Chapter 6: Environmental Monitoring Programs – Eastern Snake River Plain Aquifer Monitoring

CHAPTER 6

One potential pathway for exposure from contaminants released at the Idaho National Laboratory (INL) Site is through the groundwater pathway. Historic waste disposal practices have produced localized areas of chemical and radiochemical contamination beneath the INL Site in the eastern Snake River Plain Aquifer. These areas are regularly monitored by the United States (U.S.) Geological Survey (USGS), and reports are published showing the extent of contamination plumes. Results for most monitoring wells within the plumes show decreasing concentrations of tritium, strontium-90 (^{90}Sr), and iodine-129 (^{129}I) over the past 20 years. The decrease is the result of radioactive decay, discontinued disposal, dispersion, and dilution within the aquifer.

In 2024, the USGS sampled 24 groundwater monitoring wells at the INL Site for analysis of 61 purgeable (volatile) organic compounds. Ten purgeable organic compounds were detected in at least one well. Most of the detected concentrations were less than the maximum contaminant levels (MCLs) established by the U.S. Environmental Protection Agency (EPA) for public drinking water supplies. One exception was carbon tetrachloride, which was detected in the production well and a perched groundwater well at the Radioactive Waste Management Complex (RWMC). This compound has shown a decreasing trend since 2005 and is removed from the water prior to human consumption. Also, trichloroethylene was also detected above the MCL at a perched groundwater well near RWMC where this contaminant has been detected in previous sampling events.

Groundwater surveillance monitoring required in area-specific Records of Decision under the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) was performed at Waste Area Groups (WAGs) 1–4, and WAG 7 in 2024.

In addition to the effluent and associated ground water monitoring at the Advanced Test Reactor (ATR) Complex and the Materials and Fuels Complex (MFC), as discussed in Chapter 5, the INL contractor monitors groundwater at the Remote-Handled Low-Level Waste Disposal (RHLLW) Facility for the surveillance of select radiological analytes as well. The 2024 results continue to show no discernible impacts to the aquifer from RHLLW operations.

There are 11 drinking water systems on the INL Site monitored by INL Site contractors. All contaminant concentrations measured in drinking water systems in 2024 were below the regulatory limits.

Drinking water and springs were sampled in the vicinity of the INL Site and analyzed for gross alpha and gross beta activity and tritium. Some locations were co-sampled with the Idaho Department of Environmental Quality (DEQ) INL Oversight Program. Results were consistent with the historical measurements and do not indicate any impact from historical INL Site releases.

6. ENVIRONMENTAL MONITORING PROGRAMS – EASTERN SNAKE RIVER PLAIN AQUIFER

The eastern Snake River Plain Aquifer serves as the primary source of drinking water and crop irrigation in the upper Snake River Basin. This chapter presents the results of water monitoring conducted on and off the INL Site within the eastern Snake River Plain Aquifer hydrogeologic system. This includes the collection of water from the aquifer—including the drinking water wells—through downgradient springs along the Snake River where the aquifer discharges the water and an ephemeral stream (the Big Lost River), which flows through the INL Site and helps to recharge the aquifer.

The purpose of this monitoring program is to:

- Demonstrate that eastern Snake River Plain groundwater is protected from contamination from current INL Site activities
- Show areas of known underground contamination from past INL Site operations are monitored and trended
- Determine whether drinking water consumed by workers and visitors at the INL Site and by the public downgradient of the INL Site is safe
- Demonstrate that the Big Lost River, which occasionally flows through the INL Site, is not contaminated by INL Site activities before entering the aquifer via channel loss and playas on the north end of the INL Site.

Analytical results are compared to applicable regulatory guidelines for compliance and informational purposes. These include the following:

- State of Idaho groundwater primary and secondary constituent standards (IDAPA 58.01.11)
- Health-based MCLs for drinking water according to the EPA (40 CFR 141)
- U.S. Department of Energy (DOE) Derived Concentration Standards (DCSs) for the ingestion of water (DOE 2022a).

6.1 Organization of Monitoring Programs

Three organizations monitor the eastern Snake River Plain Aquifer hydrogeologic system:

- The USGS INL Project Office performs groundwater monitoring, analyses, and scientific studies to improve the understanding of the hydrogeological conditions affecting the movement of groundwater and contaminants in the eastern Snake River Plain Aquifer underlying and adjacent to the INL Site. The USGS utilizes an extensive network of strategically placed monitoring wells on the INL Site and at locations throughout the eastern Snake River Plain.

  In 2024, USGS personnel collected and analyzed more than 1,200 samples for radionuclides and inorganic constituents, including trace elements, and another 24 samples for purgeable organic compounds. USGS INL Project Office personnel also published two reports, two software packages, and five data releases covering hydrogeologic conditions and monitoring at the INL Site. Links to these reports and products are available through the bibliography website.

- The Idaho Cleanup Project (ICP) contractor conducts groundwater monitoring at various WAGs delineated on the INL Site for compliance with the CERCLA. The ICP contractor also conducts drinking water monitoring at the Idaho Nuclear Technology and Engineering Center (INTEC), RWMC, and Naval Reactors Facility (NRF) Deactivation and Decommissioning project. In 2024, the ICP contractor also monitored groundwater at Test Area North (TAN), the ATR Complex, INTEC, the Central Facilities Area (CFA), and the RWMC in WAGs 1, 2, 3, 4, and 7, respectively.

- The INL contractor monitors groundwater at MFC, the ATR Complex, and the RHLLW Disposal Facility. Groundwater compliance and surveillance monitoring at the ATR Complex and MFC are associated with effluent discharges and are presented in Chapter 5. As noted in Subsection 6.5.6, CERCLA groundwater monitoring for MFC in WAG 9 was discontinued in 2022. The RHLLW Disposal Facility does not generate or discharge liquid effluent. The 2024 RHLLW groundwater monitoring results are summarized in Subsection 6.6 and Table 6-12. The INL contractor also monitors the drinking water at eight INL Site facilities: the ATR Complex, CFA, the Critical Infrastructure Test Range Complex (CITRC), the Experimental Breeder Reactor-I (EBR-I), the Gun Range, the Main Gate, MFC, and TAN/Contained Test Facility (CTF).

  The INL contractor also collects drinking water samples from offsite locations. Natural surface waters on and off the INL Site also are sampled for surveillance purposes as well. This includes the Big Lost River, which occasionally flows through the INL Site, and springs along the Snake River that are downgradient from the INL Site.

Details of the integrated approach used by these three organizations for their aquifer, drinking water, and surface water compliance and surveillance monitoring programs may be found in the "Idaho National Laboratory Site Environmental Monitoring Plan" (DOE-ID 2023), the "Technical Basis for Environmental Monitoring and Surveillance at the Idaho National Laboratory Site" (DOE-ID 2023b), and the "Idaho National Laboratory Groundwater Monitoring and Contingency Plan Update" (DOE-ID 2021b).

6.2 Hydrogeologic Data Management

Over time, hydrogeologic environmental data at the INL Site have been collected by various organizations, including USGS, current and past contractors, and other groups. The following data management systems are used:

- The Environmental Data Warehouse is the official warehouse for long-term management and storage of INL Sitewide environmental data. The Environmental Data Warehouse houses sampling and analytical data collected by the INL Site contractors and the USGS to support compliance-reporting, decision-making, trending, and transport modeling efforts. It also stores comprehensive information pertaining to wells, including construction, location, completion zone, type, and status.
- The Hydrogeologic Data Repository provides scientific and technical information that is compiled to support remedial investigation and feasibility study activities, Environmental Impact Statement preparation, site selection and characterization, and transport modeling in vadose and saturated zones. The available information includes: (1) well construction, video logs, and drill hole information; (2) geophysical logs; (3) historical reports; (4) aquifer characteristics; (5) soil characterization; and (6) sediment property studies.
- The USGS Data Management Program involves putting all data in the National Water Information System. Data collected by the USGS at the INL Site is available here.

6.3 USGS Radiological Groundwater Monitoring at the INL Site

Historical waste disposal practices have produced localized areas of radiochemical contamination in the eastern Snake River Plain Aquifer beneath the INL Site. The USGS collects samples annually from select wells at the INL Site for tritium, ^{90}Sr, gross alpha, gross beta, gamma spectrometry analyses, and plutonium and americium isotope activities. When the USGS installs new monitoring wells, a sample is collected for uranium isotope activity and stable isotope determination as well. Periodically, the USGS collects samples analysis of ^{129}I. The most recent interpretation of radiochemical trends in groundwater, from 1989 through 2021, are summarized in Treinen et al. (2024a; 2024b). Results for wells sampled in 2024 are available here (USGS 2025).

Presently, ^{90}Sr is the only radionuclide that continues to be detected by the ICP contractor and the USGS above the primary constituent standard (PCS) in some surveillance wells at TAN and between INTEC and CFA. Other radionuclides (e.g., gross alpha) have been detected above the PCS in wells monitored at individual WAGs.

Tritium. Because tritium is equivalent in chemical behavior to hydrogen—a key component of water—it has formed the largest plume of any of the radiochemical pollutants at the INL Site. The configuration and extent of the tritium contamination area, based on the most recent interpreted USGS data (2021), are shown in Figure 6-1 (Treinen et al. 2024a). The area of elevated tritium concentrations near CFA likely represents water originating at INTEC some years earlier when larger amounts of tritium were disposed. This source is further supported by the fact that there are no known sources of tritium contamination in groundwater at CFA.

Two monitoring wells downgradient of the ATR Complex (e.g., USGS-065) and INTEC (e.g., USGS-114) have continually shown the highest tritium concentrations in the aquifer over the past 20 years. For this reason, these two wells are considered representative of maximum concentration trends in the rest of the aquifer. The concentration of tritium in USGS-065 near the ATR Complex increased slightly from 1110 ± 80 pCi/L in 2023 to 1230 ± 80 pCi/L in 2024; however, considering the 1σ uncertainty of these measurements, they are considered consistent. The tritium concentration in USGS-114, which is south of INTEC, decreased slightly from 3,620 ± 130 pCi/L in 2023 to 3,250 ± 130 pCi/L in 2024.

The Idaho PCS for tritium (20,000 pCi/L) in groundwater is the same as the EPA MCL for tritium in drinking water. The values in Wells USGS-065 and USGS-114 dropped below this limit in 1997 due to radioactive decay (e.g., tritium has a half-life of 12.33 years), discontinuation of tritium disposal, advective dispersion, and dilution within the aquifer. An evaluation of long-term tritium trends at monitoring wells can be found in Treinen et al. (2024a) and Fisher et al. (2021).

Strontium-90. The configuration and extent of ^{90}Sr in groundwater, based on the latest published USGS data, are shown in Figure 6-2 (Treinen et al. 2024a). The contamination originates at INTEC from the historical injection of wastewater. All ^{90}Sr at the ATR Complex was disposed to infiltration ponds in contrast to the direct injection that occurred at INTEC. At the ATR Complex, ^{90}Sr is retained in surficial sedimentary deposits, interbeds, and perched groundwater zones.

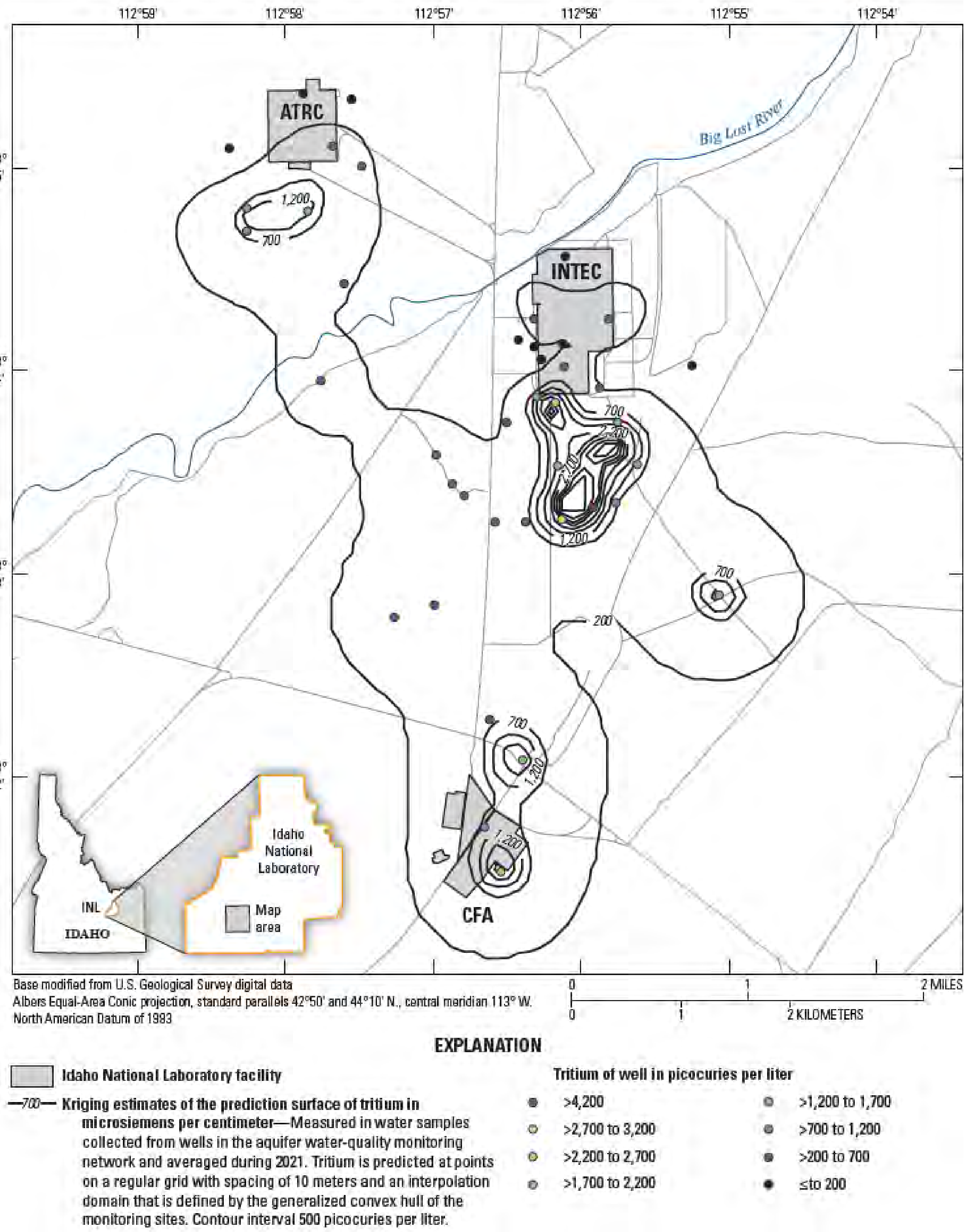

Figure 6-1. Distribution of tritium (pCi/L) in the eastern Snake River Plain Aquifer onsite in 2021 (Treinen et al. 2024a).

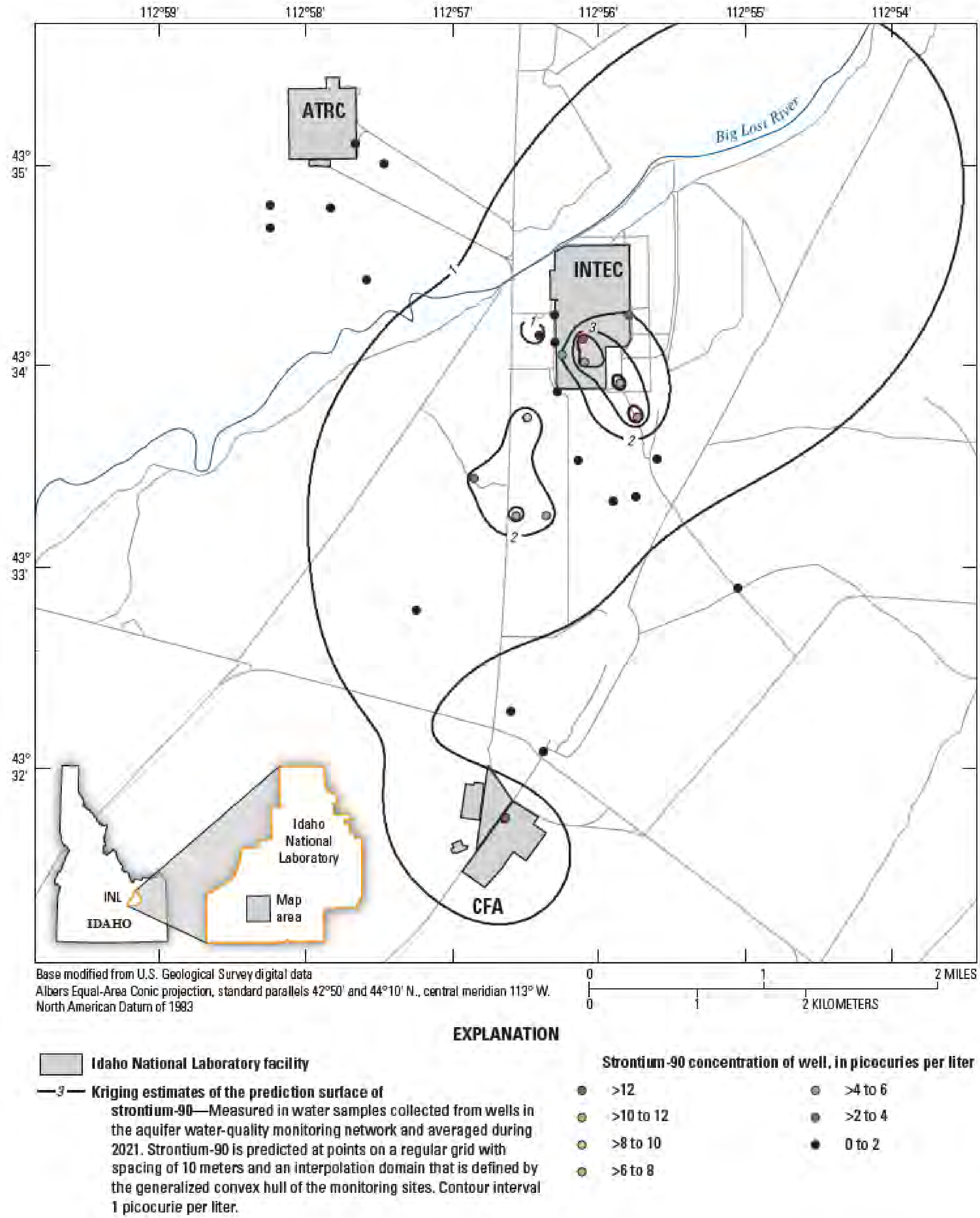

Figure 6-2. Distribution of ⁹⁰Sr (pCi/L) in the eastern Snake River Plain Aquifer onsite in 2021 (Treinen et al. 2024a).

The ^{90}Sr trends from 1989 to 2024 are all showing decreasing trends in Wells USGS-047, USGS-057, and USGS-113, which are all located at or downgradient from the INTEC facility. Concentrations in Well USGS-047 have varied throughout time but indicate a general decrease with a concentration of 12.2 ± 1 pCi/L in 2024. Concentrations in Wells USGS-057 and USGS-113 have generally decreased during this period, with concentrations of 6 ± 1 and 5.8 ± 1 pCi/L, respectively. A 2015 report by the USGS (Davis et al. 2015) indicated that long-term water quality trends for ^{90}Sr in all but two perched water wells at the INL Site showed decreasing or no statistically significant trend. A recent report by the USGS (Treinen et al. 2024a) documented that these two perched wells near the ATR Complex consistently have ^{90}Sr concentrations at or above the established EPA MCL of 8 pCi/L.

Summary of other USGS Radiological Groundwater Monitoring. From 2019–2021, concentrations of cesium-137 (^{137}C), plutonium-239/240 ($^{239/240}Pu$), and americium-241 (^{241}Am) were less than the reporting level, which is three times the standard deviation (3*s*) provided by the laboratory, in all sampled wells. In 2019–2021, reportable concentrations (> 3*s*) of gross alpha radioactivity were observed in seven of the 49 wells and ranged from 6 ± 2 to 125 ± 7 pCi/L. Beta radioactivity equaled or exceeded the reporting level in all of the sampled wells, while concentrations ranged from 2.1 ± 0.7 to 716 ± 40 pCi/L (Treinen et al. 2024a).

Periodically, the USGS has sampled for ^{129}I in the eastern Snake River Plain Aquifer. Periodic monitoring programs from 1977 to 2022 are summarized in Treinen et al. (2024a). The most recent USGS sampling event for ^{129}I in INL Site wells was conducted in the fall of 2021 and the spring of 2022. Concentrations ranged from slightly above the locally determined background concentration of 5.4×10^{-6} pCi/L. Overall, the average concentration of ^{129}I in 15 wells sampled by the USGS during six different sample periods decreased from 1.15 pCi/L during 1990–1991 to 0.145 pCi/L during 2021–2022. Decreasing ^{129}I trends in individual wells over time can be partly attributed to wastewater disposal practices and dilution and dispersion throughout the aquifer. The distribution of ^{129}I concentrations from the 2021-2022 sampling event near the ATR Complex and INTEC facility is shown in Figure 6-3 (Treinen et al. 2024b). Concentrations generally decrease downgradient, and with distance from, the INTEC facility (Treinen et al. 2024b).

6.4 USGS Non-radiological Groundwater Monitoring at the INL Site

The USGS collects samples annually from select wells at the INL Site for chloride, sulfate, sodium, fluoride, nitrate, chromium, and other trace elements and purgeable organic compounds. Treinen et al. (2024a) provides a detailed discussion of the results for samples collected during 2019–2021. A concentration of chromium at the MCL of 100 µg/L was observed in Well USGS-065 in 2009 (Fisher et al. 2021), and while its concentration has since been below the MCL, this concentration increased to 98.2 µg/L in 2024. However, this well has shown a long-term decreasing chromium trend overall (Fisher et al. 2021, Appendix 7).

Concentrations of chloride, nitrate, sodium, and sulfate historically have been above the background concentrations in many wells at the INL Site. Current concentrations of chloride, nitrate, sodium, and sulfate for all INL wells monitored by the USGS can be found here.

Volatile organic compounds (VOCs) are present in water from the eastern Snake River Plain Aquifer because of historical waste disposal practices at the INL Site. Products containing VOCs were used for degreasing, decontamination, and other activities at INL Site facilities. The USGS sampled purgeable organic compounds in groundwater at the INL Site during 2024. Samples from 24 groundwater monitoring wells were collected and submitted to the USGS National Water Quality Laboratory in Lakewood, Colorado; the samples were analyzed for 61 purgeable organic compounds. USGS reports describe the methods used to collect the water samples and ensure sampling and analytical quality (Mann 1996; Bartholomay et al. 2003; Knobel et al. 2008; Bartholomay et al. 2021). Table 6-1 identifies a subset of the ten purgeable organic compounds detected above the laboratory reporting levels of 0.2 or 0.1 µg/L in at least one well on the INL Site.

Historically, concentrations of VOCs in water samples from several wells at and near the RWMC exceeded the reporting levels (Treinen et al. 2024a). However, concentrations for all VOCs, except tetrachloromethane (also known as carbon tetrachloride) and trichloroethene, were less than the MCL for drinking water (40 CFR 141, Subpart G). The RWMC production well was monitored monthly for tetrachloromethane during 2024 (data January through July is reported below; August through December data are still pending). Concentrations exceeded the MCL of 5 µg/L during 3 of the 7 months that data was available, as shown in Table 6-2.

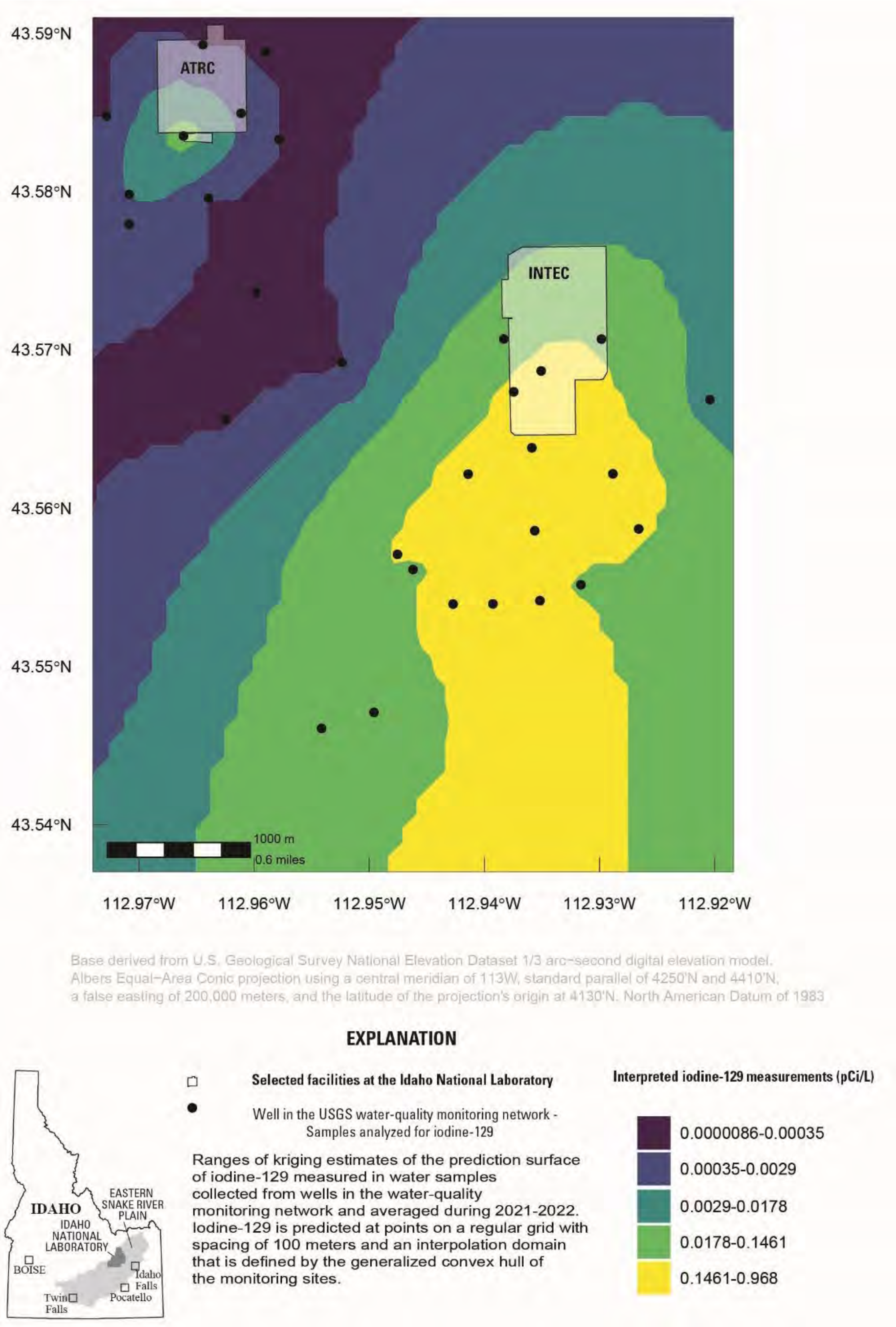

Figure 6-3. Distribution of ^{129}I (pCi/L) in the eastern Snake River Plain Aquifer onsite during 2021–2022 (Treinen et al. 2024b).

Table 6-1. Purgeable organic compounds in annual USGS groundwater well samples (2024).

CONSTITUENT	USGS-120	USGS-88	RWMC M3S	USGS-87	RWMC M7S	USGS-065	TAN-2312	USGS-92
1,1,1-Trichloroethane (MCL = 200 µg/L)[a]	<0.1	<0.1	<0.1	0.112	<0.1	<0.1	<0.1	1.30
cis-1,2-Dichoroethene[b] (MCL = 70 µg/L)[a]	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Ethylbenzene (MCL = 700 µg/L)[a]	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Tetrachloroethene[b] (MCL = 5 µg/L)[a]	<0.1	<0.1	0.20	0.184	0.400	<0.1	4.51	2.73
Tetrachloromethane (PCS = 2 µg/L)[c]	<0.2	1.52	<0.2	3.64	<0.2	<0.2	<0.2	11.5
Trichloroethene[b] (MCL = 5 µg/L)[a]	0.20	0.666	1.06	1.15	2.30	<0.1	0.111	15.3
Trichloromethane (MCL = 5 µg/L)[a]	<0.1	0.446	<0.1	0.315	<0.1	0.239	1.76	21.4
trans-1,2-Dichloroethene[b] (MCL = 100 µg/L)[a]	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1

a. MCL = maximum contaminant level from the EPA (40 CFR 141).

b. The International Union of Pure and Applied Chemistry name for ethylene is ethene. For example, trichloroethene is equivalent to trichloroethylene. This is the name reported in the USGS database. This nomenclature is used in this table in case the reader wants to look up the constituent in the USGS database.

c. PCS = primary constituent standard values from IDAPA 58.01.11.

Table 6-2. Purgeable organic compounds in monthly production well samples at the RWMC (January through July, 2024).

CONSTITUENT	JAN	FEB	MAR	APR	MAY	JUN	JUL
1,1,1-Trichloroethane (MCL = 200 µg/L)[a]	0.214	0.229	0.232	0.220	0.221	0.210	0.227
Tetrachloroethene[b] (MCL = 5 µg/L)[a]	0.345	0.449	0.332	0.337	0.351	0.285	0.302
Tetrachloromethane (MCL = 5 µg/L)[a]	4.60	4.69	4.98	4.94	5.22	5.19	5.15
Trichloroethene[b] (MCL = 5 µg/L)[a]	3.55	3.67	3.48	3.3	3.47	2.42	2.76
Trichloromethane (PCS = 2 µg/L)[c]	1.55	1.68	1.78	1.66	1.85	1.35	1.54

a. MCL = maximum contaminant level values from the EPA (40 CFR 141)

b. The International Union of Pure and Applied Chemistry name for ethylene is ethene. For example, trichloroethene is equivalent to trichloroethylene. This is the name reported in the USGS database. This nomenclature is used in this table in case the reader wants to look up the constituent in the USGS database.

c. PCS = primary constituent standard values from IDAPA 58.01.11.

Since 1998, concentrations have routinely exceeded the MCL for tetrachloromethane in drinking water (5 µg/L) at RWMC. (Note: VOCs are removed from production well water prior to human consumption.) Trend test results for tetrachloromethane concentrations in water from the RWMC production well indicated a statistically significant increase in concentrations has occurred from 1989 through 2021; however, Treinen et al. (2024a) indicated that more recent data through 2021 showed no trend for the entire dataset and a decreasing trend for data collected since 2007. The more recent decreasing trend indicates that engineering practices designed to reduce VOC movement to the aquifer are having a positive effect. Concentrations of tetrachloromethane from Wells USGS-87 and USGS-120, which are both located south of RWMC, have had an increasing trend since 1987, but concentrations have decreased through time at Well USGS-88 (Davis et al. 2015; Bartholomay et al. 2020; Fisher et al. 2021; Treinen et al. 2024a). As observed in Table 6-1, trichloroethylene (or trichloroethene [TCE]) and trichloromethane exceeded the MCL of 5 µg/L from one sample that was collected from one perched RWMC well.

6.5 Comprehensive Environmental Response, Compensation, and Liability Act Groundwater Monitoring During 2024

CERCLA activities at the INL Site are divided into WAGs that roughly correspond to the major facilities, with the addition of the INL Sitewide WAG 10. The following subsections provide an overview of the groundwater sampling results. More detailed discussions of CERCLA groundwater sampling can be found in the WAG-specific monitoring reports within the CERCLA Administrative Record at Administrative Record Information Repository (ARIR) Home – ARIR. WAG 8 is managed by the NRF and is not discussed in this report.

6.5.1 Summary of Waste Area Group 1 Groundwater Monitoring Results

Groundwater is monitored at WAG 1 to evaluate the progress of remedial actions at TAN. The VOC groundwater plume at TAN has been divided into three zones based on the 1997 TCE concentrations with three different remedy components, which work together to remediate the entire VOC plume. The monitoring program and results are summarized by plume zone in the following paragraphs.

Hot Spot Zone (Historical TCE Concentrations Exceeding 20,000 µg/L). In situ bioremediation (ISB) was used in the hot spot near Well TSF-05 to create conditions favorable for naturally occurring anaerobic bacteria in the aquifer to break down chlorinated solvents, principally TCE. The hot spot concentration was defined using TCE data from 1997, which is identified in Figure 6-4, and is not reflective of current concentrations, as shown in Figure 6-5. With regulatory agency concurrence, an ISB rebound test began in July 2012 to determine whether the residual TCE source in the aquifer had been sufficiently treated. Currently, the ISB rebound test has been split into two components: (1) an ISB rebound test for the area near the former Injection Well TSF-05; and (2) ISB activities to treat the TCE source affecting Well TAN-28.

Data collected in 2024 during the ISB rebound test for the area near the former Injection Well TSF-05 indicated that anaerobic conditions created by ISB were still present in the hot spot area, and that the TCE concentrations were near or below the MCLs in the wells near the former Injection Well TSF-05, as shown in Figure 6-5. After background aquifer conditions are re-established, the effectiveness of the ISB part of the remedy will be re-evaluated (DOE-ID 2025a). To address the source of TCE in Well TAN-28, continued dual ISB injections into Wells TAN-2336 and TAN-1860A were made in order to increase the efficiency of the injection strategy. During 2024, a total of 19 totes of amendment (or 4,750 gal) were injected over the course of five injection events into these two wells. Five injections with a total of 11 totes of amendment (or 2,750 gal) were performed at Well TAN-2336, while five additional injections with a total of eight totes of amendment (or 2,000 gal) went into Well TAN-1860A, as recorded in the first quarter surveillance report (DOE-ID 2025a). Despite some variations, TCE concentrations have declined in Well TAN-28 due to the ISB injections, which were aimed at treating the TCE source. ISB injections will continue into these wells until it can be determined that the TCE source in Well TAN-28 has been successfully treated and a transition to a rebound test for the TCE source in this well can be made.

Medial Zone (Historical TCE Concentrations Between 1,000 and 20,000 µg/L). A pump and treat system has been used in the medial zone, which extracts contaminated groundwater, circulates the groundwater through air strippers to remove VOCs like TCE, and reinjects treated groundwater back into the aquifer. Generally throughout 2024, the Pump and Treat Facility operated Monday through Thursday, except for shutdowns due to maintenance. All Pump and Treat Facility compliance samples during 2024 were below the discharge limits. The TCE concentrations used to define the medial zone (e.g., 1,000–20,000 µg/L) are based on data collected in 1997, which is before remedial actions began, as shown in Figure 6-4, and do not reflect the current concentrations shown in Figure 6-5. In 2024, none of the wells were above the concentration of 1,000 µg/L used historically to define the medial zone. The concentrations of TCE in Wells TAN-33, TAN-36, and TAN-44 near the Pump and Treat Facility are used as indicators of TCE concentrations migrating past the Pump and Treat Facility extraction wells into the distal zone. During 2024, the TCE concentrations for Wells TAN-33, TAN-36, and TAN-44 ranged from 8.63 to 35.1 µg/L (DOE-ID 2025a).

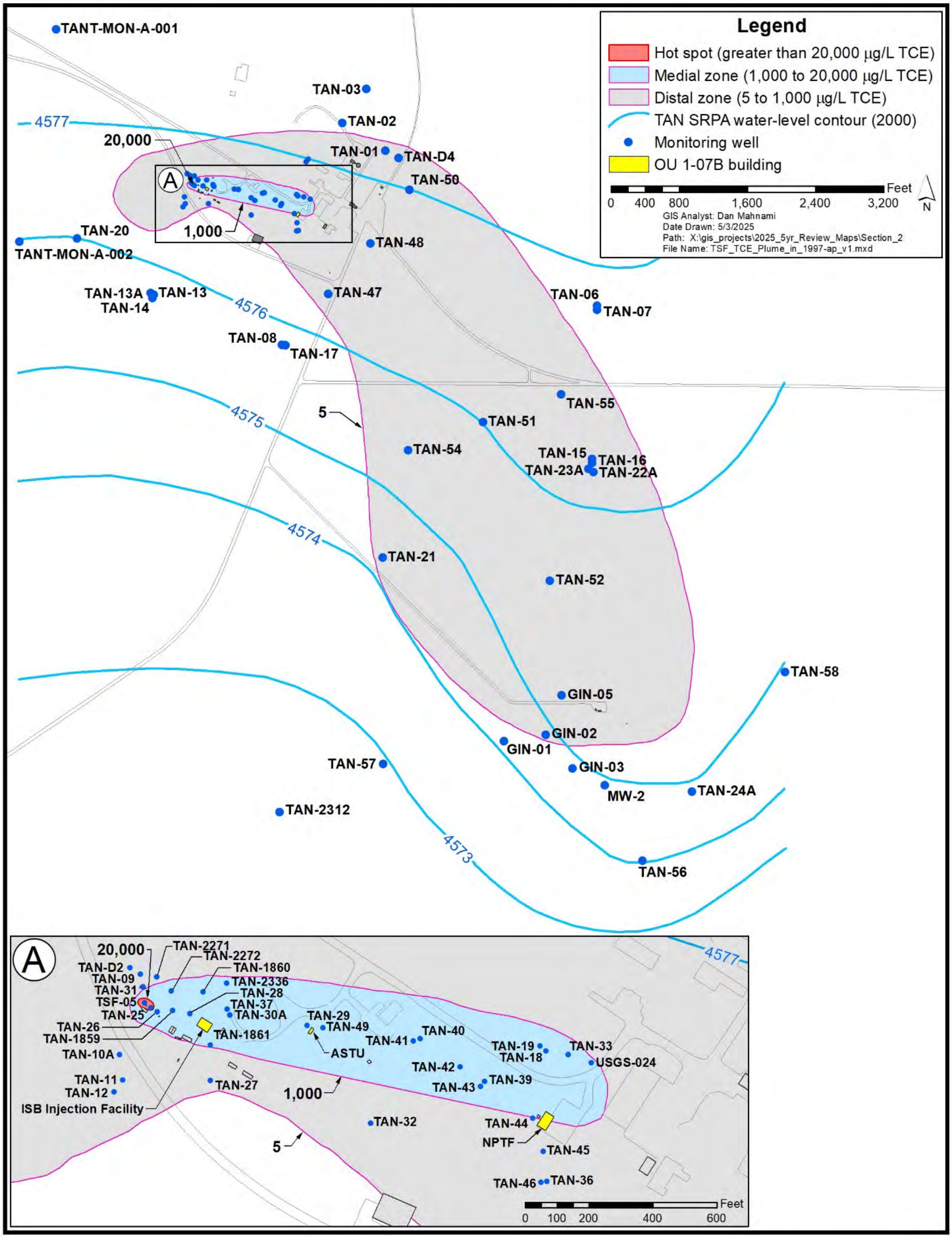

Figure 6-4. TCE plume at TAN in 1997.

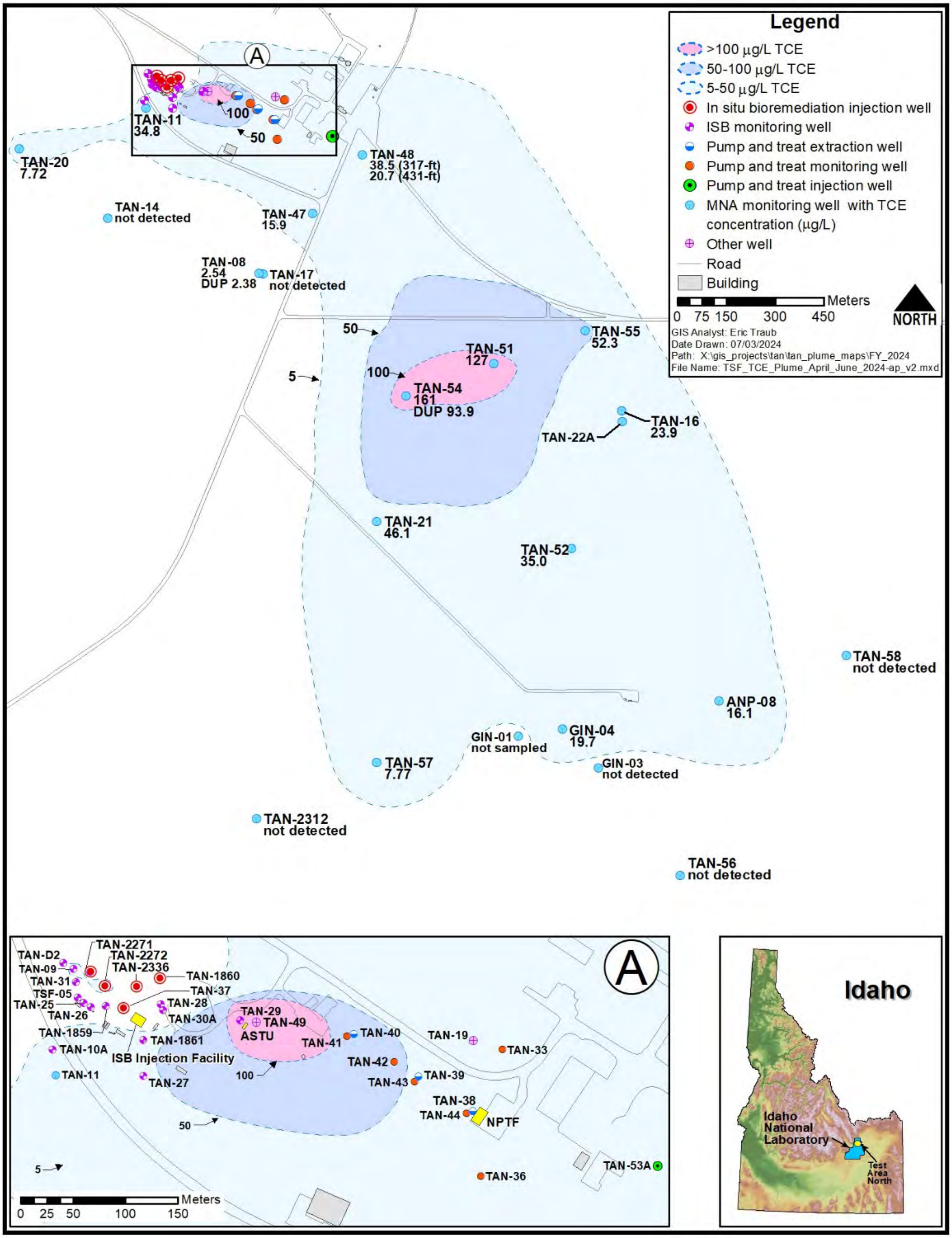

Figure 6-5. Distribution of TCE in the Snake River Plain Aquifer from April to June 2024.

Distal Zone (Historical TCE Concentrations Between 5 and 1,000 µg/L). Monitored natural attenuation is the remedial action for the distal zone of the plume, as shown in Figure 6-4. Monitored natural attenuation is the sum of physical, chemical, and biological processes that act without human intervention to reduce the mass, toxicity, mobility, volume, or concentration of groundwater contaminants. Institutional controls are in place to protect current and future users from the health risks associated with groundwater contamination until the concentrations decline through natural attenuation to levels below the MCL. The TCE data collected in FY 2024 from the distal zone wells indicate that all wells are consistent with the model predictions but additional data are needed to confirm the monitored natural attenuation part of the remedy will meet the remedial action objective of all wells below the MCL by 2095 (DOE-ID 2025a). The TCE data from the plume expansion wells suggest that the plume expansion is currently within the limits allowed in the Record of Decision Amendment (DOE-ID 2001).

Radionuclide Monitoring. In addition to the VOC plume, ^{90}Sr, ^{137}Cs, tritium, and uranium-234 (^{234}U) are listed as contaminants of concern in the Record of Decision Amendment (DOE-ID 2001). Concentrations of ^{90}Sr and ^{137}Cs are expected to naturally decline below their respective MCLs before 2095. However, wells in the source/ISB area currently show elevated concentrations of ^{90}Sr and ^{137}Cs compared with the levels prior to starting ISB. The elevated ^{90}Sr and ^{137}Cs concentrations are due to enhanced mobility created by elevated concentrations of competing cations (e.g., calcium, magnesium, sodium, potassium) for adsorption sites in the aquifer. The elevated cation concentrations are due to ISB activities to treat VOCs. As competing cation concentrations decline toward background conditions, ^{90}Sr and ^{137}Cs are trending lower. The radionuclide concentrations are expected to continue to decrease, and concentration trends will continue to be evaluated to determine whether the remedial action objective of declining below MCLs by 2095 will be met. Sampling will be conducted for ^{234}U after ISB conditions dissipate because ISB conditions suppress the uranium concentrations (DOE-ID 2025a).

6.5.2 Summary of Waste Area Group 2 Groundwater Monitoring Results

Groundwater samples were collected from six aquifer wells to monitor WAG 2 in the ATR Complex during 2024. All wells were sampled and analyzed for ^{90}Sr, gamma-emitting radionuclides (e.g., the target analyte is cobalt-60), tritium, and chromium (filtered) in accordance with the groundwater monitoring plan (DOE-ID 2016). The results for the October 2024 sampling event will be included in the FY 2025 Annual Report for WAG 2 (DOE-ID 2025b). The October 2024 sampling data are summarized in Table 6-3.

Table 6-3. WAG 2 aquifer groundwater quality summary (October 2024).

ANALYTE	MCL	BACKGROUND[a]	MAXIMUM	MINIMUM	NUMBER OF WELLS ABOVE MCL
Chromium (filtered) (µg/L)	100	4	96.7	1.70	0
Cobalt-60 (pCi/L)	100	0	ND[b]	ND	0
Strontium-90 (pCi/L)	8	0	ND	ND	0
Tritium (pCi/L)	20,000	34	2,630	ND	0

a. Background concentrations are for western tributary water for the eastern Snake River Plain Aquifer from Bartholomay and Hall (2016).

b. ND = not detected.

No analyte occurred above its MCL in the Snake River Plain Aquifer at WAG 2. The highest chromium concentration occurred in Well USGS-065 at 96.7 µg/L and was below the MCL of 100 µg/L. The second-highest chromium concentration appeared in Well TRA-07 at 84.0 µg/L. The chromium concentrations in both wells have shown short-term increases in recent years (DOE-ID 2025b).

Tritium was the only radionuclide analyte detected in the aquifer and was below the MCL of 20,000 pCi/L in all the sampled wells. The highest tritium concentration was 2,630 pCi/L in Well TRA-07 (DOE-ID 2025b). Chromium and tritium concentrations in the aquifer have declined faster than predicted by the WAG 2 models used for the Operable Unit 2-12 Record of Decision and the revised modeling performed after the first five-year review (DOE-NE-ID 2005).

The October 2024 eastern Snake River Plain Aquifer water table map prepared for the vicinity of the ATR Complex was consistent with previous maps showing general groundwater flow direction to the southwest. Aquifer water levels in the vicinity of the ATR Complex declined by approximately 0.49 ft on average from October 2023 to October 2024 (DOE-ID 2025b).

6.5.3 Summary of Waste Area Group 3 Groundwater Monitoring Results

At INTEC, groundwater samples are collected from 17 Snake River Plain Aquifer monitoring wells during odd-numbered years and from 14 wells during even-numbered years. During the reporting period, all required wells were sampled. A limited number of samples were collected from Well USGS-059 due to the sample pump losing function during the collection of the samples. Groundwater samples were analyzed for a suite of radionuclides and inorganic constituents. The data are summarized in the 2024 Annual Report (DOE-ID 2025c). Table 6-4 summarizes the maximum concentrations observed, along with the number of MCL exceedances reported for each constituent.

Table 6-4. Summary of constituents detected in WAG 3 aquifer monitoring wells (FY 2024).

CONSTITUENT	EPA MCL	UNITS	SNAKE RIVER PLAIN AQUIFER GROUNDWATER – APRIL 2024		
			MAXIMUM REPORTED VALUE	NUMBER OF RESULTS	RESULTS > MCL
Gross alpha	15	pCi/L	4.93 ± 1.88 J[a]	13	0
Gross beta	NA[b]	pCi/L	798 ± 13	13	NA
Cesium-137	200	pCi/L	ND[a]	14	0
Strontium-90	8	pCi/L	**12.6 ± 1.17**[c]	14	4
Technetium-99	900	pCi/L	**1,270 ± 73.7**[c]	14	1
Iodine-129	1	pCi/L	0.902 ± 0.322 J[b]	13	0
Tritium	20,000	pCi/L	1,780 ± 265	14	0
Plutonium-238	15	pCi/L	—[d]	—[d]	—[d]
Plutonium-239/240	15	pCi/L	—[d]	—[d]	—[d]
Uranium-233/234	NA MCL[e]	pCi/L	1.73 ± 0.214	14	NA
Uranium-235	NA MCL	pCi/L	0.147 ± 0.073 J[b]	14	NA
Uranium-238	NA MCL	pCi/L	1.17 ± 0.132	14	NA
Bicarbonate	NA	mg/L	151	13	NA
Calcium	NA	mg/L	60.6	13	NA
Chloride	250	mg/L	114 J+[b]	13	0
Magnesium	NA	mg/L	21.1	13	NA
Nitrate/Nitrite (as N)	10	mg/L	**13.6**[c]	14	1
Potassium	NA	mg/L	4.44	13	NA
Sodium	NA	mg/L	28.6	13	NA
Sulfate	250	mg/L	34.3	13	0
Total dissolved solids	500	mg/L	438	13	0

a. Data-qualifier flags:
ND = constituent not detected in sample.
J = estimated detection.
J+ = estimated detection; highly biased.
b. NA = not applicable.
c. **Bold** values exceed MCL.
d. — = Gross alpha did not exceed 15 pCi/L; the constituent was not analyzed.
e. NA MCL = EPA MCL is reported in mass units (µg/L), while the values listed are reported in pCi/L.

Strontium-90, technetium-99 (^{99}Tc), and nitrate (as N) exceeded their respective drinking water MCLs in one or more of the eastern Snake River Plain Aquifer monitoring wells at or near INTEC, with ^{90}Sr exceeding its MCL by the greatest margin. Concentrations of ^{90}Sr remained above the MCL (e.g., 8 pCi/L) at four of the well locations sampled. During 2024, the highest level of ^{90}Sr in eastern Snake River Plain Aquifer groundwater was measured at Monitoring Well USGS-047 (12.6 ± 1.17 pCi/L), which is located south (downgradient) of the former INTEC injection well.

Technetium-99 was detected above the MCL (900 pCi/L) at eight monitoring wells. During 2024, the highest ^{99}Tc level in eastern Snake River Plain Aquifer groundwater was located at Well ICPP-MON-A-230 (1,270 ± 73.7 pCi/L), which lies north of the INTEC Tank Farm. All of the sampled wells showed stable or declining trends from the previous reporting period.

Nitrate was detected in all of the wells sampled during this reporting period. Monitoring Well ICPP-20201-AQ was the only location to exceed the nitrate concentration MCL of 10 mg/L as elevated nitrate with a reported level of 13.6 mg/L. The presence of nitrate concentrations in groundwater southeast of the tank farm is attributed primarily to impacts from tank farm releases and residual vadose-zone sources. These nitrate concentrations were similar or slightly lower than those observed in previous years.

Tritium was detected at most of the sampled wells, but none of the groundwater samples exceeded the tritium MCL (20,000 pCi/L). The highest tritium concentrations in groundwater were reported at Well USGS-051 (1,780 ± 265 pCi/L), situated southeast of INTEC. Tritium concentrations have declined at nearly all locations over the past few years.

During the reporting period, no plutonium isotope analyses were performed because the current monitoring plan identifies the contingency for plutonium analysis if gross alpha exceeds 15 pCi/L. Uranium-238 (^{238}U) was detected at all eastern Snake River Plain Aquifer well locations, with the highest concentration at Well ICPP-MON-A-230 (1.17 ± 0.132 pCi/L). Uranium-234 (^{234}U) was detected in all the groundwater samples as well, with the greatest concentrations of 1.73 ± 0.214 pCi/L measured at Well ICPP-MON-A-230. Uranium-234 is the daughter product (from alpha decay) of the long-lived, naturally occurring ^{238}U. All uranium results for the other wells are consistent with background concentrations reported for Snake River Plain Aquifer groundwater. The ^{234}U/^{238}U ratio for all samples fell within the background range of 1.5 to 3.1 (Roback et al. 2001).

Uranium-235 (^{235}U) was detected at four of the 14 sample locations. All results were reported as an estimated concentration with a validation flag of "J." The highest reported level at any sample location for ^{235}U was measured at Well USGS-051 (0.147 ± 0.073 J pCi/L). Uranium concentrations reported in pCi/L were converted to mass-basis concentrations (µg/L) for comparison to the total uranium MCL of 30 µg/L. The highest total uranium concentration in the groundwater samples was 3.8 µg/L, which was sampled at Well ICPP-MON-A-230. Thus, the uranium results for all Snake River Plain Aquifer wells were well below the total uranium MCL.

6.5.4 Summary of Waste Area Group 4 Groundwater Monitoring Results

The WAG 4 groundwater monitoring consists of two different components: (1) monitoring the CFA landfill, and (2) monitoring a nitrate plume south of CFA. The wells at the CFA landfills are monitored to determine the potential impacts from the landfills, while the nitrate plume south of CFA is monitored to evaluate the nitrate trends. Groundwater monitoring for the CFA landfills consisted of sampling seven wells for metals (filtered), VOCs, and anions (nitrate, chloride, sulfate) and two wells for VOCs only, in accordance with the long-term monitoring plan (DOE-ID 2018). Four wells south of CFA were sampled for nitrate, sulfate, and chloride to monitor the CFA nitrate plume.

Analytes detected in groundwater are compared to the regulatory levels identified in Table 6-5. In 2024, no analytes exceeded an EPA MCL. The manganese secondary maximum contaminant level (SMCL) was exceeded in one well and two other wells exceeded a pH SMCL. The elevated pH in these two wells was due to grout placed beneath the well screens during well construction. A complete list of the groundwater sampling results will be included in the FY 2024 Annual Report for WAG 4 (DOE-ID 2025d).

In the CFA nitrate plume monitoring wells south of CFA, Well CFA-MON-A-002 continued to exceed the nitrate groundwater MCL of 10 mg/L-N. The nitrate concentration within Well CFA-MON-A-002 remained mostly stable with a reading of 12.5 mg/L-N in 2023 and 13.5 mg/L-N in 2024. However, Well CFA-MON-A-002 is consistent with a declining trend that began in 2006. The nitrate concentration of 8.08 mg/L-N in Well CFA-MON-A-003 is below the MCL and reveals a slight downtrend (DOE-ID 2025d).

Water level measurements taken at CFA showed an increase on the average of 0.40 ft from August 2023 to August 2024. A water level contour map based on August 2024 water levels showed groundwater gradients and flow directions consistent with previous maps (DOE-ID 2025d).

Table 6-5. Comparison of CFA landfill and CFA nitrate plume groundwater sampling results to regulatory levels (August 2024).

COMPOUND	MCL OR SMCL	MAXIMUM DETECTED VALUE	NUMBER OF WELLS ABOVE MCL OR SMCL
CFA NITRATE PLUME WELLS			
Chloride (mg/L)	*250*[a]	70.1	0
Sulfate (mg/L)	*250*	32.8	0
Nitrate/nitrite (mg/L-N)	10	**13.5**[b]	1
CFA LANDFILL WELLS			
ANIONS			
Chloride (mg/L)	*250*	58.4	0
Sulfate (mg/L)	*250*	38.5	0
Nitrate/nitrite (mg/L-N)	10	2.51	0
COMMON CATIONS			
Calcium (µg/L)	None	60,600	NA[c]
Magnesium (µg/L)	None	19,800	NA
Potassium (µg/L)	None	6,290	NA
Sodium (µg/L)	None	27,000	NA
INORGANIC ANALYTES			
Antimony (µg/L)	6	ND[d]	0
Aluminum (µg/L)	*50–200*	ND	0[e]
Arsenic (µg/L)	10	2.56	0
Barium (µg/L)	2,000	97.4	0
Beryllium (µg/L)	4	ND	0
Cadmium (µg/L)	5	ND	0
Chromium (µg/L)	100	22.4	0
Copper (µg/L)	*1,300*	1.60	0
Iron (µg/L)	*300*	35.6	0
Lead (µg/L)	15	ND	0
Manganese (µg/L)	50	54.2	1
Mercury (µg/L)	2	ND	0
Nickel (µg/L)	None	46.8	NA
Selenium (µg/L)	50	2.42	0
Silver (µg/L)	100	ND	0
Thallium (µg/L)	2	ND	0
Vanadium (µg/L)	None	6.71	NA
Zinc (µg/L)	*5,000*	14.9	0
DETECTED VOCS			
Chloroform (µg/L)	80	1.18	0

a. Numbers in *italic* text are for the secondary MCL.
b. **Bold** values exceed an MCL or SMCL.
c. NA = not applicable.
d. ND = not detected.

6.5.5 Summary of Waste Area Group 7 Groundwater Monitoring Results

Groundwater samples collected from 12 monitoring wells near and downgradient of RWMC in May 2024 were analyzed for radionuclides, inorganic constituents, and VOCs. Of the 283 aquifer analytical results (excluding field and trip blanks), 20 met the reportable criteria established in Subsection 5.5.3 of the "Field Sampling Plan for Operable Unit 7-13/14 Aquifer Monitoring" (DOE-ID 2021c). Table 6-6 summarizes the reportable contaminants of concern in 2024. Figure 6-6 depicts the WAG 7 aquifer well monitoring network. These results are:

- *Carbon tetrachloride* – Carbon tetrachloride was reportable at seven monitoring locations in May 2024, none of which were detected above the MCL of 5 µg/L. These concentrations of carbon tetrachloride are similar to the amounts observed in 2023, as shown in Figures 6-7 and 6-8.
- *Trichloroethylene* – Concentrations of reportable TCE in May 2024 remained steady in the wells near and downgradient of RWMC, as shown in Figure 6-9. No TCE concentrations were detected above the MCL of 5 µg/L.
- *Nitrate (as Nitrogen)* – The only inorganic analyte detected above its reporting threshold (a local background concentration of 1.05 mg/L) in 2024 was nitrate (as nitrogen), which was calculated based on maximum concentrations in upgradient background wells (DOE-ID 2021c). All detections were below the MCL of 10 mg/L.

Table 6-6. Summary of WAG 7 aquifer analyses for May 2024 sampling.

ANALYTE	NUMBER OF WELLS SAMPLED	NUMBER OF SAMPLES ANALYZED[a]	NUMBER OF REPORTABLE DETECTIONS[a,b]	CONCENTRATION MAXIMUM[a]	LOCATION OF MAXIMUM CONCENTRATION	NUMBER OF DETECTIONS GREATER THAN MCL[c]	MCL[c]
Carbon tetrachloride	12	14	7	4.98 µg/L	M15S	0	5 µg/L
Trichloro-ethylene	12	14	5	3.81 µg/L	M15S	0	5 µg/L
Nitrate (as nitrogen)	12	14	8	2.08 mg/L	USGS-132:Port 22	0	10 mg/L

a. Includes field duplicate samples collected for quality control purposes and samples collected from wells with multiple ports.
b. Results that exceeded reporting criteria as established in the "Field Sampling Plan for Operable Unit 7 13/14 Aquifer Monitoring" (DOE-ID 2021c).
c. MCLs are from the "National Primary Drinking Water Regulations" (40 CFR 141).

No radiological analytes met the reportable criteria in May 2024.

As in previous years, groundwater-level measurements in the monitoring wells at RWMC were taken prior to the sample collection for the May 2024 event. The groundwater-level contour map for the 2024 sampling period indicates groundwater flow toward the south-southwest beneath the RWMC, as shown in Figure 6-10.

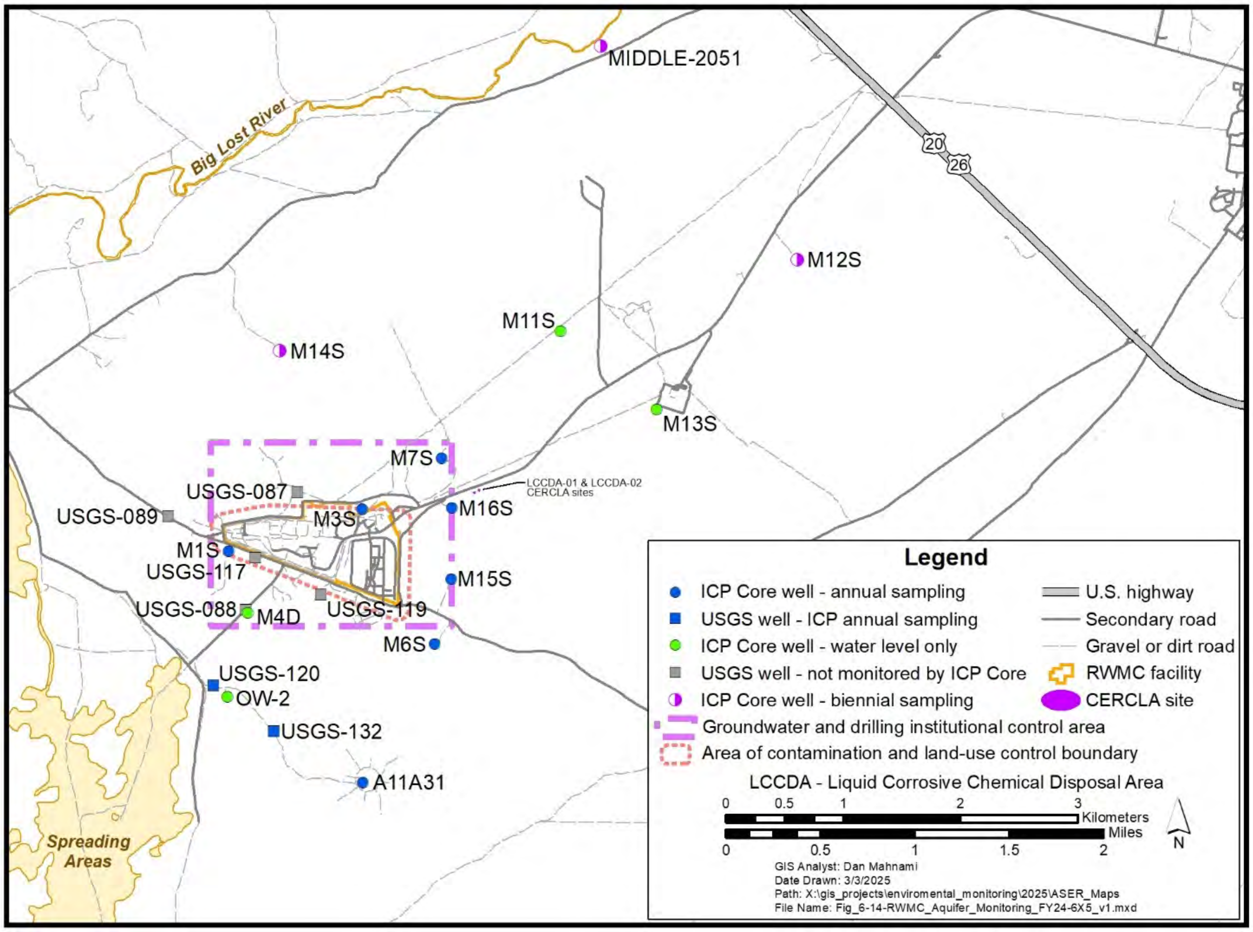

Figure 6-6. The WAG 7 aquifer well monitoring network at the RWMC (DOE-ID 2021c).

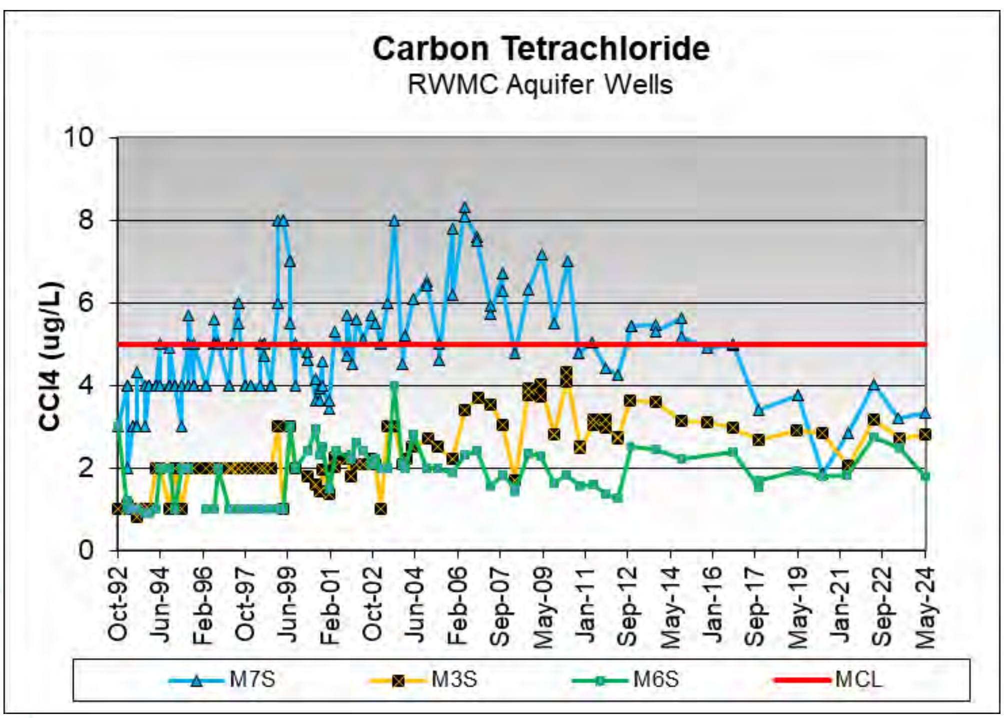

Figure 6-7. Carbon tetrachloride (CCL4) concentration trends in RWMC aquifer Wells M7S, M3S, and M6S.

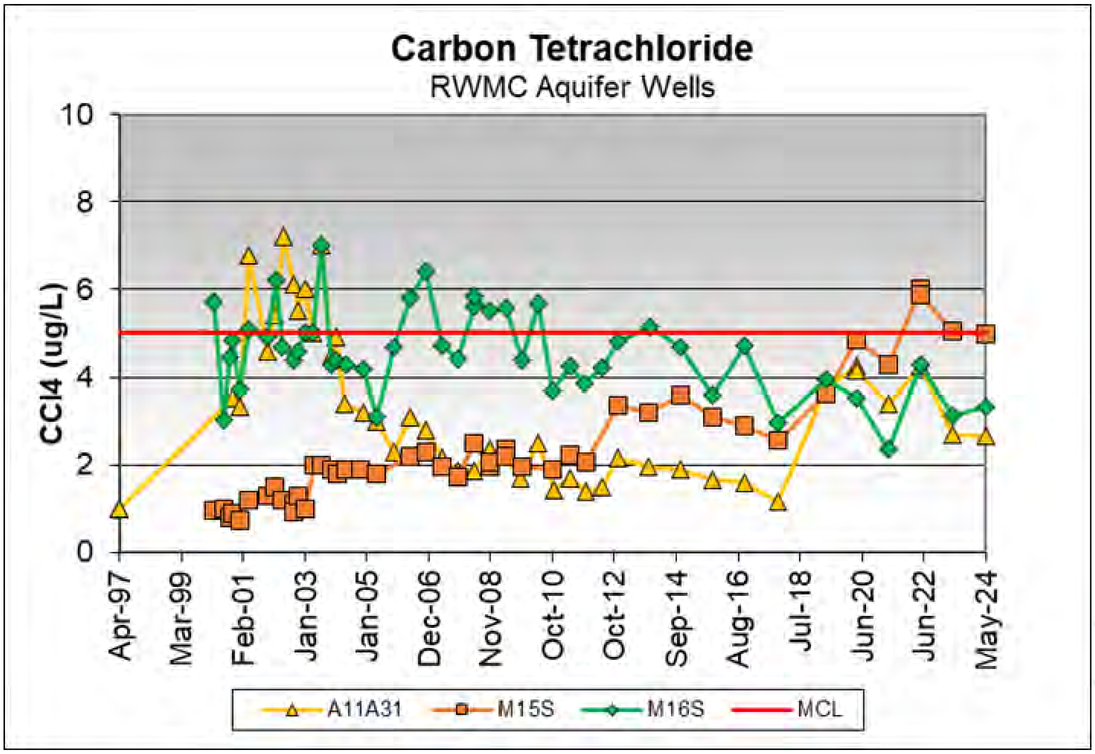

Figure 6-8. Carbon tetrachloride (CCL_4) concentration trends in RWMC aquifer Wells A11A31, M15S, and M16S.

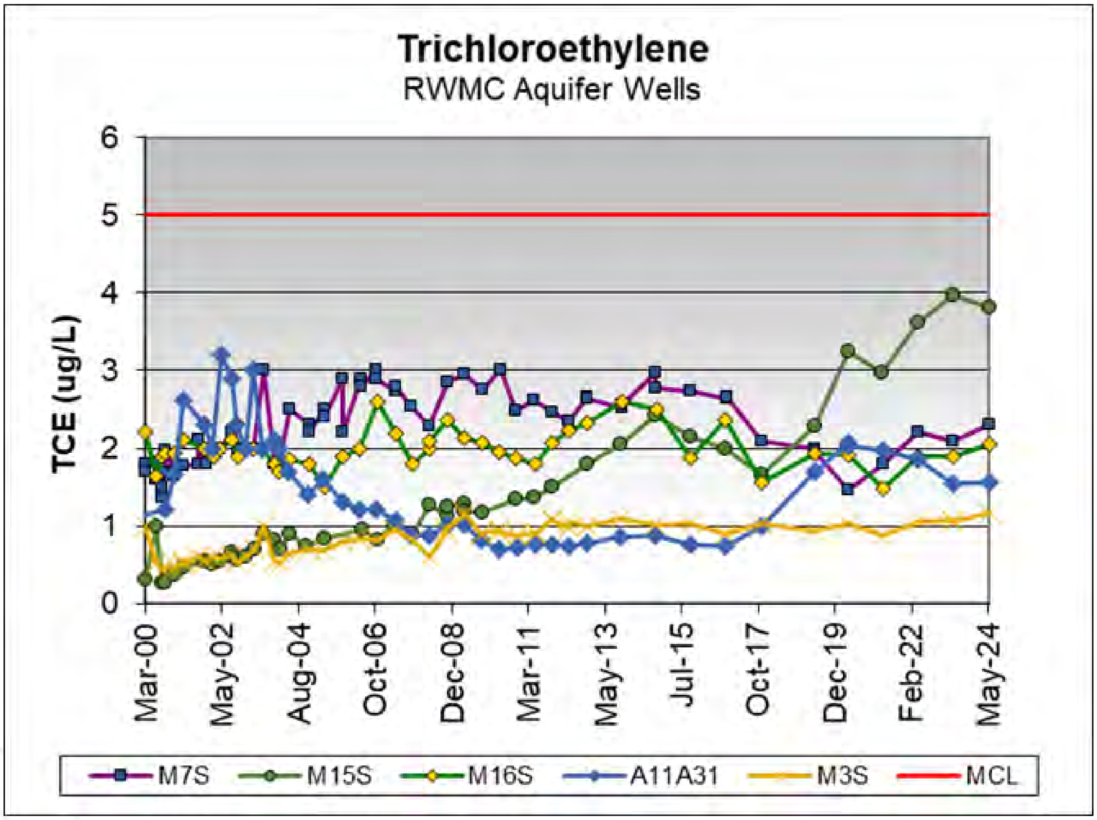

Figure 6-9. Concentration history of TCE in RWMC aquifer Wells M7S, M15S, M16S, A11A31, and M3S.

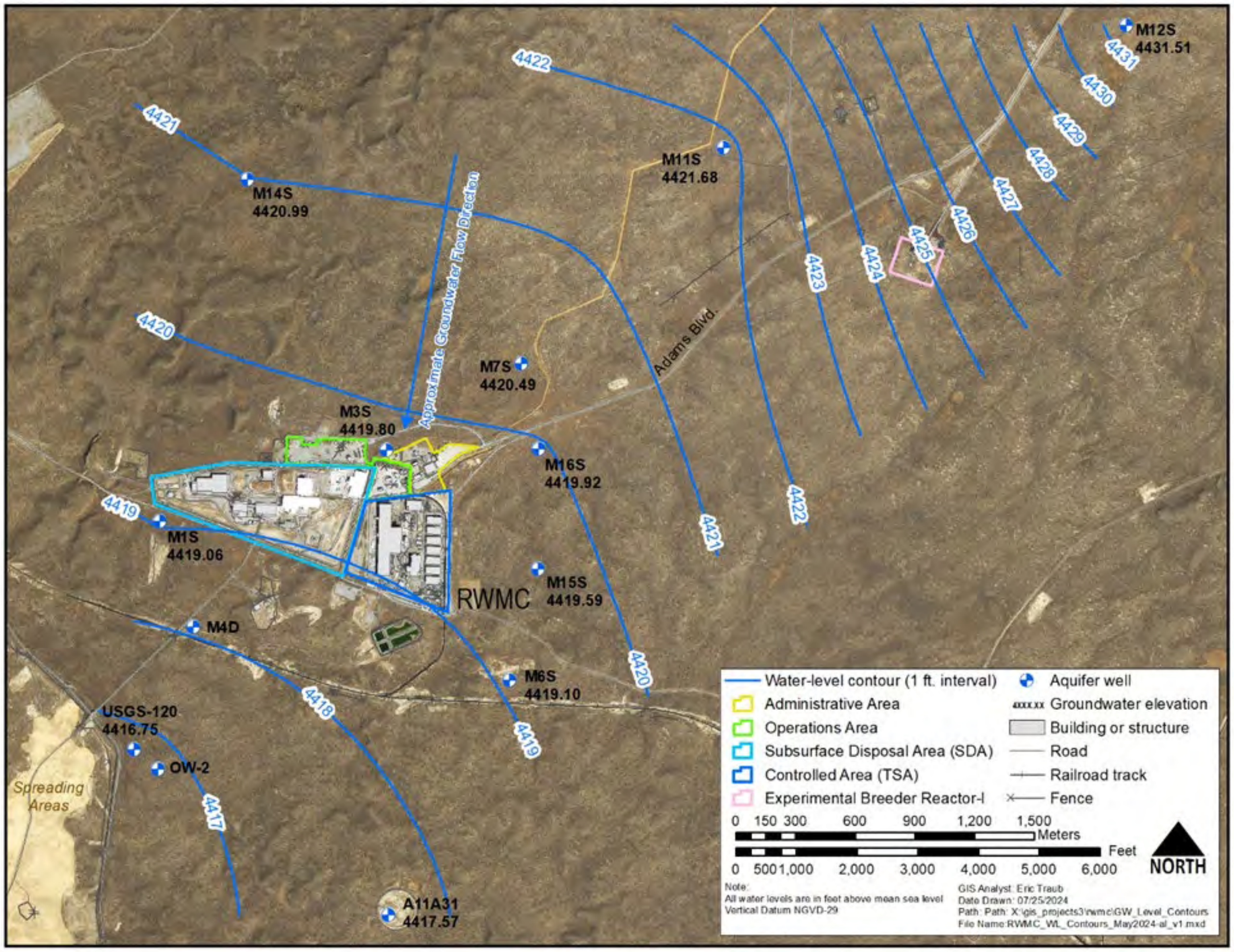

Figure 6-10. Groundwater-level contours in the aquifer near the RWMC based on 2024 measurements.

6.5.6 Summary of Waste Area Group 9 Groundwater Monitoring Results

Prior to 2023, five MFC wells (e.g., four monitoring and one production) were sampled twice per year by the INL contractor for selected radionuclides, metals, anions, cations, and other water quality parameters, as surveillance monitoring under the WAG 9 Record of Decision (ANL-W 1998).

Groundwater monitoring performed to meet the CERCLA requirements of the WAG 9 Record of Decision began in 1998 and was discontinued at the end of 2022. The "Operable Unit 9-04 Operations and Maintenance Report for Fiscal Years 2008–2014" (DOE-ID 2015) indicates the groundwater monitoring data:

- Demonstrate that concentrations of organic, inorganic, and radionuclide constituents have never exceeded the groundwater or drinking water standards at WAG 9
- Show the remedies have achieved their expected outcomes
- Show no discernible impact from previous or current activities at MFC.

Termination of CERCLA semiannual groundwater monitoring in 2022 was formalized in the "Five-Year Review of CERCLA Response Actions at the Idaho National Laboratory Site: Fiscal Years 2015–2019" (DOE-ID 2021d).

While CERCLA-specific groundwater monitoring ended in 2022, groundwater monitoring for certain metals, inorganics, and radionuclides continued in 2024 at MFC Monitoring Wells ANL-MON-A-012, ANL-MON-A-013, and ANL-MON-A-014 to meet the MFC reuse permit and the DOE environmental surveillance monitoring requirements. The 2024 MFC groundwater monitoring results related to current operations are discussed in Chapter 5.

6.6 Remote-Handled Low-Level Waste Disposal Facility

The RHLLW Disposal Facility does not generate or discharge liquid effluents; however, the INL contractor does monitor groundwater at the RHLLW Disposal Facility to demonstrate compliance with DOE O 435.1, "Radioactive Waste Management," the surveillance requirements of DOE Order 458.1, "Radiation Protection of the Public and the Environment," and IDAPA 58.01.11, "Ground Water Quality Rule." Samples were collected from three monitoring wells in 2024 and analyzed for gross alpha, gross beta, carbon-14 (^{14}C), ^{129}I, ^{99}Tc, and tritium in accordance with PLN-5501, "Monitoring Plan for the INL RHLLW Disposal Facility" (INL 2024). Results for the analytes that had positive detections during sampling are summarized in Table 6-7. Gross alpha, gross beta, and tritium were detected in all three wells. Concentrations of ^{14}C, ^{129}I, and ^{99}Tc were not detected in any of the samples. The results for gross alpha, gross beta, ^{14}C, ^{129}I, and ^{99}Tc remain consistent with the concentrations measured in the aquifer that were established prior to completion of the facility (INL 2017) with no observable trends. Tritium in all three wells continue to gradually decline over time. Consistent with previous years, the 2024 results show no discernible impacts to the aquifer from RHLLW Disposal Facility operations.

While not required for compliance at the RHLLW Disposal Facility, facility performance is monitored by collecting and analyzing soil-pore water samples, where sufficient water is present, from vadose-zone lysimeters installed in native materials adjacent to and below the base of the vault arrays. For establishment of the baseline, soil-pore water samples were analyzed for the same indicator and target analytes as the aquifer compliance samples (e.g., gross alpha, gross beta, tritium, ^{14}C, ^{129}I, ^{99}Tc). The baseline monitoring results are documented in INL/RPT-23-74930, "Assessment of Baseline Monitoring Data for the Remote-Handled Low-Level Waste Disposal Facility at the Idaho National Laboratory" (INL 2023). In 2024, the post-baseline soil-pore water samples were collected from select lysimeters adjacent to each vault array and analyzed for gross alpha, gross beta, and tritium. The soil-pore water results are compared to the baseline measurements and used as early indicators of facility performance. The 2024 performance monitoring results are presented in INL/RPT-24-82600, "Annual Summary Report for the Remote-Handled Low-Level Waste Disposal Facility – FY 2024." (INL 2025c).

Table 6-7. Radioactivity detected in surveillance groundwater samples collected at the RHLLW Facility (2024).

WELL: SAMPLE DATE:	USGS-136 04/24/2024	USGS-140 04/29/2024	USGS-141 04/30/2024	PCS/SCS[a]
RADIONUCLIDES[b]				
Gross alpha (pCi/L)	1.62 ± 0.395	ND[c] [1.94 ± 0.455][d]	1.95 ± 0.512	15 pCi/L
Gross beta (pCi/L)	4.38 ± 0.372	2.34 ± 0.278 [2.73 ± 0.289]	2.96 ± 0.426	4 mrem/yr[e]
Tritium (pCi/L)	284 ± 92.5	ND [588 ± 141]	634 ± 129	20,000 pCi/L

a. PCS = primary constituent standard; SCS = secondary constituent standard, as specified in IDAPA 58.01.11.

b. Result ± 1σ. Only analytes with at least one statistically positive result greater than 3σ uncertainty are shown. Samples were analyzed for gross alpha, gross beta, ^{14}C, ^{129}I, ^{99}Tc, and tritium.

c. ND = not detected.

d. Duplicate sample results are shown in brackets.

e. IDAPA 58.01.11 specifies a PCS for combined beta/photon emitters of 4 millirems/yr effective dose equivalent. Speciation of the individual radionuclides present would be necessary to determine the equivalent PCS in units of pCi/L. For comparison purposes only, the EPA specifies a 4 mrem/yr MCL for public drinking water systems and uses a screening level of 50 pCi/L. Public drinking water samples with gross beta activity greater than 50 pCi/L must be analyzed to identify the major radionuclides present.

6.7 Onsite Drinking Water Sampling

The INL Site contractors monitor drinking water to demonstrate that it is safe for consumption and meets federal and state regulations. Drinking water parameters are regulated by the state of Idaho under the authority of the Safe Drinking Water Act (40 CFR 141, 142). Parameters are sampled according to a nine-year monitoring cycle, which identifies the frequency and the specific classes of contaminates to monitor at each drinking water source. Parameters with primary MCLs must be monitored at least once every three years, unless a waiver is granted for reduced monitoring every six or nine years.

Many parameters require more frequent sampling during an initial period to establish a baseline, and a subsequent monitoring frequency is determined from the baseline results.

The INL Site has 11 drinking water systems that are monitored by the INL Site contractors. The INL contractor monitors eight of these drinking water systems, while the ICP contractor monitors three. The NRF also monitors a drinking water system; however, the results are not included in this annual report but are addressed in the “Naval Reactors Facility Environmental Monitoring Report for Calendar Year 2024” (FMP 2025). According to the “Idaho Rules for Public Drinking Water Systems” (IDAPA 58.01.08), INL Site drinking water systems are classified as either non-transient or transient, non-community water systems. The four INL contractor transient, non-community water systems are located at CITRC, EBR-I, the Gun Range, and the Main Gate. The four remaining INL contractor water systems are classified as non-transient, non-community water systems. They are located at the ATR Complex, CFA, MFC, and TAN/CTF. Two of the ICP contractor systems, located at INTEC and RWMC, are classified as non-transient, non-community water systems, while the NRF Deactivation and Decommissioning (D&D) Facility is classified as a transient, non-community water system.

As required by the state of Idaho, INL and the ICP drinking water programs use EPA-approved (or equivalent) analytical methods to analyze drinking water in compliance with the current editions of IDAPA 58.01.08 and 40 CFR Parts 141–143. State regulations also require that analytical laboratories be certified by Idaho or another state whose certification is recognized by Idaho. Idaho DEQ oversees the certification program and maintains a list of approved laboratories.

The INL Site contractors monitor certain parameters more frequently than required by regulation because of low volume usage on weekends. For example, bacterial analyses are conducted monthly rather than quarterly at all eight INL contractor drinking water systems and at the three ICP contractor drinking water systems. Because of known groundwater plumes near one ICP contractor drinking water well, additional sampling is conducted for carbon tetrachloride at RWMC.

The INL contractor enforces methods to shield the water supply from contamination threats as outlined in IDAPA 58.01.08 and the Idaho Plumbing code. A key protective strategy involves the stringent prevention of cross-connections between potable drinking water systems, industrial water systems, and fire-suppression water systems. This is achieved through the implementation of cross-connection control, which entails fitting protective devices, such as double-check valves and reduced-pressure-zone valves, at the point where a facility's plumbing meets the public water main. It is compulsory for facilities that handle hazardous materials, which might inadvertently contaminate the potable water system under conditions of low-water pressure, to install these cross-connection control devices.

During 2024, 309 cross-connection control devices were inspected at all INL facilities, including primary devices installed at interfaces to the potable water main and secondary control devices at the point of use. If a problem with a cross-connection device was encountered during testing, the device was repaired and retested to ensure proper function.

6.7.1 INL Site Drinking Water Monitoring Results

During 2024, the INL contractor collected 86 routine/compliance samples from the eight INL-operated drinking water systems. Semiannual sampling was conducted at all eight water systems for gross alpha, gross beta, and tritium. In addition, CFA was sampled for ^{129}I and ^{90}Sr due to its location downgradient of the plume around INTEC. Table 6-8 lists the results of routine/compliance and radiological surveillance monitoring. In addition to routine samples, the INL contractor collected 228 surveillance bacteriological, radiological, and per- and polyfluoroalkyl substances (PFAS) samples and 45 quality control samples in the form of blanks.

The ICP contractor collected 25 routine/compliance samples and five quality control samples from the ICP drinking water systems. ICP also collected 54 surveillance bacteriological, PFAS, synthetic organic compound, and VOC samples. Two gross alpha/beta samples were collected semiannually from both the ICP drinking water systems at INTEC and RWMC. One tritium sample also was collected from each drinking water system as well, as shown in Table 6-8.

All INL Site water systems were sampled for nitrates. Samples for total trihalomethanes and haloacetic acids were collected at the ATR Complex, CFA, INTEC, MFC, RWMC, and TAN/CTF. In compliance with the DEQ monitoring schedule, the ATR Complex and CFA were sampled for VOCs, while TAN/CTF was sampled for Phase 2 and 5 inorganic contaminants. Results for the most frequently sampled analytes are summarized in Table 6-8.

All INL Site drinking water systems were either well below the regulatory limits for drinking water or no detections were observed. No trends in the data were evident over the last five years. Tritium concentrations at CFA have hovered around 2,000 pCi/L for the last five years, but it is important to note that this facility has demonstrated a significant downward trend in tritium concentrations over the last 25 years from a high of 12,500 pCi/L in the year 2000. Since all water systems are categorized as public water systems (PWSs), the data for all but the radiological constituents are shown on the Idaho DEQ’s PWS Switchboard.

Table 6-8. Summary of INL Site drinking water results (2024).

CONSTITUENT (units)	MCL	ATR COMPLEX PWS[a] 6120020	CFA PWS 6120008	CITRC PWS 6120019	EBR-I PWS 6120009	GUN RANGE PWS 6120025	INTEC PWS 6120012	MAIN GATE PWS 6120015	MFC PWS 6060036	NRF D&D PWS 6120031	RWMC PWS 6120018	TAN CTF PWS 6120013
RADIOLOGICAL SURVEILLANCE MONITORING												
Gross Alpha[b] (pCi/L)	15	ND[c]–3.13	ND–3.21	ND–3.06	ND	ND–5.02	ND	ND	ND–4.18	NA[d]	ND	ND–3.22
Gross Beta[b] (pCi/L)	50 screening	ND–2.68	6.14–7.68	4.70–6.74	2.85–3.61	3.16–5.47	1.79–2.23	2.40–3.25	3.14–4.87	NA	3.44–3.92	ND–3.85
Tritium[b] (pCi/L)	20,000	ND	1,370–2,030	ND	ND	ND–480	ND	ND	ND	NA	ND	ND
Iodine-129 (pCi/L)	1	NA	ND	NA	NA	NA	NA	NA	NA	NA	NA	NA
Strontium-90[b] (pCi/L)	8	NA	ND	NA	NA	NA	ND	NA	NA	NA	ND–3.10	NA
COMPLIANCE MONITORING												
Nitrate[b] (mg/L)	10	ND	2.92	ND	ND	1.03	0.564	ND	2.42–2.45	NA	0.954	ND
Total trihalomethanes[b] (ppb)	80	6.70	3.20	NA	NA	NA	5.24	NA	6.30	0.500/ 6.60[b]	3.47	4.15
Total coliform	See 40 CFR 141.63	Absent	Absent	Absent	Absent	Absent	Absent	6 Absent 10 Present[e]	Absent	Absent	Absent	Absent
E. coli	See 40 CFR 141.63	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent
Haloacetic acids (ppb)	60	ND	ND	NA	NA	NA	ND	NA	ND	NA	ND	ND

a. PWS = public water system.
b. Range of results (minimum – maximum) presented.
c. ND = not detected greater than or equal to the MCL.
d. NA = not applicable based on water system classification or not analyzed.
e. Includes routines, repeats, and source samples.

In February 2023, DOE published the "Guide for Investigating Historical and Current Uses of Per- and Polyfluoroalkyl Substances at Department of Energy Sites" (DOE 2023). This guide outlines a framework for DOE programs investigating historic or current PFAS uses at DOE-owned or -operated entities nationwide. INL Site contractors will continue to monitor PFAS based on the "DOE PFAS Strategic Roadmap: DOE Commitments to Action 2022–2025" (DOE 2022b), the INL PFAS Implementation Plan (Chunn 2023), and the ICP PFAS Implementation Plan (ICP 2022). In 2023, the INL Site contractors hired subcontractors to conduct a preliminary assessment on past uses of PFAS at INL, in accordance with the DOE Roadmap. This work is ongoing.

In 2024, the INL contractor sampled all operating potable water wells and entry points to the distribution system for PFAS, completing a five-year baseline sampling effort. In 2024, the ICP contractor collected PFAS samples from two drinking water wells at INTEC and one well at RWMC. CFA was the only sample location with any detections of perfluorooctanoic acid (PFOA) and perfluorooctane sulfonate (PFOS). CFA had detections of perfluorobutane sulfonic acid (PFBS), while both CFA and TAN CTF had detections of perfluorohexanesulfonic acid (PFHxS). All sample results at INL are below the final MCLs for PFAS, and levels were consistently low throughout the baseline sampling period.

6.8 Offsite Drinking Water Sampling

The public drinking water source in southeastern Idaho is primarily derived from groundwater. Due to the potential for contaminant migration beyond the INL Site boundary, surveillance monitoring of radioactivity in offsite drinking water systems are conducted by the INL contractor to meet DOE O 458.1 (DOE 2020). Samples are collected from municipal water sources that have been through a water treatment facility or a well that is used for drinking water. Samples collected offsite are included as drinking water samples but are not used for compliance with drinking water regulations. Instead, media results are used to assess groundwater quality. Public water system owners and operators are responsible for complying with state and federal regulations to monitor water quality.

As part of the offsite surveillance monitoring program, drinking water samples were collected off the INL Site for radiological analyses in 2024. Two downgradient locations of the INL Site at Shoshone and Minidoka, and one upgradient location at Mud Lake, were co-sampled with the state of Idaho DEQ-INL Oversight Program (DEQ-IOP) in May and November 2024. Samples were collected at Atomic City, Craters of the Moon, Howe, Idaho Falls, and the public rest area at Highway 20/26 as well. These samples were analyzed for gross alpha and gross beta activities and for tritium. To improve the readability of this chapter, INL contractor offsite drinking water data tables are included when surveillance monitoring results exceeded 3σ. All sample media results for 2024 are provided in the INL quarterly surveillance reports (INL 2025a; INL 2025b). The DEQ-IOP results are reported quarterly and annually.

Gross alpha activity was detected in several locations, as observed in Table 6-9. The concentrations were similar to previous results from offsite drinking water sampling.

Table 6-9. Gross alpha concentrations detected in offsite drinking water samples collected by the INL contractor in 2024.

LOCATION	SAMPLE RESULTS (pCi/L)[a]	
	GROSS ALPHA[b]	
	SPRING	FALL
Atomic City	2.30 ± 0.76	2.72 ± 0.84
Control	ND	0.56 ± 0.16
Craters of the Moon	ND	2.84 ± 0.73
Howe	ND	3.14 ± 0.61
Minidoka	ND	3.06 ± 0.62
Shoshone	ND	6.30 ± 0.67

a. Results ≥ 3σ are considered to be statistically positive.
b. EPA MCL = 15 pCi/L.
c. ND = not detected.

Gross beta activity was detected in all offsite drinking water samples, except for the samples collected from Idaho Falls and a control sample. The concentrations were similar to previous results from offsite drinking water sampling. Natural levels of radioactive decay products of thorium and uranium exist in the Snake River Plain Aquifer and are likely the source of the measured concentrations. The highest reported gross beta result for offsite drinking water was 8.51 ± 0.40 pCi/L in the sample collected from Howe on November 14, 2024.

Tritium was not detected in any offsite drinking water samples. The DCS for tritium in water is 2.6 x 10^6 pCi/L.

6.9 Surface Water Sampling

Two main sources of water could potentially be affected from activities on the INL Site: (1) the eastern Snake River Plain Aquifer, and (2) the Big Lost River. The eastern Snake River Plain Aquifer is a primary source of regional drinking water and supplies irrigation water to regional agricultural and aquaculture economy.

The Big Lost River is an intermittent, ephemeral body of water that flows only during periods of high-spring runoff and when the Mackay dam, which impounds the river upstream of the INL Site, releases water. The river flows through the INL Site and enters a depression where the water flows into the ground, which is called the Big Lost River Sinks. The river then mixes with other water in the eastern Snake River Plain Aquifer and emerges about 100 miles (160 km) away at Thousand Springs near Hagerman and at other springs downstream of Twin Falls.

Normally, the riverbed is dry due to upstream irrigation and rapid infiltration into the desert soil and underlying basalt. No Big Lost River samples were collected in 2024 due to the absence of water flow. Offsite surface water samples are collected semiannually at three locations downgradient of the INL Site: (1) Alpheus Springs near Twin Falls, (2) Clear Springs near Buhl, and (3) a trout farm near Hagerman. These locations were co-sampled with the DEQ-IOP in May and November 2024.

All sample media results for 2024 are provided in the INL quarterly surveillance reports (INL 2025a; INL 2025b).

Gross alpha activity was detected in one of the surface water samples (2.38 ± 0.60 pCi/L) collected from Alpheus Springs.

Gross beta activity was detected in all surface water samples. The concentrations were similar to previous results from surface water sampling. Natural levels of radioactive decay products of thorium and uranium exist in the Snake River Plain Aquifer and are likely the source of the measured concentrations. The highest concentration was 7.46 ± 0.38 pCi/L collected from Alpheus Springs.

Tritium was not detected in any surface water sample. The DCS for tritium in water is 2.6 x 10^6 pCi/L.

6.10 USGS 2024 Publication Abstracts

In 1949, the USGS was asked to characterize water resources prior to the building of nuclear-reactor testing facilities at the INL Site. Since that time, USGS hydrologists and geologists have been studying the hydrology and geology of the eastern Snake River Plain and the eastern Snake River Plain Aquifer.

At the INL Site and in the surrounding area, the USGS INL Project Office:

- Monitors and maintains a network of existing wells
- Drills new research and monitoring wells, providing information about subsurface water, rock, and sediment
- Performs geophysical and video logging of new and existing wells
- Maintains the Lithologic Core Storage Library
- Provides data to the public.

Data gathered from these activities are used to create and refine hydrologic and geologic models of the aquifer, track contaminant plumes in the aquifer, and improve understanding of the complex relationships between the rocks, sediments, and water that compose the aquifer. The USGS INL Project Office publishes reports about their studies, which are available through the bibliography website.

6.11 References

40 CFR 141. 2024. "National Primary Drinking Water Regulations." Code of Federal Regulations, Office of the Federal Register, National Archives and Records Administration, Washington, DC.

40 CFR 141, Subpart G. 2024. "National Primary Drinking Water Regulations, Maximum Contaminant Levels and Maximum Residual Disinfectant Levels." Code of Federal Regulations, Office of the Federal Register, National Archives and Records Administration, Washington, DC.

40 CFR 142. 2024. "National Primary Drinking Water Regulations Implementation." Code of Federal Regulations, Office of the Federal Register, National Archives and Records Administration, Washington, DC.

40 CFR 143. 2024. "Other Safe Drinking Water Act Regulations." Code of Federal Regulations, Office of the Federal Register, National Archives and Records Administration, Washington, DC.

ANL-W. 1998. "Final Record of Decision for Argonne National Laboratory-West," W7500-00-ES-04, September 1998. Argonne National Laboratory-West, Argonne, IL.

Bartholomay, R. C., B. J. Tucker, L. C. Davis, and M. R. Green. 2000. "Hydrologic Conditions and Distribution of Selected Constituents in Water; Snake River Plain Aquifer, Idaho National Engineering and Environmental Laboratory, Idaho, 1996 through 1998." U.S. Geological Survey Water Resources Investigations Report 2000-4192, DOE/ID-22167. U.S. Geological Survey, Idaho National Engineering Laboratory, Idaho Falls, ID.

Bartholomay, R. C., L. L. Knobel, and J. P. Rousseau. 2003. "Field Methods and Quality-Assurance Plan for Quality-of-Water Activities." U.S. Geological Survey, Idaho National Engineering and Environmental Laboratory, Idaho," U.S. Geological Survey Open-File Report 2003-42, DOE/ID-22182. U.S. Geological Survey, Idaho Falls, ID.

Bartholomay, R. C., and L. F. Hall, 2016. "Evaluation of Background Concentrations of Selected Chemical and Radiochemical Constituents in Water from the Eastern Snake River Plain Aquifer at and near the Idaho National Laboratory, Idaho." USGS Scientific Investigations Report 2016-5056, DOE/ID-22237. U.S. Geological Survey, Idaho National Engineering Laboratory, Idaho Falls, ID.

Bartholomay, R. C., N. V. Maimer, G. W. Rattray, and J. C. Fisher. 2020. "An Update of Hydrologic Conditions and Distribution of Selected Constituents in Water, Eastern Snake River Plain Aquifer and Perched Groundwater Zones, Idaho National Laboratory, Idaho, Emphasis 2016–2018." U.S. Geological Survey Scientific Investigations Report 2019-5149, DOE/ID-22251. U.S. Geological Survey, Idaho National Engineering Laboratory, Idaho Falls, ID.

Bartholomay, R.C., N. V. Maimer, A. J. Wehnke, and S. L. Helmuth. 2021. "Field Methods, Quality-Assurance, and Data Management Plan for Water-Quality Activities and Water-Level Measurements, Idaho National Laboratory, Idaho." U.S. Geological Survey Open-File Report 2021-1004. U.S. Geological Survey, Idaho National Engineering Laboratory, Idaho Falls, ID.

Chunn, R. C., email to G. J. Tomlinson. 2023. "Battelle Energy Alliance Per- and Polyfluoroalkyl Substances Implementation Plan." February 6, 2023. CCN 253128. Battelle Energy Alliance, Idaho Falls, ID.

Davis, L. C., R. C. Bartholomay, J. C. Fisher, and N. V. Maimer. 2015. "Water-quality Characteristics and Trends for Selected Wells Possibly Influenced by Wastewater Disposal at the Idaho National Laboratory, Idaho, 1981–2012." U.S. Geological Survey Scientific Investigations Report 2015-5003, DOE/ID-22233. U.S. Geological Survey, Idaho National Engineering Laboratory, Idaho Falls, ID.

DOE. 2022a. "Derived Concentration Technical Standard." DOE-STD-1196-2022, December 2022. U.S. Department of Energy, Washington, DC.

DOE. 2022b. "PFAS Strategic Roadmap: DOE Commitments to Action 2022–2025." August 2022. U.S. Department of Energy, Washington, DC.

DOE. 2023. "Guide for Investigating Historical and Current Uses of Per- and Polyfluoroalkyl Substances at Department of Energy Sites." February 2023. U.S. Department of Energy, Washington, DC.

DOE-ID. 2001. "Record of Decision Amendment Technical Support Facility Injection Well (TSF-05) and Surrounding Groundwater Contamination (TSF-23) and Miscellaneous No Action Sites, Final Remedial Action." DOE/ID-10139, Amendment, Rev. 0, August 2001. U.S. Department of Energy, Idaho Operations Office, Idaho Falls, ID.

DOE-ID. 2015. "Operable Unit 9-04 Operations and Maintenance Report for Fiscal Years 2008–2014." DOE/ID-11529, Rev. 0, June 2015. U.S. Department of Energy, Idaho Operations Office, Idaho Falls, ID.

DOE-ID. 2016. "Groundwater Monitoring Plan for the Advanced Test Reactor Complex Operable Unit 2-13." DOE/ID-10626, Rev. 9, September 2016. U.S. Department of Energy Idaho Operations Office, Idaho Falls, ID.

DOE-ID. 2018. "Long-Term Monitoring and Field Sampling Plan for the Central Facilities Area Landfills I, II, and III under Operable Unit 4-12." DOE/ID-11374, Rev. 2, July 2018. U.S. Department of Energy, Idaho Operations Office, Idaho Falls, ID.

DOE-ID. 2021b. "Idaho National Laboratory Groundwater Monitoring and Contingency Plan Update." DOE/ID-11034, Rev. 4, July 2021. U.S. Department of Energy, Idaho Operations Office, Idaho Falls, ID.

DOE-ID. 2021c. "Field Sampling Plan for Operable Unit 7-13/14 Aquifer Monitoring." DOE/ID-11492, Rev. 3, August 2021. Idaho Cleanup Project Core, Idaho Falls, ID.

DOE-ID. 2021d. "Five-Year Review of CERCLA Response Actions at the Idaho National Laboratory Site: Fiscal Years 2015–2019." DOE/ID-12034, Rev. 0, January 2021. U.S. Department of Energy, Idaho Operations Office, Idaho Falls, ID.

DOE-ID. 2023a. "Idaho National Laboratory Site Environmental Monitoring Plan." DOE/ID-11088, Rev. 6, September 2023. U.S. Department of Energy, Idaho Operations Office, Idaho Falls, ID.

DOE-ID. 2023b. "Technical Basis for Environmental Monitoring and Surveillance at the Idaho National Laboratory Site." DOE/ID-11485, Rev. 3, July 2023. U.S. Department of Energy, Idaho Operations Office, Idaho Falls, ID.

DOE-ID. 2025a. "Annual Report for the Final Groundwater Remediation, Test Area North, Operable Unit 1-07B, Fiscal Year 2024." DOE/ID-12131, Rev. 0. U.S. Department of Energy, Idaho Operations Office, Idaho Falls, ID.

DOE-ID. 2025b. "Annual Groundwater Monitoring Status Report for Waste Area Group 2 for Fiscal Year 2025." DOE/ID-12139, Rev. 0. U.S. Department of Energy, Idaho Operations Office, Idaho Falls, ID.

DOE-ID. 2025c. "Fiscal Year 2024 Annual Report for Operable Unit 3-14, Tank Farm Soil and INTEC Groundwater." DOE/ID-12135, Rev. 0. U.S. Department of Energy, Idaho Operations Office, Idaho Falls, ID.

DOE-ID. 2025d. "Central Facilities Area Landfills I, II, and III Annual Monitoring Report—Fiscal Year 2024." DOE/ID-12133, Rev. 0. U.S. Department of Energy, Idaho Operations Office, Idaho Falls, ID.

DOE-NE-ID. 2005. "Response to the First Five-Year Review Report for the Test Reactor Area, Operable Unit 2-13, at the Idaho National Engineering and Environmental Laboratory." DOE/NE-ID 11189, Rev. 0. U.S. Department of Energy Idaho Operations Office, Idaho Falls, ID.

DOE O 435.1. 2001. "Radioactive Waste Management." Change 2. U.S. Department of Energy, Washington, DC.

DOE O 458.1. 2020. "Radiation Protection of the Public and the Environment." Administrative Change 4. U.S. Department of Energy, Washington, DC.

FMP. 2025. "Naval Reactors Facility Environmental Monitoring Report for Calendar Year 2024." NRF-OSQ-ESH-01639. Fluor Marine Propulsion, LLC, Schenectady, NY.

Fisher, J. C., R. C. Bartholomay, G. W. Rattray, and N. V. Maimer. 2021. "Optimization of the Idaho National Laboratory Water-quality Aquifer Monitoring Network, Southeastern Idaho." U.S. Geological Survey Scientific Investigations Report 2021-5031, DOE/ID-22252. U.S. Geological Survey, Idaho National Engineering Laboratory, Idaho Falls, ID.

ICP. 2022. "Sampling of Public Water Systems." SPR-190, Rev. 4, July 2022. Idaho Cleanup Project, Idaho Falls, ID.

IDAPA 58.01.08. 2025. "Idaho Rules for Public Drinking Water Systems." Idaho Administrative Procedures Act, Idaho Department of Environmental Quality, Boise, ID.

IDAPA 58.01.11. 2025. "Ground Water Quality Rule." Idaho Administrative Procedures Act, Idaho Department of Environmental Quality, Boise, ID.

INL. 2017. "Assessment of Aquifer Baseline Conditions at the Idaho National Laboratory Remote-Handled Low-Level Waste Disposal Facility," INL/EXT-17-40920, Idaho National Laboratory, Idaho Falls, ID.

INL. 2024. "Monitoring Plan for the Idaho National Laboratory Remote-Handled Low-Level Waste Disposal Facility." PLN-5501, Rev. 3. Idaho National Laboratory, Idaho Falls, ID.

INL. 2025a. "Idaho National Laboratory Surveillance Program Report: Second Quarter 2024." INL/RPT-24-81473, January 2025. Idaho National Laboratory, Idaho Falls, ID.

INL. 2025b. "Idaho National Laboratory Surveillance Program Report: Fourth Quarter 2024." INL/RPT-25-83989, May 2025. Idaho National Laboratory, Idaho Falls, ID.

INL. 2025c. “Annual Summary Report for the Remote-Handled Low-Level Waste Disposal Facility—FY 2024.” INL/RPT-24-82600, January 2025. Idaho National Laboratory, Idaho Falls, ID.

Knobel, L. L., B. J. Tucker, and J. P. Rousseau. 2008. “Field Methods and Quality-Assurance Plan for Quality-of-Water Activities.” U.S. Geological Survey Open-File Report 2008-1165, DOE/ID-22206, U.S. Geological Survey, Idaho National Laboratory, Idaho Falls, ID.

Mann, L. J., 1996, “Quality-Assurance Plan and Field Methods for Quality-of-Water Activities.” U.S. Geological Survey Open-File Report 96-615, DOE/ID-22132. U.S. Geological Survey, Idaho National Engineering Laboratory, Idaho Falls, ID.

Roback, R. C., T. M. Johnson, T. L. McLing, M. T. Murrell, S. Luo, and T. Ku. 2001. “Uranium Isotopic Evidence for Groundwater Chemical Evolution and Flow Patterns in the Eastern Snake River Plain Aquifer, Idaho,” *Geological Society to America Bulletin*, 113(9): 1133–1141.

Treinen, K. C., A. R. Trcka, and J. C. Fisher. 2024a. “An Update of Hydrologic Conditions and Distribution of Selected Constituents in Water, Eastern Snake River Aquifer and Perched Groundwater Zones, Idaho National Laboratory, Idaho, Emphasis 2019–2021.” U.S. Geological Survey Scientific Investigations Report 2023–5128, DOE/ID-22261. U.S. Geological Survey, Idaho National Engineering Laboratory, Idaho Falls, ID.

Treinen, K. C., A. R. Trcka, N. Krohe, and G. Lehotsky. 2024b. “Iodine-129 in the Eastern Snake River Plain Aquifer At and Near the Idaho National Laboratory, Idaho, 2021–2022.” U.S. Geological Survey Scientific Investigations Report 2024–5124, DOE/ID 22262. U.S. Geological Survey, Idaho National Engineering Laboratory, Idaho Falls, ID.

U.S. Geological Survey. 2025. “USGS Water Data for Idaho: U.S. Geological Survey National Water Information System Database.” U.S. Geological Survey, Idaho National Engineering Laboratory, Idaho Falls, ID.

A beetle enjoying vegetation.