

Executive Summary

This document describes calendar year 2014 groundwater monitoring results for the U.S. Department of Energy (DOE) Hanford Site in Washington State. Groundwater is monitored for *Resource Conservation and Recovery Act of 1976* (RCRA) units; for *Comprehensive Environmental Response, Compensation and Liability Act of 1980* (CERCLA) groundwater operable units (OUs); and for the *Atomic Energy Act of 1954* (AEA), as required by DOE orders. DOE publishes details on CERCLA remediation activities in separate reports that are summarized and referenced in this report.

The Hanford Site, part of the DOE nuclear weapons complex, encompasses approximately 1,500 km² (579 mi²) along the Columbia River in southeastern Washington State. During World War II and the Cold War period, the government built and operated a total of nine nuclear reactors for the production of plutonium and other nuclear materials.

During reactor operations, chemical and radioactive waste was released into the environment and contaminated the soil and groundwater beneath portions of the Hanford Site, mostly in the 200 East Area, 200 West Area, 300 Area, 1100 Area, and the 100 Area, which includes reactor areas along the river (e.g., 100-BC and 100-K) (Figure ES-1). Since 1989, using its authority under CERCLA (42 U.S. Code 9601 et seq.), DOE has worked to remediate this contamination. As the U.S. Environmental Protection Agency (EPA) placed the Hanford Site on the CERCLA National Priorities List in 1989, and pursuant to CERCLA Section 120, DOE entered the Hanford Federal Facility Agreement and Consent Order (Ecology, EPA, and DOE, 1989), referred to as the Tri-Party Agreement, with EPA and the Washington State Department of Ecology (Ecology). The purpose of the Tri-Party Agreement is to provide a joint plan to address groundwater and vadose zone contamination and other aspects of remediating the radiological and chemical contamination of the Hanford Site. Key goals of this effort are (1) to protect the Columbia River and groundwater from further contamination, (2) to develop a cleanup decision process, and (3) to achieve final cleanup restoring groundwater to usable condition (e.g., restore groundwater to highest beneficial use).

Groundwater on the Hanford Site occurs in an unconfined aquifer within unconsolidated gravel and sand units. Groundwater in the unconfined aquifer generally flows from

upland areas in the west toward the regional discharge areas along the Columbia River (Figure ES-2).

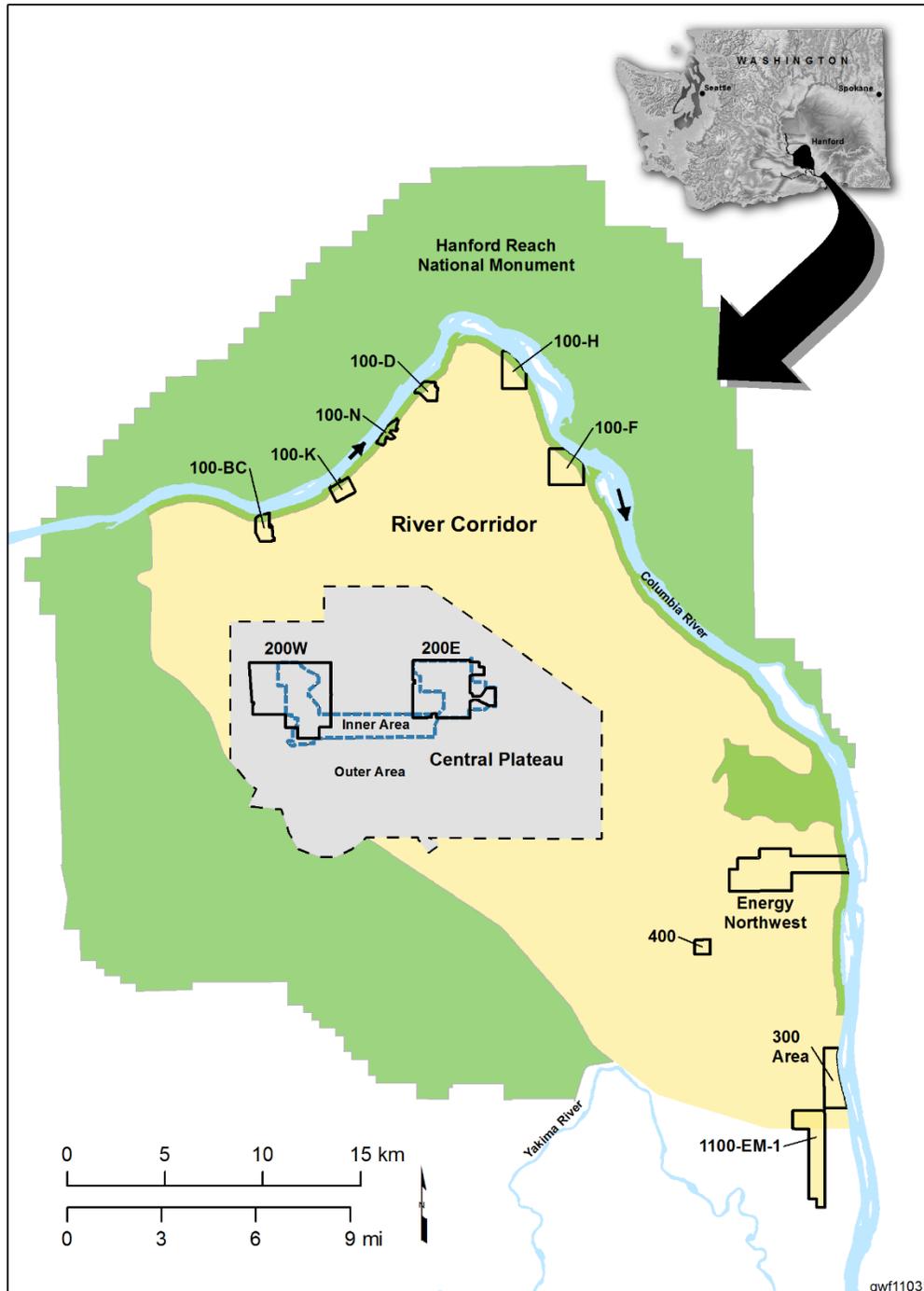


Figure ES-1. Regions of the Hanford Site

Hanford Site operations were primarily located in the 100 and 300 Areas of the River Corridor and the Inner Area of the Central Plateau. Most of the other portions of the site, including the Hanford Reach National Monument, are relatively undisturbed shrub steppe habitat.

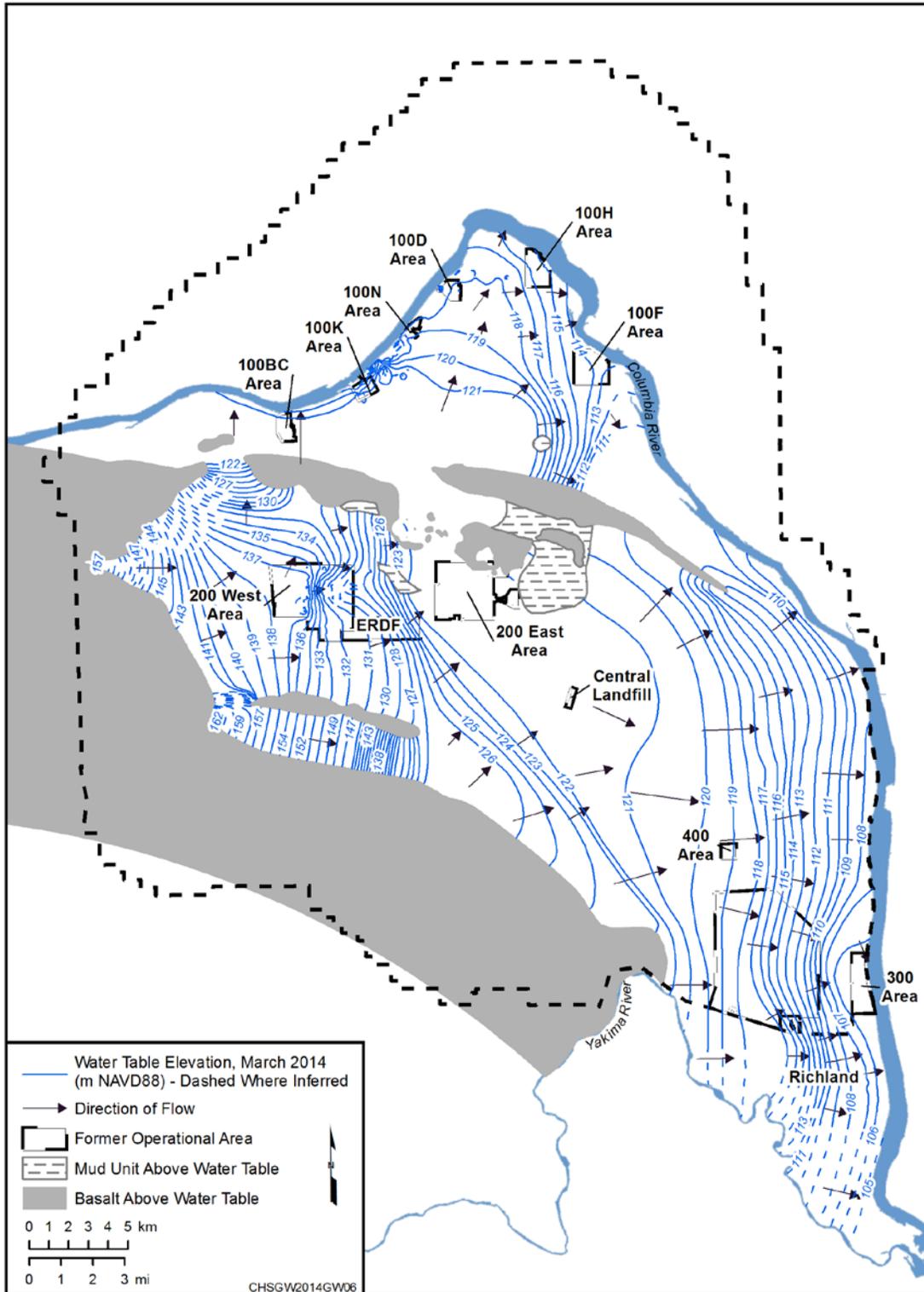


Figure ES-2. Hanford Site 2014 Water Table and Directions of Groundwater Flow

Groundwater flows from areas where the water table is high to where it is lower, and eventually discharges to the Columbia River.

The flow of water divides beneath the 200 East Area, with some water flowing toward the north and some flowing southeast. Maximum concentrations of key groundwater contaminants are presented in Tables ES-1 and ES-2.

Table ES-1. Overview of the River Corridor Groundwater Interest Areas Contaminant Concentrations

River Corridor Overview										
Area	Primary Operations	Status of Waste Site Remediation ^a	Status of Ground-water ROD	Groundwater Contamination: Maximum Concentration and Plume Area						
				Carbon-14	Hexavalent Chromium	Nitrate	Strontium-90	Trichloro-ethene	Tritium	Uranium
100-BC	Reactor operations -- B Reactor 1944-69; C Reactor 1952-69	93% complete	None to date	N	63 µg/L	47 mg/L	43 pCi/L	2.43 µg/L	17,000 pCi/L	9 µg/L
100-K	Reactor operations -- KE Reactor 1955-71; KW Reactor 1955-70	59% complete	Interim action P&T	14,300 pCi/L	520 µg/L	74 mg/L	231	6.8 µg/L	414,000 pCi/L	7.7 µg/L
100-N	Reactor operations -- N Reactor 1963-87	92% complete	Interim action permeable reactive barrier	52 pCi/L	181 µg/L	186 mg/L	15,500 pCi/L	N	761,000 pCi/L	6.6 µg/L
100-D & 100-H	Reactor operations -- D Reactor 1944-67; DR Reactor 1950-64; H Reactor 1949-65	87% complete	Interim action P&T	N	3,440 µg/L	53 mg/L	36.4 pCi/L	N	20,400 pCi/L	52.1 µg/L
100-F	Reactor operations -- F Reactor 1945-65; Biological experiments until 1976	98% complete	Final action MNA	N	29 µg/L	146 mg/L	144 pCi/L	15.3 µg/L	5,500 pCi/L	21.1 µg/L
300	Nuclear fuel fabrication and research -- 1940s-1960s	91% complete	Final action enhanced attenuation, MNA	N	5.6 µg/L	(b)	1.9 pCi/L	83	994,000 pCi/L	358 µg/L
1100 and Offsite	Vehicle maintenance, 1954-85; solid waste landfill --1950s-1970	100% complete (final action ROD)	Final action MNA; goals met	N	N	(b)	N	0.71 µg/L	121 pCi/L	(b)
Standards ^c				2,000 pCi/L	10 µg/L	45 mg/L	8 pCi/L	5 µg/L	20,000 pCi/L	30 µg/L
Half-life (years)				5,730	N/A	N/A	28.8	N/A	12	>159,000
Mobility in subsurface				High	High to Moderate	High	Slight	Moderate	High	Moderate
Legend										
Colors indicate maximum concentration in 2014					Height of bar indicates plume area above standard (km ²)					
<div style="display: flex; flex-direction: column; gap: 5px;"> <div style="background-color: red; width: 20px; height: 10px; display: inline-block;"></div> ≥1,000 x standard</div> <div style="background-color: orange; width: 20px; height: 10px; display: inline-block;"></div> ≥100 x standard and <1,000 x standard										

Table ES-2. Overview of Central Plateau Groundwater Interest Areas Contaminant Concentrations

Central Plateau Overview				Groundwater Contamination: Maximum Concentration and Plume Area											
Area	Primary Operations	Status of Groundwater ROD	Groundwater Remedial Action	Carbon Tetrachloride	Chromium	Cyanide	Iodine-129	Nitrate	Strontium-90	Trichloroethene	Technetium-99	Tritium	Uranium		
200-ZP-1	T Plant (Pu separation) 1944-1956; Pu Finishing Plant: 1949-1989	Signed 2008 (final action)	Groundwater P&T and MNA: 1995-present. Soil vapor extraction 1991-2013	2,000 µg/L	186 µg/L	N	1.9 pCi/L	536 mg/L	N	8.6 µg/L	21,500	72,000 pCi/L	2.7 µg/L		
200-UP-1	REDOX Plant (Pu separation) 1952-1967; U Plant (U recovery) 1952-1957	Signed 2012 (interim action)	U plant P&T: 1994-2011; S-SX P&T: 2012-present	See 200-ZP-1	497 µg/L	2.5 µg/L	11 pCi/L	2,270 mg/L	1.15 pCi/L	8.7 µg/L	86,500 pCi/L	280,000 pCi/L	734 µg/L		
200-BP-5	B Plant Pu separation: 1945-1952; B Plant Sr and Cs recovery: 1967-1985	Expected 2016	Perched aquifer P&T test: 2011-2014	1.7 µg/L	172 µg/L	1,600 µg/L	6.05 pCi/L	1,480 mg/L	1,100 pCi/L	3.97 µg/L	42,000 pCi/L	37,000	4,030 µg/L		
200-PO-1	PUREX Plant Pu separation: 1956-1972 and 1983-1989	Expected 2016	Vadose zone desiccation test: 2011	1.8 µg/L	167 µg/L	9.7 µg/L	6.49 pCi/L	156 mg/L	15 pCi/L	1.6 µg/L	1,840	510,000 pCi/L	57.8		
Standards*				5 µg/L	48 µg/L	200 µg/L	1 pCi/L	45 mg/L	8 pCi/L	5 µg/L	900 pCi/L	20,000 pCi/L	30 µg/L		
Half-life (years)				N/A	N/A	N/A	16,000,000	N/A	28.8	N/A	212,000	12	>159,000		
Mobility in subsurface				Multi-phase	High to Moderate	Moderate	High	High	Slight	Moderate	High	High	Moderate		
Legend															
Colors indicate maximum concentration in 2014				Height of bar indicates plume area above standard (km ²)											
N Not detected or not analyzed															
*Drinking water standards for all but hexavalent chromium (MTC standard)															
ABBREVIATIONS															
N/A = Not applicable				P&T = pump-and-treat				ROD = record of decision				MTC = Model Toxics Control Act		CHSGW2014GW05	

Figure ES-3 presents time series graphs of plume area over time for the largest plumes (tritium, iodine-129, nitrate, carbon tetrachloride, and chromium). The figure also illustrates the area of the combined plume footprint for all the plumes mapped for this report, which also include carbon-14, cyanide, strontium-90, technetium-99, trichloroethene, total petroleum hydrocarbons-diesel, and uranium.

DOE has taken the following actions to protect the Columbia River from contaminated groundwater:

- Ceasing discharge of all unpermitted liquids in the central Hanford Site
- Remediating waste sites in the 100 and 300 Areas

- Containing groundwater plumes and reducing the mass of primary contaminants through remedial actions such as pump and treat (P&T)

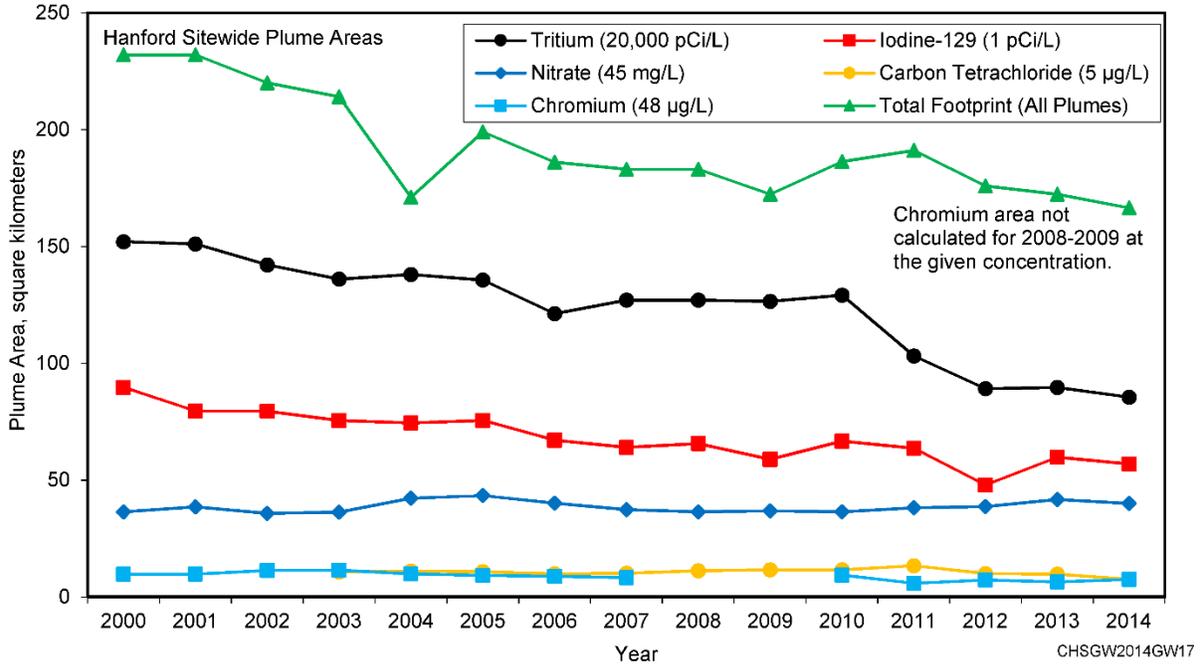
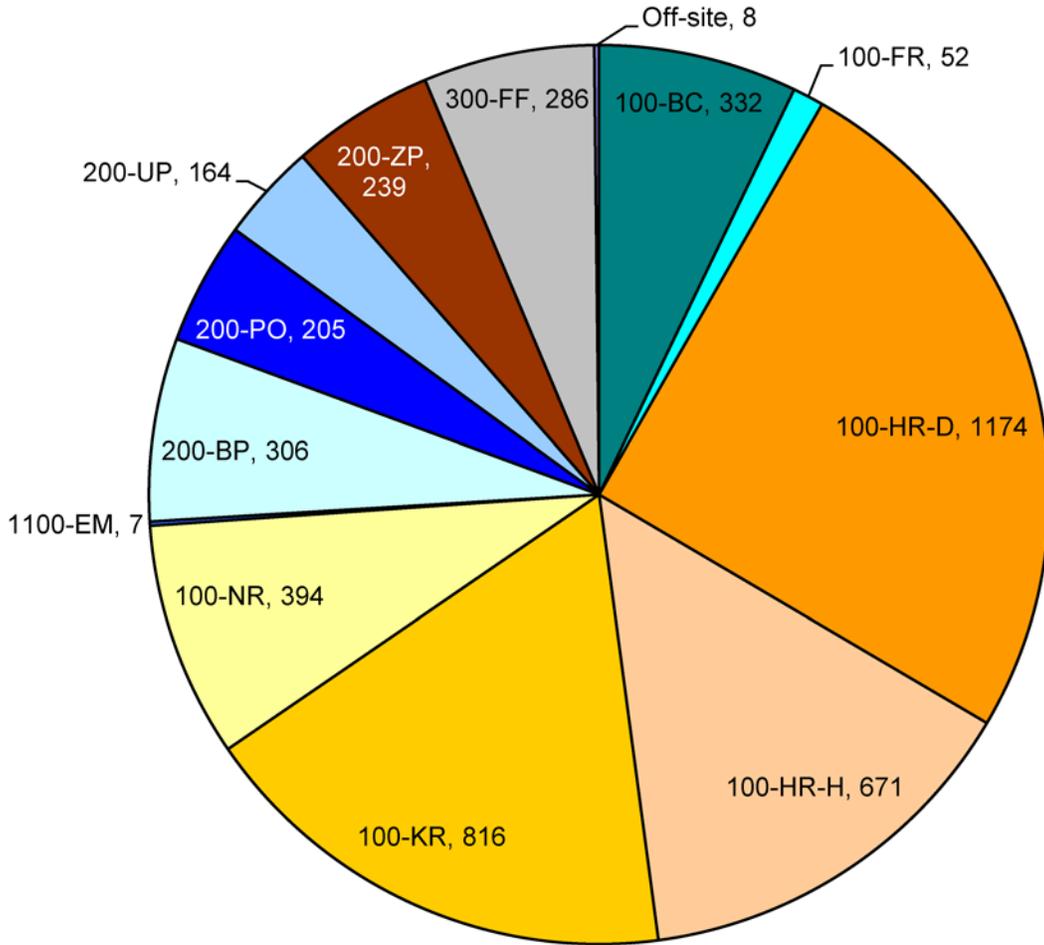


Figure ES-3. Hanford Sitewide Plume Areas in the Upper Part of the Unconfined Aquifer

This graph shows changes in plume areas, primarily based on data from wells screened near the top of the unconfined aquifer. Tritium and iodine-129 form the largest groundwater plumes on the Hanford Site. Their estimated areas have declined over time.

DOE operates an extensive groundwater monitoring program on the Hanford Site, collecting thousands of samples from hundreds of wells each year, and analyzing the samples for a variety of radionuclides and chemicals (Figures ES-4 and ES-5). In addition to monitoring wells, DOE monitors hundreds of sampling points near the Columbia River, known as aquifer sampling tubes, for general information about groundwater approaching the river. The percent useable groundwater monitoring data for 2014 is 96.7 percent, which exceeds the DOE groundwater monitoring requirement of 85 percent data usability. Figure ES-6 compares maximum concentrations of the major groundwater contaminants in various parts of the Site in 2014. These contaminants are discussed further in the remaining sections of this Executive Summary.

2014 Sampling Trips



CHSGW2014GW30

Figure ES-4. 2014 Sampling Events (Wells and Aquifer Tubes).

DOE sampled 977 monitoring and extraction wells, and 324 aquifer tubes in 2014. Many of them were sampled multiple times, for a total of 4,654 sampling events.

2014 Laboratory Analyses

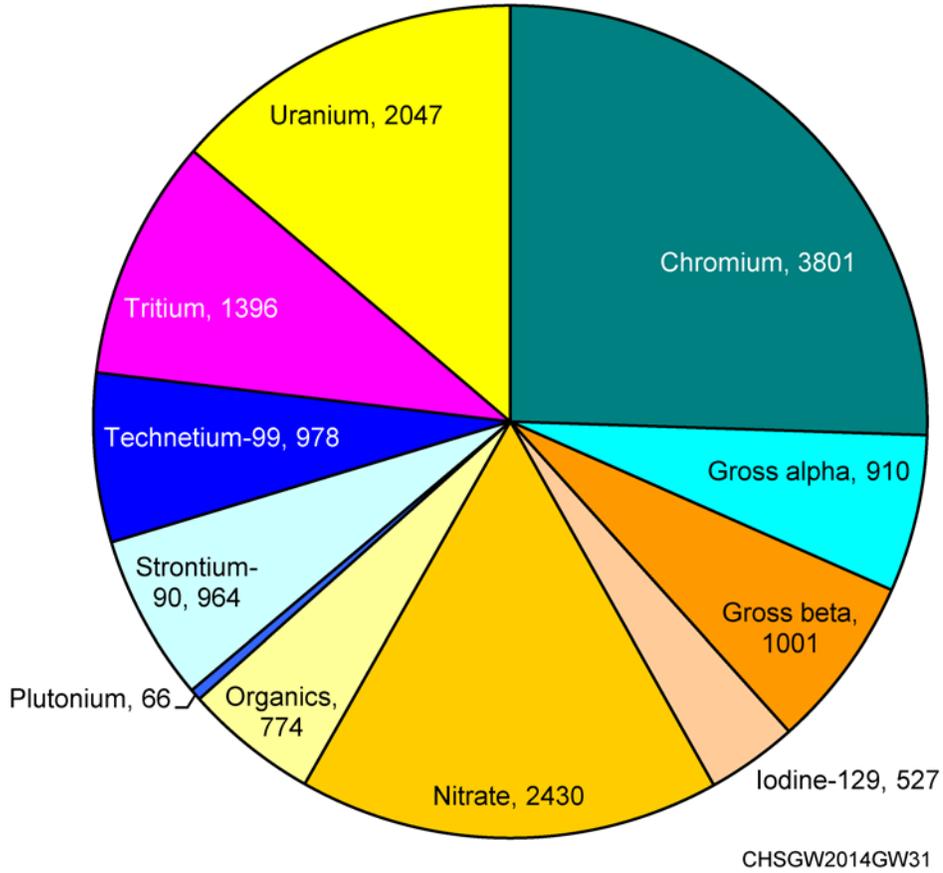


Figure ES-5. 2014 Laboratory Analyses of Groundwater Samples.

This chart shows the number of laboratory analyses run on Hanford Site groundwater samples for the most common constituents in 2014.

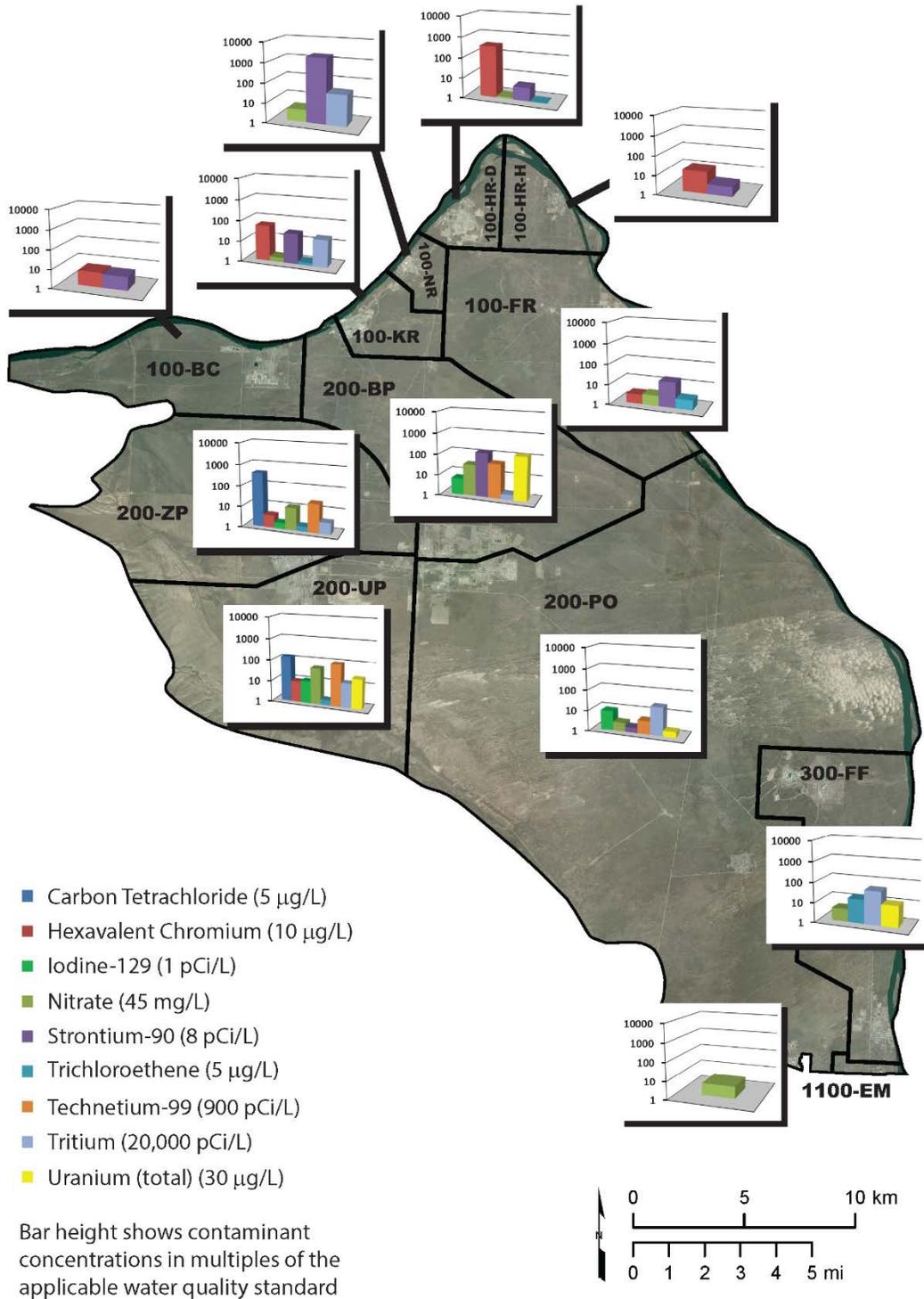


Figure ES-6. Exceedance Ratios of Groundwater Contaminants

This map shows the maximum concentrations of groundwater contaminants in each groundwater interest area in 2014. The heights of the bars represent multiples of the applicable water quality standards. For example in 100-FR, the maximum strontium-90 concentration was 144 pCi/L and the bar is 18 units high because the DWS is 8 pCi/L.

This summary is organized by geographic regions known as “groundwater interest areas” (Figure ES-6) that include the River Corridor and the Central Plateau.

River Corridor

Highlights:

- As of the end of 2014, 89 percent of the waste sites in the River Corridor had been remediated or were classified as not needing remediation under interim Records of Decision (RODs), as compared to 85 percent in 2013 and 74 percent in 2012. Cleanup of the remaining sites is underway.
- Based on remedy performance monitoring and the reduction in length of shoreline impacted by contaminant plumes, groundwater remediation systems in 100-HR, 100-KR, and 100-NR are reducing the amount of contamination entering the Columbia River.

Table ES-1 provides a summary of the River Corridor groundwater interest areas and associated contamination plumes. In the 100 Area, groundwater contamination is related to past disposal of waste associated with water-cooled nuclear reactors. The primary groundwater contaminants of concern (COCs) in the 100 Area are chromium (hexavalent and total), strontium-90, nitrate, trichloroethene, and tritium (Figure ES-7). Sources of hexavalent chromium contamination included the routine disposal of reactor cooling water, which contained the corrosion inhibitor sodium dichromate, and unplanned spills and leaks of the high-concentration sodium dichromate stock solution. In the 300 Area, the groundwater COCs are uranium, tritium, nitrate, gross alpha, trichloroethene and cis-1,2-dichloroethene.

Since the 1990s, DOE has been remediating waste sites and groundwater in the River Corridor under interim records of decision (RODs). Removal of contaminated soil has reduced the potential for exposure to contaminants, including future groundwater impacts.

Under interim action RODs, groundwater remediation systems in the 100-HR-3 and 100-KR-4 Operable Units are limiting the amount of contamination reaching the Columbia River and reducing the mass of contaminants. The primary contaminant addressed is hexavalent chromium. The comparison concentration for inland groundwater wells is 20 µg/L. Similar to other river corridor decisions (e.g., 100-FR-3),

the cleanup level for groundwater discharges to the river for the final action ROD for 100-HR-3 and 100-KR-4 is expected to be 10 µg/L, when they are completed.

EPA and DOE signed a final action ROD for 100-FR waste sites and groundwater in 2014. Final action RODs previously were signed for the 300-FF-5 and 1100-EM-1 OUs. Final action RODs for the other portions of the River Corridor are expected to be developed in the next few years.

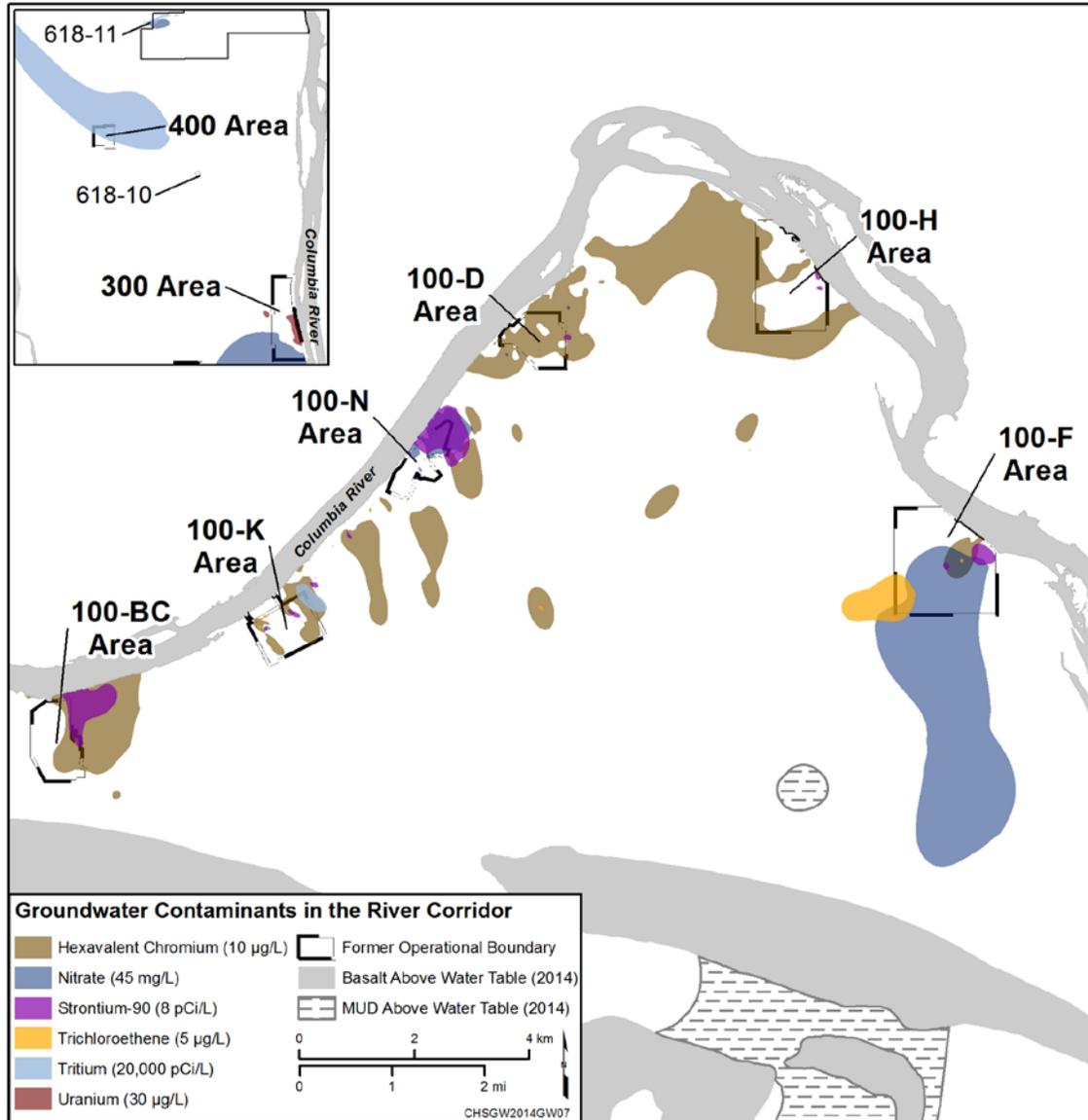


Figure ES-7. Groundwater Contaminants in the River Corridor

The largest contaminant plumes in the former reactor areas are hexavalent chromium and nitrate. Smaller plumes of strontium-90, tritium, and trichloroethene are also present. A uranium plume is present in 300 Area groundwater.

100-BC

Highlights:

- Remedial investigation (RI) studies continued in 100-BC in 2014, with additional sampling of wells and river shoreline sampling points installed in 2013. The studies, which are expected to conclude in 2016, will provide data to support remedy decisions for groundwater cleanup. This includes ongoing, intensive sampling of water in the shallow river bed to evaluate variable concentrations of hexavalent chromium, at the groundwater/surface water interface.

Groundwater contaminants in 100-BC include hexavalent chromium and strontium-90. Tritium concentrations remained below the drinking water standard (DWS) in 2014. Waste sites in 100-BC have been remediated under an interim action ROD, so contaminant levels in groundwater are expected to continue to decline.

DOE and EPA have agreed that additional RI studies are needed to reduce uncertainties relating to (1) the completion of waste site remediation; (2) short-term changes in groundwater contaminants related to waste site remediation; (3) modeling results predicting that the hexavalent chromium plume could persist for over 100 years; and (4) the level of risk associated with variable hexavalent chromium concentrations in Columbia River pore water.

100-KR

Highlights:

- Approximately 59 percent of the waste sites have been remediated or were determined not to require remediation under an interim action ROD.
- Three P&T systems continued to operate in 100-KR to remove hexavalent chromium from groundwater. In 2014, over 2.3 billion L (607.6 million gal) of groundwater was pumped from 41 extraction wells. A total of 797 kg of hexavalent chromium have been removed to date.
- The hexavalent chromium plume area (greater than 20 µg/L) was estimated to be 0.76 km² (0.29 mi²) in 2014, a decrease from 2013. Since 2007, the plume area above 20 µg/L has decreased by approximately 70 percent, and the length of shoreline that the plume is interpreted to intersect (based on data from wells and

aquifer tubes) has decreased from 2,200 meters (7,200 feet) to 200 meters (660 feet) (Figure ES-8).



Figure ES-8. 100-KR Hexavalent Chromium Plume in 1996 (Before Interim Action) and 2014 (During Interim Action)

- *Three P&T systems reduce the amount of hexavalent chromium entering the Columbia River from 100-KR. The concentrations and size of the main plume have declined as a result of remediation, hydraulic control, and natural processes.*

Hexavalent chromium is the primary contaminant in 100-KR groundwater. Smaller plumes of carbon-14, tritium, strontium-90, nitrate, and trichloroethene also are present. Cleanup actions for these other contaminants will be defined in an upcoming ROD. DOE has proposed additional P&T for hexavalent chromium as part of a preferred alternative for groundwater remediation. The draft RI/Feasibility Study (FS) and Proposed Plan underwent review in 2012, and DOE will incorporate the results of supplemental source characterization activities that includes drilling boreholes near the KE Fuel Storage Basin and 116-KE-3 Crib and Reverse Well. These boreholes are expected to be drilled in 2015.

For AEA purposes, DOE monitors groundwater near the KW and former KE Fuel Storage Basins, which were integral parts of each reactor building. Until 2004, the concrete, water-filled basins were used to store irradiated fuel from the last run of N Reactor, as well as miscellaneous fuel fragments recovered during remedial actions at other reactor areas. The KE Basin was demolished. The KW Basin has been emptied of fuel rods, but remains a depository for contaminated sludge from the KE and KW Basins. Groundwater monitoring in 2014 did not show new groundwater impacts from the basins.

100-NR

Highlights:

- The major liquid waste disposal sites have been remediated, and excavation is continuing at remaining waste sites. Work is expected to be complete in 2015.
- Under an interim action ROD, a 900 ft (170 m) section of a permeable reactive barrier was placed along the shoreline, reducing the amount of strontium-90 migrating from groundwater into the river. Expansion of the barrier to its full 2500 ft (760 m) length is pending.
- Work continued in 2014 on revisions to the RI/FS report in response to Ecology comments.

Principal groundwater activities for 100-NR include RCRA monitoring and remediation of strontium-90 and total petroleum hydrocarbons. Other groundwater contaminants include nitrate and tritium. Hexavalent chromium from 100-KR has affected 100-NR groundwater in some locations.

Strontium-90, which originated at the 116-N-1 and 116-N-3 waste sites, is the primary contaminant. Strontium (including the strontium-90 isotope) substitutes for calcium in the sediment, reducing the mobility of this contaminant in the vadose zone and groundwater. As a result, the shape and size of the plume (Figure ES-9) has not changed significantly since 1996. P&T technology, which operated from 1995 to 2006, was found to be ineffective in cleaning up strontium-90, so DOE is now applying an in situ technology called strontium-90 sequestration, using an apatite chemical solution.

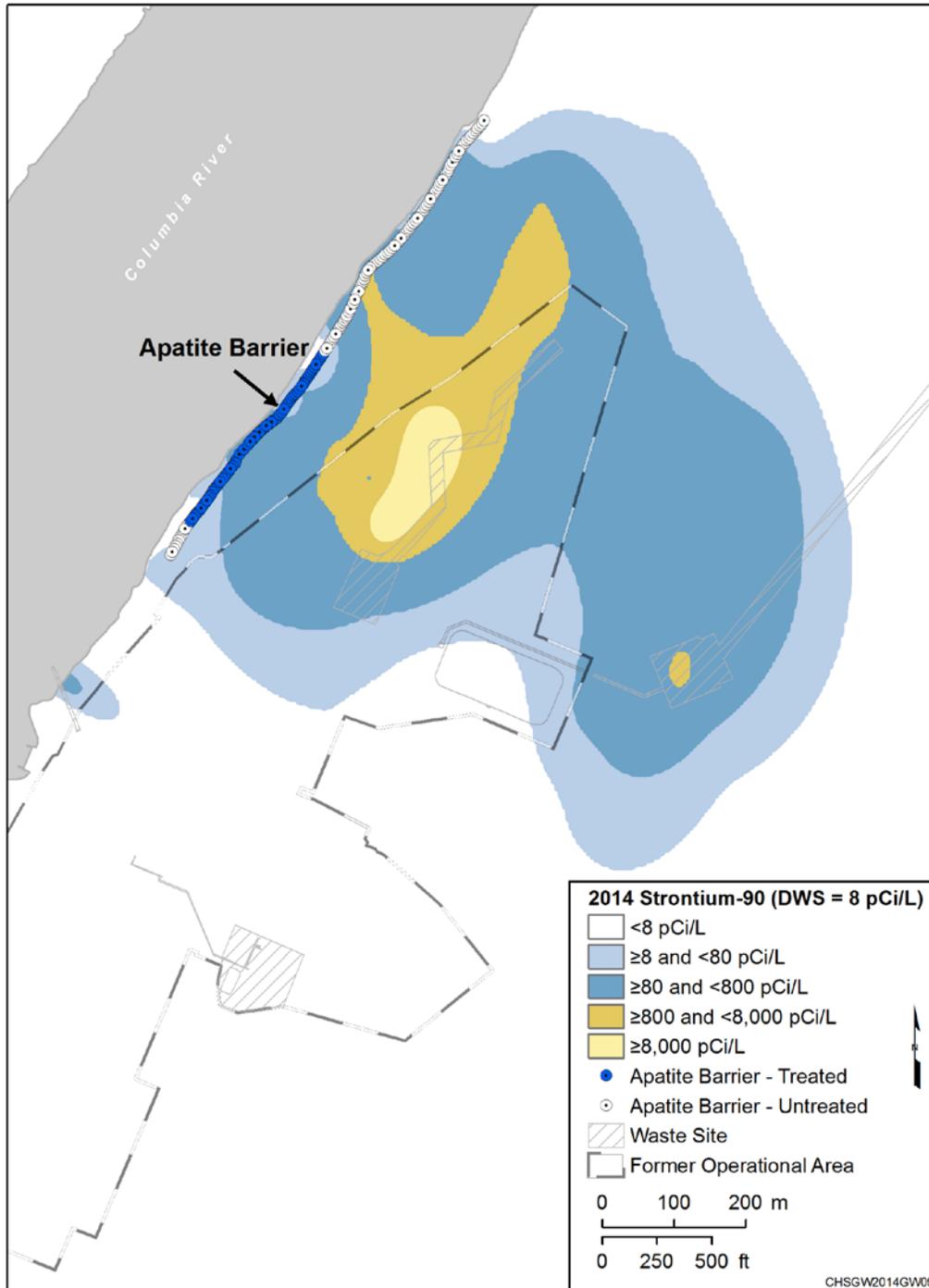


Figure ES-9. 100-NR 2014 Strontium-90 Plume and Apatite Barrier

To create the apatite barrier, DOE injected chemicals into a line of wells along the river shore, creating a treatment zone in the aquifer. As contaminated groundwater flows through this zone, much of the strontium-90 binds to the sediment grains before it can reach the river.

In 2014, RCRA monitoring continued under final status detection programs at the 1301-N, 1324-N/NA, and 1325-N facilities (waste sites 116-N-1, 120-N-1, 120-N-2, and 116-N-3). Results indicated no releases of dangerous waste constituents from the RCRA units.

DOE submitted a draft RI/FS report and proposed plan to Ecology for review in 2013. When finalized, these documents will be used to develop a ROD documenting remediation of waste sites and groundwater.

100-HR

Highlights:

- Approximately 87 percent of the former waste sites have been remediated or were determined not to require remediation under an interim action ROD. Remediation of waste sites continued in 2014, including 100-D-100, a major source of hexavalent chromium. Contaminated sediment was excavated down to the water table, and excavation into the top of the aquifer continues in 2015.
- Two P&T systems continued to operate under an interim action ROD, removing hexavalent chromium. In 2014, 2.4 billion L (634 million gal) of groundwater were pumped from 74 extraction wells. A total of 2,246 kg of hexavalent chromium have been removed to date. The plume area (greater than 20 µg/L) was estimated to be 3.5 km² (1.4 mi²) in 2014, a decline from 2013. Since 2005 the plume has decreased in area by over 60 percent, and the length of shoreline intersected by the plume (above 20 µg/L) has been reduced from 2,550 m (8,200 ft) to 0 m (Figure ES-10). The changes are a result of contaminant removal, remediation of sources, hydraulic control, and natural processes.
- Ecology accepted the 100-HR-3 RI/FS Report in October 2014.

The 100-HR-3 Groundwater OU in the northern Hanford Site includes the 100-HR-D and 100-HR-H groundwater interest areas. Hexavalent chromium is the primary COC. Additional groundwater contaminants in 100-HR include strontium-90 and nitrate (Figure ES-7).

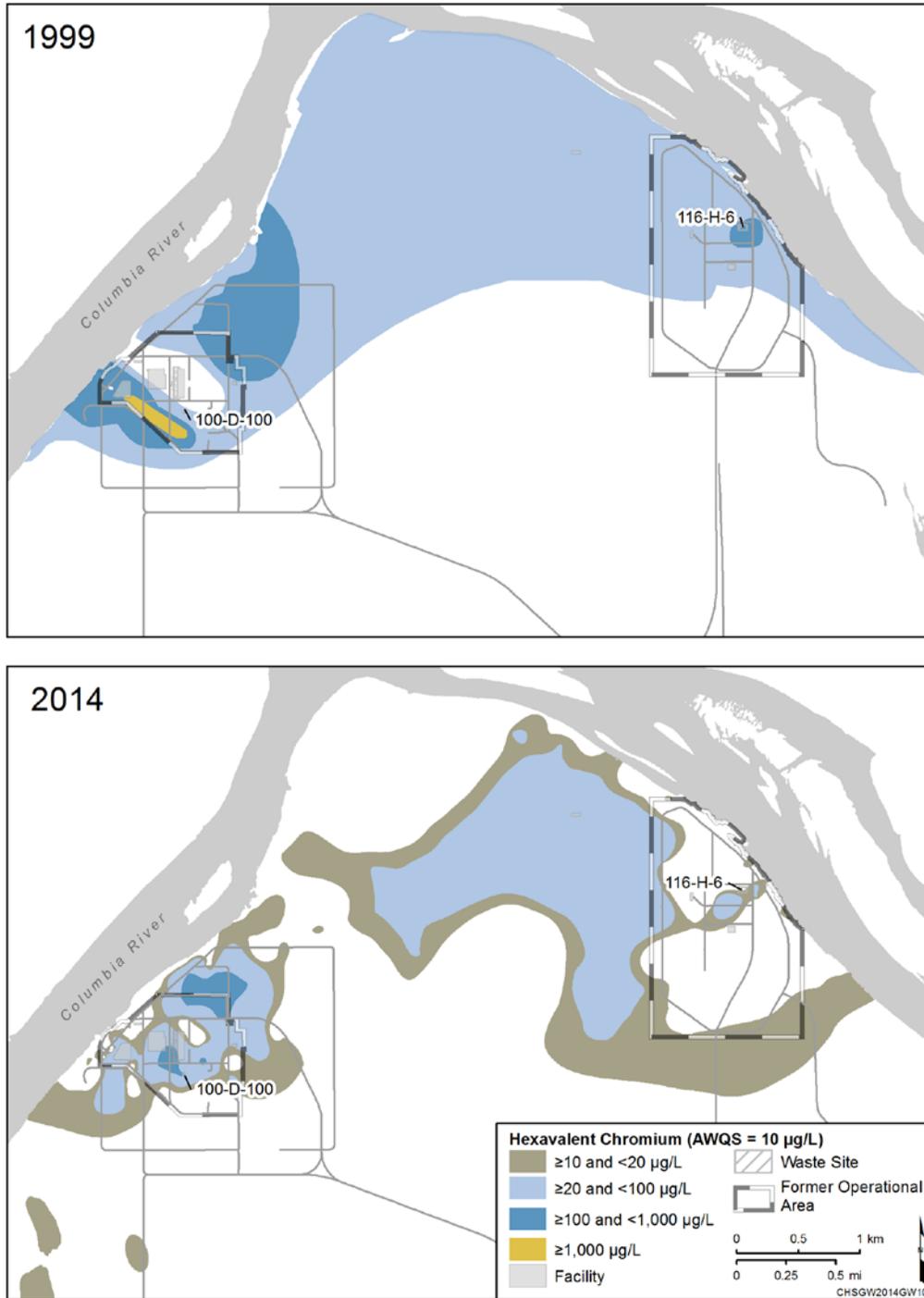


Figure ES-10. 100-HR Hexavalent Chromium Plume in 1999 (Early in Interim Action Period) and 2014 (During Interim Action)

Two P&T systems are remediating groundwater in the 100-HR-3 OU. The size and concentration of the plumes have declined since remediation began, especially in areas adjacent to the Columbia River.

Investigation of groundwater conditions at 100-HR greatly changed the understanding of the extent of chromium contamination since P&T began, primarily because many more wells were installed. In 1997, 110 wells and aquifer tubes were sampled, and in 2014, over 330 wells and aquifer tubes were sampled in 100-HR. The added wells and aquifer tubes identified areas of higher chromium concentrations at 100-D, in the Horn, and in the Ringold Formation upper mud unit (RUM). Even with areas of high levels of contamination being identified, the overall areal extent of the plume has decreased as a result of remediation (Figure ES-10).

The CERCLA process is underway to make final cleanup decisions for 100-HR. DOE submitted the Draft A RI/FS and Proposed Plan in 2012. In 2013 and 2014, DOE and Ecology worked through the comment resolution process, and Ecology accepted the RI/FS in 2014. The Proposed Plan is expected to be available for public comment in 2015 or 2016. A ROD will then be issued that identifies the final remedial alternatives. DOE has proposed ongoing P&T as the preferred alternative for remediating hexavalent chromium in groundwater.

The former 183-H Solar Evaporation Basins (waste site 116-H-6) constitute the only RCRA site in 100-HR. The site is monitored in accordance with RCRA corrective action requirements during the post-closure period to track contaminant trends during operation of the CERCLA interim action for hexavalent chromium.

100-FR

Highlights:

- Former 100-FR waste sites have been excavated and backfilled under an interim action ROD.
- In 2014, EPA and DOE signed a ROD that includes monitored natural attenuation (MNA) as the preferred alternative for 100-FR-3 groundwater remediation. Preparation of a work plan and sampling and analysis plan are underway.

Groundwater contamination in 100-FR originated from disposal of solid and liquid waste associated with operation of the water-cooled F Reactor and biological experiments. Nitrate concentrations in groundwater exceed the DWS beneath much of the 100-F Area and the plume extends southward approximately 5 km (3.1 mi). Smaller plumes of

hexavalent chromium, strontium-90, and trichloroethene are present (Figure ES-7). Contaminant concentrations are below cleanup standards near the river and are declining.

300-FF

Highlights:

- Approximately 91 percent of the waste sites have been remediated or classified as not requiring remediation. Remediation is continuing at the remaining sites.
- The remedial design report/remedial action work plan that implements the 2013 final action ROD is anticipated to be issued in 2015.
- DOE is conducting field and laboratory studies to understand and model the processes that control contaminant flux between groundwater and the Columbia River. In 2014, studies focused on seasonal water quality dynamics (including uranium and nitrate).

Three geographic regions comprise 300-FF: the 300 Area Industrial Complex; the 618-11 Burial Ground region; and a region including the 618-10 Burial Ground and 316-4 Cribs (Figure ES-7).

EPA and DOE signed a ROD in 2013. The remedial action for groundwater includes enhanced attenuation of uranium using sequestration by phosphate application. MNA is the selected remedy for other COCs: trichloroethene and cis-1,2-dichloroethene at the 300 Area Industrial Complex and tritium and nitrate at the 618-11 Burial Ground. Uranium concentrations remain above the cleanup level (30 µg/L) in groundwater in the 300 Area Industrial Complex and downgradient from the 618-7 Burial Ground (Figure ES-11). Contamination from 618-7 was mobilized by waste site remediation activities in recent years.

Trichloroethene concentrations exceeded the cleanup level (4 µg/L) in one 300-FF monitoring well and several aquifer tubes in 2014. Concentrations of nitrate above 45 mg/L are also present in groundwater beneath part of the 300 Area Industrial Complex, but these originated from sources off the Hanford Site; nitrate in the 300 Area Industrial Complex is not a COC for 300-FF.



Figure ES-11. 300-FF Uranium Plume in 1996 and 2014

The uranium plume in the 300 Area is attenuating slowly. Groundwater remediation will include chemically sequestering contamination in the deep vadose zone and at the top of the aquifer beneath a former waste site, to decrease the amount of uranium feeding the groundwater plume.

Groundwater associated with the 618-11 Burial Ground, north of the 300 Area Industrial Complex, contains a high-concentration tritium plume originating from irradiated material in the burial ground. The waste site has not been remediated. Nitrate concentrations near the 618-11 Burial Ground also continued to exceed the cleanup level (45 mg/L).

RCRA groundwater monitoring continued at the 300 Area Process Trenches (waste site 316-5). The unit is monitored in accordance with post-closure corrective action requirements (WAC 173-303-645[11]). Uranium and cis-1,2-dichloroethene continued to exceed permit concentration limits in 2014. In accordance with the closure plan, groundwater corrective action will be addressed as part of the remediation for the CERCLA 300-FF-5 Groundwater OU.

1100-EM and Richland North

Highlights:

- Remediation of the former 1100-EM-1 OU is complete.
- DOE monitors wells in and near the north Richland well field, which is part of the municipal water supply system. Tritium concentrations are at background levels.

The 1100-EM-1 Groundwater OU was removed from the “National Priorities List” (40 CFR 300, Appendix B) in 1996. The selected remedy was MNA of volatile organic compounds, with institutional controls (ICs) on drilling of new water supply wells. Trichloroethene is the primary COC, but concentrations have remained below the cleanup level since 2001.

Uranium concentrations in Hanford Site wells in the vicinity of DOE’s inactive Horn Rapids Landfill have increased gradually since 1996, exceeding the DWS in 2012 and dropping slightly below the standard in 2014. The presence of uranium at these locations is attributed to a plume moving northeast from an active offsite facility, AREVA NP, Inc. a nuclear fuel production facility.

Columbia River

Highlights:

- River water downstream of the Hanford Site meets water quality standards.

DOE samples Columbia River water, river sediment, and riverbank seeps to determine the extent of Hanford Site contaminants. Except for tritium and uranium isotopes, radionuclides were undetected in upstream and downstream samples. The average tritium concentration downstream of the Site, near the City of Richland, was 48 pCi/L, compared to 18 pCi/L upstream of the Site. The DWS for tritium is 20,000 pCi/L. The average concentration of uranium-238 downstream of the Site was 0.22 pCi/L, compared to 0.18 pCi/L upstream of the Site. The sum of uranium isotopes downstream of the Site equates to 0.72 µg/L total uranium, compared to the DWS of 30 µg/L. Chromium was undetected in upstream and downstream water samples.

Two DOE studies addressed the entire River Corridor in order to support the multiple River Corridor RI/FS documents. The 100 Area and 300 Area component of DOE’s

River Corridor baseline risk assessment, published in 2011 and 2012 (DOE/RL-2007-21 and DOE/RL-2010-117) addresses post-remediation, residual contaminant concentrations in these areas, as well as the Hanford and White Bluffs town sites. The assessment also investigated the risks related to the potential transport of Hanford Site contaminants into Columbia River riparian and near-shore environments adjacent to the operational areas.

DOE completed an investigation of Hanford Site contaminant releases in the Columbia River in 2010 (DOE/RL-2010-117). Samples were collected of pore water (i.e., groundwater discharge into the river bottom sediment), river sediment, river water, fish, and island soil. Pore water in some samples from 100-BC, 100-K, 100-D, and 100-H had concentrations of hexavalent chromium above the aquatic standard, and strontium-90 exceeded the DWS in some 100-N Area samples. Tritium concentrations exceeded the DWS in some pore water samples near the former Hanford town site (location shown in Figure ES-17), and uranium exceeded the DWS in pore water near the 300 Area. The information obtained from this investigation is being used to help make final cleanup decisions for each of the River Corridor units.

Central Plateau

Highlights:

- An estimated 570,000 to 920,000 kg of liquid wastes with carbon tetrachloride was discharged to waste sites in 200-ZP-1. Remediation has reduced the size of the high-concentration core and the overall footprint of the carbon tetrachloride plume. Combined, the final action system, the interim action system, and a soil vapor extraction system have removed a total of 100,496 kg of carbon tetrachloride from the subsurface.
- A P&T system at Waste Management Area (WMA) S-SX in the 200-UP-1 OU, which began operating in July 2012, has removed 1.66 Ci of technetium-99, 16,280 kg of nitrate, 28.1 kg of chromium, and 250 kg of carbon tetrachloride from groundwater.
- The size of the regional tritium plume associated with 200-PO-1 has decreased in area by more than one-half (from 185 to 79 km²) since 1980, primarily as a result of radioactive decay and dispersion.

When the Hanford Site was operating as a plutonium-production facility, irradiated fuel reprocessing, isotope recovery, and associated waste management activities occurred in the 200 East and 200 West Areas in the central portion of the Site. Ponds, cribs, and ditches used for disposal of liquid waste were primary sources of groundwater contamination. There are also seven single-shell tank WMAs in the 200 Area. Some of these tanks have leaked, contaminating the vadose zone and groundwater beneath the tanks.

Contamination is still present in many parts of the thick vadose zone, and may continue to drain into the groundwater. Remediation of the Central Plateau waste sites and vadose zone will accelerate after River Corridor remediation is complete. Meanwhile, DOE has been remediating groundwater and testing methods to remediate the deep vadose zone.

Groundwater contaminant plumes of tritium, nitrate, and iodine-129 formed when the waste discharged to ponds and cribs reached the aquifer. These contaminants form regional plumes originating on the Central Plateau. The plumes have decreased in area over the years as a result of dispersion and, in the case of tritium, radioactive decay. A large carbon tetrachloride plume originated in the Plutonium Finishing Plant (PFP) area of 200 West. Other groundwater contaminants in the Central Plateau include technetium-99, uranium, strontium-90, trichloroethene, hexavalent chromium, cyanide, and other dangerous waste constituents (Table ES-2 and Figure ES-12).

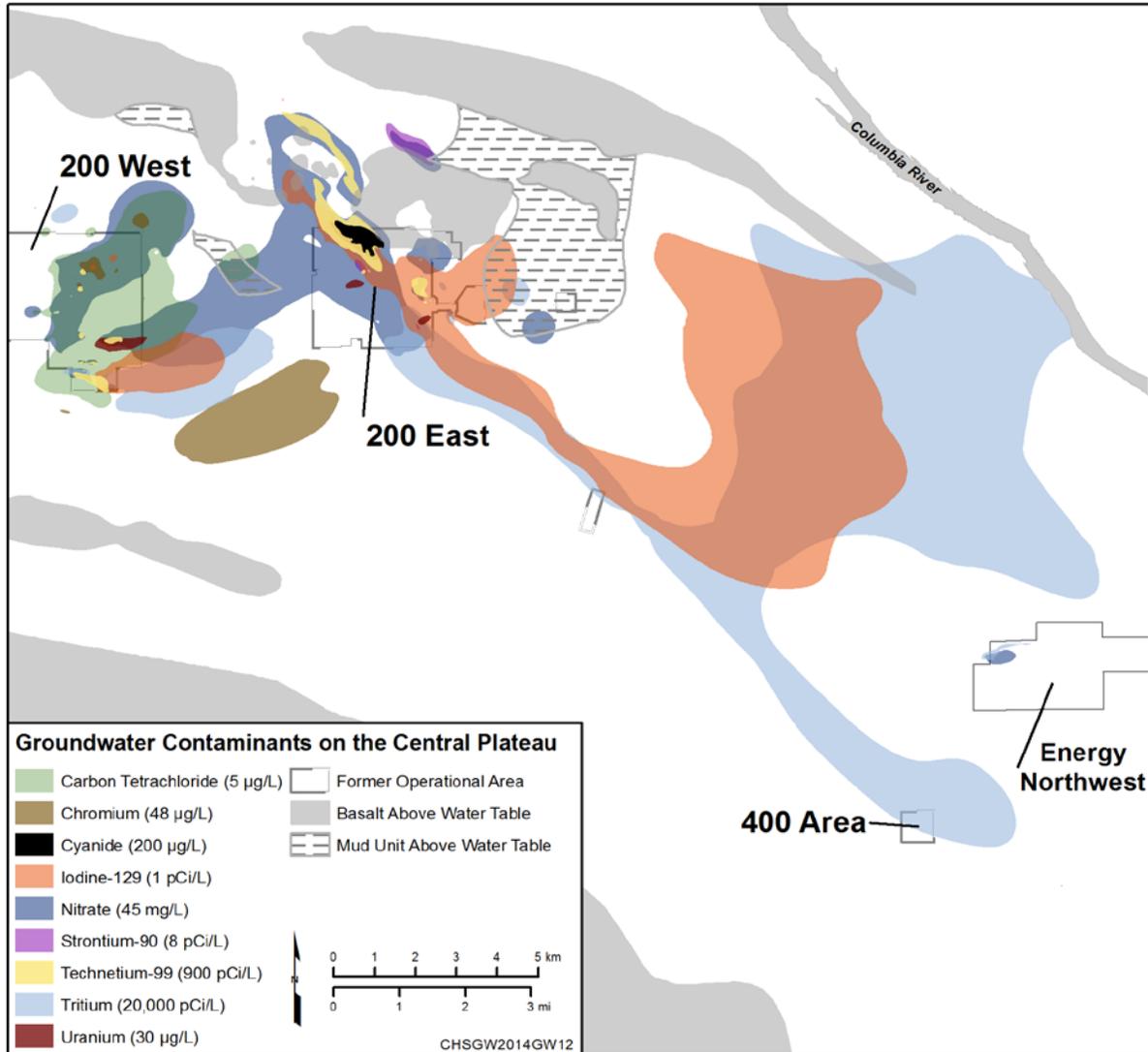


Figure ES-12. Groundwater Contaminants in the Central Plateau

Tritium and iodine-129 are mobile in groundwater and have formed extensive plumes that originated in the 200 Areas. Carbon tetrachloride forms a large plume beneath the 200 West Area. Other radionuclides and chemicals form smaller plumes beneath the Central Plateau.

200-ZP

Highlights:

- A P&T system has reduced the high-concentration core area of the carbon tetrachloride plume (Figure ES-13). The plume area above 5 µg/L was 13.1 km² (5.1 mi²) in 2014, compared to 15.4 km² (5.9 mi²) in 2013.
- In 2014, 20 extraction wells and 20 injection wells were in use and the treatment plant operated at a flow rate of 5,913 L/min (1,562 gpm) (71 percent of its design capacity). Additional wells were installed in 2014 that will be used to expand the extraction network. In 2014, the system processed 3.1 billion L (819 million gal) of groundwater and removed 2,796 kg of carbon tetrachloride, 234,616 kg of nitrate, and other contaminants from groundwater.
- Combined, the final action system, the interim action system, and a soil vapor extraction system have removed a total of 100,496 kg of carbon tetrachloride from the subsurface (Figure ES-14).

Contaminant sources in 200-ZP, located in the 200 West Area, included cribs, ponds, and single-shell storage tanks. A final action ROD for 200-ZP-1 OU groundwater identified carbon tetrachloride as the primary COC. Other COCs are trichloroethene, iodine-129, technetium-99, nitrate, chromium, and tritium.

Two Low-Level Waste Management Areas (LLWMA-3 and LLWMA-4) in 200-ZP are monitored under RCRA interim status, contaminant indicator parameter programs. Monitoring results showed no indication that either of these is contaminating groundwater.

RCRA assessment monitoring continued at WMA T and WMA TX-TY. Due to CERCLA remediation activities (operation of the 200 West P&T system) near WMA T, chromium concentrations are declining and the plume extents at both WMAs are shrinking.

The State-Approved Land Disposal Site (SALDS) receives treated water from the Hanford Site's Effluent Treatment Facility. It is regulated under a state waste discharge permit and has created a local tritium plume. All groundwater sampling results from the SALDS proximal wells were within permit compliance limits during 2014.

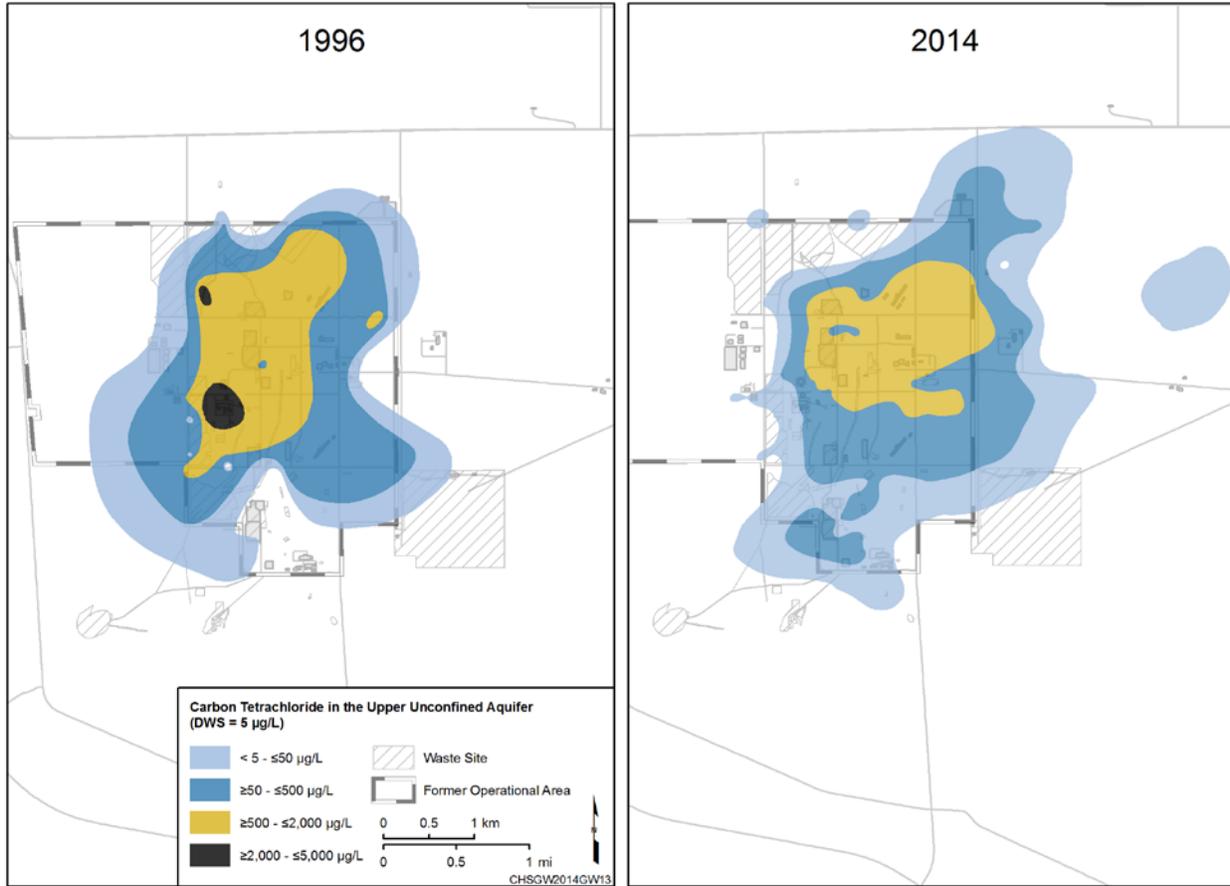


Figure ES-13. 200-West Carbon Tetrachloride Plume in 1996 (Upper Part of Unconfined Aquifer) and 2014 (Including Available Vertical Interval Data)

In 1996, little was known about the distribution of carbon tetrachloride in the deep part of the aquifer. Today, the plume is characterized throughout its full thickness, and the 2014 map includes data from various depths. An extensive P&T system is remediating the high-concentration portions of the plume.

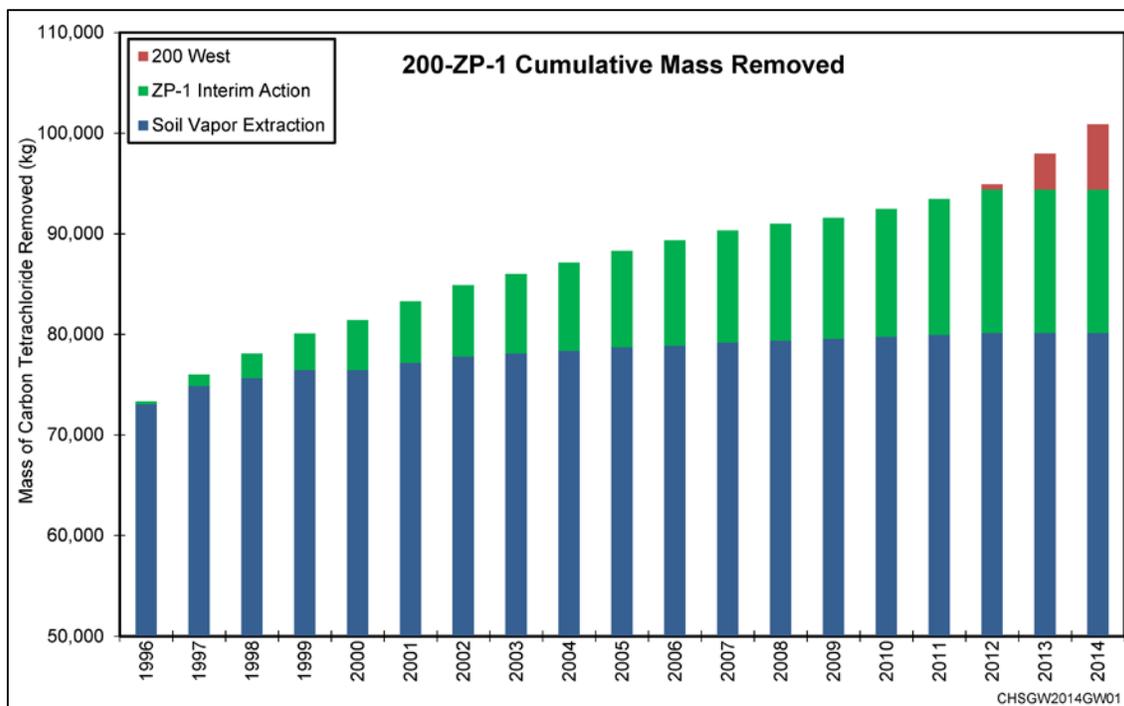


Figure ES-14. 200-ZP Carbon Tetrachloride Mass Removed by Final P&T, Interim P&T, and Soil Vapor Extraction

Since 1996 DOE has removed more than 100,000 kilograms of carbon tetrachloride from the vadose zone and groundwater in 200-ZP. The 200 West P&T system began to operate in 2012 under a final action ROD.

200-UP

Highlights:

- A P&T system at WMA S-SX began operating in July 2012. From 2012 to 2014 the system removed a 1.66 Ci of technetium-99, 16,280 kg of nitrate, 28.1 kg of chromium, and 250 kg of carbon tetrachloride from groundwater.
- Another part of groundwater remediation under the interim action ROD is a groundwater extraction system to remediate the uranium and technetium-99 plumes in the U Plant area. The system is currently being designed and will be constructed in 2015.

The southern portion of the 200 West Area and adjacent areas to the east and south comprise 200-UP. Contaminant sources included cribs, ponds, and single-shell tanks. Carbon tetrachloride, technetium-99, uranium, tritium, iodine-129, nitrate, and chromium plumes are present. Carbon tetrachloride in this region originated from sources

in 200-ZP. Wells near WMA S-SX monitor the highest technetium-99 concentrations on the Hanford Site, and the plume has grown in recent years (Figure ES-15).

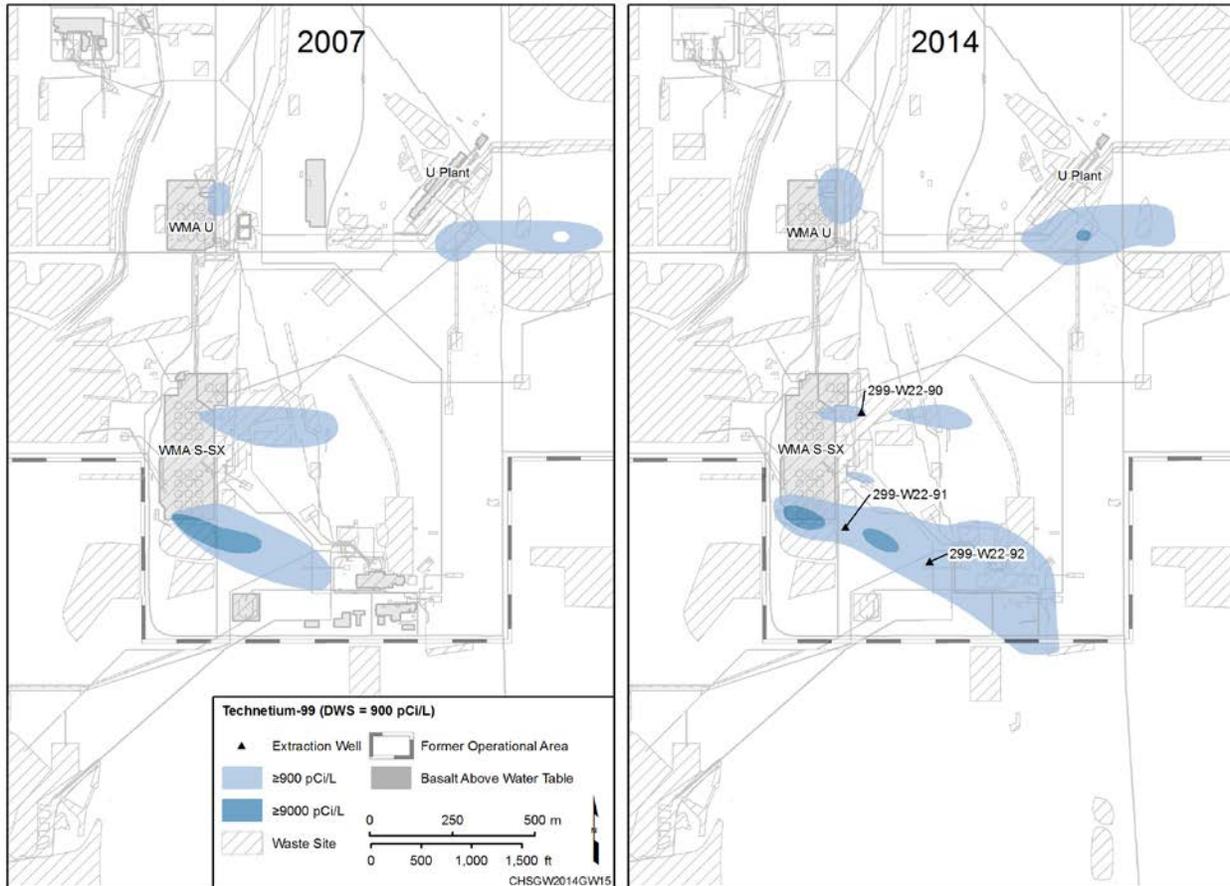


Figure ES-15. WMA S-SX Technetium-99 Plume in 2007 and 2014

A technetium-99 plume at the S and SX tank farms has expanded in recent years. Groundwater is now being extracted from the plume to remediate it.

An interim action ROD addressing all of the major contaminant plumes within the 200-UP-1 OU was published in 2012. The selected remedy in the ROD consists of a combination of P&T, MNA, hydraulic containment, and institutional controls.

RCRA monitoring in 200-UP includes interim status groundwater quality assessment monitoring at WMA S-SX and WMA U, and interim status indicator parameter evaluation monitoring at the 216-S-10 Pond and Ditch. WMA S-SX has contaminated groundwater with chromium, nitrate, and the non-RCRA constituent technetium-99. Water levels have declined at WMA S-SX due to groundwater extraction, causing some monitoring wells to go dry sooner than they would have otherwise. One new well was

installed in 2014 and four additional replacement wells are planned in 2015. Sources within WMA U have contaminated groundwater with nitrate and chromium. The groundwater beneath this tank farm is within the capture zone of a nearby extraction well. Indicator parameters did not exceed statistical comparison values at the 216-S-10 Pond and Ditch during 2014.

The Environmental Restoration Disposal Facility (ERDF) is a CERCLA disposal facility used for disposal of low-level radioactive mixed waste generated by remedial actions. The results of groundwater monitoring in 2014 continued to indicate that the facility has not impacted groundwater.

200-BP

Highlights:

- Wells in the northwestern part of 200-BP detect the highest concentrations of uranium in Hanford Site groundwater. Concentrations are even higher in a zone of perched water that lies above the water table. DOE, EPA, and Ecology signed an Action Memorandum in 2014 that directs continuing the extraction of contaminated perched water as a non-time-critical removal action under CERCLA. Approximately 53 kg of uranium were removed from the perched zone through the end of 2014.
- A draft RI report for the 200-BP-5 OU was prepared in 2014, describing the nature and extent of contamination and identifying contaminants of potential concern to support a future FS. In addition, work began on the FS in late 2014.

The 200-BP groundwater interest area includes the northern 200 East Area and the region to the northwest where mobile contaminants have migrated between Gable Mountain and Gable Butte. Most of the groundwater contamination is concentrated beneath WMA B-BX-BY and adjacent waste sites in the northwestern portion of the 200 East Area. Nitrate, iodine-129, and technetium-99 form the largest contaminant plumes. The high-concentration cores of these plumes have grown in size since 2007 due to continued drainage of contaminated water from the vadose zone into the aquifer (Figure ES-16). Smaller plumes of uranium, cyanide, strontium-90, and tritium also exceed their respective DWSs. Cesium-137 and plutonium-239/240 contamination is limited to one or two wells.

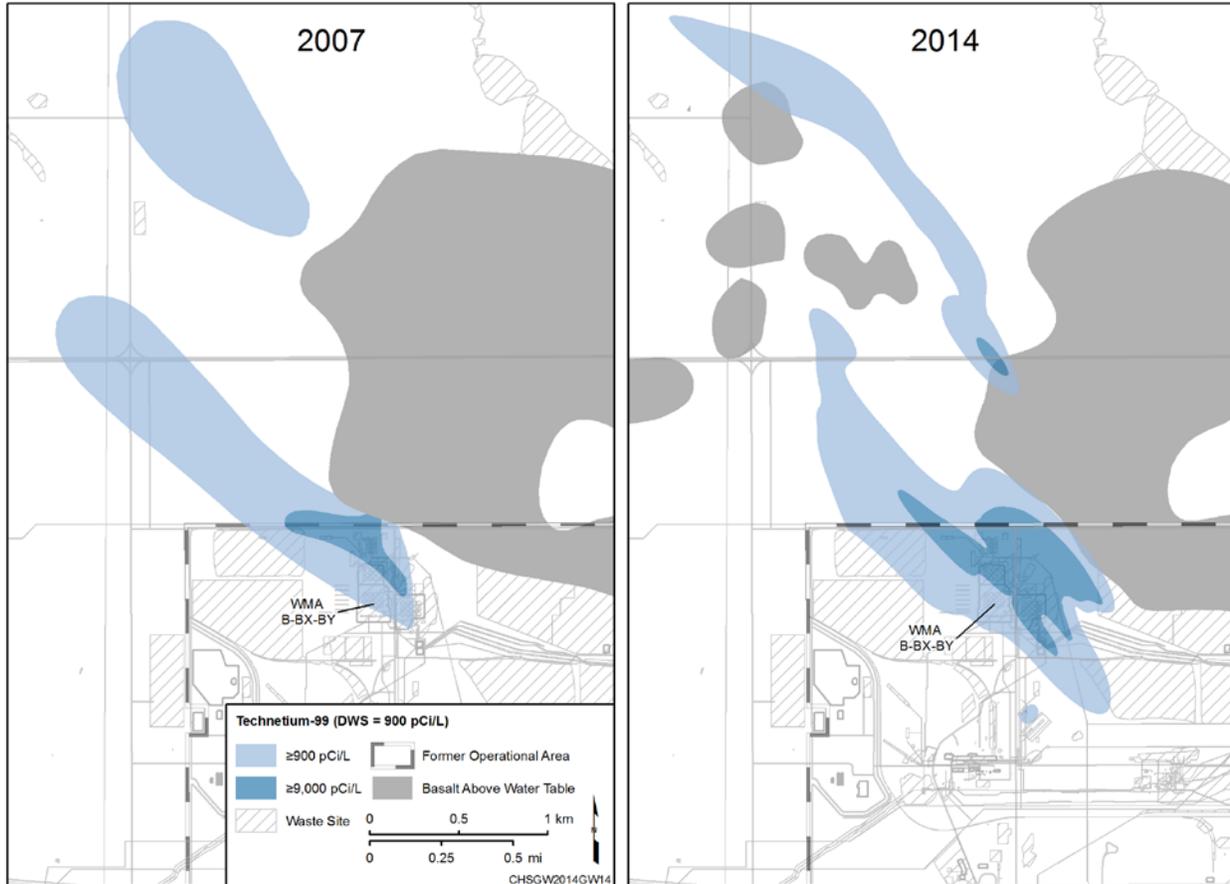


Figure ES-16. 200-BP Technetium-99 Plume in 2007 and 2014

The high-concentration cores of 200-BP contaminant plumes have grown in size since 2007 due to drainage of contaminated water from the vadose zone into the aquifer. DOE is pumping and treating perched water to lessen the amount that enters groundwater.

Six RCRA sites with groundwater monitoring requirements are located in 200-BP. RCRA groundwater quality assessment monitoring at WMA B-BX-BY and WMA C indicates that the dangerous waste constituent cyanide in groundwater originated in the WMAs. Because of the continued migration of this dangerous waste constituent an additional well was installed at WMA B-BX-BY in 2014. RCRA contamination indicator parameter monitoring continued at the 216-B-63 Trench, LLWMA-1, and LLWMA-2 in 2014. Results continued to show that these units have not impacted groundwater. DOE monitors the Liquid Effluent Retention Facility (LERF) under a RCRA final status detection program. Results showed no indication that the site has affected groundwater. A new groundwater monitoring plan for LERF was implemented in 2014.

200-PO

Highlights:

- The size of the regional tritium plume (Figure ES-17) from 200-PO has decreased in area by more than one-half since 1980 (from 185 to 79 km²). The maximum concentration has declined from over 6 million pCi/L in the 1980s to 510,000 pCi/L in 2014.
- An RI addendum report for the 200-PO-1 OU is currently being prepared to update the risk assessment based on additional groundwater data collected since the RI was completed in 2008 and 2009. In addition, work began on the FS in late 2014.

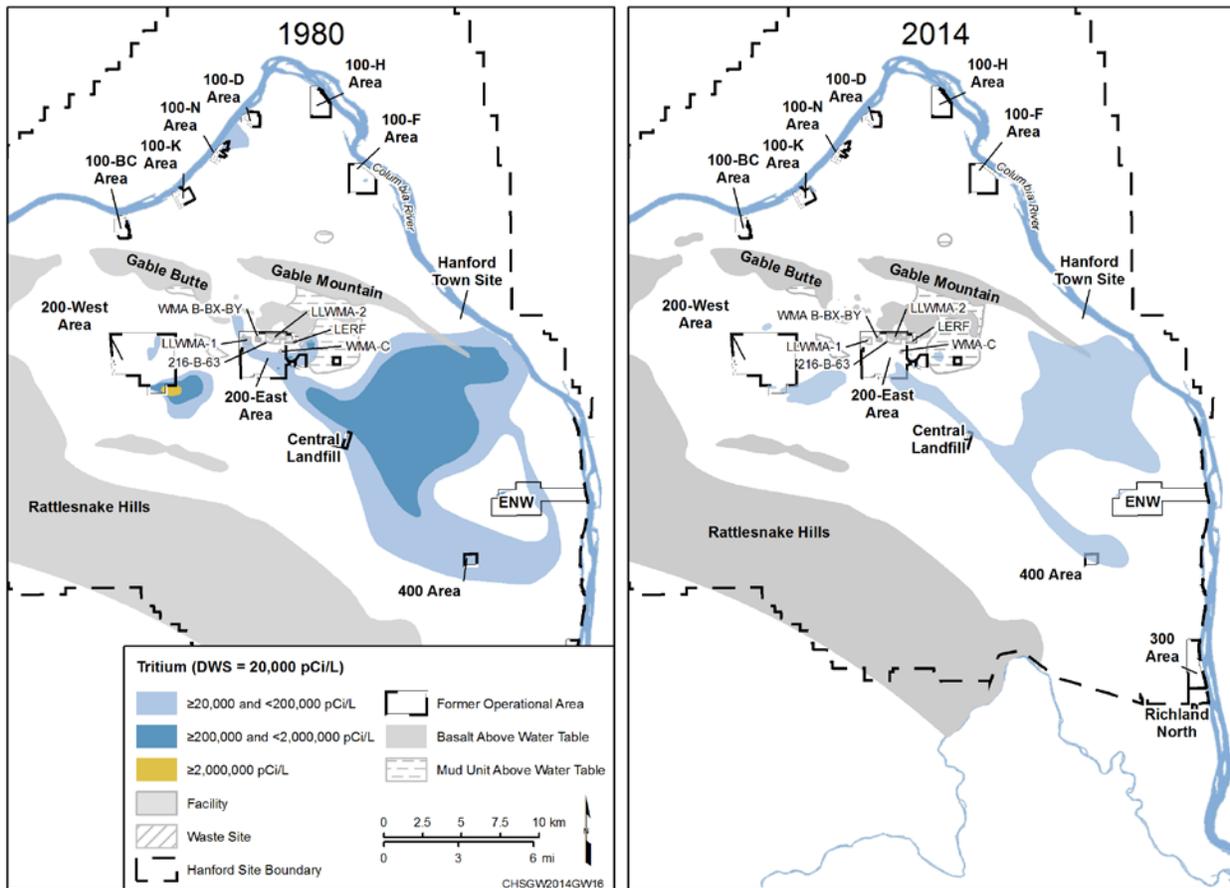


Figure ES-17. Hanford Site Tritium Plumes in 1980 and 2014

Hanford Site tritium plumes are shrinking as a result of radioactive decay, dispersion, and discharge to the Columbia River. Since 1980 the total area of the plumes has decreased by more than 50 percent and the maximum concentration has declined by 90 percent.

The southern portion of the 200 East Area and a large region of the Hanford Site to the east and southeast comprise 200-PO. Disposal of large volumes of liquid waste created regional groundwater plumes of tritium, iodine-129, and nitrate. The tritium plume had an estimated area of 79.2 km² (30.6 mi²) in 2014, a 5 percent decrease from 2013. Concentrations of tritium are declining as the groundwater plume attenuates naturally as a result of radioactive decay and dispersion. The area of the iodine-129 plume above the 1 pCi/L contour has decreased slightly over the past decade, and maximum concentrations have declined as a result of dispersion. Radioactive decay has not decreased the level of iodine-129 contamination noticeably because this isotope has a half-life of 15.7 million years. The nitrate plume covers a large area, with concentrations above background, but mostly below the DWS. Other contaminants in 200-PO include strontium-90, technetium-99, and uranium in smaller areas near their discharge sources (Figure ES-12).

In 2014, RCRA assessment monitoring continued at WMA A-AX and interim status indicator parameter programs continued at the 216-A-36B Crib, 216-A-37-1 Crib, 216-A-29 Ditch, 216-B-3 Pond, and Nonradioactive Dangerous Waste Landfill (NRDWL). One monitoring well with casing corrosion associated with WMA A-AX was decommissioned in 2013. Drilling of a replacement well started in November 2014 and will be completed in early 2015. Monitoring results from the interim status sites provided no indication of releases from these facilities to groundwater.

The Integrated Disposal Facility is an expandable, double-lined landfill that is regulated under RCRA and the AEA. It is not yet in use, and current groundwater monitoring is directed at obtaining baseline data.

The Solid Waste Landfill is regulated under Washington State solid waste handling regulations. As in previous years, some of the monitoring wells showed higher concentrations of regulated constituents than the statistically calculated background threshold values. Background threshold values exceeded during 2014 included specific conductance, nitrite, sulfate, and total organic carbon.

Three on-site water supply wells provide drinking water and serve as an emergency water supply for the 400 Area, which is in the footprint of 200-PO. Because the 400 Area is in the path of the Hanford Sitewide tritium plume, DOE routinely monitors the wells for tritium.

Confined Aquifers

Although most Hanford Site groundwater contamination is found in the unconfined aquifer, DOE monitors wells in deeper aquifers because of potential downward movement of contamination.

One confined aquifer occurs within sand and gravel at the base of the Ringold Formation. Carbon tetrachloride, nitrate, and technetium-99 have contaminated this unit in a portion of the 200 West Area where the upper confining unit is absent. Newer wells have been installed to monitor and remediate this contamination. The Ringold confined aquifer is the uppermost aquifer in a region east of 200 East (within portions of 200-BP and 200-PO). Iodine-129 and tritium are detected in wells at this location, but the contamination has not migrated farther to the east or southeast.

In the northern Hanford Site, fine-grained sedimentary units, informally called the RUM, confine deeper sediments in the Ringold Formation. In some parts of 100-HR this unit is contaminated with hexavalent chromium at concentrations over 100 $\mu\text{g/L}$ and is being remediated by a P&T system.

Groundwater within basalt fractures and joints, interflow contacts, and sedimentary interbeds make up the upper basalt-confined aquifer system.

Wells

Highlights:

- During 2014, DOE installed thirty new wells and six new aquifer tubes

Over the lifetime of the Hanford Site, DOE has installed thousands of wells to monitor and remediate groundwater and provide geologic data. Table ES-3 lists wells installed in 2014 and Figure ES-18 illustrates the number of wells installed during the past ten years.

DOE identifies wells, boreholes, or other subsurface installations for decommissioning when they are no longer needed. This involved sealing the wells in compliance with Washington State standards for construction and maintenance of wells (WAC 173-160). Four temporary wells in 100-D Area (199-D5-155, 199-D5-156, 199-D5-157, and 199-D5-158), were decommissioned in 2014.

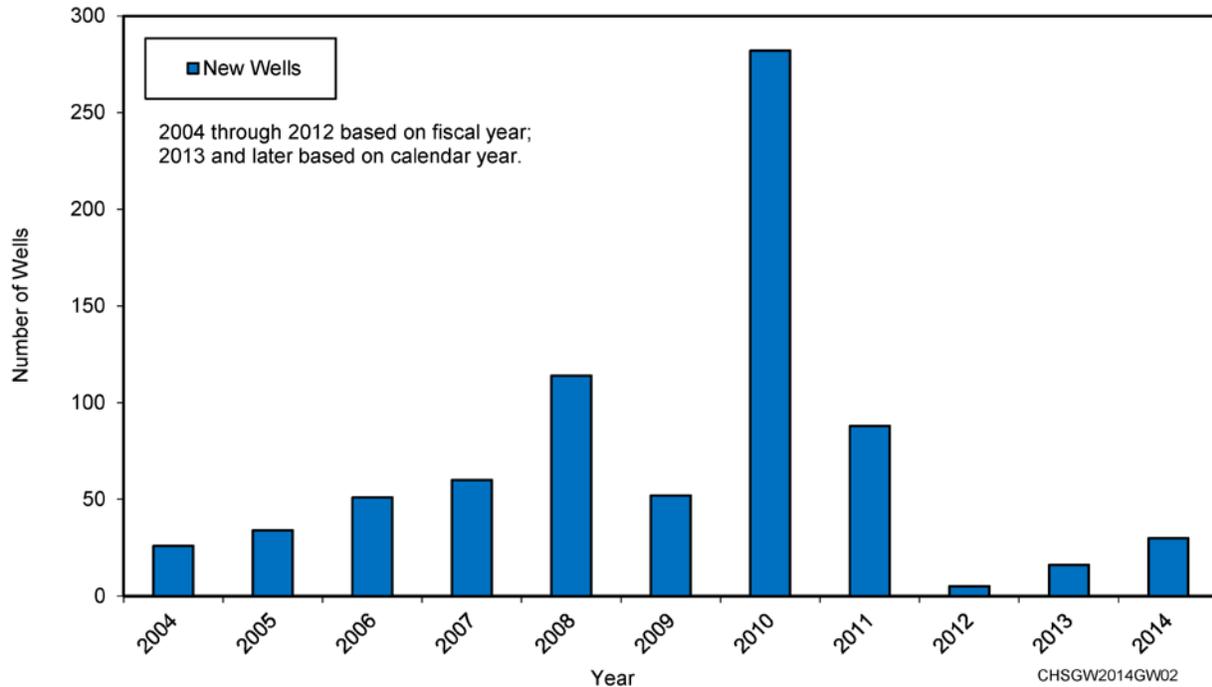


Figure ES-18. New Wells Installed on the Hanford Site, 2004 to 2014

New wells are installed to characterize, monitor, and remediate groundwater.

Table ES-3 New Wells and Aquifer Tubes Completed in 2014

Groundwater Interest Area	Wells	Aquifer Tubes
100-BC	8	6
100-HR-D	4	0
100-KR	6	0
200-BP	3	0
200-PO	3	0
200-UP	2	0
200-ZP	4	0
Total	30	6
Monitoring wells are constructed to WAC 173-160 specifications; aquifer tubes are not		

Additional Information

The monitoring data presented in this report, and information on monitoring well locations, construction details, and screened intervals, can be found through the DOE Environmental Dashboard Application at <https://ehs.hanford.gov/eda/>, in the interactive version of this document, or on the PHOENIX website at <http://phoenix.pnnl.gov>.

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