Department of Environmental Quality
INL Oversight Program

# ENVIRONMENTAL SURVEILLANCE PROGRAM
# QUARTERLY DATA REPORT

**January - March, 2022**


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# 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 1/1000$^{th}$ 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 |

# 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 first quarter, 2022 (**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 both high-volume (8x10-inch filter) and low-volume (47-mm filter) total suspended particulate (TSP) air samplers. Many of these air samplers were found to be operating outside of their expected flow rate range in the first quarter, 2022. A calibrated flow rate gauge was taken into the field weekly to measure the sample start and stop flow rates of these samplers. The calibrated flow rate gauge measurements were used for the activity concentration calculations in the suspect measurements and have been footnoted as estimates. Weekly gross alpha and gross beta particulate radioactivity results for 47-mm filters from the low-volume TSP samplers are presented in **Appendix A** and summarized as a range of results in **Table 2**. Results are within the expected historical range.

Composites of 47-mm filters collected from low-volume TSP samplers during a calendar quarter are analyzed using gamma spectrometry. Composites of 8x10-inch filters collected from high-volume TSP samplers during each calendar month are also analyzed using gamma spectrometry. Typically, gamma spectrometry results are only reported when exceeding a minimum detectable concentration (MDC). Gamma spectrometry results for the first quarter of 2022 for 47-mm and 8x10-inch TSP filters are presented in **Tables 3** and **4**. For both filter sizes, the only reported gamma-emitting radionuclide was beryllium-7 (Be-7), a naturally occurring, cosmogenic radionuclide. The MDC for cesium-137 (Cs-137) is also reported since Cs-137 is the most likely of the man-made gamma emitting radionuclides to be detected.

Beginning in first quarter 2022, quarterly composites of 8x10-inch filters collected using high-volume TSP samplers are analyzed using radiochemical separation techniques. Results from the quarterly 8x10-inch filter composite analyses are typically presented in the following quarter's report. The samples are analyzed for Strontium-90, Plutonium-238, Plutonium-239/240, and Americium-241. Measurable quantities of these radionuclides are expected in the environment due to historic above ground testing of nuclear weapons, and possibly from INL programs. DEQ-INL OP's action levels of 19 for Americium-241 (Am-241), 190 for Strontium-90 (Sr-90), 21 for Plutonium-238 (Pu-238), and 20 for Plutonium-239/240 (Pu-239/240) (in 1 x $10^{-5}$ pCi/$m^3$) are 10 percent of the compliance values listed for the specific radionuclides in 40 CFR 61, Appendix E, Table 2. Field sample concentrations which exceed these amounts require further investigation.

Radiochemical analyses results for composited 4-inch TSP filters from calendar year 2022 are presented in **Table 8.** The ISU vendor lab (ALS, Ft. Collins, CO.) non-conformance report listed significant quality control issues associated with the analyses of these samples, as discussed in the Quality Assurance section of this report. The original filter composite samples were completely consumed in the initial radiochemical separations, so repeat separations and analyses were not possible. The low tracer yields for Pu-238, Pu-239/240, and Am-241, and low chemical carrier recoveries for Sr-90 caused the MDCs to be elevated.

Three results exceed the Sr-90 MDC for the 2022 annual composite at Craters of the Moon, Experimental Field Station, and Van Buren Avenue. No results exceed the Pu-238 MDC. Two results exceed the Pu-239/240 MDC at Experimental Field Station and Fort Hall. One result is equal to the Am-241 MDC at Fort Hall. These greater-than-MDC results are all elevated compared to historical results and may suggest an INL source. However, the validity of these results is in doubt and their accuracy is questionable due to the vendor lab's quality control issues. Also, wood ash is known to contain the fallout radionuclides Sr-90 and Cs-137[1]. It is possible that heavy smoke from wildfires in the third quarter of 2022 caused the elevated Sr-90 concentrations but an analysis of collected particulate matter mass data for the 2020 and 2022 filters was not informative. The questionable results from 2022 annual composites are all well below DEQ-INL OP action levels.

Preliminary radiochemical results from the first quarter 2022 8x10-inch filter quarterly composites are lower and in the range of historical values. Greater-than-MDC values range from 0.82 to 3.95 x $10^{-5}$ pCi/$m^3$ for Sr-90, 0.03 to 0.04 x $10^{-5}$ pCi/$m^3$ for Pu-238, and 0.02 to 0.03 x $10^{-5}$ pCi/$m^3$ for Pu-239/240. There are no greater-than-MDC results for Am-241 (MDC range is 0.02 to 0.09 x $10^{-5}$ pCi/$m^3$).

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 using gamma spectrometry (**Table 5**). 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 first quarter of 2022.

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. All results are below MDCs and well below the DEQ-INL OP

[1] https://www.burningissues.org/car-www/science/radwaste1.html. Also (PDF) Cesium-137 in Wood Ash Results of Nationwide Survey (researchgate.net)

action level of 150 pCi/$m^3$ (40 CFR 61). Atmospheric tritium concentrations and their weighted quarterly means are presented in **Table 6**.

Precipitation samples were collected at six monitoring locations during the first quarter of 2022. Precipitation samples were analyzed for tritium and man-made 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 man-made gamma emitting radionuclides were below minimum detectable concentration in precipitation collected during the first quarter of 2022. Analysis results for Tritium (H-3) and Cesium-137, the most likely to be detected of man-made gamma emitting radionuclides, are presented in **Table 7**.

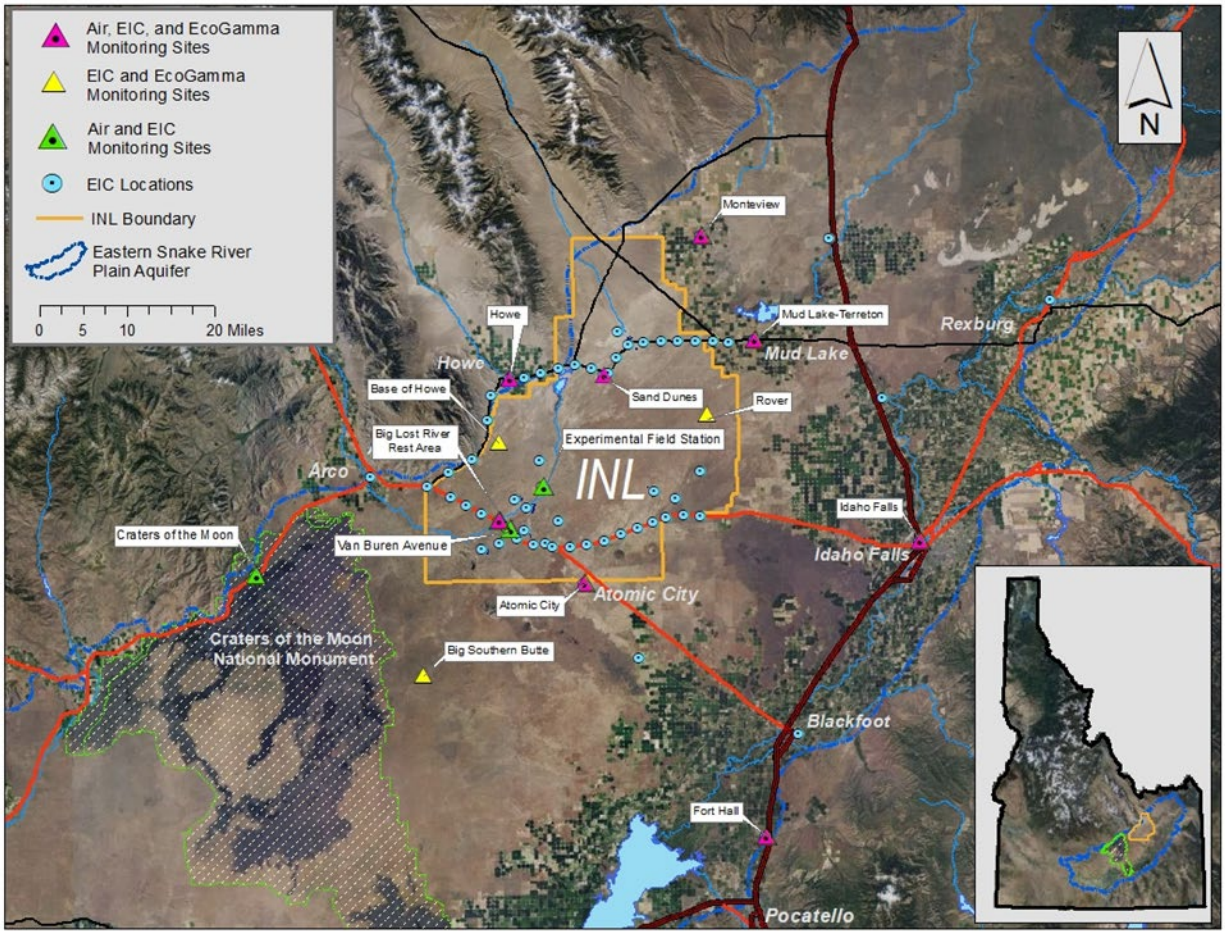


**Figure 1. Air and radiation monitoring locations.**

**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, first quarter, 2022.**

| Station Location | Concentration | | | | | |
|---|---|---|---|---|---|---|
| | Gross Alpha | | | Gross Beta | | |
| **On-Site Locations** | | | | | | |
| Big Lost River Rest Area | 0.2 | - | 0.9 | 15.6 | - | 52.5 |
| Experimental Field Station | 0.1 | - | 1.0 | 16.9 | - | 59.4 J[2] |
| Sand Dunes Tower | 0.1 | - | 0.8 | 13.9 | - | 66.0 |
| Van Buren Avenue | 0.1 | - | 0.9 J+[3] | 15.9 J[2] | - | 48.6 |
| **Boundary Locations** | | | | | | |
| Atomic City | 0.1 | - | 1.0 | 16.0 | - | 65.8 |
| Howe | 0.2 | - | 1.1 J[2] | 17.3 | - | 55.6 J[2] |
| Monteview | 0.2 | - | 1.2 | 15.7 | - | 63.1 |
| Mud Lake | 0.3 | - | 1.3 | 17.4 | - | 61.2 |
| **Distant Locations** | | | | | | |
| Craters of the Moon | -0.1 | - | 0.9[3] | 13.2 | - | 39.0 |
| Fort Hall[1] | 0.1 J[2] | - | 1.1 J+[2,3] | 10.2 J[2] | - | 34.3 J[2] |
| Idaho Falls | 0.2 J[2] | - | 1.0 J+[2,3] | 15.7 J[2] | - | 48.6 J[2] |

[1]Operated by Shoshone-Bannock Tribes.
[2]Air volume was estimated. Results are J-flagged as estimates.
[3] The TSP blank gross alpha result for the week of 2/16/22-2/23/22 minimally exceeded the MDC. The associated TSP gross alpha field result listed here was qualified as a biased-high estimate (J+) .
Note: Concentrations are expressed in 1 x $10^{-3}$ pCi/$m^3$.

**Table 3. Gamma spectrometry analysis data for 47-mm TSP filters, quarterly composite samples, first quarter, 2022.**

| Station Location | Naturally Occurring Radionuclide Beryllium-7 | | | Man-Made Gamma Emitting Radionuclides | | |
|---|---|---|---|---|---|---|
| | Concentration | ± 2 SD | MDC | Concentration | ± 2 SD | MDC[2] |
| **On-site Locations** | | | | | | |
| Big Lost River Rest Area | 54.6 | 3.9 | 2.4 | 0.07 | 0.08 | 0.13 |
| Experimental Field Station | 79.6 J[3] | 5.3 J | 2.5 J | 0.01 J | 0.14 J | 0.24 J |
| Sand Dunes Tower | 102.0 J[3] | 7.0 J | 3.4 J | -0.01 J | 0.08 J | 0.16 J |
| Van Buren Avenue | 61.1 J[3] | 4.6 J | 1.6 J | 0.01 J | 0.07 J | 0.12 J |
| **Boundary Locations** | | | | | | |
| Atomic City | 79.8 J[3] | 5.0 J | 1.8 J | 0.04 J | 0.07 J | 0.12 J |
| Howe | 63.1 J[3] | 4.2 J | 1.5 J | 0.00 J | 0.06 J | 0.10 J |
| Monteview | 83.4 | 5.4 | 2.3 | 0.11 | 0.11 | 0.18 |
| Mud Lake | 61.6 J[3] | 4.2 J | 1.4 J | 0.03 J | 0.06 J | 0.10 J |
| **Distant Locations** | | | | | | |
| Craters of the Moon | 87.4 | 5.8 | 2.7 | 0.08 | 0.12 | 0.19 |
| Fort Hall[1] | 70.5 J[3] | 4.5 J | 1.9 J | 0.09 J | 0.09 J | 0.15 J |
| Idaho Falls | 89.1 J[3] | 5.7 J | 2.8 J | 0.03 J | 0.08 J | 0.13 J |

[1]Operated by Shoshone-Bannock Tribes.
[2]MDC is for Cs-137. No man-made gamma emitting radionuclides were detected.
[3]Air volume was estimated in at least one weekly TSP sample for all locations. Results are J-flagged as estimates.
Note: Concentrations are reported in 1 x $10^{-3}$ pCi/$m^3$ with associated uncertainty (± 2 SD) and minimum detectable concentration (MDC).

**Table 4. Gamma spectrometry analysis data for 8x10-inch TSP filters, monthly composite samples, first quarter, 2022.**

| Station Location | Month | Naturally Occurring Radionuclide Beryllium-7 | | | Man-Made Gamma Emitting Radionuclides | | |
|---|---|---|---|---|---|---|---|
| | | Concentration | ± 2 SD | MDC | Concentration | ± 2 SD | MDC[2] |
| **On-site Locations** | | | | | | | |
| Big Lost River Rest Area | Jan | 82.6 | 4.5 | 1.0 | 0.00 | 0.03 | 0.06 |
| | Feb | 93.0 | 5.3 | 0.7 | 0.03 | 0.04 | 0.06 |
| | Mar[7] | 101.3 | 5.8 | 0.7 | -0.01 | 0.03 | 0.05 |
| Experimental Field Station | Jan | NS[4] | NS | NS | NS | NS | NS |
| | Feb | 82.0 | 4.8 | 0.6 | 0.02 | 0.03 | 0.06 |
| | Mar[7] | 107.6 | 6.1 | 0.6 | 0.01 | 0.02 | 0.04 |
| Sand Dunes Tower | Jan | 90.1 | 5.3 | 0.8 | 0.04 | 0.04 | 0.06 |
| | Feb | 88.4 | 5.1 | 0.8 | 0.03 | 0.04 | 0.07 |
| | Mar[7] | 108.1 | 6.1 | 0.6 | 0.02 | 0.02 | 0.04 |
| Van Buren Avenue | Jan | 88.5 | 4.8 | 1.1 | -0.02 | 0.03 | 0.05 |
| | Feb | 79.7 | 4.6 | 0.7 | 0.02 | 0.03 | 0.05 |
| | Mar[7] | 90.9 | 5.2 | 0.6 | 0.01 | 0.03 | 0.06 |
| **Boundary Locations** | | | | | | | |
| Atomic City | Jan | 104.8 | 6.0 | 0.8 | -0.02 | 0.05 | 0.08 |
| | Feb | 92.6 | 5.4 | 0.7 | 0.01 | 0.04 | 0.06 |
| | Mar[7] | 125.5 | 7.1 | 0.6 | 0.02 | 0.03 | 0.05 |
| Howe | Jan[5] | 84.0 | 5.1 | 1.6 | -0.03 | 0.08 | 0.14 |
| | Feb | 78.1 | 4.5 | 0.7 | 0.03 | 0.04 | 0.06 |
| | Mar[7] | 99.2 | 5.6 | 0.7 | 0.02 | 0.03 | 0.04 |
| Monteview | Jan | 97.4 | 5.3 | 1.0 | -0.01 | 0.03 | 0.06 |
| | Feb | 98.9 | 5.8 | 0.8 | -0.01 | 0.03 | 0.06 |
| | Mar[7] | 107.9 | 6.2 | 0.6 | 0.00 | 0.02 | 0.04 |
| Mud Lake | Jan[5] | 93.4 | 6.5 | 3.9 | 0.01 | 0.05 | 0.09 |
| | Feb | 77.7 | 4.5 | 0.8 | 0.01 | 0.04 | 0.06 |
| | Mar[7] | 107.0 | 6.1 | 0.7 | 0.01 | 0.02 | 0.04 |
| **Distant Locations** | | | | | | | |
| Craters of the Moon | Jan | 91.3 | 5.3 | 0.7 | 0.01 | 0.03 | 0.04 |
| | Feb | 113.7 | 6.5 | 0.7 | -0.01 | 0.05 | 0.09 |
| | Mar[7] | 112.7 | 6.4 | 0.6 | -0.01 | 0.02 | 0.04 |
| Fort Hall[1] | Jan | NS[4] | NS | NS | NS | NS | NS |
| | Feb[6] | 86.9 | 5.6 | 2.5 | -0.04 | 0.12 | 0.20 |
| | Mar[7] | 85.0 | 4.9 | 0.6 | 0.01 | 0.02 | 0.03 |
| Idaho Falls | Jan | 88.3 | 4.8 | 1.0 | 0.00 | 0.03 | 0.05 |
| | Feb | 86.9 | 5.1 | 0.8 | -0.01 | 0.03 | 0.05 |
| | Mar[7] | 116.8 | 6.6 | 0.6 | 0.00 | 0.03 | 0.05 |
| Idaho Falls Duplicate[3] | Jan | NS[4] | NS | NS | NS | NS | NS |
| | Feb | 82.9 | 4.8 | 0.8 | 0.02 | 0.03 | 0.05 |
| | Mar[7] | 95.2 | 5.5 | 0.6 | -0.01 | 0.02 | 0.04 |

[1]Operated by Shoshone-Bannock Tribes.
[2]MDC is for Cs-137. No man-made gamma emitting radionuclides were detected.
[3] A duplicate 8x10-inch filter TSP sampler is currently being operated at the Idaho Falls location.
[4] NS – No sample. The Experimental Field Station and Idaho Falls Duplicate samplers were deployed on1/26/22. The Fort Hall sampler was started on 2/15/22.
[5] Two filters/composite in January for Howe and Mud Lake. The Howe and Mud Lake samplers were deployed on 1/12/22. Other locations had four filters/composite.
[6] One filter in February for Fort Hall. Other locations had four filters/composite.
[7] Five filters/composite in March for all locations.
Note: Concentrations are reported in 1 x $10^{-3}$ pCi/$m^3$ with associated uncertainty (± 2 SD) and minimum detectable concentration (MDC).

**Table 5. Iodine-131 activity in weekly charcoal filter composites, first quarter, 2022.**

| Start Date | Collection Date | Iodine-131 activity (pCi/composite) | | |
|---|---|---|---|---|
| | | Activity | ± 2 SD | MDA[1] |
| 12/29/21 | 01/05/22 | -0.31 | 1.34 | 2.32 |
| 01/05/22 | 01/12/22 | -0.50 | 1.46 | 2.52 |
| 01/12/22 | 01/19/22 | -0.19 | 1.28 | 2.22 |
| 01/19/22 | 01/26/22 | -0.72 | 1.11 | 1.99 |
| 01/26/22 | 02/02/22 | -0.93 | 1.46 | 2.55 |
| 02/02/22 | 02/09/22 | -0.59 | 1.37 | 2.92 |
| 02/09/22 | 02/16/22 | -0.24 | 1.11 | 1.93 |
| 02/16/22[2] | 02/23/22 | -1.03 | 2.07 | 3.55 |
| 02/23/22[2] | 03/02/22 | 0.08 | 1.56 | 2.66 |
| 03/02/22 | 03/09/22 | -0.10 | 1.35 | 2.31 |
| 03/09/22 | 03/16/22 | -0.16 | 1.11 | 1.93 |
| 03/16/22 | 03/23/22 | 0.06 | 1.45 | 2.47 |
| 03/23/22 | 03/30/22 | 0.03 | 1.39 | 2.37 |

[1]The minimum detectable activity (MDA) is established for the least efficient counting position in the eleven-cartridge composite.
[2]For the weeks beginning on 02/16/22 and 02/23/22, there were no cartridges from the Experimental Field Station sampler. Based on a typical 20,000 $ft^3$ (566 $m^3$) air volume per cartridge, and only ten cartridges per composite for the week of 02/16/22, the highest I-131 MDA of 3.55 pCi/composite is equivalent to a maximum MDC of 6 $x10^{-4}$ $pCi/m^3$.

**Table 6. Tritium concentrations in air from atmospheric moisture, first quarter, 2022.**

| Station Location | Start Date | Collection Date | Tritium | | |
|---|---|---|---|---|---|
| | | | Concentration | ± 2 SD | MDC |
| **On-site Locations** | | | | | |
| Big Lost River Rest Area | 12/29/2021 | 03/09/2022 | -0.02 | 0.21 | 0.35 |
| Big Lost River Rest Area | 03/09/2022 | 03/30/2022 | 0.23 | 0.38 | 0.63 |
| **Big Lost River Rest Area Mean** | **12/29/2021** | **03/30/2022** | **0.05** | **0.25** | **0.43** |
| | | | | | |
| Experimental Field Station | 12/29/2021 | 03/16/2022 | 0.30 | 0.22 | 0.35 |
| Experimental Field Station | 03/16/2022 | 03/30/2022 | 0.27 | 0.43 | 0.71 |
| **Experimental Field Station Mean** | **12/29/2021** | **03/30/2022** | **0.29** | **0.27** | **0.43** |
| | | | | | |
| Sand Dunes Tower | 12/29/2021 | 03/16/2022 | 0.14 | 0.22 | 0.37 |
| Sand Dunes Tower | 03/16/2022 | 03/30/2022 | 0.43 | 0.42 | 0.68 |
| **Sand Dunes Tower Mean** | **12/29/2021** | **03/30/2022** | **0.19** | **0.26** | **0.42** |
| | | | | | |
| Van Buren Avenue | 12/29/2021 | 02/23/2022 | -0.06 | 0.21 | 0.37 |
| Van Buren Avenue | 02/23/2022 | 03/30/2022 | 0.01 | 0.29 | 0.49 |
| **Van Buren Avenue Mean** | **12/29/2021** | **03/30/2022** | **-0.03** | **0.24** | **0.42** |
| | | | | | |
| **Boundary Locations** | | | | | |
| Atomic City | 12/29/2021 | 02/23/2022 | 0.07 | 0.22 | 0.37 |
| Atomic City | 02/23/2022 | 03/30/2022 | 0.18 | 0.31 | 0.52 |
| **Atomic City Mean** | **12/29/2021** | **03/30/2022** | **0.11** | **0.25** | **0.42** |
| | | | | | |
| Howe | 12/29/2021 | 03/09/2022 | -0.09 | 0.20 | 0.35 |
| Howe | 03/09/2022 | 03/30/2022 | 0.00 | 0.37 | 0.64 |
| **Howe Mean** | **12/29/2021** | **03/30/2022** | **-0.07** | **0.23** | **0.41** |
| | | | | | |
| Mud Lake | 12/29/2021 | 03/16/2022 | 0.21 | 0.22 | 0.36 |
| Mud Lake | 03/16/2022 | 03/30/2022 | 0.17 | 0.43 | 0.72 |
| **Mud Lake Mean** | **12/29/2021** | **03/30/2022** | **0.21** | **0.25** | **0.42** |
| | | | | | |
| Monteview | 12/29/2021 | 03/30/2022 | -0.05 | 0.23 | 0.39 |
| **Monteview Mean** | **12/29/2021** | **03/30/2022** | **-0.05** | **0.23** | **0.39** |
| **Distant Locations** | | | | | |
| Craters of the Moon | 12/29/2021 | 02/16/2022 | 0.09 | 0.22 | 0.37 |
| Craters of the Moon | 02/16/2022 | 03/30/2022 | 0.10 | 0.27 | 0.46 |
| **Craters of the Moon Mean** | **12/29/2021** | **03/30/2022** | **0.10** | **0.25** | **0.42** |
| | | | | | |
| Fort Hall[1] | 12/29/2021 | 02/16/2022 | -0.04 | 0.30 | 0.52 |
| Fort Hall | 02/16/2022 | 03/30/2022 | 0.04 | 0.32 | 0.55 |
| **Fort Hall Mean** | **12/29/2021** | **03/30/2022** | **0.00** | **0.31** | **0.53** |
| | | | | | |
| Idaho Falls | 12/29/2021 | 02/16/2022 | -0.07 | 0.26 | 0.45 |
| Idaho Falls | 02/16/2022 | 03/30/2022 | 0.22 | 0.33 | 0.55 |
| **Idaho Falls Mean** | **12/29/2021** | **03/30/2022** | **0.06** | **0.29** | **0.49** |

[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 7. Tritium and gamma-emitting radionuclide concentrations from precipitation, first quarter, 2022.**

| Station Location | Tritium | | | Cesium-137 | | |
|---|---|---|---|---|---|---|
| | Concentration | ± 2 SD | MDC | Concentration | ± 2 SD | MDC |
| **On-site Locations** | | | | | | |
| Big Lost River Rest Area | 40 | 100 | 160 | -0.9 | 1.1 | 2.1 |
| **Boundary Locations** | | | | | | |
| Atomic City | -10 | 90 | 160 | 0.4 | 1.2 | 2.1 |
| Howe | 10 | 90 | 160 | 1.1 | 1.5 | 2.5 |
| Monteview | 70 | 100 | 160 | 0.8 | 1.5 | 2.6 |
| Mud Lake | 20 | 90 | 160 | 0.6 | 1.2 | 2.0 |
| **Distant Locations** | | | | | | |
| Idaho Falls | -40 | 90 | 160 | -0.6 | 1.2 | 2.3 |

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

**Table 8. Annual radiochemical separation analysis data for 4-inch TSP particulate filters collected during 2021.**

| Station Location | $^{90}$Sr | | | $^{238}$Pu | | | $^{239/240}$Pu | | | $^{241}$Am | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Value[1] | ±2SD | MDC | Value[1] | ± 2SD | MDC | Value[1] | ±2SD | MDC | Value[1] | ±2SD | MDC |
| **On-Site Locations** | | | | | | | | | | | | |
| BLR[4] Rest Area J[6] | 2.01 | 3.55 | 5.80 | 0.03 | 0.06 | 0.10 | 0.03 | 0.06 | 0.10 | 0.03 | 0.03 | 0.13 |
| EFS[3] J[6] | 9.0 | 4.58 | 6.42 | 0.03 | 0.16 | 0.09 | 0.18 | 0.16 | 0.09 | -0.05 | 0.09 | 0.21 |
| Sand Dunes J[6] | 5.36 | 4.76 | 7.50 | -0.05 | 0.24 | 0.52 | 0.08 | 0.21 | 0.40 | -0.05 | 0.15 | 0.36 |
| Van Buren J[6] | 12.46 | 6.09 | 8.58 | 0.17 | 0.29 | 0.50 | 0.11 | 0.26 | 0.50 | 0.02 | 0.03 | 0.06 |
| **Boundary Locations** | | | | | | | | | | | | |
| Atomic City J[6] | 8.22 | 5.52 | 8.35 | 0.05 | 0.30 | 0.59 | 0.05 | 0.27 | 0.40 | -0.01 | 0.06 | 0.13 |
| Howe J[6] | 5.03 | 4.40 | 7.04 | -0.52 | 0.77 | 1.81 | 0.00 | 0.63 | 1.38 | 0.10 | 0.60 | 1.25 |
| Monteview J[6] | 5.73 | 4.63 | 7.28 | 0.08 | 0.19 | 0.34 | 0.08 | 0.21 | 0.40 | 0.06 | 0.33 | 0.65 |
| Mud Lake J[6] | 0.24 | 2.74 | 4.64 | 0.07 | 0.09 | 0.13 | 0.07 | 0.09 | 0.13 | 0.03 | 0.04 | 0.06 |
| **Distant Locations** | | | | | | | | | | | | |
| Craters of Moon J[6] | 22.11 | 6.59 | 6.45 | 0.00 | 0.52 | 0.78 | -0.11 | 0.52 | 0.99 | 0.10 | 0.52 | 0.82 |
| Fort Hall[2] J[6] | 6.36 | 6.36 | 10.1 | 0.03 | 0.07 | 0.13 | 0.07 | 0.05 | 0.03 | 0.05 | 0.04 | 0.05 |
| Idaho Falls J[6] | 0.00 | 5.08 | 8.39 | -0.12 | 0.20 | 0.44 | 0.17 | 0.23 | 0.38 | 0.01 | 0.03 | 0.07 |
| Idaho Falls Dup J[6] | 7.27 | 5.96 | 9.30 | -0.18 | 0.23 | 0.52 | -0.08 | 0.21 | 0.48 | -0.07 | 0.29 | 0.56 |

Note: Concentrations are reported in 1 x $10^{-5}$ pCi/m$^3$ with associated uncertainty (± 2 SD), minimum detectable concentration (MDC), and correspond to filter composites collected during the calendar year.

[1] Measurable quantities of these radionuclides are expected in the environment due to historic above-ground testing of nuclear weapons, and possibly from INL programs. DEQ-INL OP's action levels of 19 for americium-241, 190 for strontium-90, 21 for plutonium-238, and 20 for plutonium-239/240 (in 1 x $10^{-5}$ pCi/m$^3$) are 10 percent of the compliance values listed for the specific radionuclide in 40 CFR 61, Appendix E, Table 2.

[2] Operated by Shoshone-Bannock Tribes.

[3] Experimental Field Station.

[4] BLR – Big Lost River.

[5] Dup – Duplicate TSP sampler being run at the Idaho Falls location in 2021.

[6] The ISU vendor lab non-conformance report listed significant quality control issues associated with the analyses of these samples. Also, air volume was estimated in at least one weekly TSP sample for all locations. All values are therefore considered as estimates (J-flagged).

# Environmental Radiation Monitoring Results

The ESP operated 13 environmental radiation stations during the first quarter of 2022 (**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 an EcoGamma gamma radiation monitor with low and high range Geiger-Müller detectors (**Table 8**).

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

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 EcoGammas at each location are transmitted to DEQ-INL OP and presented graphically via the worldwide web at https://www.deq.idaho.gov/idaho-national-laboratory-oversight/inl-oversight-program/gamma-radiation-measurements. Historically, DEQ-INL OP has used high-pressure ion chambers (HPIC) for real-time gamma radiation measurements. We have now completed a change-over of removing the old HPICs and replacing them with EcoGammas at each of our monitoring stations. Slight differences between EcoGamma data and historical HPIC data are expected.

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 9** lists the average radiation exposure rates measured by the EcoGammas for first quarter 2022. **Table 10** lists the EIC monitoring results for first quarter 2022. Overall exposure rates were within the expected historical range of values observed by DEQ-INL OP for background radiation

**Table 9. Summary of instrumentation at radiation monitoring stations.**

| Station Location | Instrument Type | |
|---|---|---|
| | 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 10. Average gamma exposure rates, first quarter, 2022, EcoGamma* network.**

| Station Location | Exposure Rate (µR/hr) | |
|---|---|---|
| | Quarterly Average | ± 2 SD |
| **On-site Locations** | | |
| Base of Howe | 16.7 | 1.1 |
| Big Lost River Rest Area | 14.7 | 0.8 |
| Rover[1] | - | - |
| Sand Dunes Tower | 15.1 | 0.8 |
| **Boundary Locations** | | |
| Atomic City | 14.2 | 0.9 |
| Big Southern Butte | 16.2 | 1.4 |
| Big Southern Butte Duplicate[2] | 12.7 | 1.0 |
| Howe Met Tower | 14.1 | 0.8 |
| Monteview | 12.1 | 0.8 |
| Mud Lake / Terreton | 14.1 | 0.8 |
| **Distant Locations** | | |
| Fort Hall | 13.8 | 0.7 |
| Idaho Falls | 15.5 | 0.8 |

*The 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.

[1] No data for this quarter.

[2] A duplicate EcoGamma is installed at Big Southern Butte for testing.

**Table 11. Electret ionization chamber (EIC) cumulative average exposure rates, first quarter, 2022.**

| Station Location | Exposure Rate (µR/hr) | |
|---|---|---|
| | Quarterly Average[1] | ± 2 SD |
| **On-Site Locations** | | |
| Base of Howe | 11.5 | 0.5 |
| Big Lost River Rest Area | 12.8 | 1.7 |
| Experimental Field Station | 11.7 | 2.7 |
| Rover | 14.2 | 1.6 |
| Sand Dunes Tower | 12.0 | 2.1 |
| Van Buren Avenue | 20.4, 20.8 | - |
| **Boundary Locations** | | |
| Atomic City | 12.7 | 1.4 |
| Big Southern Butte | 13.3 | 2.2 |
| Howe Met Tower | 13.5 | 4.6 |
| Monteview | 14.1 | 3.2 |
| Mud Lake/Terreton | 13.6 | 5.4 |
| **Distant Locations** | | |
| Craters of the Moon | 11.2 | 4.9 |
| Fort Hall | 8.5, 9.7 | - |
| Idaho Falls | 10.3 | 1.5 |

[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 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 85-90 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 second 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.[2] 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 first quarter of 2022, DEQ-INL OP sampled groundwater from the aquifer at 6 facility locations. **Table 12** lists the sample date, co-sampler, well depth, and analyses requested for the locations sampled this quarter. Analytical results are reported in **Tables 14 through 22** and summarized below.

**Table 13** 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 background ranges due to higher-than-average concentrations of naturally occurring uranium, thorium, or potassium-40.

[2] 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 for gross alpha and gross beta radioactivity, gamma-emitting radionuclides, and tritium during the second quarter. In the fourth quarter, samples are collected for common ions, metals, nitrate-plus-nitrite, and other constituents along with gross alpha and gross beta radioactivity, gamma-emitting radionuclides, and tritium.

Six facility locations were analyzed for gross alpha and beta radioactivity this quarter. (**Table 14**). Gross alpha radioactivity was measured at concentrations within the known background range at all locations. In contrast, elevated gross beta concentrations were measured at all but one location. TAN-2336 had the highest gross beta concentration value at 1601.5 ± 48.9 pCi/L, which is consistent with the well's elevated $^{90}$Sr results. At INTEC, an elevated gross beta concentration result of 720.6 ± 6.3 pCi/L was measured at ICPP-MON-A-230. Concentrations are consistent with previous results. The gross beta values at USGS-052 this quarter at 246.2 ± 3.5 pCi/L were elevated from the 2021 values of 199.9 ± 3.3 pCi/L. The elevated gross beta concentrations are likely due to increasing $^{99}$Tc values. In 2021, $^{99}$Tc concentration values for USGS-052 were 316 ± 53 pCi/L. This quarter they increased to 337 ± 56 pCi/L (original sample) and 401 ± 67 pCi/L (duplicate). We will continue to watch this well for an upward trend. All other detectable concentrations in groundwater were consistent with historical data and were measured in areas of known contamination related to past INL waste disposal practices.

*Manmade gamma-emitting radionuclides*

There was just one location sampled this quarter where manmade gamma-emitting radionuclides were detected: TAN-2336 had a cesium-137 concentration of 6.1 ± 1.9 pCi/L. Although the values increased from 3.0 ± 1.8 pCi/L in 2021, they are well below the drinking water MCL of 200 pCi/L for Cs-137. All results for cesium-137 ($^{137}$Cs), the manmade gamma-emitter most likely to be detected in groundwater, are reported in **Table 14**.

*Tritium*

Tritium was analyzed for all INTEC and TAN aquifer locations sampled this quarter (**Table 15**) with elevated tritium concentrations observed in all the samples. The highest tritium concentration was observed at INTEC well USGS-123 at 1552 ± 160 pCi/L. Elevated tritium concentrations (475 ± 110 pCi/L) were also present at TAN-2336.

Results from the wells are consistent with historical trends and all tritium concentrations reported in this quarter are below the drinking water MCL of 20,000 pCi/L. No low-level tritium samples were taken this quarter and there is currently no backlog for low-level tritium analyses.

*Strontium-90*

All six aquifer facility wells (INTEC and TAN) were sampled for $^{90}$Sr this quarter (**Table 16**) and all samples with exception of USGS-123, had detectible concentrations. Concentrations ranged from 1.93 ± 0.51 pCi/L at USGS-052 to 590 ± 140 pCi/L at TAN-2336. TAN-2336, USGS-047, and USGS-067 exceeded the drinking water MCL of 8 pCi/L; however, all results were within historical ranges.

In the Fall of 2021, boundary well USGS-104 was sampled for $^{90}$Sr with results of 1.03 ± 0.42 pCi/L (MDC = 0.63). The historical range of values for this location has been approximately 0 – 0.2 pCi/L (less-than-MDC values). The lab did not indicate problems with the analysis yielding the elevated values and the gross beta results for USGS-104 were consistent with past results at 2.4 ± 0.9 pCi/L; no reason was found to reject the elevated results. Due to the increased $^{90}$Sr values, a re-analysis of the original sample along with a re-analysis of the original sample for CFA-2, located directly upstream from USGS-104, were requested from the lab. The re-analyses resulted in non-detects for both samples with USGS-104 at -0.05 ± 0.12 pCi/L (MDC = 0.23 pCi/L) and CFA-2 at 0.01 ± 0.13 pCi/L (MDC = 0.25 pCi/L). Routine sampling of USGS-104 and CFA-2 is scheduled to occur in the Fall of 2022. Future results will be carefully reviewed.

*Technetium-99*

All five of the INTEC locations were sampled for $^{99}Tc$ (**Table 17**) and all results were consistent with historical data. ICPP-MON-A-230, USGS-052, and USGS-067 had detectable concentrations, with the highest concentrations of 1310 ± 210 pCi/L at ICPP-MON-A-230. This is a slight decrease from concentrations of 1510 ± 240 pCi/L observed in 2021. With exception of ICPP-MON-A-230, all concentrations were below the drinking water MCL of 900 pCi/L.

*Iodine-129*

Three INTEC locations (USGS-047, USGS-067, and USGS-123) were sampled for $^{129}I$; however, the results from the lab are not yet available. Once available, results will be published in a future quarterly report.

*Actinides*

One location at TAN (TAN-2336) was sampled for uranium isotopes this quarter (**Table 18**). Results for $^{234}U$ and $^{238}U$ measured within background concentration levels at 0.94 ± 0.26 pCi/L and 0.17 ± 0.09 pCi/L, respectively. An elevated $^{234}U/^{238}U$ activity ratio of 5.5 suggests that the source was anthropogenic. Results for $^{235}U$ were elevated above background levels at 0.09 ± 0.074 pCi/L; however, this result is considered an estimate (J-flagged) because it is less than three sample standard deviations. All results for uranium isotopes were consistent with previous results.

*Common ions, trace metals, and nutrients*

All five INTEC locations were sampled for chloride, chromium, sulfate, alkalinity, and dissolved nutrients (nitrate-plus-nitrite). One TAN location was sampled for common ions, trace metals, nutrients (nitrate-plus-nitrite), and phosphorus. (**Tables 19, 20, and 21**).

TAN-2336 exceeded most background levels for common ions, trace metals, and phosphorus, which is likely due to the on-going bioremediation well injections. TAN-2336 had the highest concentrations above background for chloride at 125 mg/L and alkalinity at 5660 mg/L. The alkalinity results were much higher than reported for TAN-2336 in 2021 at 1260 mg/L. INTEC well ICPP-MON-A-230 had slightly elevated concentrations of chloride (74.0 mg/L) above background. All other locations' results for common ions were within background concentration levels.

TAN-2336 exceeded background levels for trace metals: barium (1600 µg/L, MCL is 2000 µg/L), chromium (130 µg/L, MCL is 100 µg/L), iron (16000 µg/L, SMCL is 300 µg/L), and manganese (2200 µg /L, SMCL is 50 µg/L). ICPP-MON-A-230, USGS-123, USGS-047, USGS-052, and USGS-067 had slightly elevated concentrations of chromium above background; however, these values were similar to past values.

ICPP-MON-A-230 exceeded background concentration levels for nutrients ($NO_3 + NO_2$) at 6.8 mg/L, however, this value is slightly lower than the 2021 value of 7.3 mg/L. USGS-067 exceeded background concentration levels for nutrients at 5.2 mg/L. This value is essentially the same as the 2021 value of 5.3 mg/L. The other wells sampled for nutrients were within the background range (<0.04 – 3.59). The only well that was sampled for phosphorus this quarter was TAN-2336, which resulted in a phosphorus concentration above background at 11 mg/L.

*Volatile organic compounds (VOCs)*

VOCs were measured at TAN-2336 (**Table 22**). Notable MCL exceedances and/or changes from previous measurements include:

- TAN-2336: MEK (2-Butanone) = 1140 µg/L, up from <0.5 µg/L in 2021
- TAN-2336: Methylene chloride = 21.2 µg/L, up from <0.5 µg/L in 2021

During the fermentation process that results from the bioremediation well injections conducted at TAN-2336, significant levels of MEK (2-Butanone) are produced. The levels are transient and are expected to rapidly dissipate once the bioremediation injections are complete. An article written by Fowler, Thompson, Mueller, 2011 discussing this process, can be found at: https://doi.org/10.1002/rem.21296. The VOCs detected above do not have established EPA MCLs. No other VOCs were detected this quarter. Appendix C provides a list of VOCs analyzed for water samples.

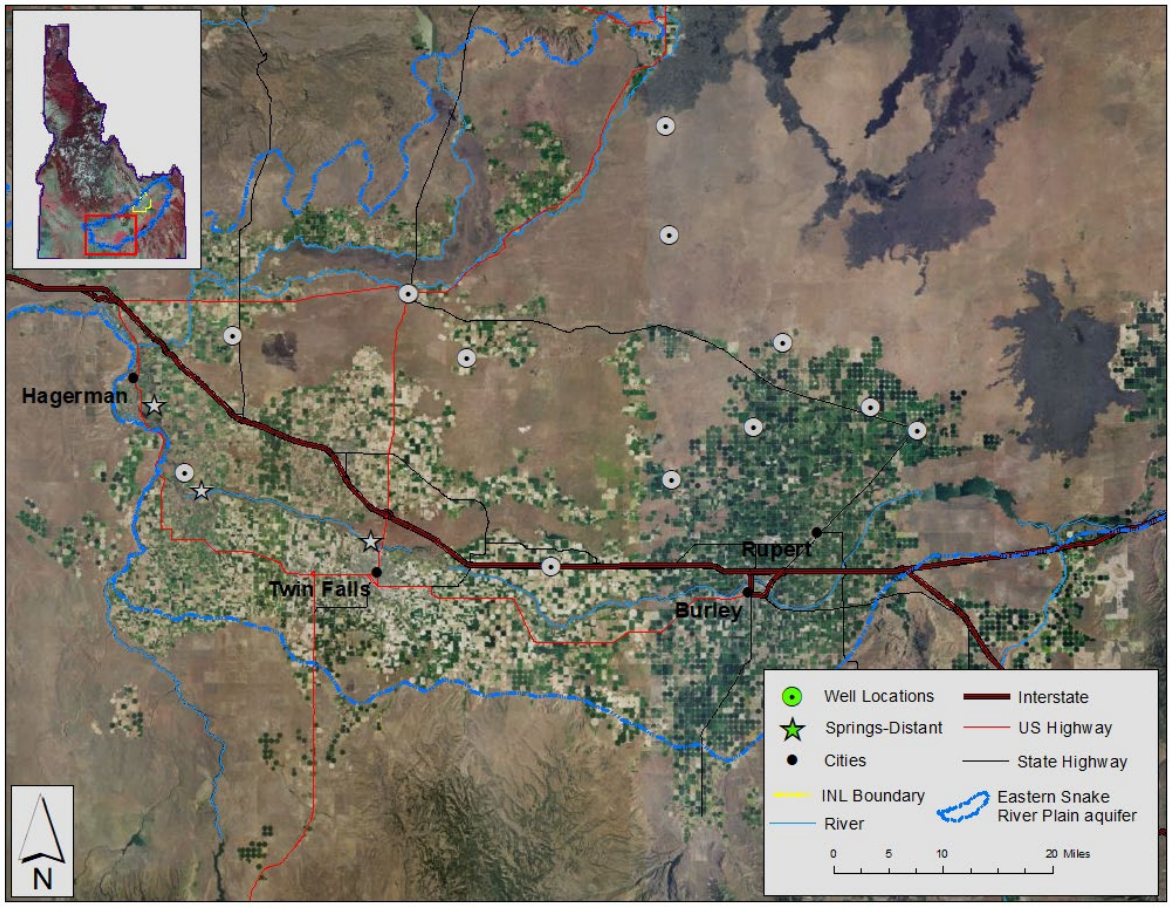


**Figure 2. Distant water monitoring locations. No distant water monitoring sites were sampled during reporting period.**

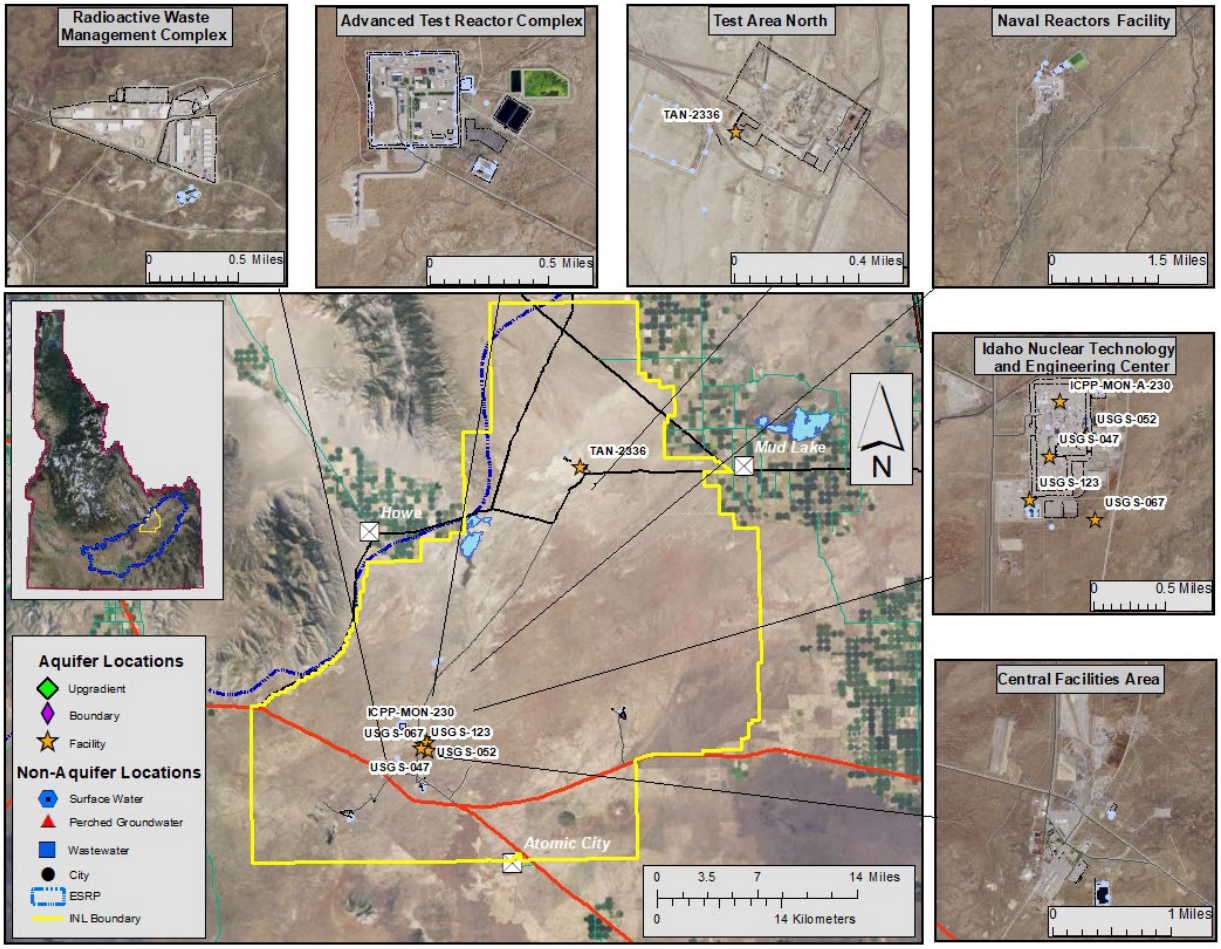


**Figure 3. Up-gradient, facility, boundary, perched groundwater (GW), surface water, and wastewater monitoring locations.**

**Table 12. Locations sampled for water, first quarter, 2022.**

| Sample Location | Date Sampled | Co-sampler | Well Depth (ft bgs) | Analyses* |
|---|---|---|---|---|
| **Aquifer Samples** | | | | |
| **Facility** | | | | |
| ***Idaho Nuclear Technology and Engineering Center:*** | | | | |
| ICPP-MON-A-230 | 03/28/2022 | IEC | 503 | α, β, γ, $^{3}H$, $^{90}Sr$, $^{99}Tc$, $Cl^-$, $SO_4^{2-}$, Cr, $NO_3$+$NO_2$ |
| USGS-047 | 03/28/2022 | IEC | 488 | α, β, γ, $^{3}H$, $^{90}Sr$, $^{99}Tc$, $^{129}I$, $Cl^-$, $SO_4^{2-}$, Cr, $NO_3$+$NO_2$ |
| USGS-052 | 03/29/2022 | IEC | 461 | α, β, γ, $^{3}H$, $^{90}Sr$, $^{99}Tc$, $Cl^-$, $SO_4^{2-}$, Cr, $NO_3$+$NO_2$ |
| USGS-067 | 03/29/2022 | IEC | 685 | α, β, γ, $^{3}H$, $^{90}Sr$, $^{99}Tc$, $^{129}I$, $Cl^-$, $SO_4^{2-}$, Cr, $NO_3$+$NO_2$ |
| USGS-123 | 03/02/2022 | IEC | 474 | α, β, γ, $^{3}H$, $^{90}Sr$, $^{99}Tc$, $^{129}I$, U iso, $Cl^-$, $SO_4^{2-}$, Cr, $NO_3$+$NO_2$ |
| ***Test Area North:*** | | | | |
| TAN-2336 | 01/11/2022 | IEC | 255 | α, β, γ, $^{3}H$, $^{90}Sr$, U iso., com. ions, trace metals, $NO_3$+$NO_2$, P, VOCs |

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; $^{241}Am$ = Americium-241; P iso. = $^{238}Pu$, $^{239/240}Pu$; U iso. = $^{234}U$, $^{235}U$, $^{238}U$; $Cl^-$ = chloride; Cr = chromium; com. ions = calcium ($Ca^{2+}$), magnesium ($Mg^{2+}$), sodium ($Na^+$), potassium ($K^+$), chloride ($Cl^-$), sulfate ($SO_4^{2-}$), alkalinity; trace metals = arsenic (As), barium (Ba), chromium (Cr), iron (Fe), manganese (Mn), lead (Pb); $NO_3$+$NO_2$ = nitrate plus nitrite; P = phosphorus, and VOCs = volatile organic compounds.
IEC = Idaho Environmental Coalition, LLC - This is a contractor that replaced Fluor Idaho, LLC in 2021.

**Table 13. 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,3] | 30 µg/L (total U) |
| Uranium-235 | 0-0.048[b] | |
| Uranium-238 | 0.021-0.719[b,3] | |
| 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.
[3] ESRPA samples containing only naturally occurring uranium should have a $^{234}U/^{238}U$ activity ratio of about 1.5 to 3.1.

**Table 14. Gross alpha, gross beta, and man-made gamma-emitting radionuclide concentrations (pCi/L) in water samples, first quarter, 2022.**

| Sample Location | Sample Date | Gross Alpha | | | Gross Beta | | | Cesium-137* | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | Concentration | | 2 SD | Concentration | | 2 SD | Concentration | | 2 SD |
| **Aquifer Samples** | | | | | | | | | | |
| **Facility** | | | | | | | | | | |
| ***Idaho Nuclear Technology and Engineering Center*** | | | | | | | | | | |
| ICPP-MON-A-230 | 03/28/2022 | 5.2 | - | 1.5 | 720.6 | - | 6.3 | 0.4 | U | 1.3 |
| USGS-047 | 03/28/2022 | 1.7 | - | 0.8 | 33.7 | - | 1.5 | 2.1 | U | 1.4 |
| USGS-052 | 03/292022 | -0.5 | U | 0.8 | 246.2 | - | 3.5 | 0.3 | U | 1.3 |
| USGS-067 | 03/292022 | 2.2 | - | 0.9 | 106.6 | - | 2.5 | 0.8 | U | 1.1 |
| USGS-123 | 03/02/2022 | 2.0 | - | 0.7 | 2.5 | - | 0.9 | -0.4 | U | 1.1 |
| ***Test Area North*** | | | | | | | | | | |
| TAN-2336 | 01/11/2022 | 2.7 | U | 24.8 | 1601.5 | - | 48.9 | 6.1 | - | 1.9 |

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.
Typical MDC range (gross alpha) 0.7 – 1.9 pCi/L. Typical MDC range (gross beta) 1.2 – 1.4 pCi/L. Higher 2 SDs and MDCs for TAN-2336 were a result of high suspended/dissolved solids requiring a smaller sample for evaporation prior to counting. Typical MDC range (Cs-137) 1.8 – 2.7 pCi/L.

**Table 15. Tritium concentrations (pCi/L) in water samples, first quarter, 2022.**

| Sample Location | Sample Date | Tritium | | |
|---|---|---|---|---|
| | | Concentration | | 2 SD |
| **Aquifer Samples** | | | | |
| **Facility** | | | | |
| ***Idaho Nuclear Technology and Engineering Center*** | | | | |
| ICPP-MON-A-230 | 03/28/2022 | 695 | - | 120 |
| USGS-047 | 03/28/2022 | 342 | - | 110 |
| USGS-052 | 03/292022 | 313 | - | 120 |
| USGS-067 | 03/29/2022 | 1543 | - | 150 |
| USGS-123 | 03/02/2022 | 1552 | - | 160 |
| ***Test Area North*** | | | | |
| TAN-2336 | 01/11/2022 | 475 | - | 110 |

Data qualifiers: U = undetected, J = estimate, R = rejected, "+" or "-" after a J means that the estimated result is biased high or low, respectively. MDC range 150 - 170 pCi/L.

**Table 16. Strontium-90 concentrations (pCi/L) in water samples, first quarter, 2022.**

| Sample Location | Sample Date | Strontium-90 | | |
|---|---|---|---|---|
| | | Concentration | | 2 SD |
| **Aquifer Samples** | | | | |
| **Facility** | | | | |
| ***Idaho Nuclear Technology and Engineering Center*** | | | | |
| ICPP-MON-A-230 | 03/28/2022 | 2.31 | - | 0.62 |
| USGS-047 | 03/28/2022 | 11.8 | - | 2.8 |
| USGS-052 | 03/292022 | 1.93 | - | 0.54 |
| USGS-067 | 03/29/2022 | 9.2 | - | 2.2 |
| USGS-123 | 03/02/2022 | 0.50 | U | 0.38 |
| ***Test Area North*** | | | | |
| TAN-2336 | 01/11/2022 | 590 | - | 140 |

Data qualifiers: U = undetected, J = estimate, R = rejected, "+" or "-" after a J means that the estimated result is biased high or low, respectively.
MDC range 0 – 0.75 pCi/L.

**Table 17. Technetium-99 concentrations (pCi/L) for water samples, first quarter, 2022.**

| Sample Location | Sample Date | Technetium-99 | | |
|---|---|---|---|---|
| | | Concentration | | 2 SD |
| **Aquifer Samples** | | | | |
| **Facility** | | | | |
| ***Idaho Nuclear Technology and Engineering Center*** | | | | |
| ICPP-MON-A-230 | 03/28/2022 | 1310 | - | 210 |
| USGS-047 | 03/28/2022 | 2.5 | U | 3.4 |
| USGS-052 | 03/292022 | 337 | - | 56 |
| USGS-067 | 03/29/2022 | 128 | - | 23 |
| USGS-123 | 03/02/2022 | -1.7 | UJ | 3.4 |

Data qualifiers: U = undetected, J = estimate, R = rejected, "+" or "-" after a J means that the estimated result is biased high or low, respectively.
MDC range 5 – 10 pCi/L.

**Table 18. Uranium isotope concentrations (pCi/L) for water samples, first quarter, 2022.**

| 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-2336 | 01/11/2022 | 0.94 | - | 0.26 | 0.09 | J# | 0.074 | 0.173 | | 0.098 |

Data qualifiers: U = undetected, J = estimate, R = rejected, "+" or "-" after a J means that the estimated result is biased high or low, respectively.
# Result is >MDC and >2SD but <3SD and is therefore considered questionable and J-flagged as an estimate.
MDC (U-234) 0.09 pCi/L. MDC (U-235) 0.075 pCi/L. MDC (U-238) 0.087 pCi/L.

**Table 19. Common ion concentrations (mg/L) in water samples, first quarter, 2022.**

| Sample Location | Sample Date | Calcium* | | Magnesium* | | Sodium* | | Potassium* | | Fluoride | | Chloride | | Sulfate | | Alkalinity† | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Aquifer Samples** | | | | | | | | | | | | | | | | | |
| **Facility** | | | | | | | | | | | | | | | | | |
| ***Idaho Nuclear Technology and Engineering Center*** | | | | | | | | | | | | | | | | | |
| ICPP-MON-A-230 | 03/28/2022 | - | - | - | - | - | - | - | - | - | - | 74.0[1] | - | 35.8 | - | 135 | - |
| USGS-047 | 03/28/2022 | - | - | - | - | - | - | - | - | - | - | 14.1 | - | 23.0 | - | 145 | - |
| USGS-052 | 03/292022 | - | - | - | - | - | - | - | - | - | - | 20.4 | - | 24.6 | - | 142 | - |
| USGS-067 | 03/29/2022 | - | - | - | - | - | - | - | - | - | - | 41.3[1] | - | 27.7 | - | 135 | - |
| USGS-123 | 03/02/2022 | - | - | - | - | - | - | - | - | - | - | 19.9 | - | 21.1 | - | 130 | - |
| ***Test Area North*** | | | | | | | | | | | | | | | | | |
| TAN-2336 | 01/11/2022 | 170 | - | 120 | - | 2600 | - | 23 | - | - | - | 125[2] | - | 2.45[2] | UJ | 5660 | - |

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 $CaCO_3$.
"-" = not analyzed.
Note 1. Lab indicated that a 5:1 dilution of this sample was required for this analyte.
Note 2. Lab indicated that a 20:1 dilution of this sample was required for this analyte.

**Table 20. Dissolved metals concentrations (µg/L) in water samples, first quarter, 2022.**

| Sample Location | Sample Date | Arsenic | | Barium | | Chromium | | Iron | | Lead | | Manganese | | Selenium | | Zinc | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Aquifer Samples** | | | | | | | | | | | | | | | | | |
| **Facility** | | | | | | | | | | | | | | | | | |
| ***Idaho Nuclear Technology and Engineering Center*** | | | | | | | | | | | | | | | | | |
| ICPP-MON-A-230 | 03/28/2022 | - | - | - | - | 5.7 | - | - | - | - | - | - | - | - | - | - | - |
| USGS-047 | 03/28/2022 | - | - | - | - | 7.4 | - | - | - | - | - | - | - | - | - | - | - |
| USGS-052 | 03/292022 | - | - | - | - | 7.0 | - | - | - | - | - | - | - | - | - | - | - |
| USGS-067 | 03/29/2022 | - | - | - | - | 6.7 | - | - | - | - | - | - | - | - | - | - | - |
| USGS-123 | 03/02/2022 | - | - | - | - | 6.2 | - | - | - | - | - | - | - | - | - | - | - |
| ***Test Area North*** | | | | | | | | | | | | | | | | | |
| TAN-2336[1] | 01/11/2022 | 15[2] | UJ | 1600 | - | 130 | - | 16000 | - | 0 | U | 2200 | - | - | - | - | - |

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.
Note 1. Lab indicated that a 12.5:1 dilution of this sample was required for these analytes.
Note 2. The MDC was elevated due to the 12.5:1 dilution and therefore this value is a non-detect.

**Table 21. Dissolved nutrient concentrations (mg/L) in water samples, first quarter, 2022.**

| Sample Location | Sample Date | Nitrate + Nitrite* | | Total Phosphorus | |
|---|---|---|---|---|---|
| **Aquifer Samples** | | | | | |
| **Facility** | | | | | |
| ***Idaho Nuclear Technology and Engineering Center*** | | | | | |
| ICPP-MON-A-230 | 03/28/2022 | 6.8[1] | - | - | - |
| USGS-047 | 03/28/2022 | 1.6 | - | - | - |
| USGS-052 | 03/292022 | 2.1[2] | - | - | - |
| USGS-067 | 03/29/2022 | 5.2[1] | - | - | - |
| USGS-123 | 03/02/2022 | 1.2[3] | - | - | - |
| ***Test Area North*** | | | | | |
| TAN-2336 | 01/11/2022 | 0.056 | - | 11[4] | - |

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. Lab indicated that a 5:1 dilution of this sample was required for this analyte.
2. Lab indicated that a 4:1 dilution of this sample was required for this analyte.
3. Lab indicated that a 2:1 dilution of this sample was required for this analyte.
4. Lab indicated that a 50:1 dilution of this sample was required for this analyte.

**Table 22. Volatile organic compound concentrations (µg/L) in water samples, first quarter, 2022.**

| Sample Location | Sample Date | PCE | | TCE | | 1,1-DCE | | cis-1,2-DCE | | trans-1,2-DCE | | Vinyl chloride | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| TAN-2336[1] | 01/11/2022 | <5.0 | U | <5.0 | U | <5.00 | U | <5.0 | U | <5.0 | U | <5.0 | U |

**Table 22. continued - Volatile organic compound concentrations (µg/L) in water samples, first quarter, 2022.**

| Sample Location | Sample Date | 2-Butanone | | Methylene Chloride | | Chloro-methane | | 1,1-DCA | |
|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | |
| TAN-2336[1] | 01/11/2022 | 1140[2] | - | 21.2 | J | <5.0 | U | <5.0 | U |

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 10:1 dilution of this sample was required for all analytes. This resulted in MDC increases by a factor of 10 from 0.5 to 5.0µg/L.
Note 2. Transient and expected to rapidly dissipate. Fowler, Thompson, and Mueller, 2011 (DOI: 10.1002/rem.21296).

# 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 *in-situ* gamma spectrometric measurements were performed, nor were any soil samples physically collected during the first calendar quarter of 2022.

## 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 monthly. Results for gamma spectrometric analyses of milk samples are presented in **Table 23**. $^{40}$K was detected in all samples within the expected range of concentrations. $^{131}$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 23. Gamma spectrometry analysis data for milk samples, first quarter, 2022.**

| 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 | 01/18/22 | 1412 | 127 | 0.5 | 2.4 | 4.0 |
| | 02/15/22 | 1443 | 88 | 1.1 | 2.7 | 4.4 |
| | 03/15/22 | 2004 | 109 | -0.2 | 1.1 | 1.9 |
| **Verification Samples[1]** | | | | | | |
| Minidoka | 01/04/22 | 1568 | 93 | 0.3 | 1.7 | 2.9 |
| Terreton | 01/05/22 | 1363 | 112 | 0.5 | 1.9 | 3.1 |
| Dietrich | 02/01/22 | 1328 | 84 | 0.3 | 1.9 | 3.2 |
| Rigby | 02/01/22 | 1349 | 124 | 0.1 | 1.9 | 3.3 |
| Minidoka | 03/01/22 | 1423 | 116 | 0.4 | 1.2 | 2.0 |
| Howe | 03/03/22 | 1376 | 86 | -0.7 | 2.3 | 3.8 |

[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.

# 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 first quarter of 2022. 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 first quarter of 2022, DEQ-INL OP submitted 74 QC samples for various radiological and non-radiological analyses (**Table 24**).

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.[3] 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.

Sample results for blank TSP filters submitted for gross alpha and gross beta screening in air for the first quarter of 2022 are presented in **Table 25**. Blank sample results for select gamma emitters in air from TSP filters composited for the quarter are presented in **Table 26**. Data for blank analyses used to assess data quality for tritium in water vapor in air are presented in **Table 27**. Blank analysis results for 2021 TSP annual radiochemical composites of 4-inch filters are presented in **Table 28**.

[3] The water used by DEQ-INL OP to create blank samples contains measurable 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 (33 pCi/L).

The TSP blank 47-mm filter gross alpha result for the week of 2/16-2/23/22 minimally exceeded the MDC. The associated TSP gross alpha field results for that week were qualified as biased-high estimates (J+). All other blank sample results passed acceptance criteria in the first quarter of 2022.

## 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:

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

$R_1$ = 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 sample results is less than five times the MDC, the results agree 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 29**. Duplicate results for metals, common ions and nutrients, and VOCs in groundwater are presented in **Tables 30, 31,** and **32.**

The gross alpha duplicate results for USGS-052 failed acceptance criteria. The other duplicate gross alpha results were acceptable. No sample results were qualified as a result of this failure. The technetium-99 (Tc-99) duplicate results for USGS-123 failed acceptance criteria. The original USGS-123 Tc-99 result was qualified as an estimate (J-flag) due to its large disagreement with the duplicate result. There were no other field sample Tc-99 results associated with this duplicate. The other duplicate technetium-99 results were acceptable. The methylene chloride duplicate results for TAN-2336 failed acceptance criteria. The original TAN-2336 result was flagged as an estimate. There were no other field sample VOC results associated with this duplicate. All other duplicate results passed acceptance criteria in the first quarter of 2022.

## 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).

No spiked water samples were analyzed during the first quarter of 2022.

DEQ-INL OP also prepares additional "spike-like" quality control samples to assess ambient radiation measurement bias. Once per quarter, DEQ-INL OP irradiates several 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. Overall response for each control set is considered acceptable if the average of the three individual results for the set has a percent recovery of 100 ± 25%. The irradiation results for first quarter 2022 are presented in **Table 31**. Real-time pressure correction is used to calculate the net exposure measured by these EIC control sets. All individual EIC measurements and average EIC results passed DEQ-INL OP acceptance criteria.

## Laboratory QC Issues

Radiochemical analyses results for composited 4-inch TSP filters from calendar year 2021 are presented in **Table 8** of this report**.** The ISU vendor lab (ALS, Fort Collins, CO.) non-conformance report listed significant quality control issues associated with the analyses of these samples: **(1)** The report stated the chemical yields for all samples are below the 30% lower control limit for Pu-238 and Pu-239/240, ranging from 1.45% to 20.5%. Additionally, eight of thirteen samples for Am-241 analysis have yields below the 30% lower control limit, ranging from 1.79% to 23.9%. The chemical carrier recoveries for Sr-90 for all samples are below the 40% lower control limit ranging from 10.3% to 22.6%. The vendor lab stated that spectral quality is adequate for accurate quantification. The lab believes that the low yields and recoveries are caused by matrix interference, as another client's samples prepared in the batch with these samples had acceptable yields, as did the batch method blank, laboratory control sample, and laboratory control sample duplicate. The samples all had large amounts of iron in them, as seen in Inductively Coupled Plasma (ICP) data. The samples were all counted for 1000 minutes to achieve the lowest MDC possible. **(2)** The Quality Control section of the report indicated that Pu-239/240 activity in the associated method blank was above the MDC value. However, the measured blank activity was below the requested MDC. **(3)** The vendor lab analysts who ashed these samples stated that the filter samples were much larger and thicker than they are used to, so they did not completely ash. Additionally, the small muffle furnace that goes up to 600 degrees Celsius was out of service, so they could only ash in the larger ovens that only go up to 450 degrees Celsius. This caused the aqueous samples to be much darker than normal after ashing and the three-acid digestion. It is believed that this caused significant interference when the samples were loaded onto the chloride ion-exchange columns for isotopic Pu and Am-241 separation, and then the strontium column. Because of these non-conformances, all 2021 4-inch TSP filter composite radiochemical analysis results are J-flagged as estimates. The validity of these results is in doubt and their accuracy is questionable.

## DEQ-INL OP Equipment QC Issue

Many of the 47-mm filter TSP air samplers were found to be operating outside of their expected flow rate range in the first quarter, 2022. A calibrated flow rate gauge was taken into the field weekly to measure the sample start and stop flow rates of these samplers. The calibrated flow rate gauge measurements were used for the activity concentration calculations in the suspect measurements, and results are considered (usable) estimates.

### Qualification of Low Level Sample Results

Sample results >MDC are generally considered detections, with the following exceptions[4] 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 detections 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 first quarter of 2022 which significantly affected data quality. The ratio of total QC analyses to total field sample analyses of 14.1% is acceptable and above the DEQ-INL OP minimum requirement of 10%. Methodologies and data reports issued by the contracting laboratories generally conformed to the requirements of DEQ-INL OP during the first quarter of 2022.

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 (non-rejected results divided by the total number of field sample results reported) of 99.6% for the first quarter of 2022 is excellent and well above the acceptable value of 90% for the DEQ-INL OP ESP and is summarized in **Table 24**. The overall data completeness (usable results divided by the total number of field sample results expected) of 98.5% is also well above the acceptable value of 90%.

## Preventative Maintenance and Equipment Reliability

All equipment was calibrated and checked according to prescribed periodicity. The Experimental Field Station 47-mm filter TSP and radioiodine sampler was out of service from 2/16/22 to 3/04/22 for motor maintenance/replacement. The Howe and Mud Lake 8x10-inch filter TSP samplers were not deployed until 1/12/22. The Experimental Field Station and Idaho Falls Duplicate 8x10-inch filter TSP samplers were not deployed until 1/26/22. The Fort Hall 8x10-inch filter TSP sampler was not started up until 2/15/22. Service reliability for air sampling equipment for the first quarter of 2022 is summarized in **Table 34**.

## Conclusion

All data collected for the first quarter of 2022 have been assigned the applicable qualifiers to designate the appropriate use of the data. The overall data usability of 99.6% and data completeness of 98.5% are well above the acceptable value of 90% for the quarter, with the data meeting the requirements and data quality objectives established by DEQ-INL OP.

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

**Table 24. Summary of the analyses performed, first quarter, 2022.**

| 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 | 140 | 13 | 0 | 0 | 1 | ISU-EML |
| | | Gross beta | 140 | 13 | 0 | 0 | 1 | ISU-EML |
| | | Gamma emitters | 44 | 4 | 0 | 0 | 0 | ISU-EML |
| | | Radiochemical | 12 | 1 | 0 | 0 | 0 | ISU Sub |
| **Water Vapor** | Desiccant column | Tritium | 21 | 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 | 6 | 0 | 3 | 0 | 0 | ISU-EML |
| | | Gross beta | 6 | 0 | 3 | 0 | 0 | ISU-EML |
| | | Gamma emitters | 6 | 0 | 3 | 0 | 0 | ISU-EML |
| | | Tritium | 6 | 0 | 3 | 0 | 0 | ISU-EML |
| | | Low-level tritium | 0 | 0 | 0 | 0 | 0 | ISU-EML |
| | | Radiochemical[6] | 12 | 0 | 6 | 0 | 0 | ISU Sub |
| | | Metals | 6 | 0 | 3 | 0 | 0 | IBL |
| | | Common Ions | 6 | 0 | 3 | 0 | 0 | IBL |
| | | Nutrients | 6 | 0 | 3 | 0 | 0 | IBL |
| | | Volatile Organics | 1 | 0 | 1 | 0 | 0 | IBL |
| **Terrestrial** | | | | | | | | |
| **Milk** | Grab or composite | Gamma emitters | 9 | 0 | 0 | 0 | 0 | ISU-EML |
| **Soil** | *in situ* | Gamma emitters | 0 | 0 | 0 | 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 |
| | EcoGamma | Gamma Radiation | 11 | NA | NA | NA | 0 | DEQ-INL OP |
| **Total analyses performed** | | | **524** | **37** | **28** | **9** | **2** | |
| **Total QC analyses performed (blanks, duplicates, and spikes)** | | | **74** | | | | | |
| **Ratio of total QC analyses to total sample analyses[3]** | | | **14.1%** | | | | | |
| **Data usability[4], percent** | | | **99.6%** | | | | | |
| **Data completeness[5], percent** | | | **98.5%** | | | | | |

[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.

[6] Radiochemical includes Strontium-90, Technetium-99, Uranium 234, 235, and 238, Plutonium-238, 239/240, and Americium-241.

**Table 25. Blank analysis results for gross alpha and beta in 47-mm particulate air (TSP) filters, first quarter, 2022.**

| Collection Period | | Corrected volume ($m^3$)[1] | Gross alpha | | | Gross beta | | |
|---|---|---|---|---|---|---|---|---|
| Start | Stop | | Value | ± 2 SD | MDC | Value | ±2 SD | MDC |
| 12/29/21 | 01/05/22 | 525 | -0.2 | 0.3 | 0.6 | 0.3 | 0.6 | 1.0 |
| 01/05/22 | 01/12/22 | 525 | 0.0 | 0.3 | 0.6 | -0.1 | 0.6 | 1.0 |
| 01/12/22 | 01/19/22 | 525 | -0.1 | 0.3 | 0.6 | -0.8 | 0.7 | 1.2 |
| 01/19/22 | 01/26/22 | 525 | -0.1 | 0.3 | 0.7 | -0.7 | 0.7 | 1.2 |
| 01/26/22 | 02/02/22 | 525 | 0.0 | 0.3 | 0.6 | -0.5 | 0.7 | 1.2 |
| 02/02/22 | 02/09/22 | 525 | 0.1 | 0.3 | 0.6 | -0.3 | 0.6 | 1.0 |
| 02/09/22 | 02/16/22 | 525 | -0.1 | 0.3 | 0.5 | -1.1 | 0.6 | 1.2 |
| 02/16/22 | 02/23/22 | 525 | 0.5 | 0.3 | 0.4 | 0.2 | 0.8 | 1.3 |
| 02/23/22 | 03/02/22 | 525 | 0.0 | 0.3 | 0.6 | 0.2 | 0.8 | 1.3 |
| 03/02/22 | 03/09/22 | 525 | -0.1 | 0.3 | 0.6 | 0.3 | 0.7 | 1.2 |
| 03/09/22 | 03/16/22 | 525 | 0.0 | 0.3 | 0.6 | -0.7 | 0.7 | 1.3 |
| 03/16/22 | 03/23/22 | 525 | 0.1 | 0.4 | 0.6 | -0.6 | 0.7 | 1.2 |
| 03/23/22 | 03/30/22 | 525 | -0.1 | 0.3 | 0.7 | -0.8 | 0.7 | 1.3 |

Note: Concentrations, associated uncertainties (± 2 SD), and minimum detectable concentrations (MDC) 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 26. Blank analysis results for gamma spectrometry for 47-mm TSP air filters, quarterly composite samples, first quarter, 2022.**

| Analysis Date | Beryllium-7 | | | Ruthenium-106/Rhodium-106 | | | Antimony-125 | | |
|---|---|---|---|---|---|---|---|---|---|
| | Concentration[1] | ± 2 SD | MDC | Concentration | ± 2 SD | MDC | Concentration | ± 2 SD | MDC |
| 04/26/2022 | -41 | 82 | 147 | -17 | 132 | 237 | -5 | 14 | 24 |

| Analysis Date | Cesium-134 | | | Cesium-137 | | |
|---|---|---|---|---|---|---|
| | Concentration[1] | ± 2 SD | MDC | Concentration | ± 2 SD | MDC |
| 04/26/2022 | -62 | 9 | 15 | -20 | 9 | 16 |

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 passed through the blank filters.

**Table 26 (continued). Blank analysis results for gamma spectrometry for 8x10-inch TSP air filters, monthly composite samples, first quarter, 2022.**

| Month | Beryllium-7 | | | Ruthenium-106/Rhodium-106 | | | Antimony-125 | | |
|---|---|---|---|---|---|---|---|---|---|
| | Concentration[1] | ± 2 SD | MDC | Concentration | ± 2 SD | MDC | Concentration | ± 2 SD | MDC |
| Jan 2022 | -5 | 19 | 34 | 0 | 68 | 118 | -6 | 5 | 10 |
| Feb 2022 | -1 | 22 | 38 | 0 | 68 | 118 | 3 | 7 | 12 |
| Mar 2022 | -11 | 25 | 44 | -38 | 54 | 95 | -2 | 5 | 9 |

| Month | Cesium-134 | | | Cesium-137 | | |
|---|---|---|---|---|---|---|
| | Concentration[1] | ± 2 SD | MDC | Concentration | ± 2 SD | MDC |
| Jan 2022 | 1 | 2 | 4 | 1 | 2 | 4 |
| Feb 2022 | -2 | 2 | 4 | -1 | 3 | 5 |
| Mar 2022 | 0 | 2 | 3 | 0 | 2 | 4 |

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 month. 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 passed through the blank filters.

**Table 27. Blank analysis results for 2021 TSP annual radiochemical composites of 4-inch air filters.**

| Sample Description | $^{90}$Sr | | | $^{238}$Pu | | | $^{239}$Pu/$^{240}$Pu | | | $^{241}$Am | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Value[1] | ± 2 SD | MDC | Value[1] | ± 2 SD | MDC | Value[1] | ± 2 SD | MDC | Value[1] | ± 2 SD | MDC |
| Blank | 1.57 | 3.52 | 5.84 | -0.03 | 0.16 | 0.30 | 0.00 | 0.16 | 0.30 | 0.01 | 0.08 | 0.15 |

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 year. 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 passed through the blank filters.

**Table 28. Blank analysis results for tritium in water vapor from air samples, first quarter, 2022.**

| Sample Number | Start Date | Collection Date | Analysis Date | Tritium | | |
|---|---|---|---|---|---|---|
| | | | | Concentration | ± 2 SD | MDC |
| OP221ZTR01 | 03/08/2022 | 03/11/2022 | 03/16/2022 | -0.02 | 0.10 | 0.17 |
| OP221ZTR02 | 03/08/2022 | 03/11/2022 | 03/16/2022 | 0.01 | 0.10 | 0.17 |
| OP221ZTR03 | 03/23/2022 | 03/31/2022 | 04/11/2022 | 0.02 | 0.09 | 0.16 |
| OP221ZTR04 | 03/23/2022 | 03/31/2022 | 04/11/2022 | -0.07 | 0.09 | 0.16 |
| OP221 FRIDGE | 03/08/2022 | 04/12/2022 | 04/15/2022 | -0.01 | 0.10 | 0.17 |
| OP221 SINK | 03/08/2022 | 04/12/2022 | 04/15/2022 | 0.02 | 0.10 | 0.17 |

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

**Table 29. Duplicate sample results (pCi/L) for radiological constituents in groundwater and/or surface water, first quarter, 2022.**

| 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** | | | | | | | | | | |
| TAN-2336 | 221W001 | 2.7 | 24.8 | 221W009 | -18.8 | 22.1 | -267 | 21.5 | 49.8 | Yes |
| USGS-123 | 221W017 | 2.0 | 0.7 | 221W025 | 3.2 | 0.9 | -46 | 1.2 | 1.7 | Yes |
| USGS-052 | 221W033 | -0.5 | 0.8 | 221W055 | 2.9 | 0.9 | -283 | 3.4 | 1.8 | No |
| **Gross Beta** | | | | | | | | | | |
| TAN-2336 | 221W001 | 1601.5 | 48.9 | 221W009 | 1654.3 | 49.4 | -3 | 52.8 | 104.3 | Yes |
| USGS-123 | 221W017 | 2.5 | 0.9 | 221W025 | 1.5 | 0.9 | 50 | 1.0 | 1.9 | Yes |
| USGS-052 | 221W033 | 246.2 | 3.5 | 221W055 | 242.2 | 3.6 | 2 | 4.0 | 7.5 | Yes |
| **Cesium-137** | | | | | | | | | | |
| TAN-2336 | 221W001 | 6.1 | 1.9 | 221W009 | 3.8 | 1.9 | 46 | 2.3 | 4.0 | Yes |
| USGS-123 | 221W017 | -0.4 | 1.1 | 221W025 | 1.2 | 1.4 | -400 | 1.6 | 2.7 | Yes |
| USGS-052 | 221W033 | 0.3 | 1.3 | 221W055 | -0.6 | 1.7 | -600 | 0.9 | 3.2 | Yes |
| **Tritium (standard method)** | | | | | | | | | | |
| TAN-2336 | 221W003 | 480 | 110 | 221W011 | 530 | 110 | -10 | 50 | 233 | Yes |
| USGS-123 | 221W021 | 1550 | 160 | 221W029 | 1540 | 160 | 1 | 10 | 339 | Yes |
| USGS-052 | 221W036 | 310 | 120 | 221W058 | 510 | 120 | -49 | 200 | 255 | Yes |
| **Strontium-90** | | | | | | | | | | |
| TAN-2336 | 221W002 | 590 | 140 | 221W010 | 540 | 130 | 9 | 50 | 287 | Yes |
| USGS-123 | 221W019 | 0.50 | 0.38 | 221W027 | 0.13 | 0.35 | 117 | 0.37 | 0.77 | Yes |
| USGS-052 | 221W034 | 1.93 | 0.54 | 221W056 | 1.77 | 0.51 | 9 | 0.16 | 1.11 | Yes |
| **Uranium-234** | | | | | | | | | | |
| TAN-2336 | 221W004 | 0.94 | 0.26 | 221W012 | 0.85 | 0.29 | 10 | 0.09 | 0.58 | Yes |
| **Uranium-235** | | | | | | | | | | |
| TAN-2336 | 221W004 | 0.09 | 0.074 | 221W012 | 0.042 | 0.081 | 73 | 0.048 | 0.165 | Yes |
| **Uranium-238** | | | | | | | | | | |
| TAN-2336 | 221W004 | 0.173 | 0.098 | 221W012 | 0.27 | 0.15 | -44 | 0.097 | 0.269 | Yes |
| **Technetium-99** | | | | | | | | | | |
| USGS-123 | 221W020 | -1.7 | 3.4 | 221W028 | 12.8 | 5.5 | -261 | 14.5 | 8.5 | No |
| USGS-052 | 221W035 | 337 | 56 | 221W057 | 401 | 67 | -17 | 64 | 131 | Yes |

RPD = relative percent difference.

**Table 30. Duplicate results for metals (µg/L) in groundwater, first quarter, 2022.**

| Sample Location | Sample Number | Sample Date | Arsenic | Barium | Chromium | Iron | Lead | Manganese | Selenium | Zinc |
|---|---|---|---|---|---|---|---|---|---|---|
| TAN-2336[1] | 221W006 | 1/11/2022 | 15 UJ | 1600 | 130 | 16000 | <12 | 2200 | - | - |
| TAN-2336[1] | 221W014 | 1/11/2022 | 16 UJ | 1600 | 140 | 15000 | <12 | 2300 | - | - |
| **RPD** | | | **-6** | **0** | **-7** | **6** | **0** | **-4** | **-** | **-** |
| USGS-123 | 221W023 | 3/02/2022 | - | - | 6.2 | - | - | - | - | - |
| USGS-123 | 221W031 | 3/02/2022 | - | - | 6.4 | - | - | - | - | - |
| **RPD** | | | **-** | **-** | **-3** | **-** | **-** | **-** | **-** | **-** |
| USGS-052 | 221W038 | 3/29/2022 | - | - | 7.0 | - | - | - | - | - |
| USGS-052 | 221W060 | 3/29/2022 | - | - | 7.2 | - | - | - | - | - |
| **RPD** | | | **-** | **-** | **-3** | **-** | **-** | **-** | **-** | **-** |

RPD = relative percent difference.
Data qualifier: J = estimate.
[1] Lab indicated that a 12.5:1 dilution of this sample was required for these analytes. The elevated MDCs indicate that the arsenic values are non-detections.

**Table 31. Duplicate sample results for common ions and nutrients (mg/L) in groundwater, first quarter, 2022.**

| Sample Location | Sample Number | Sample Date | Calcium | Magnesium | Sodium | Potassium | Fluoride | Chloride | Sulfate | Total Alkalinity† | Total Nitrogen | Total Phosphorus |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| TAN-2336 | 221W001[1], 006, 007[5] | 1/11/2022 | 170 | 120 | 2600 | 23 | - | 125 J[2] | 2.45 J[2] | 5560 | 0.056 | 11 |
| TAN-2336 | 221W013[1], 014, 015[5] | 1/11/2022 | 160 | 120 | 2500 | 22 | - | 129 J[2] | 2.24 J[2] | 5580 | 0.064 | 12 |
| **RPD** | | | **6** | **0** | **4** | **4** | **-** | **-3** | **9** | **-0.4** | **-13** | **-9** |
| USGS-123 | 221W022, 024[4] | 3/02/2022 | - | - | - | - | - | 19.9 | 21.1 | 130 | 1.2 | - |
| USGS-123 | 221W030, 032 | 3/02/2022 | - | - | - | - | - | 19.8 | 21.1 | 130 | 1.0 | - |
| **RPD** | | | **-** | **-** | **-** | **-** | **-** | **0.5** | **0** | **0** | **18** | **-** |
| USGS-052 | 221W037, 039[3] | 3/29/2022 | - | - | - | - | - | 20.4 | 24.6 | 142 | 2.1 | - |
| USGS-052 | 221W059, 061[4] | 3/29/2022 | - | - | - | - | - | 20.6 | 24.7 | 142 | 2.1 | - |
| **RPD** | | | **-** | **-** | **-** | **-** | **-** | **-1** | **-0.4** | **0** | **0** | **-** |

RPD = relative percent difference.
† As $CaCO_3$.
[1]Sample required a 20:1 dilution for chloride and sulfate analyses.
[2]Results are flagged as estimates. The matrix spike and matrix spike duplicate did not meet the laboratory's acceptance criteria.
[3]Sample required a 4:1 dilution for total nitrogen analysis.
[4]Sample required a 2:1 dilution for total nitrogen analysis.
[5]Sample required a 50:1 dilution for total phosphorus analysis.

**Table 32. Duplicate sample results (µg/L) for VOCs in water, first quarter, 2022.**

| | Sample Number | Sample Date | PCE | TCE | 1,1-DCE | cis-1,2-DCE | trans-1,2-DCE | Vinyl Chloride | 1,1-DCA | Carbon Tetrachloride | Methylene Chloride | Chloro-methane | Styrene | Chloro-form | MEK |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| TAN-2336 | 221W008[1] | 1/11/22 | <5 | <5 | <5 | <5 | <5 | <5 | <5 | <5 | 21.2 | <5 | <5 | <5 | 1140 J[2] |
| TAN-2336 | 221W016[1] | 1/11/22 | <5 | <5 | <5 | <5 | <5 | <5 | <5 | <5 | 14.7 | <5 | <5 | <5 | 1170 J[2] |
| **RPD** | | | **0** | **0** | **0** | **0** | **0** | **0** | **0** | **0** | **36** | **0** | **0** | **0** | **-3** |

RPD = relative percent difference.
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, MEK = Methyl Ethyl Ketone (2-Butanone).
[1]Sample required a 10:1 dilution.
[2]Results are flagged as estimates. The matrix spike and matrix spike duplicate did not meet the laboratory's acceptance criteria.

**Table 33. Electret ionization chamber (EIC) irradiation results (categorized as spiked samples), first quarter, 2022.**

| Electret # | Exposure Received | | Net Measured Exposure[1] | | %R | Within Spec? |
|---|---|---|---|---|---|---|
| | (mR) | Uncertainty (±1 SD, mR) | (mR) | Uncertainty (±1 SD, mR) | | |
| SKR267 | 40.0 | 2.0 | 32.2 | 1.3 | 80.6% | Yes |
| SKR342 | 40.0 | 2.0 | 36.7 | 1.4 | 91.9% | Yes |
| SJX015 | 40.0 | 2.0 | 31.9 | 1.3 | 79.7% | Yes |
| | | | | **Triplicate AVG:** | **84.1** | **Yes** |
| SKR589 | 30.0 | 1.5 | 26.6 | 1.4 | 88.7% | Yes |
| SJX031 | 30.0 | 1.5 | 22.9 | 1.3 | 76.3% | Yes |
| SKR401 | 30.0 | 1.5 | 24.8 | 1.3 | 82.7% | Yes |
| | | | | **Triplicate AVG:** | **82.6%** | **Yes** |
| SKR353 | 20.0 | 1.0 | 16.8 | 1.3 | 84.0% | Yes |
| SJX054 | 20.0 | 1.0 | 17.1 | 1.3 | 85.5% | Yes |
| SKR496 | 20.0 | 1.0 | 16.8 | 1.4 | 84.0% | Yes |
| | | | | **Triplicate AVG:** | **84.5%** | **Yes** |

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

**Table 34. Air sampling field equipment service reliability (percent operational), first quarter, 2022.**

| Station Locations | Sample Type | | | | |
|---|---|---|---|---|---|
| | 47-mm TSP | 8x10-inch TSP | Radioiodine | Atmospheric Moisture | Precipitation |
| **Onsite Locations** | | | | | |
| Big Lost River Rest Area | 100% | 100% | 100% | 100% | 100% |
| Experimental Field Station | 85% | 100% [3] | 85% | 100% | NC[1] |
| Sand Dunes Tower | 100% | 100% | 100% | 100% | NC[1] |
| Van Buren Avenue | 100% | 100% | 100% | 100% | NC[1] |
| **Boundary Locations** | | | | | |
| Atomic City | 100% | 100% | 100% | 100% | 100% |
| Howe | 100% | 100% [4] | 100% | 100% | 100% |
| Monteview | 100% | 100% | 100% | 100% | 100% |
| Mud Lake | 100% | 100% [4] | 100% | 100% | 100% |
| **Distant Locations[2]** | | | | | |
| Craters of the Moon | 100% | 100% | 100% | 100% | NC[1] |
| Idaho Falls | 100% | 100% | 100% | 100% | 100% |
| Idaho Falls Duplicate[5] | NC[1] | 100% [3] | - | - | - |

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.

[3] The Experimental Field Station and Idaho Falls Duplicate 8x10-inch samplers were 100% operational from their 1/26/22 deployment to the end of the quarter.

[4] The Howe and Mud Lake 8x10-inch samplers were 100% operational from their 1/12/22 deployment to the end of the quarter.

[5] A duplicate 8x10-inch filter TSP sampler is currently installed at the Idaho Falls location.

# Appendix A

**Table A-1. Weekly concentrations (in 1 x $10^{-3}$ pCi/$m^3$) for gross alpha and gross beta analyses of 47-mm TSP filters for all locations, first quarter, 2022.**

| Sample Location | Collection Date | | Gross Alpha | | Gross Beta | |
|---|---|---|---|---|---|---|
| | Start | Stop | Concentration | ±2 SD | Concentration | ±2 SD |
| **On-Site Locations** | | | | | | |
| **Big Lost River Rest Area** | 12/29/21 | 01/05/22 | 0.4 | 0.5 | 20.6 | 1.6 |
| | 01/05/22 | 01/12/22 | 0.4 | 0.5 | 20.4 | 1.6 |
| | 01/12/22 | 01/19/22 | 0.9 | 0.6 | 52.5 | 2.5 |
| | 01/19/22 | 01/26/22 | 0.5 | 0.6 | 33.4 | 2.1 |
| | 01/26/22 | 02/02/22 | 0.3 | 0.5 | 34.5 | 2.1 |
| | 02/02/22 | 02/09/22 | 0.2 | 0.5 | 34.5 | 2.0 |
| | 02/09/22 | 02/16/22 | 0.7 | 0.5 | 40.8 | 2.2 |
| | 02/16/22 | 02/23/22 | 0.9 J+ [9] | 0.5 J+ [9] | 23.4 | 1.9 |
| | 02/23/22 | 03/02/22 | 0.8 | 0.6 | 45.7 | 2.4 |
| | 03/02/22 | 03/09/22 | 0.2 | 0.5 | 28.8 | 2.0 |
| | 03/09/22 | 03/16/22 | 0.3 | 0.5 | 15.6 | 1.7 |
| | 03/16/22 | 03/23/22 | 0.4 | 0.6 | 16.1 | 1.8 |
| | 03/23/22 | 03/30/22 | 0.7 | 0.5 | 23.1 | 1.5 |
| **Experimental Field Station** | 12/29/21 | 01/05/22 | 0.3 | 0.4 | 26.2 | 1.5 |
| | 01/05/22 | 01/12/22 [1] | 0.4 | 0.4 | 27.6 | 1.5 |
| | 01/12/22 | 01/19/22 [1] | 0.8 | 0.4 | 59.4 | 2.1 |
| | 01/19/22 | 01/26/22 [1] | 0.6 | 0.4 | 39.8 | 1.8 |
| | 01/26/22 | 02/02/22 [1] | 0.4 | 0.4 | 42.7 | 1.8 |
| | 02/02/22 | 02/09/22 | 0.6 | 0.3 | 39.9 | 1.6 |
| | 02/09/22 | 02/16/22 [2] | R | R | R | R |
| | 02/16/22 | 02/23/22 [3] | NS | NS | NS | NS |
| | 02/23/22 | 03/02/22 [3] | NS | NS | NS | NS |
| | 03/04/22 | 03/09/22 [4] | 0.1 | 0.4 | 19.7 | 1.6 |
| | 03/09/22 | 03/16/22 | 0.2 | 0.3 | 17.4 | 1.2 |
| | 03/16/22 | 03/23/22 | 0.8 | 0.4 | 16.9 | 1.2 |
| | 03/23/22 | 03/30/22 | 1.0 | 0.5 | 25.9 | 1.5 |
| **Sand Dunes Tower** | 12/29/21 | 01/05/22 | 0.4 | 0.3 | 27.8 | 1.4 |
| | 01/05/22 | 01/12/22 | 0.1 | 0.3 | 25.1 | 1.4 |
| | 01/12/22 | 01/19/22 | 0.8 | 0.4 | 66.0 | 2.2 |
| | 01/19/22 | 01/26/22 | 0.6 | 0.4 | 38.3 | 1.7 |
| | 01/26/22 | 02/02/22 [1] | 0.6 | 0.4 | 57.2 | 2.2 |
| | 02/02/22 | 02/09/22 | 0.3 | 0.3 | 37.7 | 1.6 |
| | 02/09/22 | 02/16/22 [1] | 1.1 | 0.4 | 49.0 | 1.8 |
| | 02/16/22 | 02/23/22 [5] | NS | NS | NS | NS |
| | 02/23/22 | 03/02/22 | 0.8 | 0.4 | 44.3 | 1.8 |
| | 03/02/22 | 03/09/22 | 0.6 | 0.4 | 30.4 | 1.6 |
| | 03/09/22 | 03/16/22 | 0.2 | 0.4 | 13.9 | 1.3 |
| | 03/16/22 | 03/23/22 [1] | 0.4 | 0.4 | 16.1 | 1.2 |
| | 03/23/22 | 03/30/22 [1] | 0.4 | 0.4 | 26.0 | 1.5 |

**Table A-1 continued. Weekly concentrations (in 1 x $10^{-3}$ pCi/$m^3$) for gross alpha and gross beta analyses of 47-mm TSP filters for all locations, first quarter, 2022.**

| Sample Location | Collection Date | | Gross Alpha | | Gross Beta | |
|---|---|---|---|---|---|---|
| | Start | Stop | Concentration | ±2 SD | Concentration | ±2 SD |
| **Van Buren Avenue** | 12/29/21 | 01/05/22 | 0.4 | 0.3 | 19.9 | 1.2 |
| | 01/05/22 | 01/12/22 | 0.1 | 0.3 | 23.3 | 1.3 |
| | 01/12/22 | 01/19/22 | 0.6 | 0.4 | 48.6 | 1.8 |
| | 01/19/22 | 01/26/22 | 0.5 | 0.4 | 35.1 | 1.6 |
| | 01/26/22 | 02/02/22 | 0.7 | 0.4 | 32.0 | 1.5 |
| | 02/02/22 | 02/09/22 | 0.6 | 0.4 | 34.5 | 1.6 |
| | 02/09/22 | 02/16/22 | 0.8 | 0.4 | 46.8 | 1.9 |
| | 02/16/22 | 02/23/22 | 0.9 J+ [9] | 0.3 J+ [9] | 27.2 | 1.5 |
| | 02/23/22 | 03/02/22 | 0.6 | 0.4 | 44.8 | 1.9 |
| | 03/02/22 | 03/09/22 | 0.6 | 0.4 | 29.3 | 1.6 |
| | 03/09/22 | 03/16/22 [1] | 0.2 | 0.3 | 15.9 | 1.2 |
| | 03/16/22 | 03/23/22 | 0.3 | 0.4 | 17.4 | 1.3 |
| | 03/23/22 | 03/30/22 [1] | 0.2 | 0.4 | 25.4 | 1.5 |
| **Boundary Locations** | | | | | | |
| **Atomic City** | 12/29/21 | 01/05/22 | 0.6 | 0.4 | 20.3 | 1.2 |
| | 01/05/22 | 01/12/22 | 0.6 | 0.4 | 24.4 | 1.3 |
| | 01/12/22 | 01/19/22 | 0.7 | 0.4 | 65.8 | 2.1 |
| | 01/19/22 | 01/26/22 | 0.7 | 0.4 | 33.4 | 1.5 |
| | 01/26/22 | 02/02/22 | 0.6 | 0.3 | 39.6 | 1.6 |
| | 02/02/22 | 02/09/22 | 0.5 | 0.4 | 39.3 | 1.7 |
| | 02/09/22 | 02/16/22 | 1.0 | 0.4 | 36.6 | 1.6 |
| | 02/16/22 | 02/23/22 [1] | 1.0 J+ [9] | 0.4 J+ [9] | 28.5 | 1.6 |
| | 02/23/22 | 03/02/22 [1] | 0.9 | 0.4 | 52.5 | 2.1 |
| | 03/02/22 | 03/09/22 | 0.3 | 0.3 | 23.6 | 1.3 |
| | 03/09/22 | 03/16/22 | 0.1 | 0.3 | 16.0 | 1.2 |
| | 03/16/22 | 03/23/22 | 0.7 | 0.4 | 17.3 | 1.2 |
| | 03/23/22 | 03/30/22 | 0.8 | 0.4 | 23.3 | 1.4 |
| **Howe** | 12/29/21 | 01/05/22 [1] | 0.4 | 0.4 | 26.2 | 1.4 |
| | 01/05/22 | 01/12/22 [1] | 0.2 | 0.4 | 20.6 | 1.3 |
| | 01/12/22 | 01/19/22 [1] | 0.9 | 0.4 | 55.5 | 2.0 |
| | 01/19/22 | 01/26/22 [1] | 0.8 | 0.4 | 37.7 | 1.7 |
| | 01/26/22 | 02/02/22 [1] | 0.8 | 0.4 | 48.1 | 1.9 |
| | 02/02/22 | 02/09/22 [6] | 0.5 | 0.4 | 35.7 | 1.7 |
| | 02/09/22 | 02/16/22 [1] | 1.1 | 0.4 | 55.6 | 2.1 |
| | 02/16/22 | 02/23/22 [1] | 0.9 J+ [9] | 0.3 J+ [9] | 31.9 | 1.7 |
| | 02/23/22 | 03/02/22 [1] | 1.1 | 0.5 | 49.6 | 2.0 |
| | 03/02/22 | 03/09/22 | 0.4 | 0.4 | 33.7 | 1.8 |
| | 03/09/22 | 03/16/22 | 0.2 | 0.3 | 18.2 | 1.3 |
| | 03/16/22 | 03/23/22 | 0.6 | 0.4 | 17.3 | 1.3 |
| | 03/23/22 | 03/30/22 | 0.4 | 0.4 | 23.9 | 1.5 |

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**Table A-1 continued. Weekly concentrations (in 1 x $10^{-3}$ pCi/$m^3$) for gross alpha and gross beta analyses of 47-mm TSP filters for all locations, first quarter, 2022.**

| Sample Location | Collection Date | | Gross Alpha | | Gross Beta | |
|---|---|---|---|---|---|---|
| | Start | Stop | Concentration | ±2 SD | Concentration | ±2 SD |
| **Monteview** | 12/29/21 | 01/05/22 | 0.4 | 0.3 | 25.9 | 1.4 |
| | 01/05/22 | 01/12/22 | 0.3 | 0.3 | 22.6 | 1.3 |
| | 01/12/22 | 01/19/22 | 0.9 | 0.4 | 63.1 | 2.1 |
| | 01/19/22 | 01/26/22 | 0.4 | 0.4 | 28.2 | 1.5 |
| | 01/26/22 | 02/02/22 | 0.5 | 0.4 | 42.0 | 1.7 |
| | 02/02/22 | 02/09/22 | 0.5 | 0.4 | 32.9 | 1.5 |
| | 02/09/22 | 02/16/22 | 1.2 | 0.4 | 45.4 | 1.8 |
| | 02/16/22 | 02/23/22 | 0.9 J+ [9] | 0.3 J+ [9] | 30.2 | 1.6 |
| | 02/23/22 | 03/02/22 | 1.1 | 0.4 | 47.4 | 1.9 |
| | 03/02/22 | 03/09/22 | 0.3 | 0.3 | 24.0 | 1.4 |
| | 03/09/22 | 03/16/22 | 0.3 | 0.4 | 16.9 | 1.3 |
| | 03/16/22 | 03/23/22 | 0.2 | 0.4 | 15.7 | 1.3 |
| | 03/23/22 | 03/30/22 | 0.6 | 0.4 | 23.1 | 1.4 |
| **Mud Lake** | 12/29/21 | 01/05/22 | 0.4 | 0.3 | 29.1 | 1.4 |
| | 01/05/22 | 01/12/22 | 0.3 | 0.3 | 22.3 | 1.3 |
| | 01/12/22 | 01/19/22 | 1.0 | 0.4 | 61.2 | 2.0 |
| | 01/19/22 | 01/26/22 | 0.5 | 0.4 | 30.1 | 1.5 |
| | 01/26/22 | 02/02/22 | 0.4 | 0.4 | 50.1 | 1.9 |
| | 02/02/22 | 02/09/22 | 0.6 | 0.4 | 33.8 | 1.5 |
| | 02/09/22 | 02/16/22 | 1.0 | 0.4 | 43.9 | 1.8 |
| | 02/16/22 | 02/23/22 | 0.8 J+ [9] | 0.3 J+ [9] | 27.9 | 1.5 |
| | 02/23/22 | 03/02/22 | 1.3 | 0.4 | 46.6 | 1.9 |
| | 03/02/22 | 03/09/22 | 0.5 | 0.4 | 28.7 | 1.5 |
| | 03/09/22 | 03/16/22 | 0.5 | 0.4 | 17.4 | 1.3 |
| | 03/16/22 | 03/23/22 [1] | 0.4 | 0.4 | 18.5 | 1.4 |
| | 03/23/22 | 03/30/22 [1] | 0.9 | 0.4 | 25.6 | 1.5 |
| **Distant Locations** | | | | | | |
| **Craters of the Moon** | 12/29/21 | 01/05/22 | 0.0 | 0.4 | 15.8 | 1.4 |
| | 01/05/22 | 01/12/22 | 0.2 | 0.5 | 13.2 | 1.4 |
| | 01/12/22 | 01/19/22 | 0.1 | 0.5 | 32.2 | 2.0 |
| | 01/19/22 | 01/26/22 | -0.1 | 0.5 | 20.2 | 1.7 |
| | 01/26/22 | 02/02/22 | 0.0 | 0.5 | 22.8 | 1.8 |
| | 02/02/22 | 02/09/22 | 0.5 | 0.5 | 27.7 | 1.8 |
| | 02/09/22 | 02/16/22 | 0.7 | 0.5 | 27.0 | 1.8 |
| | 02/16/22 | 02/23/22 | 0.9 J+ [9] | 0.4 J+ [9] | 21.4 | 1.8 |
| | 02/23/22 | 03/02/22 | 0.6 | 0.5 | 39.0 | 2.2 |
| | 03/02/22 | 03/09/22 | 0.3 | 0.5 | 24.0 | 1.8 |
| | 03/09/22 | 03/16/22 | 0.1 | 0.5 | 17.0 | 1.6 |
| | 03/16/22 | 03/23/22 | 0.5 | 0.5 | 16.6 | 1.6 |
| | 03/23/22 | 03/30/22 | 0.2 | 0.4 | 21.0 | 1.5 |

**Table A-1 continued. Weekly concentrations (in 1 x $10^{-3}$ pCi/$m^3$) for gross alpha and gross beta analyses of 47-mm TSP filters for all locations, first quarter, 2022.**

| Sample Location | Collection Date | | Gross Alpha | | Gross Beta | |
|---|---|---|---|---|---|---|
| | Start | Stop | Concentration | ±2 SD | Concentration | ±2 SD |
| **Fort Hall**[8] | 12/29/21 | 01/05/22[7] | 0.1 | 0.3 | 10.2 | 0.9 |
| | 01/05/22 | 01/12/22[7] | 0.2 | 0.3 | 11.7 | 1.0 |
| | 01/12/22 | 01/19/22[7] | 0.8 | 0.4 | 32.1 | 1.5 |
| | 01/19/22 | 01/26/22[7] | 0.6 | 0.4 | 17.7 | 1.2 |
| | 01/26/22 | 02/02/22[7] | 0.3 | 0.4 | 22.8 | 1.4 |
| | 02/02/22 | 02/09/22[7] | 0.4 | 0.4 | 23.7 | 1.4 |
| | 02/09/22 | 02/16/22[7] | 0.9 | 0.4 | 34.1 | 1.6 |
| | 02/16/22 | 02/23/22[7] | 1.1 J+[9] | 0.3 J+[9] | 19.5 | 1.2 |
| | 02/23/22 | 03/02/22[7] | 0.8 | 0.4 | 34.3 | 1.6 |
| | 03/02/22 | 03/09/22[7] | 0.7 | 0.4 | 19.8 | 1.2 |
| | 03/09/22 | 03/16/22[7] | 0.3 | 0.3 | 14.7 | 1.2 |
| | 03/16/22 | 03/23/22[7] | 0.6 | 0.4 | 16.1 | 1.2 |
| | 03/23/22 | 03/30/22[7] | 0.9 | 0.5 | 19.5 | 1.4 |
| **Idaho Falls** | 12/29/21 | 01/05/22[1] | 0.2 | 0.3 | 23.1 | 1.3 |
| | 01/05/22 | 01/12/22[1] | 0.5 | 0.4 | 24.7 | 1.3 |
| | 01/12/22 | 01/19/22[1] | 0.8 | 0.3 | 46.3 | 1.5 |
| | 01/19/22 | 01/26/22[1] | 0.5 | 0.4 | 34.0 | 1.5 |
| | 01/26/22 | 02/02/22[1] | 0.5 | 0.4 | 38.3 | 1.7 |
| | 02/02/22 | 02/09/22[1] | 0.6 | 0.4 | 34.7 | 1.6 |
| | 02/09/22 | 02/16/22[1] | 0.9 | 0.4 | 48.6 | 1.8 |
| | 02/16/22 | 02/23/22[1] | 1.0 J+[9] | 0.3 J+[9] | 22.0 | 1.4 |
| | 02/23/22 | 03/02/22[1] | 0.9 | 0.4 | 40.5 | 1.8 |
| | 03/02/22 | 03/09/22 | 0.7 | 0.5 | 35.4 | 2.1 |
| | 03/09/22 | 03/16/22[1] | 0.3 | 0.4 | 17.6 | 1.4 |
| | 03/16/22 | 03/23/22[1] | 0.4 | 0.4 | 15.7 | 1.2 |
| | 03/23/22 | 03/30/22[1] | 0.7 | 0.4 | 23.7 | 1.4 |

Note: MDCs typically range from (0.3 to 0.9) x $10^{-3}$ pCi/$m^3$ for gross alpha and from (0.9 to 1.8) x $10^{-3}$ pCi/$m^3$ for gross beta.
[1] Faulty rotameter-indicated flow rate. Rotameter stop flow rate was greater than the ± 10% error tolerance when compared with a field calibrator. Total volume is an estimate based on elapsed time multiplied by the average of the start and stop flow rate measurements from the calibrator. Results are considered (usable) estimates.
[2] Power off on arrival. Insufficient sample for valid analysis. Results are rejected (R).
[3] NS – No sample. Motor maintenance.
[4] Motor replaced and restarted on 03/04/2022.
[5] NS – No sample. Lost filter.
[6] Damaged filter. Results are (usable) estimates.
[7] Improper sampling orientation with the filter not fully exposed to the ambient air. Results are considered (usable) estimates.
[8] Operated by Shoshone-Bannock Tribes.
[9] The TSP blank gross alpha result for the week of 2/16-2/23/22 minimally exceeded the MDC. The associated TSP gross alpha field results for that week were qualified as biased-high estimates (J+).

# Appendix B

**Table B.1. Results for all electret ionization chamber (EIC) locations, first quarter, 2022.**

| Sample Location | Net Corrected Exposure Rate (µR/hr)[1] | ± 2 SD (µR/hr) |
|---|---|---|
| Arco | 10.4 | 0.8 |
| Craters of the Moon | 11.2 | 4.9 |
| Big Lost River Rest Area | 12.8 | 1.7 |
| Van Buren Avenue | 20.4, 20.8 | - |
| Experimental Field Station | 11.7 | 2.7 |
| Main Gate | 15.9 | 3.4 |
| Atomic City | 12.7 | 1.4 |
| Taber | 12.3 | 3.4 |
| Blackfoot | 12.1, 16.8 | - |
| Ft. Hall | 8.5, 9.7 | - |
| Idaho Falls | 10.3 | 1.5 |
| Mud Lake/ Terreton | 13.6 | 5.4 |
| Monteview | 14.1 | 3.2 |
| Sand Dunes | 12.0 | 2.1 |
| Howe Met. Tower | 13.5 | 4.6 |
| MP282 -20 | 11.9 | 2.1 |
| MP280 -20 | 10.9 | 3.3 |
| MP278 -20 | 10.7 | 2.7 |
| MP276 -20 | 12.6 | 2.4 |
| MP274 -20 | 11.7 | 3.8 |
| MP272 -20 | 14.0, 14.2 | - |
| MP270 -20 | 10.8, 12.0 | - |
| MP268 -20 | 9.4 | 0.5 |
| MP266 -20 | 12.4 | 4.1 |
| MP264 -20 | 10.5 | 3.9 |
| MP270 -20/26 | 13.7 | 1.3 |
| MP268 -20/26 | 12.2 | 3.2 |
| MP266 -20/26 | 9.4 | 2.8 |
| MP263 -20/26 | 12.8 | 2.8 |
| MP261 -20/26 | 10.1 | 4.2 |
| MP259 -20/26 | 10.7 | 2.0 |
| MP256 -20/26 | 7.4 | 3.0 |
| MFC (EBR II) | 15.6 | 1.3 |
| EBR I | 13.1 | 1.3 |
| RWMC | 13.1 | 1.4 |
| CFA | 16.8 | 3.8 |
| CITRC (PBF) | 14.4 | 1.9 |
| INTEC | 18.7 | 5.2 |
| ATR (TRA) | 14.1 | 0.3 |
| NRF | 15.6 | 3.4 |
| TAN/SMC | 13.9 | 3.7 |
| Mud Lake Bank of Commerce | 13.5 | 2.1 |
| MP43-33 | 10.2 | 4.7 |
| MP41-33 | 11.2 | 4.9 |
| MP39-33 | 15.2 | 3.5 |
| MP37-33 | 11.3 | 3.7 |
| MP35-33 | 10.2 | 2.4 |
| MP33-33 | 15.0 | 5.0 |
| MP31-33 | 8.6 | 0.9 |
| MP29-33 | 9.6 | 1.9 |

**Table B.1 cont. Results for all electret ionization chamber (EIC) locations, first quarter, 2022.**

| Sample Location | Net Corrected Exposure Rate (µR/hr)[1] | ± 2 SD (µR/hr) |
|---|---|---|
| MP27-33 | 15.1 | 5.4 |
| MP25-33 | 13.5 | 3.6 |
| MP23-33 | 14.0 | 4.3 |
| MP21-33 | 11.6 | 4.5 |
| MP19-33 | 12.7 | 2.9 |
| MP14-33 | 11.0 | 3.0 |
| MP11-33 | 12.9 | 3.6 |
| MP06-33 | 9.3 | 1.2 |
| MP03-33 | 10.2 | 3.9 |
| Base of Howe | 11.5 | 0.5 |
| Rover | 14.2 | 1.6 |
| Hamer | 14.5 | 4.5 |
| Sugar City | 15.9 | 3.9 |
| Roberts | 13.9 | 3.7 |
| Big Southern Butte | 13.3 | 2.2 |
| T4 North | 18.6 | 2.6 |
| T4 South | 9.0, 9.0 | - |

[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 concentration (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 |
| Trichloroethylene | 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 concentration (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 Ethyl Ketone (MEK) | 10 |
| 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 |