Department of Environmental Quality
INL Oversight Program

ENVIRONMENTAL SURVEILLANCE PROGRAM
QUARTERLY DATA REPORT

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Table of Contents

List of Tables

List of Figures

Table of Acronyms

aCi/L	-	attocuries per liter
ATR	-	Advanced Test Reactor
BEA	-	Battelle Energy Alliance, LLC
BLR	-	Big Lost River
CERCLA	-	Comprehensive Environmental Response, Compensation and Liability Act
CFA	-	Central Facilities Area
CFR	-	Code of Federal Regulations
CITRC	-	Critical Infrastructure Test Range Complex
DEQ-INL OP	-	The State of Idaho, Department of Environmental Quality, Idaho National Laboratory Oversight Program
DOE	-	U.S. Department of Energy
EBR I & II	-	Experimental Breeder Reactors I & II
EFS	-	Experimental Field Station
EIC	-	electret ionization chamber
EML	-	Environmental Monitoring Laboratory
EPA	-	Environmental Protection Agency
ESER	-	Environmental Surveillance, Education and Research Program
ESP	-	Environmental Surveillance Program
ESRP	-	Eastern Snake River Plain
ESRPA	-	Eastern Snake River Plain Aquifer
Ft bls		feet below land surface
HPIC	-	high-pressure ion chamber
IBL	-	Idaho Bureau of Laboratories
ICPP	-	Idaho Chemical Processing Plant
ICP	-	Idaho Cleanup Project
ISB	-	In-situ bioremediation
IDL	-	instrument detection limit
INL	-	Idaho National Laboratory
INTEC	-	Idaho Nuclear Technology and Engineering Center
ISU	-	Idaho State University
LLD	-	lower limit of detection
LSC	-	liquid scintillation counting
MCL	-	maximum contaminant level
MDA	-	minimum detectable activity
MDC	-	minimum detectable concentration
MFC	-	Materials and Fuels Complex
µg/L	-	micrograms per liter
mg/L	-	milligrams per liter
MP	-	milepost
mrem	-	millirem or 1/1000th of a rem
mR	-	milliRoentgen
mR/hr	-	milliRoentgen per hour
µR/hr	-	microRoentgen per hour
MV	-	Magic Valley
NIST	-	National Institute of Standards and Technology
nCi/L	-	nanocuries per liter
NCRP	-	National Council on Radiation Protection and Measurements
NOAA	-	National Oceanic and Atmospheric Administration
NRF	-	Naval Reactors Facility
PBF	-	Power Burst Facility
pCi/g	-	picocuries per gram
pCi/L	-	picocuries per liter
pCi/m^3	-	picocuries per cubic meter
QAPP	-	Quality Assurance Program Plan
QA/QC	-	Quality Assurance/Quality Control
RCRA	-	Resource Conservation and Recovery Act
RPD	-	relative percent difference
RTC	-	Reactor Technology Complex
RWMC	-	Radioactive Waste Management Complex
SD	-	Sample standard deviation
SMC	-	Specific Manufacturing Capability
SMCL	-	secondary maximum contaminant level
TAN	-	Test Area North
TDS	-	total dissolved solids
TMI	-	Three Mile Island
TRA	-	Test Reactor Area
TSP	-	total suspended particulate
TSS	-	total suspended solids
USGS	-	U.S. Geological Survey
VOC	-	volatile organic compound
WLAP	-	Wastewater Land Application Permit

aCi/L	-	attocuries per liter
ATR	-	Advanced Test Reactor
BEA	-	Battelle Energy Alliance, LLC

Introduction

The State of Idaho, Department of Environmental Quality, Idaho National Laboratory Oversight Program (DEQ-INL OP) conducts an Environmental Surveillance Program (ESP) at locations on the INL, near the boundaries of the INL, and at distant locations to the INL in accordance with accepted monitoring procedures and management practices. This program is designed to provide the people of the state of Idaho with independently evaluated information about the impacts of the Department of Energy's (DOE) activities in Idaho.

The primary objective for DEQ-INL OP's ESP is to maintain an independent environmental monitoring and verification program designed to verify and supplement DOE's environmental data and programs. This program also provides the citizens of Idaho with information on current and proposed DOE programs that has been independently evaluated to enable them to reach informed conclusions about DOE activities in Idaho and potential impacts to public health and the environment.

Results of the ESP are published using two distinct reporting formats: quarterly data reports and an annual ESP report. The annual ESP report is designed for a broad audience and summarizes the results of the ESP for the previous four quarters. The annual report's primary emphasis is to focus on trends, ascertain the impacts of DOE operations on the environment, and confirm the validity of DOE monitoring programs. This quarterly report is designed to document the results of the ESP on a quarterly basis and provide detailed data. It is organized according to the media sampled and also provides a quality assurance assessment.

Air and Precipitation Monitoring Results

The ESP operated eight air monitoring stations on and near the INL as well as two monitoring stations distant from the INL during the fourth quarter, 2020 (**Figure 1**). These stations employed instrumentation for collecting airborne particulate matter, gaseous radioiodine, precipitation, and water vapor for tritium analysis (**Table 1**). The Shoshone-Bannock Tribes operated an air monitoring station located at Fort Hall. The Fort Hall station uses identical instrumentation and sampling protocol as the ten stations operated by the ESP. The DEQ-INL OP reports the Fort Hall station data as an additional distant site.

Airborne particulate matter was sampled using high-volume total suspended particulate (TSP) air samplers. A new sampler model (HVP-4304VFC) began to be deployed in the third quarter 2020. Locations using the new model for at least half of the fourth quarter were Craters of the Moon, Howe, Monteview, Idaho Falls, and a second sampler in Idaho Falls being run as a duplicate. Weekly gross alpha and gross beta particulate radioactivity results for filters from the TSP samplers are presented in **Appendix A** and summarized as a range of results in **Table 2**. Missing data in Appendix A at the Monteview location from 12/9/20 to 12/29/20 and at the Van Buren Avenue location from 11/25/20 to 12/2/20 were due to sampler malfunction and time for repair. All results are within the expected historical range.

Composites of filters collected using TSP samplers during the course of a calendar quarter are analyzed using gamma spectroscopy. Typically, gamma spectroscopy results are only reported when exceeding a minimum detectable activity (MDA) or minimum detectable concentration (MDC). Gamma spectroscopy results for the fourth quarter of 2020 for TSP filters are presented in **Table 3**. Beryllium-7, a naturally occurring, cosmogenic radionuclide was seen at all locations. No man-made gamma-emitting radionuclides were detected. The MDC for Cs-137 is also reported since Cs-137 is the most likely of the man-made gamma emitting radionuclides to be detected.

Radioactive iodine samples are collected weekly. Samples are collected by drawing air through a canister filled with activated charcoal using a low-volume air pump. The activated charcoal contained in the canister traps the radioiodine by adsorption onto its porous surface. Each week, canisters are collected from all eleven air monitoring stations and analyzed together as a composite. If Iodine-131 is detected in this grouping, the canisters are individually analyzed. No radioactive isotopes of iodine, specifically Iodine-131, were detected on the weekly charcoal cartridges used to collect this nuclide during the fourth quarter.

Atmospheric moisture was collected by drawing air through hygroscopic media at each of the 11 monitoring stations. This moisture was stripped from the hygroscopic media and analyzed to calculate the atmospheric tritium concentration. Reported values are the result of either a single sample or a weighted mean based upon the volume of air sampled when more than one atmospheric moisture sample was collected during the calendar quarter. There were four individual samples within the weighted means that exceeded MDC. These were located at the Experimental Field Station sampling site: 0.76 pCi/m^3 (MDC 0.38 pCi/m^3), Fort Hall: 0.62 pCi/m^3 (MDC 0.49 pCi/m^3), Big Lost River Rest Area: 0.46 pCi/m^3 (MDC 0.38 pCi/m^3), and Monteview: 0.62 pCi/m (MDC 0.47 pCi/m^3). The weighted mean at the Experimental Field Station also exceeded its MDC: 0.53 pCi/m^3 (MDC 0.38 pCi/m^3) While these results are above MDC they are well below the DEQ-INL OP action level of 150 pCi/m^3 (40 CFR 61). Mean atmospheric tritium concentrations are presented in **Table 4**.

Precipitation samples were collected at six monitoring locations during the fourth quarter of 2020. Precipitation samples were analyzed for tritium and manmade gamma-emitting radionuclides. Reported values were either the result of a single sample or a weighted mean when more than one precipitation sample was collected during the calendar quarter. Tritium and manmade gamma-emitting radionuclides were below minimum detectable concentration in precipitation collected during the fourth quarter of 2020. Analysis results for Tritium (H-3) and Cesium-137, the most likely to be detected of manmade gamma-emitting radionuclides, are presented in **Table 5**.

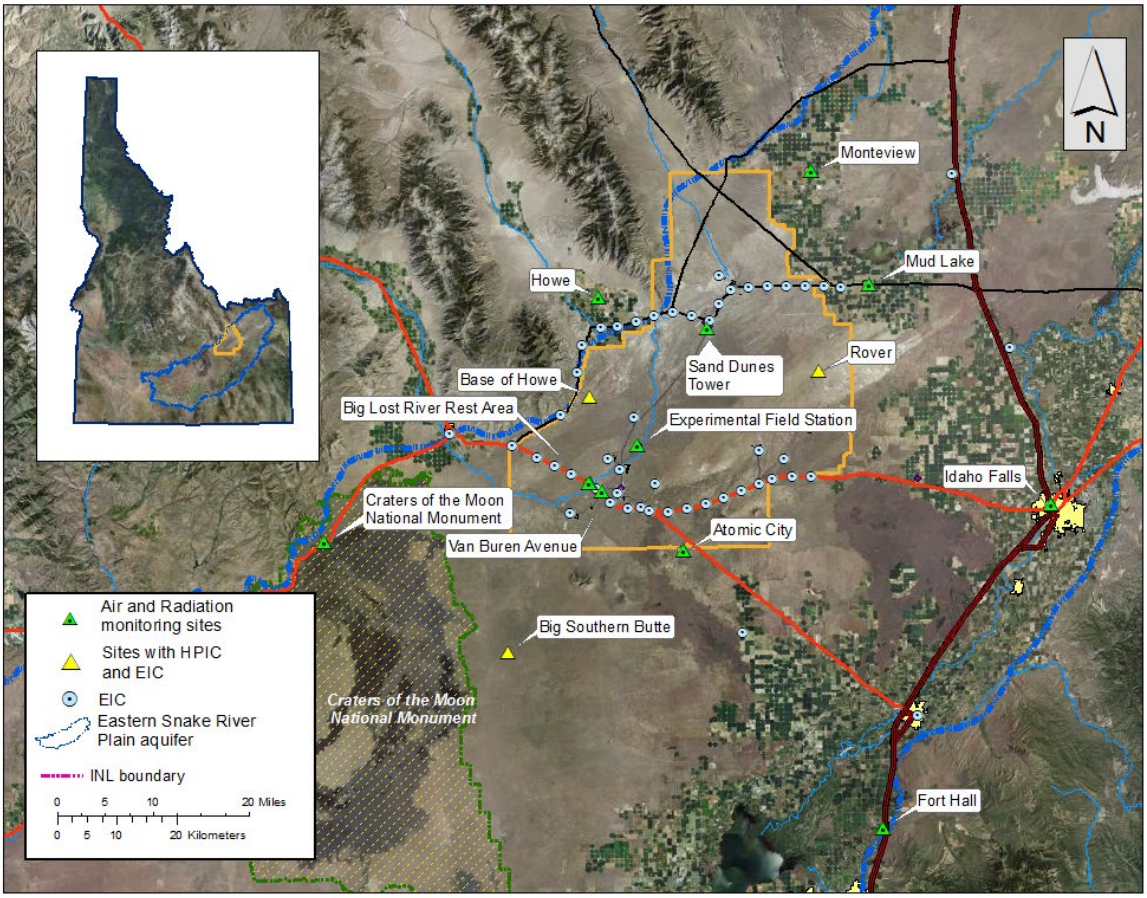

Figure 1. Air and radiation monitoring locations.

Table 1. Sampling locations and sample type

Station Locations	Sample type[1]			
	TSP	Radioiodine	Water Vapor	Precipitation
On-site Locations				
Big Lost River Rest Area	□	□	■	■
Experimental Field Station	□	□	■	
Sand Dunes Tower	□	□	■	
Van Buren Avenue	□	□	■	
Boundary Locations				
Atomic City	□	□	■	■
Howe	□	□	■	■
Monteview	□	□	■	■
Mud Lake	□	□	■	■
Distant Locations				
Craters of the Moon	□	□	■	
Fort Hall[2]	□	□	■	
Idaho Falls	□	□	■	■

[1] □Samples collected weekly; ■ Samples collected quarterly.
[2]TSP and radioiodine samples collected by Shoshone-Bannock Tribes.

Table 2. Range of gross alpha and gross beta concentrations for TSP filters, fourth quarter, 2020.

Station Location	Concentration					
	Gross Alpha			Gross Beta		
On-Site Locations						
Big Lost River Rest Area	0.2	-	2.1	20.3	-	57.9
Experimental Field Station	0.3	-	2.2	12.7	-	42.6
Sand Dunes Tower	0.3	-	2.1	22.0	-	94.9
Van Buren Avenue	0.3	-	1.9	21.0	-	78.7
Boundary Locations						
Atomic City	0.4	-	2.2	16.3	-	65.8
Howe	0.2	-	2.0	15.1	-	47.1
Monteview	0.2	-	1.9	7.0	-	41.7
Mud Lake	0.5	-	2.2	17.6	-	78.8
Distant Locations						
Craters of the Moon	0.2	-	2.3	14.6	-	47.8
Fort Hall[1]	0.5	-	3.0	17.8	-	81.8
Idaho Falls – HVP 4304VFC	0.3	-	2.4	15.2	-	50.1
Idaho Falls – HVP 4304VFC^{DP}	0.4	-	2.6	17.5	-	59.5

[1]Operated by Shoshone-Bannock Tribes.
^{DP}The second HVP-4304VFC sampler is being run as a duplicate.
Note: Concentrations are expressed in 1 x 10^{-3} pCi/m^3.

Table 3. Gamma spectroscopy analysis data for TSP filters, composite samples, fourth quarter, 2020.

Station Location	Naturally Occurring Radionuclide Beryllium-7		Man-Made Gamma Emitting Radionuclides	
	Concentration	± 2 SD	Concentration	MDC
On-site Locations				
Big Lost River Rest Area	87.6	4.7	<MDC[2]	
Experimental Field Station	52.9	3.0	<MDC	
Sand Dunes Tower	114.7	6.1	<MDC	
Van Buren Avenue	68.5	3.7	<MDC	
Boundary Locations				
Atomic City	89.3	4.8	<MDC	
Howe	79.4	4.2	<MDC	
Monteview	52.0	3.0	<MDC	
Mud Lake	91.0	4.8	<MDC	
Distant Locations				
Craters of the Moon	96.5	5.0	<MDC	
Fort Hall[1]	118.4	6.2	<MDC	
Idaho Falls – HVP 4304VFC	70.7	3.9	<MDC	
Idaho Falls – HVP 4304VFC[DP]	89.3	4.7	<MDC	

[1]Operated by Shoshone-Bannock Tribes.
[2]MDC for Cs-137 typically (0.05-0.10) x 10^{-3} pCi/m^3.
[DP]The second HVP-4304 sampler is being run as a duplicate.
Note: Concentrations are reported in 1 x 10^{-3} pCi/m^3 with associated uncertainty (± 2 SD) and minimum detectable concentration (MDC).

Table 4. Mean tritium concentrations in air from atmospheric moisture, fourth quarter, 2020.

Station Location	Tritium		
	Concentration	± 2 SD	MDC
On-site Locations			
Big Lost River Rest Area	0.32	0.23	0.37
Experimental Field Station	0.53	0.25	0.38
Sand Dunes Tower	0.30	0.23	0.36
Van Buren Avenue	0.19	0.19	0.31
Boundary Locations			
Atomic City	0.06	0.23	0.38
Howe	0.22	0.24	0.40
Mud Lake	0.12	0.22	0.37
Monteview	0.41	0.28	0.45
Distant Locations			
Craters of the Moon	0.06	0.21	0.36
Fort Hall[1]	0.39	0.30	0.48
Idaho Falls	0.26	0.27	0.46

[1]Operated by Shoshone-Bannock Tribes.
Note: Concentrations are reported in pCi/m^3 with associated uncertainty (± 2 SD) and minimum detectable concentration (MDC).

Table 5. Tritium and gamma-emitting radionuclide concentrations from precipitation, fourth quarter, 2020.

Station Location	Tritium			Cesium-137		
	Concentration	± 2 SD	MDC	Concentration	± 2 SD	MDC
On-site Locations						
Big Lost River Rest Area	40	120	200	0.2	1.5	2.6
Boundary Locations						
Atomic City	60	120	200	0.9	1.4	2.3
Howe	0	120	200	-0.8	2.1	3.5
Monteview	-20	120	200	1.5	1.4	2.2
Mud Lake	50	120	200	1.2	1.6	2.6
Distant Locations						
Idaho Falls	10	120	200	0.1	1.5	2.6

Note: Concentrations are reported in pCi/L with associated uncertainty (± 2 SD) and minimum detectable concentration (MDC).

Environmental Radiation Monitoring Results

The ESP operated 13 environmental radiation stations during the fourth quarter of 2020 (**Figure 1**). To detect gamma radiation, each station is instrumented with triplicate electret ionization chambers (EIC), and 10 of the stations also are equipped with a high-pressure ion chamber (HPIC) or EcoGamma dual Geiger–Müller gamma radiation monitor. (**Table 6**).

The Shoshone-Bannock Tribes operate an air monitoring station at Fort Hall which is also equipped with EICs and an HPIC, both of which are owned and operated by the DEQ-INL OP. The DEQ-INL OP reports these results as a distant site.

HPICs and EcoGammas are instruments capable of real-time measurements, and are sensitive enough to detect small changes in gamma radiation levels. The real-time gamma radiation measurements collected by the HPICs and EcoGammas at each location are radioed to DEQ-INL OP and presented graphically via the worldwide web at http://www.deq.idaho.gov/inl-oversight/monitoring/gamma-radiation-measurements.aspx.

EICs are a passive-integrating system that provides a cumulative measure of environmental gamma radiation exposure in the field. EICs are deployed, collected, and analyzed quarterly. EICs offer an inexpensive methodology to measure gamma radiation over a wide area, particularly in regions which do not have a power source. EICs can also provide valuable gamma radiation data in the event of an emergency. For this reason, EICs are deployed at 67 locations by DEQ-INL OP in a widespread network around the INL measuring external radiation. This information is tabulated in **Appendix B.**

These two systems are used by DEQ-INL OP to measure external gamma radiation for various radiological monitoring objectives. **Table 7** lists the average radiation exposure rates measured by the HPICs/EcoGammas for fourth quarter 2020. **Table 8** lists the EIC monitoring results for fourth quarter 2020. There were two EIC locations that indicated higher than expected exposure rate values at Rover (35.9, 39.1 µR/hr) and T4 South (37.2, 39.3 µR/hr). These readings are suspected to be false, most likely due to operator error when reading the EICs, but are presented for reference. There was an EcoGamma also stationed at the Rover location which only indicated normal expected exposure rate values (16.9 µR/hr) for the monitoring period. All other locations were within the expected historical range of values observed by DEQ-INL OP for background radiation including stations nearest to Rover and T4 South and stations nearest to INL facilities.

Table 6. Summary of instrumentation at radiation monitoring stations.

Station Location	Instrument Type		
	HPIC	EcoGamma	EIC
On-site Locations			
Base of Howe		■	■
Big Lost River Rest Area	■		■
Experimental Field Station			■
Rover		■	■
Sand Dunes Tower		■	■
Van Buren Avenue			■
Boundary Locations			
Atomic City	■		■
Big Southern Butte		■	■
Howe Met Tower		■	■
Monteview	■		■
Mud Lake/Terreton	■		■
Distant Locations			
Craters of the Moon			■
Fort Hall	■		■
Idaho Falls	■		■

Table 7. Average gamma exposure rates, fourth quarter, 2020, from HPIC/EcoGamma* network.

Station Location	Exposure Rate (µR/hr)	
	Quarterly Average	± 2 SD
On-site Locations		
Base of Howe	19.0	1.0
Big Lost River Rest Area	13.7	2.3
Rover	16.9	1.0
Sand Dunes Tower	16.1	1.0
Boundary Locations		
Atomic City	13.6	1.2
Big Southern Butte	18.4	2.2
Howe Met Tower	15.6	0.9
Monteview	13.3	1.0
Mud Lake / Terreton	13.6	1.3
Distant Locations		
Fort Hall	12.9	1.3
Idaho Falls	10.5	2.1

**The HPIC's and EcoGammas are sensitive electronic devices that can experience intermittent malfunctions and/or interference, this typically results in characteristic positive and/or negative data spikes. These aberrations are removed from the data set based on the judgement of the data analyst.*

Table 8. Electret ionization chamber (EIC) cumulative average exposure rates, fourth quarter, 2020.

Station Location	Exposure Rate (µR/hr)	
	Quarterly Average[1]	± 2 SD
On-Site Locations		
Base of Howe	14.5	2.8
Rest Area	12.2	3.2
Experimental Field Station	12.6	1.9
Rover	35.9, 39.1	-
Sand Dunes	17.6	1.6
Van Buren Avenue	15.0	2.4
Boundary Locations		
Atomic City	12.5, 14.1	-
Big Southern Butte	12.9	0.7
Howe Met. Tower	8.5, 9.5	-
Monteview	12.2, 13.8	-
Mud Lake/ Terreton	10.7	1.6
Distant Locations		
Craters of the Moon	11.9	3.2
Ft. Hall	11.3	2.1
Idaho Falls	11.9, 13.5	-

[1]Results are the average of triplicate exposure rate measurements with the associated sample variability (±2 SD), or the 2 measured exposure rates remaining after removal of an outlying value. One of the triplicate measurements is rejected if it is outside the average of the triplicate measurements ±2 SD of the historical population variability. Typically, the two most consistent measurements are reported, based on judgment of the data analyst.

Water Monitoring Results

DEQ-INL OP collects groundwater samples from wells and springs located within, upgradient of, and downgradient of the INL in order to evaluate the effects of INL contaminants on water quality in the eastern Snake River Plain (ESRP) aquifer and verify the results of DOE and USGS monitoring. Each year, DEQ-INL OP samples approximately 80-85 locations concurrently with a DOE contractor or the USGS and 15-20 locations independently. Co-sampled locations are primarily on or near the INL Site and are usually sampled during the third and fourth calendar quarters. DEQ-INL OP publishes a comparison of its own analytical results with those obtained by co-samplers in the DEQ-INL Oversight Program Annual Report. Locations sampled independently by DEQ-INL OP are mostly in the Magic Valley and are typically sampled during the third calendar quarter.

Most water samples are collected from wells drilled into the aquifer or springs formed by the intersection of the aquifer water table with the surface. Each aquifer well or spring is categorized as upgradient, facility, boundary, or distant based on its location (**Figure 2** and **Figure 3**):

- *Upgradient* sites are situated north or northeast of INL facilities in areas that have not been affected by INL operations. They are used to monitor background concentrations in the aquifer.

- *Facility* sites are located near facility complexes within the INL, including the Advanced Test Reactor complex (ATR), the Central Facilities Area (CFA), the Idaho Nuclear Technology and Engineering Center (INTEC), the Materials and Fuels Complex (MFC), the Naval Reactors Facility (NRF), the Radioactive Waste Management Complex (RWMC), and Test Area North (TAN). Facility sites are located within or immediately downgradient of known areas of

contamination and are sampled to monitor the concentrations and migration of specific contaminants.

- *Boundary* sites are located near the southern boundary of the INL, downgradient of potential sources of INL contamination. These include several wells equipped with Westbay Multilevel Groundwater Monitoring Systems ("Westbay wells"), which offer a look at the vertical distribution of constituents in the aquifer.

- *Distant* sites are located farther downgradient of the INL, primarily in the Magic Valley, and include wells and springs used for agricultural, municipal, domestic, and industrial purposes.

A small number of samples are also collected each year from streams, waste-pond effluent, and wells drilled into perched groundwater (groundwater that sits above the aquifer).

Samples collected from water-monitoring sites are analyzed for radiological and non-radiological constituents, many of which are present in the aquifer both naturally and as a result of INL operations. All locations are sampled for gross alpha and gross beta radioactivity, manmade gamma-emitting nuclides, tritium, chloride, chromium, and nitrate-plus-nitrite.[1] Samples from locations at which tritium concentrations are too low to be detected by the standard method are re-analyzed for tritium using an electrolytic enrichment method (referred to as the low-level method), which has a minimum detectable concentration (MDC) about ten times lower than the standard method. Selected sites are also sampled for specific radionuclides—including uranium isotopes (^{234}U, ^{235}U, and ^{238}U), plutonium isotopes (^{238}Pu, $^{239/240}$Pu), americium-241 (^{241}Am), strontium-90 (^{90}Sr), and technetium-99 (^{99}Tc)—selected trace metals, common ions, total phosphorous, and/or volatile organic compounds (VOCs) based on past and present INL operations or a history of elevated concentrations. If unexpected levels of radioactivity are detected in gross measurements, additional samples will be collected and analyzed for specific radionuclides.

During the fourth quarter of 2020, DEQ-INL OP sampled groundwater from the aquifer at 13 facility locations, 3 boundary locations, 5 distant locations including 3 spring locations, and one upgradient location. DEQ-INL OP also sampled water from 4 perched water locations, 2 surface water locations, and 2 waste water locations. **Table 9** lists the sample date, co-sampler, well depth, and analyses requested for the locations sampled this quarter. Analytical results are reported in **Tables 11 through 20** and summarized below. The results of low-level tritium analyses for 19 samples collected in 2019 and 2020 are reported in **Table 13** and discussed below.

Table 10 shows the range of background concentrations for each constituent in the ESRP aquifer and the EPA drinking water maximum contaminant level (MCL) or secondary maximum contaminant level (SMCL). Background concentrations depend on local geology, and the concentrations of constituents at sites not influenced by INL activities may on occasion be higher than the given background ranges due to local factors and natural variability.

Gross alpha and gross beta radioactivity

Gross alpha and gross beta analyses are used to screen for unexpectedly high levels of radioactivity in samples. DEQ-INL OP has determined from past sampling that background concentration ranges for gross alpha and gross beta radioactivity in the ESRP aquifer are approximately 0-5.6 pCi/L and 0-8.6 pCi/L, respectively. Occasional measurements of concentrations above these background ranges in uncontaminated samples are statistically probable due to uncertainties inherent in measuring low levels of radioactivity. Additionally, some samples will have levels of radioactivity slightly higher than

[1] Distant locations Alpheus Spring, Bill Jones Hatchery, Clear Spring, Minidoka Water Supply, and Shoshone Water Supply and upgradient location Mud Lake Water Supply are sampled only for gross alpha and gross beta radioactivity, gamma-emitting radionuclides, and tritium during the second quarter. Samples for chloride, chromium, nitrate-plus-nitrate, and other constituents are collected at these locations during the fourth quarter.

background ranges due to higher-than-average concentrations of naturally occurring uranium, thorium, or potassium-40.

Gross alpha and beta radioactivity were detected at low levels in most samples (**Table 11**). Gross alpha radioactivity was measured at concentrations within the known background range at all locations, with the exception of PW-9, a perched groundwater well at ATR where a slightly elevated value of 7.9 ± 2.3 pCi/L was measured. Elevated gross beta concentrations were measured at ATR perched water location PW-12 and the ATR Cold Waste Pond. PW-12 is a relatively new well added to the program based on recent ICP contractor reports of spikes in tritium results. The PW-12 elevated gross beta value of 63.3 ± 2.0 pCi/L is consistent with the ^{90}Sr result discussed below. Other elevated gross beta results were measured at TAN wells TAN-10A and TAN-37A, and INTEC wells USGS-112 and USGS-115 and are consistent with known ^{90}Sr or ^{99}Tc contamination in each of these wells. All other detectable concentrations in groundwater were consistent with historical trends.

Manmade gamma-emitting radionuclides

No manmade gamma-emitting radionuclides were detected at the locations sampled this quarter. Results for cesium-137 (^{137}Cs), the manmade gamma-emitter most likely to be detected in groundwater, are reported in **Table 11**.

Tritium

Tritium was analyzed for all locations sampled this quarter (**Table 12**). Elevated tritium concentrations were observed in aquifer wells at or near ATR, INTEC, RWMC, TAN, CFA, and near the southern INL boundary at USGS-104. In the aquifer, elevated tritium concentrations ranged from 340 ± 110 at TAN-10A to 3,470 ± 210 pCi/L at TRA-07. In perched groundwater, elevated tritium concentrations ranged from 370 ± 110 pCi/L at USGS-073 to 1760 ±160 pCi/L at PW-9.

Four samples from second quarter 2019, one from third quarter 2019, seven from second quarter 2020 and seven from third quarter 2020 requiring low-level tritium analysis were analyzed this quarter, and the results are reported in **Table 13**. Nine samples are from boundary wells, one is from a facility well, and the remaining nine are from distant water locations. All concentrations from facility and distant sites are within the background range (0-33 pCi/L). All nine boundary locations have elevated tritium concentrations, ranging from 44 ± 11 pCi/L at USGS-108 to 176 ± 14 pCi/L at USGS-105, indicating an INL influence. A backlog of 22 samples to be analyzed for low-level tritium remains.

All tritium concentrations reported in this quarter are well below the drinking water MCL of 20,000 pCi/L.

Nine facility locations and four ATR perched groundwater locations were sampled for ^{90}Sr this quarter (**Table 14**)**.** All three of the ATR aquifer wells (TRA-07, TRA-08, and USGS-140) had non-detectable ^{90}Sr results. At INTEC, well USGS-112 had a ^{90}Sr value of 5.9 ± 1.5 pCi/L, following a decreasing trend line, and USGS-115 had a non-detectable result. RWMC wells USGS-120 and RWMC Production produced non-detectable results. The TAN-37A aquifer well had a ^{90}Sr value of 275 ± 65 pCi/L, which is less than half the 2019 value of 620 ± 150 pCi/L. The TAN-10A value of 42 ±10 pCi/L follows a decreasing trend at this aquifer well. Perched water wells PW-9, PW-11, and USGS-073 at ATR produced non-detectable results. ATR perched water well PW-12 had a ^{90}Sr value of 22.3 ± 5.3 pCi/L.

Five facility and two boundary aquifer locations were sampled for ^{99}Tc (**Table 15**). ATR well Middle-1823, INTEC well 112, RWMC Production, and boundary well Highway 3 produced non-detectable results. The elevated ^{99}Tc value at INTEC well USGS-115 is consistent with an increasing trend since the mid-2000s. The Central Facilities Area well CFA-2 value of 7.3 ±4.0 pCi/L (MDC = 5.3 pCi/L) was above the historical range of about 2-5 pCi/L. The boundary well USGS-104 value of 8.2 ± 4.2 pCi/L

(MDC = 5.5 pCi/L) was significantly above the historical range of about 0-2 pCi/L. A complete re-analysis of the USGS-104 water sample was performed by the ISU vendor lab, producing a result of 3.7 ± 3.9 pCi/L (MDC = 6.2 pCi/L). This result was a non-detection, although it was within 3 sample standard deviations (3 SD) of the original result. USGS-104 and CFA-2 have both been re-sampled for ^{99}Tc. Results are not yet available and will be reported in the next quarterly report.

Two TAN facility locations, TAN-10A and TAN-37A, were sampled for uranium isotopes this quarter (**Table 16**). Both locations yielded positive results for ^{234}U and ^{238}U, and TAN-10A yielded a positive result for ^{235}U. The high ^{234}U/^{238}U ratio of 6.8 for TAN-37A suggests that the source is anthropogenic. Results are consistent with historical data.

Common ions, trace metals, and nutrients

All locations except upgradient and distant locations were sampled for chloride, chromium, sulfate, alkalinity, and dissolved nutrients (nitrate-plus-nitrite). Four locations (TAN-10A, TAN-37A, TRA Cold Waste Pond, and MFC–Industrial Waste Pipe) were sampled for other common ions and trace metals. Three locations (TAN-37A, TRA Cold Waste Pond, and MFC-Industrial Waste Pipe) were sampled for phosphorus during the quarter (**Tables 17, 18, and 19**).

Most results were consistent with past results with some elevated compared to background concentrations. TAN-10A had elevated concentrations of chloride (77.3 mg/L), barium (200µg/L), iron (1600 µg/L, SMCL is 300 mg/L), and manganese (480 mg/L, SMCL is 50 mg/L). CFA-2 and PW-9 also had elevated chloride concentrations. TAN-37A had an elevated alkalinity (4380 mg/L). The TRA Cold Waste Pond had elevated concentrations of calcium (180 mg/L), sulfate (622 mg/L, SMCL is 250 mg/L), arsenic (6.0 µg/L, MCL is 10 µg/L), and barium (190 µg/L, MCL is 2000 µg/L). Chromium concentrations were elevated at TRA-07 (73 µg/L) and perched groundwater well PW-9 (84 µg/L, MCL is 100 µg/L).The perched groundwater well USGS-073 had an elevated nitrate plus nitrite concentration of 32 mg/L (MCL is 10 mg/L).

Volatile organic compounds (VOCs)

VOCs were measured in aquifer wells RWMC Production and USGS-120 near RWMC, and TAN-10A at TAN (**Table 20**). Carbon tetrachloride, trichloroethene (TCE), and chloroform continue to be detected at RWMC Production at levels consistent with previous observations. Notable MCL exceedances and/or changes from previous measurements include:

- TAN-10A cis-1,2-DCE = 4.36 µg/L, up from 3.28 µg/L in 2019, a new maximum (MCL is 70 µg/L)
- TAN-10A PCE = 11.3 µg/L, essentially the same as the 2019 value of 11.1 (MCL is 5 µg/L)
- TAN-10A TCE = 41.5 µg/L, essentially the same as 41.6 µg/L in 2019 (MCL is 5 µg/L)
- USGS-120 Carbon tetrachloride = 2.35 µg/L, down from 3.52 µg/L in 2019 (MCL is 5 µg/L)
- USGS-120 TCE = 0.79 µg/L, down from 1.26 µg/L in 2019

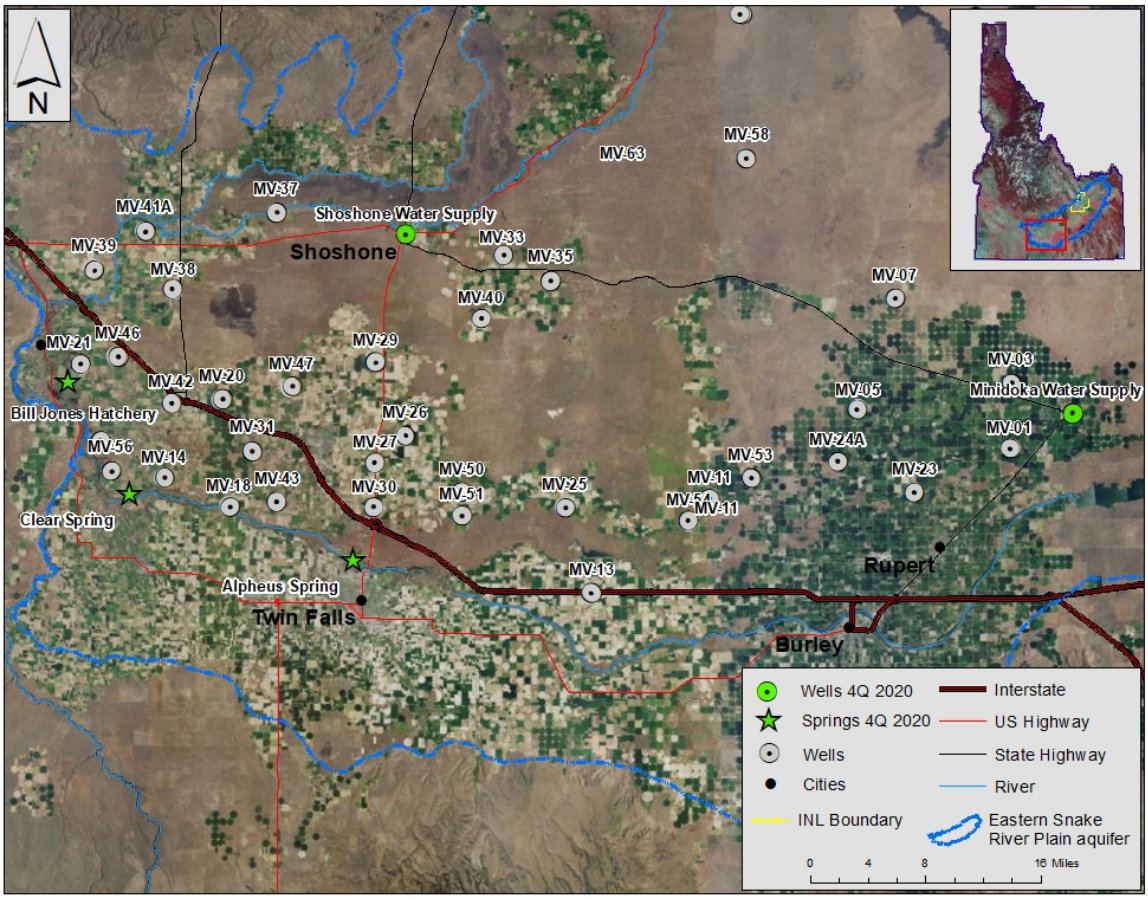

Figure 2. Distant water monitoring locations.

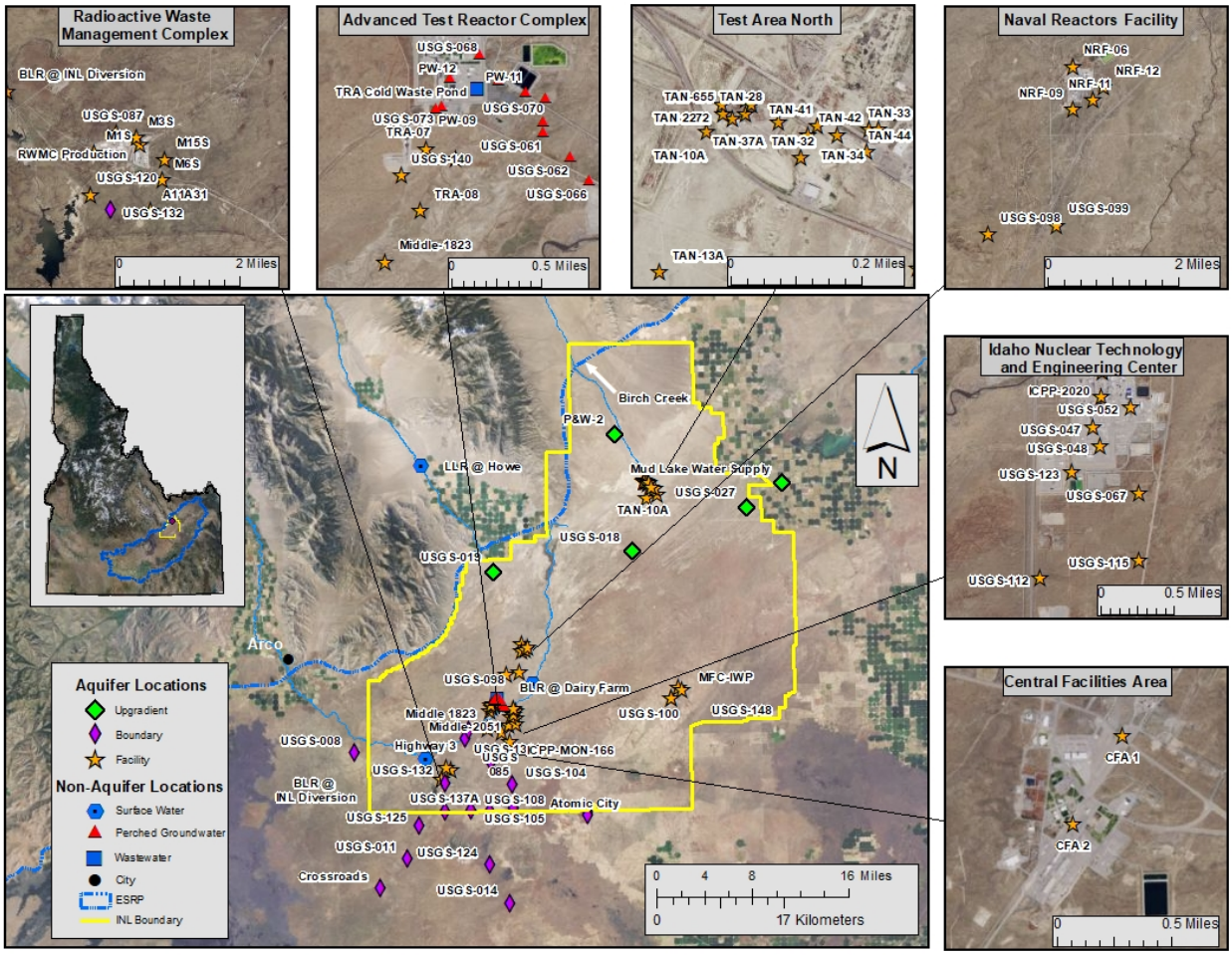

Figure 3. Up-gradient, facility, boundary, perched groundwater (GW), surface water, and wastewater monitoring locations.

Table 9. Locations sampled for water, fourth quarter, 2020.

Sample Location	Date Sampled	Co-sampler	Well Depth (ft bgs)	Analyses*
Aquifer Samples				
Upgradient				
Mud Lake Water Supply	11/10/2020	None	330	α, β, γ, ^{3}H
Facility				
Advanced Test Reactor Complex:				
Middle-1823	10/19/2020	Fluor	729.7	α, β, γ, ^{3}H, ^{99}Tc, Cl, Cr, NO_3+NO_2
TRA-07	10/19/2020	Fluor	501	α, β, γ, ^{3}H, ^{90}Sr, Cl, Cr, NO_3+NO_2
TRA-08	10/19/2020	Fluor	501.5	α, β, γ, ^{3}H, ^{90}Sr, Cl, Cr, NO_3+NO_2
USGS-140	10/13/2020	USGS	546	α, β, γ, ^{3}H, ^{90}Sr, Cl, Cr, NO_3+NO_2
Idaho Nuclear Technology and Engineering Center:				
USGS-112	10/06/2020	USGS	507	α, β, γ, ^{3}H, ^{90}Sr, ^{99}Tc, Cl, Cr, NO_3+NO_2
USGS-115	10/06/2020	USGS	581	α, β, γ, ^{3}H, ^{90}Sr, ^{99}Tc, Cl, Cr, NO_3+NO_2
Radioactive Waste Management Complex:				
RWMC Production	10/14/2020	USGS	685	α, β, γ, ^{3}H, ^{90}Sr, ^{99}Tc, Cl, Cr, NO_3+NO_2, VOCs
USGS-120	10/14/2020	USGS	705	α, β, γ, ^{3}H, ^{90}Sr, Cl, Cr, NO_3+NO_2, VOCs
Test Area North:				
TAN-10A	10/12/2020	Fluor	250	α, β, γ, ^{3}H, ^{90}Sr, U iso, com. ions, metals, NO_3+NO_2, VOCs
TAN-37A	10/12/2020	Fluor	240	α, β, γ, ^{3}H, ^{90}Sr, U iso, com. ions, metals, NO_3+NO_2, P, VOCs
Central Facilities Area:				
CFA 2	10/01/2020	USGS	507	α, β, γ, ^{3}H, ^{99}Tc, Cl, Cr, NO_3+NO_2
Materials and Fuels Complex:				
USGS-148	10/21/2020	USGS	680	α, β, γ, ^{3}H, Cl, Cr, NO_3+NO_2
Naval Reactors Facility:				
USGS-099	09/30/2020**	USGS	426	α, β, γ, ^{3}H, Cl, Cr, NO_3+NO_2
Boundary				
Highway 3	10/13/2020	USGS	750	α, β, γ, ^{3}H, ^{99}Tc, Cl, Cr, NO_3+NO_2
USGS-014	10/14/2020	USGS	751	α, β, γ, ^{3}H, Cl, Cr, NO_3+NO_2
USGS-104	10/14/2020	USGS	700	α, β, γ, ^{3}H, ^{99}Tc, Cl, Cr, NO_3+NO_2
Distant				
Alpheus Spring	11/09/2020	None	0	α, β, γ, ^{3}H
Bill Jones Hatchery	11/09/2020	None	0	α, β, γ, ^{3}H
Clear Spring	11/09/2020	None	0	α, β, γ, ^{3}H
Minidoka Water Supply	11/09/2020	None	282	α, β, γ, ^{3}H
Shoshone Water Supply	11/09/2020	Veolia	n/a	α, β, γ, ^{3}H
Other Samples				
Perched Groundwater				
Advanced Test Reactor Complex:				
PW-9	09/30/2020	USGS	200	α, β, γ, ^{3}H, ^{90}Sr, Cl, Cr, NO_3+NO_2
PW-11	10/20/2020	Fluor	134.5	α, β, γ, ^{3}H, ^{90}Sr, Cl, Cr, NO_3+NO_2
PW-12	10/20/2020	Fluor	128	α, β, γ, ^{3}H, ^{90}Sr, Cl, Cr, NO_3+NO_2
USGS-073	09/30/2020	USGS	127	α, β, γ, ^{3}H, ^{90}Sr, Cl, Cr, NO_3+NO_2
Surface Water				
Birch Creek	10/13/2020	USGS	0	α, β, γ, ^{3}H, Cl, Cr, NO_3+NO_2
Little Lost River (LLR)	10/13/2020	USGS	0	α, β, γ, ^{3}H, Cl, Cr, NO_3+NO_2
Wastewater				
TRA Cold Waste Pond	10/06/2020	BEA	0	α, β, γ, ^{3}H, com. ions, metals, NO_3+NO_2, P
MFC-Industrial Waste Pipeline	10/27/2020	BEA	0	α, β, γ, ^{3}H, com. ions, metals, NO_3+NO_2, P

ft bgs = feet below ground surface.
*α = gross alpha radioactivity; β = gross beta radioactivity; γ = manmade gamma-emitting radionuclides; ^{3}H = tritium; ^{90}Sr = Strontium-90, ^{99}Tc = Technetium-99, U iso. = uranium isotopes ^{234}U, ^{235}U, ^{238}U; Cl = chloride; Cr = chromium; com. ions = Ca^{2+}, Mg^{2+}, Na^{+}, K^{+}, Cl^{-}, SO_4^{2-}, alkalinity; trace metals (metals) = arsenic (As), barium (Ba), chromium (Cr), iron (Fe), manganese (Mn), lead (Pb), selenium (Se); NO_3+NO_2 = nitrate plus nitrite; P = phosphorus.
n/a = well depth not available.
**Typically a fourth quarter sample; sampled early this year per USGS co-sampler schedule.

Table 10. Constituent background concentration ranges and EPA drinking water standards.

Constituent	Background[1]	MCL or SMCL[2]
Radiological Constituents (pCi/L)		
Gross alpha	0-5.6[a]	15
Gross beta	0-8.6[a]	4 mrem/yr
Cesium-137	0	200
Tritium	0-33[a]	20,000
Strontium-90	0	8
Technetium-99	0	900
Uranium-234	0.043-1.9[b]	30 µg/L (total U)
Uranium-235	0-0.048[b]	
Uranium-238	0.021-0.719[b]	
Plutonium-238	0	---
Plutonium-239/240	0	---
Americium-241	0	---
Non-radiological Constituents		
Common Ions (mg/L)		
Alkalinity (as $CaCO_3$)	91-261[a]	---
Calcium	23 – 71[a]	---
Chloride	4.9 – 66.6[a]	250*
Fluoride	0.1 – 1.50[a]	4
Magnesium	10.1 – 27.4[a]	---
Potassium	1.2 – 5.8[a]	---
Sodium	2.6 – 27.0[a]	---
Sulfate	9.6 – 40.4[a]	250*
Trace Metals (µg/L)		
Arsenic	2 – 3[c]	10
Barium	50 – 70[c]	2000
Chromium	<1.0 – 5.2[a]	100
Iron	4 – 16[d]	300*
Lead	<5[c]	15
Manganese	<1 – 4[a]	50*
Selenium	<1[c]	50
Zinc	<3 – 10.5[d]	5000*
Nutrients (mg/L)		
Nitrate plus nitrite	<0.04 – 3.59[b]	10 for NO_3^-, 1 for NO_2^-
Phosphorus	<0.01 – 0.02[d]	---
Volatile Organic Compounds (µg/L)		
Tetrachloroethene (PCE)	0	5
Trichloroethene (TCE)	0	5
1,1-Dichloroethene	0	7
cis-1,2-dichloroethene	0	70
trans-1,2-dichloroethene	0	100
Vinyl chloride	0	2
Carbon tetrachloride	0	5
Chloroform	0	80[e]
Chloromethane	0	---
Methylene Chloride	0	5
Methyl Ethyl Ketone	0	---
1,1-Dichloroethane	0	---

[1] Sources for background ranges are: [a] DEQ data compiled from distant, boundary, and surface water sites from 1993-2018;
[b] Bartholomay and Hall, 2016 (DOE/ID-22237); [c] Knobel and others, 1992; [d] Knobel and others, 1999 (DOE/ID-22164).
[2] Maximum Contaminant Levels (MCLs) are the highest levels of contaminants legally allowed in public drinking water systems in Idaho. Most wells sampled by DEQ-INL OP are not used for drinking water. A * designates a Secondary MCL (SMCL), which is a guideline recommended by the EPA for constituents that may affect the taste, color, or odor of drinking water. [e] MCL is for total trihalomethanes.

Table 11. Gross alpha, gross beta, and man-made gamma-emitting radionuclide concentrations (pCi/L) for water samples, fourth quarter, 2020.

Sample Location	Sample Date	Gross Alpha			Gross Beta			Cesium-137*		
		Concentration		2 SD	Concentration		2 SD	Concentration		2 SD
Aquifer Samples										
Upgradient										
Mud Lake Water Supply	11/10/2020	1.0	U	0.7	4.1		0.8	0.2	U	1.1
Facility										
Advanced Test Reactor Complex										
Middle-1823	10/19/2020	1.4	U	1.0	2.0		0.9	0.3	U	1.3
TRA-07	10/19/2020	2.5		1.3	5.5		1.1	1.4	U	1.6
TRA-08	10/19/2020	3.2		1.2	3.4		1.0	1.0	U	1.3
USGS-140	10/13/2020	0.5	U	0.9	1.4		0.8	0.2	U	1.3
Idaho Nuclear Technology and Engineering Center										
USGS-112	10/06/2020	1.8		1.0	18.5		1.3	-0.5	U	1.6
USGS-115	10/06/2020	1.1	U	0.9	8.8		1.0	1.1	U	1.5
Radioactive Waste Management Complex										
RWMC Production	10/14/2020	1.7		1.0	2.8		0.9	0.3	U	1.2
USGS-120	10/14/2020	2.0		1.0	4.5		0.9	-0.2	U	1.6
Test Area North										
TAN-10A	10/12/2020	5.0		1.3	82.2		2.3	1.2	U	1.4
TAN-37A	10/12/2020	-1.1	U	9.2	207.4		14.2	1.8	U	1.4
Central Facilities Area										
CFA 2	10/01/2020	4.2		1.6	5.8		1.5	-0.2	U	1.5
Materials and Fuels Complex										
USGS-148	10/21/2020	1.6		1.0	3.5		0.9	1.9	U	1.6
Naval Reactors Facility										
USGS-099	09/30/2020	0.6	U	1.1	2.5		1.0	1.1	U	1.2
Boundary										
Highway 3	10/13/2020	1.4		0.9	2.6		0.8	0.3	U	1.5
USGS-014	10/14/2020	2.6		0.9	2.7		0.8	1.5	U	1.4
USGS-104	10/14/2020	1.6		0.9	3.0		0.8	0.8	U	1.1
Distant										
Alpheus Spring	11/09/2020	1.5	U	1.1	7.4		1.1	0.1	U	1.4
Bill Jones Hatchery	11/09/2020	0.9	U	0.8	4.0		0.9	1.6	U	1.5
Clear Spring	11/09/2020	1.6		1.0	4.3		1.0	-0.3	U	1.2
Minidoka Water Supply	11/09/2020	1.5	U	1.0	4.0		1.0	0.1	U	1.3
Shoshone Water Supply	11/09/2020	1.1	U	0.9	2.7		0.9	0.4	U	1.4
Other Samples										
Perched Groundwater										
Advanced Test Reactor Complex										
PW-9	09/30/2020	7.9		2.3	8.6		1.7	0.4	U	1.6
PW-11	10/20/2020	2.0		1.3	7.7		1.1	1.3	U	1.7
PW-12	10/20/2020	1.7		1.0	63.3		2.0	0.0	U	1.8
USGS-073	09/30/2020	4.8		2.6	7.6		2.3	0.9	U	1.3
Surface Water										
Birch Creek	10/13/2020	2.3		1.0	2.2		0.8	0.5	U	1.5
Little Lost River (LLR)	10/13/2020	0.4	U	0.8	1.4		0.8	1.1	U	1.3
Wastewater										
TRA Cold Waste Pond	10/06/2020	3.7	U	2.9	9.9		2.2	-0.3	U	1.5
MFC-Industrial Waste Pipeline	10/27/2020	1.8	U	1.3	8.6		1.2	2.4	U	1.6

Data qualifiers: U = undetected, J = estimate, R = rejected, "+" or "-" after a J means that the estimated result is biased high or low, respectively.
*ISU-EML analyzes water samples for all common manmade gamma-emitting radionuclides. If none are detected, only the results for ^{137}Cs, the manmade gamma-emitter most likely to be detected in groundwater, are reported in this table.

Table 12. Tritium concentrations (pCi/L) for water samples, fourth quarter, 2020.

Sample Location	Sample Date	Tritium		
		Concentration		2 SD
Aquifer Samples				
Upgradient				
Mud Lake Water Supply	11/10/2020	20	U	100
Facility				
Advanced Test Reactor Complex				
Middle-1823	10/19/2020	420		110
TRA-07	10/19/2020	3470		210
TRA-08	10/19/2020	730		130
USGS-140	10/13/2020	940		130
Idaho Nuclear Technology and Engineering Center				
USGS-112	10/06/2020	390		110
USGS-115	10/06/2020	620		120
Radioactive Waste Management Complex				
RWMC Production	10/14/2020	450		110
USGS-120	10/14/2020	80	U	100
Test Area North				
TAN-10A	10/12/2020	340		110
TAN-37A	10/12/2020	400		110
Central Facilities Area				
CFA 2	10/01/2020	2430		180
Materials and Fuels Complex				
USGS-148	10/21/2020	30	U	90
Naval Reactors Facility				
USGS-099	09/30/2020	-30	U	90
Boundary				
Highway 3	10/13/2020	50	U	100
USGS-014	10/14/2020	20	U	90
USGS-104	10/14/2020	570		120
Distant				
Alpheus Spring	11/09/2020	30	U	90
Bill Jones Hatchery	11/09/2020	0	U	90
Clear Spring	11/09/2020	-60	U	90
Minidoka Water Supply	11/09/2020	-60	U	90
Shoshone Water Supply	11/09/2020	-20	U	90
Other Samples				
Perched Groundwater				
Advanced Test Reactor Complex				
PW-9	09/30/2020	1760		160
PW-11	10/20/2020	880		130
PW-12	10/20/2020	630		120
USGS-073	09/30/2020	370		110
Surface Water				
Birch Creek	10/13/2020	-10	U	90
Little Lost River (LLR)	10/13/2020	-10	U	90
Wastewater				
TRA Cold Waste Pond	10/06/2020	-20	U	90
MFC-Industrial Waste Pipeline	10/27/2020	0	U	90

Data qualifiers: U = undetected, J = estimate, R = rejected, "+" or "-" after a J means that the estimated result is biased high or low, respectively.

Table 13. Low-level tritium concentrations (pCi/L) in water samples collected during 2019 and 2020 analyzed using the electrolytic enrichment method, fourth quarter of 2020.

Sample Location	Sample Date	Tritium		
		Concentration		2 SD
Aquifer Samples				
Facility				
Test Area North				
TAN-56	06/08/2020	-3	U	7
Boundary				
USGS-103	06/16/2020	127		12
USGS-105	06/26/2019	155		14
USGS-105	06/23/2020	176		14
USGS-108	06/24/2019	44		11
USGS-132	06/19/2019	151		13
USGS-132	06/15/2020	106		9
USGS-137A	06/11/2020	68		9
Middle-2051	06/27/2019	134		14
Middle-2051	06/10/2020	113	J	11
Distant				
MV-21	07/14/2020	10	U	6
MV-37	07/13/2020	13		8
MV-50	07/13/2020	12		7
MV-53	07/16/2019	17		8
MV-59	06/09/2020	3	U	7
Alpheus Spring	07/13/2020	13		7
Bill Jones Hatchery	07/14/2020	5	U	7
Clear Spring	07/14/2020	-1	U	6
Minidoka Water Supply	07/14/2020	8	U	8

Data qualifiers: U = undetected, J = estimate, R = rejected, "+" or "-" after a J means that the estimated result is biased high or low, respectively. ft bgs = feet below ground surface

Table 14. Strontium-90 concentrations (pCi/L) for water samples, fourth quarter, 2020.

Sample Location	Sample Date	Strontium-90		
		Concentration		2 SD
Aquifer Samples				
Facility				
Advanced Test Reactor Complex				
TRA-07	10/20/2020	-0.05	U	0.29
TRA-08	10/20/2020	-0.05	U	0.29
USGS-140	10/13/2020	0.27	U	0.30
Idaho Nuclear Technology and Engineering Center				
USGS-112	10/06/2020	5.9		1.5
USGS-115	10/06/2020	0.06	U	0.31
Radioactive Waste Management Complex				
RWMC Production	10/14/2020	-0.03	U	0.26
USGS-120	10/14/2020	0.20	U	0.28
Test Area North				
TAN-10A	10/12/2020	42		10
TAN-37A	10/12/2020	275		65
Other Samples				
Perched Groundwater				
Advanced Test Reactor Complex				
PW-9	09/30/2020	0.13	U	0.32
PW-11	10/20/2020	0.60	U	0.36
PW-12	10/20/2020	22.3		5.3
USGS-073	09/30/2020	0.59	U	0.38

Data qualifiers: U = undetected, J = estimate, R = rejected, "+" or "-" after a J means that the estimated result is biased high or low, respectively.

Table 15. Technetium-99 concentrations (pCi/L) for water samples, fourth quarter, 2020.

Sample Location	Sample Date	Technetium-99		
		Concentration		2 SD
Aquifer Samples				
Facility				
Advanced Test Reactor Complex				
Middle-1823	10/20/2020	4.9	U	3.4
Idaho Nuclear Technology and Engineering Center				
USGS-112	10/06/2020	2.2	U	3.1
USGS-115	10/06/2020	12.4		4.7
Radioactive Waste Management Complex				
RWMC Production	10/14/2020	-2.2	U	2.6
Central Facilities Area				
CFA-2	10/01/2020	7.3		4.0
Boundary				
Highway 3	10/13/2020	1.1	U	3.4
USGS-104	10/14/2020	8.2		4.2
USGS 104 re-analysis	10/14/2020	3.7	U	3.9

Data qualifiers: U = undetected, J = estimate, R = rejected, "+" or "-" after a J means that the estimated result is biased high or low, respectively.

Table 16. Uranium isotope concentrations (pCi/L) for water samples, fourth quarter, 2020.

Sample Location	Sample Date	Uranium-234			Uranium-235			Uranium-238		
		Concentration		2 SD	Concentration		2 SD	Concentration		2 SD
Aquifer Samples										
Facility										
Test Area North										
TAN-10A	10/12/2020	2.71		0.55	0.130		0.084	0.68		0.20
TAN-37A	10/12/2020	2.24		0.54	0.098	U	0.095	0.33		0.16

Table 17. Common ion concentrations (mg/L) in water samples, fourth quarter, 2020.

Sample Location	Sample Date	Calcium*		Magnesium*		Sodium*		Potassium*		Fluoride		Chloride		Sulfate		Alkalinity†	
Aquifer Samples																	
Facility																	
Advanced Test Reactor Complex																	
Middle-1823	10/19/2020	-	-	-	-	-	-	-	-	-	-	10.7		30.7		169	
TRA-07	10/19/2020	-	-	-	-	-	-	-	-	-	-	21.0		137		137	
TRA-08	10/19/2020	-	-	-	-	-	-	-	-	-	-	11.1		43.6		152	
USGS-140	10/13/2020	-	-	-	-	-	-	-	-	-	-	13.1		32.8		162	
Idaho Nuclear Technology and Engineering Center																	
USGS-112	10/06/2020	-	-	-	-	-	-	-	-	-	-	15.4		26.4		144	
USGS-115	10/06/2020	-	-	-	-	-	-	-	-	-	-	47.6		25.6		104	
Radioactive Waste Management Complex																	
RWMC Production	10/14/2020	-	-	-	-	-	-	-	-	-	-	23.4		28.4		138	
USGS-120	10/14/2020	-	-	-	-	-	-	-	-	-	-	18.0		35.1		145	
Test Area North																	
TAN-10A	10/12/2020	69		19		35		3.4		-	-	77.3		31.3		196	
TAN-37A	10/12/2020	Note 1		Note 1		Note 1		Note 1		-	-	Note 2		Note 2		4380	
Central Facilities Area																	
CFA-2	10/01/2020	-	-	-	-	-	-	-	-	-	-	116		43.5		129	
Materials and Fuels Complex																	
USGS-148	10/21/2020	-	-	-	-	-	-	-	-	-	-	15.2		16.8		133	
Naval Reactors Facility																	
USGS-099	09/30/2020	-	-	-	-	-	-	-	-	-	-	19.1		25.8		190	
Boundary																	
Highway 3	10/13/2020	-	-	-	-	-	-	-	-	-	-	5.90		20.3		142	
USGS-014	10/14/2020	-	-	-	-	-	-	-	-	-	-	20.4		21.1		136	
USGS-104	10/14/2020	-	-	-	-	-	-	-	-	-	-	14.5		20.7		121	
Other Samples																	
Perched Groundwater																	
Advanced Test Reactor Complex																	
PW-9	09/30/2020	-	-	-	-	-	-	-	-	-	-	81.8		49.7		120	
PW-11	10/20/2020	-	-	-	-	-	-	-	-	-	-	16.9		145		154	
PW-12	10/20/2020	-	-	-	-	-	-	-	-	-	-	33.2		22.1		171	
USGS-073	09/30/2020	-	-	-	-	-	-	-	-	-	-	226		40.7		152	
Surface Water																	
Birch Creek	10/13/2020	-	-	-	-	-	-	-	-	-	-	4.60		24.4		142	
Little Lost River (LLR)	10/13/2020	-	-	-	-	-	-	-	-	-	-	7.03		16.6		152	
Wastewater																	
TRA Cold Waste Pond	10/06/2020	180		68		41		6.6		-		43.9		622		82.8	
MFC-Industrial Waste Pipeline	10/27/2020	63		20		31		5.3		-		32.4		30.3		217	

Data qualifiers: U = undetected, J = estimate, R = rejected, "<" = less than detection limit, "+" or "-" after a J means that the estimated result is biased high or low, respectively.
* Sample was not filtered in the field.
† As $CaCO_3$.
"-" = not analyzed.
1. Sample results unavailable from IBL.
2. Sample not suitable for anion testing per IBL.

Table 18. Dissolved metals concentrations (µg/L) in water samples, fourth quarter, 2020.

Sample Location	Sample Date	Arsenic		Barium		Chromium		Iron		Lead		Manganese		Selenium		Zinc	
Aquifer Samples																	
Facility																	
Advanced Test Reactor Complex																	
Middle-1823	10/19/2020	-	-	-	-	9.4		-	-	-	-	-	-	-	-	-	-
TRA-07	10/19/2020	-	-	-	-	73		-	-	-	-	-	-	-	-	-	-
TRA-08	10/19/2020	-	-	-	-	18		-	-	-	-	-	-	-	-	-	-
USGS-140	10/13/2020	-	-	-	-	15		-	-	-	-	-	-	-	-	-	-
Idaho Nuclear Technology and Engineering Center																	
USGS-112	10/06/2020	-	-	-	-	9.0		-	-	-	-	-	-	-	-	-	-
USGS-115	10/06/2020	-	-	-	-	5.4		-	-	-	-	-	-	-	-	-	-
Radioactive Waste Management Complex																	
RWMC Production	10/14/2020	-	-	-	-	11		-	-	-	-	-	-	-	-	-	-
USGS-120	10/14/2020	-	-	-	-	7.5		-	-	-	-	-	-	-	-	-	-
Test Area North																	
TAN-10A	10/12/2020	0.86	J	200		1.5		1600		<1.0	U	480		-	-	-	-
TAN-37A	10/12/2020	Note 1		Note 1		Note 1		Note 1		Note 1		Note 1		-	-	-	-
Central Facilities Area																	
CFA-2	10/01/2020	-	-	-	-	11		-	-	-	-	-	-	-	-	-	-
Materials and Fuels Complex																	
USGS-148	10/21/2020	-	-	-	-	1.5		-	-	-	-	-	-	-	-	-	-
Naval Reactors Facility																	
USGS-099	09/30/2020	-	-	-	-	5.6		-	-	-	-	-	-	-	-	-	-
Boundary																	
Highway 3	10/13/2020	-	-	-	-	2.2		-	-	-	-	-	-	-	-	-	-
USGS-014	10/14/2020	-	-	-	-	3.1		-	-	-	-	-	-	-	-	-	-
USGS-104	10/14/2020	-	-	-	-	7.7		-	-	-	-	-	-	-	-	-	-
Other Samples																	
Perched Groundwater																	
Advanced Test Reactor Complex																	
PW-9	09/30/2020	-	-	-	-	84		-	-	-	-	-	-	-	-	-	-
PW-11	10/20/2020	-	-	-	-	13		-	-	-	-	-	-	-	-	-	-
PW-12	10/20/2020	-	-	-	-	5.1		-	-	-	-	-	-	-	-	-	-
USGS-073	09/30/2020	-	-	-	-	12		-	-	-	-	-	-	-	-	-	-
Surface Water																	
Birch Creek	10/13/2020	-	-	-	-	1.0		-	-	-	-	-	-	-	-	-	-
Little Lost River (LLR)	10/13/2020	-	-	-	-	<1.0	U	-	-	-	-	-	-	-	-	-	-
TRA Cold Waste Pond	10/06/2020	6.0		190		15		40		<1.0	U	2.2		4.9		-	-
MFC-Industrial Waste Pipeline	10/27/2020	3.5		63		3.0		15		1.2		1.2		<1.0	U	-	-

Samples were filtered in the field unless otherwise noted.
Data qualifiers: U = undetected, J = estimate, R = rejected, "<" = less than detection limit, "+" or "-" after a J means that the estimated result is biased high or low, respectively.
"-" = not analyzed.
1. Sample results unavailable from IBL.

Table 19. Dissolved nutrient concentrations (mg/L) in water samples, fourth quarter, 2020.

Sample Location	Sample Date	Nitrate + Nitrite*		Total Phosphorus	
Aquifer Samples					
Facility					
Advanced Test Reactor Complex					
Middle-1823	10/19/2020	0.98		-	-
TRA-07	10/19/2020	1.0		-	-
TRA-08	10/19/2020	1.0		-	-
USGS-140	10/13/2020	1.0		-	-
Idaho Nuclear Technology and Engineering Center					
USGS-112	10/06/2020	1.0		-	-
USGS-115	10/06/2020	1.6		-	-
Radioactive Waste Management Complex					
RWMC Production	10/14/2020	1.0		-	-
USGS-120	10/14/2020	0.72		-	-
Test Area North					
TAN-10A	10/12/2020	0.39		-	-
TAN-37A	10/12/2020	Note 1		5.8	
Central Facilities Area					
CFA-2	10/01/2020	3.5		-	-
Materials and Fuels Complex					
USGS-148	10/21/2020	2.4		-	-
Naval Reactors Facility					
USGS-099	09/30/2020	1.6		-	-
Boundary					
Highway 3	10/13/2020	0.50		-	-
USGS-014	10/14/2020	1.3		-	-
USGS-104	10/14/2020	0.88		-	-
Other Samples					
Perched Groundwater					
Advanced Test Reactor Complex					
PW-9	09/30/2020	4.4		-	-
PW-11	10/20/2020	1.5		-	-
PW-12	10/20/2020	1.3		-	-
USGS-073	09/30/2020	32		-	-
Surface Water					
Birch Creek	10/13/2020	0.24		-	-
Little Lost River (LLR)	10/13/2020	0.22		-	-
Wastewater					
TRA Cold Waste Pond	10/06/2020	3.7		2.7	
MFC-Industrial Waste Pipeline	10/27/2020	4.0		0.11	

Samples were filtered in the field unless otherwise noted.
Data qualifiers: U = undetected, J = estimate, R = rejected, "<" = less than detection limit, "+" or "-" after a J means that the estimated result is biased high or low, respectively.
* As N.
"-" = not analyzed.
1. Sample not suitable for Nitrate analysis per IBL.

Table 20. Volatile organic compound concentrations (µg/L) in water samples, fourth quarter, 2020. Only VOCs detected this quarter or in the recent past are shown.

Sample Location	Sample Date	PCE	TCE	1,1-DCE	cis-1,2-DCE	trans-1,2-DCE	Vinyl chloride	Carbon tetrachloride	Chloroform	Chloro-methane	1,1-DCA
Aquifer Samples											
Facility											
Radioactive Waste Management Complex:											
RWMC Production	10/14/2020	<0.50 U	2.30	<0.50 U	<0.50 U	<0.50 U	<0.50 U	3.92	1.41	<0.50 U	<0.50 U
USGS-120	10/14/2020	<0.50 U	0.79	<0.50 U	<0.50 U	<0.50 U	<0.50 U	2.35	<0.50	<0.50 U	<0.50 U
Test Area North:											
TAN-10A	10/12/2020	11.3	41.5	<0.50 U	4.36	<0.50 U	<0.50 U	<0.50 U	<0.50 U	<0.50 U	<0.50 U
TAN-37A	10/12/2020	Note 1									
Other Samples											
None											

Abbreviations: PCE = tetrachloroethene; TCE = trichloroethene; 1,1-DCE = 1,1-dichloroethene; cis-1,2-DCE = cis-1,2-dichloroethene; trans-1,2-DCE = trans-1,2-dichloroethene; 1,1-DCA = 1,1-dichloroethane.

Data qualifiers: U = undetected, J = estimate, R = rejected, "<" = less than detection limit, "+" or "-" after a J means that the estimated result is biased high or low, respectively.
Note 1. Lab indicated that a 1:25 dilution of this sample was required. This dilution raised the minimum reporting limit by a factor of 25, from 0.5 µg/L to 12.5 µg/L for most VOCs. No VOCs were detected above this limit.

Terrestrial Monitoring Results

The DEQ-INL OP conducts terrestrial (soil and milk) monitoring to characterize deposition and migration of contaminants, and provide independent verification of DOE's terrestrial monitoring programs. Physical soil sampling and *in-situ* gamma spectrometry are used to characterize actual deposition and accumulation of radioactive contaminants in soils. Milk samples are collected to evaluate the potential for ingestion of radioactivity by the population around the INL. No physical soil samples were collected during the fourth calendar quarter of 2020.

Milk

DEQ-INL OP monitors milk for the naturally occurring radionuclide potassium-40 (^{40}K) and man-made iodine-131 (^{131}I). Milk samples are collected on a monthly basis. Results for analyses of milk samples are presented in **Table 21**. ^{40}K was detected in all samples within the expected range of concentration. ^{131}I was not detected. Based on measurements of radionuclides in milk, there were no discernable impacts to the off-site environment from INL operations.

Table 21. Gamma spectroscopy analysis data for milk samples, fourth quarter, 2020.

Sample Location/Dairy	Sample Date	Naturally occurring Potassium-40		Man-made Iodine-131		
		Concentration[2]	± 2 SD	Concentration[2]	± 2 SD	MDC
Monitoring Samples						
Gooding	10/19/20	1435	85	-0.3	1.7	2.9
	11/10/20	1358	112	-0.3	1.6	2.8
Riverside	10/4/20	1574	129	-1.2	2.0	3.4
	11/1/20	1927	145	-0.6	1.0	1.8
	12/6/20	1854	102	1.0	1.5	2.5
Verification Samples[1]						
Terreton	10/6/20	1427	116	0.5	5.9	10.1
Dietrich	10/6/20	1762	135	0.6	2.4	4.1
Minidoka	11/2/20	1509	88	-0.5	2.2	3.7
Idaho Falls	11/3/20	1440	87	0.8	1.7	2.9
Howe	12/1/20	1379	120	-0.1	3.1	5.3
Dietrich	12/1/20	1569	91	-1.0	3.0	5.1

[1] DEQ-INL OP samples collected by the off-site INL environmental surveillance contractor.
[2] Concentrations with associated uncertainties (± 2 SD) and minimum detectable concentrations (MDC) are expressed in pCi/L.

Soil

DEQ-INL OP monitors long-term radiological conditions via physical soil sampling as well as field instrumentation capable of identifying and measuring *in-situ* concentrations of gamma-emitting radionuclides in soil. Monitoring concentrations of gamma-emitting radionuclides in surface soil provides some insight to transport, deposition, and accumulation of radioactive material in the environment as a result of INL operations as well as historical above ground testing of nuclear weapons.

In-Situ gamma spectroscopic measurements were performed at 41 locations (see **Figure 4**) during the fourth calendar quarter of 2020. ^{137}Cs was the only man made gamma emitting radionuclide detected. Analysis results for ^{137}Cs concentrations for *in-situ* soil monitoring are shown in **Table 22**.

Table 22. *In-Situ* gamma spectroscopic analysis results (^{137}Cs) for soil, fourth quarter, 2020.

Location	Date Acquired	Concentration[1]	2-sigma	MDA
Boundary Sampling Locations				
Big Southern Butte	11/19/2020	0.122	0.027	0.009
ESER Soil Site Monteview	11/20/2020	0.121	0.020	0.007
Monteview air station	11/20/2020	0.059	0.027	0.009
ESER Soil Site Mud Lake #2	11/20/2020	0.124	0.039	0.013
Mud Lake Air station	11/20/2020	0.023	0.018	0.008
Howe Met Tower	11/23/2020	0.070	0.025	0.009
ESER Soil Site FAA tower	11/24/2020	0.197	0.034	0.009
Large Grid 18-4	11/25/2020	0.148	0.025	0.008
Frenchman's Cabin Soil Site	11/25/2020	0.137	0.023	0.008
Large Grid 12-4	11/25/2020	0.146	0.025	0.008
Large Grid 12-5	11/25/2020	0.194	0.037	0.011
ESER Soil Site Butte City	12/1/2020	0.192	0.037	0.012
ESER Soil Site Atomic City	12/1/2020	0.183	0.025	0.009
Atomic City Air station	12/1/2020	0.094	0.021	0.008
ESER Soil Site Reno Ranch	12/4/2020	0.244	0.024	0.008
Distant Sampling Locations				
IF air station[2]	11/17/2020	0.051	0.017	0.008
IF CMS[3]	11/17/2020	0.036	0.015	0.006
St Anthony	11/17/2020	0.147	0.031	0.010
Sage Junction	11/17/2020	0.185	0.023	0.007
Roberts Met Tower	11/23/2020	0.137	0.031	0.010
ESER Soil Site Carey	12/1/2020	0.192	0.025	0.010
ESER soil site Blackfoot	12/10/2020	0.148	0.045	0.012
Crystal Ice Caves	12/10/2020	0.193	0.027	0.008
On site Sampling Locations				
Van Buren Air station	11/23/2020	0.235	0.033	0.011
Rest Area A	11/23/2020	0.119	0.028	0.010
Base of Howe	11/23/2020	0.112	0.029	0.010
ESER Soil Site Howe	11/23/2020	0.199	0.023	0.008
Large Grid 18-8	11/24/2020	0.231	0.039	0.011
Large Grid 24-2	11/24/2020	0.278	0.052	0.014
Large Grid 24-7 A	11/24/2020	0.163	0.043	0.012
Large Grid 18-3	11/24/2020	0.164	0.036	0.012
Rover	11/24/2020	0.088	0.041	0.011
Large Grid 24-9	12/4/2020	0.221	0.039	0.012
Large Grid 24-8	12/4/2020	0.212	0.024	0.008
Large Grid 18-1	12/4/2020	0.183	0.046	0.014
Large Grid 18-7	12/4/2020	0.120	0.023	0.010
Large Grid 30-1	12/4/2020	0.185	0.025	0.008
Sand Dunes Air station	12/4/2020	0.101	0.057	0.015
Large Grid 6-3	12/10/2020	0.196	0.056	0.014
EFS field air station	12/10/2020	0.327	0.043	0.014
INL Main Gate	12/10/2020	0.185	0.053	0.015

[1]Concentrations are reported in pCi/g.
[2]DEQ-INL OP HPIC air monitoring station near Idaho Falls, ID.
[3]DEQ-INL OP HPIC Community Monitoring Station (CMS) near John's Hole Bridge Idaho Falls, ID.

The average Cesium-137 value was 0.16 picocuries per gram (pCi/g) with a minimum value of 0.02 pCi/g and a maximum of 0.33 pCi/g, well below the DEQ-INL OP action level of 6.4 pCi/g and the recommended federal screening limit for surface soil of 6.8 pCi/g (NCRP Report 129).

Based upon terrestrial radiological measurements of soil and milk, there were no discernable impacts to the off-site environment from INL operations. Long-term accumulation of radionuclides observed by soil monitoring was consistent with historical measurements and was in the range of concentrations expected as a result of historic above-ground testing of nuclear weapons

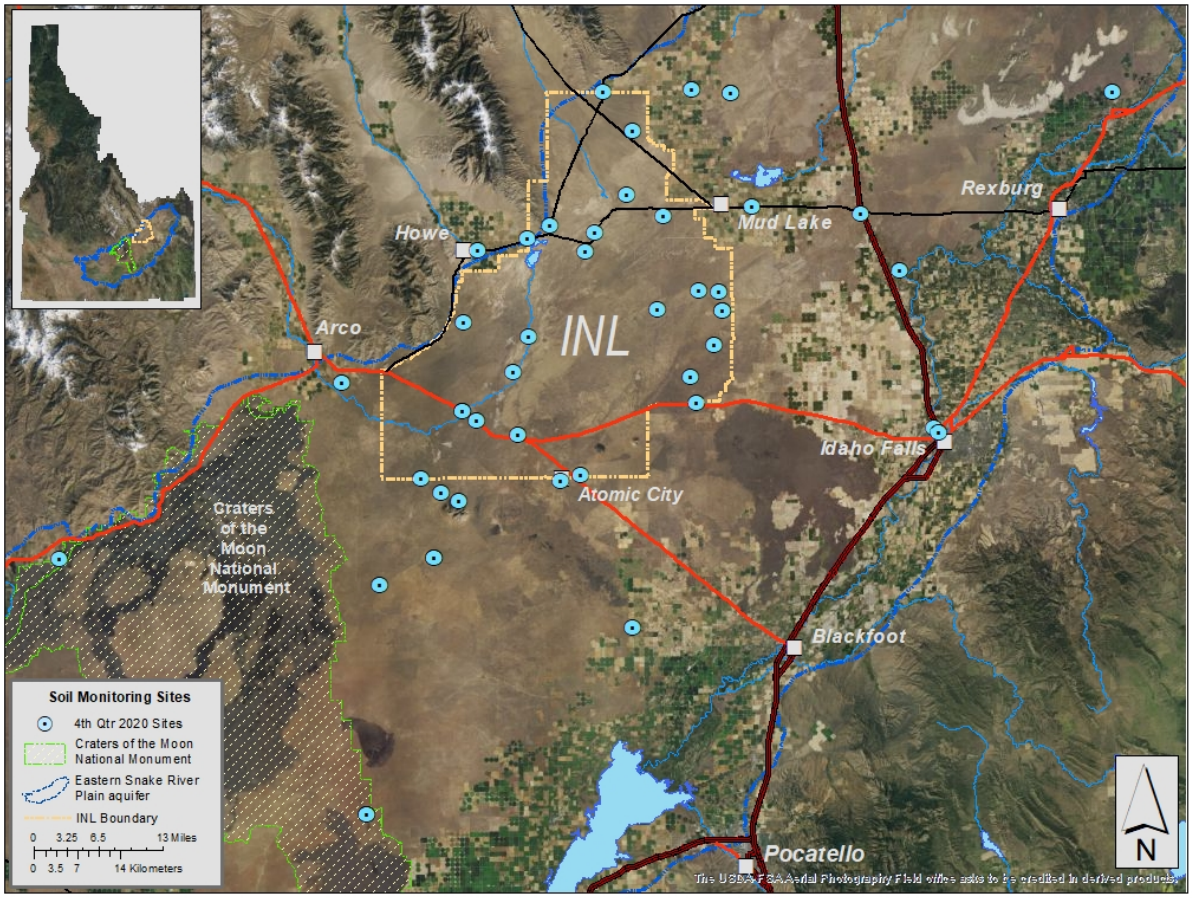

Figure 4. *In-situ* soil monitoring sites, fourth quarter 2020.

Quality Assurance

Measurements of constituent concentrations in environmental media are subject to inaccuracy from errors that may be introduced during the collection, transportation, and analysis of samples, calibration of equipment, and recording and reporting of results. While it is impossible to quantify every error that may affect a result, a quality assurance (QA) program can evaluate the overall quality of a dataset and, in many cases, identify and address errors or inaccuracies. DEQ-INL OP's QA program is designed to (1) ensure sample integrity, (2) evaluate the precision and accuracy of analytical results, and (3) ensure that the environmental data are representative and complete.

This section summarizes the quality assurance assessment of the data collected by DEQ-INL OP in the fourth quarter of 2020. Included are the results of quality control (QC) samples (blanks, duplicates, and spikes) that DEQ-INL OP submitted to Idaho State University's Environmental Monitoring Laboratory (ISU-EML) for radiological analyses and to the Idaho Bureau of Laboratories-Boise (IBL) for non-

radiological analyses during the quarter. The analytical results of QC samples are used to assess the precision, accuracy, and representativeness of the environmental data presented in this report. During the fourth quarter of 2020, DEQ-INL OP submitted 74 QC samples for various radiological and non-radiological analyses (**Table 23**).

All samples referenced in this report were collected in accordance with written procedures maintained by the DEQ-INL OP. Analytical methods and QC procedures used by the laboratories were performed in accordance with approved written procedures maintained by each lab. QC samples analyzed by the labs as part of each lab's internal QA program are not discussed in this report.

Blank Samples

Blank samples consist of matrices that contain immeasurable or acceptably low concentrations of the analyte(s) of interest. They are used to monitor for contamination introduced during sample collection, storage, shipment, and analysis. For water matrices, a blank sample consists of 18-megaohm deionized water from the DEQ-Idaho Falls Regional office and is categorized as a field blank, equipment blank, or trip blank depending on how the blank is handled. A field blank is used to monitor for contamination introduced from the environment during sample collection, an equipment blank is used to monitor for contamination introduced by contaminated equipment, and a trip blank is used to monitor for contamination introduced during transportation of samples (trip blanks are typically only used for VOCs). Most water blank samples submitted to laboratories by DEQ-INL OP are field blanks.

For all analyses except low-level tritium in water, a blank sample result is considered acceptable if it is less than or equal to the minimum detectable concentration (MDC). For low-level tritium analyses in water samples, a blank sample result is acceptable if it is less than or equal to 33 pCi/L.[2] If a blank result exceeds acceptance criteria, above-MDC results in other samples collected, transported, or analyzed together with the failed blank may be qualified as biased high (J+) or rejected (R), or may remain unqualified, depending on the relative sizes of the blank detection and other sample results.

Blank sample results submitted for gross alpha and gross beta screening in air for the fourth quarter of 2020 are presented in **Table 24**. Blank sample results for select gamma emitters in air from composited air filters are presented in **Table 25**. Data for blank analyses used to assess data quality for tritium in water vapor in air are presented in **Table 26**. Blank sample results for radiological and non-radiological analytes in ground and surface water are presented in **Tables 27-30**.

All blank sample results passed acceptance criteria in the fourth quarter of 2020.

Duplicate Samples

A duplicate sample is one that is collected at the same location and approximately the same time as another sample (referred to as the "original" sample). Duplicate sample results are compared to the original sample's results to evaluate reproducibility. Significant differences between the two could indicate poor analytical precision or a non-uniform sample matrix.

The difference between the results of an original and duplicate sample (referred to below as a "duplicate-sample pair") is evaluated differently for radiological and non-radiological analyses. For radiological analyses, the results of a duplicate-sample pair are considered to be in agreement if their absolute difference is less than or equal to three times the pooled error of the results:

[2] The water used by DEQ-INL OP to create blank samples contains measureable concentrations of tritium produced cosmogenically and by above-ground testing of nuclear weapons during the twentieth century. The highest tritium concentration that DEQ considers acceptable in a blank is calculated as the mean tritium concentration in DEQ blanks from 2013 to 2017 plus two standard deviations.

$$|R_1 - R_2| \leq 3\sqrt{S_1^2 + S_2^2}$$

R_1 = Original sample result
R_2 = Duplicate sample result

S_1 = Analytical uncertainty (1 SD) of the original result
S_2 = Analytical uncertainty (1 SD) of the duplicate result

Radiological results are also considered to be in agreement if their relative percent difference (RPD) is no more than ±20 percent. RPD is calculated as:

$$RPD = \frac{R_1 - R_2}{(R_1 + R_2)/2} \times 100$$

For non-radiological analyses, the RPD is used to evaluate duplicate sample pairs in which both results exceed five times the MDC. An RPD of up to ±20 percent is acceptable. If one or both of the sample results is less than five times the MDC, the results are in agreement if their absolute difference is less than or equal to the MDC.

Duplicate results for radiological analyses in groundwater and surface water are presented in **Table 31-33**. Duplicate results for in-situ soil analyses are presented in **Table 34.** Duplicate groundwater low level tritium samples from Middle-2051 on 06/10/2020 failed agreement criteria. The original sample result is J-flagged as an estimate in **Table 13** of the water monitoring section. No other samples were affected by this failure. All other duplicate results passed acceptance criteria in the fourth quarter of 2020.

Spiked Samples

Spiked samples are samples to which known concentrations of specific analytes have been added. They are used to assess a laboratory's analytical accuracy. The percent recovery (%R) of each spiked-sample analysis is calculated as the ratio of the spike concentration determined by the lab to the known spike concentration. DEQ-INL OP considers the lab's result to be in control if the percent recovery is 100 ± 25%. If the percent recovery of a spiked sample is 50-74%, above-MDC results of samples analyzed in the same batch as the spiked sample may be qualified as low-biased estimates (J-), and below-MDC results may be qualified as undetected estimates (UJ). If the percent recovery of a spiked sample is 126-150%, above-MDC results of associated samples may be qualified as high-biased estimates (J+), and below-MDC results may be qualified as undetected (U). If the percent recovery of a spiked sample is <50% or >150%, the results of all associated samples may be qualified as rejected (R), except for sample results below MDC associated with a spiked-sample analysis having a percent recovery >150%, in which case the sample result remains qualified as undetected (U).

Spiked sample results for metals, common ions and nutrients, and VOCs are presented in **Tables 35, 36, and 37.** All spike results were within the 75% to 125% acceptance criteria except the VOC vinyl chloride, which was high at 129%. Associated field samples had undetectable (U flag) vinyl chloride results and no further qualification of these is required.

DEQ-INL OP also prepares additional "spike-like" quality control samples to assess ambient radiation measurement bias. Once per quarter, DEQ-INL OP irradiates a number of electret ionization chambers (EICs) to verify EIC response. Irradiations of EICs are conducted in a repeatable geometry to a known exposure of near 30 mR and two additional higher and lower exposures, ranging from 15 to 60 mR. EIC responses are compared directly with the exposure received from the NIST traceable cesium-137 source provided by ISU-EML. EIC response is considered acceptable if each measurement has a percent recovery of 100 ± 25% when compared to the known irradiated quantity. The irradiation results for fourth

quarter 2020 are presented in **Table 38**. Real-time pressure correction is used to calculate the net exposure measured by these EIC control sets. All EIC spiked samples passed the DEQ-INL OP criteria.

Laboratory QC Issues

There were no laboratory QC issues to report in the fourth quarter of 2020.

DEQ-INL OP Equipment QC Issue

For high-volume total suspended particulate (TSP) air sampling, DEQ-INL OP has used mass flow control samplers historically. In 2020 it became apparent that these samplers were having difficulty maintaining correct flow and flow indication. After discussions with the vendor, DEQ-INL OP began field deployment of new sampler model (HVP-4304VFC) in third quarter 2020. This model uses volume flow control and indication. Locations using the new model for at least half of the fourth quarter were Craters of the Moon, Howe, Monteview, Idaho Falls, and a second sampler in Idaho Falls being run as a duplicate. These samplers were flow checked upon arrival from the vendor and when deployed in the field. Results were satisfactory at that time. However, in first quarter of 2021 flow rate problems were discovered with these new samplers. Due to limited flow rate checks/calibrations in fourth quarter 2020 it is unknown whether these problems existed then. The uncertainties for the TSP results in Appendix A are therefore considered minimum values, and the TSP results themselves are considered (usable) estimates of the true values. DEQ-INL OP is currently testing and evaluating other similar methods for obtaining more accurate TSP values.

Qualification of Low Level Sample Results

Sample results >MDC are generally considered detections, with the following exceptions[3] that apply primarily to radionuclide concentrations in water samples:

1. Results >MDC but < 2SD are considered non-detections and U-flagged as undetected, where SD is the sample standard deviation.
2. Results >MDC and >2SD but <3SD are considered questionable and J-flagged as estimates.

Analytical QA/QC Assessment

Other than those discussed above, no issues involving sample chain of custody, sample holding times, and the analysis of blank, duplicate, and spiked samples were observed during the fourth quarter of 2020 which significantly affected data quality. Methodologies and data reports issued by the contracting laboratories generally conformed to the requirements of DEQ-INL OP during the fourth quarter of 2020.

Data usability is the measure of field sample results that are not rejected divided by the total number of field sample results obtained. The overall data usability of 99.5% for the fourth quarter of 2020 is well above the minimum acceptable value of 90% for the DEQ-INL OP ESP and is summarized in **Table 23**. The overall data completeness (non-qualified results divided by the total number of field sample results expected) of 98.1% is also above the minimum acceptable value of 90%.

Preventative Maintenance and Equipment Reliability

All equipment was calibrated and checked according to prescribed periodicity. During the fourth quarter of 2020 the TSP sampler motor malfunctioned at Van Buren Avenue, resulting in no sample for the week of 11/25/20 – 12/02/20. The Monteview TSP sampler motor also malfunctioned, resulting in no samples

[3] Monitoring and Surveillance Committee, Consistency in Reporting Results Subcommittee Meeting Summary, 2/5/04 and 4/1/04.

for the weeks of 12/09/20 – 12/16/20, 12/16/20 – 12/23/20, and 12/23/20 – 12/30/20. Service reliability for air sampling equipment for the fourth quarter of 2020 is summarized in **Table 39**.

Conclusion

All data collected for the fourth quarter of 2020 have been assigned the applicable qualifiers to designate the appropriate use of the data. The overall data usability of 99.5% and data completeness of 98.1% are above the minimum acceptable level of 90% for the quarter, with the data meeting the requirements and data quality objectives established by DEQ-INL OP.

Table 23. Summary of the analyses performed in the fourth quarter, 2020.

Media Sampled	Collection Device	Analyte	Sample Analyses	Blank Analyses	Duplicate Analyses	Spike Analyses	Data Rejected[1]	Analyzing Lab[2]
Air								
Particulate	4-inch filter	Gross alpha	152	13	0	0	2	ISU-EML
		Gross beta	152	13	0	0	2	ISU-EML
		Gamma emitters	12	1	0	0	0	ISU-EML
		Radiochemical	0	0	0	0	0	ISU Sub
Water Vapor	Desiccant column	Tritium	22	6	0	0	0	ISU-EML
Gaseous	Charcoal filter	Iodine-131	13	0	0	0	0	ISU-EML
Precipitation	Poly bottle	Tritium	6	0	0	0	0	ISU-EML
		Gamma emitters	6	0	0	0	0	ISU-EML
Water								
Groundwater & Surface Water	Grab or composite	Gross alpha	30	2	1	0	0	ISU-EML
		Gross beta	30	2	1	0	0	ISU-EML
		Gamma emitters	30	2	1	0	0	ISU-EML
		Tritium	30	2	1	0	0	ISU-EML
		Low-level tritium	19	2	2	0	0	ISU-EML
		Radiochemical	22	0	0	0	0	ISU Sub
		Metals	23	1	1	1	0	IBL
		Common Ions	24	1	1	1	0	IBL
		Nutrients	24	1	1	1	0	IBL
		Volatile Organics	3	1	0	1	0	IBL
Terrestrial								
Milk	Grab or composite	Gamma emitters	11	0	0	0	0	ISU-EML
Soil	*in situ*	Gamma emitters	41	0	5	0	0	DEQ-INL OP
	Grab – "puck"	Gamma emitters	0	0	0	0	0	ISU-EML
Radiation								
Ambient	EICs	Gamma Radiation	67	0	0	9	0	DEQ-INL OP
	HPICs/Eco Gammas	Gamma Radiation	11	NA	NA	NA	0	DEQ-INL OP
Total analyses performed			**728**	**47**	**14**	**13**	**4**	
Total QC analyses performed (blanks, duplicates, and spikes)			**74**					
Ratio of total QC analyses to total sample analyses[3]			**10.2%**					
Data usability[4], percent			**99.5%**					
Data completeness[5], percent			**98.1%**					

[1] Combined Laboratory and DEQ-INL OP rejection criteria (data was rejected for any reason).

[2] ISU-EML = Idaho State University – Environmental Monitoring Laboratory; ISU Sub = Subcontract laboratory to ISU-EML; IBL = Idaho Bureau of Laboratories, Boise; IBL Sub = Subcontract laboratory to IBL; DEQ-INL OP = Analyzed by INL Oversight Program, Idaho Department of Environmental Quality.

[3] DEQ-INL OP requires that the number of QC analyses performed be at least 10 percent of the number of sample analyses performed.

[4] Data usability is calculated as [total analyses – rejected data]/[total analyses]. DEQ-INL OP considers a data usability rate of 90 percent or higher to be acceptable.

[5]Data completeness is calculated as usable results divided by the total number of field sample results expected. DEQ-INL OP considers a data completeness rate of 90 percent or higher to be acceptable.

Table 24. Blank analysis results for gross alpha and beta in (TSP) air filters, fourth quarter, 2020.

Collection Period		Corrected volume (m^3)[1]	Gross alpha		Gross beta	
Start	Stop		Value	Uncertainty (± 2 SD)	Value	Uncertainty (± 2 SD)
09/30/2020	10/07/2020	2040	-0.1	0.1	-0.6	0.5
10/07/2020	10/14/2020	2040	-0.2	0.1	-0.5	0.5
10/14/2020	10/21/2020	2040	-0.3	0.2	0.0	0.5
10/21/2020	10/28/2020	2040	0.0	0.1	-0.3	0.5
10/28/2020	11/04/2020	2040	0.0	0.2	0.0	0.5
11/04/2020	11/12/2020	2040	-0.2	0.1	-0.3	0.5
11/12/2020	11/18/2020	2040	0.0	0.1	-0.5	0.5
11/18/2020	11/25/2020	2040	-0.1	0.2	-0.1	0.5
11/25/2020	12/02/2020	2040	-0.2	0.2	-0.1	0.5
12/02/2020	12/09/2020	2040	-0.1	0.2	0.1	0.5
12/09/2020	12/16/2020	2040	0.0	0.1	-0.2	0.5
12/16/2020	12/23/2020	2040	-0.1	0.1	-0.1	0.5
12/23/2020	12/30/2020	2040	-0.1	0.1	-0.1	0.5

Note: Concentrations and associated uncertainties (± 2 SD) are expressed in 1 x 10^{-3} pCi/m^3.

[1] A volume equal to the average of the weekly volumes collected through each valid field filter was used to compute "concentrations" for the blank for meaningful comparison to sample results. No air was passed through the blank filters.

Table 25. Blank analysis results for gamma spectroscopy for TSP air filters, composite samples, fourth quarter, 2020.

Analysis Date	Beryllium-7			Ruthenium-106/Rhodium-106			Antimony-125		
	Concentration[1]	± 2 SD	MDC	Concentration	± 2 SD	MDC	Concentration	± 2 SD	MDC
01/15/2021	9	29	50	12	55	96	5	6	10

Analysis Date	Cesium-134			Cesium-137		
	Concentration[1]	± 2 SD	MDC	Concentration	± 2 SD	MDC
01/15/2021	-1	3	5	0	3	5

Note: Concentrations are expressed in 1 x 10^{-5}pCi/m^3 with associated uncertainty (± 2 SD) and minimum detectable concentration (MDC).

[1] These concentrations are from blank filters collected weekly, composited, and analyzed for the calendar quarter. A composite volume equal to the sum of the weekly average volumes collected through each valid field filter was used to compute "air concentrations" for the blank for meaningful comparison to sample results. No air was actually passed through the blank filters.

Table 26. Blank analysis results for tritium in water vapor from air samples, fourth quarter, 2020.

Sample Number	Start Date	Collection Date	Analysis Date	Tritium		
				Concentration	± 2 SD	MDC
OP204ZTR03	11/25/2020	11/27/2020	02/13/2021	0.11	0.09	0.15
OP204ZTR04	11/25/2020	11/27/2020	01/12/2021	0.10	0.09	0.15
OP204ZTR05	01/12/2021	01/19/2021	01/25/2021	0.10	0.10	0.17
OP204ZTR06	01/12/2021	01/19/2021	01/25/2021	0.12	0.11	0.17
OP204 Fridge	11/27/2020	01/19/2021	01/25/2021	-0.10	0.10	0.18
OP204 Sink	11/27/2020	01/19/2021	01/25/2021	-0.06	0.10	0.17

Note: Concentrations are expressed in nCi/L with associated uncertainty (± 2 SD) and minimum detectable concentration (MDC).

Table 27. Blank analysis results (pCi/L) for radiological constituents in water, fourth quarter, 2020.

Sample Number	Sample Date	Blank Type	Concentration	± 2 SD	MDC	Within Blank Criteria?
Gross Alpha						
201W598	09/30/2020	Field	0.0	0.2	0.5	Yes
201W766	11/09/2020	Field	0.0	0.3	0.6	Yes
Gross Beta						
201W598	09/30/2020	Field	0.3	0.6	1.0	Yes
201W766	11/09/2020	Field	-0.2	0.6	1.0	Yes
Cesium-137						
201W598	09/30/2020	Field	0.3	1.6	2.7	Yes
201W766	11/09/2020	Field	0.5	1.7	2.8	Yes
Tritium (standard method)						
201W599	09/30/2020	Field	-20	90	160	Yes
201W767	11/09/2020	Field	-100	90	160	Yes
Tritium (low-level method)						
201W388	06/08/2020	Field	8	6	9	Yes
201W599	09/30/2020	Field	15	7	10	Yes*

MDC = minimum detectable concentration.
*Detections in this range are typical of the DI water used by DEQ to prepare blank samples.

Table 28. Blank analysis results (µg/L) for metals in groundwater and/or surface water, fourth quarter, 2020.

Sample Number	Sample Date	Blank Type	Arsenic	Barium	Chromium	Iron	Lead	Manganese	Selenium	Zinc
201W601	9/30/2020	Field	-	-	<1.0	-	-	-	-	-

Table 29. Blank analysis results (mg/L) for common ions and nutrients in groundwater and/or surface water, fourth quarter, 2020.

Sample Number	Sample Date	Blank Type	Calcium	Magnesium	Sodium	Potassium	Fluoride	Chloride	Sulfate	Alkalinity†	NO_3+NO_2*	Total Phosphorus
201W600, 602	9/30/2020	Field	-	-	-	-	-	<0.4	<0.8	<1.0	<0.01	-

† As $CaCO_3$.

* As N.

Table 30. Blank analysis results (µg/L) for VOCs in water, fourth quarter, 2020.

Sample Number	Sample Date	Blank Type	PCE	TCE	1,1-DCE	cis-1,2-DCE	trans-1,2-DCE	Vinyl Chloride	1,1-DCA	Carbon Tetrachloride	Methylene Chloride	Chloro-form	Chloro-methane
201W705	10/12/2020	Field	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50

Abbreviations: PCE = tetrachloroethene; TCE = trichloroethene; 1,1-DCE = 1,1-dichloroethene; cis-1,2-DCE = cis-1,2-dichloroethene; trans-1,2-DCE = trans-1,2-dichloroethene; 1,1-DCA = 1,1-dichloroethane

Table 31. Duplicate sample results (pCi/L) for radiological constituents in groundwater and/or surface water, fourth quarter, 2020.

Analysis/Sample Location	Original Sample Number	Concentration	± 2 SD	Duplicate Sample Number	Concentration	± 2 SD	RPD	$\lvert R_1-R_2 \rvert$	$3(S_1^2+S_2^2)^{1/2}$	Within Criteria?
Gross Alpha										
USGS-014	201W634	2.6	0.9	201W639	3.7	1.2	-35	1.1	2.2	Yes
Gross Beta										
USGS-014	201W634	2.7	0.8	201W639	4.4	0.9	-48	1.7	1.8	Yes
Cesium-137										
USGS-014	201W634	1.6	1.4	201W639	-0.4	1.1	333	2.0	2.7	Yes
Tritium (standard method)										
USGS-014	201W635	20	90	201W640	-50	90	-467	70	191	Yes
Tritium (low-level method)										
Middle-2051	201W406	113	11	201W407	153	12	-30	40	24	No
USGS-105	201W421	176	14	201W422	144	11	20	32	27	Yes

RPD = relative percent difference.

Table 32. Duplicate results for metals (µg/L) in groundwater, fourth quarter, 2020.

Sample Location	Sample Number	Sample Date	Arsenic	Barium	Chromium	Iron	Lead	Manganese	Selenium	Zinc
USGS-014	201W637	10/14/2020	-	-	3.1	-	-	-	-	-
USGS-014	201W642	10/14/2020	-	-	3.3	-	-	-	-	-
RPD			-	-	-6	-	-	-	-	-

RPD = relative percent difference.

Table 33. Duplicate sample results for common ions and nutrients (mg/L) in groundwater, fourth quarter, 2020.

Sample Location	Sample Number	Sample Date	Calcium	Magnesium	Sodium	Potassium	Fluoride	Chloride	Sulfate	Total Alkalinity†	Total Nitrogen	Total P*
USGS-014	201W636, 638	10/14/2020	-	-	-	-	-	20.4	21.1	136	1.3	-
USGS-014	201W641, 643	10/14/2020	-	-	-	-	-	20.6	21.3	137	1.3	-
RPD							-	-2	-1	-1	0	

RPD = relative percent difference.
† As $CaCO_3$.
*P = phosphorus.

Table 34. Duplicate *in-situ* analyses of gamma emitting radionuclides in soil, fourth quarter, 2020.

Sample Location	Sample Date	Original Result K-40 (pCi/g)[1]	Duplicate Result K-40 (pCi/g)[1]	K-40 RPD (%)	K-40 Less than 3 sigma test	K-40 Meets either criterion?	Original Result Cs-137 (pCi/g)[1]	Duplicate Result Cs-137 (pCi/g)[1]	Cs-137 RPD (%)	Cs-137 Less than 3 sigma test	Cs-137 Meets either criterion?
ESER Soil Site Monteview	11/20/2020	10.9 ± 0.6	10.9 ± 0.6	0.3	Yes	Yes	0.121 ± 0.020	0.136 ± 0.021	-11.9	Yes	Yes
Big Lost River Rest Area	11/23/2020	16.9 ± 0.9	19.3 ± 1.0	-13.3	No	Yes	0.119 ± 0.028	0.116 ± 0.035	2.3	Yes	Yes
Large Grid 24-7	11/24/2020	21.2 ± 1.0	21.1 ± 1.0	0.6	Yes	Yes	0.163 ± 0.043	0.159 ± 0.040	2.5	Yes	Yes
Large Grid 18-4	11/25/2020	13.3 ± 0.7	13.3 ± 0.7	0.0	Yes	Yes	0.148 ± 0.025	0.138 ± 0.032	6.8	Yes	Yes
Crystal Ice Caves	12/10/2020	16.3 ± 0.7	16.9 ± 0.8	-3.6	Yes	Yes	0.193 ± 0.027	0.188 ± 0.045	2.8	Yes	Yes

[1]Result ±2 SD

Table 35. Spiked sample results (µg/L) for metals in water, fourth quarter, 2020.

Sample Number	Sample Date	Barium			Chromium			Lead			Manganese			Zinc		
		Spike	Result	%R	Spike	Result	%R	Spike	Result	%R	Spike	Result	%R	Spike	Result	%R
201W745	10/10/2019	-	-	-	81.7	80	98	-	-	-	-	-	-	-	-	-

Table 36. Spiked sample results (mg/L) for common ions and nutrients in water, fourth quarter, 2020.

Sample Number	Sample Date	Chloride			Sulfate			Total Alkalinity as $CaCO_3$			Total Nitrogen			Total Phosphorus		
		Spike	Result	%R	Spike	Result	%R	Spike	Result	%R	Spike	Result	%R	Spike	Result	%R
201W744, 746	10/14/2020	61.9	61.6	99	12.9	12.1	94	32.3	31.3	97	2.50	2.5	100	0.0202	0.020	99

Table 37. Spiked sample results (µg/L) for VOCs in water, fourth quarter, 2020.

Sample Number	Sample Date	Carbon Tetrachloride			Styrene			Tetrachloroethene			Trichloroethene			Vinyl Chloride		
		Spike	Result	%R	Spike	Result	%R	Spike	Result	%R	Spike	Result	%R	Spike	Result	%R
201W747	10/14/2020	5.18	6.10	118	16.6	15.2	92	10.1	11.6	115	9.13	11.4	125	10.0	12.9	129

Table 38. Electret ionization chamber (EIC) irradiation results (categorized as spiked samples), fourth quarter, 2020.

Electret #	Exposure Received		Net Measured Exposure[1]		%R	Within Spec?
	(mR)	Uncertainty (±1 SD, mR)	(mR)	Uncertainty (±1 SD, mR)		
SJW997	40.1	2.0	32.7	1.4	81.7	Y
SKR403	40.1	2.0	30.4	1.4	75.8	Y
SJX038	40.1	2.0	32.2	1.3	80.4	Y
				Triplicate AVG:	**79.3**	**Y**
SJX082	30.6	1.5	24.5	1.3	80.2	Y
SJX036	30.6	1.5	26.2	1.3	85.6	Y
SJW946	30.6	1.5	25.8	1.3	84.3	Y
				Triplicate AVG:	**83.4**	**Y**
SJE214	20.4	1.0	16.7	1.3	81.9	Y
SJE208	20.4	1.0	17.6	1.3	86.3	Y
SJE047	20.4	1.0	17.0	1.3	83.3	Y
				Triplicate AVG:	**83.8**	**Y**

Note: A percent recovery (%R) of 100 ± 25 is considered acceptable.
[1] Net measured exposure estimate includes a correction for atmospheric pressure.

Table 39. Air sampling field equipment service reliability (percent operational), fourth quarter, 2020.

Station Locations	Sample Type			
	TSP	Radioiodine	Atmospheric Moisture	Precipitation
Onsite Locations				
Big Lost River Rest Area	100%	100%	100%	100%
Experimental Field Station	100%	100%	100%	NC[1]
Sand Dunes Tower	100%	100%	100%	NC[1]
Van Buren Avenue	92%	100%	100%	NC[1]
Boundary Locations				
Atomic City	100%	100%	100%	100%
Howe	100%	100%	100%	100%
Monteview	77%	100%	100%	100%
Mud Lake	100%	100%	100%	100%
Distant Locations[2]				
Craters of the Moon	100%	100%	100%	NC[1]
Idaho Falls	100%	100%	100%	100%

Note: The values in this table were calculated by dividing the number of weeks the equipment was in operation by the number of weeks in the quarter.
[1] NC = Sample not collected at this location.
[2] The Fort Hall Station, operated by the Shoshone- Bannock Tribes, is not included here.

Appendix A

Table A-1. Weekly concentrations (in 1 x 10^{-3} pCi/m^3) for gross alpha and gross beta analyses for TSP filters for all locations, fourth quarter, 2020.

Sample Location	Collection Date		Gross Alpha		Gross Beta	
	Start	Stop	Concentration	±2 SD	Concentration	±2 SD
On-Site Locations						
Big Lost River Rest Area	09/30/20	10/07/20	2.1	0.3	52.8	1.6
	10/07/20	10/14/20	1.8	0.3	40.3	1.4
	10/14/20	10/21/20	0.2	0.3	22.6	1.2
	10/21/20	10/28/20	1.4	0.3	44.3	1.4
	10/28/20	11/04/20	1.4	0.3	50.8	1.5
	11/04/20	11/12/20	1.4	0.3	35.6	1.2
	11/12/20	11/18/20	0.6	0.2	20.3	1.1
	11/18/20	11/25/20	0.7	0.2	36.4	1.3
	11/25/20	12/02/20	0.5	0.2	33.5	1.3
	12/02/20	12/09/20	0.9	0.3	51.9	1.5
	12/09/20	12/16/20	1.2	0.2	57.9	1.6
	12/16/20	12/23/20	0.5	0.2	31.2	1.2
	12/23/20	12/30/20	0.5	0.2	30.0	1.2
Experimental Field Station	09/30/20	10/07/20	2.1	0.4	35.9	1.5
	10/07/20	10/14/20	2.2	0.3	26.4	1.2
	10/14/20	10/21/20	0.5	0.3	12.7	1.0
	10/21/20	10/28/20	1.2	0.3	20.6	1.0
	10/28/20	11/04/20	1.2	0.3	28.9	1.2
	11/04/20	11/12/20	1.0	0.2	24.1	1.0
	11/12/20	11/18/20	0.5	0.2	14.1	1.0
	11/18/20	11/25/20	0.6	0.2	21.9	1.1
	11/25/20	12/02/20	0.4	0.2	19.8	1.0
	12/02/20	12/09/20	0.7	0.3	30.0	1.2
	12/09/20	12/16/20	0.9	0.2	42.6	1.6
	12/16/20	12/23/20	0.3	0.2	22.0	1.1
	12/23/20	12/30/20	0.3	0.2	17.3	1.0
Sand Dunes Tower	09/30/20	10/07/20	R[1]	R[1]	R[1]	R[1]
	10/07/20	10/14/20	R[1]	R[1]	R[1]	R[1]
	10/14/20	10/21/20	0.3	0.3	22.0	1.1
	10/21/20	10/28/20	1.3	0.3	44.0	1.4
	10/28/20	11/04/20	1.8	0.3	65.0	1.7
	11/04/20	11/12/20	1.0	0.2	46.5	1.3
	11/12/20	11/18/20	0.4	0.2	27.6	1.3
	11/18/20	11/25/20	0.8	0.2	47.7	1.5
	11/25/20	12/02/20	1.1	0.3	56.6	1.6
	12/02/20	12/09/20	2.1	0.4	94.9	2.0
	12/09/20	12/16/20	1.5	0.3	74.9	1.8
	12/16/20	12/23/20	0.9	0.2	50.2	1.5
	12/23/20	12/30/20	0.6	0.2	44.2	1.4

[1]Insufficient sample volume for valid analysis; result was rejected (R).

Table A-1 continued. Weekly concentrations (in 1 x 10^{-3} pCi/m^3) for gross alpha and gross beta analyses for TSP filters for all locations, fourth quarter, 2020.

Sample Location	Collection Date		Gross Alpha		Gross Beta	
	Start	Stop	Concentration	±2 SD	Concentration	±2 SD
Van Buren Avenue	09/30/20	10/07/20	1.8	0.3	39.2	1.3
	10/07/20	10/14/20	1.1	0.3	37.4	1.3
	10/14/20	10/21/20	0.7	0.3	21.0	1.0
	10/21/20	10/28/20	1.5	0.3	41.2	1.4
	10/28/20	11/04/20	1.5	0.3	49.6	1.5
	11/04/20	11/12/20	1.5	0.3	39.7	1.2
	11/12/20	11/18/20	0.6	0.2	30.6	1.3
	11/18/20	11/25/20	1.0	0.3	43.0	1.4
	11/25/20	12/02/20	NS[1]	NS[1]	NS[1]	NS[1]
	12/02/20	12/09/20	1.9	0.3	78.7	1.8
	12/09/20	12/16/20	1.1	0.2	46.1	1.5
	12/16/20	12/23/20	0.4	0.2	24.7	1.1
	12/23/20	12/30/20	0.3	0.2	22.5	1.1
Boundary Locations						
Atomic City	09/30/20	10/07/20	2.2	0.3	56.1	1.6
	10/07/20	10/14/20	1.6	0.3	39.8	1.3
	10/14/20	10/21/20	0.4	0.3	16.3	0.9
	10/21/20	10/28/20	1.4	0.3	44.5	1.4
	10/28/20	11/04/20	1.6	0.3	51.6	1.5
	11/04/20	11/12/20	1.1	0.2	31.8	1.11
	11/12/20	11/18/20	0.6	0.2	21.5	1.2
	11/18/20	11/25/20	1.0	0.3	46.1	1.4
	11/25/20	12/02/20	0.6	0.2	35.0	1.3
	12/02/20	12/09/20	1.2	0.3	61.6	1.6
	12/09/20	12/16/20	1.5	0.3	65.8	1.7
	12/16/20	12/23/20	0.7	0.2	35.0	1.3
	12/23/20	12/29/20	0.4	0.2	30.3	1.3
Howe	09/30/20	10/07/20	2.0	0.3	47.1	1.5
	10/07/20	10/14/20	1.9	0.3	35.0	1.3
	10/14/20	10/21/20	0.7	0.3	16.2	1.0
	10/21/20	10/28/20	1.7	0.3	39.0	1.4
	10/28/20	11/04/20	1.5	0.3	40.1	1.4
	11/04/20	11/12/20	1.2	0.3	31.7	1.2
	11/12/20	11/18/20	0.5	0.2	15.1	1.0
	11/18/20	11/25/20	0.6	0.2	28.3	1.2
	11/25/20	12/02/20	0.3	0.2	24.2	1.1
	12/02/20	12/09/20	0.7	0.3	38.5	1.4
	12/09/20	12/16/20	0.8	0.2	32.8	1.3
	12/16/20	12/23/20	0.4	0.2	20.6	1.0
	12/23/20	12/30/20	0.2	0.2	21.4	1.1

[1]Sampler motor malfunction. No sample (NS).

Table A-1 continued. Weekly concentrations (in 1 x 10^{-3} pCi/m^3) for gross alpha and gross beta analyses for TSP filters for all locations, fourth quarter, 2020.

Sample Location	Collection Date		Gross Alpha		Gross Beta	
	Start	Stop	Concentration	±2 SD	Concentration	±2 SD
Monteview	09/30/20	10/07/20	1.9	0.3	41.7	1.4
	10/07/20	10/14/20	1.6	0.3	33.7	1.3
	10/14/20	10/21/20	0.4	0.3	13.6	0.9
	10/21/20	10/28/20	0.8	0.2	23.0	1.1
	10/28/20	11/04/20	0.8	0.2	21.9	1.1
	11/04/20	11/12/20	0.5	0.2	20.2	1.0
	11/12/20	11/18/20	0.2	0.2	7.0	0.8
	11/18/20	11/25/20	0.3	0.2	14.8	0.9
	11/25/20	12/02/20	0.2	0.2	13.0	0.9
	12/02/20	12/09/20	0.4	0.2	16.7	1.0
	12/09/20	12/16/20	NS[1]	NS[1]	NS[1]	NS[1]
	12/16/20	12/23/20	NS[1]	NS[1]	NS[1]	NS[1]
	12/23/20	12/30/20	NS[1]	NS[1]	NS[1]	NS[1]
Mud Lake	09/30/20	10/07/20	2.2	0.4	51.3	1.5
	10/07/20	10/14/20	2.0	0.3	43.0	1.4
	10/14/20	10/21/20	0.7	0.3	17.6	1.0
	10/21/20	10/28/20	1.3	0.3	40.6	1.4
	10/28/20	11/04/20	2.2	0.3	55.6	1.6
	11/04/20	11/12/20	1.2	0.3	33.2	1.2
	11/12/20	11/18/20	0.5	0.2	21.1	1.2
	11/18/20	11/25/20	0.7	0.2	35.7	1.3
	11/25/20	12/02/20	0.6	0.3	39.4	1.4
	12/02/20	12/09/20	1.4	0.3	71.6	1.8
	12/09/20	12/16/20	1.9	0.3	78.8	1.9
	12/16/20	12/23/20	0.5	0.2	30.8	1.2
	12/23/20	12/30/20	0.6	0.2	38.8	1.3
Distant Locations						
Craters of the Moon	09/30/20	10/07/20	2.3	0.4	47.8	1.8
	10/07/20	10/14/20	1.8	0.3	37.2	1.3
	10/14/20	10/21/20	0.3	0.3	16.8	1.0
	10/21/20	10/28/20	1.0	0.2	42.3	1.4
	10/28/20	11/04/20	0.8	0.2	38.9	1.3
	11/04/20	11/12/20	0.7	0.2	27.2	1.1
	11/12/20	11/18/20	0.2	0.2	14.6	1.0
	11/18/20	11/25/20	0.4	0.2	30.6	1.2
	11/25/20	12/02/20	0.3	0.2	29.1	1.2
	12/02/20	12/09/20	0.4	0.2	40.1	1.4
	12/09/20	12/16/20	0.8	0.2	40.5	1.4
	12/16/20	12/23/20	0.3	0.2	16.9	1.0
	12/23/20	12/30/20	0.3	0.2	22.2	1.1

[1]Sampler motor malfunction. No sample (NS).

Table A-1 continued. Weekly concentrations (in 1 x 10^{-3} pCi/m^3) for gross alpha and gross beta analyses for TSP filters for all locations, fourth quarter, 2020.

Sample Location	Collection Date		Gross Alpha		Gross Beta	
	Start	Stop	Concentration	±2 SD	Concentration	±2 SD
Fort Hall[1]	09/30/20	10/07/20	3.0	0.4	68.9	1.8
	10/07/20	10/14/20	2.6	0.4	52.4	1.6
	10/14/20	10/21/20	0.8	0.3	22.6	1.1
	10/21/20	10/28/20	1.8	0.3	44.0	1.4
	10/28/20	11/04/20	2.2	0.3	48.2	1.5
	11/04/20	11/12/20	1.5	0.3	38.4	1.2
	11/12/20	11/18/20	0.7	0.3	22.1	1.2
	11/18/20	11/25/20	1.2	0.3	41.2	1.4
	11/25/20	12/02/20	1.0	0.3	42.1	1.4
	12/02/20	12/09/20	2.0	0.3	81.8	1.9
	12/09/20	12/16/20	2.1	0.3	79.2	1.9
	12/16/20	12/23/20	0.5	0.2	17.8	0.9
	12/23/20	12/30/20	0.8	0.2	33.9	1.3
Idaho Falls	09/30/20	10/07/20	2.4	0.4	50.1	1.5
	10/07/20	10/14/20	2.4	0.4	38.4	1.4
	10/14/20	10/21/20	0.9	0.3	19.7	1.0
	10/21/20	10/28/20	2.0	0.3	39.1	1.4
	10/28/20	11/04/20	1.7	0.3	40.9	1.4
	11/04/20	11/12/20	1.0	0.2	31.4	1.1
	11/12/20	11/18/20	0.3	0.2	15.2	1.0
	11/18/20	11/25/20	0.6	0.2	29.2	1.2
	11/25/20	12/02/20	0.4	0.2	31.0	1.2
	12/02/20	12/09/20	0.8	0.3	42.0	1.4
	12/09/20	12/16/20	1.2	0.2	49.9	1.5
	12/16/20	12/23/20	0.4	0.2	19.2	1.0
	12/23/20	12/30/20	0.5	0.2	19.8	1.0
Idaho Falls[DP]	09/30/20	10/07/20	2.6	0.4	54.5	1.6
	10/07/20	10/14/20	1.4	0.3	30.8	1.2
	10/14/20	10/21/20	0.8	0.4	24.0	1.3
	10/21/20	10/28/20	2.0	0.3	42.8	1.4
	10/28/20	11/04/20	2.0	0.3	46.6	1.5
	11/04/20	11/12/20	1.2	0.3	33.6	1.2
	11/12/20	11/18/20	0.4	0.2	17.5	1.1
	11/18/20	11/25/20	0.7	0.2	33.2	1.3
	11/25/20	12/02/20	0.5	0.2	34.6	1.3
	12/02/20	12/09/20	1.2	0.3	47.0	1.5
	12/09/20	12/16/20	1.4	0.3	59.5	1.6
	12/16/20	12/23/20	0.6	0.2	22.5	1.1
	12/23/20	12/29/20	0.6	0.2	24.6	1.2

[1]Sampler owned and operated by the Shoshone-Bannock Tribes.
[DP]Sampler being run as a duplicate.

Appendix B

Table B.1. Results for all electret ionization chamber (EIC) locations, fourth quarter, 2020.

Sample Location	Net Corrected Exposure Rate (µR/hr)[1]	± 2 SD (µR/hr)
Arco	13.0, 13.7	-
Craters of the Moon	11.9	3.2
Rest Area	12.2	3.2
Van Buren Avenue	15.0	2.4
Experimental Field Station	12.6	1.9
Main Gate	13.3	2.0
Atomic City	12.5, 14.1	-
Taber	12.0	1.9
Blackfoot	12.9	3.0
Ft. Hall	11.3	2.1
Idaho Falls	11.9, 13.5	-
Mud Lake/ Terreton	10.7	1.6
Monteview	12.2, 13.8	-
Sand Dunes	17.6	1.6
Howe Met. Tower	8.5, 9.5	-
MP282 -20	12.9	2.4
MP280 -20	12.8, 15.0	-
MP278 -20	12.4, 12.9	-
MP276 -20	12.3	1.9
MP274 -20	8.1, 9.5	-
MP272 -20	12.8	2.9
MP270 -20	12.7, 13.4	-
MP268 -20	11.4, 12.7	-
MP266 -20	13.4	1.9
MP264 -20	15.9	2.4
MP270 -20/26	14.2	2.6
MP268 -20/26	15.3	2.3
MP266 -20/26	14.7	1.1
MP263 -20/26	14.8, 15.9	-
MP261 -20/26	10.5, 10.5	-
MP259 -20/26	10.9, 11.8	-
MP256 -20/26	11.5	2.7
MFC (EBR II)	13.4	2.5
EBR I	11.1	1.6
RWMC	12.4, 14.0	-
CFA	13.6, 16.5	-
CITRC (PBF)	16.6, 19.3	-
INTEC	18.4	3.1
ATR (TRA)	11.5, 13.6	-
NRF	15.1, 16.0	-
TAN/SMC	13.3	3.3
Mud Lake Bank of Commerce	12.5	0.5
MP43-33	14.0, 15.1	-
MP41-33	14.4, 15.1	-
MP39-33	14.6	1.5
MP37-33	12.8	1.0
MP35-33	11.4	2.4
MP33-33	13.5, 13.8	-
MP31-33	8.2, 9.6	-
MP29-33	13.8	2.5

Table B.1. continued. Results for all electret ionization chamber (EIC) locations, fourth quarter, 2020.

Sample Location	Net Corrected Exposure Rate (µR/hr)[1]	± 2 SD (µR/hr)
MP27-33	13.9	2.7
MP25-33	11.5, 13.2	-
MP23-33	10.6, 10.6	-
MP21-33	12.7	2.0
MP19-33	13.2	2.4
MP14-33	11.9, 12.4	-
MP11-33	11.3	0.5
MP06-33	7.9	1.0
MP03-33	11.6	1.3
Base of Howe	14.5	2.8
Rover	35.9, 39.1	-
Hamer	12.1	3.0
Sugar City	13.8, 13.9	-
Roberts	15.2, 17.8	-
Big Southern Butte	12.9	0.7
T4 North	13.7	2.0
T4 South	37.2, 39.3	-

[1]Results are the average of triplicate exposure rate measurements with the associated sample variability (±2 SD), or the 2 measured exposure rates remaining after removal of an outlying value. One of the triplicate measurements is rejected if it is outside the average of the triplicate measurements ±2 SD of the historical population variability. Typically, the two most consistent measurements are reported, based on judgment of the data analyst.

Appendix C

Table C-1. List of volatile organic compounds (VOCs) analyzed for water samples.

Analyte	Minimum detectable concentrations (MDC) (expressed in µg/L)
Benzene	0.5
Carbon tetrachloride	0.5
Chlorobenzene	0.5
1,4-Dichlorobenzene	0.5
1,2-Dichlorobenzene	0.5
1,2-Dichloroethane	0.5
1,1-Dichloroethene	0.5
cis-1,2-Dichloroethene	0.5
trans-1,2-Dichloroethene	0.5
1,2-Dichloropropane	0.5
Ethylbenzene	0.5
Methylene Chloride	0.5
Styrene	0.5
Tetrachloroethene (PCE)	0.5
Toluene	0.5
1,2,4-Trichlorobenzene	0.5
1,1,1-Trichloroethane	0.5
1,1,2-Trichloroethane	0.5
Trichloroethene (TCE)	0.5
Vinyl chloride	0.5
Xylenes (total)	0.5
Bromodichloromethane	0.5
Dibromochloromethane	0.5
Bromoform	0.5
Chloroform	0.5
Bromobenzene	0.5
Bromochloromethane	0.5
Bromomethane	0.5
n-Butylbenzene	0.5
sec-Butylbenzene	1.0
tert-Butylbenzene	0.5
Chloroethane	0.5
Chloromethane	0.5
2-Chlorotoluene	0.5

Table C.1 continued. List of volatile organic compounds (VOCs) analyzed for water samples.

Analyte	Minimum detectable concentrations (MDC) (expressed in µg/L)
4-Chlorotoluene	0.5
1,2-Dibromo-3-chloropropane (DBCP)	0.5
1,2-Dibromoethane (EDB)	0.5
Dibromomethane	0.5
1,3-Dichlorobenzene	0.5
Dichlorodifluoromethane	0.5
1,1-Dichloroethane	0.5
1,3-Dichloropropane	0.5
2,2-Dichloropropane	0.5
1,1-Dichloropropene	0.5
cis-1,3-Dichloropropene	0.5
trans-1,3-Dichloropropene	1.0
Hexachlorobutadiene	0.5
Isopropylbenzene	0.5
p-Isopropyltoluene	0.5
Methyl Tert Butyl Ether (MTBE)	0.5
Naphthalene	0.5
n-Propylbenzene	0.5
1,1,1,2-Tetrachloroethane	0.5
1,1,2,2-Tetrachloroethane	0.5
1,2,3-Trichlorobenzene	0.5
Trichlorofluoromethane	0.5
1,2,3-Trichloropropane	0.5
1,2,4-Trimethylbenzene	1.0
1,3,5-Trimethylbenzene	0.5