

2019 Highlights

Contaminant Plume Areas

The estimated area of Hanford Site groundwater contaminant plumes above regulatory standards in 2019 was 62 mi² (160 km²), about 5% less than 2018. The combined plume area has declined since 2000 as a result of remediation and natural attenuation.

Groundwater Remediation

- Pump-and-treat systems in the 100 Areas removed 103 kg of hexavalent chromium in 2019 and 3,589 kg in their lifetimes.
- Pump-and-treat systems in the 200-West Area removed 1,917 kg of carbon tetrachloride in 2019 and 30,951 kg since 1994. Other groundwater contaminants removed by pump-and-treat systems in the 200 Areas include chromium, cyanide, technetium-99, and uranium.
- The U.S. Department of Energy continued to make progress on other groundwater remedial actions in 2019, including a permeable reactive barrier in 100-N Area, enhanced attenuation in the 300 Area, hydraulic control in the 200 Area, and monitored natural attenuation of selected plumes in the 100, 200, and 300 Areas.

Well installation: In 2019, the U.S. Department of Energy drilled 44 wells and boreholes for monitoring, groundwater remediation, and characterization.

8.0 Groundwater Monitoring

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This section summarizes results of Hanford Site groundwater monitoring for 2019. DOE/RL-2018-66, *Hanford Site Groundwater Monitoring Report for 2019*, contains detailed information and is accessible through the Internet at <http://www.hanford.gov/page.cfm/SoilGroundwaterAnnualReports>. The U.S. Department of Energy (DOE) provides groundwater data to the public via the Internet at <https://ehs.hanford.gov/eda>.

Chemical and radioactive wastes contaminated the soil and groundwater beneath portions of the Hanford Site. The majority of the contamination is found in the 200-East Area, 200-West Area, 300 Area, and 100 Area (Figure 8-1).

DOE operates an extensive groundwater monitoring program on the Hanford Site. 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; for other Washington State-required programs; and for the *Atomic Energy Act of 1954*, as required by DOE Orders. Figure 8-1 shows the location and extent of the most widespread groundwater contaminants: iodine-129, tritium, nitrate, and carbon tetrachloride. Figure 8-2 shows how the sizes of these four plumes and the combined plume footprint (all contaminants) have changed over the years.

8.1 River Corridor

The 100 and 300 Areas form the River Corridor of the Hanford Site. About 94% of the waste sites in this region have been remediated or were determined not to require remediation, reducing the possibility of continued contaminant migration to groundwater. Remedial action decisions for the remaining 6% of the waste sites are in progress.

Figure 8-3 illustrates the contaminant plumes along the River Corridor where concentrations exceeded cleanup levels in 2019. Beyond the mapped plume boundaries, additional contamination may be present at concentrations below contour levels. Maps in DOE/RL-2018-66 provide all of the data, whether above or below contour levels. Table 8-1 compares the maximum concentrations measured in 2019 and 2018 for the contaminants in each of the River Corridor groundwater interest areas.

River Corridor groundwater is being remediated under CERCLA (Table 8-2). The total area of the hexavalent chromium plumes has decreased markedly since 2002 due to waste site removal, groundwater remediation by pump-and-treat (P&T) systems, and natural attenuation (Figure 8-4). The size of the tritium plume has declined due to natural attenuation, but the uranium and strontium-90 plumes are attenuating more slowly. The interpreted size of the 100-FR trichloroethene (TCE) plume increased in 2019 based on data from new monitoring wells.

Figure 8-5 illustrates the maximum contaminant concentrations in the River Corridor over time. Maximum concentrations of contaminants such as tritium, strontium 90, and nitrate have declined.

DOE has established derived concentration standards for use in conducting the radiological environmental protection program. The standards represent the concentration of a given radionuclide in water or air that would result in a person receiving a 100 mrem total effective dose following continuous exposure for 1 year. Figure 8-6 illustrates the total effective dose that would occur if a person consumed River Corridor groundwater for 1 year. The dose in wells with values >100 mrem/yr in the River Corridor is primarily from strontium-90 in the 100-N Area and uranium in the 300 Area.

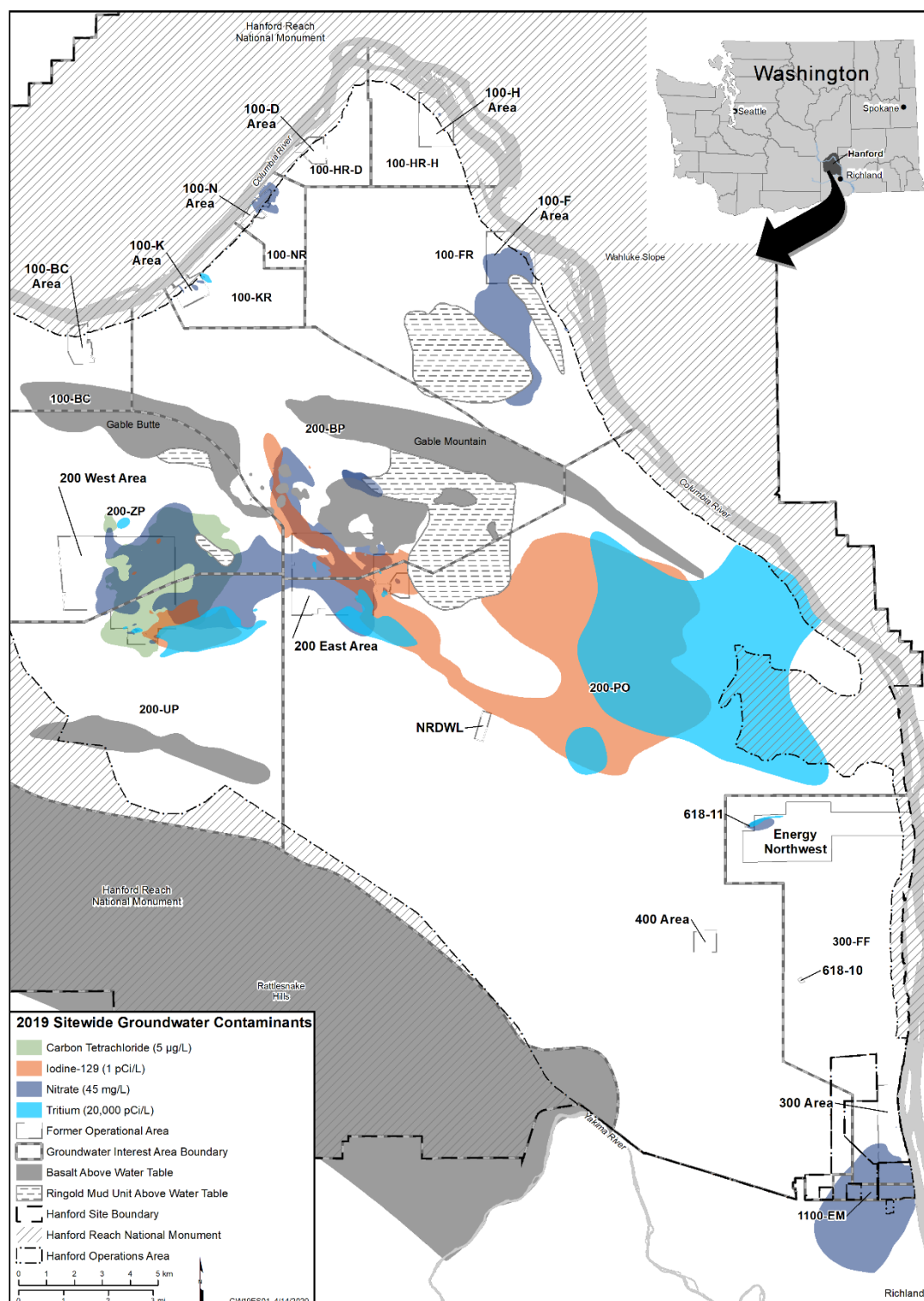


Figure 8-1. Regions of the Hanford Site and Most Extensive Contaminant Plumes.

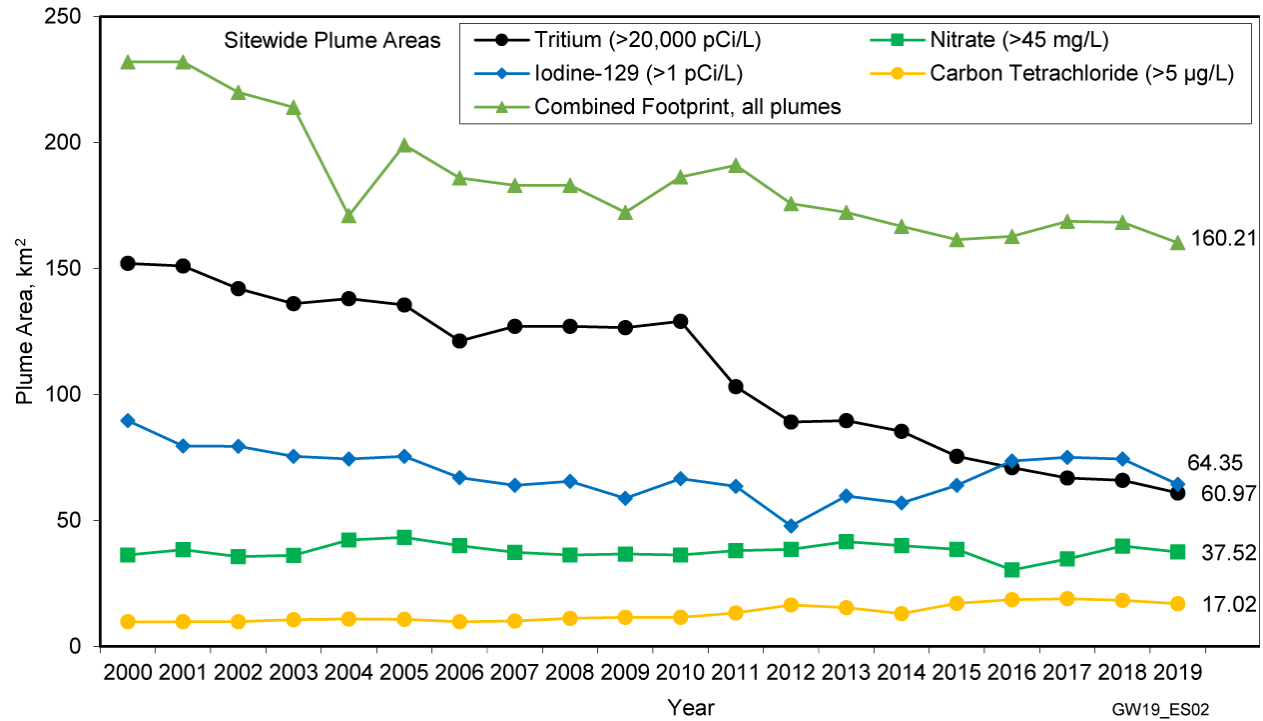


Figure 8-2. Hanford Site Plume Areas.

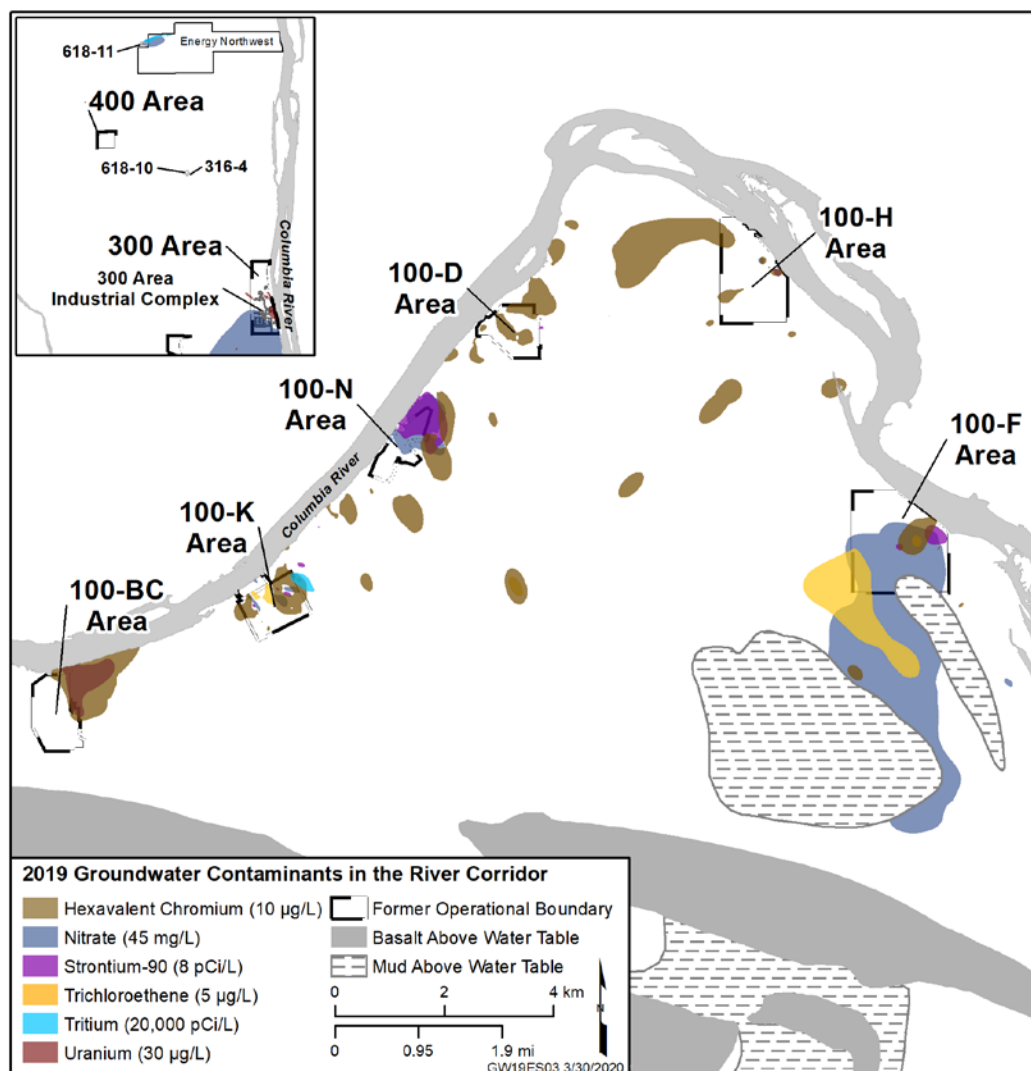


Figure 8-3. Groundwater Contaminant Plumes in the River Corridor.

Table 8-1. River Corridor Groundwater Contaminants, 2018 and 2019. (2 Pages)

Groundwater Interest Area	Maximum Concentrations							
	Year	Carbon-14 (pCi/L)	Cr(VI) (µg/L)	Nitrate (mg/L)	Strontium-90 (pCi/L)	Trichloroethene (µg/L)	Tritium (pCi/L)	Uranium (µg/L)
100-BC	2019	N	63.1	12.0	34.3	4.6	9,860	5.1
	2018	N	57	19.5	61.8	6.19	8,840	6.9
100-FR	2019	N	53.8	281	112	20.1	3,050	11.0

Table 8-1. River Corridor Groundwater Contaminants, 2018 and 2019. (2 Pages)

Groundwater Interest Area	Maximum Concentrations							
	Year	Carbon-14 (pCi/L)	Cr(VI) (µg/L)	Nitrate (mg/L)	Strontium-90 (pCi/L)	Trichloroethene (µg/L)	Tritium (pCi/L)	Uranium (µg/L)
	2018	63.8	58.0	304	135	15	3,180	27.7
100-HR	2019	N	833	345	29.0	N	5,690	49.0
	2018	N	800	416	24.5	N	16,200	89
100-KR	2019	42,600	1,700	102	1,230	7.6	405,000	14.8
	2018	32,900	528	88.5	4,050	7.3	225,000	22.4
100-NR	2019	485	124	319	11,400	N	326,000	9.3
	2018	274	123	190	11,600	N	383,000	13.4
300-FF	2019	N	8.88	252	N	1.57	251,000	1,510
	2018	N	20.5	208	4.38	1.5	450,000	3,600
1100-EM	2019	N	3.4	137 ^a	N	N	N	32.2 ^a
	2018	14	N	137 ^a	N	N	N	35.4 ^a
Standard ^b		2,000	10	45	8	5	20,000	30
Half-life (years)		5,730	N/A	N/A	28.8	N/A	12	>159,000
Mobility		High	High to moderate	High	Slight	Moderate	High	Moderate

Note: Colors and listed values indicate maximum concentration, as follows:

	≤ Standard
	> Standard and ≤10 × standard
	>10 × standard and ≤100 × standard
	>100 × standard and ≤1,000 × standard
	>1,000 × standard

^a Originates from offsite sources.

^b Drinking water standards for all but Cr(VI) (aquatic standard).

Cr(VI) = hexavalent chromium

N = not detected or not analyzed

N/A = not applicable

Table 8-2. Summary of CERCLA Groundwater Remediation in the River Corridor.

Groundwater Operable Unit	CERCLA Decision Status	Groundwater Contaminants of (Potential) Concern ^a	Current Groundwater Remediation	Mass Removed in 2019 (and Since Startup)
100-BC-5	RI/FS report and proposed plan released in 2019	Cr(VI), strontium-90, TCE, and tritium	No interim action required; final action pending	N/A
100-FR-3	ROD for final action signed in 2014	Cr(VI), nitrate strontium-90, and TCE	MNA	N/A
100-HR-3	ROD for final action signed in 2018	Cr(VI), total chromium, nitrate, and strontium-90	P&T for Cr(VI) and total chromium 1997–2019; MNA for nitrate and strontium-90	Cr(VI): 54.7 kg (2,601 kg)
100-KR-4	Interim ROD; Draft B RI Report released for regulatory agency review in 2019; FS report in progress	Cr(VI), total chromium, carbon-14, nitrate, strontium-90, TCE, and tritium	Interim action P&T for Cr(VI) 1997–2019; soil flushing in 2019	Cr(VI): 48.6 kg (988 kg)
100-NR-2	Draft B RI/FS report released for regulatory agency review in 2019	Strontium-90, TPH-D, nitrate, Cr(VI), total chromium, and tritium	Interim action permeable reactive barrier for strontium-90; removal of TPH-D	Strontium-90: not applicable TPH-D: 1.23 kg (20 kg)
300-FF-5	ROD for final action signed in 2013	Uranium, gross alpha, <i>cis</i> -1,2-dichloroethene, TCE, nitrate, and tritium	Enhanced attenuation (sequestration) for uranium; MNA for others	N/A
1100-EM-1	ROD signed in 1993	TCE	No longer required; remedial action objectives achieved	N/A

^a Contaminants of concern are listed for operable units with RODs for final action. The primary contaminants of potential concern are listed for the other operable units.

CERCLA = *Comprehensive Environmental Response, Compensation, and Liability Act of 1980*

Cr(VI) = hexavalent chromium

FS = feasibility study

MNA = monitored natural attenuation

N/A = not applicable

P&T = pump and treat

RI = remedial investigation

ROD = Record of Decision

TCE = trichloroethene

TPH-D = total petroleum hydrocarbons-diesel range

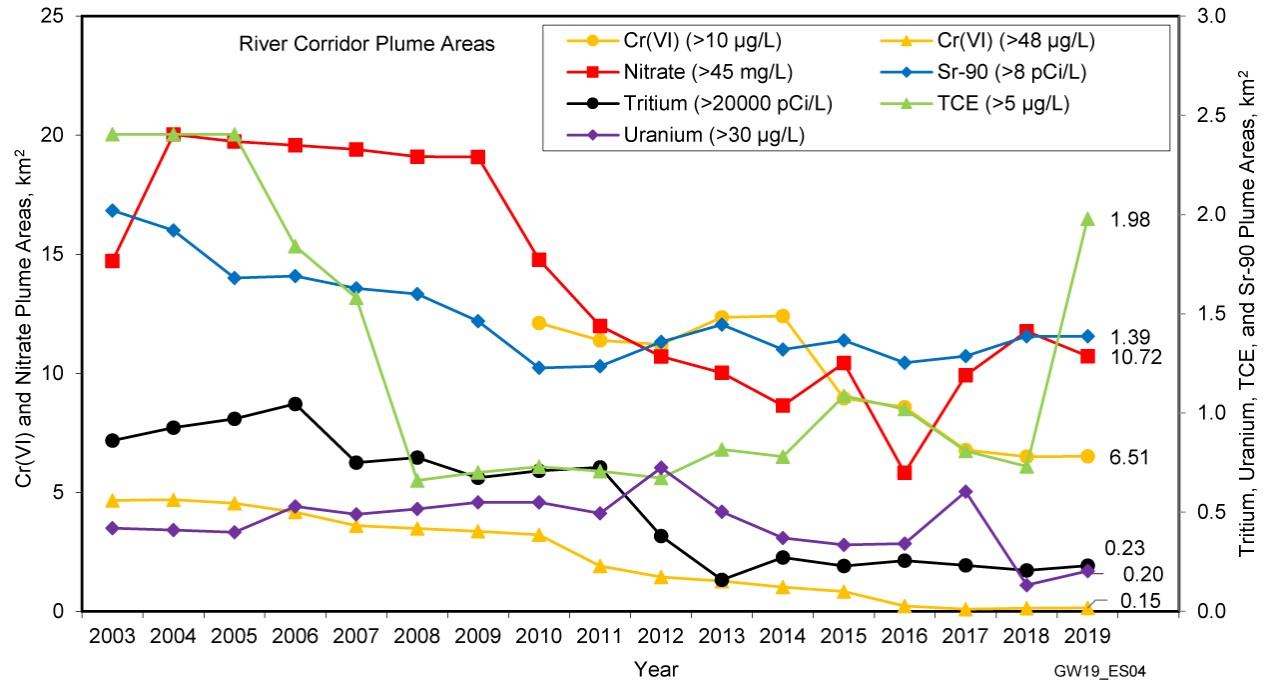


Figure 8-4. River Corridor Plume Areas.

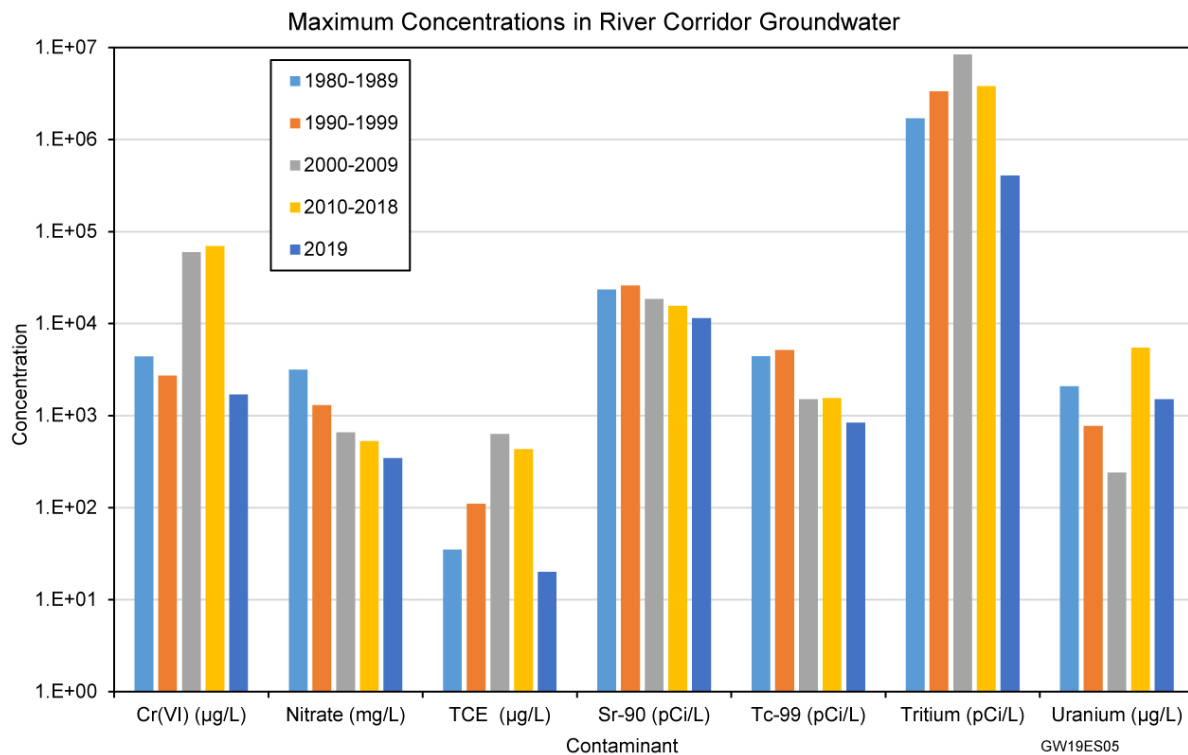


Figure 8-5. Maximum Concentrations of River Corridor Contaminants Over Time.

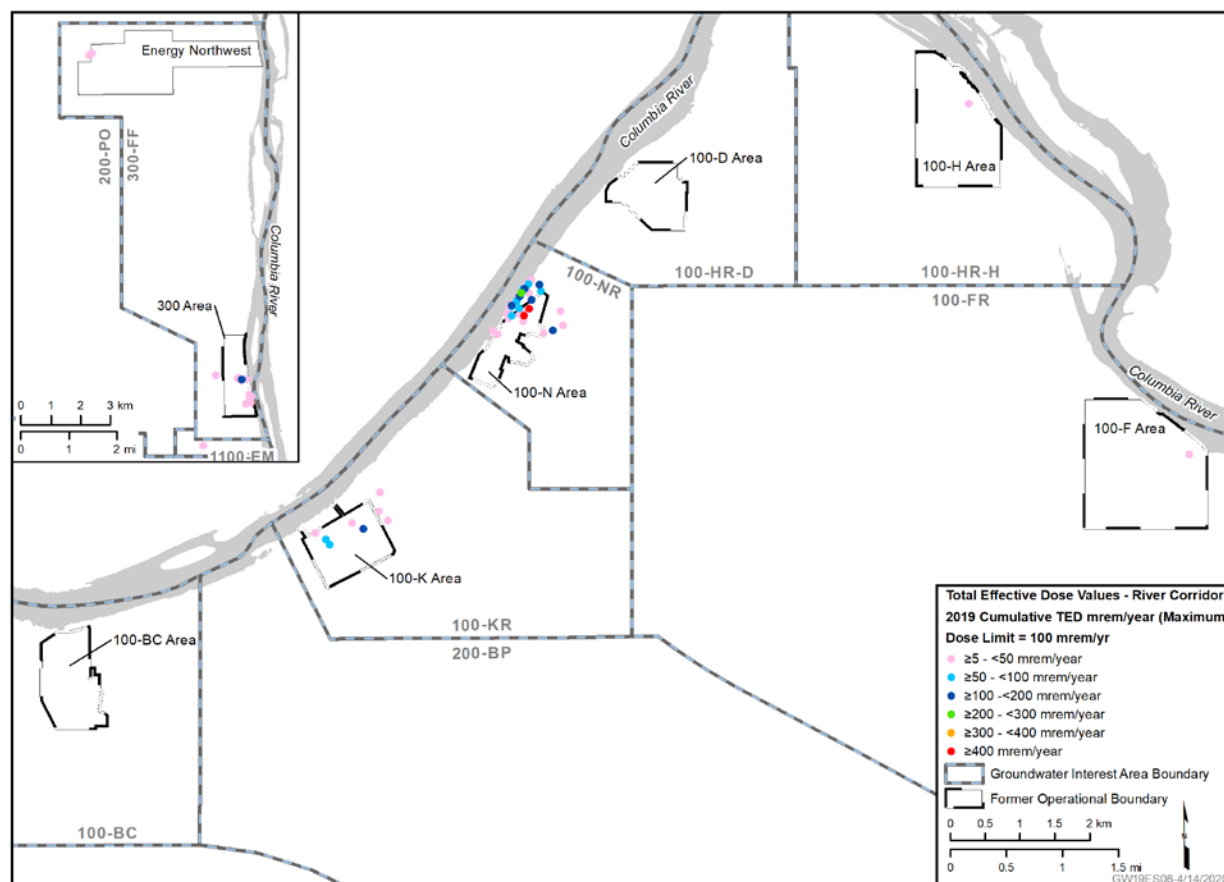


Figure 8-6. Groundwater Dose Calculation for the River Corridor.

The following activities or changes occurred in the River Corridor in 2019:

- **100-BC**
 - A remedial investigation (RI)/feasibility study (FS) report (DOE/RL-2010-96) and proposed plan (DOE/RL-2016-43) for remediation were released, and public comments on the proposed plan were received.
- **100-FR**
 - Six new monitoring wells were installed. Data from the new wells resulted in the interpreted nitrate plume to shrink and the TCE plume to expand.
- **100-HR**
 - The hexavalent chromium plumes in the unconfined aquifer continued to shrink in response to ongoing groundwater remediation, and concentrations continue to decline. One extraction well and two injection wells were installed in the unconfined aquifer to support remediation in 2019.
 - A potentiometric map and hexavalent chromium plume map were created for the Ringold upper mud aquifer for the first time in 2019. Six new monitoring wells and one new extraction well were installed in 2019 to improve monitoring and remediation of that aquifer.

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- Draft A of the remedial design/remedial action work plan (DOE/RL-2017-13) was released in 2019 for regulatory review.
 - **100-KR**
 - In 2019, a soil flushing treatability test was implemented at the 183.1KW Headhouse area to address a continuing source of groundwater contamination (DOE/RL-2017-30). The goal of soil flushing was to flush hexavalent chromium from the deep portions of the vadose zone into the groundwater and then capture the material with the active P&T system.
 - Draft B of the 100-K RI report (DOE/RL-2010-97) was released in 2019 for regulatory agency review. The revision incorporates supplemental data associated with the 105-KE fuel storage basins and 116-KE-3 Crib and reverse well, as well as data collected to support soil and groundwater interim remedial actions.
 - **100-NR**
 - Draft B of the 100-N Area RI/FS report (DOE/RL-2012-15) was released in November 2019 for regulatory agency review. The RI/FS report will be used to support future cleanup decisions specified in a proposed plan and Record of Decision (ROD) planned for 2021.
 - **300-FF**
 - Two stages of uranium sequestration have been conducted in the 300 Area Industrial Complex, and monitoring of the Stage B wells continued in 2019.
 - Nine uranium sequestration boreholes were drilled for post-treatment soil samples.
 - One new monitoring well was installed in the 300 Area to monitor the 324 Building, and a replacement monitoring well was installed at the 618-10 Burial Ground.
 - Nitrate concentrations increased in one monitoring well near the 618-11 Burial Ground.
 - **RCRA**
 - Post-closure corrective action monitoring continued at the 183-H Solar Evaporation Basins and the 300 Area Process Trenches in 2019.

8.2 Central Plateau

The Central Plateau, located in the middle of the Hanford Site, includes the 200-West and 200-East Areas. Ponds, cribs, and ditches used for liquid waste disposal were the primary sources of groundwater contamination. Seven single shell tank waste management areas are also located in the 200 Areas. Contamination is still present at some locations in the thick Central Plateau vadose zone and in some areas continues to migrate into the groundwater. DOE is expanding remediation activities in the 200 Areas to contain and remove contamination from the vadose zone and groundwater.

Figure 8-7 shows the Central Plateau groundwater contaminant plumes in 2019, and Table 8-3 compares the maximum contaminant concentrations measured in 2019 and 2018 in the Central Plateau groundwater interest areas.

Groundwater beneath portions of the Central Plateau is being remediated under CERCLA. Table 8-4 summarizes the status of CERCLA remediation for the Central Plateau groundwater and deep vadose zone operable units. In 2019, P&T systems continued to remove carbon tetrachloride, technetium-99, uranium, and other contaminants from groundwater.

The size of the Central Plateau tritium plume continued to decline in 2019 due to natural attenuation, which includes radioactive decay (Figure 8-8). The technetium 99 and uranium plume areas continued to decline gradually due to groundwater remediation. The interpreted nitrate plume increased in 2019 because of changes in the 200-West P&T as part of an optimization study. The size of the carbon tetrachloride plume declined between 2018 and 2019. The hexavalent chromium plume area increased in recent years as data from new wells became available.

Maximum concentrations of most Central Plateau groundwater contaminants have decreased over time (Figure 8-9) due to remediation, migration, dispersion, and radioactive decay.

Figure 8-10 illustrates the total effective dose from hypothetical exposure to members of the public by drinking Central Plateau groundwater. Radionuclides contributing to doses >100 mrem/yr include iodine 129, strontium 90, technetium 99, tritium, and uranium.

The following activities or changes occurred in the Central Plateau in 2019:

- **200-BP**

- Groundwater was extracted from two wells in the B Complex area in 2019, and concentrations and plume sizes of nitrate, technetium-99, uranium, and cyanide continued to decline in monitoring wells.
- Perched water continued to be extracted from three wells in the B Complex area to reduce migration of contamination to groundwater.
- Four new monitoring wells were drilled in 2019 to complete the B Complex removal action performance monitoring network.
- DOE issued an interim action FS for the 200-BP-5 and 200-PO-1 Operable Units (DOE/RL-2018-30, *200-BP-5 and 200-PO-1 Groundwater Operable Units Feasibility Study for Interim Action*), and Rev. 0 of a proposed plan for interim action remediation (DOE/RL-2018-58, *Proposed Plan for Interim Action Remediation of the 200-BP-5 and 200-PO-1 Operable Units*). The U.S. Environmental Protection Agency, Washington State Department of Ecology, and DOE are pursuing an interim ROD for these two groundwater operable units to expedite remediation of the technetium-99 and uranium groundwater plumes.

- **200-PO**

- The large tritium plume originating from sources in the 200-East Area continued to shrink in 2019 due to dispersion and radioactive decay.

- In 2019 the highest tritium concentration in groundwater was 4,240,000 pCi/L in a well near the 216-A-36A Crib. This concentration was much higher than the maxima in recent years (Figure 8-9). The well, which is nearly dry, had not been sampled since 2002, when the concentration was 5,570,000 pCi/L.
- Three new wells were installed to monitor the Integrated Disposal Facility.
- **200-UP**
 - Groundwater extraction and treatment for Waste Management Area SSX and the U Plant area continued in 2019. Contaminant concentrations have declined in many monitoring wells in response to remediation.
 - In 2019, three new wells were installed to characterize the uranium plume near U Plant, and two wells were installed to monitor the Environmental Restoration Disposal Facility.
- **200-ZP**
 - As a result of remediation by the 200-West P&T, carbon tetrachloride concentrations have declined in locations where the highest levels were formerly present. The downgradient, lower concentration portion of the plume not captured by the P&T system is expected to attenuate naturally over time, as described in the 200-ZP-1 Operable Unit ROD.
 - In 2019, an optimization study plan was implemented, and biological treatment was suspended to improve contaminant capture and increase removal of carbon tetrachloride. This resulted in higher nitrate concentrations in treated water reinjected into the aquifer, which are expected to be remediated by monitored natural attenuation.
 - Three new monitoring wells, one new injection well, and one new extraction well were installed for the 200-West P&T in 2019.
- **RCRA**
 - RCRA groundwater monitoring continued at 20 dangerous waste management units in the Central Plateau in 2019.

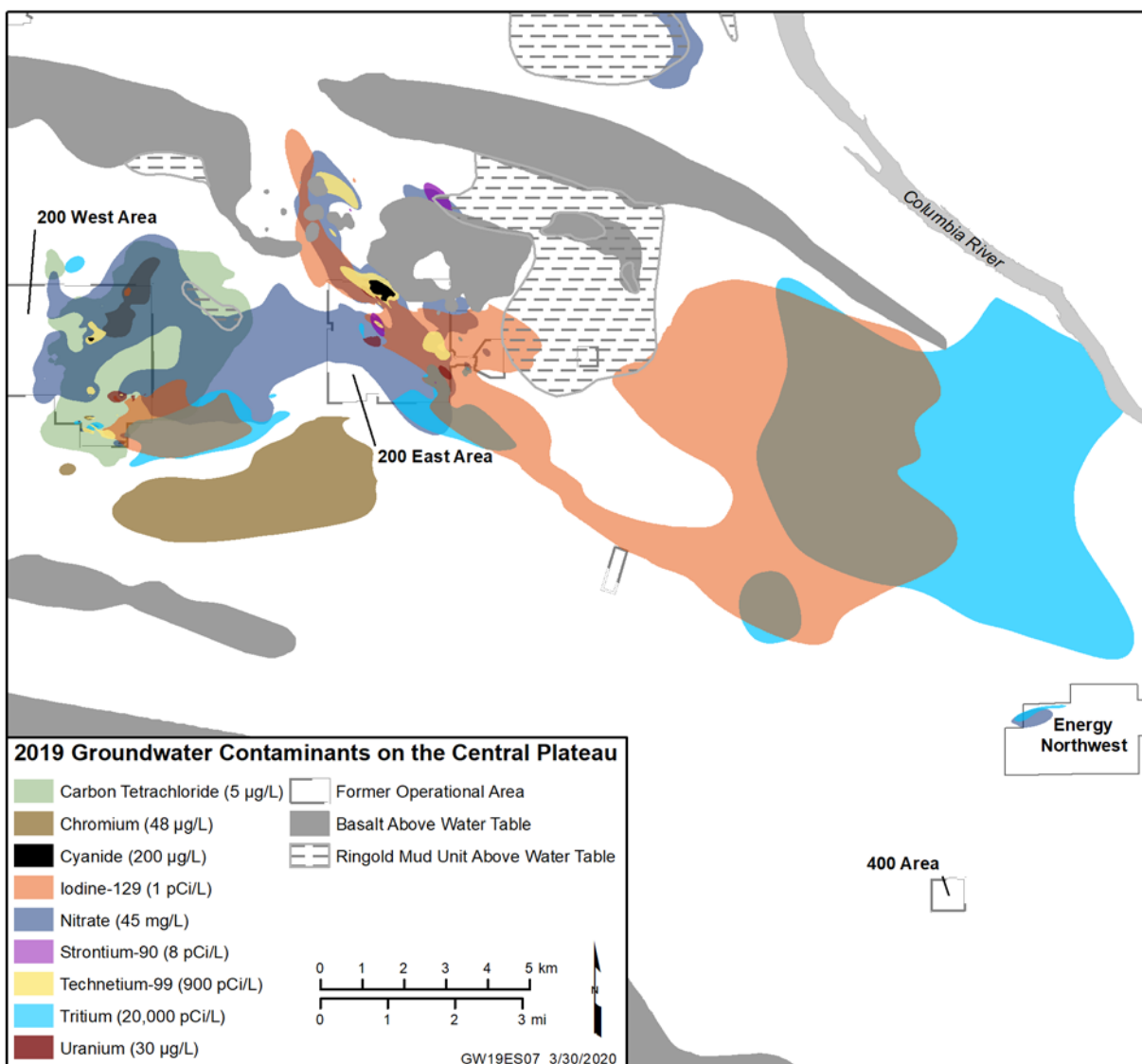


Figure 8-7. Groundwater Contaminant Plumes in the Central Plateau.

Table 8-3. Central Plateau Groundwater Contaminants, 2018 and 2019

Groundwater Interest Area	Year	Maximum Concentrations							
		Carbon Tetrachloride (µg/L)	Hexavalent Chromium (µg/L)	Iodine-129 (pCi/L)	Nitrate (mg/L)	Strontium-90 (pCi/L)	Technetium-99 (pCi/L)	Tritium (pCi/L)	Uranium (µg/L)
200-BP	2019	0.83	38.2	7.14	974	337	25,500	28,700	641
	2018	0.80	39.0	9.87	1,060	602	29,100	33,700	1,100
200-PO	2019	N	159	12.2	133	11.9	6,300	4,240,000	68
	2018	N	130	13.1	159	14.8	4,850	365,000	71
200-UP	2019	408	463	23.7	211	37.1	15,200	222,000	2,100
	2018	428	373	23.0	270	23.5	30,900	187,000	3,520
200-ZP	2019	1,830	175	2.15	553	N	25,200	58,100	4.9
	2018	1,750	140	1.87	664	N	13,800	56,000	3.5
Regulatory standard		5	48	1	45	8	900	20,000	30
Half-life (years)		N/A	N/A	1.6E+07	N/A	28.8	212,000	12.3	>159,000
Mobility		Multi-phase	High to moderate	High	High	Slight	High	High	Moderate

Note: Colors and listed values indicate maximum concentration, as follows:

	≤ Standard
	> Standard and ≤10 × standard
	>10 × standard and ≤100 × standard
	>100 × standard and ≤1,000 × standard

N = not detected or not analyzed

N/A = not applicable

Table 8-4. Summary of CERCLA Groundwater Remediation on the Central Plateau. (2 Pages)

Operable Unit	CERCLA Decision Status	Groundwater Contaminants of (Potential) Concern ^a	Current Groundwater Remediation	Mass Removed in 2019 (and Since Startup)
200-BP-5	Implemented action memorandum (2016); FS and draft proposed plan released in 2019	Cyanide, iodine-129, nitrate, strontium-90, technetium-99, tritium, and uranium	Groundwater extraction removal action (2015–2019)	Cyanide: 47 kg (207 kg) Nitrate: 63,411 kg (285,774 kg) Technetium-99: 56.5 g (313.5 g) Uranium: 22.4 kg (187 kg)
200-PO-1	FS and draft proposed plan released in 2019	Iodine-129, tritium, nitrate, strontium-90, technetium-99, and uranium	None to date; pending interim action decision	Not applicable

Table 8-4. Summary of CERCLA Groundwater Remediation on the Central Plateau. (2 Pages)

Operable Unit	CERCLA Decision Status	Groundwater Contaminants of (Potential) Concern ^a	Current Groundwater Remediation	Mass Removed in 2019 (and Since Startup)
200-UP-1	ROD for interim remedial action signed (2012); submitted remedial design investigation report for the southeast chromium plume (2019)	Technetium-99, uranium, carbon tetrachloride, Cr(VI), total chromium, iodine-129, nitrate, tritium, trichloroethene, chloroform, tetrachloroethene, strontium-90, and 1,4-dioxane	Interim actions: P&T near U Plant (2015–2019) P&T at WMAS-SX (2012–2019) Hydraulic containment for iodine-129 (2015–2019) MNA	Nitrate: 21,646 kg (223,924 kg ^b) Technetium-99: 23 g (401 g ^b) Uranium: 14 kg (967 kg ^b)
200-ZP-1	ROD for final remedial action signed (2008)	Carbon tetrachloride, Cr(VI), total chromium, iodine-129, nitrate, technetium-99, trichloroethene, and tritium	P&T and MNA (2012–2019)	Carbon tetrachloride: 1,917 kg (30,951 kg ^b) Chromium: 68.5 kg (506 kg) Nitrate: 245,982 kg (2,186,276 kg)
200-DV-1 ^c	Implemented action memorandum (2016); characterization of the deep vadose zone in progress	Nitrate, technetium-99, uranium, tritium, total chromium, and Cr(VI) (perched water)	Removal action: Perched water extraction (2011–2019)	Nitrate: 1,280 kg (5,364 kg ^b) Technetium-99: 2.7 g (10.7 g ^b) Uranium: 63 kg (294 kg ^b)

^a Contaminants of concern are listed for operable units with RODs for final action and implemented action memoranda.

The primary contaminants of potential concern are listed for the other operable units.

^b Totals includes mass from P&T system under earlier RODs for interim action and 200-DV-1 Operable Unit treatability test.

^c Deep vadose zone operable unit.

CERCLA = *Comprehensive Environmental Response, Compensation, and Liability Act of 1980*

Cr(VI) = hexavalent chromium

FS = feasibility study

MNA = monitored natural attenuation

P&T = pump and treat

ROD = Record of Decision

WMA = waste management area

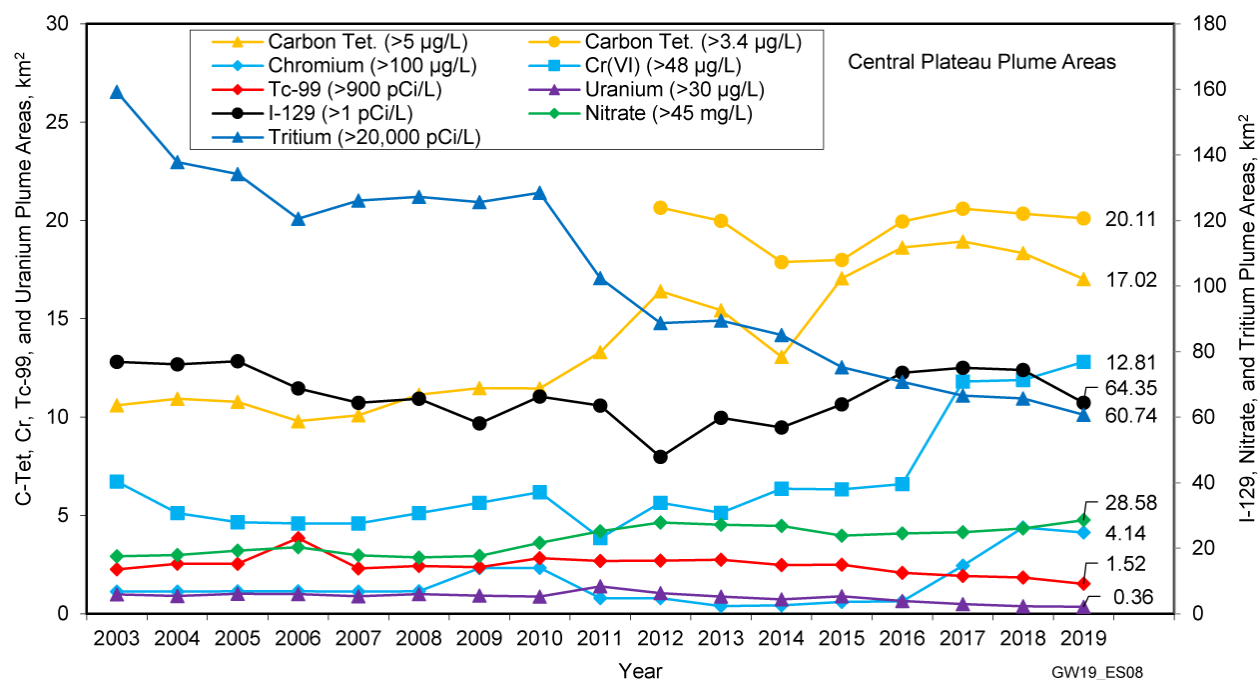


Figure 8-8. Central Plateau Plume Areas.

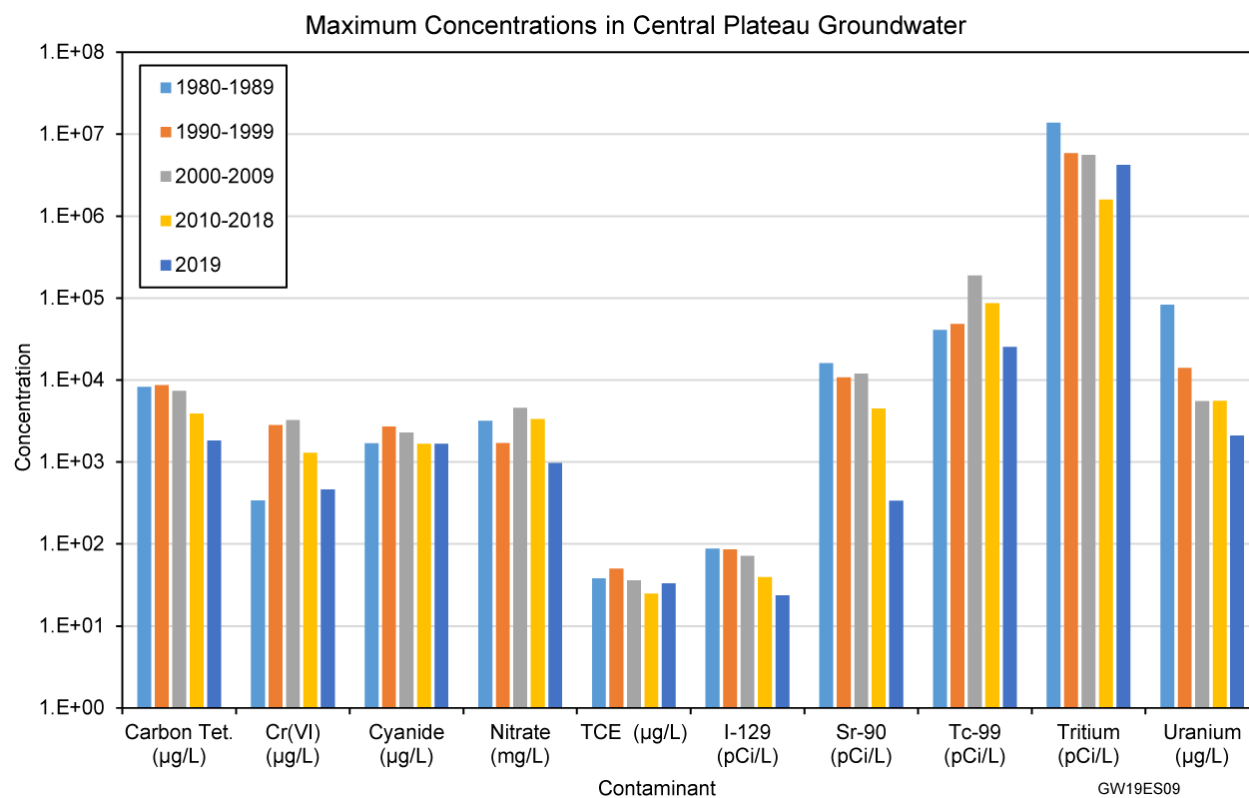


Figure 8-9. Maximum Concentrations of Central Plateau Contaminants over Time.

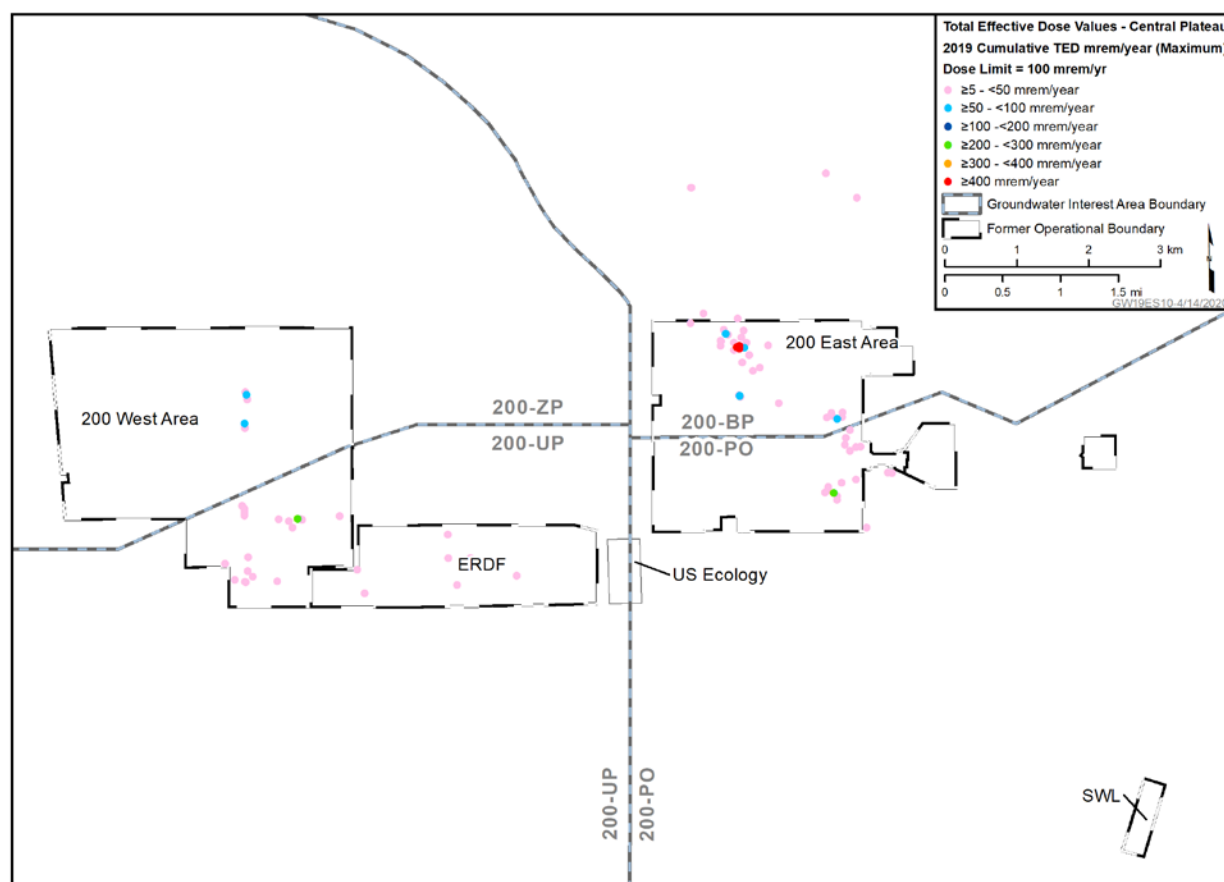


Figure 8-10. Groundwater Dose Calculation for the Central Plateau.

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