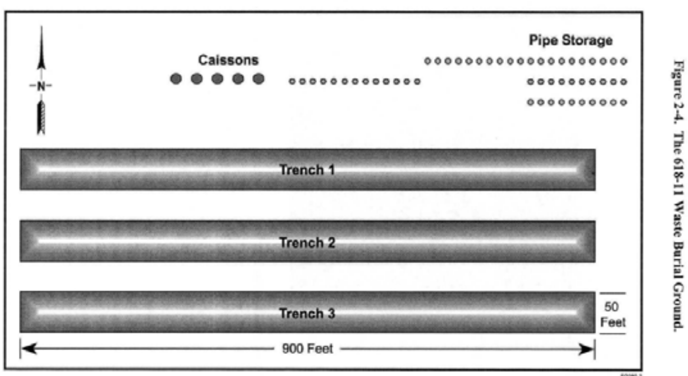


Figure G.2-4. Schematic of 618-11 Solid Waste Burial Ground showing trenches, pipe storage units, and caissons.

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[5]. 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?

[5] The *Inventory Data Package for Hanford Assessments* (Kincaid et al., 2006) gives a tritium (^{3}H) inventory in CY 2000 of 2200 Ci, which decays to 1660 Ci in CY 2005. No nitrate inventory is provided.

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 Figure G.2-5 and the caissons in Figure G.2-6. The trenches are shown in Figure G.2-7. 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).

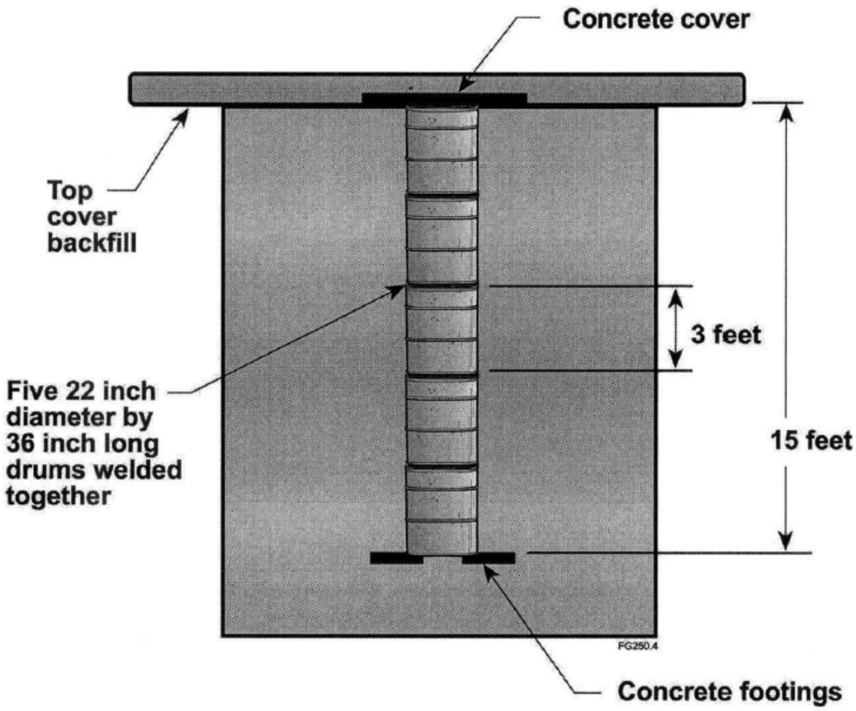


Figure G.2-5. Schematic of vertical pipe unit from CP-14592 REV 0 2003.

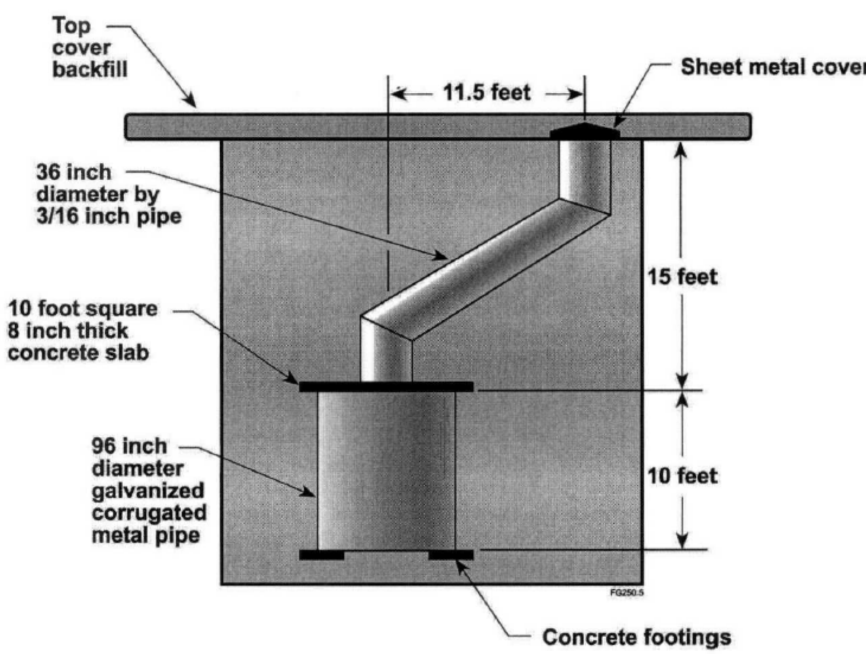


Figure G.2-6. Caisson in 618-11 area as depicted in CP-14592 Rev. 0 2003.

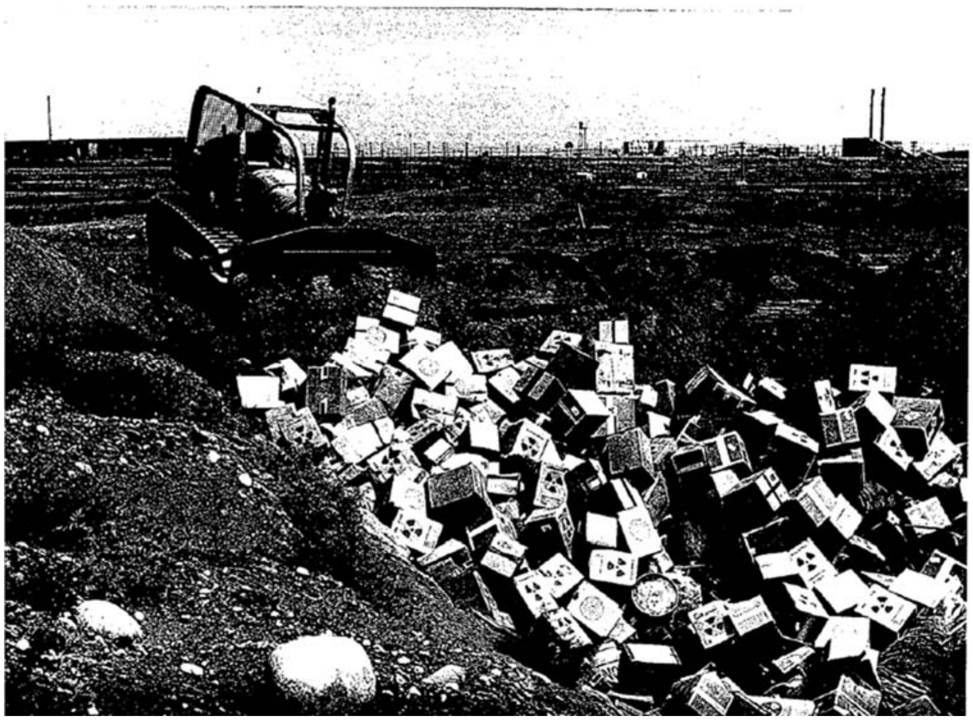


Figure G.2-7. Covering boxes with radioactive contents disposed 618-11 trenches with soil, from HNF-EP-0649 Rev. 0, 1997.

What is the physical state of the primary contaminants (i.e., adsorbed in contaminated soil, as debris, in subsurface piping)?

PNNL 13675 (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). The sources are the tritium and nitrate plumes under the 618-11 site are given as 618-11 in the most recent groundwater monitoring report (DOE/RL, 2016).

What is the origin of the contamination (e.g., spills, intentional discharges, disposal areas)?

The tritium (Figure G.2-8) and nitrate plumes are attributed to the 618-11 site (DOE/RL, 2016). 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 (Figure G.2-9). However, a contaminated groundwater plume extends from the 200 Area adjacent to 618-11, as shown in Figure G.2-8. Cover soils placed over the wastes in the 618-11 area are comprised of eolian sediments similar to those shown at the surface in Figure G.2-8.

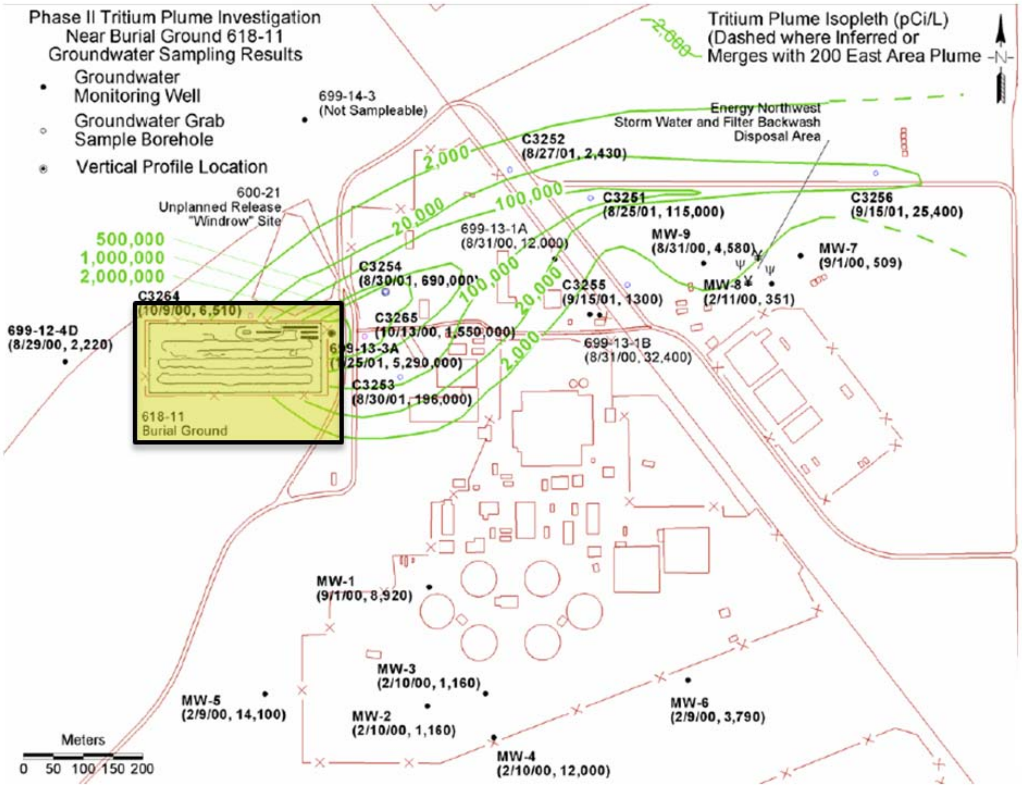


Figure G.2-8. Tritium isochors associated with the 618-11 site (yellow box), from page 2.9 of PNNL 15293.

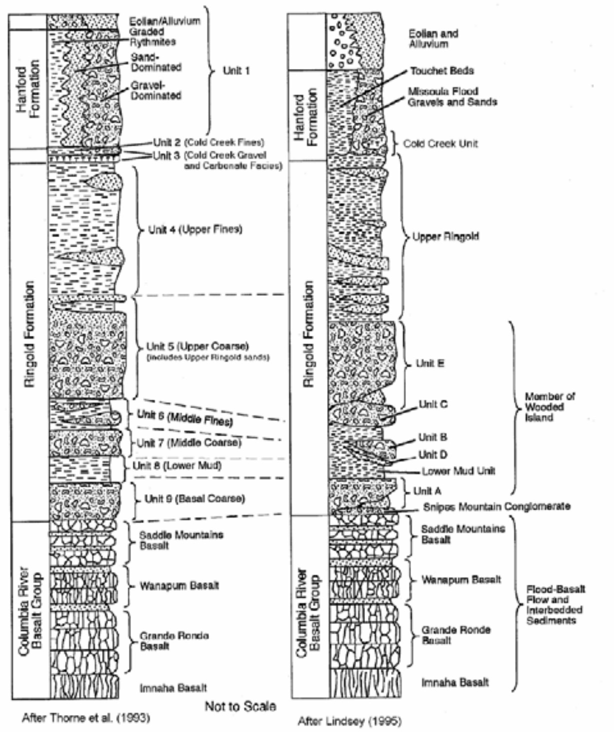


Figure G.2-9. Geological cross-section at 618-11 site.

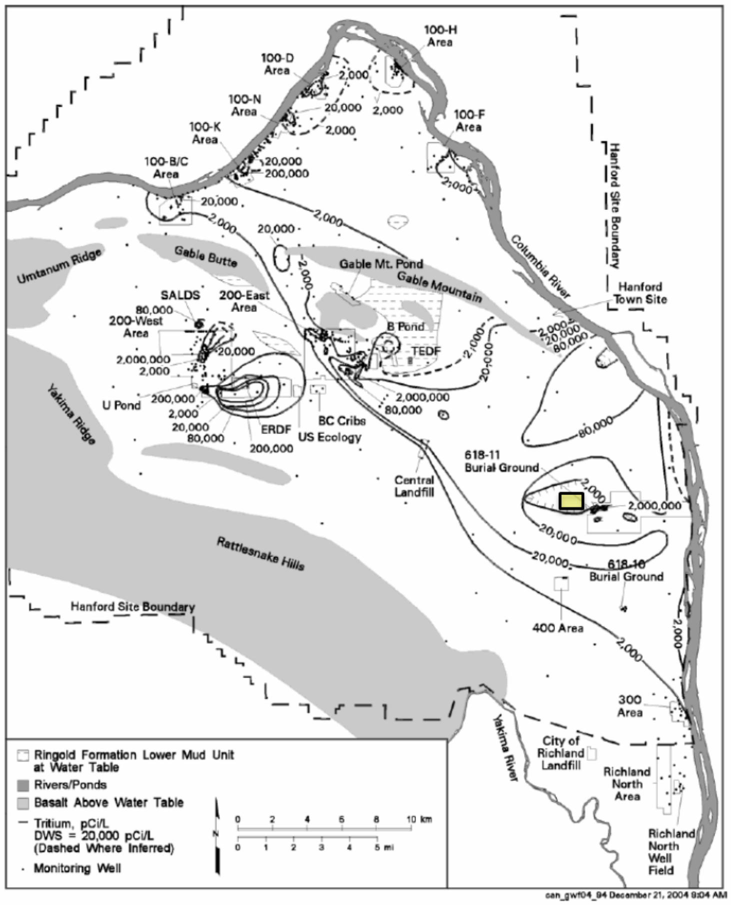


Figure G.2-10. Location of 618-11 (yellow box) and isochors of tritium concentration in Hanford formation from other sources.

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, 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.)

See Table G.2-6.

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, 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. … 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 the TC&WM EIS identifies only ^{90}Sr (1000 Ci), ^{137}Cs (1000 Ci), and $^{239-240}$Pu (623 Ci). The *Inventory Data Package for Hanford Assessments* (Kincaid et al., 2006) gave lower estimates for Sr-90 (11 Ci) and Cs-137 (12 Ci) in 618-11 than the above values. The tritium (^{3}H) inventory in CY 2000 was also estimated to be 2200 Ci, which decays to 1660 Ci in CY 2005. No nitrate inventory is provided in the presentation and reports.

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, 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). The most recent groundwater monitoring report indicates that 618-11 is the source for both the ^{3}H and nitrate plumes that underlie the burial ground (DOE/RL, 2016).

Groundwater Plumes

Specific inventory of ^{3}H or nitrate in the vadose zone attributed to the 618-11 burial site has not been found; however, Kincaid, et al. (2006) indicated that the tritium (^{3}H) inventory in CY 2000 was estimated to be 2200 Ci, which would decay to 1660 Ci by CY 2005.

From (DOE/RL, 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, 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)."

EU Designation: RC-LS-1 (618-11 Burial Ground)

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	NR	NR	NR	5300	NR	NR	NR	NR
618-11	Burial Ground	Unknown	DUNHAM, Z. 2012	230	NR	NR	NR	5300	NR	NR	NR[b]	NR

a. NR = Not reported for indicated EU

b. The *Inventory Data Package for Hanford Assessments* (Kincaid et al., 2006) gave lower estimates for Sr-90 (11 Ci) and Cs-137 (12 Ci) in 618-11 than the above values. The tritium (^{3}H) inventory in CY 2000 was also estimated to be 2200 Ci, which decays to 1660 Ci in CY 2005. Because the tritium is a Group C primary contaminant, the plume area is used for the rating; thus the inventory is not is not used in this context. Several other minor constituents are also provided by Kincaid, et al. (2006); however, these are very minor and would not drives risks to groundwater.

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			NR	NR	770	4200	NR	NR
618-11	Burial Ground	Unknown	DUNHAM, Z. 2012	NR	NR	770	4200	NR	NR

a. NR = Not reported for indicated EU

Table G.2-5. Inventory of Primary Contaminants (cont)[a]

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)
All	Sum		NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
618-11	Burial Ground	DUNHAM, Z. 2012	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR

a. NR = Not reported 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	*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 (CRESP, 2015).

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 2015 Hanford Annual Groundwater Report (DOE/RL, 2016).

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

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 during the Active Cleanup period. However, a *Low* rating is given after the 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:

From (DOE/RL, 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 2003) 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, 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; however, the tritium (Group C) and nitrate (Group C) plumes have been linked to 618-11 EU sources (DOE/RL, 2016). Because these Group C plumes exceed the appropriate threshold (0.10 km^2 from Figure 6-9 (CRESP, 2015)), these plumes translate to current *Medium* ratings. As described in **Part I**, the tritium and nitrate ratings are *Low* for the remainder of the Active Cleanup period. Furthermore, the tritium and nitrate rating is *Not Discernible* (*ND*) for the Near-term, Post-Cleanup period (see **Part I**). Based on the transport and decay properties of Sr-90, Sr-90 is not expected to impact the groundwater so a rating of *Not Discernible* (*ND*) is applied during (and after) the Active Cleanup period as described in **Part I**.

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 ND ratings during the Active Cleanup period. As described in **Part I**, tritium concentrations will be below the cleanup level when the plume reaches the Columbia River (DOE/RL, 2016). For the nitrate plume, sources outside of the 618-11 Burial Ground EU are the primary sources for nitrate plumes in the 300-FF groundwater interest area (GWIA); these impacts are evaluated in Appendix D.2.

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

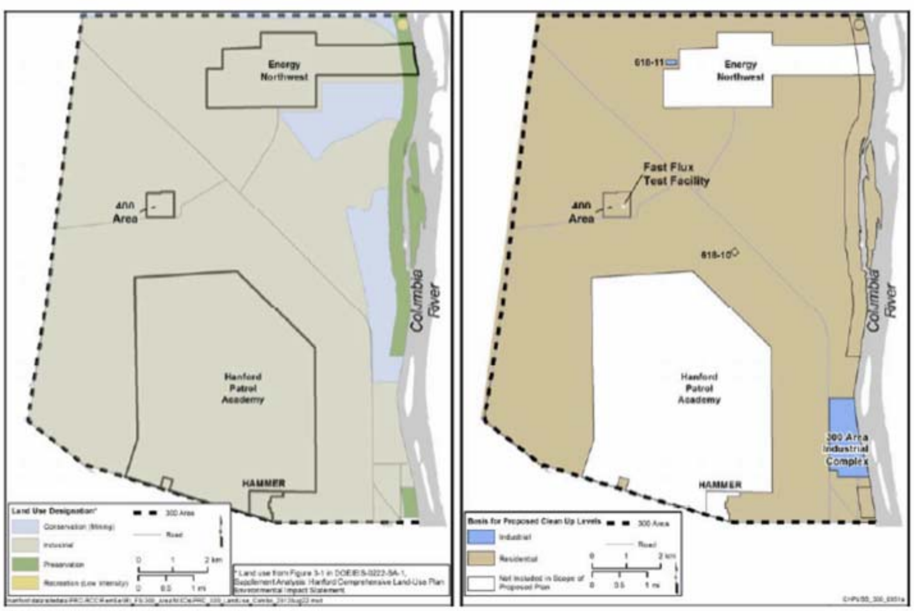
Selected or Potential Cleanup Approaches:

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[6]:

- 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, 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)

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[6] 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

The proposed remediation goals for 618-11 are shown in the table below (DOE/RL, 2013) pages 67-69

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: Proposed Shallow PRGs for Protection of Human Health (<= 4.6 m [15 ft] bgs)	PRGs[a,b] Based on the Residential Scenario for Areas Outside Both the 300 Area Industrial Complex and the 618-11 Burial Ground: Proposed Vadose Zone PRGs (Irrigation) for Groundwater and Surface Water Protection[f]	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)	PRGs[b,c] for Areas Inside the 300 Area Industrial Complex and the 618-11 Burial Ground: 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, 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 contamination (m^3, linear m or number as appropriate)	Amt. with high levels of contamination (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 groundwater 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; however, the tritium (Group C) and nitrate (Group C) plumes have been linked to 618-11 EU sources (DOE/RL, 2016). Because these Group C plumes exceed the appropriate threshold (0.10 km^2 from Figure 6-9 (CRESP, 2015)), these plumes translate to current *Medium* ratings. As described in **Part I**, the tritium and nitrate ratings are *Low* for the remainder of the Active Cleanup period. Furthermore, the tritium and nitrate ratings are *Not Discernible* (*ND*) for the Near-term, Post-Cleanup period (see **Part I**). Based on the transport and decay properties of Sr-90, Sr-90 is not expected to impact the groundwater so a rating of *Not Discernible* (*ND*) is applied during the Active Cleanup period. A *Low* rating is applied afterwards (for Sr-90) to account for remedial actions in the vadose zone (**Part I**).

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.

There is no known plume associated with Sr-90 from this EU. This leads to a ND ratings during the Active Cleanup period. As described in **Part I**, tritium concentrations will be below the cleanup level when the plume reaches the Columbia River (DOE/RL, 2016). Thus tritium concentrations will be below drinking water standards by the time the reach a public receptor or protected resource. For the nitrate plume, sources outside of the 618-11 Burial Ground EU are the primary sources for nitrate plumes in the 300-FF groundwater interest area (GWIA); these impacts are evaluated in Appendix D.2

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.
Human	Co-located Person	Not Discernible (ND)	None
Human	Public	ND	Public access will be prevented by physical barriers and institutional controls
Environmental	Groundwater from vadose zone[a]	ND	The remediation will eliminate the source of potential contaminants, thereby eliminating risks to groundwater (US EPA 2013). As described in **Part I**, tritium will decay and disperse and there appear to be insufficient sources of nitrate-bearing wastes in 618-11 to support a continued plume (DOE/RL, 2016).
Environmental	Columbia River from vadose zone[a]	ND	The remediation will eliminate the source of potential contaminants, thereby eliminating risks to the Columbia River (US EPA 2013).
Environmental	Ecological Resources[b]	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[b]	**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.

a. Threat to groundwater or Columbia River is typically associated with Group A and B primary contaminants (PCs) remaining in the vadose zone; however, in this case, Group C PCs (nitrate and tritium) were the risk drivers during the Active Cleanup period. Threats from existing plumes associated with the 618-11 Burial Ground EU are described in **Part I** with detailed information in Appendix D.2.

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. Ecological ratings are described in Table 4-11 of the Final Report.

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

The 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.

REFERENCES

CP-14592 REV. 0 2003. 618-10 and 618-11 Waste Burial Grounds Basis for Interim Operation. *In:* HANFORD, F. (ed.). Richland, Wash.: Richland, Wash. : U.S. Dept. of Energy, Richland Operations Office.

CRESP 2015. Methodology for the Hanford Site-Wide Risk Review Project. Nashville, TN: Consortium for Risk Evaluation with Stakeholder Participation (CRESP).

DOE/EIS-0391 2012. Tank Farm Closure & Waste Management (TC&WM) Environmental Impact Statement. Richland, WA: U.S. Department of Energy.

DOE/RL-2011-47, R. 2013. Proposed Plan for Remediation of the 300-FF-1, 300-FF-2, and 300-FF-5 Operable Units. Richland, Wash.: Richland, Wash. : U.S. Department of Energy, Richland Operations Office.

DOE/RL 2013. Proposed Plan for Remediation of the 300-FF-1, 300-FF-2, and 300-FF-5 Operable Units. Richland, Wash.: Richland, Wash. : U.S. Department of Energy, Richland Operations Office.

DOE/RL 2016. Hanford Site Groundwater Monitoring Report for 2015. Richland, WA: U.S. Department of Energy, Richland Operations Office.

DOE VPP 2012. Report from the Department of Energy Voluntary Protection Program Onsite Review, June 11-14 2012. Available at: <https://energy.gov/sites/prod/files/2014/03/f10/WashingtonClosureHanfordLLCHanfordJune2012.pdf> (March 14 2017).

DUNHAM, Z. 2012. 618-11 Project Status Presentation to NRC. *Energy Northwest 618-11 Remediation Project.*

HNF-EP-0649 REV. 0 1997. Characterization of the 618-11 Solid Waste Burial Ground, Disposed Waste, and Description of the Waste-Generating Facilities. Richland, Wash: Richland, Wash. : U.S. Department of Energy, Richland Operations Office.

KINCAID, C. T., ESLINGER, P. W., AABERG, R. L., MILEY, T. B., NELSON, I. C., STRENGE, D. L. & EVANS, J. C. 2006. Inventory Data Package for Hanford Assessments. Richland, WA: Pacific Northwest National Laboratory.

LANDON, S. & NOLAN, L. Characterization modeling to support the hanford 618-10 and 618-11 burial grounds remediation design solution: two differing approaches with similar results. 2007. WM Symposia, 1628 E. Southern Avenue, Suite 9-332, Tempe, AZ 85282 (United States).

PNNL-13675 2001. Measurement of helium-3/helium-4 ratios in soil gas at the 618-11 burial ground. Richland, Wash.: Richland, Wash. : Pacific Northwest National Laboratory.

PNNL-15293 2005. Evaluation of the Fate and Transport of Tritium Contaminated Groundwater from the 618-11 Burial Ground. Richland, Wash.: Richland, Wash. : Pacific Northwest National Laboratory.

US EPA 2013, 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. Available at: http://pdw.hanford.gov/arpir/pdf.cfm?accession=0087180 (August 2015).