Environmental Surveillance, Education, and Research Program

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Idaho National Laboratory
Site Environmental Report
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U.S. Department of Energy, Idaho Operations Office

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Anderson's Larkspur
Delphinium andersonii

To Our Readers

The Idaho National Laboratory Site Environmental Report for Calendar Year 2014 is an overview of environmental management activities conducted on and in the vicinity of the Idaho National Laboratory (INL) Site from January 1 through December 31, 2014. This report includes:

- Effluent monitoring and environmental surveillance of air, water, soil, vegetation, biota, and agricultural products for radioactivity. The results are compared with historical data, background measurements, and/or applicable standards and requirements in order to verify that the INL Site does not adversely impact the environment or the health of humans or biota.
- A summary of environmental management systems in place to protect air, water, land, and other natural and cultural resources impacted by INL Site operations.
- Ecological and other scientific research conducted on the INL Site which may be of interest to the reader.

The report addresses three general levels of reader interest:

- The first is a brief summary with a “take-home” conclusion. This is presented in the chapter highlights text box at the beginning of each chapter. There are no tables, figures, or graphs in the highlights. A lay person with little knowledge of science may comfortably read the chapter highlights at the start of each chapter.
- The second level is a more in-depth discussion with figures, summary tables, and summary graphs accompanying the text. The chapters of the annual report represent this level, which requires some familiarity with scientific data and graphs. A person with some scientific background can read and understand this report after reading the section entitled “Helpful Information.”
- The third level includes links to supplemental and technical reports and websites that support the annual report. This level is directed toward scientists who would like to see original data and more in-depth discussions of the methods used and results. The links to these reports may be found on this page or in the CD provided with the hard copy of this report.

In addition to the Environmental Surveillance, Education, and Research Program, which is managed by Gonzales-Stoller Surveillance, LLC, the contributors to the annual report include Battelle Energy Alliance, CH2M-WG Idaho, Department of Energy, Idaho Operations Office, National Oceanic and Atmospheric Administration (NOAA), and U.S. Geological Survey. Links to their websites may be found on this page or in the CD provided with the hard copy of this report.

- Idaho National Laboratory (https://inlportal.inl.gov/portal/server.pt/community/home/255)
- Idaho Cleanup Project (https://idahocleanupproject.com/)
- Department of Energy, Idaho Operations Office (http://www.id.doe.gov/)
- Field Research Division of NOAA’s Air Resources Laboratory (http://www.noaa.inel.gov/)
- U.S. Geological Survey (http://id.water.usgs.gov/)

Included in the chapter headings of this report are photographs, as well as common and scientific names of flowering plants native to the INL Site.

Showy Townsend Daisy
Townsendia florifer

Executive Summary

INTRODUCTION

In operation since 1949, the Idaho National Laboratory (INL) Site is a U.S. Department of Energy (DOE) reservation located in the southeastern Idaho desert, approximately 25 miles west of Idaho Falls (Figure ES-1). At 890 square miles (569,135 acres), the INL Site is roughly 85 percent the size of Rhode Island. It was established in 1949 as the National Reactor Testing Station, and for many years was the site of the largest concentration of nuclear reactors in the world. Fifty-two nuclear reactors were built, including the Experimental Breeder Reactor-I which, in 1951, produced the first usable amounts of electricity generated by nuclear power. Researchers pioneered many of the world's first nuclear reactor prototypes and advanced safety systems at the INL Site. During the 1970s, the laboratory's mission broadened into other areas, such as biotechnology, energy and materials research, and conservation and renewable energy.

Today the INL is a science-based, applied engineering national laboratory dedicated to supporting the DOE's missions in nuclear and energy research, science, and national defense.

The INL mission is to ensure the nation's energy security with safe, competitive, and sustainable energy systems and unique national and homeland security capabilities. In order to clear the way for the facilities required for the new nuclear energy research mission, the Idaho Cleanup Project (ICP) has been charged with the environmental cleanup of the legacy wastes generated from World War II-era conventional weapons testing, government-owned reactors, spent fuel reprocessing, and nuclear and alternative energy research. The overarching aim of the project is to reduce risks to workers, the public, and the environment and to protect the Snake River Plain aquifer. A great deal of this cleanup has occurred since 2005. Significantly,

Figure ES-1. Regional Location of the Idaho National Laboratory Site.

the ICP Decontamination and Decommissioning Project was officially closed out in 2012 with the safe decontamination and decommissioning of 223 buildings and structures for a total footprint reduction of over 1.6 million square feet.

PURPOSE OF THE INL SITE ENVIRONMENTAL REPORT

The INL Site's operations, as well as the ongoing cleanup, necessarily involve a commitment to environmental stewardship and full compliance with environmental protection laws. As part of this commitment, the INL Site Environmental Report is prepared annually to inform the public, regulators, stakeholders, and other interested parties of the INL Site's environmental performance during the year.

This report is published for the U.S. Department of Energy, Idaho Operations Office (DOE-ID) in compliance with DOE Order 231.1B, "Environment, Safety and Health Reporting." Its purpose is to:

- Present the INL Site, mission, and programs
- Report compliance status with all applicable, federal, state, and local regulations
- Describe the INL Site environmental programs and activities
- Summarize results of environmental monitoring
- Discuss potential radiation doses to the public residing in the vicinity of the INL Site
- Report on ecological monitoring and research conducted at the Idaho National Environmental Research Park
- Describe quality assurance methods used to ensure confidence in monitoring data.

MAJOR INL SITE PROGRAMS AND FACILITIES

There are three primary programs at the INL Site: the INL, the ICP, and the Advanced Mixed Waste Treatment Project (AMWTP). DOE is committed to safely retrieve, characterize, treat, and package transuranic waste for shipment out of Idaho to permanent disposal at the Waste Isolation Pilot Plant in New Mexico. Characterized waste containers that need further treatment before they can be shipped are sent to the AMWTP Treatment Facility where the waste can be size-reduced, sorted, and repackaged. The prime contractors at the INL Site are: Battelle Energy Alliance, the management and operations contractor for the INL; CH2M-WG Idaho, LLC, which manages ongoing cleanup operations under the ICP; and Idaho Treatment Group, LLC, which operates AMWTP. The INL Site consists of several primary facilities situated on an expanse of otherwise undeveloped terrain. Buildings and structures at the INL Site are clustered within these facilities, which are typically less than a few square miles in size and separated from each other by miles of undeveloped land. In addition, DOE-ID owns or leases laboratories and administrative offices in the city of Idaho Falls, some 25 miles east of the INL Site border. About 30 percent of employees work in administrative, scientific support, and non-nuclear laboratory programs and have offices in Idaho Falls.

The major facilities at the INL Site are the Advanced Test Reactor (ATR) Complex; Central Facilities Area (CFA); Critical Infrastructure Test Range Complex; Idaho Nuclear Technology and Engineering Center (INTEC); Materials and Fuels Complex (MFC); Naval Reactors Facility; Radioactive Waste Management Complex (RWMC); and Test Area North (TAN), which includes the Specific Manufacturing Capability (Figure ES-2). The Research and Education Campus is located in Idaho Falls. The major facilities and their missions are outlined in Table ES-1.

ENVIRONMENTAL PROTECTION PROGRAMS

Directives (Orders, guides, and manuals) are DOE's primary means of establishing policies, requirements, responsibilities, and procedures for DOE offices and contractors. Among these are a series of Orders directing each DOE site to implement sound stewardship practices that are protective of the public and the environment. These orders require the implementation of an environmental management system (EMS), a Site Sustainability Plan, radioactive waste management, and radiation protection of the public and biota.

Battelle Energy Alliance, CH2M-WG Idaho, LLC, and Idaho Treatment Group have each established and implemented an EMS and contribute to the INL Site Sustainability Plan, as required by DOE and executive orders. Each EMS integrates environmental protection,

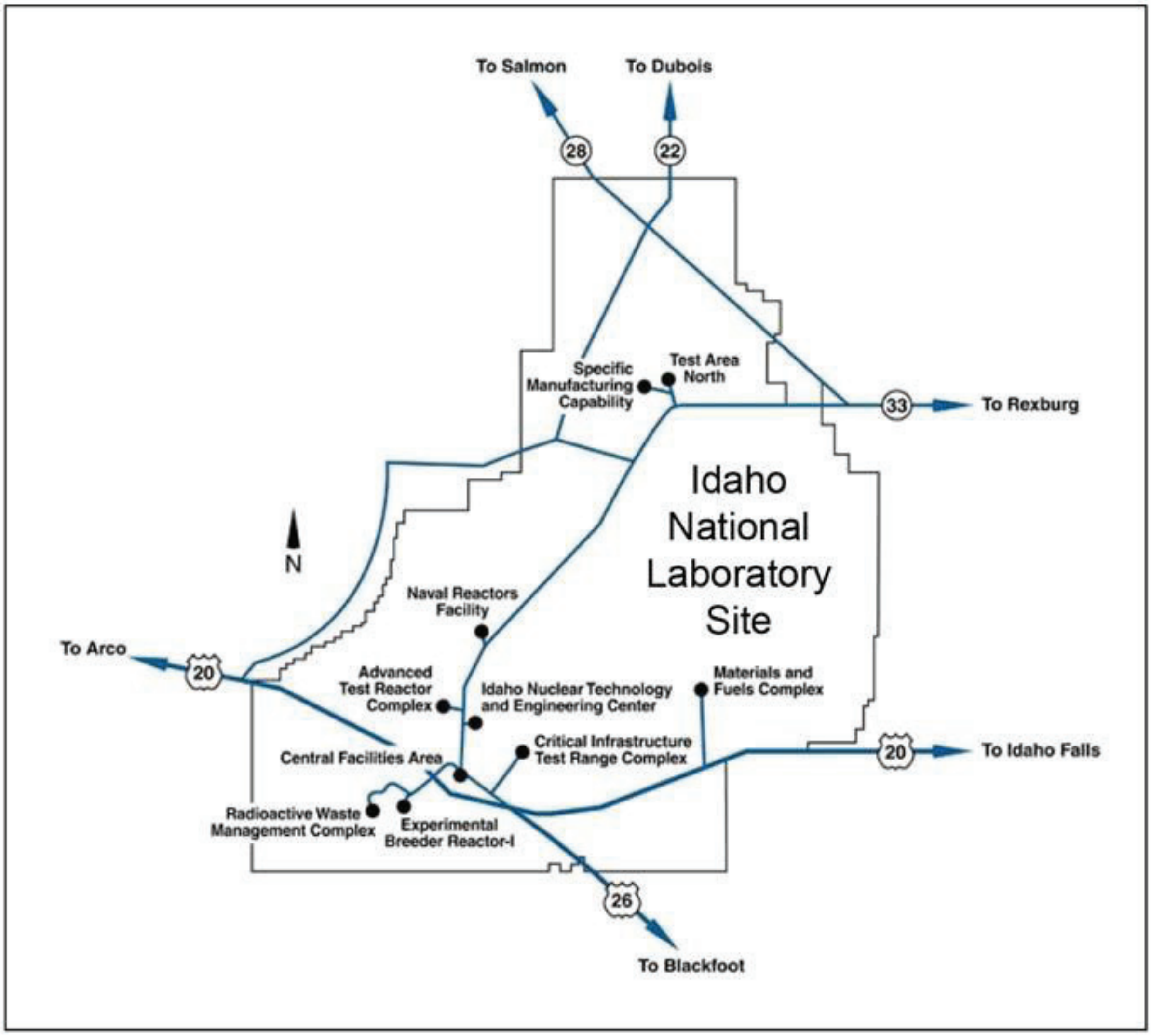


Figure ES-2. Idaho National Laboratory Site Facilities.

environmental compliance, pollution prevention, and waste minimization into work planning and execution throughout all work areas. The INL Sustainability Plan contains strategies and activities that will lead to continual greenhouse gas reductions as well as energy, water, and transportation fuels efficiency at the INL Site. Plan requirements are integrated into each INL Site contractor's Integrated Safety Management System and EMS. In 2014, the INL Site as a whole achieved reductions in energy, water, and fossil fuel usage, decreased greenhouse gas emissions, and increased alternative fuels usage.

The INL Site met all DOE public and biota dose limits for radiation protection in 2014.

ENVIRONMENTAL RESTORATION

Environmental restoration at the INL Site is conducted under the Federal Facility Agreement and Consent Order (FFA/CO) among DOE, the state of Idaho, and U.S. Environmental Protection Agency (EPA). The Consent Order governs the INL Site's environmental remediation. It specifies actions that must be complete to safely clean up past release sites at the INL Site in compliance with the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA). The INL Site is divided into ten Waste Area Groups (WAGs) as a result of the FFA/CO, and each WAG is

Table ES-1.Major INL Site Areas and Missions.

Major INL Site Area[a]	Operated By	Mission
Advanced Test Reactor (ATR) Complex	INL	Research and development of nuclear reactor technologies. Home of the ATR, a DOE National Scientific User Facility and the world's most advanced nuclear test reactor.
Central Facilities Area (CFA)	INL	INL Support for the operation of other INL Site facilities.
Critical Infrastructure Test Range Complex (CITRC)	INL	Supports National and Homeland Security missions of the laboratory, including program and project testing (i.e., critical infrastructure resilience and nonproliferation testing and demonstration).
Idaho Nuclear Technology and Engineering Center (INTEC)	ICP	Dry and wet storage of spent nuclear fuel, management of high-level waste calcine and sodium-bearing liquid waste, and operation of the Idaho Comprehensive Environmental Response, Compensation and Liability Act Disposal Facility including a landfill, evaporation ponds, and a staging and treatment facility.
Materials and Fuels Complex (MFC)	INL	Focuses on research and development of nuclear fuels. Pyroprocessing, which uses electricity to separate waste products in the recycling of nuclear fuel, is also researched here. Nuclear batteries for use on the nation's space missions are made at MFC.
Radioactive Waste Management Complex (RWMC)	ICP	Environmental remediation; and waste treatment, storage, and disposal for wastes generated at the INL Site and other DOE sites. Advanced Mixed Waste Treatment Project (AMWTP), operated by Idaho Treatment Group, LLC, and co-located with RWMC, characterizes, treats, and packages transuranic waste for shipment out of Idaho to permanent disposal facilities.
Research and Education Campus (REC)	INL	Located in Idaho Falls, is home to INL administration, the INL Research Center (IRC), the Center for Advanced Energy Studies (CAES), and other energy and security research programs. Research is conducted at IRC in robotics, genetics, biology, chemistry, metallurgy, computational science, and hydropower. CAES is a research and education partnership between Boise State University, INL, Idaho State University, and University of Idaho to conduct energy research and address the looming nuclear energy work-force shortage.
Test Area North (TAN)/Specific Manufacturing Capability	INL	Several historic nuclear research and development projects were conducted at TAN. Major cleanup and demolition of the facility was completed in 2008 and the current mission is manufacture of tank armor for the U.S. Army's battle tanks at the SMC for the U.S. Department of Defense.

a. The Naval Reactors Facility (NRF) is also located on the INL Site. It is operated for Naval Reactors by Bechtel Marine Propulsion Corporation. The Naval Nuclear Propulsion Program is exempt from DOE requirements and is therefore not addressed in this report.

divided into smaller cleanup areas called operable units. Since the FFA/CO was signed in 1991, the INL Site has cleaned up release sites containing asbestos, acids and bases, radionuclides, unexploded ordnance and explosive residues, polychlorinated biphenyls, heavy metals, and other hazardous materials.

Comprehensive remedial investigation/feasibility studies have been conducted at all WAGs and closeout activities have been implemented at five WAGs. In 2014, all institutional controls and operational and maintenance requirements were maintained and active remediation continued on WAGs 1, 3, 7, and 6/10.

RADIATION DOSE TO THE PUBLIC AND BIOTA FROM INL SITE RELEASES

Humans, plants, and animals potentially receive radiation doses from various INL Site operations. The DOE sets dose limits for the public and biota to ensure that exposure to radiation from site operations are not a health concern. Potential radiological doses to the public from INL Site operations were calculated to determine compliance with pertinent regulations and limits (Table ES-2). The calculated dose to the maximally exposed individual in 2014 was 0.036 mrem (0.36 µSv), well below the 10-mrem standard established by the Clean Air Act. The maximally exposed individual is a hypothetical member of the public who could receive the maximum possible dose from INL Site releases. This person was assumed to live just south of the INL Site boundary. For comparison, the dose from natural background radiation was estimated in 2014 to be 389 mrem (3,890 µSv) to an individual living on the Snake River Plain. The maximum potential population dose to the approximately 318,528 people residing within an 80-km (50-mi) radius of any INL Site facility was calculated as 0.607 person-rem (0.006 person-Sv), below that expected from exposure to background radiation (123,907 person-rem or 1,234 person-Sv).

The maximum potential individual dose from consuming waterfowl at the INL Site, based on the highest concentrations of radionuclides measured in samples of these animals, was estimated to be 0.032 mrem (0.32 µSv). There were no gamma-emitting radionuclides detected in big game animals sampled in 2014, hence there was no dose associated with consuming big game. When the dose estimated for the air pathway was summed with the dose from consuming contaminated waterfowl, assuming that the waterfowl is eaten by the same individual, the maximally exposed individual could potentially receive a total dose of 0.0689 mrem (0.689 µSv) in 2014. This is 0.0689 percent of the DOE health-based dose limit of 100 mrem/yr (1 mSv/yr) from all pathways for the INL Site.

Tritium has been previously detected in two U.S. Geological Survey (USGS) monitoring wells located along the southern INL Site boundary. A hypothetical individual drinking water from these wells would receive a dose of less than 0.2 mrem (0.002 mSv) in one year. This is an unrealistic pathway to humans because there are no drinking water wells located along the southern boundary of the INL Site.

The maximum contaminant level established by EPA for tritium corresponds to a dose of approximately 4 mrem (0.04 mSv).

Doses were also evaluated using a graded approach for nonhuman biota at the INL Site. Maximum concentrations of radionuclides measured in waterfowl tissue were used to estimate doses to those wildlife accessing ATR Complex ponds. Ducks were estimated to receive less than the standard of 1 rad/d (1 mGy/d) established by DOE for aquatic biota. Based on the calculations, there is no evidence that INL Site-related radioactivity in soil or water is harming populations of plants or animals.

ENVIRONMENTAL COMPLIANCE

One measure of the achievement of the environmental programs at the INL Site is compliance with applicable environmental regulations, which have been established to protect human health and the environment. Overall, the INL Site met all federal, state, and local regulatory commitments in 2014. INL Site compliance with major federal regulations established for the protection of human health and the environment is presented in Table ES-3. There were no reportable environmental occurrences or unplanned releases in 2014.

ENVIRONMENTAL MONITORING OF AIR

Airborne releases from INL Site operations are reported annually in a document prepared in accordance

Table ES-2. Contribution to Estimated Dose to a Maximally Exposed Individual by Pathway (2014).

Pathway	Dose to Maximally Exposed Individual (mrem)	Dose to Maximally Exposed Individual (mSv)	Percent of DOE 100-mrem/yr Dose Limit[a]	Estimated Population Dose (person-rem)	Estimated Population Dose (person-Sv)	Population within 80 km	Estimated Background Radiation Population Dose (person-rem)[b]
Air	0.0365	0.365	0.0365	0.607	0.00607	318,528	123,907
Waterfowl ingestion	0.0324	0.324	0.0324	NA[c]	NA	NA	NA
Big game animals	0	0	NA	NA	NA	NA	NA
Total pathways	**0.0689**	**0.689**	**0.0689**	**NA**	**NA**	**NA**	**NA**

a. The DOE limit for all pathways is 100 mrem/yr total effective dose equivalent. For this analysis, it was assumed that the hunter who eats contaminated waterfowl lives at the same location (Frenchman's Cabin) as the maximally exposed individual. The EPA regulatory standard for the air pathway is 10 mrem/yr effective dose equivalent and does not include the waterfowl consumption pathway.

b. The individual dose from background was estimated to be 389 mrem (3.9 mSv) in 2014 (Table 7-5).

c. NA = Not applicable.

with the Code of Federal Regulations, Title 40, "Protection of the Environment," Part 61, "National Emission Standards for Hazardous Air Pollutants," Subpart H, "National Emission Standards for Emissions of Radionuclides Other than Radon from Department of Energy Facilities." An estimated total of 2,350 curies of radioactivity, primarily in the form of short-lived noble gas isotopes, were released as airborne effluents in 2014. The highest releases were from the ATR Complex (54.8 percent of total), INTEC (41.8 percent of total), and RWMC (3.3 percent of total.) In terms of the calculated dose to the maximally exposed individual, facility contributions were 42 percent from the RWMC, 36 percent from the ATR Complex, and 22 percent from INTEC. The major radionuclide contributors to dose were tritium (28.5 percent), transuranic radionuclides (33 percent), strontium-90 (^{90}Sr) (14.3 percent), iodine-129 (8.5 percent), argon-41 (8.4 percent), and cesium-137 (^{137}Cs) (3.5 percent).

The INL Site environmental surveillance programs, conducted by the INL, ICP, and the Environmental Surveillance, Education, and Research (ESER) contractors, emphasize measurement of airborne radionuclides because air transport is considered the major potential pathway from INL Site releases to human receptors. During 2014, the INL contractor monitored ambient air outside 15 INL Site facilities and at five locations off the INL Site. The ICP contractor focused on ambient air monitoring of waste management facilities, namely INTEC and the RWMC. The ESER contractor sampled ambient air at three locations on the INL Site, at seven locations bounding the INL Site, and at six locations distant from the INL Site (including Jackson, Wyoming).

Air particulate samples were collected weekly by the ESER and INL contractors and bimonthly by the ICP contractor. These samples were then analyzed for gross alpha and gross beta activity. Charcoal cartridges were also collected weekly and analyzed for radioiodine. The particulate samples were combined into monthly, or quarterly composite samples by the ICP contractors and ESER, and INL contractors, respectively, and were analyzed for gamma-emitting radionuclides, such as ^{137}Cs. Particulate filters were also composited quarterly by the ICP and ESER contractors and analyzed for specific alpha- and beta-emitting radionuclides, specifically ^{90}Sr, plutonium-238, plutonium-239/240, and americium-241.

Table ES-3. Major Federal Regulations Established for Protection of Human Health and the Environment.

Regulator/ Regulation	Regulatory Program Description	Compliance Status	Report Sections
EPA/40 CFR 61, Subpart H	The Clean Air Act (CAA) is the basis for national air pollution control. Emissions of radioactive hazardous air pollutants are regulated by EPA, via the National Emission Standards for Hazardous Air Pollutant (NESHAPs), (40 CFR 61, Subpart H).	The INL Site is in compliance, as reported in National Emission *Standards for Hazardous Air Pollutants – Calendar Year 2014.*	2.1.1 4.2 8.2.1
DOE/Order 458.1, Change 2	The order establishes requirements to protect the public and the environment against undue risk from radiation associated with radiological activities conducted under the control of DOE pursuant to the Atomic Energy Act of 1954, as amended. The Order requires the preparation of an Environmental Radiation Protection Plan which outlines the means by which facilities monitor their impacts on the public and environment.	The INL Site maintains and implements several plans and programs for ensuring that the management of facilities, wastes, effluents, and emissions does not present risk to the public, workers, or environment. Environmental monitoring plans are well documented and the results are published in the INL Site Environmental Report.	Chapter 4 Chapter 5 Chapter 6 Chapter 7 Chapter 8
EPA/40 CFR 300	The Comprehensive Environmental Response, Compensation and Liability Act (CERCLA) provides the regulatory framework for remediation of releases of hazardous substances and remediation (including decontamination and decommissioning [D&D]) of inactive hazardous waste disposal sites.	Nuclear research and other operations at the INL Site left behind contaminates that pose a potential risk to human health and the environment. In 1991, the INL Site entered into a tri-party agreement, the Federal Facility Agreement and Consent Order, with EPA, the state of Idaho, and DOE-ID. INL Site remediation is conducted by the Idaho Cleanup Project (ICP).	3.2
EPA/40 CFR 109-140	The Clean Water Act (CWA) establishes goals to control pollutants discharged to U.S. surface waters.	The INL Site complies with two CWA permits – the National Pollution Discharge Elimination System (NPDES) permits and Storm Water Discharge Permits for construction activity.	2.4.1
EPA/40 CFR 141-143	The Safe Drinking Water Act (SDWA) establishes primary standards for public water supplies to ensure it is safe for consumption.	The INL Site has 12 active drinking water systems which area routinely sampled and analyzed as required by the state of Idaho and EPA.	5.4

All radionuclide concentrations in ambient air samples were below DOE radiation protection standards for air and were within historical measurements. In addition, gross alpha and gross beta concentrations were analyzed statistically, and there were no differences between samples collected on the INL Site, at the INL Site boundary, and off the INL Site. Trends in the data appear to be seasonal in nature and do not demonstrate any INL Site influence. This indicates that INL Site airborne effluents were not measureable in environmental air samples.

The INL contractor collected atmospheric moisture samples at three stations on and two stations off the INL Site. The ESER contractor also collected atmospheric moisture at four offsite locations. In addition, the ESER contractor sampled precipitation at two stations on the INL Site and one location off the INL Site. These samples were all analyzed for tritium. The results were within measurements made historically and by the EPA and were below DOE standards. Tritium measured in these samples is most likely the result of natural production in the atmosphere and not the result of INL Site effluent releases.

ENVIRONMENTAL MONITORING OF GROUNDWATER, DRINKING, AND SURFACE WATER FOR COMPLIANCE PURPOSES

The INL and ICP contractors monitor liquid effluents, drinking water, groundwater, and storm water runoff at the INL Site, primarily for nonradioactive constituents, to comply with applicable laws and regulations, DOE Orders, and other requirements. Wastewater is typically discharged from INL Site facilities to the ground surface. Wastewater discharges occur at percolation ponds southwest of INTEC, a cold waste pond at the ATR Complex, and a sewage treatment facility at CFA. These effluents are regulated by the state of Idaho groundwater quality and wastewater rules through wastewater reuse permits, which require monitoring of the wastewater and, in some instances, groundwater in the area. During 2014, liquid effluent and groundwater monitoring were conducted in support of wastewater reuse permit requirements. An annual report for each permitted facility was prepared and submitted to the Idaho Department of Environmental Quality. No permit limits were exceeded.

Additional liquid effluent monitoring was performed at ATR Complex, CFA, INTEC, and MFC to comply with environmental protection objectives of DOE Orders. Most results were within historical measurements. All radioactive parameters were below health-based contaminant levels.

Drinking water parameters are regulated by the state of Idaho under authority of the Safe Drinking Water Act. Drinking water was sampled in nine drinking water systems at the INL Site in 2014. Results were below limits for all relevant drinking water standards. The CFA distribution system serves 500 workers daily and is downgradient from an historic groundwater plume of radionuclides resulting from wastewater injection by INTEC and the ATR Complex directly into the aquifer. Because of this, a dose was calculated to a worker who might obtain all their drinking water from the CFA drinking water system during 2014. The dose, 0.18 mrem (1.8 µSv), is below the EPA standard of 4 mrem/yr (40 µSv/yr) for public drinking water systems.

Surface water flows off the SDA following periods of heavy precipitation or rapid snowmelt. During these times, water may be pumped out of the SDA retention basin into a drainage canal, potentially carrying radionuclides originating from radioactive waste or contaminated surface soil off the SDA. Surface water is collected when it is available. Americium-241, plutonium-238, plutonium-239/240, and ^{90}Sr were detected within historical levels. The detected concentrations are well below standards established by DOE for radiation protection of the public and the environment.

ENVIRONMENTAL MONITORING OF THE EASTERN SNAKE RIVER PLAIN AQUIFER

The eastern Snake River Plain aquifer beneath the eastern Snake River Plain is perhaps the single-most important aquifer in Idaho. Composed of layered basalt lava flows and some sediment, it covers an area of approximately 10,800 square miles. The highly productive aquifer has been declared a sole source aquifer by the EPA due to the nearly complete reliance on the aquifer for drinking water supplies in the area.

The USGS began to monitor the groundwater below the INL Site in 1949. Currently, the USGS performs groundwater monitoring, analyses, and studies of the eastern Snake River Plain aquifer under and adjacent to the INL Site. These activities utilize an extensive network of strategically placed monitoring wells on and around the INL. In 2014, the USGS continued to monitor localized areas of chemical and radiochemical contamination beneath the INL Site produced by past waste disposal practices, in particular the direct injection of wastewater into the aquifer at INTEC and the ATR Complex. Results for monitoring wells sampled within the plumes show nearly all wells had decreasing or no trends of tritium and ^{90}Sr concentrations over time.

Several purgeable (volatile) organic compounds were detected by USGS in 26 groundwater monitoring wells and one perched well sampled at the INL Site in 2014. Most concentrations of the 61 compounds analyzed were either below the laboratory reporting levels or their respective primary contaminant standards. An increasing trend for carbon tetrachloride for the Radioactive Waste Management Complex Production Well has been observed for the period 1987–2012; however, trend analyses of data collected since 2005 show no statistically significant trend indicating that engineering practices designed to reduce movement of volatile organic compounds to the aquifer may be having a positive effect on the aquifer. Trichloroethene (TCE) was measured in another well at TAN, which was expected as there is a known groundwater plume at this location.

Groundwater surveillance monitoring continued for the CERCLA WAGs on the INL Site in 2014. At TAN (WAG 1), groundwater monitoring continues to monitor the progress of remediation of the plume of TCE. Remedial action consists of three components: in situ bioremediation; pump and treat; and monitored natural attenuation.

Data from groundwater in the vicinity of the ATR Complex (WAG 2) show no concentrations of chromium, ^{90}Sr, and tritium above their respective primary contaminant standards.

Groundwater samples were collected from thirteen aquifer monitoring wells at and near INTEC (WAG 3) during 2014. Strontium-90 is still measureable, as a result of past disposal of service waste to the injection well at INTEC, but at levels similar or slightly lower than those reported in previous samples. Technicium-99, from past releases from the INTEC Tank Farm, was also detected but all wells showed stable or declining trends from the previous reporting period. The presence of nitrate is attributed to past Tank Farm releases and has remained relatively constant or slightly lower than observed in previous years. Iodine-129 concentrations were below detection levels at all but one well location and continue to show stable or declining trends.

Monitoring of groundwater at WAG 4 consists of CFA landfill monitoring and monitoring of a nitrate plume south of the CFA. Wells at the landfills were monitored in 2014 for metals (filtered), volatile organic compounds, and anions (nitrate, chloride, fluoride, and sulfate). These contaminants were either undetected or below their respective primary contaminant standards. Nitrate continued to exceed the EPA maximum contaminated level in one well in the plume south of the CFA 2014, but overall the data show a downward trend since 2006.

At the RWMC (WAG 7), carbon tetrachloride and TCE were detected at several locations and TCE slightly exceeded the EPA maximum contaminant level in one aquifer well northeast of the facility. The TCE concentration at this well, however, showed little change from the previous year. In general, radionuclides in the aquifer at RWMC are relatively stable or trending slightly downward.

Wells at the MFC (WAG 9) were sampled for radionuclides, metals, total organic carbon, total organic halogens, and other water quality parameters. Overall, the results show no evidence of impacts from MFC activities.

Drinking water and surface water samples were sampled downgradient of the INL Site and analyzed for gross alpha and beta activity and tritium. Tritium was detected in some samples at levels within historical measurements and below the EPA maximum contaminant level for tritium. Gross alpha and beta results were within historical measurements and the gross beta activity was well below the maximum contaminant level for ^{90}Sr, which is a beta emitting radionuclide.

MONITORING OF AGRICULTURAL PRODUCTS, WILDLIFE, AND DIRECT RADIATION MEASUREMENTS

To help assess the impact of contaminants released to the environment by operations at the INL Site, agricultural products (milk, lettuce, grain, and potatoes) and wildlife were sampled and analyzed for radionuclides in 2014. The agricultural products were collected on, around and distant from the INL Site by the ESER contractor.

Wildlife sampling included collection of ducks from wastewater ponds in the vicinity of the ATR Complex and the MFC, as well as big game animals killed by vehicles on roads within the INL Site. In addition, direct radiation was measured on and off the INL Site in 2014.

Some human-made radionuclides were detected in agricultural product and waterfowl samples. However, measurements were consistent with those made historically.

Strontium-90, a radionuclide measured in fallout, was detected at low levels in all lettuce samples collected locally. No gamma-emitting radionuclides were detected in the two big game animals sampled in 2014.

Cesium-137, cobalt-60, zinc-65, and selenium-75 were measured in the edible tissue of waterfowl accessing ATR Complex wastewater ponds.

Direct radiation measurements made at offsite, boundary, and onsite locations were consistent with historical and/or natural background levels.

MONITORING OF WILDLIFE POPULATIONS

Field data are routinely collected on several key groups of wildlife at the INL Site for information that can be used to prepare National Environmental Policy Act documents and to enable DOE to make informed decisions for planning projects and compliance with environmental policies and executive orders related to protection of wildlife. Surveys are routinely conducted on bird, big game, and bat populations on the INL Site. Monitoring in 2014 included the midwinter eagle survey, sage-grouse lek surveys, and a breeding bird survey. During 2014 permanent bat monitoring stations continued to be monitored at the INL Site.

ENVIRONMENTAL RESEARCH AT THE IDAHO NATIONAL ENVIRONMENTAL RESEARCH PARK AT THE INL SITE

In 1975, the mostly pristine land within the INL Site's borders became DOE's second National Environmental Research Park. All lands within the Park serve as an ecological field laboratory where scientists from government agencies, universities, and private foundations may set up long-term research. This research has covered a broad range of topics and issues from studies on the basic ecology of native sagebrush steppe organisms to the potential natural pathways of radiological materials through the environment, and even to highly applied research on the design of landfill covers that prevent water from reaching buried waste. The research topics have included native plants and wildlife as well as attempts to understand and control non- native, invasive species. The Park also provides interpretation of research results to land and facility managers to support the National Environmental Policy Act process natural resources management, radionuclide pathway analysis, and ecological risk assessment.

The Idaho National Environmental Research Park maintains several regionally and nationally important long-term ecological data sets. It is home to one of the largest data sets on sagebrush steppe vegetation anywhere. In 1950, 100 vegetation plots were established on the INL Site and were originally designed to look for the potential effects of nuclear energy research on native vegetation. Since then the plots have been surveyed about every five to seven years. In 2014, six major ecological research projects took place on the Idaho National Environmental Research Park. The researchers were from Idaho State University; Boise State University; College of Idaho, Environmental Surveillance, Education, and Research Program; and U.S. Geological Survey, Forest and Rangeland Ecosystem Science Center, Boise, ID.

USGS RESEARCH

The USGS INL Project Office drills and maintains research wells which provide information about subsurface water, rock and sediment, and contaminant movement in the eastern Snake River Plain aquifer at and near the INL Site. In 2014, the USGS published five research reports.

QUALITY ASSURANCE

Quality assurance and quality control programs are maintained by contractors conducting environmental monitoring and by laboratories performing environmental analyses to help provide confidence in the data and ensure data completeness. Programs involved in environmental monitoring developed quality assurance programs and documentation which follow requirements and criteria established by DOE. Environmental monitoring programs implemented quality assurance program elements through quality assurance project plans developed for each contractor.

Adherence to procedures and quality assurance project plans was maintained during 2014. Data reported in this document were obtained from several commercial, university, government, and government contractor laboratories. To assure quality results, these laboratories participated in a number of laboratory quality check programs. Quality issues that arose with laboratories used by the INL, ICP and ESER contractors during 2014 were addressed with the laboratories and have been or are being resolved.

Helpful Information

Much of the Annual Site Environmental Report deals with radioactivity levels measured in environmental media, such as air, water, soil, and plants. The following information is intended for individuals with little or no familiarity with radiological data or radiation dose. It presents terminology and concepts used in the Annual Site Environmental Report to aid the reader.

WHAT IS RADIATION?

Matter is composed of atoms. Some atoms are energetically unstable and change to become more stable. During this transformation, unstable or radioactive atoms give off energy called “radiation” in the form of particles or electromagnetic waves. Generally, we refer to the various radioactive atoms as radionuclides. The radiation released by radionuclides has enough energy to eject electrons from other atoms it encounters. The ejected electrons and associated positively charged atoms are called “ions,” and the energetic radiation that produced the ions is called “ionizing” radiation. Ionizing radiation is referred to simply as “radiation” in the rest of this report. The most common types of radiation are alpha particles, beta particles, X-rays, and gamma-rays. X-rays and gamma-rays, just like visible light and radiowaves, are packets of electromagnetic radiation. Collectively, packets of electromagnetic radiation are called photons. One may, for instance, speak of X-ray photons or gamma-ray photons.

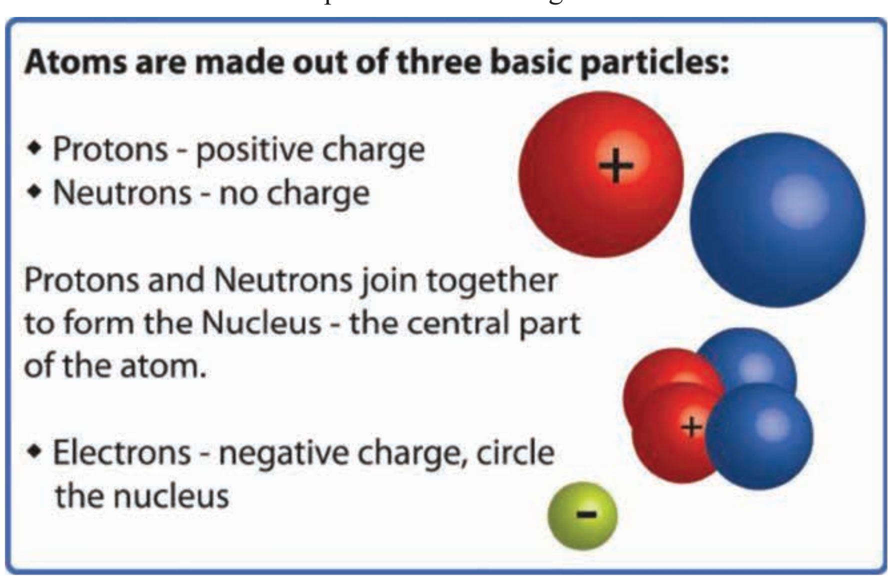
Alpha Particles. An alpha particle is a helium nucleus without orbital electrons. It is composed of two protons and two neutrons and has a positive charge of plus two. Because alpha particles are relatively heavy and have a double charge, they cause intense tracks of ionization, but have little penetrating ability (Figure HI-1). Alpha particles can be stopped by thin layers of materials, such as a sheet of paper or piece of aluminum foil. Alpha particles can be detected in samples containing radioactive atoms of radon, uranium, plutonium, and americium.

Beta Particles. Beta particles are electrons that are ejected from unstable atoms during the transformation or decay process. Beta particles penetrate more than alpha particles, but are less penetrating than X-rays or gamma-rays of equivalent energies. A piece of wood or a thin block of plastic can stop beta particles (Figure HI-1). The ability of beta particles to penetrate matter increases with energy. Examples of beta-emitting radionuclides include tritium (^{3}H) and radioactive strontium.

X-Rays and Gamma-Rays. X-rays and gamma-rays are photons that have very short wavelengths compared to other electromagnetic waves, such as visible light, heat rays, and radio waves. Gamma-rays and X-rays have identical properties, behavior, and effects, but differ only in their origin. Gamma-rays originate from an atomic nucleus, and X-rays originate from interactions with the electrons orbiting around atoms. All photons travel at the speed of light. Their energies, however, vary over a large range. The penetration of X-ray or gamma-ray photons depends on the energy of the photons, as well as the thickness, density, and composition of the shielding material. Concrete is a common material used to shield people from gamma-rays and X-rays (Figure HI-1). Examples of gamma-emitting radionuclides include radioactive atoms of iodine and cesium. X-rays may be produced by medical X-ray machines in a doctor’s office.

HOW ARE RADIONUCLIDES DESIGNATED?

Radionuclides are frequently expressed with a one or two letter abbreviation for the element and a superscript to the left of the symbol that identifies the atomic weight of the isotope. The atomic weight is the number of



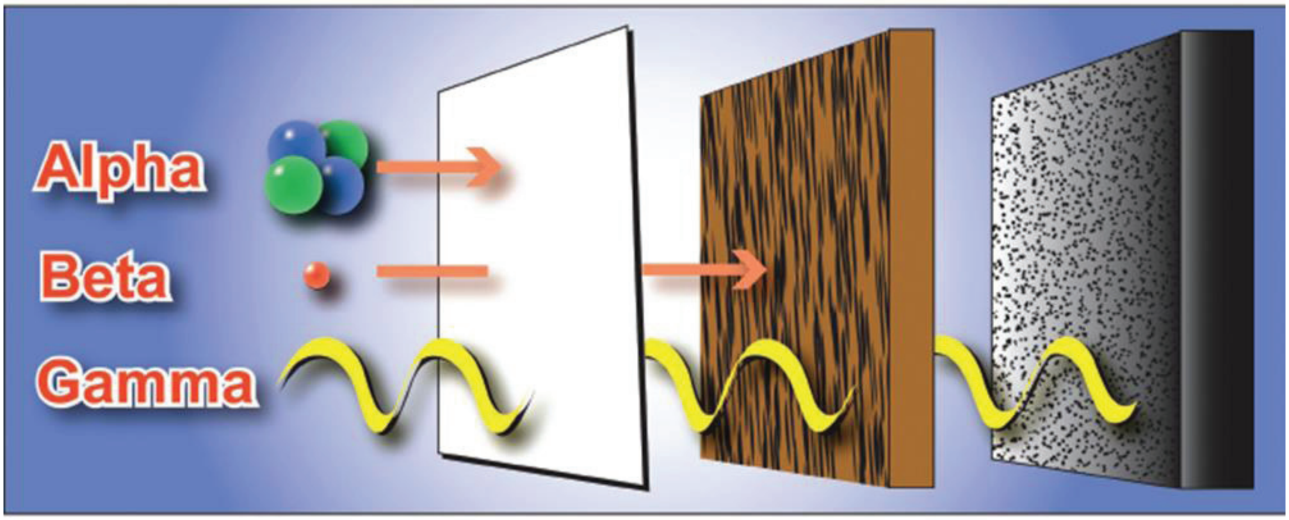


Figure HI-1. Comparison of Penetrating Ability of Alpha, Beta, and Gamma Radiation.

protons and neutrons in the nucleus of the atom. Most radionuclide symbols used in this report are shown in Table HI-1. The table also shows the half-life of each radionuclide. Half-life refers to the time in which one-half of the atoms of a radioactive sample transforms or decays in the quest to achieve a more energetically stable nucleus. Most radionuclides do not decay directly to a stable element, but rather undergo a series of decays until a stable element is reached. This series of decays is called a decay chain.

HOW ARE RADIOACTIVITY AND RADIONUCLIDES DETECTED?

Environmental samples of air, water, soil, and plants are collected in the field and then prepared and analyzed for radioactivity in a laboratory. A prepared sample is placed in a radiation counting system with a detector that converts the ionization produced by the radiation into electrical signals or pulses. The number of electrical pulses recorded over a unit of time is called a "count rate." The count rate is proportional to the amount of radioactivity in the sample.

Air and water samples are often analyzed to determine the total amount of alpha and beta-emitting radioactivity present. This is referred to as a "gross" measurement, because the radiation from all alpha-emitting and beta-emitting radionuclides in the sample is quantified. Such sample analyses measure both human-generated and naturally occurring radioactive material. Gross alpha and beta analyses are generally considered screening measurements, since specific radionuclides are not identified. The amount of gross alpha and beta-emitting radioactivity in air samples is frequently measured to screen for the presence of man-made radionuclides. If the results are higher than normal, sources other than background radionuclides may be suspected, and other laboratory techniques may be used to identify the specific radionuclides in the sample. Gross alpha and beta activity also can be examined over time and between locations to detect trends.

The low penetration ability of alpha-emitting particles makes detection by any instrument difficult. Identifying specific alpha-emitting radionuclides typically involves chemical separations in the laboratory to purify the sample prior to analysis with an alpha detection instrument. Radiochemical analysis is very time consuming and expensive.

Beta particles are easily detected by several types of instruments, including the common Geiger-Mueller (G-M) counter. However, detection of specific beta-emitting radionuclides, such as tritium-3 (^{3}H) and strontium-90 (^{90}Sr), requires chemical separation first.

Table HI-1. Radionuclides and Their Half-lives.

Symbol	Radionuclide	Half-life[a,b]	Symbol	Radionuclide	Half-life
^{241}Am	Americium-241	432.2 yr	^{54}Mn	Manganese-54	312.5 d
^{243}Am	Americium-243	7,380 yr	^{59}Ni	Nickel-59	7.5 x 10^{4} yr
^{125}Sb	Antimony-125	2.77 yr	^{63}Ni	Nickel-63	96 yr
^{41}Ar	Argon-41	1.827 hr	^{238}Pu	Plutonium-238	87.74 yr
^{137m}Ba	Barium-137m	2.552 min	^{239}Pu	Plutonium-239	2.4065 x 10^{4} yr
^{140}Ba	Barium-140	12.74 d	^{240}Pu	Plutonium-240	6.537 x 10^{3} yr
^{7}Be	Beryllium-7	53.3 d	^{241}Pu	Plutonium-241	14.4 yr
^{14}C	Carbon-14	5,730 yr	^{242}Pu	Plutonium-242	3.763 x 10^{5} yr
^{141}Ce	Cerium-141	32.5 d	^{40}K	Potassium-40	1.28 x 10^{9} yr
^{144}Ce	Cerium-144	284.3 d	^{226}Ra	Radium-226	1.62 x 10^{3} yr
^{134}Cs	Cesium-134	2.062 yr	^{228}Ra	Radium-228	5.75 yr
^{137}Cs	Cesium-137	30.0 yr	^{220}Rn	Radon-220	55.6 s
^{51}Cr	Chromium-51	27.704 d	^{222}Rn	Radon-222	3.8235 d
^{60}Co	Cobalt-60	5.271 yr	^{103}Ru	Ruthenium-103	39.28 d
^{152}Eu	Europium-152	13.33 yr	^{106}Ru	Ruthenium-106	368.2 d
^{154}Eu	Europium-154	8.8 yr	^{90}Sr	Strontium-90	29.12 yr
^{3}H	Tritium	12.35 yr	^{99}Tc	Technetium-99	2.13 x 10^{5} yr
^{129}I	Iodine-129	1.57 x 10^{7} yr	^{232}Th	Thorium-232	1.405 x 10^{10} yr
^{131}I	Iodine-131	8.04 d	^{233}U	Uranium-233	1.585 x 10^{5} yr
^{55}Fe	Iron-55	2.7 yr	^{234}U	Uranium-234	2.445 x 10^{5} yr
^{59}Fe	Iron-59	44.529 d	^{235}U	Uranium-235	7.038 x 10^{8} yr
^{85}Kr	Krypton-85	10.72 yr	^{238}U	Uranium-238	4.468 x 10^{9} yr
^{87}Kr	Krypton-87	1.27 hr	^{90}Y	Yttrium-90	64.0 hr
^{88}Kr	Krypton-88	2.84 hr	^{65}Zn	Zinc-65	243.9 d
^{212}Pb	Lead-212	10.64 hr	^{95}Zr	Zirconium-95	63.98 d

a. From EPA (1999).

b. d = days; hr = hours; min = minutes; s = seconds; yr = years.

The high-energy photons from gamma-emitting radionuclides are relatively easy to detect. Because the photons from each gamma-emitting radionuclide have a characteristic energy, gamma emitters can be simply identified in the laboratory with only minimal sample preparation prior to analysis. Gamma-emitting radionuclides, such as cesium-137 (^{137}Cs), can even be measured in soil by field detectors called "in-situ" detectors.

Gamma radiation originating from naturally occurring radionuclides in soil and rocks on the earth's surface is a primary contributor to the background external radiation exposure measured in air. Cosmic radiation from outer space is another contributor to the external radiation background. External radiation is easily measured with devices known as environmental dosimeters.

HOW ARE RESULTS REPORTED?

Scientific Notation. Concentrations of radionuclides detected in the environment are typically quite small. Scientific notation is used to express numbers that are very small or very large. A very small number may be expressed with a negative exponent, for example, 1.3×10^{-6}. To convert this number to its decimal form, the decimal point is moved left by the number of places equal to the exponent (six, in this case). The number 1.3×10^{-6} may also be expressed as 0.0000013.

When considering large numbers with a positive exponent, such as 1.0×10^{6}, the decimal point is moved to the right by the number of places equal to the exponent. In this case, 1.0×10^{6} represents one million and may also be written as 1,000,000.

Unit Prefixes. Units for very small and very large numbers are often expressed with a prefix. One common example is the prefix kilo (abbreviated k), which means 1,000 of a given unit. One kilometer, therefore, equals 1,000 meters. Table HI-2 defines the values of commonly used prefixes.

Units of Radioactivity. The basic unit of radioactivity used in this report is the curie (abbreviated Ci). The curie is based on the disintegration rate occurring in 1 gram of the radionuclide radium-226, which is 37 billion (3.7×10^{10}) disintegrations per second (becquerels). For any other radionuclide, 1 Ci is the amount of the radionuclide that produces this same decay rate.

Units of Exposure and Dose (Table HI-3). Exposure, or the amount of ionization produced by gamma or X-ray radiation in air, is measured in terms of the roentgen (R). Dose is a general term to express how much radiation energy is deposited in something. The energy deposited can be expressed in terms of absorped, equivalent, and/or effective dose. The term "rad", which is short for radiation absorbed dose, is a measure of the energy absorbed in an organ or tissue. The equivalent dose, which takes into account the effect of different types of radiation on tissues and therefore the potential for biological effects, is expressed as the roentgen equivalent man or "rem." Radiation exposures to the human body, whether from external or internal sources, can involve all or a portion of the body. To enable radiation protection specialists to express partial-body exposures (and the accompanying doses) to portions of the body in terms of an equal dose to the whole body, the concept of "effective dose" was developed.

The Système International (SI) is the official system of measurement used internationally to express units of radioactivity and radiation dose. The basic SI unit of radioactivity is the Becquerel (Bq), which is equivalent to one nuclear disintegration per second. The number of curies must be multiplied by 3.7×10^{10} to obtain the equivalent number of becquerels. The concept of dose may also be expressed using the SI units, Gray (Gy) for absorbed dose and sievert (Sv) for effective dose, where 1 Sv equals 100 rem.

Concentrations of Radioactivity in Environmental Sample Media. Table HI-4 shows the units used to identify the concentration of radioactivity in various sample media.

There is always uncertainty associated with the measurement of radioactivity in environmental samples. This is mainly because radioactive decay events are inherently random. Thus, when a radioactive sample is counted again and again for the same length of time, the results will differ slightly, but most of the results will be close to the "true value" of the activity of the radioactive material in the sample. Statistical methods are used to estimate the true value of a single measurement and the associated uncertainty of the measurement. The uncertainty of a measurement is reported by following the result with an uncertainty value which is preceded by the plus or minus symbol, ± (e.g., 10 ± 2 pCi/L). For concentrations of greater than or equal to three times the uncertainty, there is 95 percent probability that the radionuclide was detected in a sample. For example, if a radionuclide is reported for a sample at a concentration of 10 ± 2 pCi/L, that radionuclide is considered to be detected in that sample because 10 is greater than 3 × 2 or 6. On the other hand, if the reported concentration of a radionuclide (e.g., 10 ± 6 pCi/L) is smaller than three times its associated uncertainty, then the sample probably does not contain that radionuclide (i.e., 10 is less than 3 × 6 or 18). Such low concentrations are considered to be undetected by the method and/or instrumentation used.

Mean, Median, Maximum, and Minimum Values. Descriptive statistics are often used to express the

Table HI-2. Multiples of Units.

Multiple	Decimal Equivalent	Prefix	Symbol
10^6	1,000,000	mega-	M
10^3	1,000	kilo-	k
10^2	100	hecto-	h
10	10	deka-	da
10^{-1}	0.1	deci-	d
10^{-2}	0.01	centi-	c
10^{-3}	0.001	milli-	m
10^{-6}	0.000001	micro-	µ
10^{-9}	0.000000001	nano-	n
10^{-12}	0.000000000001	pico-	p
10^{-15}	0.000000000000001	femto-	f
10^{-18}	0.000000000000000001	atto-	a

Table HI-3. Names and Symbols for Units of Radioactivity and Radiological Dose Used in this Report.

Symbol	Name
Bq	Becquerel
Ci	Curie (37,000,000,000 Bq)
mCi	Millicurie (1×10^{-3} Ci)
µCi	Microcurie (1×10^{-6} Ci)
mrad	Millirad (1×10^{-3} rad)
mrem	Millirem (1×10^{-3} rem)
R	Roentgen
mR	Milliroentgen (1×10^{-3} R)
µR	Microroentgen (1×10^{-6} R)
Sv	Sievert (100 rem)
mSv	Millisievert (100 mrem)

Table HI-4. Units of Radioactivity.

Media	Unit
Air	Microcuries per milliliter (µCi/mL)
Liquid, such as water and milk	Picocuries per liter (pCi/L)
Soil and agricultural products	Picocuries per gram (pCi/g) dry weight
Annual human radiation exposure, measured by environmental dosimeters	Milliroentgens (mR) or millirem (mrem), after being multiplied by an appropriate dose equivalent conversion factor

patterns and distribution of a group of results. The most common descriptive statistics used in this report are the mean, median, minimum, and maximum values. Mean and median values measure the central tendency of the data. The mean is calculated by adding up all the values in a set of data and then dividing that sum by the number of values in the data set. The median is the middle value in a group of measurements. When the data are arranged from largest (maximum) to smallest (minimum), the result in the exact center of an odd number of results is the median. If there is an even number of results, the median is the average of the two central values. The maximum and the minimum results represent the range of the measurements.

Statistical analysis of many of the air data reported in this annual report indicate that the median is a more appropriate representation of the central tendency of those results. For this reason, some of the figures present the median value of a data group. For example, Figure HI-2 illustrates the minimum, maximum, and median of a set of air measurements. The vertical lines drawn above and below the median represent the range of values between the minimum and maximum results.

HOW ARE DATA REPRESENTED GRAPHICALLY?

Charts and graphs often are used to compare data and to visualize patterns, such as trends over time. Four kinds of graphics are used in this report to represent data: pie charts, column graphs, line plots, and contour lines.

A **pie chart** is used in this report to illustrate fractions of a whole. For example, Figure HI-3 shows the approximate contribution to dose that a typical person might receive while living in southeast Idaho. The percentages are derived from the table in the upper right-hand corner of the figure. The medical, consumer, and occupational/industrial portions are from National Council on Radiation Protection and Measurements Report No. 160 (NCRP 2009). The contribution from background (natural radiation, mostly radon) is estimated in Table 7-5 of this report.

A **column or bar chart** can show data changes over a period of time or illustrate comparisons among items. Figure HI-4 illustrates the contribution of radionuclides released into air from INL Site operations from 1975 through 1984 to the dose (mrem) calculated for the maximally exposed individual. The maximally exposed individual is a hypothetical member of the public who is exposed to radionuclides from airborne releases through various environmental pathways and the media through which the radionculides are transported (i.e., air, water, and food). One column (red) represents the annual dose from krypton-88 (^{88}Kr) released. The second column (green) plots the annual dose from all radionuclides released into the air. The chart shows the general decreasing trend of the dose as well as the relative contribution to dose from the ^{88}Kr. The relative contribution to the total dose from ^{88}Kr varies over time. For example, it represents approximately one-third of the total dose in 1975 and a little over one-half of the dose in 1976.

A **plot** can be useful to visualize differences in results over time. Figure HI-5 shows the median, minimum, and maximum results of gross beta measurements in all air filters collected by the Environmental Surveillance, Education, and Research contractor for ten years (2002 through 2011). The results

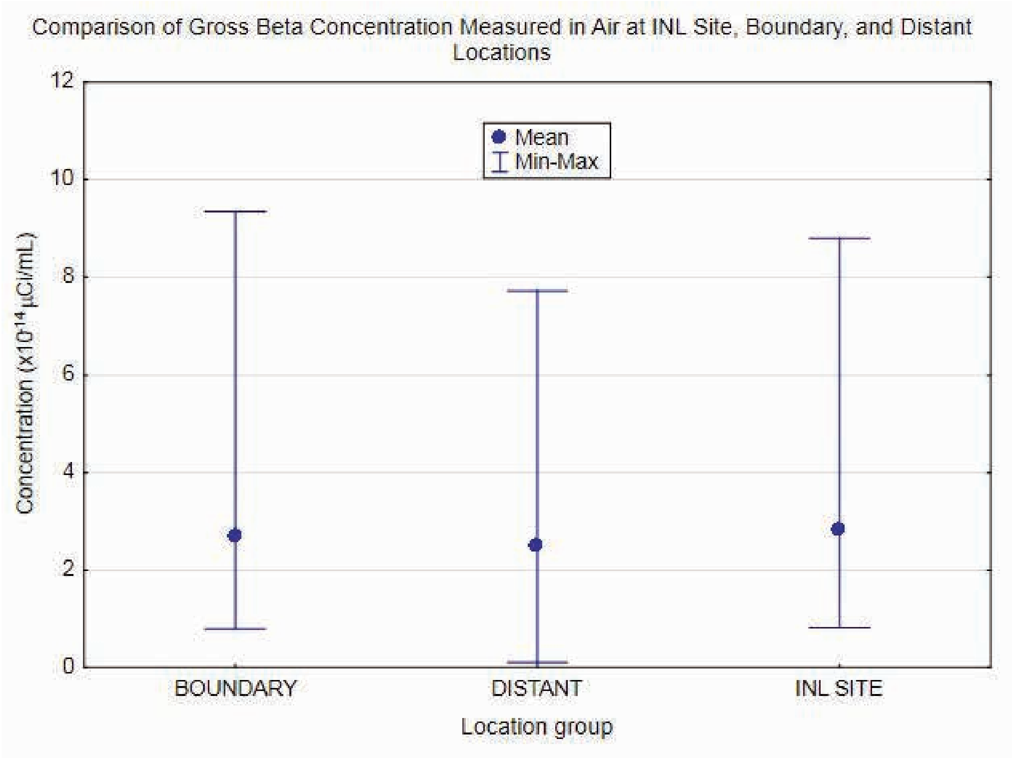


Figure HI-2. A Graphical Representation of Minimum, Median, and Maximum Results.

are plotted by the week of the year. Thus, the median for each week represents the midpoint of measurements made at all locations during the ten-year period for that week. The plot shows that the results can vary greatly, particularly during the winter.

Contour lines are sometimes drawn on a map to discern patterns over a geographical area. For example, Figure HI-6 shows the distribution of ^{3}H in groundwater around the Idaho Nuclear Technology and Engineering Center (INTEC). Each contour line, or isopleth, represents a specific concentration of the radionuclide in groundwater. It was estimated from measurements of samples collected from wells around INTEC. Each contour line separates areas that have concentrations above the contour line value from those that have concentrations below that value. The figure shows the highest concentration gradient near INTEC and the lowest farther away. It reflects the movement of the radionuclide in groundwater from INTEC where it was injected into the aquifer in the past.

HOW ARE RESULTS INTERPRETED?

To better understand data, results are compared in one or more ways, including:

- Comparison of results collected at different locations. For example, measurements made at INL Site locations are compared with those made at locations near the boundary of the INL Site and distant from the INL Site to find differences that may indicate an impact (Figure HI- 2).
- Trends over time or space. Data collected during the year can be compared with data collected at the same location or locations during previous years to see if concentrations are increasing, decreasing, or remaining the same with time. See, for example, Figure HI-4, which shows a general decrease in dose over time. Figure HI-6 illustrates a clear spatial pattern of radionuclide concentrations in groundwater decreasing with distance from the source.
- Comparison with background measurements. Humans are now, and always have been, continuously exposed to ionizing radiation from natural background sources. Background sources include natural radiation and radioactivity as well as radionuclides from human activities. These sources are discussed in the following section.

WHAT IS BACKGROUND RADIATION?

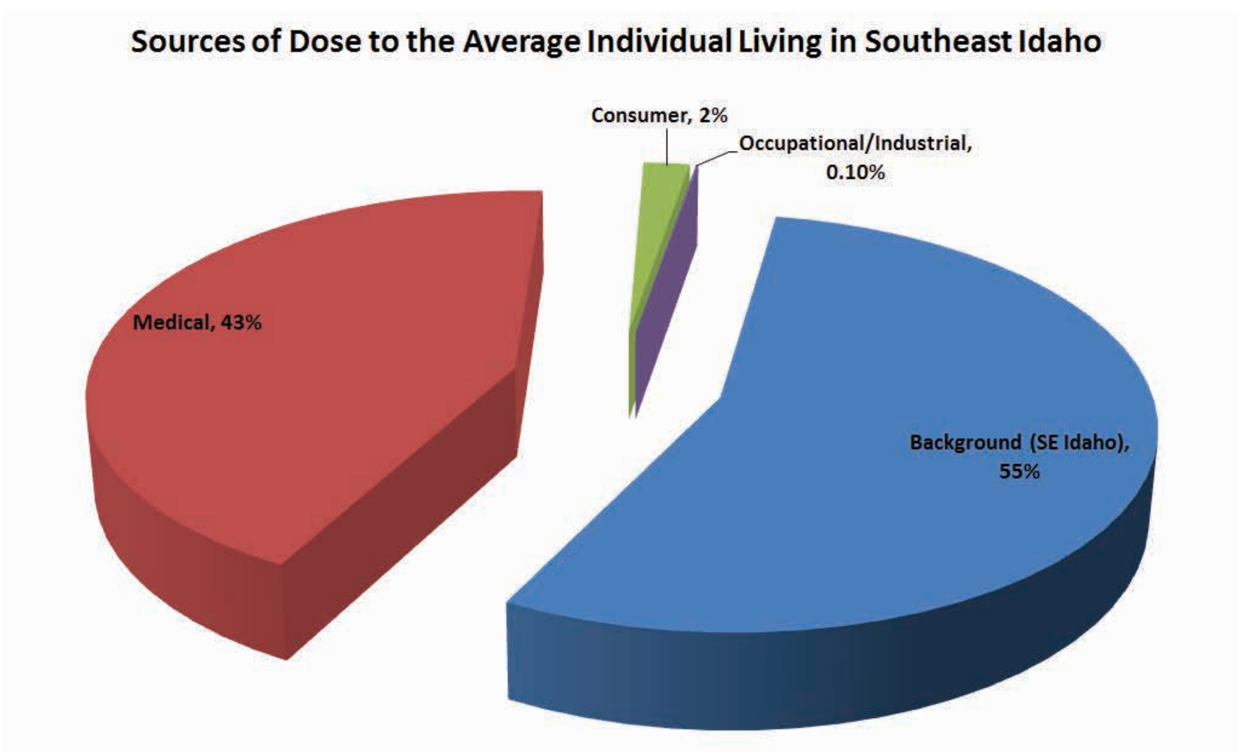
Radioactivity from natural and fallout sources is detectable as "background" in all environmental media. Natural sources of radiation include: radiation of extraterrestrial origin (called cosmic rays), radionuclides produced in the atmosphere by cosmic ray interaction with matter (called cosmogenic radionuclides), and radionuclides present at the time of the formation of the earth (called primordial radionuclides). Radiation that has resulted from the activities of modern man is primarily fallout from past atmospheric testing of nuclear weapons. One of the challenges to environmental monitoring on and around the INL Site is to distinguish between what may have been released from the INL Site and what is already present in background from natural and fallout sources. These sources are discussed in more detail below.

Natural Sources. Natural radiation and radioactivity in the environment, that is natural background, represent a major source of human radiation exposure (NCRP 1987, NCRP 2009). For this reason, natural radiation frequently is used as a standard of comparison for exposure to various human-generated sources of ionizing radiation. An individual living in southeast Idaho was estimated in 2014 to receive an average dose of about 389 mrem/yr (3.9 mSv/yr) from natural background sources of radiation on earth (Figure HI-7). These sources include cosmic radiation and naturally occurring radionuclides.

Cosmic radiation is radiation that constantly bathes the earth from extraterrestrial sources. The atmosphere around the earth absorbs some of the cosmic radiation, so doses are lowest at sea level and increases sharply with altitude. Cosmic radiation is estimated, using data in NCRP (2009), to produce a dose of about 57 mrem/yr (0.57 mSv/yr) to a typical individual living in southeast Idaho (Figure HI-7). Cosmic radiation also produces cosmogenic radionuclides, which are found naturally in all environmental media and are discussed in more detail below.

Naturally occurring radionuclides are of two general kinds: cosmogenic and primordial. Cosmogenic radionuclides are produced by the interaction of cosmic radiation within the atmosphere or in the earth. Cosmic rays have high enough energies to blast apart atoms in the earth's atmosphere. The result is the

Figure HI-3. Data Presented Using a Pie Chart.



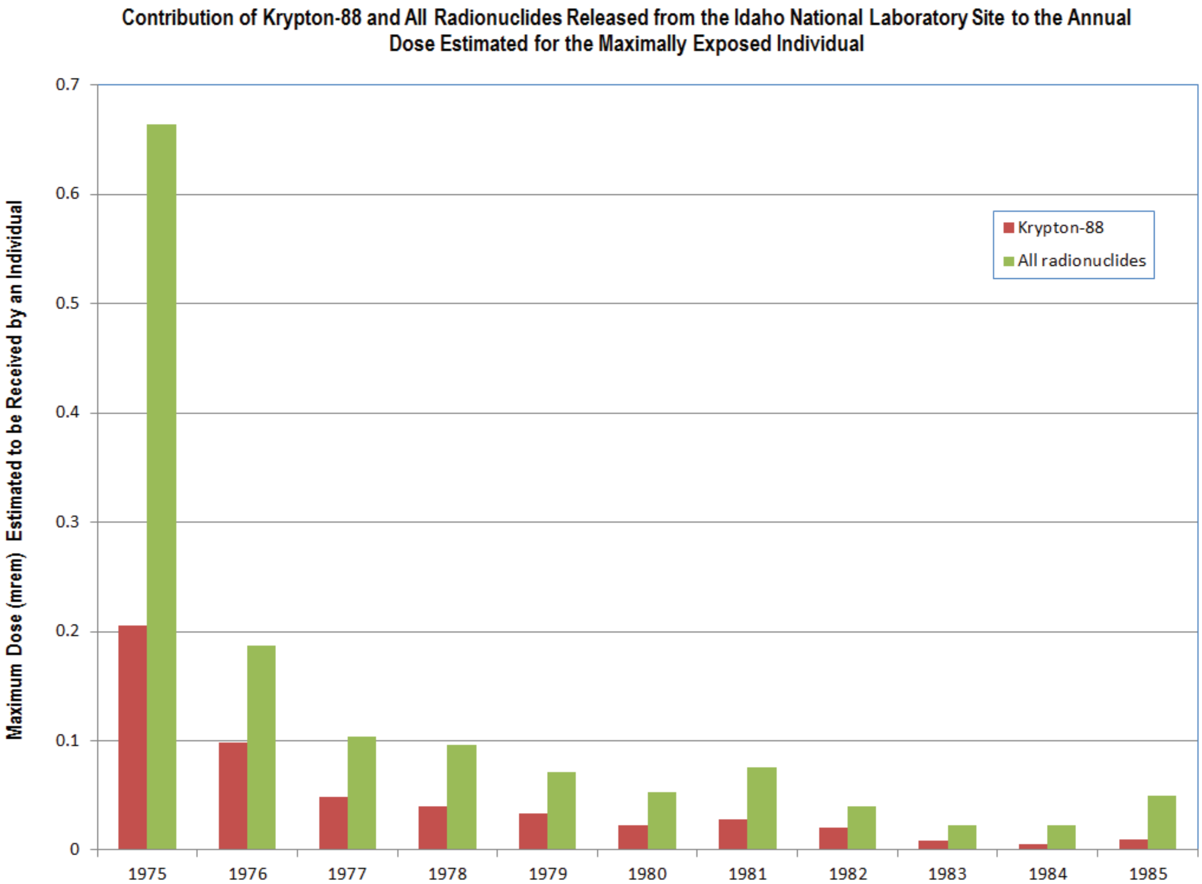


Figure HI-4. Data Plotted Using a Column Chart.

continuous production of radionuclides, such as ^{3}H, beryllium-7 (^{7}Be), sodium-22 (^{22}Na), and carbon-14 (^{14}C). Cosmogenic radionuclides, particularly ^{3}H and ^{14}C, have been measured in humans, animals, plants, soil, polar ice, surface rocks, sediments, the ocean floor, and the atmosphere. Concentrations are generally higher at mid-latitudes than at low- or high-latitudes. Cosmogenic radionuclides contribute only about 1 mrem/yr to the total average dose, mostly from ^{14}C, that might be received by an adult living in the United States (NCRP 2009). Tritium and ^{7}Be are routinely detected in environmental samples collected by environmental monitoring programs on and around the INL Site (Table HI-5), but contribute little to the dose which might be received from natural background sources.

Primordial radionuclides are those that were present when the earth was formed. The primordial radionuclides detected today are billions of years old. The radiation dose to a person from primordial radionuclides comes from internally deposited radioactivity, inhaled radioactivity, and external radioactivity in soils and building materials. Three of the primordial radionuclides, potassium-40 (^{40}K), uranium-238 (^{238}U), and thorium-232 (^{232}Th), are responsible for most of the dose received by people from natural background radioactivity. They have been detected in environmental samples collected on and around the INL Site (Table HI-5). The external dose to an adult living in southeast Idaho from terrestrial natural background radiation exposure (76 mrem/yr or 0.76 mSv/yr) has been estimated using concentrations of ^{40}K, ^{238}U, and ^{232}Th measured in soil samples collected from areas surrounding the INL Site from 1976 through 1993. This number varies slightly from year to year based on the amount of snow cover. Uranium-238 and ^{232}Th are also estimated to contribute 13 mrem/yr (0.13 mSv/yr) to an average adult through ingestion (NCRP 2009).

Potassium-40 is abundant and measured in living and nonliving matter. It is found in human tissue and is a significant source of internal dose to the human body (approximately 15 mrem/yr [0.15 mSv/yr] according to

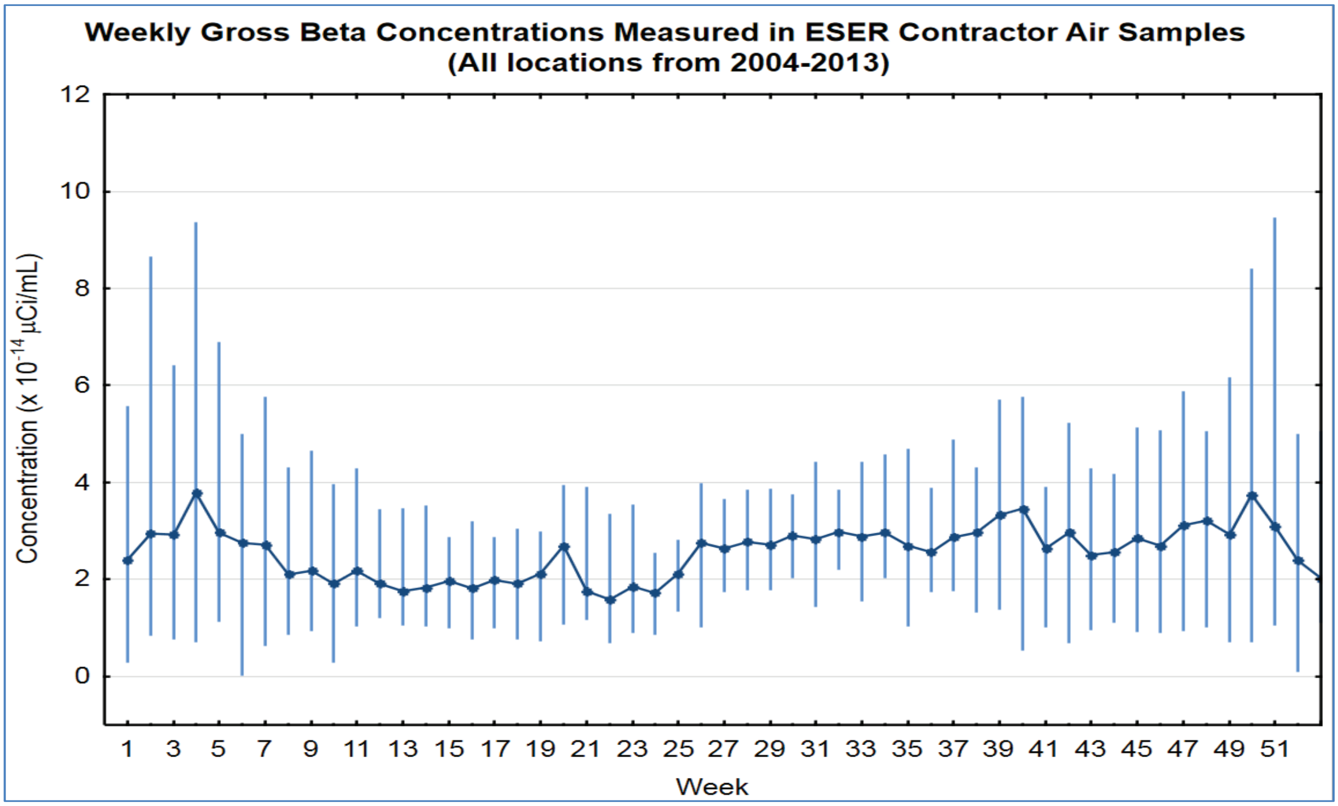


Figure HI-5. Data Plotted Using a Linear Plot.

NCRP [2009]). Rubidium-87 (^{87}Rb), another primordial radionuclide, contributes a small amount (< 1 mrem/yr) to the internal dose received by people but is not typically measured in INL Site samples.

Uranium-238 and ^{232}Th each initiate a decay chain of radionuclides. A radioactive decay chain starts with one type of radioactive atom called the "parent" that decays and changes into another type of radioactive atom called a "progeny" radionuclide. This system repeats, involving several different radionuclides. The parent radionuclide of the uranium decay chain is ^{238}U. The most familiar element in the uranium series is radon, specifically radon-222 (^{222}Rn). This is a gas that can accumulate in buildings. Radon and its progeny are responsible for most of the inhalation dose (an average of 200 mrem/yr [2.0 mSv/yr] nationwide) produced by naturally occurring radionuclides (Figure HI-7). The parent radionuclide of the thorium series is ^{232}Th. Another isotope of radon (^{220}Rn), called thoron, occurs in the thorium decay chain of radioactive atoms. Uranium-238, ^{232}Th, and their progeny often are detected in environmental samples (Table HI-5).

Global Fallout. The United States, the USSR, and China tested nuclear weapons in the atmosphere in the 1950s and 1960s, which resulted in the release of radionuclides into the upper atmosphere. This is referred to as "fallout" from weapons testing. Concerns over worldwide fallout rates eventually led to the Partial Test Ban Treaty in 1963, which limited signatories to underground testing. Not all countries stopped atmospheric testing though. France continued atmospheric testing until 1974, and China until 1980. Additional fallout, but to a substantially smaller extent, was produced by the Chernobyl nuclear accident in 1986.

Most of the radionuclides associated with nuclear weapons testing and the Chernobyl accident have decayed and are no longer detected in environmental samples. Radionuclides that are currently detected in the environment and typically associated with global fallout include ^{90}Sr and ^{137}Cs. Strontium-90, a beta-emitter with

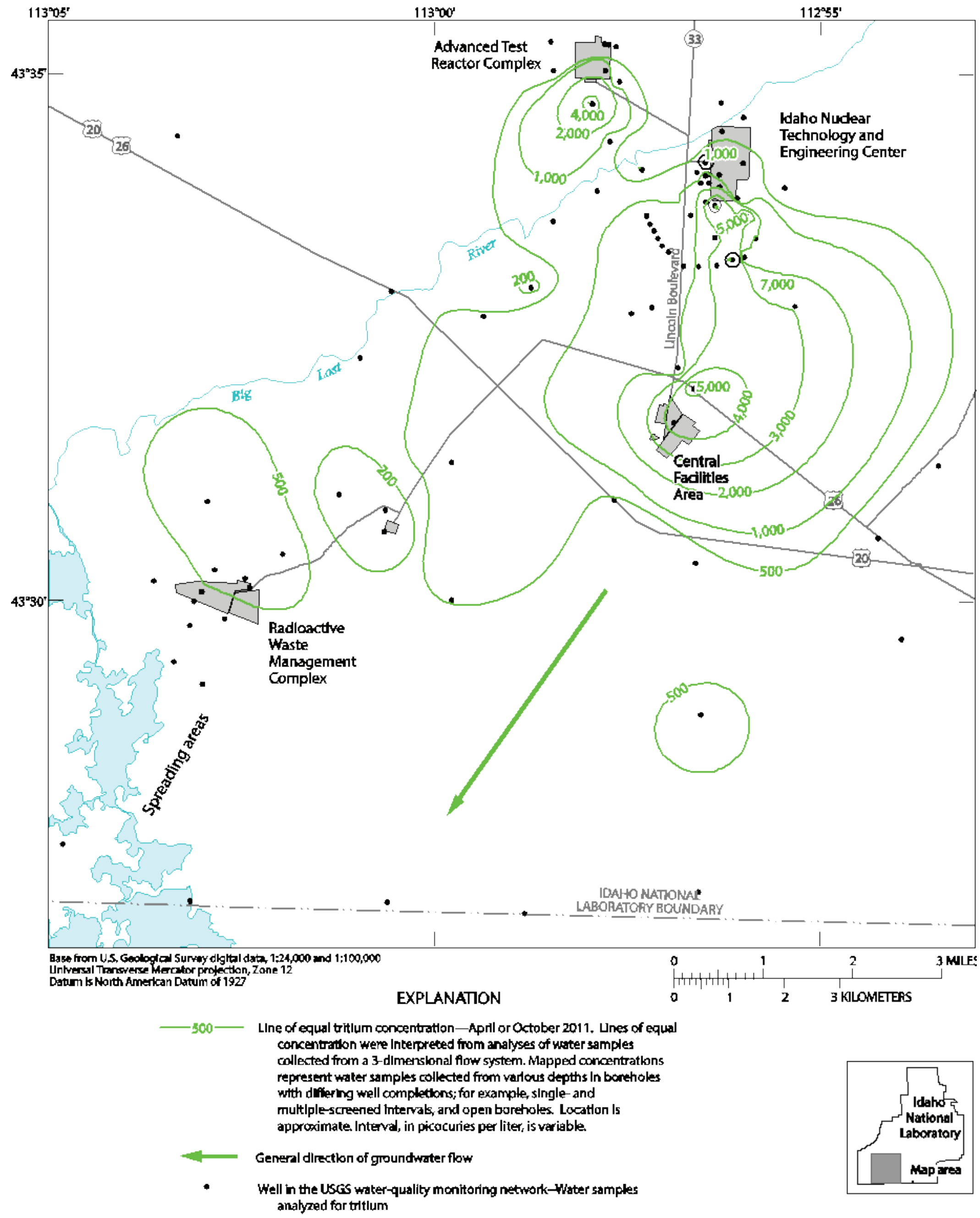


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Figure HI-6. Data Plotted Using Contour Lines. Each contour line drawn on this map connects points of equal tritium concentration in water samples collected at the same depth from wells on the INL Site.

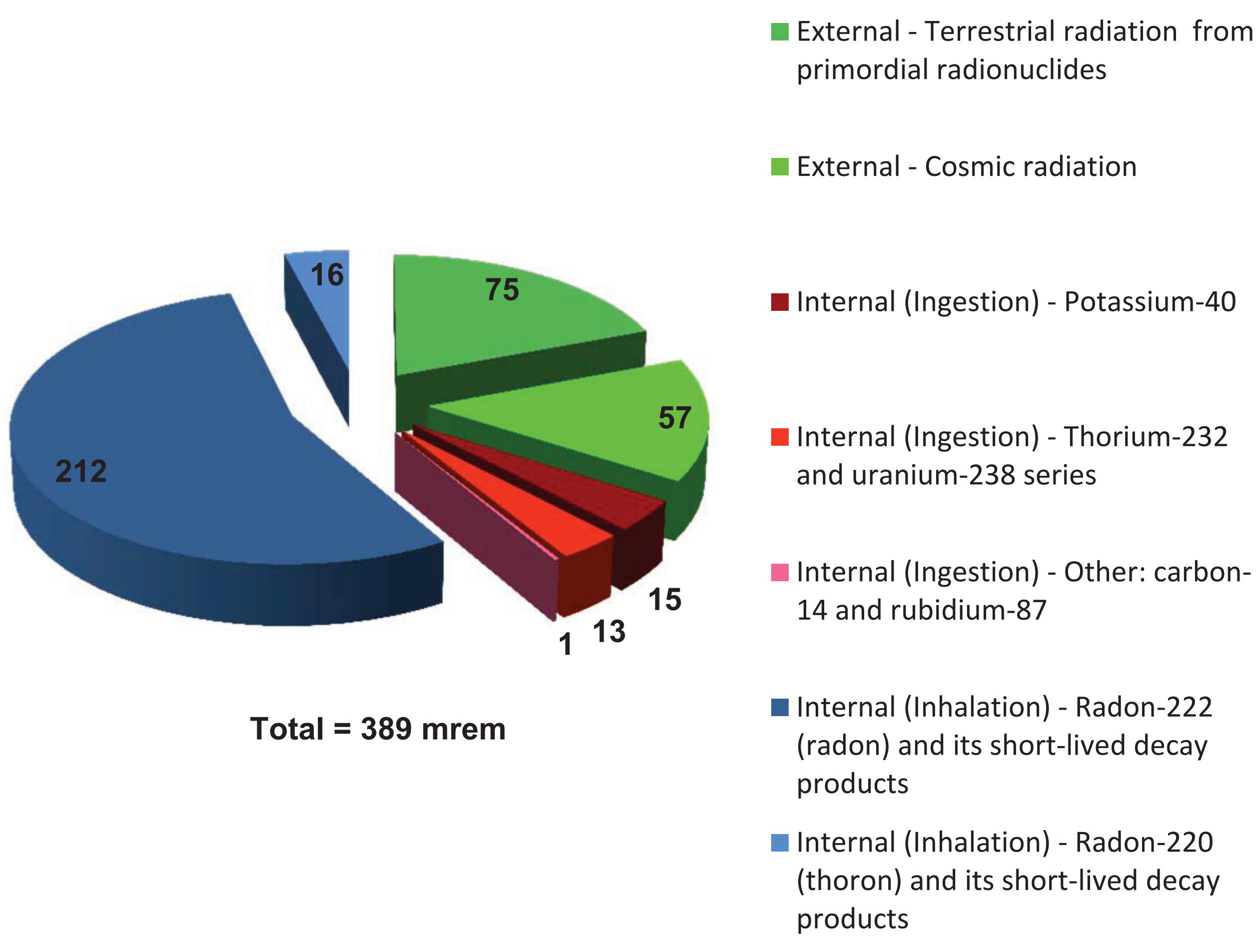

Figure HI-7. Calculated Doses (mrem per year) from Natural Background Sources for an Average Individual Living in Southeast Idaho (2014).

Table HI-5. Naturally Occurring Radionuclides that Have Been Detected in Environmental Media Collected on and around the INL Site.

Radionuclide	Half-life	How Produced?	Detected or Measured in:
Beryllium-7 (^{7}Be)	2.7×10^{6} yr	Cosmic rays	Rain, air
Tritium (^{3}H)	12.3 yr	Cosmic rays	Water, rain, air moisture
Potassium-40 (^{40}K)	1.26×10^{9} yr	Primordial	Water, air, soil, plants, animals
Thorium-232 (^{232}Th)	1.4×10^{10} yr	Primordial	Soil
Uranium-238 (^{238}U)	4.5×10^{9} yr	Primordial	Water, air, soil
Uranium-234(^{234}U)	2.5×10^{5} yr	^{238}U progeny	Water, air, soil
Radium-226 (^{226}Ra)	1,620 yr	^{238}U progeny	Water

a 29-year half-life, is important because it is chemically similar to calcium and tends to lodge in bone tissues. Cesium-137, which has a 30-year half-life, is chemically similar to potassium, and accumulates rather uniformly in muscle tissue throughout the body.

The deposition of these radionuclides on the earth's surface varies by latitude, with most occurring in the northern hemisphere at approximately 40^o. Variation within latitudinal belts is a function primarily of precipitation, topography, and wind patterns.

The dose produced by global fallout from nuclear weapons testing has decreased steadily since 1970. The annual dose rate from fallout was estimated in 1987 to be less than 1 mrem (0.01 mSv) (NCRP 1987). It has been over 30 years since that estimate, so the current dose is even lower.

WHAT ARE THE RISKS OF EXPOSURE TO LOW LEVELS OF RADIATION?

Radiation protection standards for the public have been established by state and federal agencies based mainly on recommendations of the International Commission on Radiological Protection (ICRP) and the National Council on Radiation Protection and Measurements (NCRP). The ICRP is an association of scientists from many countries, including the United States. The NCRP is a nonprofit corporation chartered by Congress. Through radiation protection standards, exposure of members of the general public to radiation is controlled so that risks are small enough to be considered insignificant compared to the risks undertaken during other activities deemed normal and acceptable in modern life.

Risk can be defined in general as the probability (chance) of injury, illness, or death resulting from some activity. There are a large amount of data showing the effects of receiving high doses of radiation, especially in the range of 50 to 400 rem (0.5 to 4.0 Sv), delivered acutely (all at once.) These are largely data resulting from studies of the survivors of the Japanese atomic bombing and of some relatively large groups of patients who were treated with substantial doses of X-rays.

It is difficult to estimate risks from low levels of radiation. Low-dose effects are those that might be caused by doses of less than 20 rem (0.2 Sv), whether delivered acutely or spread out over a period as long as a year (Taylor 1996). Most of the radiation exposures that humans receive are very close to background levels. Moreover, many sources emit radiation that is well below natural background levels. This makes it extremely difficult to isolate its effects. For this reason, government agencies make the conservative (cautious) assumption that any increase in radiation exposure is accompanied by an increased risk of health effects. Cancer is considered by most scientists to be the primary health effect from long-term exposure to low levels of radiation.

Each radionuclide represents a somewhat different health risk. However, health physicists (radiation protection professionals) currently estimate that overall, if each person in a group of 10,000 people is exposed to 1 rem (0.01 Sv) of ionizing radiation in small doses over a lifetime, we would expect five or six more people to die of cancer than would otherwise (EPA 2013). In this group of 10,000 people, about 2,000 would be expected to die of cancer from all non-radiation causes. A lifetime exposure to 1 rem (0.01 Sv) of radiation would increase that number to about 2,005 or 2,006. For perspective, most people living on the eastern Snake River Plain receive over one-third of a rem (389 mrem or 3.9 mSv) every year from natural background sources of radiation.

DOE limits the dose to a member of the public from all sources and pathways to 100 mrem (1 mSv) and the dose from the air pathway only to 10 mrem (0.1 mSv) (DOE Order 458.1). The doses estimated to maximally exposed individuals from INL Site releases are typically well below 1 mrem per year.

REFERENCES

DOE Order 231.1B, 2011, "Environment, Safety, and Health Reporting," U.S. Department of Energy.

DOE Order 458.1, 2011, "Radiation Protection of the Public and the Environment," U.S. Department of Energy.

EPA, 2013, U*nderstanding Radiation: Health Effects*, http://www.epa.gov/rpdweb00/understand/ health_effects.html, Web page visited September 3, 2013.

NCRP, 1987, *Exposure of the Population in the United States and Canada from Natural Background Radiation,* NCRP Report No. 94 National Council on Radiation Protection and Measurements.

NCRP, 2009, *Ionizing Radiation Exposure of the Population of the United States*, NCRP Report No. 160, National Council on Radiation Protection and Measurements.

Taylor, L. S., 1996, *What You Need to Know About Radiation*, http://www.physics.isu.edu/radinf/lst.htm

Whitestem Blazingstar
Mentzelia albicaulis

Acronyms

ALS-FC	ALS-Fort Collins
AMWTP	Advanced Mixed Waste Treatment Project
ARP	Accelerated Retrieval Project
ATR	Advanced Test Reactor
BEA	Battelle Energy Alliance
BBS	Breeding Bird Survey
BLS	Below Land Surface
CAA	Clean Air Act
CAP88-PC	Clean Air Act Assessment Package, 1988 Personal Computer
CCA	Candidate Conservation Agreement
CEQ	Council on Environmental Quality
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CFA	Central Facilities Area
CFR	Code of Federal Regulations
CITRC	Critical Infrastructure Test Range Complex
CRM	Cultural Resource Management
CRMO	Cultural Resource Management Office
CTF	Contained Test Facility
CWA	Clean Water Act
CWI	CH2M-WG Idaho, LLC
CWP	Cold Waste Pond
DCS	Derived Concentration Standard
DEQ	Department of Environmental Quality (state of Idaho)
DOE	U.S. Department of Energy
DOECAP	DOE Consolidated Audit Program
DOE-ID	U.S. Department of Energy, Idaho Operations Office
DQO	Data Quality Objective
DWP	Drinking Water Monitoring Program
EA	Environmental Assessment
EBR-I	Experimental Breeder Reactor-I
EBR-II	Experimental Breeder Reactor-II
EFS	Experimental Field Station
EIC	Electret Ionization Chamber
EIS	Environmental Impact Statement
EMS	Emergency Management System
EPA	U.S. Environmental Protection Agency
EPCRA	Emergency Planning and Community Right-to-Know Act
ESA	Endangered Species Act
ESER	Environmental Surveillance, Education, and Research
ESRP	Eastern Snake River Plain
FFA/CO	Federal Facility Agreement and Consent Order
FWS	U.S. Fish and Wildlife Service
FY	Fiscal Year
GHG	Greenhouse Gas
GPR	Global Positioning Radiometric Scanner
GSS	Gonzales-Stoller Surveillance, LLC
GWMP	Groundwater Monitoring Program
HETO	Heritage Tribal Office
HSS	Office of Health, Safety and Security
ICDF	Idaho CERCLA Disposal Facility
ICP	Idaho Cleanup Project
ICRP	International Commission on Radiological Protection
IDAPA	Idaho Administrative Procedures Act
IDFG	Idaho Department of Fish and Game
INL	Idaho National Laboratory
INTEC	Idaho Nuclear Technology and Engineering Center (formerly Idaho Chemical Processing Plant)
IOP	INL Oversight Program (state of Idaho DEQ)
IRC	Idaho Research Center
ISB	In Situ Bioremediation
ISFSI	Independent Spent Fuel Storage Installation
ISO	International Organization for Standardization
ISU	Idaho State University
ISU-EAL	Idaho State University-Environmental Assessment Laboratory
IWTU	Integrated Waste Treatment Unit
LCS	Laboratory Control Sample
LEMP	Liquid Effluent Monitoring Program
LOFT	Loss-of-Fluid Test
LTV	Long-Term Vegetation
MAPEP	Mixed Analyte Performance Evaluation Program
MCL	Maximum Contaminant Level
MDC	Minimum Detectable Concentration
MDIFF	Mesoscale Diffusion Model

MEI	Maximally Exposed Individual
MESODIF	Mesoscale Diffusion Model
MLLW	Mixed Low-level Waste
MFC	Materials and Fuels Complex
MQO	Method Quality Objective
NA	Not Applicable
NCRP	National Council on Radiation Protection and Measurements
ND	Not Detected
NEPA	National Environmental Policy Act
NESHAPs	National Emission Standards for Hazardous Air Pollutants
NHPA	National Historic Preservation Act
NIST	National Institute of Standards and Technology
NOAA	National Oceanic and Atmospheric Administration
NOAA ARL-FRD	National Oceanic and Atmospheric Administration Air Resources Laboratory - Field Research Division
NRF	Naval Reactors Facility
OMB	Office of Management and Budget
OP	Oversight Program
OSLD	Optically Stimulated Luminescence Dosimeters
PLN	Plan
QA	Quality Assurance
QAPjP	Quality Assurance Project Plan
QC	Quality Control
RCRA	Resource Conservation and Recovery Act
RESL	Radiological and Environmental Sciences Laboratory
RPD	Relative Percent Difference
ROD	Record of Decision
RSD	Relative Standard Deviation
RSWF	Radioactive Scrap and Waste Facility
RWMC	Radioactive Waste Management Complex
SDA	Subsurface Disposal Area
SEM	Scanning Electron Microscopy
SGCA	Sage-grouse Conservation Area
SHPO	State Historic Preservation Office
SMC	Specific Manufacturing Capability
SNF	Spent Nuclear Fuel
TAN	Test Area North
TCE	Trichloroethylene
TLD	Thermoluminescent Dosimeter
TMI	Three Mile Island
TRU	Transuranic waste
TSF	Technical Support Facility
TSCA	Toxic Substances Control Act
USFWS	U.S. Fish and Wildlife Service
USGS	U.S. Geological Survey
VOC	Volatile Organic Compounds
WAG	Waste Area Group
WNS	White-nose Syndrome
WRP	Wastewater Reuse Permit

Units

Bq	becquerel	µSv	microsieverts
C	Celsius	Ma	million years
Ci	curie	mCi	millicurie
cm	centimeter	MeV	mega electron volt
cps	counts per second	mg	milligram
d	day	MG	million gallons
F	Fahrenheit	mGy	milligrey
ft	feet	mi	mile
g	gram	min	minute
gal	gallon	mL	milliliter
ha	hectare	mR	milliroentgen
keV	kilo-electron-volts	mrad	milligrad
kg	kilogram	mrem	millirem
km	kilometer	mSv	millisievert
L	liter	oz	ounce
lb	pound	pCi	picocurie (10^{-12} curies)
m	meter	R	roentgen
µCi	microcurie (10^{-6}) curies	rad	radiation absorbed dose
µg	microgram	rem	roentgen equivalent man
µR	microroentgen	yd	yard
µS	microsiemens	yr	year

Silverleaf Phacelia
Phacelia hastata

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Meadow Death Camas
(Zigadenus venenosus)

False Dandelion
Agoseris glauca

1. INTRODUCTION

This annual report is prepared in compliance with the following U.S. Department of Energy (DOE) orders:

- DOE Order 231.1B, “Environment, Safety and Health Reporting”
- DOE Order 436.1, “Departmental Sustainability”
- DOE Order 458.1, “Radiation Protection of the Public and the Environment.”

The purpose of the report, as outlined in DOE Order 231.1B, is to present summary environmental data to:

- Characterize site environmental performance
- Summarize environmental occurrences and responses during the calendar year
- Confirm compliance with environmental standards and requirements
- Highlight significant facility programs and efforts.

This report is the principal document that demonstrates compliance with DOE Order 458.1 requirements and, therefore, describes the Idaho National Laboratory (INL) Site’s impact to the public and the environment with emphasis on radioactive contaminants.

1.1 Site Location

The INL Site encompasses about 2,305 square kilometers (km^2) (890 square miles [mi^2]) of the upper Snake River Plain in southeastern Idaho (Figure 1-1). Over 50 percent of the INL Site is located in Butte County and the rest is distributed across Bingham, Bonneville, Clark, and Jefferson counties. The INL Site extends 63 km (39 mi) from north to south, and is approximately 61 km (38 mi) at its broadest east-west portion. By highway, the southeast boundary is approximately 40 km (25 mi) west of Idaho Falls. Other towns surrounding the INL Site include Arco, Atomic City, Blackfoot, Rigby, Rexburg, Terreton, and Howe. Pocatello is almost 85 km (53 mi) to the southeast.

Federal lands surround much of the INL Site, including Bureau of Land Management lands and Craters of the Moon National Monument and Preserve to the southwest, Challis National Forest to the west, and Targhee National Forest to the north. Mud Lake Wildlife Management Area, Camas National Wildlife Refuge, and Market Lake Wildlife Management Area are within 80 km (50 mi) of the INL Site. The Fort Hall Indian Reservation is located approximately 60 km (37 mi) to the southeast.

1.2 Environmental Setting

The INL Site is located in a large, relatively undisturbed expanse of sagebrush steppe. Approximately 94 percent of the land on the INL Site is open and undeveloped. The INL Site has an average elevation of 1,500 m (4,900 ft) above sea level and is bordered on the north and west by mountain ranges and on the south by volcanic buttes and open plain. Lands immediately adjacent to the INL Site are open sagebrush steppe, foothills, or agricultural fields. Agriculture is concentrated in areas northeast of the INL Site.

About 60 percent of the INL Site is open to livestock grazing. Controlled hunting is permitted on INL Site land but is restricted to a very small portion of the northern half of the INL Site.

The climate of the high desert environment of the INL Site is characterized by sparse precipitation (about 21.6 cm/yr [8.5 in./yr]), warm summers (average daily temperature of 18.2°C [64.8°F]), and cold winters (average daily temperature of -6.2°C [20.8°F]), with all averages based on observations since 1950. The altitude, intermountain setting, and latitude of the INL Site combine to produce a semiarid climate. Prevailing weather patterns are from the southwest, moving up the Snake River Plain (DOE-ID 1989). Air masses, which gather moisture over the Pacific Ocean, traverse several hundred miles of mountainous terrain before reaching southeastern Idaho. Frequently, the result is dry air and little cloud cover. Solar heating can be intense, with extreme day-to-night temperature fluctuations.

Basalt flows cover most of the Snake River Plain, producing rolling topography. Vegetation is visually dominated by big sagebrush (*Artemisia tridentata*). Beneath these shrubs are grasses and wildflowers adapted to the harsh climate. A total of 409 different kinds (taxa) of plants have been recorded on the INL Site (Anderson et al. 1996).

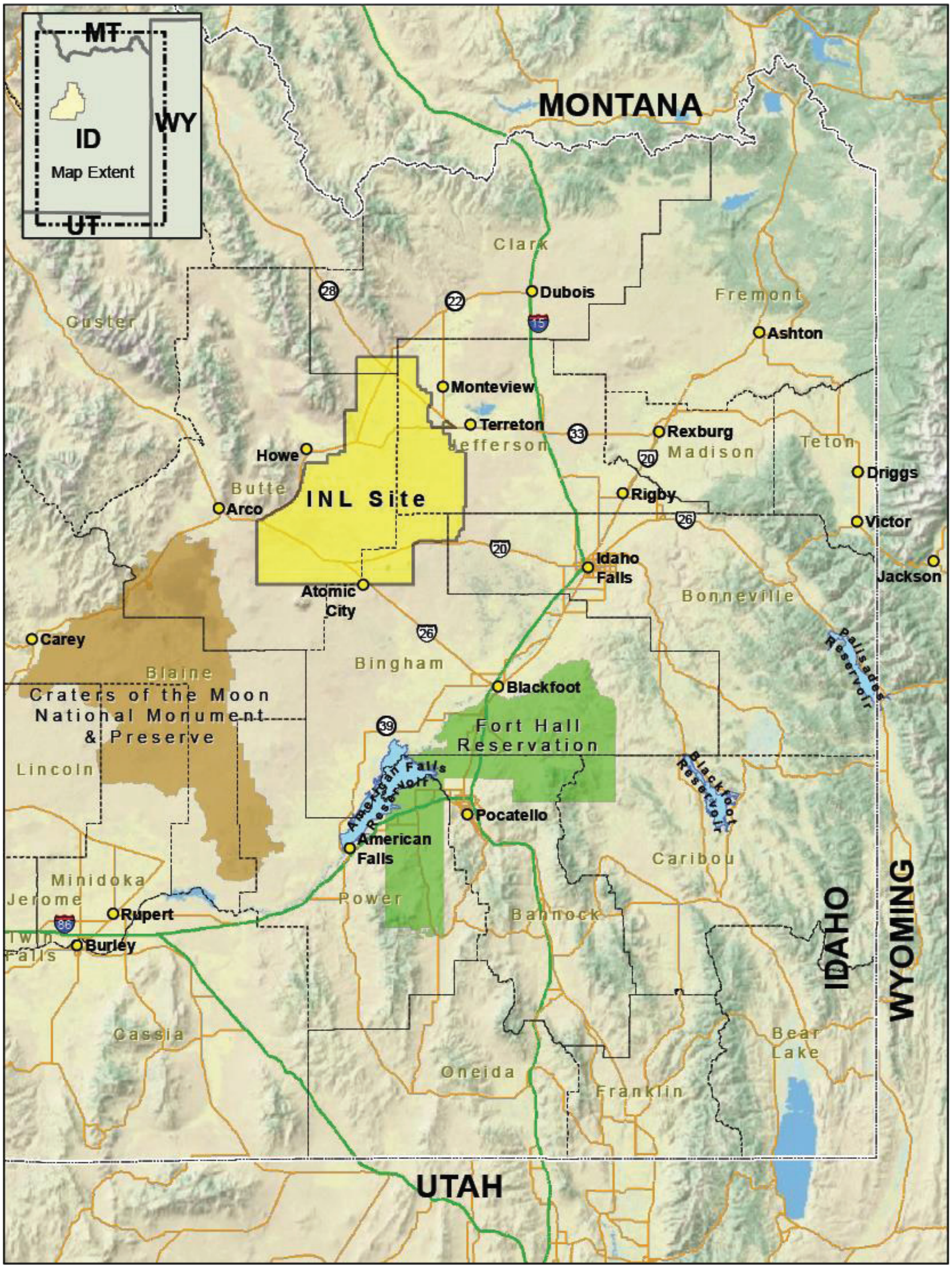

Figure 1-1. Location of the Idaho National Laboratory Site.

Vertebrate animals found on the INL Site include small burrowing mammals, snakes, birds, and several game species. Published species records include six fishes, one amphibian, nine reptiles, 164 birds, and 39 mammals (Reynolds et al. 1986).

The Big Lost River on the INL Site flows northeast, ending in a playa area, called the Big Lost River Sinks, on the northwestern portion of the INL Site. Here, the river evaporates or infiltrates into the subsurface, with no surface water moving off the INL Site.

The fractured volcanic rocks under the INL Site form a portion of the eastern Snake River Plain aquifer (Figure 1-2), which stretches 320 km (199 mi) from Island Park to King Hill, and stores one of the most bountiful supplies of groundwater in the nation. An estimated 247 to 370 billion m^3 (200 to 300 million acre-ft) of water is stored in the aquifer's upper portions. The aquifer is primarily recharged from the Henry's Fork and the South Fork of the Snake River, and to a lesser extent by the Big Lost River, Little Lost River, Birch Creek, and irrigation. Beneath the INL Site, the aquifer moves laterally southwest at a rate of 1.5 to 6 m/day (5 to 20 ft/day) (Lindholm 1996). The eastern Snake River Plain aquifer emerges in springs along the Snake River between Milner and Bliss, Idaho. Crop irrigation is the primary use of both surface water and groundwater on the Snake River Plain.

1.3 Idaho National Laboratory Site Primary Program Missions and Facilities

The INL Site mission is to operate a multi-program national research and development laboratory and to complete environmental cleanup activities stemming from past operations. The U.S. Department of Energy, Idaho Operations Office (DOE-ID) receives implementing direction and guidance primarily from two DOE Headquarters offices, the Office of Nuclear Energy and the Office of Environmental Management. The Office of Nuclear Energy is the Lead Program Secretarial Office for all DOE-ID-managed operations on the INL Site. The Office of Environmental Management provides direction and guidance to DOE-ID for environmental cleanup on the INL Site and functions in the capacity of Cognizant Secretarial Office. Naval Reactors operations on the INL Site report to the Pittsburgh Naval Reactors Office and fall outside the purview of DOE-ID and are not included in this report.

1.3.1 Idaho National Laboratory

The INL mission is to ensure the nation's energy security with safe, competitive, and sustainable energy systems and unique national and homeland security capabilities. Its vision is to be the pre-eminent nuclear energy laboratory, with synergistic, world-class, multi-program capabilities and partnerships. To fulfill its assigned duties during the next decade, INL will work to transform itself into a laboratory leader in nuclear energy and homeland security research, development, and demonstration. This transformation will be the development of nuclear energy and national and homeland security leadership highlighted by achievements such as demonstration of Generation IV reactor technologies; creation of national user facilities including the Advanced Test Reactor, Wireless, and Biomass Feedstock National User Facilities; the Critical Infrastructure Test Range; piloting of advanced fuel cycle technology; the rise to prominence of the Center for Advanced Energy Studies; and recognition as a regional clean energy resource and world leader in safe operations. Battelle Energy Alliance, LLC, is responsible for management and operation of the INL.

1.3.2 Idaho Cleanup Project

The Idaho Cleanup Project (ICP) involves the safe environmental cleanup of the INL Site, which was contaminated with waste generated during World War II-era conventional weapons testing, government-owned research and defense reactor operations, laboratory research, fuel reprocessing, and defense missions at other DOE sites. The project is led by CH2M-WG Idaho, LLC. The project focuses on meeting Idaho Settlement Agreement (DOE 1995) and environmental cleanup milestones while reducing risks to workers. Protection of the Snake River Plain aquifer, the sole drinking water source for more than 300,000 residents of eastern Idaho, was the principal concern addressed in the Settlement Agreement.

The ICP involves treating a million gallons of sodium-bearing waste, removing targeted transuranic waste from the Subsurface Disposal Area, placing spent nuclear fuel in dry storage, selecting a treatment for high-level waste calcine, and demolishing more than 200 structures, including reactors, spent nuclear fuel storage basins, and laboratories used for radioactive experiments.

1.3.3 Advanced Mixed Waste Treatment Project

The Advanced Mixed Waste Treatment Project (AMWTP) prepares and ships transuranic and mixed low-level waste out of Idaho. AMWTP is managed and operated by Idaho Treatment Group, LLC. Operations at AMWTP retrieve, characterize, treat, and package trans-

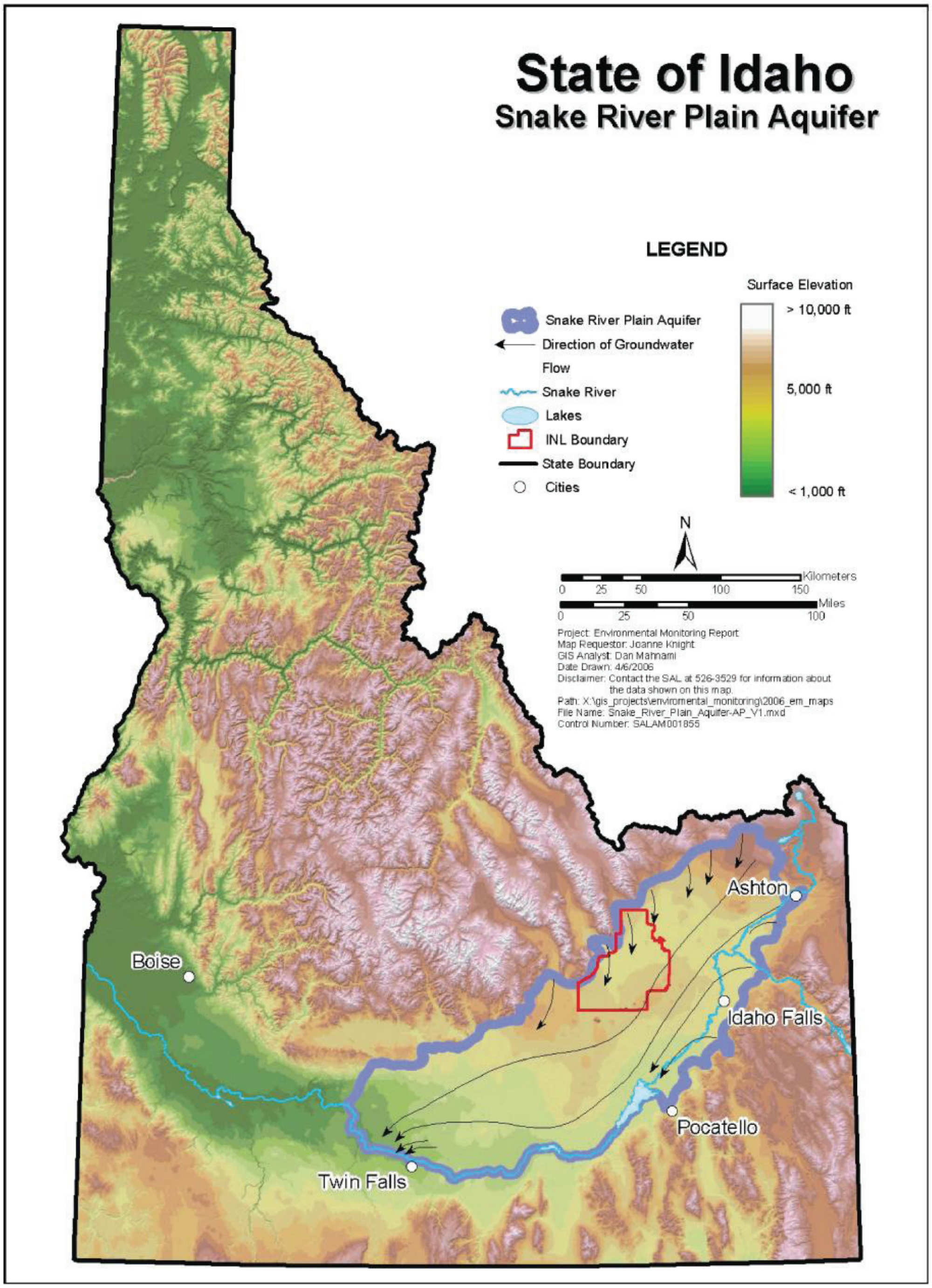

Figure 1-2. Idaho National Laboratory Site in Relation to the Eastern Snake River Plain Aquifer.

uranic waste currently stored at the INL Site. The project's schedule is aligned with court-mandated milestones in the 1995 Settlement Agreement (DOE 1995) among the state of Idaho, U.S. Navy, and DOE to remove waste from Idaho. The majority of waste AMWTP processes resulted from the manufacture of nuclear weapons components at DOE's Rocky Flats Plant in Colorado. This waste was shipped to Idaho in the 1970s and early 1980s for storage and contains industrial debris, soil and sludge, and is contaminated with transuranic radioactive elements (primarily plutonium). Most of the waste is "mixed waste" that is contaminated with radioactive and nonradioactive hazardous chemicals, such as oil and solvents. Since 1999, more than 51,034 m^3 (66,750 yd^3) of transuranic waste has been shipped off the INL Site.

1.3.4 Primary Idaho National Laboratory Site Facilities

Most INL Site buildings and structures are located within developed areas that are typically less than a few square miles and separated from each other by miles of undeveloped land. DOE controls all land within the INL Site (Figure 1-3).

In addition to the INL Site, DOE owns or leases laboratories and administrative offices in the city of Idaho Falls, 40 km (25 mi) east of the INL Site.

Central Facilities Area – The Central Facilities Area is the main service and support center for INL Site's desert facilities. Activities at Central Facilities Area support transportation, maintenance, medical, construction, radiological monitoring, security, fire protection, warehouses, and calibration activities. It is operated by the INL contractor.

Critical Infrastructure Test Range Complex – The Critical Infrastructure Test Range Complex encompasses a collection of specialized test beds and training complexes that create a centralized location where government agencies, utility companies, and military customers can work together to find solutions for many of the nation's most pressing security issues. Critical Infrastructure Test Range Complex provides open landscape, technical employees, and specialized facilities for performing work in three main areas – physical security, contraband detection, and infrastructure testing. It is operated by the INL contractor.

Idaho Nuclear Technology and Engineering Center – The Idaho Chemical Processing Plant was established in the 1950s to recover usable uranium from spent nuclear fuel used in DOE and Department of Defense reactors. Over the years, the facility recovered more than $1 billion worth of highly enriched uranium that was returned to the government fuel cycle. In addition, an innovative high-level liquid waste treatment process known as calcining was developed at the plant. Calcining reduced the volume of liquid radioactive waste generated during reprocessing and placed it in a more stable granular solid form. In the 1980s, the facility underwent a modernization, and safer, cleaner, and more efficient structures replaced most major facilities. Reprocessing of spent nuclear fuel was discontinued in 1992. In 1998, the plant was renamed the Idaho Nuclear Technology and Engineering Center. Current operations include management of sodium-bearing waste, spent nuclear fuel storage, environmental remediation, and disposing of excess facilities and management of the Idaho Comprehensive Environmental Response, Compensation and Liability Act Disposal Facility (ICDF). The ICDF is the consolidation point for Comprehensive Environmental Response, Compensation and Liability Act generated wastes within the Idaho National Laboratory Site boundaries. INTEC is operated by the ICP contractor.

Materials and Fuels Complex – The Materials and Fuels Complex is a prime testing center for advanced technologies associated with nuclear power systems. This complex is the nexus of research and development for new reactor fuels and related materials. As such, it will contribute increasingly efficient reactor fuels and the important work of nonproliferation harnessing more energy with less risk. Facilities at Materials and Fuels Complex also support manufacturing and assembling components for use in space applications. It is operated by the INL contractor.

Naval Reactors Facility – The Naval Reactors Facility (NRF) is operated by Bechtel Marine Propulsion Corporation.

As established in Executive Order 12344 (1982), the Naval Nuclear Propulsion Program is exempt from the requirements of DOE Orders 436.1, 458.1, and 414.1D. Therefore, NRF is excluded from this report. The director, Naval Nuclear Propulsion Program, establishes reporting requirements and methods implemented within the program, including those necessary to comply with appropriate environmental laws. The NRF's program is documented in the NRF Environmental Monitoring Report (BMPC 2015).

Radioactive Waste Management Complex – Since the 1950s, DOE has used the Radioactive Waste Management Complex (RWMC) to manage, store, and dispose of waste contaminated with radioactive elements generated in national defense and research programs. RWMC provides treatment, temporary storage and transportation of transuranic waste destined for the Waste Isolation Pilot Plant.

The Subsurface Disposal Area is a 39-hectare (96-acre) radioactive waste landfill that was used for more than 50 years. Approximately 14 of the 39 hectares (35 of 96 acres) contain waste, including radioactive ele-

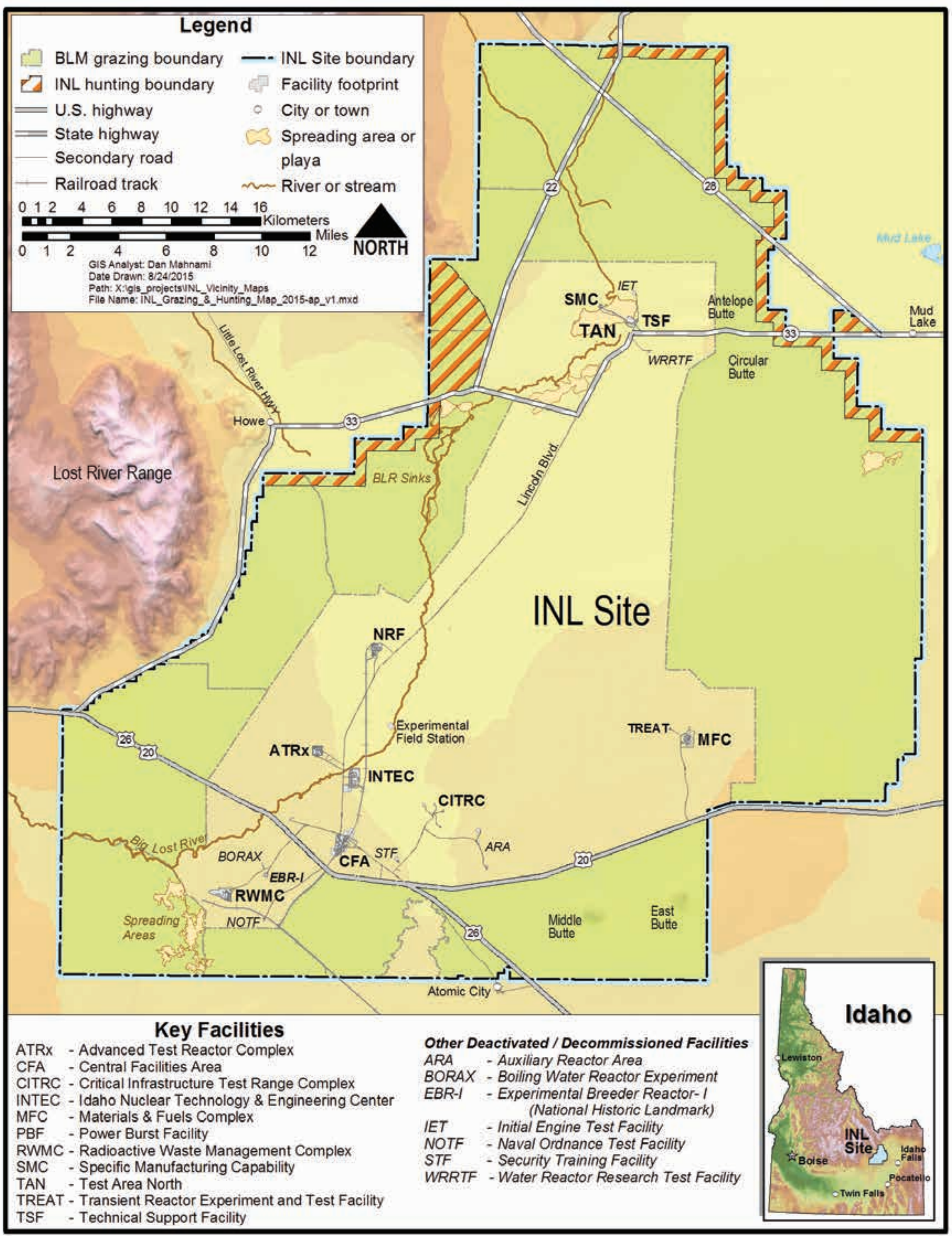

Figure 1-3. Location of the Idaho National Laboratory Site, Showing Facilities.

ments, organic solvents, acids, nitrates, and metals from historical operations such as reactor research at INL and weapons production at other DOE facilities. A Comprehensive Environmental Response, Compensation and Liability Act Record of Decision (OU-7-13/14) was signed in 2008 (DOE-ID 2008) that includes exhumation and off-site disposition of targeted waste. Through December 2014, 3.67 of the required 5.69 acres (1.48 of

2.30 hectares) have been exhumed and 6,547 m^3 (8,563 yd^3) of waste have been shipped out of Idaho. Cleanup of RWMC is managed by the ICP contractor.

Advanced Test Reactor Complex – The Advanced Test Reactor (ATR) Complex was established in the early 1950s and has been the site for operation of three major test reactors the Materials Test Reactor (1952 – 1970), the Engineering Test Reactor (1957 – 1982), and the Advanced Test Reactor (1967 – present). The current primary mission at the ATR Complex is operation of the Advanced Test Reactor, the world's premier test reactor used to study the effects of radiation on materials. This reactor also produces rare and valuable medical and industrial isotopes. The ATR is a national scientific user facility. The ATR Complex also features the ATR – Critical Facility, Test Train Assembly Facility, Radiation Measurements Laboratory, Radiochemistry Laboratory, and the Safety and Tritium Applied Research Facility – a national fusion safety user facility. The ATR Complex is operated by the INL contractor.

Research and Education Campus – The Research and Education Campus (REC), operated by the INL contractor, is the collective name for INL's administrative, technical support, and computer facilities in Idaho Falls, and the in-town laboratories where researchers work on a wide variety of advanced scientific research and development projects. As the name implies, the REC uses both basic science research and engineering to apply new knowledge to products and processes that improve quality of life. This reflects the emphasis INL is placing on strengthening its science base and increasing the commercial success of its products and processes. The Center for Advanced Energy Studies, designed to promote education and world-class research and development, is also located at the REC. Two new laboratory facilities, the Energy Systems Laboratory and the Energy Innovation Laboratory (Figure 1-4) were recently constructed, and other facilities envisioned over the next 10 years include a national security building, a visitor's center, visitor housing, and a parking structure close to current campus buildings. Facilities already in place and those planned for the future are integral for transforming INL into a renowned research laboratory. The DOE Radiological and Environmental Sciences Laboratory (RESL) is located within the Research and Education Campus. RESL provides a technical component to DOE oversight of contractor operations at DOE facilities and sites. As a reference laboratory, RESL conducts cost-effective measurement quality assurance programs that help assure key DOE missions are completed in a safe and environmentally responsible manner. By assuring the quality and stability of key laboratory measurement systems throughout DOE, and by providing expert technical assistance to improve those systems and programs, RESL assures the reliability of data on which decisions are based. RESL's core scientific capabilities are in analytical chemistry and radiation calibrations and measurements.

Test Area North – Test Area North (TAN) was established in the 1950s to support the government's Aircraft Nuclear Propulsion program with the goal to build and fly a nuclear-powered airplane. When President Kennedy cancelled the nuclear propulsion program in 1961, TAN began to host a variety of other activities. The Loss-of-Fluid Test (LOFT) reactor became part of the new mission. The LOFT reactor, constructed between 1965 and 1975, was a scaled-down version of a commercial pressurized water reactor. Its design allowed engineers, scientists, and operators to create or re-create loss-of-fluid accidents (reactor fuel meltdowns) under very controlled conditions. The LOFT dome provided containment for a relatively small, mobile test reactor that was moved in and out of the facility on a railroad car. The Nuclear Regulatory Commission incorporated data received from these accident tests into commercial reactor operating codes. Before closure, the LOFT facility conducted 38 experiments, including several small loss-of-coolant experiments designed to simulate the type of accident that occurred at Three Mile Island (TMI) in Pennsylvania. In October 2006, the LOFT reactor and facilities were decontaminated, decommissioned, and demolished.

Additionally, TAN housed the TMI Unit 2 Core Offsite Examination Program that obtained and studied technical data necessary for understanding the events leading to the TMI-2 reactor accident. Shipment of TMI-2 core samples to the INL Site began in 1985, and the program ended in 1990. INL scientists used the core samples to develop a database that predicts how nuclear fuel will behave when a reactor core degrades.

In July 2008, the TAN Cleanup Project was completed. The TAN Cleanup Project demolished 44 excess facilities, the TAN Hot Shop, and the LOFT reactor. Environmental monitoring continues at TAN.

The Specific Manufacturing Capability Project is located at TAN. This project is operated for the Department of Defense by the INL contractor and manufac-

Figure 1-4. The New Energy Innovation Laboratory at the INL's Research and Education Campus. The EIL has Received International and Regional Acclaim for Sustainable Design and Construction and has Earned the U.S. Green Building Council's Leadership in Energy and Environmental Design (LEED) Platinum Certification. Worldwide, Fewer than 5 Percent of Research Labs in the LEED Registry are Platinum-certified.

tures protective armor for the Army M1-A1 and M1-A2 Abrams tanks.

1.4 History of the INL Site

The geologic events that have shaped the modern Snake River Plain took place during the last 2 million years (Ma) (Lindholm 1996; ESRF 1996). The plain, which arcs across southern Idaho to Yellowstone National Park, marks the passage of the earth's crust over a plume of melted mantle material.

The volcanic history of the Yellowstone-Snake River Plain volcanic field is based on the time-progressive volcanic origin of the region characterized by several large calderas in the eastern Snake River Plain, with dimensions similar to those of Yellowstone's three giant Pleistocene calderas. These volcanic centers are located within the topographic depression that encompasses the Snake River drainage. Over the last 16 Ma, there was a series of giant, caldera-forming eruptions, with the most recent at Yellowstone National Park 630,000 years ago. The youngest silicic volcanic centers correspond to the Yellowstone volcanic field that are less than 2 Ma old and are followed by a sequence of silicic centers at about 6 Ma ago, southwest of Yellowstone. A third group of centers, approximately 10 Ma, is centered near Pocatello, Idaho. The oldest mapped silicic rocks of the Snake River Plain are approximately 16 Ma, are distributed across a 150-km-wide (93-mi-wide) zone in southwestern Idaho and northern Nevada, and are the suspected origin of the Yellowstone-Snake River Plain (Smith and Siegel 2000).

Humans first appeared on the upper Snake River Plain approximately 11,000 years ago. Tools recovered from this period indicate the earliest human inhabitants were hunters of large game. The ancestors of the present-day Shoshone and Bannock people came north from the Great Basin around 4,500 years ago (ESRF 1996).

People of European descent began exploring the Snake River Plain between 1810 and 1840; these explorers were trappers and fur traders seeking new supplies of beaver pelts.

Between 1840 (by which time the fur trade was essentially over) and 1857, an estimated 240,000 immigrants passed through southern Idaho on the Oregon Trail. By 1868, treaties had been signed forcing the native populations onto the reservation at Fort Hall. During the 1870s, miners entered the surrounding mountain ranges, followed by ranchers grazing cattle and sheep in the valleys.

A railroad was opened between Blackfoot and Arco, Idaho, in 1901. By this time, a series of acts (the Homestead Act of 1862, the Desert Claim Act of 1877, the Carey Act of 1894, and the Reclamation Act of 1902) provided sufficient incentive for homesteaders to attempt building diversionary canals to claim the desert. Most of these canal efforts failed because of the extreme porosity of the gravelly soils and underlying basalts.

During World War II, large guns from U.S. Navy warships were retooled at the U.S. Naval Ordnance Plant in Pocatello, Idaho. These guns needed to be tested, and the nearby uninhabited plain was put to use as a gunnery range, then known as the Naval Proving Ground. The U.S. Army Air Corps also trained bomber crews out of the Pocatello Airbase and used the area as a bombing range.

After the war ended, the nation turned to peaceful uses of atomic power. DOE's predecessor, the U.S. Atomic Energy Commission, needed an isolated location with ample groundwater supply on which to build and test nuclear power reactors. The relatively isolated Snake River Plain was chosen as the best location. Thus, the Naval Proving Ground became the National Reactor Testing Station in 1949.

In 1951, Experimental Breeder Reactor I became the first reactor to produce useful electricity. In 1955, the Boiling-Water Reactor Experiments-III reactor provided electricity to Arco, Idaho – the first time a nuclear reactor powered an entire community in the U.S. The laboratory also developed prototype nuclear propulsion plants for Navy submarines and aircraft carriers. Over time, the Site evolved into an assembly of 52 reactors, associated research centers, and waste handling areas.

The National Reactor Testing Station was renamed the Idaho National Engineering Laboratory in 1974 and Idaho National Engineering and Environmental Laboratory in 1997 to reflect the Site's leadership role in environmental management. The U.S. Atomic Energy Commission was renamed the U.S. Energy Research and Development Administration in 1975 and reorganized to the present-day DOE in 1977.

With renewed interest in nuclear power, DOE announced in 2003 that Argonne National Laboratory-West and the Idaho National Engineering and Environmental Laboratory would be the lead laboratories for development of the next generation of power reactors, and on February 1, 2005, the Idaho National Engineering and Environmental Laboratory and Argonne National Laboratory-West became the Idaho National Laboratory.

1.5 Populations Near the INL Site

The population of the region within 80 km (50 mi) of the INL Site is estimated, based on the 2010 census and projected growth, to be 318,528. Over half of this population (173,475) resides in the census divisions of Idaho Falls (103,208) and northern Pocatello (70,267). Another 25,730 live in the Rexburg census division. Approximately 18,789 reside in the Rigby census division and 15,321 in the Blackfoot census division. The remaining population resides in small towns and rural communities.

REFERENCES

Anderson, J. E., K. T. Ruppel, J. M. Glennon, K. E. Holte, and R. C. Rope, 1996, *Plant Communities, Ethnoecology, and Flora of the Idaho National Engineering Laboratory*, ESRF-005, Environmental Science and Research Foundation.

BMPC, 2015, *2014 Environmental Monitoring Report for the Naval Reactors Facility*, NRF-OSQ-ESH-00099, Bechtel Marine Propulsion Corporation.

DOE, 1995, *Settlement Agreement*, U. S. Department of Energy, U.S. Department of the Navy, and State of Idaho.

DOE Order 231.1B, 2011, "Environment, Safety and Health Reporting," Change 2, U.S. Department of Energy.

DOE Order 436.1, 2011, "Departmental Sustainability," U.S. Department of Energy.

DOE Order 458.1, 2013, "Radiation Protection of the Public and the Environment," Change 3. U.S. Department of Energy.

DOE-ID, 1989, *Climatography of the Idaho National Engineering Laboratory, 2nd Edition*, DOE/ID-12118, U.S. Department of Energy, Idaho Operations Office.

DOE-ID, 2008, *Record of Decision for Radioactive Waste Management Complex Operable Unit 7-13/14*, DOE/ID-11359, U.S. Department of Energy, Idaho Operations Office.

ESRF, 1996, "The Site, the Plain, the Aquifer, and the Magic Valley (Part One of Four)," Foundation Focus, Volume 3, Issue 3, Environmental Science and Research Foundation.

Executive Order 12344, 1982, "Naval Nuclear Propulsion Program."

Lindholm, G. F., 1996, *Summary of the Snake River Plain Regional Aquifer-System Analysis in Idaho and Eastern Oregon*, U.S. Geological Survey Professional Paper 1408-A.

Reynolds, T. D., J. W. Connelly, D. K. Halford, and W. J. Arthur, 1986, "Vertebrate Fauna of the Idaho National Environmental Research," *Great Basin Naturalist*, Vol. 46, No. 3, pp. 513– 527.

Smith, R. B. and L. J. Siegel, 2000, *Windows into the Earth, The Geologic Story of Yellowstone and Grand Teton National Parks*, Oxford University Press.

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2. Environmental Compliance Summary

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Operations at the Idaho National Laboratory (INL) Site are subject to numerous federal and state environmental statutes, executive orders, and Department of Energy (DOE) orders. As a requirement of many of these regulations, the status of compliance with the regulations and releases of non-permitted hazardous materials to the environment must be documented. Overall, the INL Site met all its regulatory commitments in 2014, and programs are in place to address areas for continued improvement. Significant environmental compliance issues/actions in 2014 include:

- The *National Emission Standards for Hazardous Air Pollutants-Calendar Year 2014 INL Report for Radionuclides* report was submitted to U.S. Environmental Protection Agency, DOE Headquarters, and state of Idaho officials in June 2015, in compliance with the Clean Air Act. The dose to hypothetical Maximally Exposed Individual from airborne releases was calculated to be far below the regulatory limit of 10 mrem per year.
- There were no reportable environmental releases at the INL Site in 2014.
- In February 2014, the DOE Idaho Operations Office (DOE-ID) finalized the Environmental Assessment for the Resumption of Transient Testing of Nuclear Fuels and Materials and issued a Finding of No Significant Impact to resume operations of the Transient Reactor Test Facility (TREAT) Reactor at the INL Site.
- During 2014, the shipment of transuranic waste was suspended due to the suspension of operations at the Waste Isolation Pilot Plant (WIPP) in Carlsbad, New Mexico. The INL Site continues to process and certify transuranic waste for eventual shipment to WIPP
- In 2014, 19 cultural resource reviews were completed for INL Site projects with potential to cause impacts to archaeological resources. Cultural resource reviews of projects that had the potential to impact INL historic architectural properties were also completed for 22 proposed activities in 2014.

2. ENVIRONMENTAL COMPLIANCE SUMMARY

This chapter reports the compliance status of the Idaho National Laboratory (INL) Site with environmental protection requirements. Operations at the INL Site are subject to numerous federal and state environmental protection requirements, such as statutes, acts, agreements, executive orders, and Department of Energy (DOE) orders. These are listed in Appendix A. The programs in place to comply with environmental protection requirements are discussed in Chapter 3.

2.1 Air Quality and Radiation Protection

2.1.1 Clean Air Act

The Clean Air Act (CAA) is the basis for national air pollution control. Congress passed the original CAA in 1963, which resulted in non-mandatory air pollution standards and studies of air pollution, primarily from automobiles. Amendments to the CAA are passed periodically, with significant amendments enacted in 1970, 1977, and 1990. These amendments contained key pieces of legislation that are considered basic elements of the CAA, which are listed below:

- ***National Ambient Air Quality Standards.*** The National Ambient Air Quality Standards establish permissible exposure levels for six pollutants (criteria air pollutants) identified as primary contributors to health-related deaths and illnesses. The six pollutants are carbon monoxide, lead, nitrogen dioxide, ozone, particulates, and sulfur oxides.
- ***State Implementation Plans.*** A state may assume responsibility for the CAA by developing an U.S. Environmental Protection Agency (EPA)-approved state implementation plan. A state implementation plan contains the laws and regulations a state will use to administer and enforce the provisions of the CAA. The state of Idaho has been delegated authority for the CAA through an approved state implementation plan.

- ***New Source Performance Standards.*** The New Source Performance Standards Program is a permitting performance standard for specific industry source categories. The standard targets sources that contribute significantly to air pollution and ensures the sources meet ambient air quality standards. The criteria air pollutants are the focus of the New Source Performance Standards Program.
- ***Prevention of Significant Deterioration.*** The Prevention of Significant Deterioration program applies to new major sources or major modifications to existing sources where the source is located in an area that is designated as attainment or unclassifiable with the National Ambient Air Quality Standards. An attainment area is one that meets the national primary or secondary ambient air quality standards. An unclassifiable area is one that cannot be classified on the basis of available information as meeting or not meeting the national primary or secondary ambient air quality standards. The INL is in an unclassifiable area.
- ***National Emissions Standards for Hazardous Air Pollutants (NESHAPs).*** The NESHAPs Program regulates emissions of hazardous air pollutants from a published list of industrial sources. The source categories must meet control technology requirements for these hazardous air pollutants. The state of Idaho has supplemented the federal NESHAPs list of hazardous air pollutants with the State List of Toxic Air Pollutants.

  The state of Idaho has not been delegated authority for one key subpart of the NESHAPs Program. Specifically, Subpart H, "National Emission Standards for Emissions of Radionuclides Other than Radon from Department of Energy Facilities" (40 Code of Federal Regulations [CFR] 61, Subpart H) is regulated by EPA. Subpart H applies to facilities owned or operated by DOE, including the INL Site. The Department of Energy, Idaho Operations Office (DOE-ID) submits an annual NESHAPs Subpart H report to EPA and the Idaho Department of Environmental Quality (DEQ). The latest report is *National Emission Standards for Hazardous Air Pollutants – Calendar Year 2014 INL Report for Radionuclides* (DOE-ID 2015). The annual NESHAPs Subpart H report uses an EPA-approved computer model to calculate the hypothetical maximum individual effective dose equivalent to a member of the public resulting from INL Site airborne radionuclide emissions. The calculations for this code are discussed further in Chapter 8, "Dose to the Public and Biota."
- ***Stratospheric Ozone Protection Program.*** The Stratospheric Ozone Protection Program limits emissions of chlorofluorocarbons, halons, and other halogenic chemicals that contribute to the destruction of stratospheric ozone.
- ***Enforcement Provisions.*** Enforcement provisions establish maximum fines and penalties for CAA violations.
- ***Operating Permit Program.*** The Operating Permit Program provides for states to issue federally enforceable operating permits to applicable stationary sources. The permits aid in clarifying operating and control requirements for stationary sources.

The Idaho Air Quality Program is primarily administered through a permitting process that sets conditions under which facilities that generate air pollutants may operate. Potential sources of air pollutants are evaluated against regulatory criteria to determine if the source is exempt from permitting. If the source is not exempted, the type of permit required depends on the type of emission or emitting source or both. Two primary types of air permits have been issued to the INL Site (Table 2-1):

- ***Permit to Construct.*** An air quality permit to construct is required of new or modified stationary sources, such as buildings, structures, or equipment that may emit pollutants into the air. State of Idaho air regulations and guidelines are used to apply for all permits to construct.
- ***Title V Operating Permit.*** A Title V operating permit, also known as a Tier I operating permit, is required for major sources. Major sources emit, or have the potential to emit per year, 10 tons or more of one hazardous air pollutant, 25 or more tons of any combination of hazardous air pollutants, or 100 tons or more of any regulated air pollutant. EPA promulgated regulations in July 1992 that established the Tier I requirements for state programs. Through the state implementation plan, Idaho has approved one Tier I operating permit for the INL Site.

Table 2-1. Environmental Permits for the INL Site (2014).

Permit Type	Active Permits
Air Emissions:	
Permit to Construct	14
Title V Operating Permit	1
Groundwater:	
Injection Well	10
Well construction	1
Surface Water:	
Wastewater Reuse Permits	4
Industrial Wastewater Acceptance	1
Resource Conservation and Recovery Act:	
Part A	2
Part B	7[a]
Ecological:	
Migratory Bird Treaty Act Special Purpose Permit	1
Cultural Resources:	
Permit for Archaeological Investigation	1

a. A Part B permit is a single permit comprised of several volumes.

2.1.2 DOE Order 458.1, Radiation Protection of the Public and the Environment

DOE Order 458.1, "Radiation Protection of the Public and the Environment," establishes requirements to protect the public and the environment against undue risk from radiation associated with radiological activities conducted under the control of DOE pursuant to the Atomic Energy Act of 1954, as amended. The objectives of this Order are:

- To conduct DOE radiological activities so that exposure to members of the public is maintained within the dose limits established in this Order
- To control the radiological clearance of DOE real and personal property
- To ensure that potential radiation exposures to members of the public are as low as reasonably achievable
- To ensure that DOE sites have the capabilities, consistent with the types of radiological activities conducted, to monitor routine and non-routine radiological releases and to assess the radiation dose to members of the public
- To provide protection of the environment from the effects of radiation and radioactive material.

DOE Order 458.1 was issued in February 2011 and replaced DOE Order 5400.5 by the same title. The Order sets the public dose limit at a total effective dose not to exceed 100 mrem/yr (1 mSv/yr) above background radiation levels. Chapter 8 presents dose calculations for INL Site releases for 2014.

DOE Standard DOE-STD-1196-2011, Derived Concentration Technical Standard, was issued in April 2011, and defines the quantities used in the design and conduct of radiological environmental protection programs at DOE facilities and sites. These quantities, Derived Concentration Standards (DCSs), represent the concentration of a given radionuclide in either water or air that results in a member of the public receiving 100 mrem (1 mSv) effective dose following continuous exposure for one year via each of the following pathways: ingestion of water, submersion in air, and inhalation. They replace the derived concentration guides, which were previously published by DOE in 1993 in DOE Order 5400.5 and represented the best available information on doses at that time. Since that publication, the radiation protection framework on which DCSs are based has evolved with more sophisticated biokinetic and dosimetric information provided by the International Commission on Radiological Protection (ICRP), thus enabling consideration of age and gender. The purpose of DOE-STD-1196-2011 is to establish DCS values reflecting the current state of knowledge and practice in radiation protection. These DCSs are based on age-specific effective dose coefficients, revised gender specific physiological parameters for the Reference Man (ICRP 2002), and the latest information on the energies and intensities of radiation emitted by radionuclides (ICRP 2008). Previous versions of the Annual Site Environmental Report used derived concentration guides, as defined in DOE Order 5400.5, to evaluate environmental monitoring results for the INL Site. With the issuance of DOE Order 458.1 and DOE-STD-1196-2011, this report now evaluates environmental monitoring results according to the corresponding DCSs.

In addition to discharges to the environment, the release of property containing residual radioactive material is a potential contributor to the dose received by the public. DOE Order 458.1 specifies limits for unrestricted release of property to the public. All INL Site contractors use a graded approach for release of material and equipment for unrestricted public use. Material has been categorized so that in some cases an administrative release can be accomplished without a radiological survey. Such material originates from non-radiological areas and includes the following:

- personal items or materials
- documents, mail, diskettes, compact disks, and other office media
- paper, cardboard, plastic products, aluminum beverage cans, toner cartridges, and other items released for recycling
- office trash
- non-radiological area housekeeping materials and associated waste
- break-room, cafeteria, and medical wastes
- medical and bioassay samples
- other items with an approved release plan.

Items originating from non-radiological areas within the Site's controlled areas not in the listed categories are surveyed prior to release to the public, or a process knowledge evaluation is conducted to verify that material has not been exposed to radioactive material or beams of radiation capable of creating radioactive material. In some cases both a radiological survey and a process knowledge evaluation are performed (e.g., a radiological survey is conducted on the outside of the item, and a process knowledge form is signed by the custodian for inaccessible surfaces).

When the process knowledge approach is employed, the item's custodian is required to sign a statement that specifies the history of the material and confirms that no radioactive material has passed through or contacted the item. Items advertised for public sale via an auction are also surveyed by the contractor prior to shipment to INL Property/excess warehouse where the materials are again resurveyed on a random basis by INL personnel prior to release, giving further assurance that material and equipment are not being released with inadvertent contamination.

All contractors complete material surveys prior to release and transport to the state-permitted landfill at Central Facilities Area. The only exception is for items that could be internally contaminated; these items are submitted to Waste Generator Services for disposal using one of the offsite treatment, storage, and disposal facilities that can accept low-level contamination. All INL Site contractors continue to follow the requirements of the scrap metal suspension. No scrap metal directly released from radiological areas is recycled.

2.2 Environmental Protection and Remediation

2.2.1 Comprehensive Environmental Response, Compensation, and Liability Act

The Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) provides the process to assess and remediate areas contaminated by the release of chemically hazardous or radioactive substances or both. Nuclear research and other operations at the INL Site left behind contaminants that pose a potential risk to human health and the environment. The INL Site was placed on the National Priorities List under CERCLA on November 29, 1989. DOE-ID, the state of

Idaho, and EPA Region 10 signed the Federal Facility Agreement and Consent Order in December 1991 (DOE 1991). The Idaho Cleanup Project (ICP) contractor, in accordance with the Federal Facility Agreement and Consent Order, is conducting environmental restoration activities at the INL Site. Specific environmental restoration activities are discussed in Chapter 3.

2.2.2 DOE Order 436.1, Departmental Sustainability

The purpose of DOE Order 436.1, "Departmental Sustainability," is to provide requirements and responsibilities for managing sustainability within DOE to:

- Ensure the Department carries out its missions in a sustainable manner that addresses national energy security and global environmental challenges, and advances sustainable, efficient, and reliable energy for the future
- Institute wholesale cultural change to factor sustainability and greenhouse gas (GHG) reductions into all DOE corporate management decisions
- Ensure DOE achieves the sustainability goals established in its Strategic Sustainability Performance Plan pursuant to applicable laws, regulations and Executive Orders, related performance scorecards, and sustainability initiatives.

These programs are summarized in this chapter and elsewhere in this report.

2.2.3 Emergency Planning and Community Right-to-Know Act

The Emergency Planning and Community Right-to-Know Act (EPCRA) is Title III of the 1986 Superfund Amendments and Reauthorization Act to CERCLA. EPCRA is intended to help local emergency response agencies better prepare for potential chemical emergencies and to inform the public of the presence of toxic chemicals in their communities. The INL Site's compliance with key EPCRA provisions is summarized in the following subsections and in Table 2-2.

Section 304 – Section 304 requires owners and operators of facilities where hazardous chemicals are produced, used, or stored to report releases of CERCLA hazardous substances or extremely hazardous substances that exceed reportable quantity limits to state and local authorities (i.e., state emergency response commissions and local emergency planning committees). There were no CERCLA-reportable chemicals released at the INL Site during 2014.

Sections 311 and 312 – Sections 311 and 312 require facilities manufacturing, processing, or storing designated hazardous chemicals to make material safety data sheets describing the properties and health effects of these chemicals available to state and local officials and local fire departments. Facilities also are required to report to state and local officials and local fire departments inventories of all chemicals that have material safety data sheets. The INL Site satisfies the requirements of Section 311 by submitting quarterly reports to state and local officials and fire departments, identifying chemicals that exceed regulatory thresholds. In compliance with Section 312, the annual Emergency and Hazardous Chemical Inventory (Tier II) Report is provided to local emergency planning committees, the state emergency response commission, and local fire departments by the regulatory due date of March 1. This report includes the types, quantities, and locations of hazardous chemicals and extremely hazardous substances stored at the INL Site and Idaho Falls facilities that exceed regulatory thresholds.

Section 313 – Section 313 requires facilities to submit a Toxic Chemical Release Inventory Form annually for regulated chemicals that are manufactured, processed,

Table 2-2. INL Site EPCRA Reporting Status (2014).

EPCRA Section	Description of Reporting	2014 Status
Section 304	Extremely Hazardous Substance Release Notification	Not Required
Section 311-312	Material Safety Data Sheet/Chemical Inventory	Required
Section 313	Toxic Chemical Release Inventory Reporting	Required

or otherwise used above applicable threshold quantities. Releases under EPCRA 313 reporting include transfers to waste treatment and disposal facilities off the INL Site, air emissions, recycling, and other activities. The INL Site submitted Toxic Chemical Release Inventory Forms for ethylbenzene, lead, and naphthalene, to EPA and the state of Idaho by the regulatory due date of July 1.

Reportable Environmental Releases – There were no reportable environmental releases at the INL Site during calendar year 2014.

2.2.4 National Environmental Policy Act

The National Environmental Policy Act (NEPA) requires federal agencies to consider and analyze potential environmental impacts of proposed actions and explore appropriate alternatives to mitigate those impacts, including a "no action" alternative. Agencies are required to inform the public of the proposed actions, impacts, and alternatives and consider public feedback in selecting an alternative. DOE implements NEPA according to procedures in the CFR (40 CFR 1500; 10 CFR 1021) and assigns authorities and responsibilities according to DOE Order 451.1B, "National Environmental Policy Act Compliance Program." Processes specific to DOE-ID are set forth in its Idaho Operations Office Management System. DOE-ID issued the Annual NEPA Planning Summary on February 4, 2014. The summary is a requirement of DOE Order 451.1B, and is prepared to inform the public and other DOE elements of:

- The status of ongoing NEPA compliance activities
- Environmental assessments expected to be prepared in the next 12 months
- Environmental Impact Statements (EISs) expected to be prepared in the next 24 months
- The planned cost and schedule for completion of each NEPA review identified.

In February 2014, DOE-ID finalized the Environmental Assessment for the Resumption of Transient Testing of Nuclear Fuels and Materials and issued a Finding of No Significant Impact to resume operations of the Transient Reactor Test Facility Reactor at the INL Site. The environmental assessment contained and evaluated the potential of resuming operations at the Reactor or modifying the Annular Core Research Reactor at Sandia National Laboratories in New Mexico, to conduct high-power radiation testing on nuclear fuels and materials.

DOE-ID also prepared an Environmental Assessment (EA) on the Disposition of Five Signature Properties at the Idaho National Laboratory. That EA provided an evaluation of the environmental impacts of dispositioning five World War II properties at the Central Facilities Area. Because of the properties' age, condition, and location, there was no reasonable potential for their reuse, transfer, or sale. The draft EA was issued in May 2014, for a 30-day public comment period. DOE received no comments on the EA and issued a Final EA and Finding of No Significant Impact to disposition the properties and implement mitigation actions in accordance with a Memorandum of Agreement with the Idaho State Historic Preservation Office and the Advisory Council on Historic Preservation.

2.2.5 Endangered Species Act

The Endangered Species Act (ESA):

- Provides a means whereby the ecosystems upon which endangered and threatened species depend may be conserved
- Provides a program for the conservation of such endangered and threatened species and their habitat
- Takes such steps as may be appropriate to achieve the purposes of the international treaties and conventions on threatened and endangered species.

The Act requires that all federal departments and agencies shall seek to conserve endangered and threatened species and shall use their authorities to further the purposes of this Act.

Personnel in the Environmental Surveillance, Education, and Research Program conduct ecological research, field surveys, and NEPA evaluations regarding ecological resources on the INL Site. Particular emphasis is given to threatened and endangered species and species of special concern identified by the U.S. Fish and Wildlife Service (USFWS) and Idaho Department of Fish and Game.

There are two species categorized under the ESA which occur or may occur on the INL Site. Table 2-3 presents a list of those species and the likelihood of their occurrence on the INL Site. Several species have been removed from the list based on the limited likelihood they would occur on the INL Site. On August 13, 2014, the USFWS withdrew a proposal to list the North American wolverine (*Gulo gulo luscus*) in the contiguous United States as a threatened species under the ESA. The wolverine has not been documented at the INL Site, but may pass through it.

On October 3, 2014 the USFWS determined threatened status for the Western Distinct Population Segment of the Yellow-billed Cuckoo (*Coccyzus americanus*). The rare species is known to breed in river valleys in southern Idaho (Federal Register, Vol. 79 No. 192, October 3, 2014), but has only been observed once near the INL Site at Atomic City.

In March 2010, the USFWS classified the Greater sage-grouse (*Centrocercus urophasianus*) as a candidate for listing under the ESA. This means that although the species warrants protection under the ESA, it is currently precluded from being listed due to higher agency priorities. In a recent (2011) U.S. district court lawsuit settlement, the USFWS agreed to make a final listing decision on all candidate species by 2016. The resulting agency work plan commits the USFWS to make a determination by 2015 to either list sage-grouse as threatened or endangered, or to remove it from the candidate list. However, the Fiscal Year 2015 budget language does not allow the Department of Interior (i.e., the USFWS) to spend money on activities related to any proposed or final listing of sage-grouse through September 30, 2015. Effectively, this will push any listing decision back several months.

In October 2014, DOE and the USFWS signed the Candidate Conservation Agreement for Greater Sage-grouse (*Centrocercus uraphasianus*) on the INL. The voluntary agreement includes conservation measures that protects sage-grouse and its habitat while allowing DOE flexibility in accomplishing its missions. The agreement was put in place in anticipation of a court ordered listing decision for sage-grouse by USFWS in September 2015.

Recently, white-nose syndrome (WNS) has been identified as a major threat to many bats that hibernate in caves. This disease is caused by a cold-adapted fungus (*Geomyces destructans*) and has killed at least 5.5 to 6.7 million bats in seven species. WNS has been labeled by some as the greatest wildlife crisis of the past century, and many species of bats could be at risk of significant declines or extinction due to this disease. At least two species of bats that occupy the INL Site could be affected by WNS if this disease arrives in Idaho – the little brown myotis (*Myotis lucifugus*) and the big brown bat (*Eptesicus fuscus*). In 2010, the little brown myotis was petitioned for emergency listing under the ESA, and the USFWS is collecting information on both species to determine if, in addition to existing threats, this disease may be increasing the extinction risk of these bats. Biologists from the Environmental Surveillance, Education, and Research Program have initiated a monitoring program using acoustical detectors set at hibernacula and important habitat features (caves and facility ponds) used by these mammals on the INL Site. Naval Reactors and DOE-ID have initiated the development of a Bat Protection Plan for the INL Site. The Bat Protection Plan would allow the INL Site to proactively position itself to continue its missions if there was an emergency listing of a bat due to WNS. The monitoring data will be incorporated into the development of that plan.

2.2.6 Migratory Bird Treaty Act

The Migratory Bird Treaty Act prohibits taking any migratory bird, or any part, nest, or egg of any such bird without authorization from the U.S. Department of the Interior. Permits may be issued for scientific collecting, banding and marking, falconry, raptor propagation, depredation, import, export, taxidermy, waterfowl sale and disposal, and special purposes. In July 2013, DOE-ID received a Special Purpose Permit for limited nest relocation and destruction and the associated take of migratory birds if absolutely necessary for mission-critical activities. The permit would be applied in very limited and extreme situations where no other recourse is practicable.

DOE-ID did not have to use the permit to relocate or destroy any active migratory bird nests in 2014. DOE-ID is required to submit an annual report to USFWS by

Table 2-3. INL Species Designated Under the ESA and Occur or May Occur on the INL Site.

Species	Designation	Presence on INL Site
Greater sage-grouse (*Centrocercus urophasianus*)	Candidate	Large populations present on INL Site.
Yellow-billed cuckoo (*Coccyzus americanus*)	Threatened	Documented once on south border of INL Site.

January 31st of each year detailing reportable activities related to migratory birds.

2.2.7 Executive Order 11988 – Floodplain Management

Executive Order 11988 requires each federal agency to issue or amend existing regulations and procedures to ensure that the potential effects of any action it may take in a floodplain are evaluated and that its planning programs and budget requests consider flood hazards and floodplain management. It is the intent of Executive Order 11988 that federal agencies implement floodplain requirements through existing procedures, such as those established to implement NEPA. 10 CFR 1022 contains DOE policy and floodplain environmental review and assessment requirements through the applicable NEPA procedures. In those instances where impacts of actions in floodplains are not significant enough to require the preparation of an EIS under NEPA, alternative floodplain evaluation requirements are established through the INL Site Environmental Checklist process.

For the Big Lost River, DOE-ID has accepted the *Big Lost River Flood Hazard Study, Idaho National Laboratory, Idaho* (Bureau of Reclamation 2005). This flood hazard report is based on geomorphological models and has undergone peer review. All activities on the INL Site requiring characterization of flows and hazards are expected to use this report.

For facilities at Test Area North, the 100-year floodplain has been delineated in a U.S. Geological Survey report (USGS 1997).

2.2.8 Executive Order 11990 – Protection of Wetlands

Executive Order 11990 requires each federal agency to issue or amend existing regulations and procedures to ensure wetlands are protected in decision-making. It is the intent of this Executive Order that federal agencies implement wetland requirements through existing procedures, such as those established to implement NEPA. The 10 CFR 1022 regulations contains DOE policy and wetland environmental review and assessment requirements through the applicable NEPA procedures. In those instances where impacts of actions in wetlands are not significant enough to require the preparation of an EIS under NEPA, alternative wetland evaluation requirements are established through the INL Site Environmental Checklist process. Activities in wetlands considered waters of the United States or adjacent to waters of the United States also may be subject to the jurisdiction of Sections 404 and 402 of the Clean Water Act.

The only area of the INL Site identified as potentially jurisdictional wetlands is the Big Lost River Sinks. The USFWS National Wetlands Inventory map is used to identify potential jurisdictional wetlands and non-regulated sites with ecological, environmental, and future development significance. In 2014, no actions took place or impacted potential jurisdictional wetlands on the INL Site.

2.2.9 Executive Order 13514 – Federal Leadership in Environmental, Energy, and Economic Performance

Executive Order 13514, "Federal Leadership in Environmental, Energy, and Economic Performance," was signed by President Obama on October 5, 2009. This Executive Order expands on the energy reduction and environmental performance requirements for federal agencies identified in Executive Order 13423, "Strengthening Federal Environmental, Energy, and Transportation Management."

The goal of Executive Order 13514 is "to establish an integrated strategy towards sustainability in the Federal Government and to make reduction of GHG emissions a priority for Federal agencies." Towards meeting that goal, federal agencies are required to meet a series of deadlines critical to achieving the GHG reduction goals of the Executive Order.

- On November 5, 2009, each agency submitted the name of their Senior Sustainability Officer to the Council on Environmental Quality (CEQ) Chair and Office of Management and Budget (OMB) Director
- On January 4, 2010, a percentage reduction target for agency-wide reductions of Scope 1 and 2 GHG emissions, in absolute terms, by fiscal year 2020, relative to a fiscal year 2008 baseline of the agency's Scope 1 and 2 GHG, was due to the CEQ Chair and OMB Director
- On June 2, 2010, Scope 3 targets and the Strategic Sustainability Performance Plan were submitted to the CEQ Chair and the OMB Director
- On January 31, 2011, the comprehensive GHG inventory was due from each of the agencies to the CEQ Chair and OMB Director.

In addition to guidance, recommendations, and plans that are due by specific dates, Executive Order 13514 specifies numerical and non-numerical targets for agencies to reach in areas such as sustainable buildings, water efficiency, electronic products, and transportation management. Beyond targets, Executive Order 13514 requires agencies to follow specific management strategies to improve sustainability.

On May 22, 2011, DOE issued DOE Order 436.1 "Departmental Sustainability." As discussed in Section 2.2.2, the Order defines requirements and responsibilities for managing sustainability at DOE to ensure that the Department carries out its missions in a sustainable manner that addresses national energy security and global environmental challenges, and advances sustainable, efficient, and reliable energy for the future; institutes wholesale cultural change to factor sustainability and GHG reductions into all DOE corporate management decisions; and ensures that DOE achieves the sustainability goals established in its Strategic Sustainability Performance Plan. This Order combined, added to, and cancels DOE Order 450.1A "Environmental Protection Program" and DOE Order 430.2B "Departmental Energy, Renewable Energy, and Economic Performance."

DOE-ID submitted the *FY 2015 INL Site Sustainability Plan with the FY 2014 Annual Report* to DOE Headquarters in December, 2014 (DOE-ID 2014a). This Plan contains strategies and activities for 2015 that are leading to continual energy efficiency, GHG reductions, environmental improvements, and transportation fuels efficiency to facilitate the INL Site in meeting the goals and requirements of Executive Order 13514, and DOE Order 436.1 before the end of fiscal year 2020.

A more detailed discussion of environmental management systems including the sustainability program, and pollution prevention programs is provided in Chapter 3.

2.3 Waste Management

2.3.1 Resource Conservation and Recovery Act

The Resource Conservation and Recovery Act (RCRA) established regulatory standards for generation, transportation, storage, treatment, and disposal of hazardous waste. The DEQ is authorized by EPA to regulate hazardous waste and the hazardous components of mixed waste at the INL Site. Mixed waste contains both radioactive and hazardous materials. The Atomic Energy Act, as administered through DOE orders, regulates radioactive wastes and the radioactive part of mixed wastes. A RCRA hazardous waste permit application contains two parts – Part A and Part B. Part A of the RCRA hazardous waste permit application consists of EPA Form 8700-23, along with maps, drawings, and photographs, as required by 40 CFR 270.13. Part B of the RCRA hazardous waste permit application contains detailed, site-specific information as described in applicable sections of 40 CFR 270.14 through 270.27. The INL Site currently has two RCRA Part A permit volumes and seven Part B permit volumes. Parts A and B are considered a single RCRA permit and are comprised of several volumes.

RCRA Reports. As required by the state of Idaho, the INL Site submitted the 2014 Idaho Hazardous Waste Generator Annual Report on the types and quantities of hazardous wastes generated, shipped for treatment and disposal, and remaining in storage. The INL Site also submitted the 2014 RCRA Biennial Report as required by EPA on the quantities, types, and management of hazardous wastes generated and received from offsite.

RCRA Closure Plan. On March 5, 2014, DEQ submitted correspondence to the DOE-ID acknowledging the completion of closure activities for Materials and Fuels Complex (MFC) MFC-799 and MFC-799A Sodium Process Facility. On September 23, 2014, DEQ submitted correspondence to the DOE-ID acknowledging the completion of closure activities for the Radioactive Waste Management Complex/ARP WMF-1619 and WMF-1621 Trailer Storage Areas.

RCRA Inspection. For fiscal year 2014, DEQ conducted an annual RCRA inspection of the INL Site April 21 through May 1, 2014. On September 23, 2014, DEQ issued a Notice of Violation to DOE and the responsible INL Site contractors. The Notice of Violation stated that six apparent violations (three of which were for the same violation at different universal waste storage areas) of the Idaho Rules and Standards for Hazardous Waste were documented in association with the INL Site annual inspection. Two of the apparent violations had been self-reported to DEQ; however, self-disclosure does not constitute a defense or shield to any enforcement action. The original Notice of Violation assessed a total penalty of $9,800 distributed to the responsible INL Site contractors. An enforcement conference was held and a Consent Order agreed to by all parties which resulted in reduction of the penalty to $2,940. The Consent Order penalty was paid through a Supplemental Environmental Project to the Western States Project Training Fund, for use by the Western States Project in environmental enforcement training programs.

2.3.2 Federal Facility Compliance Act

The Federal Facility Compliance Act requires the preparation of site treatment plans for the treatment of mixed wastes stored or generated at DOE facilities. Mixed waste contains both hazardous and radioactive components. The INL Site Proposed Site Treatment Plan was submitted to the state of Idaho and EPA on March 31, 1995. This plan outlined DOE-ID's proposed treatment strategy for INL Site mixed-waste streams, called the "backlog," and provided a preliminary analysis of potential offsite mixed low-level waste treatment capabilities. The Federal Facility Compliance Act Consent Order and Site Treatment Plan was finalized and signed by the state of Idaho on November 1, 1995 (DEQ 1995). A status of Site Treatment Plan milestones for 2014 is provided in Chapter 3.

2.3.3 Toxic Substances Control Act

The Toxic Substances Control Act (TSCA), which is administered by EPA, requires regulation of production, use, or disposal of chemicals. TSCA supplements sections of the CAA, the CWA, and the Occupational Safety and Health Act. Because the INL Site does not produce chemicals, compliance with TSCA is primarily directed toward use and management of certain chemicals, particularly polychlorinated biphenyls. Polychlorinated biphenyls-containing light ballasts are being removed at buildings undergoing demolition. The ballasts are disposed of off the INL Site in a TSCA-approved disposal facility.

2.3.4 DOE Order 435.1, Radioactive Waste Management

DOE Order 435.1, "Radioactive Waste Management," was issued to ensure that all DOE radioactive waste is managed in a manner that protects the environment and worker and public safety and health. INL Site activities related to this Order are discussed in Chapters 3 and 6.

2.3.5 1995 Settlement Agreement

On October 16, 1995, DOE, the U.S. Navy, and the state of Idaho entered into an agreement that guides management of spent nuclear fuel and radioactive waste at the INL Site. The agreement (DOE 1995) limits shipments of DOE and Naval spent nuclear fuel into the state and sets milestones for shipments of spent nuclear fuel and radioactive waste out of the state. DOE must have all Idaho spent nuclear fuel in dry storage by 2023 and all spent nuclear fuel out of Idaho by the end of 2035.

The Settlement Agreement also requires DOE to ship all waste stored as transuranic waste on the INL Site in 1995, when the Agreement was signed, out of Idaho by December 31, 2018. The estimated volume of that waste was 65,000 cubic meters (m^3). There is an additional requirement to ship an annual 3-year running average of 2,000 m^3 (2,616 cubic yards, yd^3) of that waste out of the State each year. In February 2014, the shipment of transuranic waste was curtailed due to the suspension of Waste Isolation Pilot Plant (WIPP) operations in Carlsbad, New Mexico. The INL Site continued to process and certify stored waste subject to the Settlement Agreement for shipment offsite. The annual 3-year running average of Settlement Agreement waste stored as transuranic waste shipped out of Idaho over the past three years was 2,631 m^3. In calendar year 2014, 1,983 m^3 of that waste was shipped out of Idaho and 1,483 m^3 was certified for disposal at WIPP and placed into compliant storage. The stored transuranic waste volumes shipped to WIPP in the past three years were: 2,568 m^3 in 2012; 2,487 m^3 in 2013; and 923 m^3 in 2014.

In 2014, 263 m^3 (343 yd^3) of buried transuranic waste was certified for disposal at WIPP and placed into compliant storage.

2.4 Water Quality and Protection

2.4.1 Clean Water Act

The Clean Water Act (CWA), passed in 1972, established goals to control pollutants discharged to U.S. surface waters. Among the main elements of the CWA are effluent limitations for specific industry categories set by EPA and water quality standards set by states. The CWA also provided for the National Pollutant Discharge Elimination System permit program, requiring permits for discharges into regulated surface waters.

The INL Site complies with a CWA permit through the implementation of procedures, policies, and best management practices. The permit covers discharges from Idaho Falls facilities to the city of Idaho Falls publicly-owned treatment works. The city of Idaho Falls is authorized by the National Pollutant Discharge Elimination System permit program to set pretreatment standards for nondomestic discharges to publicly-owned treatment works. This program is set out in the Municipal Code of the city of Idaho Falls in Chapter 1, Section 8. The

INL Research Center is the only facility that is required to have an Industrial Wastewater Acceptance Permit. The Industrial Wastewater Acceptance Permit contains special conditions and compliance schedules, prohibited discharge standards, reporting requirements, monitoring requirements, and effluent concentration limits for specific parameters. All discharges in 2014 were within compliance levels established in the INL Research Center Wastewater Acceptance Permit.

2.4.2 Safe Drinking Water Act

The Safe Drinking Water Act establishes rules governing the quality and safety of drinking water. The DEQ promulgates the Safe Drinking Water Act, according to Idaho Administrative Procedures Act (IDAPA) 58.01.08 – *Idaho Rules for Public Drinking Water Systems*.

The eastern Snake River Plain aquifer is the source for the 12 active public water systems at all the facilities on the INL Site. All INL Site public water systems sample their drinking water as required by the state of Idaho. Chapter 5 contains details on drinking water monitoring.

2.4.3 State of Idaho Wastewater Reuse Permits

Wastewater consists of spent or used water from a home, community, farm, or industry that contains dissolved or suspended matter that may contribute to water pollution. Methods of reusing treated wastewater include irrigation, commercial toilet flushing, dust control, and fire suppression. Land application is one method of reusing treated wastewater. It is a natural way of recycling water to provide moisture and nutrients to vegetation, and recharge to ground water.

To protect public health and prevent pollution of surface and ground waters, the state of Idaho requires anyone wishing to land-apply wastewater to obtain a Wastewater Reuse Permit. The DEQ issues the Reuse permits in accordance with IDAPA 58.01.17 Recycled Water Rules, IDAPA 58.01.16 Wastewater Rules, and IDAPA 58.01.11 Ground Water Quality Rule (http://adminrules.idaho.gov/rules/current/58/0111.pdf). All Wastewater Reuse Permits consider site-specific conditions and incorporate water quality standards for ground water protection. The following INL Site facilities have Wastewater Reuse Permits to land apply wastewater:

- Central Facilities Area Sewage Treatment Plant
- Advanced Test Reactor Complex Cold Waste Ponds
- Idaho Nuclear Technology and Engineering Center New Percolation Ponds
- Materials and Fuels Complex Industrial Waste Ditch and Industrial Waste Pond.

Chapter 5 contains details on Wastewater Reuse monitoring.

2.4.4 Corrective Action/Monitoring Plan for Petroleum Release Associated with Well ICPP-2018

The *Corrective Action/Monitoring Plan for Well ICPP-2018 Petroleum Release at the Idaho Nuclear Technology and Engineering Center* was written to address a release of petroleum hydrocarbons detected in 2007 in perched water monitoring Well ICPP-2018 at Idaho Nuclear Technology and Engineering Center (ICP 2014). The removal of petroleum product and the sampling and analysis of groundwater for benzene, toluene, ethylbenzene and xylenes compounds and polynuclear aromatic hydrocarbons are required per IDAPA 58.01.02 Water Quality Standards, Subsection 852, "Petroleum Release Response and Corrective Action." The plan identifies activities for removing petroleum product from perched water Well ICPP-2018, as well as any other monitoring well where product is found, and outlines the proposed perched water and groundwater monitoring schedule.

Over the past several years, absorbent SoakEase® socks have been effective in removing petroleum product from the well; however, due to declining thickness of weathered free-product, the Soak Ease® absorbent device was removed from Well ICPP-2018 on August 5, 2013. The well remained dry during the autumn and winter months, but water had reappeared in the well prior to April 2014. At the same time, weathered free-product thickness increased slightly to 0.22 ft. in April 2014, the maximum observed during the reporting period. No weathered free-product was recovered from Well ICPP-2018 during 2014. The declining trend of weathered free-product thickness in Well ICPP-2018 is indicative of continuing hydrocarbon biodegradation. Quarterly well monitoring activities continued throughout 2014, and the monitoring results are reported annually, as required by the corrective action plan, to DEQ.

2.4.5 Underground Storage Tanks (USTs)

Petroleum underground storage tanks (USTs) are regulated under 40 CFR 280. The Idaho DEQ is authorized by EPA, under 40 CFR 281, to regulate USTs within Idaho. To establish a state underground storage tank program, the state of Idaho passed the Idaho Underground Storage Tank Act in 2007. The Act requires DEQ to conduct on-site inspections of petroleum underground storage tank systems at least once every three years to determine compliance. DEQ's UST implementing rules, IDAPA 58.01.07, require that inspections, at a minimum, must assess compliance with notification, corrosion protection, overfill prevention, spill prevention, tank and piping release detection, reporting suspected releases, records of tank and piping repairs, secondary containment, financial responsibility, and temporary closure.

August 25, 2014, DEQ performed the 3-year inspection of the 22 INL-managed USTs. The inspection resulted in 11 informal warnings with no monetary fines. Eight of the informal warnings were related to indicator lights not working on five automatic tank gauge systems that monitor eight USTs across the site. The automatic tank guage systems were fully functional and would provide notice if there was a release, but the indicator lights on the console panel were not working. Two informal warnings were for damaged spill bucket lids, one of which resulted in water in the spill bucket. The final informal warning was for water in a sump. The sump needed a better seal to keep water out.

A summary of the corrective actions for all informal warnings was sent to DEQ December 10, 2014, and DEQ responded back that all issues were resolved and all informal warning enforcement actions were terminated.

October 29, 2014, DEQ performed the 3-year inspection of the three CH2M-WG Idaho, LLC-managed USTs. The inspection included one diesel tank and one unleaded gasoline tank at the Idaho Nuclear Technology and Engineering Center fueling station and one emergency generator diesel tank. No warnings or violations were received.

2.5 Cultural Resources Protection

INL cultural resources are numerous and represent at least 13,000 years of human land use in the region. They include prehistoric archaeological sites such as Aviators Cave, which is listed on the National Register of Historic Places; historic archaeological sites and trails such as Goodale's Cutoff, a northern spur of the Oregon Trail; important historic World War II, post-war and nuclear facilities like Experimental Breeder Reactor I, which was the first reactor in the world to produce usable electrical power and is recognized as a national Historic Landmark; places and resources of importance to the Shoshone-Bannock Tribes; and a myriad of original historical data such as 1949 aerial photographs, as-built engineering and architectural drawings, maps, early technical reports, and oral histories. Protection and preservation of cultural resources under the jurisdiction of federal agencies, including DOE, are mandated by a number of federal laws and their implementing regulations. Primary among them are the:

- National Historic Preservation Act (NHPA) of 1966, as amended – requires federal agencies to establish programs to locate, evaluate, and nominate to the National Register of Historic Places, historic properties under their jurisdiction and to do so in consultation with State Historic Preservation Offices (SHPO), Tribes, and stakeholders and to invite the Advisory Council on Historic Preservation to participate in the consultation. Federal agencies must establish programs to inventory and appropriately manage historic properties located on their lands (Section 110), take into account the effects of their undertakings on them, including mitigation when necessary (Section 106), involve Tribes, SHPOs, the Advisory Council on Historic Preservation (Advisory Council), and stakeholders in decisions; inform and educate the public about the resources, and maintain artifact collections and archival materials at professional standards. The Act also requires that this work and persons who complete this work meet certain professional standards. Implementing regulations are found at 36 CFR Part 800.
- National Environmental Policy Act (NEPA) of 1969, as amended – outlines the federal policy of general environmental protection and requires the use of natural and social sciences in planning and decision-making processes with regard to project impacts on the environment including historical, cultural, and natural resources that are important to national heritage.
- Archaeological Resource Protection Act of 1979, as amended – establishes permit requirements and felony-level penalties for unauthorized excavation, removal, damage, alterations, or defacement of any archaeological resource that is more than 100 years old and that is located on federal or tribal lands. It also fosters increased cooperation and exchange of information between governmental authorities, the professional archaeological community, and private individuals. Implementing regulations are found at 43 CFR Part 7.

- American Indian Religious Freedom Act of 1978 – prompts federal agencies to avoid interfering with access to sacred locations and traditional resources and to consult with interested tribes to aid in the protection and preservation of cultural and spiritual traditions and sites.

Many INL cultural resources remain protected and undisturbed as a result of the area's closure to the general public beginning in 1942, and an active, comprehensive cultural resource management program. Through contract, DOE-ID has tasked Battelle Energy Alliance's Cultural Resource Management Office (CRMO) with implementation of the program.

2.5.1 Compliance with Cultural Resource Management Requirements

The *Idaho National Laboratory Cultural Resource Management Plan* (DOE-ID 2013) was written specifically for INL Site resources. The Plan provides a tailored approach to comply with NHPA, NEPA, Archaeological Resource Protection Act, American Indian Religious Freedom Act, and other federal and state laws and regulations and to implement DOE cultural resource policies and goals while meeting the unique needs of the INL. The Plan is reviewed annually, updated as needed, and is legitimized through a 2004 Programmatic Agreement, *Concerning Management of Cultural Resources on the INL Site* (DOE-ID 2004). The Agreement is between DOE-ID, the Advisory Council, and the Idaho SHPO.

The INL is an active facility where thousands of work orders for projects ranging from lawn care to new facility construction are processed each year. The *INL Cultural Resource Management Plan* (DOE-ID 2013) contains an approach for assessing and, when necessary, mitigating adverse impacts to cultural resources as a consequence of all activities large or small (NHPA Section 106). Under INL procedures, a cultural resource review is prompted whenever ground disturbance or major structural or landscape modifications are proposed. In 2014, 41 projects located at the INL Site and at DOE facilities in Idaho Falls were reviewed for potential impacts to cultural resources. Appendix B provides a summary of the cultural resource reviews performed.

In 2014, 19 cultural resource reviews were completed for INL and ICP projects with potential to cause impacts to archaeological resources. Most of these proposed projects were small in size (1/2 to 10 acres) and included activities like routine maintenance, new monitoring wells, developments along U.S. highway 20/26, highway sign replacements, gravel pit expansion, and waterline installation. Nearly all were located in areas that had been previously surveyed for cultural resources, but per the guidelines of the *INL Cultural Resource Management Plan* (DOE-ID 2013), most were re-surveyed in 2014 because the original surveys were completed more than 10 years ago. Only 9 acres that had never been surveyed for cultural resources were included in the 2014 project areas, including two small projects located at DOE-ID facilities in Idaho Falls. INL CRMO staff made recommendations to avoid previously recorded archaeological resources located near Hwy 20/26 (Figure 2-1) and an INL gravel pit, but no additional archaeological resources were newly identified in or near any of the proposed projects. Cumulatively, the total number of acres surveyed for archaeological resources on the INL Site increased to 55,679 with the addition of these surveys (approximately 10 percent of the 890 square mile laboratory) and the total number of known archaeological resources remained at 2,755.

Cultural resource reviews of projects that had the potential to impact INL historic architectural properties were also completed for 22 proposed activities in 2014 (See Appendix B). Most of these projects involved activities such as routine maintenance, internal equipment repair/replacement, and in kind replacement, which have been determined categorically to pose no significant threats to historic properties. At the Advanced Test Reactor Complex, where the National Register-eligible Advanced Test Reactor is located, 10 projects were reviewed for activities such as in kind roof replacements, repair/replacement of circuit breakers, fire systems, and other equipment, and installation of removable features like LED message boards and cubicle walls. Numerous projects were also proposed at Materials and Fuels Complex facilities, due in part to preparation for re-starting the Transient Reactor Test Facility reactor. Activities included in-kind roof replacements, fire system upgrades and repair, ladder/platform repair and replacement, equipment removal, and other activities categorically exempt from cultural resource concerns under the *INL Cultural Resource Management Plan*. Based on initial consultation conducted in 2013, the largest architectural project review in 2014 involved final plans for demolition of significant World War II era INL structures at Central Facilities Area and the mitigation of adverse effects associated with this footprint reduction. The largest field survey conducted in 2014 was related to the documentation of buildings, structures, and landscape features associated with World War II at the INL Site area. Dur-

Figure 2-1. 12,000-Year-Old Projectile Point Recovered Near Highway 20/26.

ing this time, the area that now forms the core, central portion of the INL Site was used by the U.S. Navy as a Proving Ground for artillery deployed with the Pacific Fleet. Designated as the "Arco Naval Proving Ground," this facility occupied a 271 square mile landscape that included a Residential Area, Proofing Area, Test Range, and post-war conventional ordnance Test Areas. Ordnance ranging in size from 3 inch diameter to 16 inch diameter was tested there, before being shipped back to the war effort. Two Army aerial bombing test ranges were also located adjacent to the Proving Ground. During the post-war period, the U.S. Navy-Army conducted a variety of tests at areas within the Proving Ground to evaluate and revise existing standards for the safe storage and transport of ordnance. Several of the World War II-era structures associated with the Arco Naval Proving Ground have been recognized as "Signature Properties," with DOE complex-wide historical significance for their roles in aiding in the defense and eventual Ally victory in the Pacific Theater of World War II as well as significant contributions to the establishment of national standards for the safe storage and transport of conventional ordnance. Over the decades, the buildings, structures, and landscape elements associated with the Arco Naval Proving Ground have been re-used and re-purposed. Despite an ongoing search for other uses by 2013, most were vacant, exhibiting safety and health concerns (i.e., lead-based paint, asbestos, rodent damage/contamination, mold, minor radiological contamination), and proposed for demolition.

Under guidelines established in the *INL Cultural Resource Management Plan* (DOE-ID 2013), DOE-ID consulted with the Idaho SHPO to agree on measures to mitigate the adverse impacts of demolition. The resulting Memorandum of Agreement between DOE-ID, Idaho SHPO, and the Advisory Council on Historic Preservation includes stipulations for development and installation of interpretive signs to be placed at a publically accessible location (Figure 2-2), retention of original components of building CF-633, and completion of a Historic American Landscape Survey report, part of the U.S. National Park Service Heritage Documentation Program, to mitigate the losses from demolition. In addition to the buildings slated for demolition, buildings, infrastructure, and features that are not scheduled for removal but that contribute to the World War II period of significance for the Arco Naval proving Ground are also being documented in the Historic American Landscape Survey.

Figure 2-2. World War II Interpretive Signs at Big Lost River Rest Area.

Although surveys and assessments, archival research, photographic documentation, mapping and interpretation of the 271 square mile Arco Naval Proving Ground are ongoing in 2015, many unique structural, linear, and landscape elements were identified during initial fieldwork and research in 2014, including:

- ***Structures:*** Military housing, landscaping features, 16 mm gun emplacements, concussion wall, gantry crane, personnel bunkers and equipment shelters for detonation tests, concrete blast walls, bridges, firing range monuments;
- ***Linear elements:*** Roads (East and West Monuments Roads, North Connector Road, Perimeter Lighting Road), railroad tracks, perimeter lighting features;
- ***Landscape elements:*** High altitude bombing ranges, geoglyph bulls eyes, remnants of observation towers and practice sand bombs, ordnance testing areas (Mass Detonation Area, Concrete Test Area, Scale Model Test Igloo Area), 16 mm gun emplacements, craters, residential housing tract.

The results of project-specific cultural resource reviews are documented in a number of ways per the requirements outlined in the *INL Cultural Resource Management Plan* (DOE-ID 2013). Recommendations tailored to specific projects and any cultural resources that may require consideration are delivered in official e-mail notes that become part of the project's NEPA-driven Environmental Checklist and permanent record. For larger projects, technical reports are often prepared to synthesize cultural resource information and recommendations. In 2014, two short technical reports were completed jointly by INL CRMO staff and Bureau of Land Management colleagues to document requirements for the protection or archaeological sites during projects located near U.S. Highway 20/26. Detailed archival, photographic, and field survey documentation of the Arco Naval Proving Ground will be assembled in 2015 to produce a Historic American Landscape Survey report.

Information gathered during INL cultural resource investigations and reviews is managed as a valuable archive of INL cultural resources and a record of decision-making related to cultural resource compliance. These hard copy and electronic data provide the foundation for archaeological predictive modeling efforts that facilitate land use planning in both the long- and short-term and serve important roles in local and regional archaeological research. Important documents related to the historical development of the INL Site, the ground-breaking scientific research conducted throughout INL history, and inventories to identify historic properties associated with these activities are also preserved.

INL cultural resources field investigations in 2014, were also conducted to further DOE-ID obligations under Section 110 of the NHPA to develop a broad understanding of all INL Site cultural resources, not only those located in active project areas. The INL CRMO continued collaboration with researchers from the Center for the Study of the First Americans at Texas A & M University to document archaeological excavations at an important prehistoric campsite (10-BT-676) located on the banks of the Big Lost River. In 2014, samples recovered from the deeply stratified deposits at this site were submitted for radiocarbon dating, resulting in a detailed cultural and geomorphologic chronology documenting human use of the area along the Big Lost River for more than 3,800 years. Analyses of the faunal remains recovered during excavation also revealed that prehistoric inhabitants of the Pioneer site utilized large artiodactyls such as bison and pronghorn as well as smaller species such as rabbit and possibly rodents, remains of which were found with concentrations of fire-cracked rock, suggesting substantial processing and intensive prehistoric camping. A second Section 110 project in 2014 involved ongoing field documentation of prehistoric sites exposed during severe range fires in 2010. One of these sites (10-BT-121) was originally documented in the 1960s and investigations in 2014 included examination of the archival records and artifact collections from this original recording. Volcanic glass artifacts found at this site in 2013 and 2014 (Figure 2-3) were also subject to nondestructive obsidian sourcing analyses, demonstrating clear associations with several regional volcanic glass sources and hinting at population movements and trade during prehistoric times. To enhance this analysis, INL CRMO staff also began the work of documenting the Lemhi Point volcanic glass source and prehistoric quarries located on the INL Site in cooperation with colleagues from Weber State University. All of these activities will continue into 2015. Under INL-wide Stop Work Authorities, INL employees are authorized to stop work at all DOE-ID, contractor, and/or subcontractor operations if they believe the work poses an imminent danger to human health and safety, or the environment, including irreplaceable cultural resources. Procedures are in place to make immediate notifications to appropriate parties (INL CRMO, DOE-ID, Shoshone-Bannock Tribes, State of Idaho, local law enforcement) in the event of any discoveries of this nature. Additionally, areas that have previously revealed unanticipated discoveries of sensitive cultural materials are routinely monitored for new finds. No cultural materials were unexpectedly discovered at the INL Site in 2014.

Figure 2-3. Volcanic Glass Artifacts.

2.5.2 Cultural Resources Monitoring

The INL CRMO conducts yearly cultural resource monitoring that includes many sensitive archaeological, historic architectural, and tribal resources. Under the INL Cultural Resource Management (CRM) monitoring program, there are four possible findings for given monitoring, based on the level of disturbance noted:

Type 1: no visible changes to a cultural resource and/or a project is operating within the limits of cultural resource clearance recommendations.

Type 2: impacts are noted but do not threaten the integrity and National Register eligibility of a cultural resource and/or a project is operating outside of culturally cleared limitations.

Type 3: impacts are noted that threaten the integrity and National Register eligibility of a cultural resource and/or a project has been operating outside of culturally cleared limitations and impacts to cultural resources have occurred.

Type 4: impacts that threaten the integrity and National Register eligibility of a cultural resource are occurring during the monitoring visit, justifying the use of the INL Stop Work Authority.

If Type 2, 3, or 4 impacts are documented during monitoring, notifications are made to project managers, the DOE-ID Cultural Resources Management Coordinator, and various other parties, as appropriate and according to the nature and severity of the disturbance. Typically, Type 2 impacts can be corrected by CRMO personnel or with the cooperation of INL project managers, security personnel, and/or landlord organizations. In these instances, the impacts are only reported in summary fashion in year-end reports. Some Type 2 and all Type 3 or 4 impacts prompt formal investigations initiated by the INL CRMO. INL project managers, security, and/or landlord organizations, DOE-ID, and representatives from the Shoshone-Bannock Heritage Tribal Office (HeTO) may also participate in these investigations.

The INL Cultural Resource Monitoring Plan is contained in Appendix L of the *INL Cultural Resource Management Plan* (DOE-ID 2013). The Monitoring Plan describes the impact types, purpose of monitoring, process of selecting resources to be monitored each year, and how impacts will be documented.

During the reporting year, 25 cultural resource localities were visited and monitored including:

- Two locations with Native American human remains, one of which is a cave
- Two additional caves, one of which is listed on the National Register
- Eight prehistoric archaeological sites
- Six historic archaeological sites
- Two historic trails
- Experimental Breeder Reactor I (EBR-601) National Landmark
- Three Arco Naval Proving Ground Properties (CF-633, CF-642, and CF-651).

Representatives from INL projects, DOE-ID, the Idaho SHPO, and the Shoshone-Bannock Tribe's HeTO participated in several of the trips in 2014. Throughout the year, most of the cultural resources monitored exhibited no adverse impacts, resulting in Type 1 determinations. However, Type 2 impacts were noted at five sites. One of these cases involved an INL project that was found to be operating outside of the area that had been surveyed for cultural resources. In another situation, rodent burrowing was found to have caused minor impacts to two historic archaeological sites. Finally, improper drainage and delayed maintenance were documented as the cause of Type 2 impacts to two properties related to Arco Naval Proving Ground activities during World War II. In all of these cases, although impacts were noted or documentation was made of INL projects operating outside of culturally cleared limitations, cultural resources retained integrity and noted impacts did not threaten National Register eligibility. On two occasions in 2014, Type 3 impacts were documented as a result of project activities in areas that had not been adequately assessed for potential impacts to cultural resources. Per INL work control requirements, work was stopped at these projects as soon as impacts were discovered and project personnel cooperated with INL CRMO, INL landlord and environmental organization, and DOE personnel during formal investigations of the damage to cultural resources. Although impacts were documented to four archaeological sites, two of these resources were originally evaluated as ineligible for nomination to the National Register of Historic Places and impacts to two archaeological sites that are potentially eligible for the National Register of Historic Places were determined to be not adverse, with significant undisturbed cultural deposits remaining outside the disturbed areas. No new Type 4 impacts that adversely impacted significant cultural resources and threatened National Register eligibility were observed in 2014.

In an effort to address the unauthorized project activities in unsurveyed areas, the INL CRMO initiated a broad program of archaeological sensitivity training in 2014, meeting with INL employees and subcontractors to highlight the importance of cultural resource reviews for all activities conducted outside INL facility fences. Outreach and cooperation also continued throughout 2014 with INL Security personnel to combat unauthorized artifact collection and cave visitation on the INL Site. Results of all monitoring and formal impact investigations are summarized annually in a year-end report to DOE-ID that is completed each year at the end of October. The results of 2014 cultural resource monitoring are documented in the Idaho National Laboratory Cultural Resource Monitoring Report for Fiscal Year 2014 (DOE-ID 2014b).

2.5.3 Stakeholder, Tribal, Public, and Professional Outreach

Outreach and education are important elements in the INL CRM program and efforts are routinely oriented toward the general public, INL employees, important stakeholders such as the Idaho SHPO, Shoshone-Bannock Tribes, and cultural resource professionals. Tools that facilitate communication include activity reports, presentations, newspaper articles and interviews, periodic tours, regular meetings with Tribal representatives, and various INL-specific internal and external media outlets. Educational exhibits at the Experimental Breeder Reactor I Visitor's Center (a National Historic Landmark) and the Big Lost River Rest Area on U.S. Highway 20/26 are also important public outreach tools. Several legal drivers mandate these efforts, including a 2012 Memorandum of Understanding between the DOE, the Departments of Defense, Interior, and Agriculture, and the national Advisory Council on Historic Preservation to improve the protection of Indian sacred sites along with tribal access to those sites through enhanced interdepartmental coordination and collaboration.

The INL Site is located on the aboriginal territory of the Shoshone and Bannock people. The Shoshone-Bannock Tribes have a government-to-government relationship with DOE-ID that is strengthened and maintained through an Agreement-in-Principle (AIP) (revised and signed in December 2012) between the Tribes and the DOE-ID (DOE-ID 2012). The AIP defines working relationships between the Shoshone-Bannock Tribes and DOE-ID and fosters a mutual understanding and commitment to addressing a variety of tribal concerns regarding protection of health, safety, and environment, including cultural resources of importance to the Tribes.

To aid with implementing cultural resource aspects of the AIP, a Cultural Resources Working Group comprised of representatives from the Shoshone-Bannock's HeTO, DOE-ID, and the INL CRMO was established in 1993. It was the first of its kind within the DOE complex and its regular Cultural Resources Working Group meetings enable issues and opportunities to be addressed in an environment of mutual respect and learning. Tribal input is sought for new and ongoing projects and a standing invitation is extended to comment on, visit, observe, and/or assist in INL CRMO field activities. The holistic view of cultural resources and cooperative spirit encouraged in this group foster an atmosphere of mutual respect that is conducive to open communication and effective consideration of tribal views in decisions regarding INL cultural resources and overall land management.

REFERENCES

10 CFR 1021, 2014, "National Environmental Policy Act Implementing Procedures," *Code of Federal Regulations*, Office of the Federal Register.

10 CFR 1022, 2014, "Compliance with Floodplain and Wetland Environmental Review Requirements," *Code of Federal Regulations*, Office of the Federal Register.

36 CFR 800, 2014, "Protection of Historic Properties," Office of the Federal Register.

40 CFR 61, Subpart H, 2014, "National Emission Standards for Emissions of Radionuclides Other Than Radon from Department of Energy Facilities," *Code of Federal Regulations*, Office of the Federal Register.

40 CFR 280, 2014, "Technical Standards and Corrective Action Requirements for Owners and Operators of Underground Storage Tanks (UST)", Office of the Federal Register.

40 CFR 1500, 2014, "National Environmental Policy Act (NEPA), Purpose, Policy, and Mandate," *Code of Federal Regulations*, Office of the Federal Register.

43 CFR 7, 2014, "Protection of Archaeological Resources," Office of the Federal Register.

Bureau of Reclamation, 2005, *Big Lost River Flood Hazard Study*, Idaho National Laboratory, Idaho, Report 2005-2.

DEQ, 1995, *Federal Facility Compliance Act Consent Order and Site Treatment Plan*, (transmittal letter and signed enclosure from Curt Fransen, Idaho Deputy Attorney General, to Brett R. Bowhan, U.S. Department of Energy Idaho Operations Office), Idaho Division of Environmental Quality.

DOE, 1991, *Idaho National Engineering Laboratory ("INEL") Federal Facility Agreement and Consent Order*, Administrative Docket Number: 1088-06-120, U.S. Department of Energy, Office of Environmental Management; U.S. Environmental Protection Agency, Region 10; State of Idaho, Department of Health and Welfare.

DOE, 1995, *1995 Settlement Agreement*, U.S. Department of Energy, U.S. Department of the Navy, and State of Idaho.

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

DOE Order 436.1, 2011, "Departmental Sustainability," U.S. Department of Energy.

DOE Order 451.1B, 2001, "National Environmental Policy Act Compliance Program," Change 1, U.S. Department of Energy.

DOE Order 458.1, 2011, "Radiation Protection of the Public and the Environment," U.S. Department of Energy.

DOE-ID, 2004, Programmatic Agreement between the Department of Energy Idaho Operations Office, the Idaho State Historic Preservation Office, and the Advisory Council on Historic Preservation Concerning Management of Cultural Resources on the Idaho National Engineering and Environmental Laboratory, signed by U.S. Department of Energy Idaho Operations Office, Idaho State Historic Preservation Office, Advisory Council on Historic Preservation.

DOE-ID, 2012, Agreement-in-Principle (between the Shoshone-Bannock Tribes and the U.S. Department of Energy), December 2012.

DOE-ID, 2013, *Idaho National Laboratory Cultural Resource Management Plan*, DOE/ID-10997, Rev 5, February 2013.

DOE-ID, 2014a, *INL Site Sustainability Plan with the FY-2014 Annual Report*, DOE/ID-11383, U.S. Department of Energy Idaho Operations Office, December 2014.

DOE-ID, 2014b, *INL Cultural Resource Monitoring Report for FY 2014*, INL/EXT-14-33563, October 2014.

DOE-ID, 2015, *National Emission Standards for Hazardous Air Pollutants-Calendar Year 2014 INL Report for Radionuclides*, DOE/ID-11441(14), U.S. Department of Energy Idaho Operations Office, June 2015.

DOE-STD-1196-2011, Derived Concentration Technical Standard, U.S. Department of Energy, April 2011.

Executive Order 11988, 1977, "Floodplain Management."

Executive Order 11990, 1977, "Protection of Wetlands."

Executive Order 13423, 2007, "Strengthening Federal Environmental, Energy, and Transportation Management."

Executive Order 13514, 2009, "Federal Leadership in Environmental, Energy, and Economic Performance."

ICP, 2014, *2014 Annual Summary Report Corrective Action/Monitoring Plan for Petroleum, Report-1300, Release Associated with Well ICPP-2018*, Idaho Cleanup Project.

IDAPA 58.01.02, 2014, "Water Quality Standards," Idaho Administrative Procedures Act.

IDAPA 58.01.07, 2014, "Rules Regulating Underground Storage Tank Systems," Idaho Administrative Procedures Act.

IDAPA 58.01.08, 2014, "Idaho Rules for Drinking Water System," Idaho Administrative Act.

IDAPA 58.01.11, 2014, "Ground Water Quality Rule," Idaho Administrative Procedures Act.

IDAPA 58.01.16, 2014, "Wastewater Rules," Idaho Administrative Procedures Act.

IDAPA 58.01.17, 2014, "Recycled Water Rules," Idaho Administrative Procedures Act.

International Commission on Radiological Protection (ICRP), 2002, *Basic Anatomical and Physiological Data for Use in Radiological Protection*, ICRP Publication 89, Pergamon Press, Oxford.

International Commission on Radiological Protection (ICRP), 2008, *Nuclear Decay Data for Dosimetric Calculations*, ICRP Publication 107, Pergamon Press, Oxford.

USGS, 1997, *Simulation of Water-Surface Elevations for a Hypothetical 100-Year Peak Flow in Birch Creek at the Idaho National Engineering and Environmental Laboratory, Idaho, U.S. Geological Survey Water-Resources Investigations Report 97-4083*, DOE/ID-22138, U.S. Geological Survey.

Hoary Aster
Machaeranthera canescens

3. Environmental Program Information

Franklin's Sandwort
Arenaria franklinii

Environmental monitoring programs at the Idaho National Laboratory (INL) Site involve sampling environmental media, including ambient air; drinking water, surface water, and groundwater; soils; vegetation; agricultural products and wildlife; and measuring direct radiation. Thousands of samples were collected and analyzed in 2014 for a wide array of constituents, including pH, inorganics, volatile organics, gases, gross alpha and beta activity, and specific radionuclides, such as tritium, strontium, americium, and plutonium isotopes. The technical basis for environmental monitoring and surveillance performed at the INL Site was documented in 2014.

Environmental restoration at the INL Site continues. Remediation of four of ten Waste Areas Groups (WAGs) established under the Federal Facility Agreement and Consent Order has been completed. Cleanup activities conducted at the remaining WAGs include some perched water and groundwater cleanup as well as retrieval of targeted wastes (such as transuranic waste) at the Radioactive Waste Management Complex.

Management and disposal of radioactive wastes produced at the INL Site are conducted to ensure safe operations and to meet commitments of the Idaho Settlement Agreement and the 2014 INL Site Treatment Plan.

Contractors in charge of nuclear energy and cleanup operations at the INL Site had environmental management systems in place that were compliant with Department of Energy Order 436.1 ("Departmental Sustainability") requirements in 2014. These systems are managed to reduce energy and petroleum use, conserve water, reduce emissions of greenhouse gases, and prevent or minimize pollution by the INL Site.

Other major environmental programs and activities at the INL Site include decontamination and decommissioning activities, management of spent nuclear fuel, the INL Oversight Program maintained by the state of Idaho, and the Citizens Advisory Board.

3. ENVIRONMENTAL PROGRAM INFORMATION

This chapter highlights the Idaho National Laboratory (INL) Site environmental programs that help maintain compliance with major acts, agreements, and orders. Much of the regulatory compliance activity is performed through the various environmental monitoring programs (Section 3.1), environmental restoration (Section 3.2), waste management and disposition (Section 3.3), and the Environmental Management System (EMS) (Section 3.4). Section 3.5 summarizes other significant INL Site environmental programs and activities.

3.1 Environmental Monitoring Programs

Facility effluents and environmental media are monitored for radioactive and nonradioactive constituents to ensure INL Site operations protect human health and the environment and comply with applicable environmental protection laws, regulations, and permits. INL Site environmental monitoring consists of effluent monitoring and environmental surveillance, which are defined as follows:

- Effluent monitoring is the collection and analysis of samples or measurements of liquid and gaseous effluents for the purpose of:
  - Characterizing and quantifying contaminants
  - Assessing radiation exposure of members of the public
  - Providing a means to control effluents at or near the point of discharge
  - Demonstrating compliance with applicable standards and permit requirements.
- Environmental surveillance is the measurement of contaminants in the environment to assess any potential incremental effects that INL Site operations may have on human health and the environment. Routine surveillance of all exposure pathways (Figure 3-1) is performed on specific environmental media (air, water, agricultural products, animal tissue, soil, and direct radiation).

At the INL Site, several organizations conduct environmental monitoring:

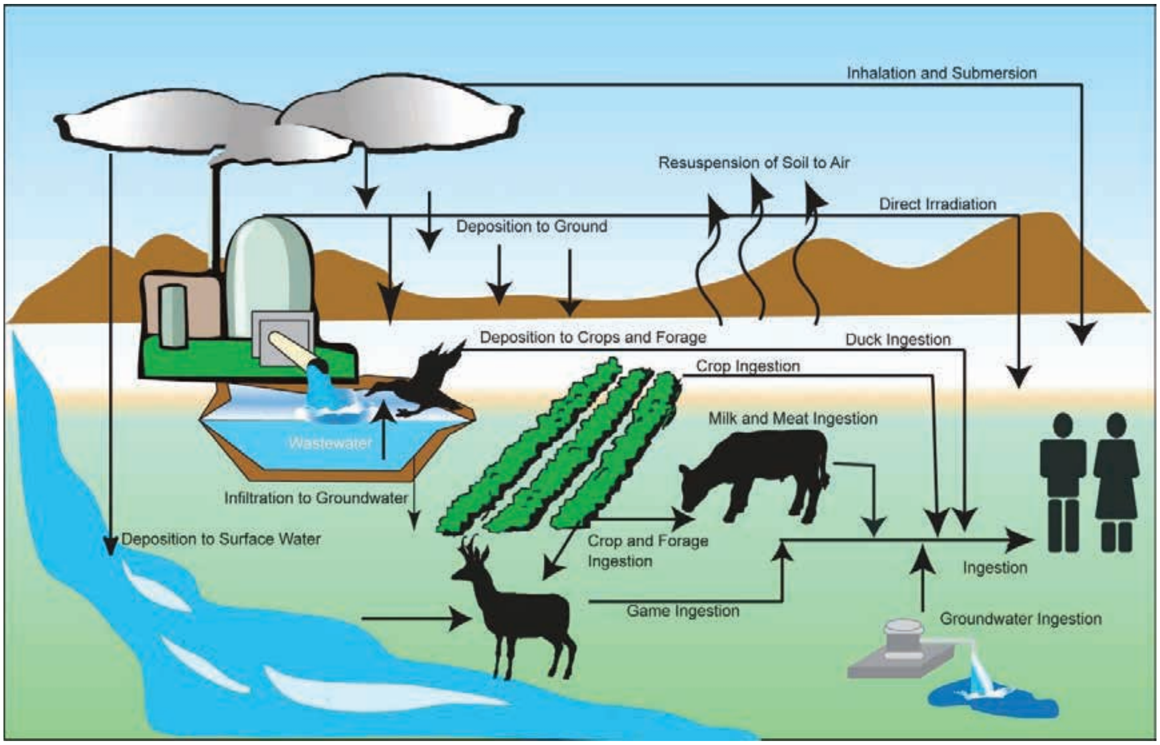


Figure 3-1. Potential Exposure Pathways to Humans from the INL Site.

- The INL contractor (Battelle Energy Alliance, LLC [BEA]) and the Idaho Cleanup Project (ICP) contractor (CH2M-WG Idaho, LLC [CWI]) perform monitoring activities on the INL Site.
- The Environmental Surveillance, Education, and Research (ESER) contractor, Gonzales-Stoller Surveillance, LLC (GSS), performs monitoring activities off the INL Site.
- Two federal agencies also perform monitoring activities on and around the INL Site under interagency agreements with the Department of Energy, Idaho Operations Office (DOE-ID). The National Oceanic and Atmospheric Administration conducts meteorological monitoring and research, and the U.S. Geological Survey (USGS) conducts groundwater monitoring and research.

Tables 3-1 through 3-6 present a summary of the environmental surveillance programs conducted by the ESER, INL and ICP contractors, and the USGS in 2014. In addition to the monitoring constituents listed in Table 3-6, the USGS collected samples twice a year from nine wells in cooperation with the Naval Reactors Facility (NRF), and collected a list of constituents from 11 multi-depth sampling wells. The constituents collected during 2014 for the multi-depth wells were tritium; gross alpha, gross beta and gamma radioactivity; chloride; sodium; chromium; sulfate; and nutrients. These data are available from the USGS by request. For a more detailed description of INL Site monitoring activities, see the Idaho National Laboratory Site Environmental Monitoring Plan (DOE-ID 2014a).

Results of the environmental monitoring programs for 2014 are presented in Chapter 4 (air), Chapter 5 (compliance monitoring for liquid effluents, groundwater, drinking water, and surface water), Chapter 6 (eastern Snake River Plain aquifer), and Chapter 7 (agricultural, wildlife, soil, and direct radiation). Chapter 8 discusses radiological doses to humans and biota. Chapter 9 summarizes wildlife population monitoring at the INL Site, and Chapter 10 presents abstracts of ecological and USGS. Quality assurance activities of the various organizations conducting environmental monitoring are described in Chapter 11. A summary of historical environmental monitoring activities, meteorological monitoring, and statistical methods used in this report are provided as supplemental reports.

Table 3-1. Environmental Surveillance, Education, and Research Program Summary (2014).

Medium Sampled	Type of Analysis	Locations and Frequency: Onsite	Locations and Frequency: Offsite	Minimum Detectable Concentration
Air (low volume)	Gross alpha	4 weekly[a]	14 weekly[a]	1 x 10^{-15} µCi/mL
	Gross beta	4 weekly	14 weekly	2 x 10^{-15} µCi/mL
	Specific gamma[b]	4 quarterly	14 quarterly	2 x 10^{-16} µCi/mL
	Plutonium-238	2 quarterly	5-6 quarterly	3.5 x 10^{-18} µCi/mL
	Plutonium-239/240	2 quarterly	5-6 quarterly	3.5 x 10^{-18} µCi/mL
	Americium-241	2 quarterly	5-6 quarterly	4.6 x 10^{-18} µCi/mL
	Strontium-90	2 quarterly	5-6 quarterly	3.4 x 10^{-17} µCi/mL
	Iodine-131	4 weekly	14 weekly	1.5 x 10^{-15} µCi/mL
	Total particulates	4 quarterly	14 quarterly	10 µg/m^3
Air (high volume)[c]	Gross beta	None	1, twice per week	1 x 10^{-15} µCi/mL
	Gamma scan	None	If gross β > 1 pCi/m^3	1 x 10^{-14} µCi/mL
	Isotopic U and Pu	None	1 annually	2 x 10^{-18} µCi/mL
Air (atmospheric moisture)	Tritium	None	4 locations, 3 - 6 per quarter	2 x 10^{-13} µCi/mL (air)
Air (precipitation)	Tritium	1 weekly/ 1 monthly[d]	1 monthly	100 pCi/L
Animal tissue (big game and waterfowl)[e]	Specific gamma	Varies annually	Varies annually	8 x 10^{-9} µCi/g
	Iodine-131	Varies annually	Varies annually	9 x 10^{-2} µCi/g
Alfalfa	Specific gamma	None	1 annually	0.1 pCi/g
	Strontium-90	None	1 annually	0.02 pCi/g
Agricultural products (milk)	Cesium-137	None	1 weekly	1 pCi/L
	Iodine-131	None	1 weekly/9 monthly	1 pCi/L
	Strontium-90	None	9 semiannually	0.2 pCi/L
	Tritium	None	9 semiannually	100 pCi/L
Agricultural products (potatoes)	Specific gamma	None	8 –10 annually	0.1 pCi/g
	Strontium-90	None	8 –10 annually	0.02 pCi/g
Agricultural products (grain)	Specific gamma	None	10 –12 annually	0.1 pCi/g
	Strontium-90	None	10 –12 annually	0.02 pCi/g
Agricultural products (lettuce)	Specific gamma	1 annually	7 – 9 annually	0.1 pCi/g
	Strontium-90	1 annually	7 – 9 annually	0.2 pCi/g
Drinking Water[f]	Gross alpha	None	9-10 semiannually	3 pCi/L
	Gross beta	None	9-10 semiannually	2 pCi/L
	Tritium	None	9-10 semiannually	100 pCi/L
Surface Water[g]	Gross alpha	6 annually	4 semiannually	3 pCi/L
	Gross beta	6 annually	4 semiannually	2 pCi/L
	Tritium	6 annually	4 semiannually	100 pCi/L
Soil	Specific gamma	None	14 biennially[h]	0.001 pCi/g
	Plutonium-238	None	14 biennially	0.01 pCi/g
	Plutonium-239/240	None	14 biennially	0.01 pCi/g

Table 3-1. Environmental Surveillance, Education, and Research Program Summary (2014). (cont.)

Medium Sampled	Type of Analysis	Locations and Frequency		Minimum Detectable Concentration
		Onsite	Offsite	
	Americium-241	None	14 biennially	0.03 pCi/g
	Strontium-90	None	14 biennially	0.1 pCi/g
Direct radiation exposure (thermoluminescent dosimeters and optically stimulated luminescence dosimeters)	Ionizing radiation	None	17 semiannually	5 mR

a. Onsite includes three locations and a duplicate sampler at one location; off INL Site includes 13 locations and a duplicate sampler at one location.
b. The minimum detectable concentration shown is for Cesium-137.
c. Filters are collected by Environmental Surveillance, Education, and Research personnel for the Environmental Protection Agency (EPA) RadNet program and sent to the EPA for analysis. Data are reported by the Environmental Protection Agency's RadNet at http://www.epa.gov/narel/radnet/.
d. A portion of the monthly sample collected at Idaho Falls is sent to the Environmental Protection Agency for analysis, and data are reported by RadNet.
e. Only big game animals (pronghorn, elk, or mule deer) that are victims of road kills or natural causes are sampled on the INL Site. No big game animal controls are collected. Waterfowl are usually collected on ponds within the Advanced Test Reactor Complex, Materials and Fuels Complex, and control areas.
f. Samples are co-located with the state of Idaho Department of Environmental Quality (DEQ) INL Oversight Program at Shoshone and Minidoka water supplies. An upgradient sample is collected at Mud Lake Well #2. The number of samples includes a duplicate sample.
g. Onsite locations are the Big Lost River (if running) at the public rest stop on Highway 20/26, at two locations along Lincoln Boulevard, at EFS, and at the Big Lost River Sinks. A duplicate sample is also collected on the Big Lost River. Offsite samples are co-located with the DEQ INL Oversight Program at Alpheus Spring, Clear Springs, and at a fish hatchery at Hagerman. A duplicate sample is also collected at one location.
h. A duplicate sample is also collected at one location.

3.1.1 Sitewide Monitoring Committees

Sitewide monitoring committees include the INL Site Monitoring and Surveillance Committee and the INL Site Water Committee. The INL Site Monitoring and Surveillance Committee was formed in March 1997 and meets every other month or as needed to coordinate activities among groups involved in environmental monitoring on and off the INL Site. This standing committee includes representatives of DOE-ID, INL Site contractors, the ESER contractor, Shoshone-Bannock Tribes, the state of Idaho INL Oversight Program, the National Oceanic and Atmospheric Administration, NRF, and USGS. The INL Site Monitoring and Surveillance Committee has served as a valuable forum to review monitoring, analytical, and quality assurance methodologies; to coordinate efforts; and to avoid unnecessary duplication.

The INL Site Water Committee was established in 1994 to coordinate drinking-water-related activities across the INL Site and to provide a forum for exchanging information related to drinking water systems. In 2007, the INL Site Water Committee expanded to include all site-wide water programs: drinking water, wastewater, storm water, and groundwater. The committee includes monitoring personnel, operators, scientists, engineers, management, data entry, and validation representatives of the DOE-ID, INL Site contractors, USGS and NRF, and serves as a forum for coordinating water-related activities across the INL Site and exchanging technical information, expertise, regulatory issues, data, and training.

The INL Site Water Committee interacts on occasion with other committees that focus on water-related topics or programs, such as the INL Site Monitoring and Surveillance Committee.

3.1.2 DOE Headquarters Independent Assessment

In 2010, at DOE-ID's request, the Department of Energy (DOE) Headquarters Office of Independent Oversight within the Office of Health, Safety, and Security conducted an independent assessment of the INL Site en-

Table 3-2. INL Contractor Air and Environmental Radiation Surveillance Summary (2014).

Medium Sampled	Type of Analysis	Locations and Frequency		Detectable Concentration
		Onsite	Offsite	
Air (low volume)[a]	Gross alpha	18 weekly	5 weekly	1×10^{-15} µCi/mL
	Gross beta	18 weekly	5 weekly	5×10^{-15} µCi/mL
	Specific gamma	18 quarterly	5 quarterly	Varies by analyte[b]
	Iodine-131	18 weekly	5 weekly	2×10^{-15} µCi/mL
Air (atmospheric moisture)	Tritium	2 to 4 per quarter	2 to 4 per quarter	1×10^{-11} µCi/mL (water)
Soil	In situ gamma	Varies annually	None	Varies by analyte
Direct radiation exposure (optically stimulated luminescence dosimeters)	Ionizing radiation	74 semiannually	13 semiannually	5 mrem
Neutron radiation exposure[c]	Neutron radiation	5 semiannually	1 semiannually	10 mrem
Direct radiation exposure (mobile radiation surveys)	Gamma radiation	Facilities and INL Site roads[b]	Not collected	Not applicable

a. Low volume air sampling locations onsite include ARA, ATR Complex, CFA, CITRC, EBR-I, Gate 4, INTEC, PBF, RWMC, SMC, MFC, EFS, Highway 26 Rest Area, Van Buren and two duplicate locations. Locations offsite (i.e, outside INL Site boundaries) include Blackfoot, Craters of the Moon, Idaho Falls, IRC, and Sugar City. A blank also is analyzed. (ARA = Auxiliary Reactor Area; ATR = Advanced Test Reactor; CFA = Central Facilities Area; CITR = Critical Infrastructure Test Range Complex; EBR-I = Experimental Breeder Reactor-1; PBF = Power Burst Facility; RWMC = Radioactive Waste Management Complex; SMC = Specific Manufacturing Capability; MFC = Materials and Fuels Complex; EFS = Experimental Field Station).

b. The perimeter at each INL Site facility and an area outside the northeast corner of INTEC are surveyed each year.

c. Neutron radiation sampling locations onsite (i.e., within the Research and Education Campus boundaries) include IF-638 Physics Lab and IF-675 PINS. The offsite location is Idaho Falls O-10.

Table 3-3. INL Contractor Drinking Water Program Summary (2014).

Type of Analysis	Frequency (onsite)	Maximum Contaminant Level
Gross alpha	9 semiannually	15 pCi/L
Gross beta	9 semiannually	4 mrem/yr
Tritium	11 annually, 9 semiannually	20,000 pCi/L
Iodine-129	1 semiannually	1 pCi/L
Parameters required by the state of Idaho under authority of the Safe Drinking Water Act	9 triennally	Varies
Nitrate	9 annually	10 mg/L (as nitrogen)
Microbes	13 quarterly 12 monthly 1 monthly during summer	If <40 samples/ month, no more than one positive for total coliform
Volatile organic compounds	2 semiannually	Varies

Table 3-4. Idaho Cleanup Project Contractor Environmental Surveillance Program Air, Surface Water, Vegetation, and Radiation Survey Summary (2014).

Medium Sampled	Type of Analysis	Location and Frequency		Minimum Detectable Concentration[c]
		RWMC[a]	INTEC[b]	
Air (low volume)	Gross alpha	8 bimonthly	1 bimonthly	7 x 10^{-13} µCi/mL
	Gross beta	8 bimonthly	1 bimonthly	2 x 10^{-12} µCi/mL
	Specific gamma	8 monthly	1 monthly	Varies by analyte
	Specific alpha	8 quarterly	1 quarterly	8 x 10^{-18} µCi/mL
	Strontium-90	8 quarterly	1 quarterly	1 x 10^{-16} µCi/mL
Surface water runoff	Specific gamma	1 quarterly	None	Varies by analyte
	Plutonium isotopes	1 quarterly	None	0.02 pCi/L
	Uranium-233/234	1 quarterly	None	0.06 pCi/L
	Uranium-235	1 quarterly	None	0.04 pCi/L
	Uranium-238	1 quarterly	None	0.04 pCi/L
	Americium-241	1 quarterly	None	0.02 pCi/L
	Strontium-90	1 quarterly	None	0.3 pCi/L
Mobile radiation surveys	Gamma radiation	1 annually	None	Not applicable

a. RWMC = Radioactive Waste Management Complex.
b. INTEC = Idaho Nuclear Technology and Engineering Center.
c. Detection limits vary with each laboratory analysis, but approximate values are provided.

Table 3-5. Idaho Cleanup Project Contractor Drinking Water Program Summary (2014).

Type of Analysis	Frequency (onsite)	Maximum Contaminant Level
Copper	20 every three years	1.3 mg/L (action level)
Gross alpha	2 semiannually	15 pCi/L
Gross beta	2 semiannually	4 mrem/yr
Haloacetic acids	3 annually	0.06 mg/L
Lead	20 every three years	0.015 mg/L (action level)
Microbes	6 to 8 monthly	If <40 samples/month, no more than one positive for total coliform
Nitrate	2 annually	10 mg/L (as nitrogen)
Strontium-90	1 annually	8 pCi/L
Total trihalomethanes	3 annually	0.08 mg/L
Tritium	1 annually	20,000 pCi/L
Volatile organic compounds	2 quarterly	Varies

Table 3-6. U.S. Geological Survey Monitoring Program Summary (2014).

Constituent	Groundwater		Surface Water		Minimum Detectable Concentration or activity
	Number of Sites[a]	Number of Samples	Number of Sites	Number of Samples	
Gross alpha	49	48	4	1	1.5 pCi/L
Gross beta	49	48	4	1	3.4 pCi/L
Tritium	142	138	7	4	200 pCi/L
Gamma-ray spectroscopy	88	85	4	1	—[b]
Strontium-90	90	87	—[c]	—	2 pCi/L
Americium-241	22	21	—[c]	—	0.03 pCi/L
Plutonium isotopes	22	21	—[c]	—	0.02 pCi/L
Iodine-129	0	0	—[c]	—	<1aCi/L
Specific conductance	142	138	7	5	Not applicable
Sodium ion	136	132	—[c]	—	0.1 mg/L
Chloride ion	142	138	7	4	0.1 mg/L
Nitrates (as nitrogen)	114	111	—[c]	—	0.05 mg/L
Fluoride	4	4	—[c]	—	0.1 mg/L
Sulfate	123	119	—[c]	—	0.1 mg/L
Chromium (dissolved)	73	70	—[c]	—	0.005 mg/L
Purgeable organic compounds[d]	26	37	—[c]	—	Varies
Trace elements	10	10	—[c]	—	Varies

a. Number of samples does not include 11 replicates and 5 blanks collected in 2014. Number of samples was different than the number of sites because one site for VOCs is sampled monthly, and several sites had pump problems and were not sampled, or in the case of surface water in the Big Lost River, three sites were dry. Number of sites does not include 24 zones from 11 wells sampled as part of the multi-level monitoring program.

b. Minimum detectable concentration for gamma spectroscopic analyses varies depending on radionuclide.

c. No surface water samples collected for this constituent.

d. Each purgeable organic compound water sample is analyzed for 61 purgeable organic compounds.

vironmental monitoring program (HSS 2010). The scope for the assessment included:

- Review of INL Site environmental monitoring activities to ensure that the sitewide environmental monitoring program as a whole is comprehensive and meets the objectives of DOE Order 450.1A (DOE 2008a), Sections 4(c)(2)(a-d), which address protection of public health and the environment for specific media, and (c)(5-6), which address monitoring and meeting data quality objectives
- Review of the INL (BEA), ICP (CWI), and ESER (GSS) contractor environmental monitoring activities to ensure compliance with the requirements of DOE Order 450.1A, Sections 4(c)(2) (a-d) and (c)(5-6) and DOE Order 5400.5 (DOE 2008b) for their contract responsibilities
- Determination of whether current monitoring activities meet selected stakeholder (Idaho Department of Fish and Game, state of Idaho, INL Oversight) expectations

- Review of the effectiveness of communication and timely access to monitoring data between site contractors and with DOE-ID on monitoring activities
- Review of the effectiveness of INL self-assessments of environmental monitoring activities
- Confirmation of the effectiveness of data storage and access, including foreseeable technological issues related to data storage, retrievability, and contractor planning to address such issues
- Confirmation that data quality objectives are appropriate and are being met
- Determination of whether monitoring is adequate for the expanding research and development activities of INL in the city of Idaho Falls
- Review of the INL Site Annual Site Environmental Report production process to ensure that the information reported is comprehensive, technically sound, written in a manner that is understandable to the public and site stakeholders, and that appropriate efforts are being made to ensure the quality and defensibility of data reported.

The Office of Health, Safety, and Security Assessment Team issued a final report detailing positive attributes of the existing program and recommended program enhancements. Recommended program enhancements have been developed and are ongoing. The full Assessment Report is available at http://energy.gov/iea/downloads/independent-oversightassessment-idaho-national-laboratory-site-may-2010. In response to an overarching recommended program enhancement, the *Technical Basis for Environmental Monitoring and Surveillance at the Idaho National Laboratory Site* (DOE-ID 2014b) was issued in 2014.

3.2 Environmental Restoration

Environmental restoration at the INL Site is conducted under the Federal Facility Agreement and Consent Order (FFA/CO) (DOE 1991). The FFA/CO outlines how the INL Site will comply with the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA). It sets up a process for DOE-ID to work with its regulatory agencies to safely execute cleanup of past release sites at the INL Site.

The INL Site is divided into ten waste area groups (WAGs) (Figure 3-2) as a result of the FFA/CO, and each WAG is further divided into smaller cleanup areas called operable units. Field investigations are used to evaluate potential release sites within each WAG and operable unit when existing data are insufficient to determine the extent and nature of contamination. After each investigation is completed, a determination is made whether a “No Action” or “No Further Action” listing is possible, or if it is appropriate to proceed with an interim cleanup action, the Operable Unit-10-08 Plug-In Remedy action, or further investigation using a remedial investigation/feasibility study. The remedial investigation/feasibility study is used to determine the nature and extent of the problem presented by the past release of contamination and to develop and evaluate options for remedial action. Results from the remedial investigation/feasibility study form the basis for risk assessments and alternative cleanup actions. This information, along with the regulatory agencies’ proposed cleanup plan, is presented to the public in a document called a proposed plan. Proposed plans present cleanup alternatives and recommend a preferred cleanup alternative to the public. After consideration of public comments, DOE, the Environmental Protection Agency, and the state of Idaho develop a record of decision (ROD) selecting a cleanup approach from the alternatives evaluated. Cleanup activities then can be designed, implemented, and completed.

Since the FFA/CO was signed in December 1991, the INL Site has cleaned up release sites containing asbestos, petroleum products, acids and bases, radionuclides, unexploded ordnance and explosive residues, polychlorinated biphenyls, heavy metals, and other hazardous materials. All twenty-four RODs that were scheduled have been signed and are being implemented. Comprehensive remedial investigation/feasibility studies have been completed for WAGs 1, 2, 3, 4, 5, 7, 8, 9, and 6/10 (6 is combined with 10). Closeout activities at WAGs 1 (excluding Operable Unit 1-07B), 2, 4, 5, and 8 have been completed. The WAG 10, Operable Unit 10-08 ROD (Sitewide Groundwater, Miscellaneous Sites and Future Sites [DOE-ID 2009]) was the last ROD and was finalized in September 2009.

Documentation associated with the FFA/CO is publicly available in the CERCLA Administrative Record and can be accessed at http://ar.inel.gov/. The location of each WAG is shown in Figure 3-2. Cleanup progress for each WAG is summarized in the following subsections.

3.2.1 Waste Area Group 1 – Test Area North

Groundwater cleanup for Operable Unit 1-07B continued throughout 2014. The New Pump and Treat

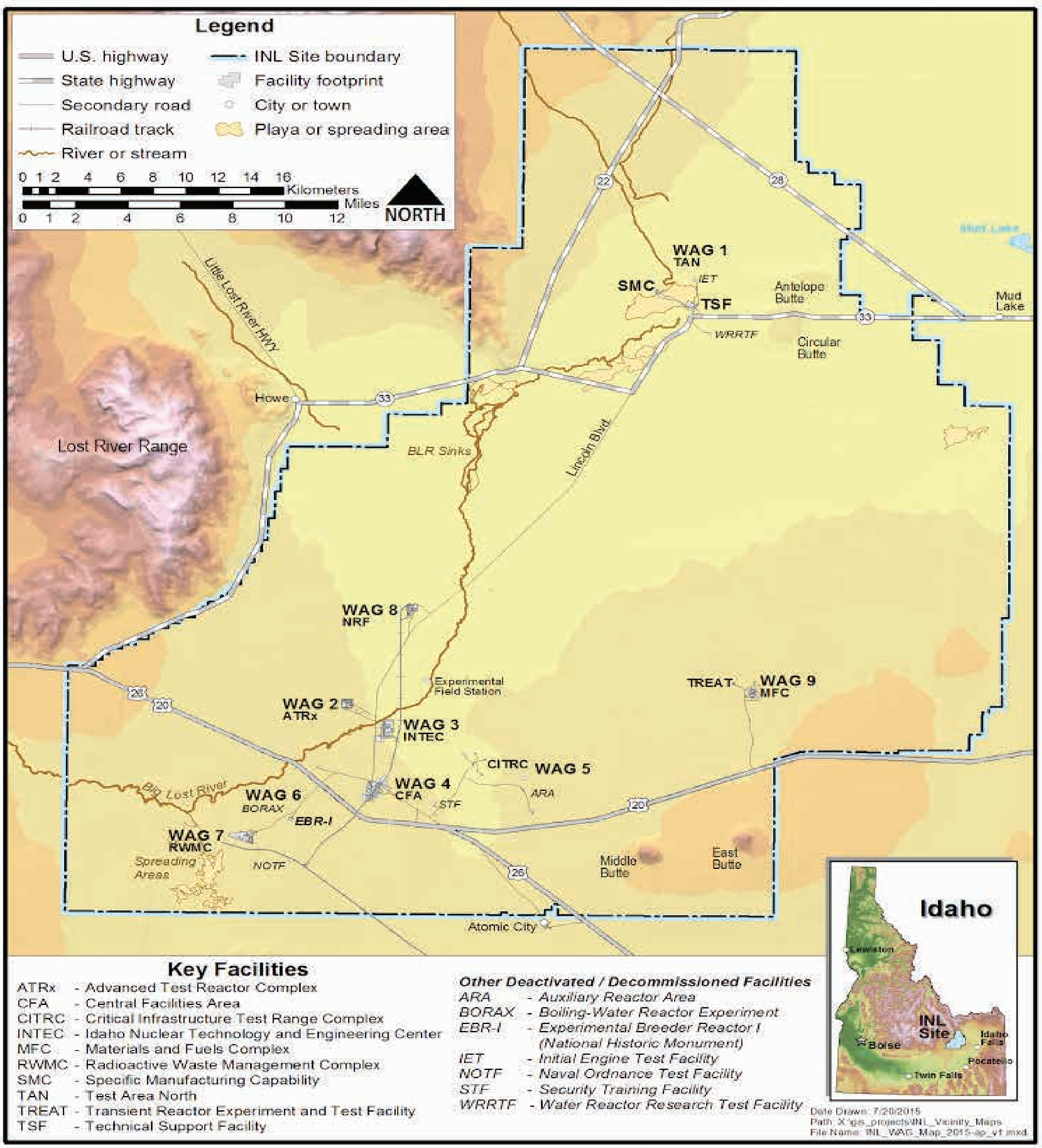


Figure 3-2. Map of the INL Site Showing Facilities and Corresponding WAGs.

Facility generally operated four days per week, except for downtime due to maintenance, to maintain trichloroethylene concentrations in the medial zone below specified targets. The in situ bioremediation transitioned into a rebound test in 2012 to determine the effectiveness of the remedy to date. The rebound test continued through 2014. The test plan will be revised in 2015 to establish how the groundwater cleanup at Test Area North will continue. All institutional controls were maintained in 2014.

3.2.2 Waste Area Group 2 – Advanced Test Reactor Complex

All active remediation in WAG 2 is complete. Some elements of the remedy, including monitoring perched water and groundwater under the facility area and maintenance of caps and covers, will continue until the risk posed by contamination left in place is acceptable. Residual soil contamination in the vicinity of the demolished Engineering Test Reactor and Materials Testing Reactor and hot cell facilities is being evaluated as new sites under Operable Unit 10-08. All institutional controls and operations and maintenance requirements were maintained in 2014.

3.2.3 Waste Area Group 3 – Idaho Nuclear Technology and Engineering Center

The Idaho CERCLA Disposal Facility (ICDF) disposes of contaminated soils and debris from CERCLA remediation operations to reduce risk to the public and the environment. During 2012, the ICDF was put in a standby mode until shipments of contaminated soil requiring disposal are resumed. The facility continues to receive small amounts of liquid and solid waste periodically for disposal in the ICDF evaporation ponds and disposal cells, respectively. The ICDF evaporation ponds are sampled annually in accordance with ICDF Complex Operational and Monitoring Sampling and Analysis Plan. Summaries of the sampling results are submitted to EPA and DEQ CERCLA programs annually. Summaries are available for 2013 (ICP 2014a) and 2014 (ICP 2015) in the CERCLA Administrative Record. These summaries document that the sampling results do not exceed the action levels established in the Sampling and Analysis Plan.

Remedial actions required by the WAG 3, Operable Unit 3-14 ROD, implemented in 2013, included the reduction of approximately 9 million gallons of anthropogenic recharge to the northern perched water zones. Remedial actions were taken at the Tank Farm Facility to reduce water infiltration that potentially could transport contaminants from the perched water to the underlying aquifer. Perched and groundwater monitoring under and near the facility will continue until the risk posed by contamination left in place is below target levels. All institutional controls and operations and maintenance requirements were maintained in 2014.

3.2.4 Waste Area Group 4 – Central Facilities Area

Remediation of WAG 4 was completed in 2004. Groundwater monitoring and maintenance of caps and covers will continue until the risk posed by contamination left in place is acceptable. All institutional controls were maintained in 2014.

3.2.5 Waste Area Group 5 – Critical Infrastructure Test Range/Auxiliary Reactor Area

Cleanup activities at WAG 5 are complete. The Remedial Action Report (DOE-ID 2005) was completed in 2005. All institutional controls and operations and maintenance requirements were maintained in 2014.

3.2.6 Waste Area Group 6/10 – Experimental Breeder Reactor I/Boiling Water Reactor Experiment, Miscellaneous Sites, Eastern Snake River Plain Aquifer

The WAG 10, Operable Unit 10-08 ROD (Sitewide Groundwater, Miscellaneous Sites, and Future Sites) was the last INL Site ROD identified and was finalized in September 2009 (DOE-ID 2009). Operable Unit 10-08 addresses eastern Snake River Plain aquifer concerns not covered by other WAGs and future sites that may be discovered. Groundwater monitoring continued in 2014 to verify that there is no unacceptable threat to human health or the environment from commingled plumes or along the southern INL Site boundary. Remediation of unexploded ordnance, in accordance with the Operable Units 6-05 and 10-04 ROD (DOE-ID 2002), continued through completion of the final report in 2014. Active field work planned to address unexploded ordnance is now essentially complete. All institutional controls, and operations and maintenance requirements were maintained in 2014.

3.2.7 Waste Area Group 7 – Radioactive Waste Management Complex

WAG 7 includes the Subsurface Disposal Area (SDA), a 39-hectare (97-acre) radioactive waste landfill that is the major focus of remedial response actions at the Radioactive Waste Management Complex (Figure 3-3). Waste is buried in approximately 14 of the 39 hectares (35 of the 96 acres) within 21 unlined pits, 58 trenches, 21 soil vault rows, and on Pad A, an above-grade disposal area. Disposal requirements have changed in accordance with laws and practices current at the time of disposal. Initial operations were limited to shallow, landfill

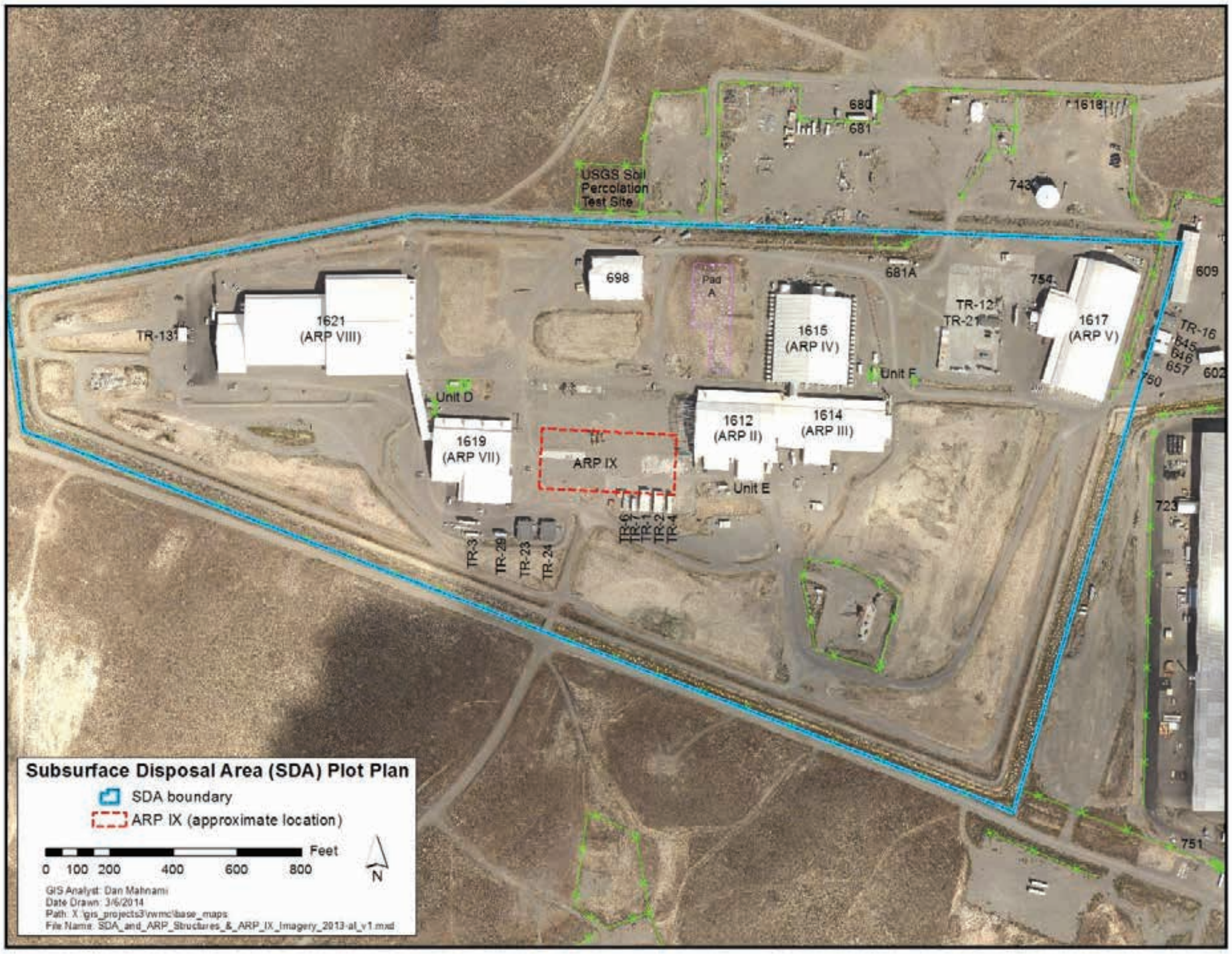


Figure 3-3. RWMC SDA (2014).

disposal of waste generated at the INL Site. Beginning in 1954, the Rocky Flats Plant near Boulder, Colorado, was authorized to send waste to the Radioactive Waste Management Complex for disposal. The Rocky Flats Plant was a nuclear weapons production facility with peak operations during the Cold War era. A variety of radioactive waste streams was disposed of, including process waste (e.g., sludge, graphite molds and fines, roaster oxides, and evaporator salts), equipment, and other waste incidental to production (e.g., contaminated gloves, paper, clothing, and other industrial trash). Much of the Rocky Flats Plant waste was contaminated with transuranic isotopes and solvents (e.g., carbon tetrachloride). In 1970, burial of transuranic (TRU) waste was prohibited. In 1984, disposal practices were modified to eliminate disposal of mixed waste. Since 1984, only low-level waste was disposed of in the SDA. Disposal of waste from offsite generators was discontinued in the early 1990s, and disposal of contact-handled waste was discontinued at the end of Fiscal Year (FY) 2008. Currently, only remote-handled, low-level waste is being disposed of in the SDA.

The Operable Unit 7-13/14 ROD (DOE-ID 2008) was signed in 2008. The ROD is consistent with DOE's obligations for removal of transuranic waste under the *Agreement to Implement U.S. District Court Order Dated May 25, 2006*, between the state of Idaho and DOE, effective July 3, 2008 (U.S. District Court 2008). The ROD calls for exhuming and packaging a minimum of 6,238 m^3 (8,159 yd^3) (measured as 7,485 m^3 [9,790 yd^3] packaged) of targeted waste from a minimum combined area of 2.3 hectares (5.69 acres). Targeted waste for retrieval contains transuranic elements (e.g., plutonium), uranium, and collocated organic solvents (e.g., carbon tetrachloride). Targeted waste retrievals in specific areas of the SDA commenced in 2005. The retrieved targeted waste is packaged, certified, and shipped out of Idaho. As of

December 2014, 6,547 m^3 (8,563 yd^3) of targeted waste has been retrieved and packaged from a combined area of 1.48 hectares (3.67 acres).

In addition to targeted waste retrieval, the ROD addresses remaining contamination in the SDA through a combination of continued vapor-vacuum extraction and treatment of solvent vapors from the subsurface, in situ grouting of specified waste forms containing mobile contaminants (completed 2010), constructing an evapotranspiration surface barrier over the entire landfill, and long-term management and control following construction. Construction will be complete by 2028.

3.2.8 Waste Area Group 8 – Naval Reactors Facility (NRF)

NRF environmental program updates are discussed in the NRF environmental monitoring reports and are not included in this report.

3.2.9 Waste Area Group 9 – Materials and Fuels Complex (MFC)

All WAG 9 remediation activities have been completed; however, the industrial waste pond (ANL-01) and interceptor canal (ANL-09) remain under institutional controls. The Industrial Waste Pond has elevated levels of chromium in the sediment and will be re-evaluated when it is no longer in use. Cesium-137 levels at the interceptor canal ditch and mound are below action levels, but above background. The site will remain under control until the cesium naturally decays to background levels.

Three sites at MFC were administratively assigned to WAG 10 and remain under institutional controls:

1. The sewage lagoons (ANL-04) pose an ecological risk because of mercury levels in the sludge. In 2012, the lagoons were replaced with new HDPE-lined evaporation ponds. Closure options for the sewage lagoons will be evaluated after the sludge dries and additional samples are collected, analyzed, and compared with remedial action levels.
2. The buried remains of buildings MFC-767 and MFC-795 (ANL-67) are controlled because of asbestos associated with piping left in place when the buildings were removed.
3. The steel shot area north of MFC (ANL-65) is contaminated with metals. This site was remediated in 2013 by removal and disposal of 98 m^3 (128 yd^3) of lead-contaminated soil.

3.3 Waste Management and Disposition

Waste management and disposition covers a variety of operations and functions, including: (1) storage of waste pending disposition; (2) characterization of waste to allow it to be placed in storage or to be transported, treated, or disposed of; (3) transportation of waste to locations on or off the INL Site for treatment or disposal or both; (4) treatment of waste prior to disposal; and (5) disposal. Safe operations and compliance with applicable federal, state, and local regulations are the highest priorities, along with meeting the commitments made in the Idaho Settlement Agreement (DOE 1995) and the *2014 Idaho National Laboratory Site Treatment Plan* (ICP 2014a).

3.3.1 Federal Facility Compliance Act

The Federal Facility Compliance Act requires preparation of a site treatment plan for the treatment of mixed wastes at the INL Site. Mixed wastes contain both radioactive and Resource Conservation and Recovery Act (RCRA)-regulated hazardous components. A backlog of mixed waste is being managed in RCRA-permitted storage units at the INL Site. During 2014, the INL Site treated or processed 3,035.5 m^3 of legacy mixed waste. Of that total, 804.3 m^3 was mixed low-level waste shipped offsite for treatment/disposal, and 2,231.2 m^3 was mixed transuranic waste that was shipped offsite to the Waste Isolation Pilot Plant for disposition, certified for disposal at WIPP, or was volume reduced due to processing.

In accordance with the INL Site Treatment Plan (ICP 2014), the INL Site began receiving mixed waste from offsite locations for treatment in January 1996. Mixed waste has been received from other sites within the DOE complex, including Hanford, Los Alamos, Paducah, Pantex, Sandia, Savannah River, Argonne, and six locations managed by the Office of Naval Reactors. All off-site mixed waste was treated and shipped offsite within the specified time frames established in the INL Site Treatment Plan in 2014.

During 2014, five INL Site Treatment Plan milestones were met and two milestone extensions were requested associated with the sodium-bearing waste treatment facility. Extensions were requested for the (P-5) milestone to commence operations and the (P-6) milestone to submit a schedule for system backlog. Due to delays associated with the startup of the sodium-bearing waste treatment facility (Integrated Waste Treatment Unit

[IWTU]), DOE notified DEQ in a letter, dated September 26, 2014, that the commence operations milestone would need to be extended. DOE and DEQ will negotiate the extension request. The subsequent P-6 milestone, submit a backlog schedule, will be established once the P-5 milestone is revised. The following milestones were completed:

- Remote-Handled Waste Disposition Project – (P-4) Commence System Testing
- Remote-Handled Waste Disposition Project – (P-5) Commence Operation
- Commercial Backlog Treatment/Disposal – 30 m^3
- Sodium Components Maintenance Shop Backlog Treatment – 2 m^3
- Original Volume Transuranic-Contaminated Waste Backlog Treatment/Processing – 4,500 m^3.

3.3.2 Advanced Mixed Waste Treatment Project (AMWTP)

Operations at AMWTP require retrieval, characterization, treatment, and packaging of transuranic waste currently stored at the INL Site. The vast majority of the waste the AMWTP processes resulted from the manufacture of nuclear components at DOE's Rocky Flats Plant in Colorado. The waste contains industrial debris, such as rags, work clothing, machine parts, and tools, as well as soil and sludge. The waste is contaminated with transuranic radioactive elements (primarily plutonium).

After the waste containers have been retrieved from waste storage, they are examined in the AMWTP Characterization Facility. During characterization, each container is examined to determine its contents. Characterized waste containers that need further treatment before they can be shipped offsite for disposal are sent to one of several treatment processes including: the AMWTP Treatment Facility, the Drum Treatment Tents in WMF-628 and WMF-635, and the Sludge Repackaging Project in Accelerated Retrieval Project-V. The AMWTP Treatment Facility treats the waste by size-reducing, sorting, and repackaging the waste, and supercompacting the waste for volume reduction. Waste sent to the Treatment Facility is transported to different areas within the facility by an intricate system of conveyers, and all waste is handled remotely. The Treatment Facility houses a supercompactor and a shredder for major size-reduction of the waste. Any restricted items, such as liquids or compressed gas cylinders, are removed, and the waste is repackaged. The Sludge Repackaging Project primarily treats drums that contain sludge waste with excess liquids by adding liquid absorbent. The Drum Treatment Tents are primarily used to repackage old drums into new drums or to overpack drums in to waste boxes.

There are two loading areas at the AMWTP. In both loading facilities, the waste containers go through two major steps: payload assembly and shipment loading. Payload assembly includes grouping the waste into four different configurations consisting of 55-gal drums, 100-gal pucks drums (i.e., drums of compacted waste), waste over-packed into boxes, and waste over-packed into ten drum overpacks. Then, the waste is loaded into the TRUPACT II containers for shipment to Waste Isolation Pilot Plant (WIPP), or onto trailers for shipment to Nevada National Security Site as mixed low-level waste (MLLW). A TRUPACT II container is a special double-containment vessel that is approved for transuranic waste transport. MLLW shipments follow all applicable Department of Transportation requirements. After the TRU payloads are placed in the TRUPACT II containers, the containers are visually and mechanically inspected before they are certified for travel. Once a TRUPACT II container is certified for travel, the waste is sent 2,092 km (1,300 mi) to its final destination at the WIPP in Carlsbad, New Mexico.

During 2014, the AMWTP shipped 922 m^3 (1,206 yd^3) of stored transuranic waste to the WIPP, for a cumulative total of 41,418 m^3 (54,173 yd^3) of TRU waste shipped off the INL Site. The AMWTP also shipped offsite 1,060 m^3 (1,386 yd^3) of mixed low-level waste that historically had been managed as stored transuranic waste, for a cumulative total of 9,616 m^3 (12,577 yd^3) of MLLW shipped offsite. A combined cumulative total of 51,034 m^3 (66,750 yd^3) of stored waste has been shipped offsite. There was an issue at WIPP that resulted in the suspension of all TRU waste shipments to WIPP in 2014. Due to suspension of WIPP operations, AMWTP was not able to ship a large quantity of waste that would otherwise have been sent to WIPP. This has resulted in a large backlog of waste that is certified for WIPP disposal, but will be compliantly stored at AMWTP until WIPP resumes operations. The current backlog of certified waste stored at AMWTP is 1,483 m^3 (1,940 yd^3). During 2014, the AMWTP did not ship any buried transuranic waste (see 3.2.7, "Waste Area Group 7 – Radioactive Waste Management Complex") to WIPP.

3.3.3 High-Level Waste and Facilities Disposition

In 1953, reprocessing of spent nuclear fuel (SNF) began at the Idaho Nuclear Technology and Engineering Center (INTEC), resulting in the generation of liquid high-level waste and sodium-bearing waste. Those wastes were placed into interim storage in underground tanks at the INTEC Tank Farm. Treatment of those wastes began in 1963 through a process called calcining. The resultant waste form, calcine, was placed in storage in stainless steel bins at the Calcine Solids Storage Facility. DOE announced the decision to stop processing SNF in 1992. Calcining of all nonsodium-bearing, liquid, high-level waste was completed on February 20, 1998, four months ahead of the June 30, 1998 Idaho Settlement Agreement milestone. Calcining of remaining sodium-bearing waste began immediately following completion of nonsodium-bearing, liquid, high-level waste treatment, more than three years ahead of the Idaho Settlement Agreement milestone. All such waste was required to be treated by the end of 2012.

In October 2002, DOE issued the *Idaho High-Level Waste and Facilities Disposition Final Environmental Impact Statement* (DOE 2002) that included alternatives other than calcination for treatment of the sodium-bearing waste. DOE-ID issued a ROD for this Final Environmental Impact Statement on December 13, 2005 (DOE 2005). This ROD specified steam reforming to treat the remaining sodium-bearing waste at the INTEC Tank Farm. This technology will treat the remaining approximately 3.4-million-L (900,000-gal) of liquid, sodium-bearing waste that has been consolidated into three 1.14-million-L (300,000-gal) below-grade tanks at the INTEC Tank Farm for interim storage.

A new facility, the Integrated Waste Treatment Unit (IWTU) was constructed and approved for operation in 2012. The IWTU is a facility for treatment of the remaining liquid sodium-bearing waste utilizing the steam reforming process. Processing of the sodium-bearing waste by IWTU has not been initiated due to problems that occurred in June 2012 during initial start-up testing and follow-on equipment commissioning. The facility has completed facility hardware and operational modifications to address issues identified during the initial start-up. The facility has completed readiness assessments for restart of testing and is expected to begin processing waste by September 2016. DOE-ID and the state of Idaho Department of Environmental Quality negotiated a revised completion date for treatment of the sodium-bearing waste. The revised consent order milestone is December 2018.

Seven other 1.14-million-L (300,000-gal) INTEC Tank Farm tanks have been emptied, cleaned, and removed from service in preparation for final closure. With regard to tank closures, DOE issued a final Section 3116 Waste Determination and amended ROD in November 2006 (71 Federal Register [FR] 68811-13, 2006). Filling the seven cleaned tanks and their surrounding vaults began in November 2006 and was completed in March 2008.

The Final Environmental Impact Statement also included analysis of alternatives for treating the calcined waste. On December 23, 2009, DOE issued an amended ROD (75 FR 137.40, 75 FR 1615-16) for the treatment of calcine using an industrially mature manufacturing process known as hot isostatic pressing (HIP).

A RCRA Part B permit was submitted to the state of Idaho Department of Environmental Quality on November 27, 2012, for the HIP process. The permit is based upon the utilization of the existing IWTU facility to the extent practicable by retrofitting the IWTU to accommodate the HIP process. Current efforts are focused on Calcine Bin Set conceptual design activities and response to any comments from the State regarding the RCRA Part B Permit application.

3.3.4 Low-Level and Mixed Radioactive Waste

In 2014, more than 2,861 m^3 (3,742 yd^3) of mixed low-level waste and 1,231 m^3 (1,610 yd^3) of low-level waste was shipped off the INL Site for treatment or disposal or both. Approximately 29.28 m^3 (38.30 yd^3) of newly generated, low-level waste was disposed of at the SDA in 2014.

3.4 Environmental Management System (EMS)

An EMS provides a framework of elements following a plan-do-check-act cycle that when established, implemented, and maintained, will foster improved environmental performance. An EMS focuses on three core concepts: pollution prevention, environmental compliance, and continuous improvement. The primary system components are (1) environmental policy, (2) planning, (3) implementation and operation, (4) checking and corrective action, and (5) management review.

Executive Order (EO) 13423, “Strengthening Federal Environmental, Energy, and Transportation Management," mandates that all federal agencies implement EMSs at all appropriate organizational levels. DOE Order 436.1, "Departmental Sustainability," requires compliance with this EO, and further requires that DOE sites use their EMS as a platform for Site Sustainability Plan implementation. Sites must maintain their EMS as being certified to or conforming to the International Organization for Standardization's (ISO) 14001:2004 in accordance with the accredited registrar provisions or self-declaration instructions.

The three main INL Site contractors have established EMSs for their respective operations. The ICP and INL contractors maintain ISO 14001 systems certified and registered by accredited registrars. Auditors from the registrars conduct periodic surveillances and full audits of the systems to determine improvement or degradation, and eligibility for recertification. January 20-22, 2014, BEA successfully completed an ISO 14001:2004 surveillance audit to maintain registration of their EMS. No nonconformities were identified. Nine system strengths and one opportunity for improvement were noted. August 11-15, 2014, an independent registrar audit of the BEA EMS was conducted to determine conformance to ISO 14001:22004. No nonconformities were identified. Twenty-one system strengths and six opportunities for improvement were noted. The audit recommended recertification of the BEA EMS.

January 15-16, 2014, CWI successfully completed an ISO 14001:2004 surveillance audit to maintain registration of their EMS. No nonconformities or opportunities for improvement were identified. Several system strengths were noted. August 18-21, 2014, an independent registrar audit of the CWI EMS was conducted to determine conformance to ISO 14001:2004. Eleven system strengths, one opportunity for improvement, and one minor nonconformance were identified. The audit recommended recertification following acceptance of the corrective action plan for the minor nonconformance.

The AMWTP contractor's EMS is self-declared conformant to the ISO standard, based upon conformance audits by independent, external, qualified auditors. DOE strongly supports the management system concept and review contractor processes to ensure they meet DOE's requirements.

3.4.1 Sustainability Program

The Site Sustainability Plan (DOE-ID 2014d) and program implemented sustainable practices in facility design operation, procurement, and program operations that meet the requirements of EO 13514, "Federal Leadership in Environmental, Energy, and Economic Performance," and DOE Order 436.1, "Departmental Sustainability." The goal of EO 13514 is "to establish an integrated strategy towards sustainability in the Federal Government and to make reduction of greenhouse gas (GHG) emissions a priority for Federal agencies."

The goal of the INL Site sustainability program is to promote economic, environmental, and social sustainability for the INL Site, helping to ensure its long-term success and viability as a premier DOE national laboratory. The sustainability program focuses on energy water and GHG reductions, as well as responsible use and disposal of materials and resources; advancing sustainable building designs; exploring the potential use of renewable energy; reducing utility costs across the INL Site; and supporting cost-effective facilities, services, and program management. The challenge is to minimize the impact of operations on the laboratory. The INL Site is integrating environmental performance improvement in the areas that matter most to its stakeholders and the laboratory, including minimizing the environmental footprint, taking a progressive approach to climate change, and championing energy conservation.

Energy Use. The DOE goal for energy usage is a 30 percent reduction of energy intensity by FY 2015, as compared to the FY 2003 energy intensity baseline. Energy intensity is defined as energy use divided by the building area measured in Btu/ft^2.

The INL Site is reducing its energy intensity to help DOE achieve its agency goal. In FY 2014, the INL Site reduced its energy intensity by 10.4 percent compared to the FY 2003 baseline. DOE constructed two large laboratories in Idaho Falls and maintains large energy intensive process facilities at the desert site that contribute to the lack of progress towards meeting the goal. Energy saving projects have a very long payback period because of low energy costs which also contribute to the lack of progress towards the goal. However, DOE is still working to implement energy savings projects where possible (see, for example, Figure 3-4.)

Water Conservation. The DOE goal for potable water usage is a 26 percent reduction of usage intensity by FY 2020 as compared to the FY 2007 Water Usage Intensity Baseline. Water intensity is defined as gallons of water used divided by building area (gal/ft^2). The INL Site has reduced its water use by 14.7 percent when compared to the FY 2007 baseline.

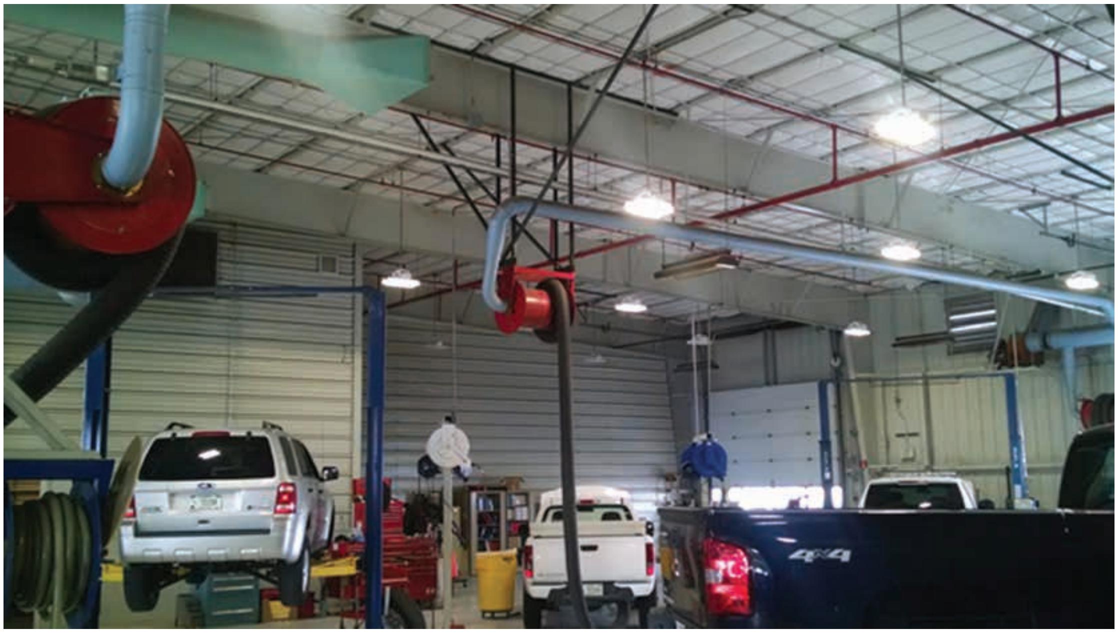


Figure 3-4. New LED Lighting System in the INL Transportation Complex.

Due to the nature of the various INL Site missions, many of the operations can be cyclical and result in varying usages of water throughout the year and from year to year. In addition, as facilities are removed and processes are shut down, the lower square footage can actually result in an increase in water intensity even as overall water usage is reduced.

A number of water-savings projects were implemented including plumbing upgrades and xeriscaping (Figure 3-5). In addition, the construction of a new laboratory that met Leadership in Energy & Environmental Design platinum certification and incorporated significant xeriscaping and efficient water fixtures should help lower water use intensity.

Achieving greater reductions in water intensity will be very difficult for the INL Site to accomplish. Long payback calculations based on inexpensive water rates make water saving projects cost ineffective. Water usage is also dependent upon process usage and unplanned events such as wildfires as well as additional demolition of existing facilities.

Petroleum Use. DOE's goal for reduced petroleum use is 30 percent by 2020 when compared to the 2005 baseline. Presently, the INL Site has reduced its petroleum use by 39.6 percent. The INL Site has diversified strategies for increasing alternative fuel consumption and reducing carbon emissions associated with light and heavy-duty vehicles.

The INL Site will continue to obtain increasingly fuel-efficient, light-duty vehicles, manage bus idling times, eliminate underutilized bus routes, and continue its use of B20 and E-85 fuels. The INL also converted six buses to dual fuel. That conversion allows those buses to run on regular diesel/biodiesel and Liquefied Natural Gas/Compressed Natural Gas (Figure 3-6).

Greenhouse Gases (GHG). EO 13514 mandates that agencies develop specific GHG reductions targets. DOE has set a reduction target of 28 percent for Scope 1 and 2 GHGs and 13 percent reduction in Scope 3 GHG emissions. The EO sets 2008 as the baseline year against which reductions are measured. Scope 1, 2, and 3 are defined as:

- **Scope 1.** Direct or INL Site-owned emissions that are produced onsite, such as stationary combustion (from fuel combustion), mobile combustion (from fleet vehicles), and fugitive emissions (from refrigerants, onsite landfills, and onsite wastewater treatment).

  These include emissions that may benefit another entity or contractor, but for which the INL Site controls or owns the associated process.

Figure 3-5. MFC Xeriscaping Project.

- **Scope 2.** Indirect or shared emissions produced by INL's electricity, heat, and steam purchases.
- **Scope 3.** Indirect or shared emissions generated by outsourced activities that benefit the INL Site (occur outside the INL Site's organizational boundaries, but are a consequence of the INL Site's activities). This can include a large number of activities, so the INL Site focuses on transmission and distribution losses, employee commuting, employee travel, contracted waste disposal, and contracted wastewater treatment since these categories were identified in the Technical Support Document for required reporting. Other activities that could be included in Scope 3 include the embodied emissions of purchased materials.

The INL Site combined Scope 1 and 2 GHG emissions are down 26.0 percent from the FY 2008 baseline. The INL Site scope 3 emissions are down 34.1 percent from the FY 2008 baseline. Many factors influence the INL Site's GHG emissions, including the large land area on which the Laboratory's facilities are located. The area requires long commutes, an extensive fleet to provide transportation for desert Site workers, and contains many antiquated inefficient facilities built before the current appreciation for energy efficiency and high-performance design.

The INL Site continues to reduce GHGs by transporting employees with a modernized transportation system. By streamlining the INL Site mass transit system that provides safe, efficient, and sustainable transportation to work for INL Site employees throughout the eastern Idaho region, contractor organizations encourage travel behavior changes to reduce carbon emissions and fossil fuel consumption and increase highway safety. Other actions include instituting a park and ride system, relocating employees to town offices, use of E-85 and biodiesel fuels (B20), and use of modern buses, vans, and light duty vehicles to reduce carbon emissions.

Waste Diversion. DOE's goal for diverting municipal waste as well as construction and demolition waste from going to a landfill is 50 percent for each waste stream

Figure 3-6. Liquefied Natural Gas (LNG) Filling Station and INL Bus Conversion to Bio Diesel/LNG.

by 2015. In 2014, INL Site facilities recycled 1,543,675 lb (700.2 metric tons [MT]) of materials, including comingled materials, office paper, cardboard, scrap metal, wood, cooking oil, and wood pallets. This accounts for a 39.7 percent diversion of municipal solid wastes collected at INL Site facilities. The INL Site also diverted 4,384,989 lb (1989 MT) of its construction and demolition waste in 2014. That accounts for a 39.5 percent diversion of waste from going to a landfill.

3.4.2 Pollution Prevention

The INL Pollution Prevention Program incorporates national and DOE requirements to reduce, reuse, and recycle wastes and pollutants by implementing cost-effective techniques, practices, and programs. Such actions are required by various federal statutes, including, but not limited to the Pollution Prevention Act and RCRA.

The INL Site Pollution Prevention Plan (DOE-ID 2014e) describes the pollution prevention practices pursued at the INL Site. This plan reflects the goals and policies for pollution prevention and sustainability at the INL Site and represents an ongoing effort to make pollution prevention and sustainability part of the INL Site's operating philosophy. This plan is a reference and guidance document for INL Site managers, operations personnel, and support staff. It contains the policy, objectives, strategies, goals, and support activities of the INL Site Pollution Prevention and Sustainability Program. Objectives of the Pollution Prevention and Sustainability Program at the INL Site can be divided into the categories of cultural and technical. Cultural objectives include:

- Foster a philosophy among employees to protect the environment while carrying out the various missions at the INL Site
- Enhance communication of pollution prevention and sustainability objectives, goals, methods, and ideas laterally and vertically among INL Site organizations and contractors
- Promote integration and coordination between waste generators and waste managers on pollution prevention and waste minimization
- Recognize employee and project accomplishments in the area of pollution prevention and waste minimization.

Technical objectives include:

- Comply with federal, state, and local regulations and DOE requirements for pollution prevention
- Reduce or eliminate the generation of waste streams through source reduction and substitution, product reformulation, improved housekeeping, inventory

control, process modification, and onsite reuse and recycling of materials to protect the air, water, land, and other natural and cultural resources impacted by the INL Site

- Identify new or modify current methods and technologies to improve pollution prevention and sustainable practices at the INL Site
- Promote the use of nonhazardous materials in plant construction, maintenance, and operations to minimize risks to human and environmental health
- Collect and exchange pollution prevention information from fellow DOE laboratories and other appropriate sites through technology transfer, outreach, and educational networks.

3.5 Other Major Environmental Programs and Activities

3.5.1 Decontamination and Decommissioning Activities

Through September 2013, the ICP decontamination and decommissioning project had safely decontaminated and decommissioned 223 buildings and structures for a total footprint reduction of over 1.6 million ft^2 (149,000 m^2) at the INL Site. The project demolished three nuclear reactors, two hot cell facilities, the largest hot shop in the world, a spent fuel reprocessing complex, large laboratory buildings, and numerous warehouses and storage buildings. This effort significantly reduced life-cycle cost and risk by eliminating aging facilities that were no longer needed for the INL Site mission.

In 2014, the ICP funded additional decontamination and decommission in work at MFC. Sodium-contaminated piping in MFC-766 (Sodium Boiler Building) was removed, and sodium-contaminated equipment was treated in 2014 and will be completed in 2015. Also, during 2014, RCRA closure of MFC-767 (EBR-II Reactor Building) and MFC-799 (Sodium Process Facility) was completed. The basement of the MFC-767 EBR-II building was also grouted, and MFC-799A (Caustic Storage Tank Building) was deactivated and demolished. Additional decontamination and decommissioning work will be done in the future as funding allows and as facility missions are completed.

3.5.2 Spent Nuclear Fuel (SNF)

SNF is fuel that has been irradiated in a nuclear reactor. SNF contains some unused enriched uranium and radioactive fission products. Because of its radioactivity (primarily from gamma rays), it must be properly shielded. DOE's SNF is from development of nuclear energy technology (including foreign and domestic research reactors), national defense, and other programmatic missions. At the INL Site, SNF is managed by the ICP contractor at INTEC, the Naval Nuclear Propulsion Program at the NRF, and the INL contractor at the ATR Complex and MFC.

Between 1952 and 1992, SNF was reprocessed at the Idaho Chemical Processing Plant (now called INTEC) to recover fissile material for reuse. However, the need for fuel-grade uranium and plutonium decreased. A 1992 decision to stop reprocessing left a large quantity of SNF in storage pending the licensing and operation of an SNF and high-level waste repository or interim storage facility. Licensing of a repository at Yucca Mountain is being reconsidered, but the Idaho Settlement Agreement requires all INL Site fuel be removed from the state of Idaho by 2035. The Blue Ribbon Commission (BRC) on America's Nuclear Future, charged with reviewing SNF management policies, issued a report to the Secretary of Energy in January 2012, detailing recommendations for creating a safe, long-term solution for managing and disposing of the nation's SNF and high-level radioactive waste. DOE published a response to the BRC report titled *Strategy for the Management and Disposal of Used Nuclear Fuel and High-Level Radioactive Waste* in January 2013 (DOE 2013). The DOE document contains a framework for moving toward a program to deploy an integrated system capable of transporting, storing, and disposing of SNF and high-level radioactive waste from civilian nuclear power generation, defense, national security and other activities.

In 2012, INL Site SNF was stored in both wet and dry conditions. An effort is underway to put all INL Site legacy SNF in dry storage. From 2005 to 2010, 3,186 fuel handling units of ICP-managed SNF were put into dry storage. Descriptions of SNF storage facilities follow.

Fluorinel Dissolution Process and Fuel Storage Facility (CPP-666) – This INTEC facility, also called FAST, is divided into two parts, an SNF storage basin area and the Fluorinel Dissolution Facility, which operated from 1983 to 1992 and is currently being used in remote-handled transuranic waste management. The storage area consists of six storage basins currently storing SNF under about 11 million L (3 MG) of water, which provides protective shielding and cooling. All ICP-managed SNF has been removed from the basins and stored in the INTEC dry storage facilities described below. SNF from the ATR, Experimental Breeder Reactor II (EBR-II), and Naval Nuclear Propulsion Program is stored in the basins. Navy SNF is being transferred to the NRF for dry storage. In 2014, ICP transferred seven of the 227 shipments of EBR-II SNF to the MFC for processing. A project total of 13 EBR-II shipments to MFC has been completed. The Idaho Settlement Agreement requires SNF to be removed from wet storage by December 2023.

Irradiated Fuel Storage Facility (IFSF, CPP-603) – This INTEC dry SNF storage facility has 636 storage positions and has provided dry storage since 1973. In 2008, decontamination and decommissioning of the old fuel storage basin (the wet side of the facility) was completed. SNF receipt from foreign and domestic research reactors was suspended in 2013. The suspension will be in place until DOE achieves compliance with settlement agreement milestones.

Cask Pad (CPP-2707) and Rail Casks – This INTEC facility provides safe dry storage of SNF in transport casks staged on an asphalt pad and on a rail siding. The two West Valley SNF casks were relocated from the INTEC railcar siding to CPP-2707.

TMI-2 Independent Spent Fuel Storage Installation (CPP-1774, ISFSI) – This INTEC facility is a U.S. Nuclear Regulatory Commission-licensed dry storage facility for SNF and debris from the Three Mile Island reactor accident. Fuel and debris were transferred to Test Area North on the INL Site for examination, study, and storage following the accident. After the examination, the SNF and debris were transferred to the ISFSI. The ISFSI provides safe, environmentally secure, above ground storage for the SNF and debris. The facility construction consists of fuel and debris in welded stainless steel canisters, placed in carbon steel casks shielded inside concrete vaults.

Peach Bottom Fuel Storage Facility (CPP-749) – This INTEC facility consists of 193 below-ground vaults of various sizes for dry storage of SNF. The vertical vaults generally are constructed of carbon steel pipe, with some of them containing concrete plugs. All of the pipes are below grade and are accessed from the top using specially designed equipment.

Fort Saint Vrain Independent Spent Fuel Storage Installation – DOE-ID manages this U.S. Nuclear Regulatory Commission-licensed dry storage facility located in Colorado. It contains about two-thirds of the SNF generated over the operational life of the Fort Saint Vrain reactor. The rest of the SNF from the Fort Saint Vrain reactor is stored in the Irradiated Fuel Storage Facility, described previously. The Nuclear Regulatory Commission granted a 20-year license extension for material possession in this storage facility (2011-2031).

Advanced Test Reactor (ATR, TRA-670) – The ATR is located at the ATR Complex. The ATR is a research reactor that performs materials testing for domestic and foreign customers. During routine maintenance outages, spent fuel elements are removed and placed in underwater racks in the ATR canal, also located in Building TRA-670. Fuel elements are allowed to cool before being transferred to the Fluorinel Dissolution Process and Fuel Storage Facility, as described previously. The ATR canal is designated as a working facility rather than a storage facility. The ultimate disposition of ATR or spent fuel may be either recycle or disposition in the repository.

Radioactive Scrap and Waste Facility (RSWF) (MFC-771) – The Radioactive Scrap and Waste Facility has operated since 1964 for the dry storage of SNF and solid radioactive wastes resulting from nuclear energy research and development. This facility is located at MFC. It is a fenced outdoor compound with over 1,000 steel pipe storage vaults set into the ground. The storage vaults are typically 0.6 m (24 in.) in diameter and just over 3.7 m (12 ft) long. The pipe storage vaults have concrete or steel shield plugs inserted into their tops to protect workers from radiation fields and to prevent water intrusion. The storage vaults also are cathodically protected from corrosion. Currently, 19.6 metric tons (43,120 lb) of SNF, mostly from the deactivated EBR-II, is stored in the steel pipe storage vaults.

Since 1996, 3.84 metric tons (8,360 lb) of the original EBR-II inventory has been removed from the RSWF and processed using a dry electrometallurgical process. This process operates at the MFC Fuel Conditioning Facility and results in extracted, fairly pure, low-enriched, uranium metal and also a ceramic and a stainless steel, solid, high-level waste. The extracted low-enriched uranium metal is stored at the Transient Reactor Test Facility Warehouse at MFC. DOE is seeking to provide this extracted uranium to the commercial nuclear fuel fabrication industry for reuse. The two high-level waste forms are expected to be disposed of at a national geologic repository. The RSWF also stores mixed waste (primarily steel reactor components waste contaminated with sodium metal) and is managed under a RCRA hazardous waste storage permit. The RSWF formerly stored legacy (pre-1996) transuranic radioactive waste. The last container of this legacy waste was removed from RSWF in October of 2013, and sent to the INTEC for characterization and packaging prior to disposal at the WIPP facility.

3.5.3 Environmental Oversight and Monitoring Agreement

The 2010 Environmental Oversight and Monitoring Agreement (DOE-ID 2010) between DOE-ID; DOE Naval Reactors, Idaho Branch Office; and the state of Idaho maintains the state's program of independent oversight and monitoring established under the first agreement in 1990 that created the state of Idaho INL Oversight Program. The main objectives of the current five-year agreement are to:

- Assess the potential impacts of present and future DOE activities in Idaho
- Assure citizens that all present and future DOE activities in Idaho are protective of the health and safety of Idahoans and the environment
- Communicate the findings to citizens in a manner that provides them the opportunity to evaluate these potential impacts.

The INL Oversight Program's main activities include environmental surveillance; emergency coordination, planning, preparedness and response; impact analyses and public information; and education. More information can be found on the INL Oversight Program website at http://www.deq.idaho.gov/.

3.5.4 Citizens Advisory Board

The INL Site Environmental Management Citizens Advisory Board is a federally appointed citizen panel formed in 1994 that provides advice and recommendations on ICP activities to DOE-ID. The Citizens Advisory Board consists of 12 members who represent a wide variety of key perspectives on issues of relevance to Idaho citizens. They come from a wide variety of backgrounds, including environmentalists, natural resource users, previous INL Site workers, and representatives of local government, health care, higher education, business, and the general public. Their diverse backgrounds assist the ICP Environmental Management program in making decisions and having a greater sense of how the cleanup efforts are perceived by the public. Additionally, one board member represents the Shoshone-Bannock Tribes. Members are appointed by the DOE Environmental Management Assistant Secretary and serve voluntarily without compensation. Three additional liaisons (nonvoting) include representatives from DOE-ID, Environmental Protection Agency Region 10, and the Idaho Department of Environmental Quality. The liaisons provide information to the Citizens Advisory Board on their respective agencies' policies and views.

The Citizens Advisory Board is chartered by DOE through the Federal Advisory Committee Act. The Citizens Advisory Board's charter is to provide input and recommendations to DOE on topics such as cleanup standards and environmental restoration, waste management and disposition, stabilization and disposition of nonstockpile nuclear materials, excess facilities, future land use and long-term stewardship, risk assessment and management, and cleanup science and technology activities. The Citizens Advisory Board has provided over 148 recommendations during its tenure. More information about the Board's recommendations, membership, and meeting dates and topics can be found at http://www.inl-cab.energy.gov.

REFERENCES

71 FR 68811-13, 2006, "Amended Record of Decision: Idaho High-Level Waste and Facilities Disposition Final Environmental Impact Statement," *Federal Register*, U.S. Department of Energy.

75 FR 137.40, 2010, "Amended Record of Decision: Idaho High-Level Waste and Facilities Disposition Final Environmental Impact Statement Revised by State 12/21/09," *Federal Register*, U.S. Department of Energy.

75 FR 1615-16, 2010, "Amended Record of Decision: Idaho High-Level Waste and Facilities Disposition Final Environmental Impact Statement; Correction," *Federal Register*, U.S. Department of Energy.

DOE, 1991, *Idaho National Engineering Laboratory ("INEL") Federal Facility Agreement and Consent Order*, Administrative Docket Number: 1088-06-120, U.S. Department of Energy, Office of Environmental Management; U.S. Environmental Protection Agency, Region 10; State of Idaho, Department of Health and Welfare.

DOE, 1993, DOE Order 5400.5 Change 2, 1993, "Radiation Protection of the Public and the Environment," U.S. Department of Energy, cancelled by DOE Order 458.1 Admin Change 2.

DOE, 1995, *1995 Settlement Agreement*, U.S. Department of Energy, U.S. Department of the Navy, and Sate of Idaho.

DOE, 2002, *Idaho High-Level Waste and Facilities Disposition Final Environmental Impact Statement*, DOE/EIS-0287, U.S. Department of Energy.

DOE, 2005, *Record of Decision For The Idaho High-Level Waste and Facilities Disposition Final Environmental Impact Statement*, DOE/EIS-0287, December 2005.

DOE, 2008a, DOE Order 450.1A, 2008, "Environmental Protection Program," U.S. Department of Energy, cancelled by DOE Order 458.1 Admin Change 2.

DOE, 2008b, *Agreement to Implement U.S. District Court Order Dated May 25, 2006*, Document 363-2, U.S. Department of Energy.

DOE, 2011, DOE Order 436.1, 2011, "Departmental Sustainability," U.S. Department of Energy.

DOE, 2013, *Strategy for the Management and Disposal of Used Nuclear Fuel and High-Level Radioactive Waste*, January 2013

DOE-ID, 2002, *Record of Decision (ROD) for Experimental Breeder Reactor-I/Boiling Water Reactor Experiment Area and Miscellaneous Sites - Operable Units 6-05 and 10-04*, DOE/ID-10980, U.S. Department of Energy Idaho Operations Office.

DOE-ID, 2005, *Remedial Action Report for the Operable Unit 5-12 Remedial Action*, DOE/NE-ID-11205, U.S. Department of Energy Idaho Operations Office.

DOE-ID, 2008, *Record of Decision for Radioactive Waste Management Complex Operable Unit 7-13/14*, DOE/ID-11359, U.S. Department of Energy Idaho Operations Office, U.S. Environmental Protection Agency, Region 10; Idaho Department of Environmental Quality.

DOE-ID, 2009, *Operable Unit 10-08 Record of Decision for Site-Wide Groundwater Miscellaneous Sites, and Future Sites*, DOE/ID-11385, Rev. 0, U.S. Department of Energy Idaho Operations Office.

DOE-ID, 2010, *Environmental Oversight and Monitoring Agreement (Agreement in Principle) Between the United States Department of Energy and the State of Idaho*, U.S. Department of Energy Idaho Operations Office.

DOE-ID, 2014a, *Idaho National Laboratory Site Environmental Monitoring Plan*, DOE/ID-10-11088, Rev. 4, U.S. Department of Energy Idaho Operations Office, February 2014.

DOE-ID, 2014b, *Technical Basis for Environmental Monitoring and Surveillance at the Idaho National Laboratory Site*, DOE/ID-11485, U.S. Department of Energy, Idaho Operations Office, February 2014.

DOE-ID, 2014c, *ICDP Complex Operational and Monitoring Sampling and Analysis Plan*, DOE/ID-11005, Rev. 3, U.S. Department of Energy Idaho Operations Office.

DOE-ID, 2014d, *FY 2015 INL Site Sustainability Plan with the FY 2014 Annual Report*, DOE/ID-11383, Rev. 6, December 2014.

DOE-ID, 2014e, *INL Site Pollution Prevention Plan*, DOE/ID-10333, Rev. 3, U.S. Department of Energy Idaho Operations Office.

Executive Order 13423, 2007, "Strengthening Federal Environmental, Energy, and Transportation Management," Washington, D.C.

Executive Order 13514, 2009, "Federal Leadership in Environmental, Energy, and Economic Performance," Washington, D.C.

HSS, 2010, *Independent Oversight Assessment of Environmental Monitoring at the Idaho National Laboratory Site*, Office of Health, Safety, and Security, May 2010.

ICP, 2014a, I*daho National Laboratory Site Treatment Plan* (INL-STP), Idaho Cleanup Project.

ICP, 2014b, *Transmittal of the Idaho CERCLA Disposal Facility Evaporation Pond Annual Sampling Results – 2013*, CCN 315980, Idaho Cleanup Project, January 13, 2014.

U.S. District Court 2008, Agreement to Implement U.S. District Court Order Dated May 25, 2006, Public Service Co. of Colorado v. Batt, No. CV-91-0035-S-EJL (D. Id.) and United States v. Batt, No. CV-91-0054-S-EJL (D. Id.) U.S. District Court, dated July 3, 2008.

2014

4. Environmental Monitoring Programs - Air

Tapertip Onion
Allium acuminatum

An estimated total of 2,350 Ci (8.70 × 10^{13} Bq) of radioactivity, primarily in the form of short-lived noble gas isotopes, was released as airborne effluents from Idaho National Laboratory (INL) Site facilities in 2014. The highest contributors to the total release were the Advanced Test Reactor Complex at 54.8 percent, Idaho Nuclear Technology and Engineering Center at 41.8 percent, and the Radioactive Waste Management Complex (RWMC) at 3.32 percent of total.

The INL Site environmental surveillance programs emphasize measurements of airborne contaminants in the environment because air is the most important transport pathway from the INL Site to receptors living outside the INL Site boundary. Because of this, samples of airborne particulates, atmospheric moisture, and precipitation were collected on the INL Site, at INL Site boundary locations, and at distant communities and were analyzed for radioactivity in 2014.

Particulates were filtered from air using the same network of low-volume air samplers, and the filters were analyzed for gross alpha activity, gross beta activity, and specific radionuclides, primarily strontium-90, cesium-137, plutonium-239/240, and americium-241. Gross alpha and gross beta activities were used primarily for trend analyses and indicated that fluctuations were observable which correlate with seasonal variations in natural radioactivity.

Strontium-90 was reported on two quarterly composited air filters: one collected on the INL Site and one collected off the INL Site. Both results were just above detection levels. The results are consistent with historical measurements associated with global fallout and well below health-based regulatory levels. No other human-made radionuclides were detected in air filters.

Airborne particulates were also collected biweekly around the perimeters of the Subsurface Disposal Area of the RWMC and the Idaho Comprehensive Environmental Response, Compensation, and Liability Act Disposal Facility at the Idaho Nuclear Technology and Engineering Center. Gross alpha and gross beta activities measured on the filters were comparable with historical results, and no new trends were identified in 2014. Detections of americium and plutonium isotopes were comparable to past measurements and are likely due to resuspended soils contaminated from past burial practices at the Subsurface Disposal Area.

Atmospheric moisture and precipitation samples were obtained at the INL Site and off the INL Site and analyzed for tritium. Tritium detected in some samples was most likely present due to natural production in the atmosphere and not INL Site releases. All measured results were below health-based regulatory limits.

4. ENVIRONMENTAL MONITORING PROGRAMS – AIR

Idaho National Laboratory (INL) Site facilities have the potential to release radioactive and nonradioactive constituents. Pathway vectors, such as air, soil, plants, animals, and groundwater, may transport these constituents to nearby populations (Figure 3-1). Air is the most important radionuclide transport pathway to members of the general public (DOE-ID 2014a). The INL Site air monitoring programs emphasize measurement of airborne radioactive contaminants because air has the potential to transport measureable amounts of radioactive materials to receptors in a relatively short period and can directly expose human receptors located off the INL Site.

This chapter presents results of radiological analyses of airborne effluents and ambient air samples collected on and off the INL Site, as well as results of meteorological monitoring at and around the INL Site. The results include those from the INL contractor, the Idaho Cleanup Project (ICP) contractor, and the Environmental Surveillance, Education, and Research Program (ESER) contractor. Table 4-1 summarizes the air monitoring activities on and off the INL Site. Details may be found in the *Idaho National Laboratory Environmental Monitoring Plan* (DOE-ID 2014b).

4.1 Organization of Air Monitoring Programs

The INL contractor monitors airborne effluents at INL facilities to comply with the Clean Air Act National

Table 4-1. Air Monitoring Activities by Organization.

Area/Facility[a]	Airborne Effluent Monitoring Programs	Environmental Surveillance Programs					
	Airborne Effluents[b]	Low-volume Charcoal Cartridges (iodine-131)	Low-volume Gross Alpha	Low-volume Gross Beta	Specific Radionuclides[c]	Atmospheric Moisture	Precipitation
ICP Contractor[d]							
INTEC	●		●	●	●		
RWMC	●		●	●	●		
INL Contractor[e]							
MFC	●						
INL/Regional		●	●	●	●	●	
Environmental Surveillance, Education, and Research Program[f]							
INL/Regional		●	●	●	●	●	●

a. INTEC = Idaho Nuclear Technology and Engineering Center, RWMC = Radioactive Waste Management Complex, MFC = Materials and Fuels Complex, INL = INL Site facilities as shown in Table 4-2, Regional = locations outside of the INL Site as shown in Table 4-3.
b. Facilities that required monitoring during 2014 for compliance with 40 CFR 61, Subpart H, "National Emissions Standards for Hazardous Air Pollutants."
c. Gamma-emitting radionuclides are measured by the ICP contractor monthly, by the ESER contractor quarterly, and by the INL contractor quarterly. Strontium-90, plutonium-238, plutonium-239/240, and americium-241 are measured by the ICP and ESER contractors quarterly and by the INL contractor when anomalous gross alpha or beta results exceed threshold levels.
d. The ICP contractor monitors waste management facilities.
e. The INL contractor monitors airborne effluents at MFC and ambient air outside INL Site facilities.
f. The ESER contractor collects samples on, around, and distant from the INL Site.

Emission Standards for Hazardous Air Pollutants (NESHAPs). Section 4.2 summarizes the results of radiological airborne effluent monitoring.

Ambient air monitoring is conducted by the INL contractor, the ESER contractor, and the ICP contractor to ensure that the INL Site remains in compliance with the U.S. Department of Energy (DOE) Orders 435.1, "Radioactive Waste Management," and 458.1, "Radiation Protection of the Public and the Environment." The INL contractor collected about 2,400 air samples (primarily on the INL Site) for various radiological analyses in 2014. The INL contractor also collects air moisture samples at four sites to determine tritium concentrations. Results of ambient air monitoring by the INL contractor and ICP contractor are summarized in Section 4.3.

The ESER contractor collects air samples from an area covering approximately 23,309 km^2 (9,000 mi^2) of southeastern Idaho, Jackson, Wyoming, as well as at locations on, around, and distant from the INL Site. The ESER contractor collected approximately 2,000 air samples, primarily off the INL Site, for radiological analyses in 2014. The ESER contractor also collects air moisture and precipitation samples at selected locations for tritium analysis. Results of ambient air monitoring by the ESER contractor are discussed in Section 4.3.

The ICP contractor monitors waste management activities on the Subsurface Disposal Area (SDA) at the Radioactive Waste Management Complex (RWMC) and at the Idaho Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) Disposal Facility (ICDF). Section 4.4 discusses air sampling by the ICP contractor in support of waste management activities.

The INL Oversight Program, conducted by the state of Idaho Department of Environmental Quality, collects air samples from a series of air monitoring stations, many of which are collocated with the INL and ESER contractors' monitoring stations. The INL Oversight Program reports their data independently at http://www.deq.idaho.gov/inl-oversight/monitoring/reports.aspx.

Unless specified otherwise, the radiological results reported in the following sections are considered statistically positive detections. See the Supplemental Report to this Annual Site Environmental Report entitled *Statistical Methods Used in the Idaho National Laboratory Annual Site Environmental Report* for more information.

Data obtained from the National Oceanic and Atmospheric Administration meteorological monitoring network at the INL Site are summarized in the supplement reoprt entitled "Meteorological Monitoring."

4.2 Airborne Effluent Monitoring

Radiological effluent monitoring results are used to estimate doses to members of the public from INL Site airborne releases. Because of this, the results are a major component of determining compliance with regulatory dose standards. Each regulated INL Site facility determines its airborne effluent concentrations as required under state and federal regulations. Criteria air pollutants and hazardous air pollutant effluent data for the INL Site are contained in the National Emission Inventory database and can be obtained from the U.S. Environmental Protection Agency (EPA) Clearinghouse for Inventories and Emission Factors website (http://www.epa.gov/ttn/chief/index.html). Information on radiological effluents is contained in *National Emission Standards for Hazardous Air Pollutants—Calendar Year 2014*, referred to hereafter as the NESHAPs Report (DOE-ID 2015).

The NESHAPs Report describes three categories of airborne emissions:

- The first category includes sources that require continuous monitoring under the NESHAPs regulation
- The second category consists of releases from other point sources
- The final category is comprised of nonpoint, or diffuse, sources, which include radioactive waste ponds and contaminated soil areas, and decontamination and decommissioning of facilities.

INL Site emissions include all three of these categories, as represented in Table 4-2. During 2014, an estimated 2,350 Ci (8.70×10^{13} Bq) of radioactivity were released to the atmosphere from all INL Site sources, which was within the range of releases from previous years, and continued the downward trend observed over the last ten years. For example, 6,614 Ci was reported to be released in 2005.

Approximately 74 percent of the radioactive effluent was from the noble gases argon, krypton, and xenon. A noble gas is inert, which means that it exists in a gaseous state and does not enter into chemical combination with other elements. Most of the remaining effluent was tritium (Table 4-2). The following facilities were contributors to the total emissions (Figure 4-1):

- **Advanced Test Reactor (ATR) Complex Emissions Sources (54.8 percent of total)** – Radiological air emissions from ATR Complex are primarily associated with operation of ATR. These emissions include noble gases, iodines, and other mixed fission and activation products, but are primarily relatively short-lived noble gases. Other radiological air emissions are associated with sample analysis, site remediation, and research and development activities. Another emission source is the INL Radioanalytical Chemistry Laboratory, in operation since 2011. Activities at the lab include wet chemical analysis to determine trace radionuclides, higher level radionuclides, inorganic, and general purpose analytical chemistry. High-efficiency particulate air filtered hoods are located in the laboratory including the radiological control room which is used for analysis of contaminated samples.

Table 4-2. Radionuclide Composition of INL Site Airborne Effluents (2014)[a].

		Airborne Effluent (Ci)[b,c]								
Radionuclide	Half Life[d]	ATR Complex[e]	CFA[e]	CITRC[e]	INTEC[e]	MFC[e]	NRF[e]	RWMC[e]	TAN	Total
Ac-228	6.15 h	—	1.83E-12	—	—	—	—	—	—	1.83E-12
Ag-110m	249.9 d	1.58E-06	—	—	—	3.00E-08	—	—	—	1.61E-06
Am-241	432.2 y	7.00E-05	1.36E-09	—	1.16E-05	7.00E-07	—	3.45E-03	—	3.53E-03
Am-243	7380 y	2.57E-14	2.31E-09	—	—	2.20E-06	—	—	—	2.20E-06
Ar-39	269 y	1.48E-19	—	—	—	—	—	—	—	1.48E-19
Ar-41	1.827 h	8.48E+02	—	—	—	—	—	—	—	8.48E+02
Ba-133	10.5 y	5.67E-12	1.87E-12	—	—	1.09E-09	—	—	—	1.10E-09
Ba-137m	2.552 m	—	5.31E-13	—	—	6.23E-07	—	—	—	6.23E-07
Ba-139	82.7 m	8.87E-03	—	—	—	—	—	—	—	8.87E-03
Ba-140	12.74 d	2.99E-06	—	—	—	—	—	—	—	2.99E-06
Ba-141	18.3 m	3.46E-09	—	—	—	—	—	—	—	3.46E-09
Be-7	53.3 d	—	—	—	—	—	—	3.06E-12	—	3.06E-12
Be-10	1.36E06 y	5.43E-20	—	—	—	—	—	—	—	5.43E-20
Bi-207	31.55 y	—	7.50E-12	—	—	7.50E-10	—	—	—	7.58E-10
Bi-210	120 h	7.68E-22	—	—	—	—	—	—	—	7.68E-22
Bi-210m	3E6 y	5.73E-28	—	—	—	—	—	—	—	5.73E-28
Bi-212	60.6 m	—	1.83E-12	—	—	—	—	2.24E-18		1.83E-12
Br-83	2.40 h	1.04E-05	—	—	—	—	—	—	—	1.04E-05
C-14	5730 y	6.28E-11	5.82E-07	—	9.82E-06	1.27E-03	9.80E-01	5.23E-02	—	1.03E+00
Ca-45	162.61 d	3.27E-14	—	—	—	—	—	—	—	3.27E-14
Cd-109	462.6 d	1.43E-11	2.01E-14	—	—	3.18E-10	—	—	—	3.32E-10
Ce-139	137.64 d	4.83E-13	4.75E-10	—	—	—	—	—	—	4.75E-10
Ce-141	32.5 d	1.02E-10	—	—	—	—	—	—	—	1.02E-10
Ce-144	284.3 d	6.66E-04	—	—	—	1.92E-08		2.28E-18		6.66E-04
Cf-242	3.483 m	—	—	—	—	1.50E-09	—	—	—	1.50E-09
Cm-242	162.8 d	6.60E-15	—	—	—	—	—	—	—	6.60E-15
Cm-243	28.5 y	1.24E-14	—	—	—	—	—	—	—	1.24E-14
Cm-244	18.11 y	9.79E-14	1.46E-08	—	5.17E-17	7.22E-10	—	4.54E-17	—	1.53E-08
Cm-248	3.48E05 y	—	—	—	—	1.70E-09	—	—	—	1.70E-09
Co-57	270.9 d	1.06E-11	7.28E-17	—	—	3.15E-10	—	—	—	3.26E-10
Co-58	70.8 d	2.97E-05	8.90E-15	—	—	2.45E-10	—	—	—	2.97E-05
Co-60	5.271 y	2.96E-02	1.29E-10	—	3.60E-05	2.15E-07	1.40E-08	9.35E-12	—	2.97E-02
Co-60m	10.5 m	1.03E-19	—	—	—	—	—	—	—	1.03E-19
Cr-51	27.704 d	6.67E-03	1.64E-13	—	—	6.82E-11	—	—	—	6.67E-03

Table 4-2. Radionuclide Composition of INL Site Airborne Effluents (2014)[a]. (cont.)

		Airborne Effluent (Ci)[b,c]								
Radionuclide	Half Life[d]	ATR Complex[e]	CFA[e]	CITRC[e]	INTEC[e]	MFC[e]	NRF[e]	RWMC[e]	TAN	Total
Cs-134	2.062 y	2.56E-05	3.28E-13	—	7.60E-08	9.25E-09	—	5.26E-10	—	2.57E-05
Cs-137	30.0 y	2.03E-02	2.26E-11	—	1.02E-02	2.35E-06	1.10E-04	5.24E-08	—	3.06E-02
Cs-138	32.2 m	2.02E-01	—	—	—	—	—	—	—	2.02E-01
Eu-152	13.33 y	3.63E-04	3.88E-13	—	3.69E-13	—	—	—	—	3.63E-04
Eu-154	8.8 y	3.15E-04	1.37E-09	—	2.96E-05	5.14E-08	—	4.48E-11	—	3.45E-04
Eu-155	4.96 y	4.72E-05	—	—	7.82E-06	1.82E-09	—	1.22E-10	—	5.50E-05
Eu-156	15.185 d	3.48E-11	—	—	—	—	—	—	—	3.48E-11
Fe-55	2.7 y	3.79E-09	3.13E-14	—	—	2.04E-05	—	9.52E-20	—	2.04E-05
Fe-59	44.4529 d	1.03E-09	—	—	—	4.96E-11	—	—	—	1.08E-09
Fe-60	1.5E06 y	1.03E-19	—	—	—	—	—	—	—	1.03E-19
Gd-153	241.6 d	—	1.76E-09	—	—	—	—	—	—	1.76E-09
Ge-71	11.43 d	3.21E-19	—	—	—	—	—	—	—	3.21E-19
H-3	12.35 y	3.60E+02	6.80E-01	—	1.20E+02	2.02E-01	1.50E-02	7.80E+01	3.26E-02	5.59E+02
Hf-175	70 d	6.32E-08	—	—	—	1.38E-10	—	—	—	6.34E-08
Hf-178m	3.94 s	2.35E-20	—	—	—	—	—	—	—	2.35E-20
Hf-179m	25.05 d	5.34E-20	—	—	—	—	—	—	—	5.34E-20
Hf-181	42.39 d	4.64E-05	3.31E-14	—	—	6.56E-10	—	—	—	4.64E-05
Hf-182	9E06 y	2.55E-23		—	—	—	—	—	—	2.55E-23
Hg-203	46.6 d	8.99E-06	3.99E-18	—	—	—	—	—	—	8.99E-06
Ho-166m	1.20E03 y	—	2.58E-10	—	—	—	—	—	—	2.58E-10
I-128	24.99 m	2.20E-03	—	—	—	—	—	—	—	2.20E-03
I-129	1.57E07 y	1.08E-07	1.61E-09	—	2.20E-02	4.56E-05	3.40E-05	—	—	2.21E-02
I-131	8.04 d	1.78E-03	—	—	—	5.07E-03	4.50E-06	—	—	6.86E-03
I-132	2.3 h	1.82E-04	—	—	—	—	—	—	—	1.82E-04
I-133	20.8 h	5.37E-04	—	—	—	—	—	—	—	5.37E-04
I-134	52.8 m	1.98E-04	—	—	—	—	—	—	—	1.98E-04
I-135	6.61 h	5.40E-05	—	—	—	—	—	—	—	5.40E-05
Ir-192	74.02 d	5.76E-21	—	—	—	—	—	—	—	5.76E-21
K-40	1.25E09 y	7.11E-08	—	—	—	—	—	2.77E-10	—	7.14E-08
Kr-85	10.72 y	1.60E-08	—	—	8.63E+02	1.34E-03	4.60E-02	5.78E-19	—	8.63E+02
Kr-85m	4.48 h	4.39E+00	—	—	—	—	—	—	—	4.39E+00
Kr-87	76.3 m	1.36E+01	—	—	—	—	—	—	—	1.36E+01
Kr-88	2.84 h	1.08E+01	—	—	—	—	—	—	—	1.08E+01
La-140	40.27 h	1.26E-07	—	—	—	—	—	—	—	1.26E-07
La-142	92.5 m	1.20E-12	—	—	—	—	—	—	—	1.20E-12
Mn-53	3.7E06 y	7.20E-23	—	—	—	—	—	—	—	7.20E-23
Mn-54	312.5 d	3.62E-05	6.78E-13	—	—	2.70E-10	—	1.45E-11	—	3.62E-05

Table 4-2. Radionuclide Composition of INL Site Airborne Effluents (2014)[a]. (cont.)

		Airborne Effluent (Ci)[b,c]								
Radionuclide	Half Life[d]	ATR Complex[e]	CFA[e]	CITRC[e]	INTEC[e]	MFC[e]	NRF[e]	RWMC[e]	TAN	Total
Mn-56	2.5785 h	1.14E-11	—	—	—	—	—	—	—	1.14E-11
Mo-93	3.5E03 y	1.01E-09	—	—	—	—	—	—	—	1.01E-09
Mo-99	66.0 h	5.86E-05	—	—	—	—	—	—	—	5.86E-05
Na-22	2.60 y	—	6.00E-10	—	—	1.50E-10	—	—	—	7.50E-10
Na-24	15.0 h	2.16E-03	—	—	—	4.23E-06	—	—	—	2.17E-03
Nb-93m	16.1 y	6.48E-13	—	—	—	—	—	—	—	6.48E-13
Nb-94	2.03E04 y	3.21E-14	—	—	—	—	—	—	—	3.21E-14
Nb-95	35.15 d	1.04E-06	1.58E-14	—	—	8.24E-12	—	—	—	1.04E-06
Nb-97	1.23 h	—	—	—	—	4.80E-12	—	—	—	4.80E-12
Ni-59	7.5E04 y	3.05E-10	4.88E-15	—	—	3.03E-10	—	—	—	6.07E-10
Ni-63	96 y	4.84E-08	1.44E-12	—	1.00E-04	3.43E-10	—	3.01E-19	—	1.00E-04
Np-237	2.14E06 y	2.33E-10	2.27E-12	—	8.43E-17	4.32E-07	—	3.88E-08	—	4.71E-07
Np-239	2.355 d	1.13E-04	—	—	—	—	—	—	—	1.13E-04
Os-185	93.6 d	4.44E-21	—	—	—	—	—	—	—	4.44E-21
Os-191	15.4 d	6.41E-05	—	—	—	—	—	—	—	6.41E-05
P-32	14.262 d	5.88E-18	3.00E-10	—					—	3.00E-10
P-33	25.34 d	3.15E-21	—	—	—	—	—	—	—	3.15E-21
Pa-233	27.0 d	—	2.55E-13	—	—	—	—	—	—	2.55E-13
Pb-205	1.53E07 y	1.72E-21	—	—	—	—	—	—	—	1.72E-21
Pb-210	22.3 y	1.11E-13	—	—	—	—	—	2.47E-08	—	2.47E-08
Pb-212	13.6 h	—	1.83E-12	—	—	—	—	2.24E-18	—	1.83E-12
Pm-147	2.6234 y	—	3.47E-11		7.60E-06	—	—	2.30E-18	—	7.60E-06
Po-210	138.38 d	1.20E-13	—	—	—	—	—	—	—	1.20E-13
Po-212	2.99E-07 s	—	1.17E-12	—	—	—	—	1.43E-18	—	1.17E-12
Po-216	0.15 s	—	1.83E-12	—	—	—	—	2.24E-18	—	1.83E-12
Pr-144	17.3 m	—	—	—	—	1.23E-09		2.29E-18	—	1.23E-09
Pr-144m	7.2 m	—	—	—	—	—	—	2.28E-10	—	2.28E-10
Pu-236	2.9 y	1.60E-14	—	—	—	—	—	—	—	1.60E-14
Pu-238	87.74 y	4.06E-14	4.02E-16	—	5.34E-05	2.88E-08	—	4.12E-05	—	9.47E-05
Pu-239	24065 y	2.67E-05	1.50E-11	—	2.47E-04	4.10E-07	2.80E-06	9.85E-04	—	1.26E-03
Pu-240	6537 y	1.29E-14	6.09E-17	—	1.21E-04	6.59E-10	—	1.79E-04	—	3.00E-04
Pu-241	14.4 y	2.45E-14	1.45E-13	—	3.90E-03	1.00E-09	—	1.41E-03	—	5.31E-03
Pu-242	3.8E05 y	1.25E-13	9.58E-11	—	—	4.47E-07	—	3.20E-08	—	4.79E-07
Ra-224	3.66 d	—	1.83E-12	—	—	—	—	2.24E-18	—	1.83E-12
Ra-226	1600 y	3.12E-10	3.15E-13	—	—	—	—	1.10E-11	—	3.23E-10
Ra-228	5.75 y	—	1.83E-12	—	—	—	—	—	—	1.83E-12

Table 4-2. Radionuclide Composition of INL Site Airborne Effluents (2014)[a]. (cont.)

		Airborne Effluent (Ci)[b,c]								
Radionuclide	Half Life[d]	ATR Complex[e]	CFA[e]	CITRC[e]	INTEC[e]	MFC[e]	NRF[e]	RWMC[e]	TAN	Total
Rb-88	17.8 m	1.66E-01	—	—	—	—	—	—	—	1.66E-01
Rb-89	15.2 m	1.25E-01	—	—	—	—	—	—	—	1.25E-01
Re-184	38.0 d	3.06E-18	—	—	—	—	—	—	—	3.06E-18
Re-184m	165 d	2.35E-18	—	—	—	—	—	—	—	2.35E-18
Re-186	3.77 d	8.28E-20	—	—	—	—	—	—	—	8.28E-20
Re-186m	2.0E05 y	8.28E-20	—	—	—	—	—	—	—	8.28E-20
Re-187	5E10 y	3.45E-17	—	—	—	—	—	—	—	3.45E-17
Re-188	17.005 h	4.37E-04	—	—	—	—	—	—	—	4.37E-04
Rh-106	29.8 s	—	—	—	—	1.18E-09	—	—	—	1.18E-09
Rn-220	55.6 s	—	6.10E-06	—	—	—	—	—	—	6.10E-06
Ru-103	39.26 d	4.92E-11	—	—	—	—	—	—	—	4.92E-11
Ru-106	373.59 d	2.59E-06	—	—	—	1.17E-09	—	—	—	2.59E-06
Sb-122	2.7238 d	9.80E-07	—	—	—	—	—	—	—	9.80E-07
Sb-124	60.2 d	3.67E-06	5.83E-14	—	—	—	—	—	—	3.67E-06
Sb-125	2.77 y	2.34E-11	1.08E-13	—	7.30E-07	2.31E-05	—	1.39E-19	—	2.38E-05
Sb-127	3.854 d	9.63E-06	—	—	—	—	—	—	—	9.63E-06
Sc-46	83.83 d	2.84E-13	1.49E-14	—	—	—	—	—	—	2.99E-13
Si-32	150 y	5.34E-18	—	—	—	—	—	—	—	5.34E-18
Sm-145	340 d	—	—	—	—	2.40E-11	—	—	—	2.40E-11
Sm-151	90 y	—	—	—	1.70E-04	—	—	—	—	1.70E-04
Sn-113	115.09 d	6.57E-12	6.89E-19	—	—	3.15E-10	—	—	—	3.22E-10
Sr-80	1.77 h	1.08E-13	—	—	—	—	—	—	—	1.08E-13
Sr-85	64.84 d	3.02E-10	—	—	—	—	—	—	—	3.02E-10
Sr-89	50.5 d	2.97E-06	—	—	—	7.74E-09	—	—	—	2.98E-06
Sr-90	29.12 y	7.03E-02	3.50E-13		8.41E-03	3.52E-06	5.50E-05	5.98E-08	1.02E-06	7.88E-02
Sr-91	9.5 h	1.76E-10	—	—	—	—	—	—	—	1.76E-10
Sr-92	2.7 h	1.20E-10	—	—	—	—	—	—	—	1.20E-10
Ta-179	1.8 y	1.34E-14	—	—	—	—	—	—	—	1.34E-14
Ta-182	114.43 d	1.26E-05	—	—	—	1.09E-10	—	—	—	1.26E-05
Ta-183	5.1 d	5.94E-10	—	—	—		—	—	—	5.94E-10
Tc-99	2.13E05 y	2.08E-11	1.70E-10	—	1.23E-07	1.50E-10	—	—	—	1.23E-07
Tc-99m	6.02 h	2.26E-04	3.48E-71	9.50E-07	—	—	—	—	—	2.27E-04
Te-123m	119.7 d	1.32E-15	—	—	—	—	—	—	—	1.32E-15
Te-125m	58.0 d	—	—	—	—	5.97E-12	—	—	—	5.97E-12
Te-129	1.16 h	—	—	—	—	1.20E-12	—	—	—	1.20E-12
Th-228	1.9116 y	2.12E-11	1.84E-12	—	—	—	—	2.24E-18	—	2.30E-11
Th-229	7340 y	3.60E-16	—	—	—	—	—	—	—	3.60E-16

Table 4-2. Radionuclide Composition of INL Site Airborne Effluents (2014)[a]. (cont.)

		Airborne Effluent (Ci)[b,c]								
Radionuclide	**Half Life[d]**	**ATR Complex[e]**	**CFA[e]**	**CITRC[e]**	**INTEC[e]**	**MFC[e]**	**NRF[e]**	**RWMC[e]**	**TAN**	**Total**
Th-230	7.7E04 y	2.77E-14	—	—	—	—	—	—	—	2.77E-14
Th-231	1.06 d	—	—	—	—	1.01E-12	—	—	—	1.01E-12
Th-232	1.4E10 y	3.09E-11	1.86E-12	—	—	1.36E-09	—	6.16E-19	—	1.39E-09
Tl-204	3.77 y	3.81E-21	—	—	—	—	—	—	—	3.81E-21
Tl-208	3.05 m	—	6.57E-13	—	—	—	—	8.03E-19	—	6.57E-13
U-232	72 y	6.86E-15	4.44E-17	—	—	—	—	4.65E-10	—	4.65E-10
U-233	1.585E05 y	1.95E-11	7.55E-08	—	2.71E-08	7.50E-06	—	9.75E-05	—	1.05E-04
U-234	2.457E05 y	1.40E-10	6.90E-12	—	2.19E-07	2.53E-07	—	2.70E-07	1.40E-11	7.43E-07
U-235	7.038E08 y	1.36E-11	2.58E-13	—	1.47E-08	1.75E-08	—	5.68E-08	9.75E-13	8.91E-08
U-236	2.34E07 y	7.20E-16	—	—	1.81E-10	3.00E-10	—	—	—	4.81E-10
U-238	4.5E09 y	1.55E-09	6.41E-11	—	7.07E-08	6.24E-09	—	1.62E-06	7.77E-11	1.69E-06
V-49	330 d	3.21E-19	—	—	—	—	—	—	—	3.21E-19
W-181	121.2 d	4.08E-09	—	—	—	—	—	—	—	4.08E-09
W-185	75.1 d	6.87E-08	—	—	—	—	—	—	—	6.87E-08
W-187	23.9 h	1.68E-04	—	—	—	—	—	—	—	1.68E-04
W-188	69.78 d	2.59E-08	—	—	—	—	—	—	—	2.59E-08
Xe-133	5.245 d	4.20E-08	—	—	—	—	—	—	—	4.20E-08
Xe-135	9.09 h	1.67E+01	—	—	—	—	—	—	—	1.67E+01
Xe-135m	15.29 m	7.79E+00	—	—	—	—	—	—	—	7.79E+00
Xe-138	14.17 m	2.94E+01	—	—	—	—	—	—	—	2.94E+01
Y-88	106.64 d	2.82E-12	3.00E-10	—	—	—	—	—	—	3.03E-10
Y-90	64.0 h	2.10E-03	—	—	3.11E-09	6.56E-07	—	—	—	2.10E-03
Y-92	3.54 h	1.56E-12	—	—	—	—	—	—	—	1.56E-12
Zn-65	243.9 d	1.48E-04	1.90E-12		—	—	—	—	—	1.48E-04
Zr-93	1.53E06 y	—	—	—	1.69E-13	—	—	—	—	1.69E-13
Zr-95	63.98 d	5.88E-06	1.50E-10	—	—	8.48E-12	—	—	—	5.88E-06
Zr-97	16.9 h	1.14E-11	—	—	—	—	—	—	—	1.14E-11
Totals		1.29E+03	6.80E-01	9.50E-07	9.83E+02	2.10E-01	1.04E+00	7.81E+01	3.26E-02	2.35E+03

a. Radionuclide release information provided by the INL contractor. One curie (Ci)= 3.7 x 10^{10} becquerels (Bq)
b. Includes only those radionuclides with a total INL Site release that potentially contribute > 1E-05 mrem (1E-07 mSv) dose.
c. d = days, h = hours, m = minutes, s = seconds, y = years
d. ATR = Advanced Test Reactor, CFA = Central Facilities Area, CITRC = Critical Infrastructure Test Range Complex, INTEC = Idaho Nuclear Technology and Engineering Center, MFC = Materials and Fuels Complex, NRF = Naval Reactors Facility, RWMC = Radioactive Waste Management Complex, including Advanced Mixed Waste Treatment Project, TAN = Test Area North, including Specific Manufacturing Capability.
e. A long dash signifies the radionuclide was not reported to be released to air from the facility in 2014.

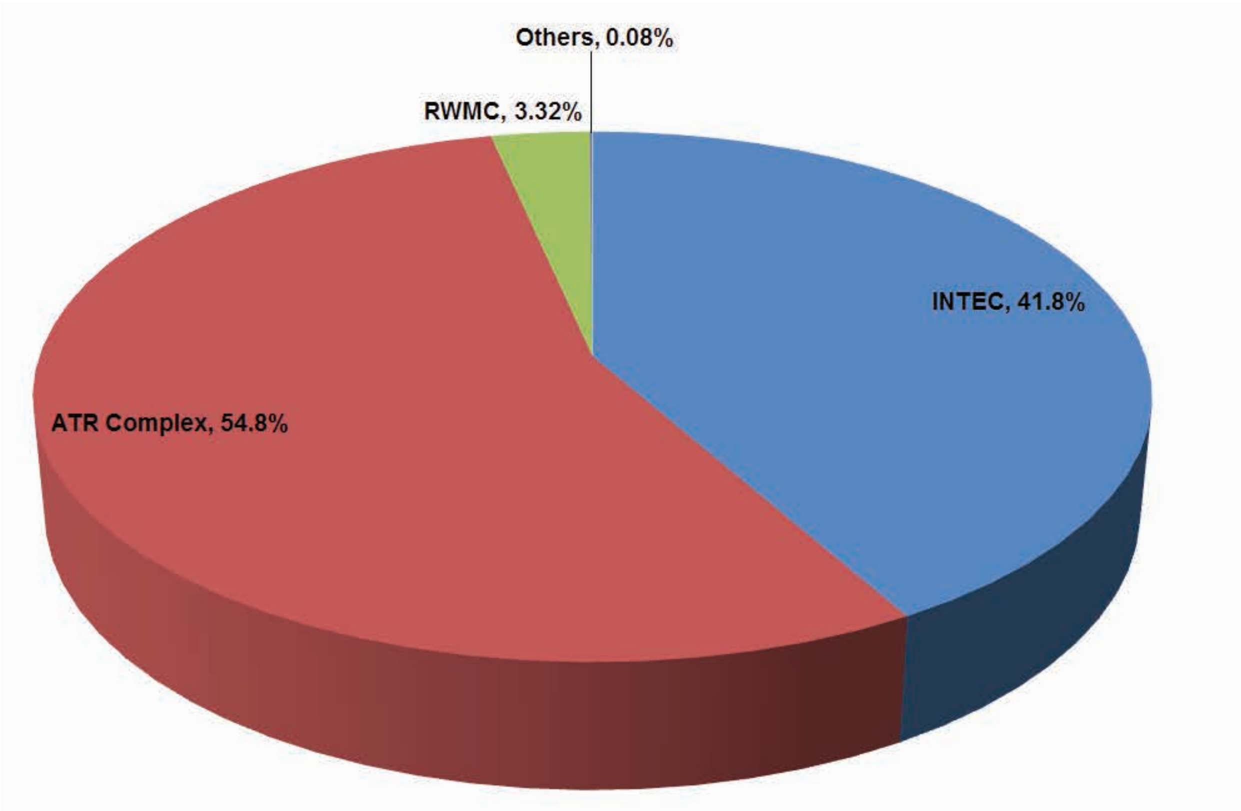


Figure 4-1. Percent Contributions, by Facility, to Total INL Site Airborne Radionuclide Releases (2014).

- **Idaho Nuclear Technology and Engineering Center (INTEC) Emissions Sources (41.8 percent of total)** – Radiological air emissions from INTEC sources are primarily associated with liquid waste operations, including effluents from the Tank Farm Facility, Process Equipment Waste Evaporator, and Liquid Effluent Treatment and Disposal, which are exhausted through the Main Stack. These radioactive emissions include particulates and gaseous radionuclides. Additional radioactive emissions are associated with wet-to-dry spent nuclear fuel movements, remote-handled transuranic waste management, radiological and hazardous waste storage facilities, and contaminated equipment maintenance.

  The ICDF is located on the southwest corner of INTEC. Radiological emissions from this facility are estimated from waste disposal in the landfill, evaporation pond operations, and waste treatment operations.

  Most of the INTEC emissions contained krypton-85 (^{85}Kr). Krypton-85 is a radionuclide commonly associated with the nuclear fuel cycle and has a 10-yr half-life. The dose potentially received from ^{85}Kr is primarily external exposure from immersion in a contaminated plume.

- **Radioactive Waste Management Complex (RWMC) Emissions Sources (3.32 percent of total)** – Emissions from RWMC result from various activities associated with the facility's mission to manage the low-level radioactive site and to temporarily store contact-handled and remote-handled transuranic waste for shipment to other designated facilities for disposal. In addition, various activities are being conducted in the SDA at RWMC to complete environmental cleanup of the area under CERCLA. These include waste retrieval activities (Accelerated Retrieval Projects [ARPs]) and operation of several units that extract volatile organic compounds from the subsurface.

Potential unabated emissions from the ARP and sludge repackaging in ARP-V exceed 0.1 mrem/yr (0.001 mSv/yr). By agreement with EPA, the ARP and sludge repackaging project used ambient air monitoring as an alternative to air dispersion calculations to verify compliance with the standard during ARP and sludge repackaging operation. Real-time monitoring is still conducted using continuous air monitors for detection of off-normal emissions.

RWMC processed (retrieved, sorted, and repackaged) radionuclide-contaminated soils and sludge within the ARP-V enclosure as part of the ARP CERCLA remediation. Exhumation of waste from the ARP-V area within WMF-1617 was completed in August of 2011. As of November 2012, the ARP-V facility (i.e., WMF-1617) was excessed from CERCLA, and a Resource Conservation and Recovery Act (RCRA) permit was completed that allowed processing of RCRA waste from the Advanced Mixed Waste Treatment Project (AMWTP) facility in WMF-1617. Processing of 6,000 drums of sludge from AMWTP under the RCRA permit was completed in June 2014.

The AMWTP sludge processing activity was designed to ensure contact-handled stored transuranic waste is compliant with off-site disposal facility waste acceptance criteria by removing prohibited waste items (e.g., free liquids). The emissions from RWMC were estimated to be almost exclusively tritium.

- **Central Facilities Area (CFA) Emissions Sources (0.0289 percent of total)** – Minor emissions occur from CFA facilities where work with small quantities of radioactive materials is conducted. This includes sample preparation and verification and radiochemical research and development. Other minor emissions result from groundwater usage.
- **Materials and Fuels Complex (MFC) Emissions Sources (0.00891 percent of total)** – Radiological air emissions at MFC are primarily associated with spent fuel treatment at the Fuel Conditioning Facility, waste characterization at the Hot Fuel Examination Facility, and fuel research and development at the Fuel Manufacturing Facility. These facilities are equipped with continuous emission monitoring systems. On a regular basis, the effluent streams from Fuel Conditioning Facility, Hot Fuel Examination Facility, Fuel Manufacturing Facility, and other non-continuous emission monitoring radiological facilities are sampled and analyzed for particulate radionuclides. Gaseous and particulate radionuclides may also be released from other MFC facilities during laboratory research activities, sample analysis, waste handling and storage, and maintenance operations. Radiological emissions at MFC also occurred from ICP decontamination and decommissioning activities in MFC-766, Sodium Boiler Building.
- **Test Area North (TAN) Emissions Sources (0.00138 percent of total)** – The main emissions sources at TAN are from the Specific Manufacturing Capability (SMC) project, and the New Pump and Treat Facility. Radiological air emissions from Specific Manufacturing Capability are associated with processing of depleted uranium. Potential emissions are uranium isotopes and associated radioactive progeny. The main purpose of the New Pump and Treat Facility is to reduce concentrations of trichloroethylene and other volatile organic compounds in the medial portion of the Operable Unit 1-07B contamination groundwater plume at TAN to below drinking water standards. Low levels of strontium-90 (^{90}Sr) and tritium are also present in the treated water and are released to the atmosphere by the treatment process.

Estimated radionuclide releases (Ci/yr) from INL Site facilities, shown in Table 4-2, were used to calculate the dose to the hypothetical maximally exposed individual (MEI), who is assumed to reside near the INL Site perimeter. In terms of the estimated dose to the MEI (0.0365 mrem/yr [0.365 µSv/yr]), facility contributions were 42 percent from the RWMC, 36 percent from the ATR Complex, 22 percent from INTEC, and <1 percent from the remaining facilities (see Figure 8-4). Most of the dose resulting from RWMC releases (about 31 percent of the total dose to the MEI) was due to estimated emissions of americium-241 (^{241}Am), and to a lesser extent ^{239}Pu, from waste retrieval operations at WMF-1617 (ARP-V), WMF-1619 (ARP-VII) and WMD-1621 (ARP-VIII). Tritium releases from beryllium blocks disposed of at the RWMC accounted for about 9 percent of the total MEI dose. The majority of the dose to the MEI from the ATR Complex was due to fugitive emissions of ^{90}Sr, tritium and ^{137}Cs from the Warm Waste Ponds, and ^{41}Ar and tritium from the ATR main stack. Iodine-129 and tritium that could potentially be released from the Three Mile Island (TMI)-Independent Spent Storage Installation at INTEC represented most of the dose associated with that facility. The potential dose from ingesting or inhaling ^{241}Am and ^{239}Pu is higher than that for other

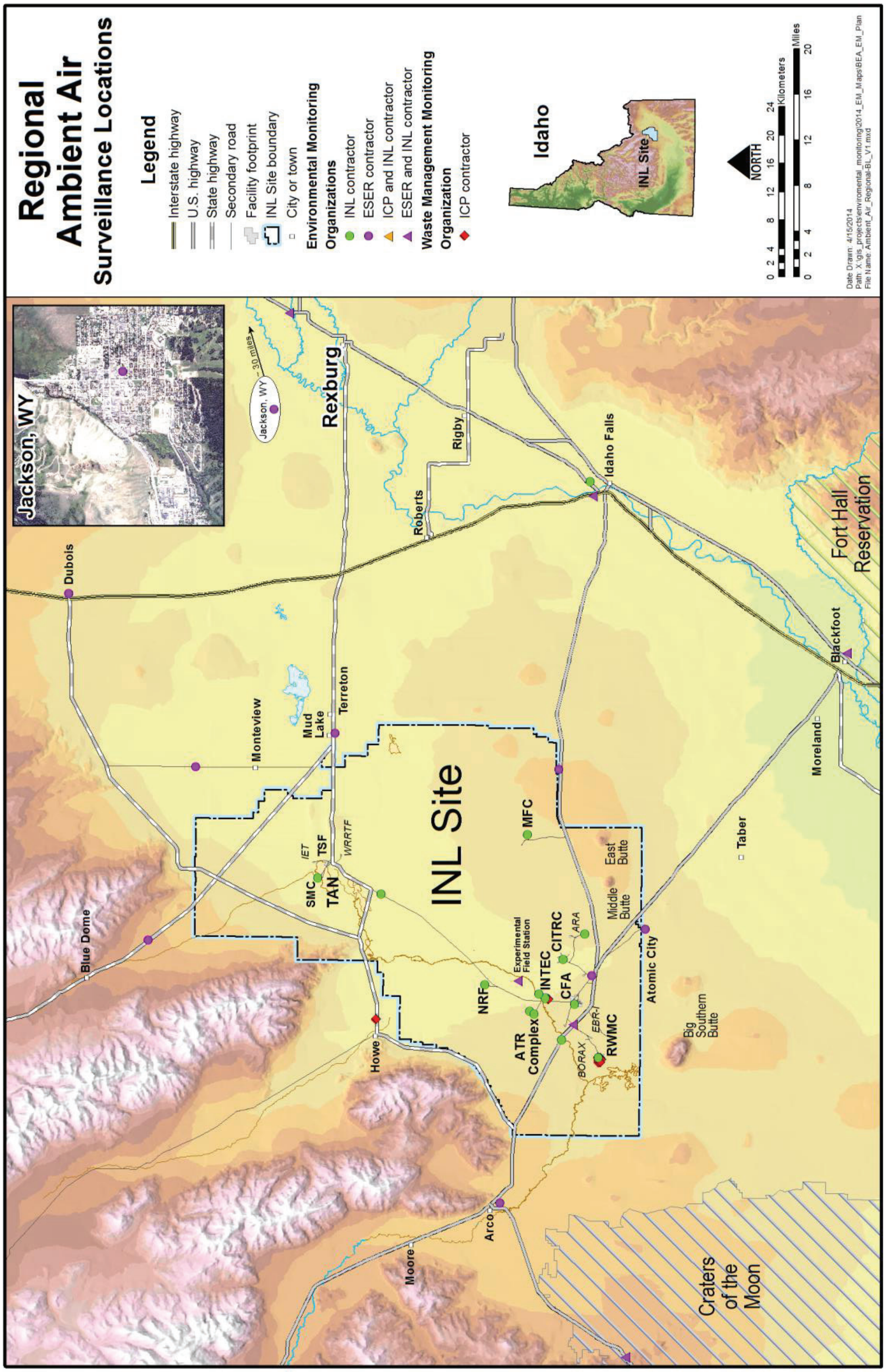


Figure 4-2. INL Site Environmental Surveillance Air Sampling Locations.

radionuclides because these radionuclides are long-lived and can stay in the body for decades and continue to expose the surrounding tissues to both alpha and gamma radiation. Although most of the activity released from the INL Site is from the ATR Complex (Figure 4-1) and consists primarily of noble gases (particularly ^{41}Ar), the dose consequences of these radionuclides is relatively small due to their short half-lives and the fact that they are not incorporated into the food chain. Potential radiation doses to the public are discussed in more detail in Chapter 8 of this report.

4.3 Ambient Air Monitoring

The INL, ICP, and ESER contractors' environmental surveillance programs monitor air pathways on and off the INL Site for radionuclides. Figure 4-2 shows the regional ambient air monitoring locations.

Filters are collected weekly by the INL and ESER contractors from a network of low-volume air monitors. At each monitor, a pump pulls air (about 57 L/min [2 ft^3/min]) through a 5-cm (2-in.), 1.2-µm membrane filter and a charcoal cartridge. The ICP contractor collects filters bimonthly using 10-cm (4-in.) and 20-cm (8-in.) membrane filters. The 10-cm membrane filters are then analyzed in a laboratory for gross alpha and beta activity. Gross alpha and beta results are considered screenings because specific radionuclides are not identified. Rather, the results reflect a mix of alpha- and beta-emitting radionuclides. Gross alpha and beta radioactivity in air samples are usually dominated by the presence of naturally occurring radionuclides. Because of this, gross alpha and gross beta radioactivity is, with rare exceptions, detected in each air filter collected. If the results are higher than normal, sources other than background radionuclides may be suspected, and other laboratory techniques can be used to identify specific radionuclides of concern. Gross alpha and beta activity are also examined over time and between locations to detect trends, which might indicate the need for more specific analyses.

The filters are composited quarterly by the ESER and INL contractors and monthly by the ICP contractor for laboratory analysis of gamma-emitting radionuclides, such as ^{137}Cs. Cesium-137 is a man-made radionuclide and is present in soil on and off the INL Site from historical INL Site activities and global fallout. The contaminated soil particles can become airborne and subsequently filtered by air samplers. Naturally occurring gamma-emitting radionuclides that are typically detected in air filters include beryllium-7 (^{7}Be) and potassium-40.

The ESER and ICP contractors also use laboratories to radiochemically analyze the quarterly and monthly composited samples for selected alpha- and beta-emitting radionuclides. These radionuclides include ^{241}Am, plutonium-238, plutonium-239/240 ($^{239/240}$Pu), and ^{90}Sr. They were selected for analysis because they have been detected historically in air samples and may be present due to resuspension of surface soil particles contaminated by INL Site activities or global fallout. The INL contractor screens for certain actinides (uranium-235, uranium-238, and ^{241}Am) using the quarterly gamma spectrometry analysis of the composited air samples and orders additional analyses based on the screening results or in response to requests from the ESER or ICP contractors.

Charcoal cartridges are collected and analyzed weekly for iodine-131 (^{131}I) by the INL and ESER contractors. Iodine-131 is of particular interest because it is produced in relatively large quantities by nuclear fission, is readily accumulated in human and animal thyroids, and has a half-life of eight days. This means that any elevated level of ^{131}I in the environment could be from a recent release of fission products.

The ESER and INL contractors monitor tritium in atmospheric water vapor in ambient air on the INL Site at the Experimental Field Station (EFS) and Van Buren Boulevard, and off the INL Site at Atomic City, Blackfoot, Craters of the Moon, Idaho Falls, and Sugar City. Air passes through a column of molecular sieve, which is an adsorbent material that adsorbs water vapor in the air. Columns are sent to a laboratory for analysis when the material has adsorbed sufficient moisture to obtain a sample. The laboratory extracts water from the material by distillation and determines tritium concentrations by liquid scintillation counting. Tritium is present in air moisture due to natural production in the atmosphere, although it also is released by INL Site facilities (Table 4-2).

Precipitation samples are collected by the ESER contractor at EFS, CFA, and Idaho Falls and analyzed for tritium using liquid scintillation counting in a laboratory.

4.3.1 Ambient Air Monitoring Results

Gaseous Radioiodines – The INL contractor collected and analyzed approximately 1,200 charcoal cartridges in 2014. There were no statistically positive detections of ^{131}I. During 2014, the ESER contractor analyzed 936 cartridges, usually in batches of ten cartridges, looking specifically for ^{131}I. No ^{131}I was detected in any of the cartridges.

Gross Activity – All air filters were analyzed for gross alpha and gross beta activity. Gross alpha and gross beta measurements were assessed in terms of historical measurements and trends between locations and contractors, as well as over time. All measurements were included in these assessments, even the few that were not considered to be detected, to make the statistical analyses more robust. For more information see the discussion of "less-than-detectable values" in the document entitled *Statistical Methods in the Idaho National Laboratory Annual Site Environmental Report*, which is a supplement to this report.

- ***Gross Alpha.*** Gross alpha concentrations measured in individual INL contractor samples ranged from a low of (-0.71 ± 0.92) × 10^{-15} µCi/mL collected at CFA on October 1, 2014, to a high of (5.4 ± 1.4) × 10^{-15} µCi/mL collected at INTEC on January 22, 2014. The maximum result was equal to historical high concentrations and attributed to inversion conditions. Gross alpha concentrations measured in weekly ESER contractor samples ranged from a minimum of (-0.26 ± 0.04) × 10^{-15} µCi/mL at Idaho Falls during the week ending March 12, 2014, to a maximum of (2.49 ± 0.24) × 10^{-15} µCi/mL during the week of January 22, 2014, at Van Buren. All results were within the range of historical measurements and less than the Derived Concentration Standard (DCS) of 4 × 10^{-14} µCi/mL for ^{241}Am (see Table A-1 of Appendix A).

  INL and ESER contractor gross alpha activity data differed little when analyzed by location grouping, as illustrated in Figure 4-3. In this figure, median concentrations measured at INL Site and offsite locations (boundary and distant) are plotted for each week of the year. Each median weekly concentration was computed using all measurements, including negative values and statistically undetected results. Both data sets (INL contractor and ESER contractor) indicate that gross alpha concentrations measured at INL Site and offsite locations follow a similar pattern with respect to time.

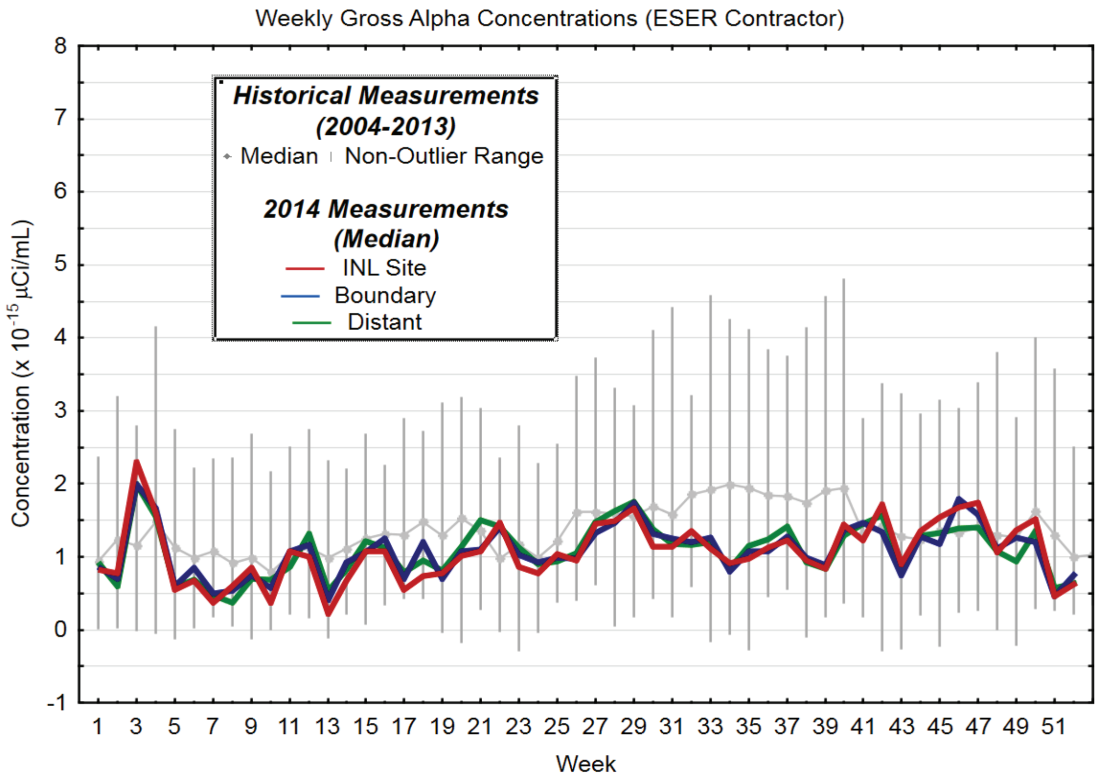
  Median annual gross alpha concentrations calculated by the INL contractor ranged from 0.97 × 10^{-15} µCi/mL at Craters of the Moon National Monument to 1.6 × 10^{-15} µCi/mL at Advanced Test Reactor Complex. Median annual gross alpha concentrations calculated by the ESER contractor for each location ranged from 0.9 × 10^{-15} µCi/mL at Craters of the Moon to 1.2 × 10^{-15} µCi/mL at Jackson, Atomic City, and Mud Lake (Table 4-3). The median annual gross alpha concentrations were typical of those detected previously, well within those measured historically, and remarkably consistent between sampling locations.

- ***Gross Beta.*** Gross beta concentrations in ESER contractor samples were fairly consistent with those of INL contractor samples. Weekly gross beta concentrations in INL contractor samples ranged from a low of (-0.023 ± 0.074) × 10^{-14} µCi/mL at EFS on June 4, 2014, to a high of (6.9 ± 0.66) × 10^{-14} µCi/mL at EFS on January 22, 2014. Weekly gross beta concentrations detected in individual ESER contractor samples ranged from a low of (1.7 ± 0.33) × 10^{-15} µCi/mL on April 2, 2014, at Van Buren to a high of (6.0 ± 0.091) × 10^{-14} µCi/mL on November 19, 2014, also at Van Buren. These results are within the range of past measurements.

  Figure 4-4 displays the median weekly gross beta concentrations for the ESER and INL contractors at INL Site, boundary, and distant sampling groups in 2014, as well as historical median and range of data measured by the ESER contractor during the 10-year period from 2004 through 2013. In general, median airborne radioactivity levels for the three groups (on INL Site, boundary, and distant locations) tracked each other closely throughout the year. These data are typical of the annual fluctuation pattern for natural gross beta concentrations in air, with higher values typically occurring at the beginning and end of the calendar year during winter inversion conditions (see sidebar). An inversion can lead to natural radionuclides being trapped close to the

What is an inversion?

Usually within the lower atmosphere, the air temperature decreases with height above the ground. This is largely because the atmosphere is heated from below as solar radiation warms the earth's surface, which, in turn, warms the layer of the atmosphere directly above it. A meteorological inversion is a deviation from this normal vertical temperature gradient such that the temperature increases with height above the ground. A meteorological inversion is typically produced whenever radiation from the earth's surface exceeds the amount of radiation received from the sun. This commonly occurs at night or during the winter when the sun's angle is very low in the sky.



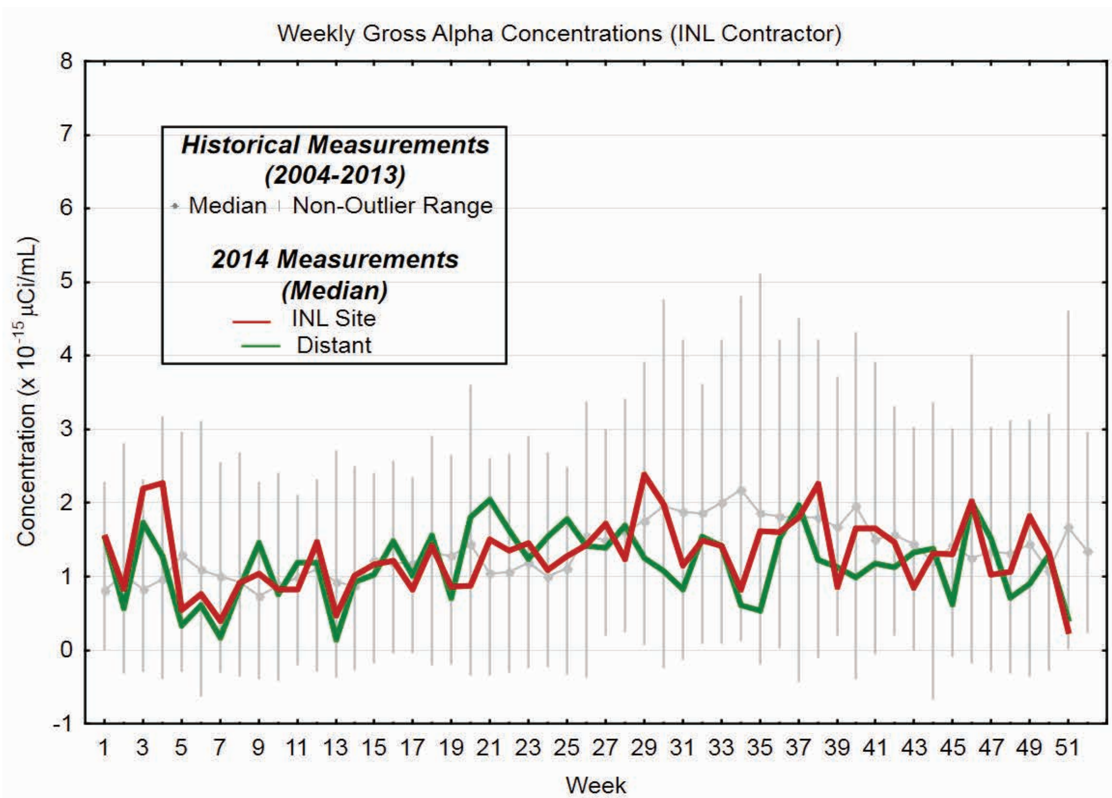


Figure 4-3. Median Weekly Gross Alpha Concentrations in Air (2014).

Table 4-3. Median Annual Gross Alpha Concentrations in Air (2014).

Group	Location[a]	No. of Samples[b]	Range of Concentrations[c] (× 10^{-15} µCi/mL)	Annual Median[c] (× 10^{-15} µCi/mL)
ESER Contractor				
Distant	Blackfoot	52	0.55 – 2.27	1.1
	Craters of the Moon	52	0.13 – 1.83	0.9
	Dubois	52	0.41 – 2.16	1.1
	Idaho Falls	52	-0.26 – 2.04	1.0
	Jackson	52	-0.13 – 2.22	1.2
	Sugar City	51	0.27 – 2.05	1.0
			Distant Median:	1.0
Boundary	Arco	50	0.31 – 2.33	1.1
	Atomic City	52	0.41 – 2.06	1.2
	Blue Dome	52	0.30 – 2.08	1.0
	Federal Aviation Administration Tower	51	-0.07 – 1.78	1.0
	Howe	52	0.14 – 2.17	1.1
	Monteview	52	0.52 – 2.24	1.1
	Mud Lake	52	0.32 – 2.18	1.2
			Boundary Median:	1.1
INL Site	EFS	52	0.23 – 2.01	1.0
	Main Gate	50	0.21 – 2.30	1.1
	Van Buren	52	0.04 – 2.49	1.0
			INL Site Median:	1.0
INL Contractor				
Distant	Blackfoot	50	-0.13– 3.3	1.3
	Craters of the Moon	51	-0.15 – 3.2	0.97
	Idaho Falls	50	-0.02 – 4.3	1.3
	Sugar City	50	-0.12 – 3.3	1.2
	IRC	50	0.14 – 3.5	1.1
			Distant Median:	1.1
INL Site	ARA	49	-0.32 – 3.3	1.3
	ATR Complex (south side)	51	0.18 – 4.3	1.6
	ATR Complex (NE corner)	50	0 – 3.8	1.2
	CFA	51	-0.71 – 3.1	1.4
	CITRC	51	-0.37 – 3.9	1.4
	INTEC (west side)	50	-0.34 – 2.6	1.1
	EBR-I	51	-0.39 – 3.3	1.0
	EFS	49	-0.49 – 6.5	1.2
	Gate 4	51	0.17 – 2.9	1.2
	INTEC (NE corner)	51	-0.12 – 5.4	1.3
	MFC	51	-0.62 – 3.0	1.4
	NRF	51	-0.13 – 4.5	1.4
	Rest Area	50	-0.09 – 4.8	1.3
	RWMC	51	-0.12 – 4.3	1.1
	SMC	50	-0.09 – 3.8	1.1

Table 4-3. Median Annual Gross Alpha Concentrations in Air (2014). (cont.)

Group	Location[a]	No. of Samples[b]	Range of Concentrations[c] (× 10^{-15} µCi/mL)	Annual Median[c] (× 10^{-15} µCi/mL)
	Van Buren	51	-0.52 – 3.7	1.2
			INL Site Median:	1.3

a. ARA = Auxiliary Reactor Area, ATR = Advanced Test Reactor Complex, CFA = Central Facilities Area, CITRC = Critical Infrastructure Test Range Complex, EBR-I = Experimental Breeder Reactor No. 1, EFS = Experimental Field Station, INTEC = Idaho Nuclear Technology and Engineering Center, MFC = Materials and Fuels Complex, NRF = Naval Reactors Facility, RWMC = Radioactive Waste Management Complex, SMC = Specific Manufacturing Capability. See Figure 4-2 for locations on INL Site.
b. Includes valid (i.e., sufficient volume) samples only. Does not include duplicate measurements.
c. All measurements, including those <3s, are included in this table and in computation of median annual values. A negative result indicates that the measurement was less than the laboratory background measurement.

ground. In 2014, the most prominent inversion periods occurred in January and November, although not as strong as many previous years. The maximum median weekly gross beta concentration was 2.2 × 10^{-14} µCi/mL, which is significantly below the DCS of 240 × 10^{-14} µCi/mL (see Table A-1 of Appendix for the most restrictive beta-emitting radionuclide in air (radium-228 [^{228}Ra]).

ESER contractor median annual gross beta concentrations ranged from 1.95 × 10^{-14} µCi/mL at Sugar City to 2.22 × 10^{-14} µCi/mL at Mud Lake. INL contractor data ranged from a median annual concentration of 2.0 × 10^{-14} µCi/ mL at Idaho Research Center to 2.6 × 10^{-14} µCi/ mL at Naval Reactors Facility (Table 4-4). All results detected by the ESER and INL contractors were well within valid measurements taken within the last 13 years (Figure 4-4). This indicates that the fluctuation patterns over the entire sampling network are representative of natural conditions and are not caused by a localized source, such as a facility or activity at the INL Site.

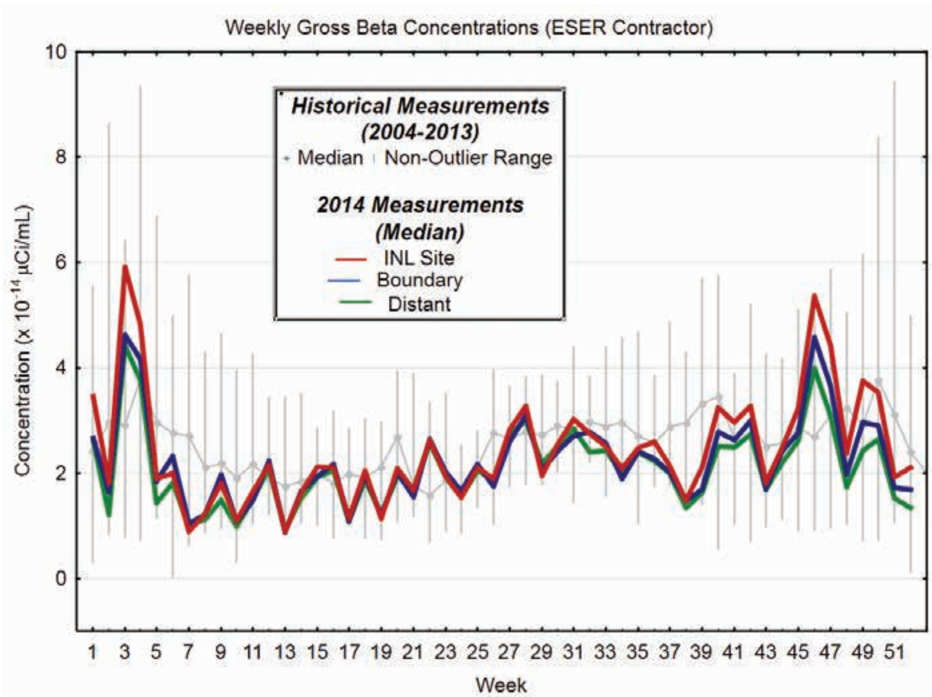
- ***Gross Activity Statistical Comparisons.*** Statistical comparisons were made using the gross alpha and gross beta radioactivity data collected by the ESER contractor from the INL Site, boundary, and distant locations (see the supplemental report, *Statistical Methods Used in the Idaho National Laboratory Annual Site Environmental Report*, for a description of methods used). If the INL Site were a significant source of offsite contamination, contaminant concentrations would be statistically greater at boundary locations than at distant locations. There were no statistical differences among annual concentrations collected from the INL Site, boundary, and distant locations in 2014. There were a few statistical differences between weekly boundary and distant data sets collected by the ESER contractor during the 53 weeks of 2014 that can be attributed to expected statistical variation in the data and not to INL Site releases. Quarterly reports detailing these analyses are provided at http://www.gsseser.com/Publications.htm.

  INL Contractor data sets from samples collected on the INL Site and distant locations were compared and concentrations were typical of those measured historically and attributable to natural data variation.

Specific Radionuclides – The ESER contractor observed two detections of ^{90}Sr during the second quarter of 2014 (Table 4-5). These occurred at Atomic City and the INL Site Main Gate. Both were just above the minimum detectable concentration for ^{90}Sr and were within the range detected in the past several years. The DCS for ^{90}Sr in air is 2.5 × 10^{-11} µCi/mL.

No other human-made radionuclides were detected in any of the composites analyzed during 2014.

Natural ^{7}Be was detected in numerous ESER and INL contractor composite samples at concentrations consistent with past concentrations. Atmospheric ^{7}Be results from reactions of galactic cosmic rays and solar energetic particles with nitrogen and oxygen nuclei in earth's atmosphere.



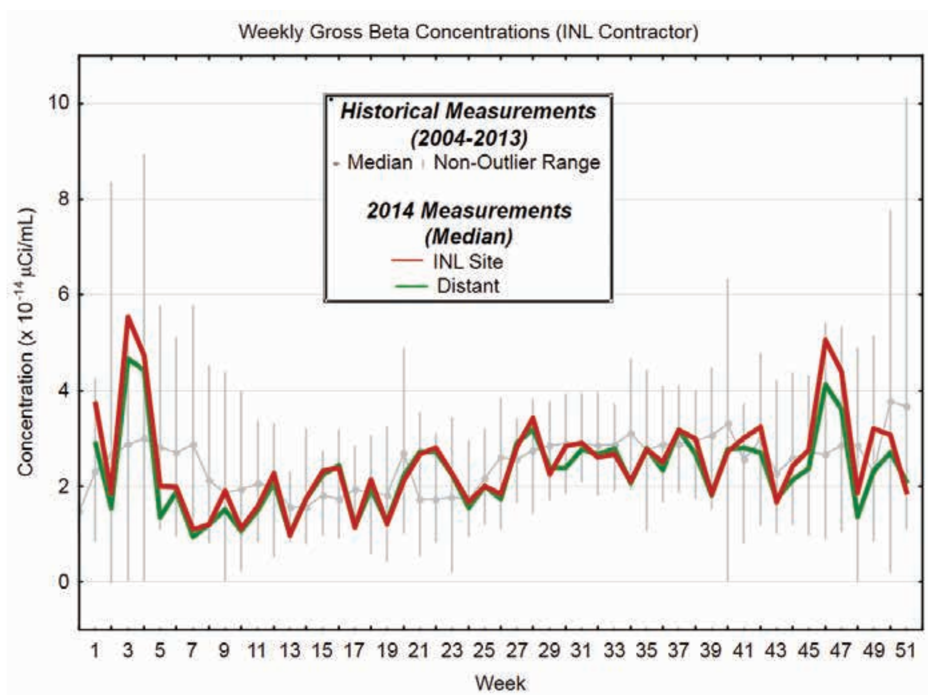


Figure 4-4. Median Weekly Gross Beta Concentrations in Air (2014).

Table 4-4. Median Gross Beta Concentrations in Air (2014).

Group	Location[a]	No. of Samples[b]	Range of Concentrations[c] ($\times 10^{-14}$ µCi/mL)	Annual Median[c] ($\times 10^{-14}$ µCi/mL)
		ESER Contractor		
Distant	Blackfoot	52	0.91 – 4.7	2.0
	Craters of the Moon	52	0.85– 4.6	2.0
	Dubois	52	0.86 – 4.7	2.0
	Idaho Falls	52	0.92 – 4.0	2.0
	Jackson	52	0.96 – 4.2	2.2
	Sugar City	51	0.90 – 4.0	2.0
			Distant Median:	2.0
Boundary	Arco	50	0.93 – 4.7	2.2
	Atomic City	52	0.88 – 5.9	2.2
	Blue Dome	52	0.81 – 4.5	2.1
	Federal Aviation Administration Tower	51	0.81 – 4.6	2.1
	Howe	52	0.98 – 4.9	2.0
	Monteview	52	0.89 – 4.8	2.1
	Mud Lake	52	0.82 – 4.8	2.2
			Boundary Median:	2.1
INL Site	EFS	52	0.90 – 5.9	2.0
	Main Gate	50	0.90 – 5.7	2.2
	Van Buren	52	0.17 – 6.0	2.1
			INL Site Median:	2.1
		INL Contractor		
Distant	Blackfoot	50	0.72 – 4.5	2.2
	Craters of the Moon	51	0.87 – 4.9	2.2
	Idaho Falls	50	0.94 – 4.9	2.2
	Sugar City	50	0.89 – 4.2	2.3
	IRC	50	0.92 – 4.4	2.0
			Distant Median	2.2
INL Site	ARA	49	1.0 – 5.3	2.2
	ATR Complex (south side)	51	1.1 – 5.4	2.6
	ATR Complex (NE corner)	50	0.8 – 5.6	2.5
	CFA	51	0.8 – 6.8	2.5
	CITRC	51	0.97 – 6.0	2.5
	INTEC (west side)	50	0.9 – 6.0	2.4
	EBR-I	51	0. 74– 5.6	2.2
	EFS	49	-0.023 – 6.9	2.2
	Gate 4	51	0.97 – 6.1	2.4
	INTEC (NE corner)	51	0.98 – 5.2	2.4
	MFC	51	0.84 – 5.1	2.2
	NRF	51	0.99 – 6.0	2.6

Table 4-4. Median Gross Beta Concentrations in Air (2014). (cont.)

Group	Location[a]	No. of Samples[b]	Range of Concentrations[c] (× 10^{-14} µCi/mL)	Annual Median[c] (× 10^{-14} µCi/mL)
	Rest Area	50	0.65 – 5.5	2.5
	RWMC	51	0.99 – 5.3	2.4
	SMC	50	0.76 – 5.5	2.6
	Van Buren	51	0.78 – 5.6	2.4
			INL Site Median:	2.4

a. ARA = Auxiliary Reactor Area, ATR = Advanced Test Reactor Complex, CFA = Central Facilities Area, CITRC = Critical Infrastructure Test Range Complex, EBR-I = Experimental Breeder Reactor No. 1, EFS = Experimental Field Station, INTEC = Idaho Nuclear Technology and Engineering Center, MFC = Materials and Fuels Complex, NRF = Naval Reactors Facility, RWMC = Radioactive Waste Management Complex, SMC = Specific Manufacturing Capability.
b. Includes valid samples only. Does not include duplicate measurements.
c. All measurements, including those <3s, are included in this table and in computation of median annual values.

Table 4-5. Human-made Radionuclides Detected in ESER Contractor Air Samples (2014).

Radionuclide	Result[a] (µCi/mL)	Location	Group	Quarter Detected
Strontium-90	$(3.01 \pm 0.95) \times 10^{-17}$	Atomic City	Boundary	2nd
	$(2.59 \pm 0.81) \times 10^{-17}$	Main Gate	INL Site	2nd

a. Results ± 1s. Results shown are ≥ 3s.

4.3.2 Atmospheric Moisture Monitoring Results

The INL contractor collected atmospheric moisture samples at the EFS and Van Buren Boulevard on the INL Site and at Idaho Falls and Craters of the Moon off the INL Site. During 2014, 40 samples were collected and no reportable measurements (i.e., >3s) were made.

During 2014, the ESER contractor collected 62 atmospheric moisture samples. Table 4-6 presents the percentage of samples that contained detectable tritium, the range of concentrations, and the mean concentration for each location. Tritium was detected in 26 samples, with a high of 28.3 × 10^{-13} µCi/ mL at Idaho Falls. The highest concentration of tritium detected in an atmospheric moisture sample since 1998 was 38 × 10^{-13} µCi/mL at Atomic City. The results are within historical measurements and are probably natural and/or weapons testing fallout in origin. The highest observed tritium concentration is far below the DCS for tritium in air (as hydrogen tritium oxygen) of 1.4 × 10^{-8} µCi/mL (see Table A-1 of Appendix A).

4.3.3 Precipitation Monitoring Results

The ESER contractor collects precipitation samples weekly at EFS, when available, and monthly at CFA and off the INL Site in Idaho Falls. A total of 43 precipitation samples were collected during 2014 from the three sites. Tritium concentrations were detected in 27 samples, and detectable results ranged up to a high of 311 pCi/L at EFS during December. Table 4-7 shows the percentage of detections, the concentration range, and the mean concentration for each location. The highest concentration is well below the DCS level for tritium in water of 1.9 × 10^6 pCi/L. The concentrations are well within the historical normal range at the INL Site. The maximum concentration measured since 1998 was 553 pCi/L at EFS in 2000. The results are well within measurements made by the EPA in Region 10 (Alaska, Idaho, Oregon, and Washington) for the past ten years (http://www.epa.gov/enviro/html/erams/).

Table 4-6. Tritium Concentrations in ESER Contractor Atmospheric Moisture Samples (2014).

	Atomic City	Blackfoot	Idaho Falls	Sugar City
Number of samples	13	18	16	15
Number of detections	4	7	7	8
Detection percentage	30.8	38.9	43.8	53.3
Concentration range (x 10^{-13} µCi/mL)	-2.40-13.45	0.30-16.04	-0.56-28.33	0.20-15.86
Mean concentration (x 10^{-13} µCi/mL)	3.43	5.09	5.89	4.40

Table 4-7. Tritium Concentrations in ESER Contractor Precipitation Samples (2014).

	Central Facilities Area	Experimental Field Station	Idaho Falls
Number of samples	11	19	13
Number of detections	8	12	7
Detection percentage	72.7	63.2	53.8
Concentration range (pCi/L)	-49-198	-20-311	-62-188
Mean concentration (pCi/L)	79.1	114.2	60.5

4.3.4 Suspended Particulates Monitoring Results

In 2014, the ESER contractor measured concentrations of suspended particulates using filters collected from the low-volume air samplers. The filters are 99 percent efficient for collection of particles greater than 0.3 µm in diameter. That is, they collect the total particulate load greater than 0.3 µm in diameter.

Mean annual particulate concentrations ranged from 6.6 µg/m^3 at Blue Dome to 19.7 µg/m^3 at Howe. In general, particulate concentrations were higher at offsite locations than at the INL Site stations. This is most likely influenced by agricultural activities off the INL Site.

4.4 Waste Management Environmental Surveillance Air Monitoring

4.4.1 Gross Activity

The ICP contractor conducts environmental surveillance in and around waste management facilities to comply with DOE Order 435.1, "Radioactive Waste Management." Currently, ICP waste management operations occur at the SDA at RWMC and the ICDF at INTEC and have the potential to emit radioactive airborne particulates. The ICP contractor collected samples of airborne particulate material from the perimeters of these waste management areas in 2014 (Figure 4-5). The ICP contractor also collected samples from a control location at Howe, Idaho (Figure 4-2), to compare with the results of the SDA and ICDF. Samples were obtained using suspended particulate monitors similar to those used by the INL and ESER contractors. The air filters are 4 in. in diameter and are changed out on the closest working day to the 1st and the 15th of each month. Gross alpha and gross beta activity were determined on all suspended particulate samples.

Table 4-8 shows the median annual and range of gross alpha concentrations at each location. Gross alpha concentrations measured at waste management operations ranged from a low of $(0.18 \pm 0.24) \times 10^{-15}$ µCi/mL collected at SDA-4.2 on February 17, 2014, to a high of $(8.82 \pm 1.05) \times 10^{-15}$ µCi/mL at the same station on August 18, 2014.

Table 4-9 shows the median annual and range of gross beta concentrations at each location. Gross beta concentrations measured at waste management operations ranged from a low of $(0.92 \pm 0.12) \times 10^{-14}$ µCi/mL collected at SDA-4.3 on April 1, 2014, to a high of $(5.75 \pm 0.49) \times 10^{-14}$ µCi/mL at INT-100.3 on February 3, 2014. The gross alpha and gross beta results for the SDA and ICDF are comparable to historical results, and no new trends were identified.

Table 4-8. Median Annual Gross Alpha Concentration in Air at Waste Management Sites (2014).[a]

Group	Location	No. of Samples	Range of Concentrations ($\times 10^{-15}$ µCi/mL)	Annual Median ($\times 10^{-15}$ µCi/mL)
Subsurface Disposal Area	SDA-1.3	24	0.90 - 6.98	1.78
	SDA-2.3	24	0.26 - 7.07	1.65
	SDA-4.2	24	0.18 - 8.82	1.54
	SDA-4.3	24	0.24 - 6.61	1.77
	SDA-6.3	24	0.44 - 3.78	1.95
	SDA-9.3	24	0.69 - 8.43	1.91
	SDA-11.3	17	0.46 - 7.72	2.04
Idaho CERCLA Disposal Facility	INT-100.3	24	0.68 - 5.70	1.89
Boundary	HOWE-400.4	24	0.53 - 4.51	1.60

a. Results ± 1s.

Table 4-9. Median Annual Gross Beta Concentration in Air at Waste Management Sites (2014).[a]

Group	Location	No. of Samples	Range of Concentrations ($\times 10^{-14}$ µCi/mL)	Annual Median ($\times 10^{-14}$ µCi/mL)
Subsurface Disposal Area	SDA-1.3	24	1.75 - 4.83	2.70
	SDA-2.3	24	1.26 - 4.35	2.45
	SDA-4.2	24	0.98 - 4.48	2.03
	SDA-4.3	24	0.92 - 4.01	2.11
	SDA-6.3	24	1.65 - 4.89	2.60
	SDA-9.3	24	1.52 - 3.74	2.44
	SDA-11.3	17	1.62 - 5.05	2.98
Idaho CERCLA Disposal Facility	INT-100.3	24	1.77 - 5.75	2.91
Boundary	HOWE-400.4	24	1.24 - 5.38	2.59

a. Results ± 1s.

4.4.2 Specific Radionuclides

In 2014, no man-made, gamma-emitting radionuclides were detected at the SDA at RWMC or at the ICDF at INTEC.

Table 4-10 shows human-made specific alpha- and beta-emitting radionuclides detected at the SDA in air samples analyzed using radiochemistry in 2014. These detections are consistent with levels measured in air at RWMC in previous years, and are attributed to resuspension of soils in and adjacent to RWMC. The values and locations for plutonium and americium detections remained consistent from 2013 to 2014. The detections shown in Table 4-10 are likely due to resuspension of contaminated soils as a result of early burial practices (Markham et al. 1978), previously flooded areas inside or northeast of the SDA, and ARP fugitive emissions. Recent studies of radionuclide concentrations in soils (VanHorn et al. 2012) confirm that $^{239/240}$Pu and ^{241}Am still are present in measurable amounts in surface soils surrounding RWMC, with maximum concentrations northeast of the SDA. Although radionuclides were detected, all detections were three to four orders of magnitude below the DCS reported in DOE-STD-1196-2011, and statistically false positives at the 95 percent confidence error are possible. No human-made specific alpha- or beta-emitting radionuclides were detected in air samples from INTEC in 2014. The ICP contractor will continue to closely monitor radionuclides to identify trends.

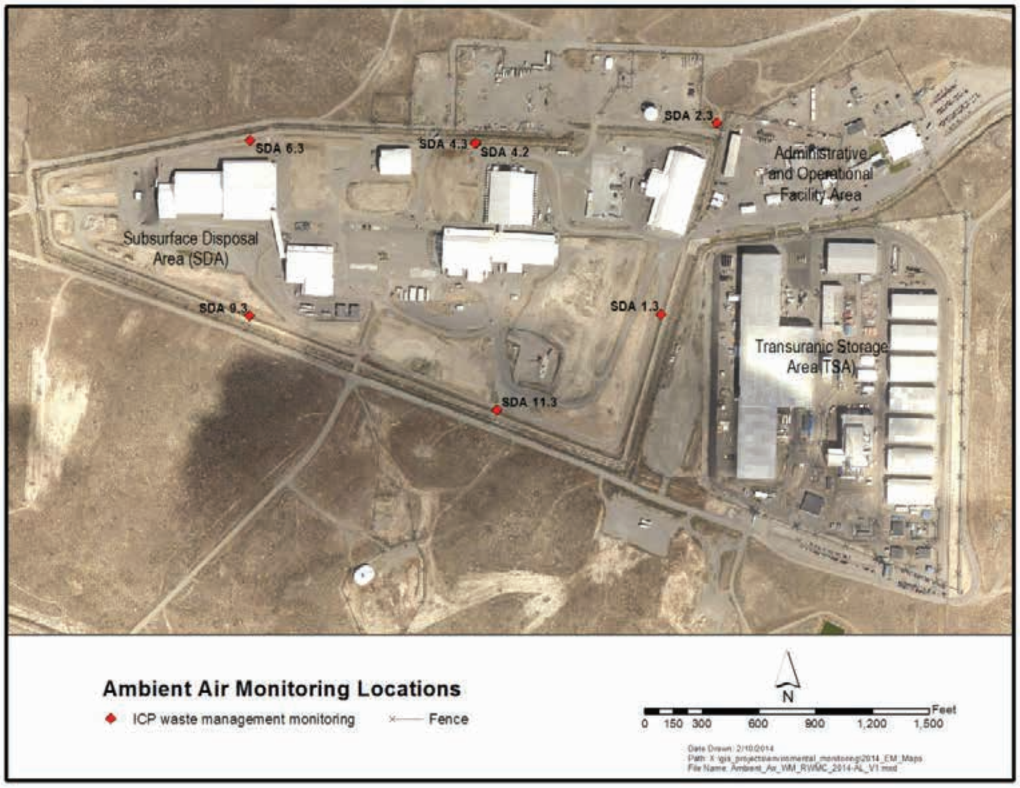


Figure 4-5. Locations of Low-volume Air Samplers at Waste Management Areas. (RWMC [top] and ICDF [bottom]).

Table 4-10. Human-made Radionuclides Detected in ICP Contractor Air Samples (2014).[a]

Radionuclide	Result (µCi/mL)	Location	Quarter Detected
Americium-241	(2.75 ± 0.31) E-17	SDA[b]-2.3	1st
	(4.87 ± 0.95) E-18	SDA-4.3	1st
	(3.02 ± -0.75) E-18	SDA-1.3	2nd
	(3.23 ± 0.78) E-18	SDA-2.3	2nd
	(3.26 ± 0.32) E-17	SDA-4.3	2nd
	(1.95 ± 0.51) E-18	SDA-1.3	3rd
	(5.71 ± 0.86) E-18	SDA-2.3	3rd
	(1.59 ± 0.18) E-17	SDA-4.3	3rd
	(4.06 ± 0.92) E-18	SDA-6.3	3rd
	(6.18 ± 0.93) E-18	SDA-9.3	3rd
	(7.49 ± 1.07) E-18	SDA-11.3	3rd
	(1.43 ± 0.41) E-18	SDA-1.3	4th
	(5.97 ± 0.88) E-18	SDA-2.3	4th
	(1.39 ± 0.16) E-17	SDA-4.3	4th
Plutonium-238	(2.54 ± 0.74) E-18	SDA-4.3	2nd
Plutonium-239/240	(5.58 ± 1.28) E-18	SDA-2.3	1st
	(1.82 ± 0.60) E-18	HOWE-400.3	2nd
	(3.43 ± 0.82) E-18	SDA-2.3	2nd
	(8.88 ± 0.84) E-17	SDA-4.3	2nd
	(3.49 ± 0.71) E-18	SDA-1.3	3rd
	(2.82 ± 0.60) E-18	SDA-2.3	3rd
	(7.49 ± 1.14) E-18	SDA-4.3	3rd
	(2.99 ± 0.71) E-18	SDA-6.3	3rd
	(2.93 ± 0.62) E-18	SDA-9.3	3rd
	(4.20 ± 0.79) E-18	SDA-11.3	3rd
	(1.33 ± 0.42) E-18	SDA-2.3	4th
	(6.52 ± 0.91) E-18	SDA-4.3	4th
	(1.40 ± 0.37) E-18	SDA-11.3	4th
Strontium-90	(5.50 ± 1.59) E-17	SDA 4.3	3rd

a. Results ± 1s. Results shown are ≥ 3s.
b. SDA - Subsurface Disposal Area.

REFERENCES

DOE Order 435.1, 2011, "Radioactive Waste Management," Change 2, U.S. Department of Energy.

DOE Order 458.1, 2013, "Radiation Protection of the Public and the Environment," Administrative Change 3, U.S. Department of Energy.

DOE, 2015, *DOE Handbook – Environmental Radiological Effluent Monitoring and Environmental Surveillance*, DOE-HDBK-1216-2015, U.S. Department of Energy.

DOE-ID, 2014a, *Technical Basis for Environmental Monitoring and Surveillance at the Idaho National Laboratory Site*, DOE/ID-11485, U.S. Department of Energy, Idaho Operations Office, February 2014.

DOE-ID, 2014b, *Idaho National Laboratory Site Environmental Monitoring Plan*, DOE/ID-10-11088, Rev. 4, U.S. Department of Energy Idaho Operations Office, February 2014.

DOE-ID, 2015, *National Emissions Standards for Hazardous Air Pollutants—Calendar Year 2014*, DOE/ID-10890(14), U.S. Department of Energy Idaho Operations Office.

DOE-STD-1196-2011, 2011, *Derived Concentration Technical Standard*, U.S. Department of Energy, April 2011.

Markham, O. D., K. W. Puphal, and T. D. Filer, 1978, "Plutonium and Americium Contamination Near a Transuranic Storage Area in Southeastern Idaho," *Journal of Environmental Quality*, Vol. 7, No. 3, July – September 1978.

VanHorn R. L., L. S. Cahn, V. M. Kimbro, K. J. Holdren, 2012, *Operable Unit 10-04 Long-Term Ecological Monitoring Report for Fiscal Years 2003 to 2008*, DOE/ID 11390, Rev. 1, U.S. Department of Energy Idaho Operations Office.

Prairie Pink
Lygodesmia grandiflora

5. Compliance Monitoring for Liquid Effluents, Groundwater, Drinking Water, and Surface Water

Indian Paintbrush
Castilleja miniata

Liquid effluents and related groundwater, drinking water, and surface water runoff were monitored in 2014 by the Idaho National Laboratory (INL) contractor and the Idaho Cleanup Project (ICP) contractor for compliance with applicable regulatory standards established to protect human health and the environment.

Wastewater discharged to land surfaces and evaporation ponds at the INL Site is regulated by the state of Idaho groundwater quality and wastewater rules and requires a wastewater reuse permit. During 2014, permitted facilities were: Central Facilities Area (CFA) Sewage Treatment Plant; Idaho Nuclear Technology and Engineering Center New Percolation Ponds; Advanced Test Reactor Complex Cold Waste Pond; and Materials and Fuels Complex Industrial Waste Ditch and Industrial Waste Pond. These facilities were sampled for parameters required by their facility-specific permits. No permit limits were exceeded in 2014. Additional liquid effluent and groundwater monitoring were performed in 2014 at these facilities to comply with environmental protection objectives of the U.S. Department of Energy. All parameters were below applicable health-based standards.

Nine drinking water systems were monitored by the INL contractor in 2014 for parameters required by "Idaho Rules for Public Drinking Water Systems." Water samples collected from drinking water systems were well below drinking water limits for all relevant regulatory parameters. Because workers can potentially be impacted from radionuclides in the CFA distribution system, the dose from ingesting tritium to a CFA worker was calculated. The dose was estimated to be 0.18 mrem (1.8 µSv) for 2014, assuming all of the worker's daily water intake comes from the well. This is below the Environmental Protection Agency standard of 4 mrem/yr (0.04 mSv/yr) for public drinking water. Two drinking water systems were monitored by the ICP contractor at the Radioactive Waste Management Complex and Idaho Nuclear Technology and Engineering Center. All parameters were below their respective drinking water limits in 2014.

To monitor the potential for radionuclides to be transported outside the RWMC boundaries, the ICP contractor collects surface water runoff samples at the Radioactive Waste Management Complex Subsurface Disposal Area, and determines if concentrations exceed administrative control levels or if concentrations have increased significantly compared to historical data. No human-made gamma-emitting radionuclides were detected in 2014.

5. COMPLIANCE MONITORING FOR LIQUID EFFLUENTS, GROUNDWATER, DRINKING WATER, AND SURFACE WATER

This chapter presents analytical results of water samples collected by the Idaho National Laboratory (INL) contractor (Battelle Energy Alliance, LLC) and Idaho Cleanup Project (ICP) contractor (CH2M-WG Idaho, LLC) at the INL Site and the Research and Education Campus (Idaho Falls facilities). Included in this chapter are descriptions and monitoring results of liquid effluent and related groundwater, drinking water, and surface water runoff conducted for compliance with regulatory limits and permits.

To improve the readability of this chapter, data tables are only included that compare monitoring results to specified discharge limits, permit limits, or maximum contaminant levels (MCLs). Data tables for other monitoring results are provided in Appendix C.

5.1 Summary of Monitoring Programs

The INL contractor and ICP contractor monitor drinking water, liquid effluent, surface water runoff, and groundwater that could be impacted by INL Site operations and activities. This monitoring is conducted to comply with applicable state and local laws and wastewater reuse permit requirements.

Table 5-1 presents compliance monitoring performed at the INL Site. A comprehensive discussion and maps of environmental monitoring performed by various organizations within and around the INL Site can be found in the *Idaho National Laboratory Site Environmental Monitoring Plan* (DOE-ID 2014).

Table 5-1. Water Monitoring at the INL Site for Regulatory Compliance.

Area/Facility	Media				
	Liquid Effluent (Permitted)[a]	Liquid Effluent (Surveillance)	Groundwater (Permitted)	Drinking Water	Surface Runoff
ICP Contractor					
INTEC	●	●	●	●	
RWMC				●	●
INL Contractor					
ATR Complex	●	●	●	●	
CFA[b]	●	●		●	
MFC	●	●	●	●	
CITRC				●	
TAN/TSF				●	
TAN/CTF (SMC)				●	

a. In 2009, the city of Idaho Falls assumed responsibility for the semiannual liquid effluent monitoring conducted at the Research and Education Campus.
b. Includes Weapons Range, Experimental Breeder Reactor-I, and Main Gate.

5.2 Wastewater and Related Groundwater Compliance Monitoring

Discharge of wastewater to the land surface is regulated by wastewater rules (Idaho Administrative Procedures Act [IDAPA] 58.01.16 and .17). Wastewater reuse permits require monitoring of nonradioactive parameters in the influent waste, effluent waste, and groundwater in accordance with the Idaho ground water quality standards stipulated in the "Ground Water Quality Rule" (IDAPA 58.01.11). Some facilities may have specified radiological parameters monitored for surveillance purposes (not required by regulations). The permits specify annual discharge volumes, application rates, and effluent quality limits. Annual reports (ICP 2015a, 2015b; INL 2015a, 2015b, 2015c, 2015d, 2015e) were prepared and submitted to the Idaho Department of Environmental Quality (DEQ).

During 2014, the INL contractor and ICP contractor monitored, as required by the permits, the following facilities (Table 5-2):

- Central Facilities Area (CFA) Sewage Treatment Plant
- Idaho Nuclear Technology and Engineering Center (INTEC) New Percolation Ponds
- Advanced Test Reactor (ATR) Complex Cold Waste Pond
- Materials and Fuels Complex (MFC) Industrial Waste Ditch and Industrial Waste Pond.

Additional effluent parameters are monitored to comply with environmental protection objectives of DOE Order 458.1. Section 5.3 discusses the results of liquid effluent surveillance monitoring.

The following subsections present results of wastewater and groundwater monitored to comply with facility-specific permits.

5.2.1 Research and Education Campus

Description. The city of Idaho Falls is authorized by the Clean Water Act, National Pollutant Discharge Elimination System to set pretreatment standards for nondomestic wastewater discharges to publicly owned treatment works. The INL contractor facilities in Idaho Falls are required to comply with the applicable regulations in Chapter 1, Section 8 of the Municipal Code of the city of Idaho Falls.

The Industrial Wastewater Acceptance Permit for the INL Research Center specifies special conditions and compliance schedules, prohibited discharges, reporting

Table 5-2. Status of Wastewater Reuse Permits.

Facility	Permit Status at End of 2014	Explanation
ATR Complex Cold Waste Pond	Renewal Permit issued	DEQ[a] issued Permit #LA-000161-01 on February 26, 2008, modified on August 20, 2008, with a scheduled expiration date of February 25, 2013. A renewal permit application (INL 2013) was submitted to DEQ. DEQ issued Permit I-161-02 on November 20, 2014.
CFA Sewage Treatment Facility	Permit issued	DEQ issued Permit #LA-000141-03 on March 17, 2010. The permit will expire on March 16, 2015.
INTEC New Percolation Ponds	Permit issued	DEQ issued Permit #LA-000130-05 on March 14, 2012, with a minor modification issued on August 8, 2014. The permit will expire on March 14, 2017.
MFC Industrial Waste Pond and Industrial Waste Ditch	Permit issued	In 2010, DEQ issued Permit #LA-000160-01, effective May 1, 2010, to April 30, 2015. DEQ issued Permit WRU-I-0160-01 (formerly LA-000160-01), Modification 1 on June 21, 2012. A reuse permit renewal application was submitted to DEQ in October 2014 (Miller 2014a).

a. DEQ = Idaho Department of Environmental Quality

requirements, monitoring requirements, and effluent concentration limits for specific parameters.

Wastewater Monitoring Results. In 2009, the city of Idaho Falls assumed responsibility for the semiannual monitoring conducted at the Research and Education Campus. Analytical results are available upon request from the city of Idaho Falls.

5.2.2 Central Facilities Area Sewage Treatment Facility

Description. The CFA Sewage Treatment Facility serves all major buildings at CFA. The treatment facility is southeast of CFA, approximately 671 m (2,200 ft) downgradient of the nearest drinking water well.

A 1,500-L/min (400-gal/min) pump applies wastewater from a 0.2-ha (0.5-acre) lined polishing pond to approximately 30 ha (74 acres) of sagebrush steppe grassland through a computerized center pivot irrigation system; refer to sections 5.3.2 and 7.2.2 for further information.

Wastewater Monitoring Results for the Wastewater Reuse Permit. DEQ issued a permit for the CFA Sewage Treatment Plant on March 17, 2010. The permit required effluent monitoring and soil sampling in the wastewater land application area (soil samples were required in 2010 and 2013). Effluent samples are collected from the pump pit (prior to the pivot irrigation system) monthly during land application. During the 2014 permit year, no wastewater was applied to the land application area; therefore, no effluent sampling was required by the permit. A recycled water reuse permit application was submitted to DEQ in September 2014 (INL 2014).

Groundwater Monitoring Results for the Wastewater Reuse Permit. The wastewater reuse permit does not require groundwater monitoring at the CFA Sewage Treatment Facility.

5.2.3 Advanced Test Reactor Complex Cold Waste Pond

Description. The Cold Waste Pond (CWP) is located approximately 137 m (450 ft) from the southeast corner of the ATR Complex compound and approximately 1.2 km (.75 mile) southwest of the Big Lost River channel (Figure 5-1). The existing CWP was excavated in 1982. It consists of two cells, each with dimensions of 55 × 131 m (180 × 430 ft) across the top of the berms, and a depth of 3 m (10 ft). Total surface area for the two cells at the top of the berms is approximately 1.44 ha (3.55 acres). Maximum capacity is approximately 10.22 million gallons (MG).

Wastewater discharged to the CWP consists primarily of noncontact cooling tower blowdown, once through cooling water for air conditioning units, coolant water from air compressors, secondary system drains, and other nonradioactive drains throughout the ATR Complex. Chemicals used in the cooling tower and other effluent streams discharged to the CWP include commercial biocides and corrosion inhibitors. DEQ issued a wastewater reuse permit for the pond in February 2008. A permit renewal application was submitted to DEQ on August 21, 2012 (INL 2013). DEQ issued a new permit on November 20, 2014 (Neher 2014).

Wastewater Monitoring Results for the Wastewater Reuse Permit. Permit #LA-000161-01 was superseded by I-161-02 on November 20, 2014. The data included in this report are limited to January to November 2014 for LA-000161-01 because only one month of data (December 2014) was collected for the revised analyte list in the new permit. The data for December 2014 will be included in the 2015 report. The industrial wastewater reuse permit requires monthly sampling of the effluent to the CWP. The permit sets monthly concentration limits for total suspended solids (100 mg/L) and total nitrogen (20 mg/L), and the results (minimum, maximum, and median) of those permit-limited parameters are shown

Figure 5-1. Permit Monitoring Locations for the ATR Complex CWP.

Table 5-3. Total Nitrogen and Total Suspended Solids Effluent Monitoring Results at ATR Complex Cold Waste Pond (January to November 2014).[a]

Parameter	Minimum	Maximum	Median	Permit Level
Total nitrogen[b] (mg/L)	<0.777	3.189	1.763	20
Total suspended solids (mg/L)	4 U[c]	4 U	4 U	100

a. Duplicate samples were collected in June, and the results for the duplicate samples are included in the summary.
b. Total nitrogen is calculated as the sum of total Kjeldahl nitrogen and nitrate + nitrite, as nitrogen.
c. U flag indicates the result was below detection limit.

in Table 5-3. During 2014, neither total suspended solids nor total nitrogen exceeded the permit limit. The minimum, maximum, and median results of all parameters monitored are presented in Table C-1.

Concentrations of sulfate and total dissolved solids are higher during reactor operation because of evaporative concentration of the corrosion inhibitors and biocides added to the reactor cooling water.

Groundwater Monitoring Results for the Wastewater Reuse Permit. To measure potential impacts from the CWP, the permit requires groundwater monitoring in April and October at five wells (Figure 5-1; Table C-2).

Aluminum, iron, and manganese were elevated in some of the unfiltered samples because of suspended aquifer matrix material or rust in the well water. The metals concentrations in the filtered samples were below the applicable standards.

5.2.4 Idaho Nuclear Technology and Engineering Center New Percolation Ponds and Sewage Treatment Plant

Description. The INTEC New Percolation Ponds are composed of two unlined ponds excavated into the surficial alluvium and surrounded by bermed alluvial material (Figure 5-2). Each pond is 93 m × 93 m (305 ft × 305 ft) at the top of the berm and is approximately 3 m (10 ft) deep. Each pond is designed to accommodate a continuous wastewater discharge rate of 3 MG per day.

The INTEC New Percolation Ponds receive discharge of only nonhazardous industrial and municipal wastewater. Industrial wastewater (i.e., service waste) from INTEC operations consists of steam condensates, noncontact cooling water, water treatment effluent, boiler blowdown wastewater, storm water, and small volumes of other nonhazardous liquids. Municipal wastewater (i.e., sanitary waste) is treated at the INTEC Sewage Treatment Plant prior to discharge to the New Percolation Ponds.

The Sewage Treatment Plant is located east of INTEC, outside the INTEC security fence, and treats and disposes of sewage, septage, and other nonhazardous industrial wastewater at INTEC. The Sewage Treatment Plant depends on natural biological and physical processes (digestion, oxidation, photosynthesis, respiration, aeration, and evaporation) to treat the sanitary waste in four lagoons. After treatment in the lagoons, the effluent is combined with the service waste and discharged to the INTEC New Percolation Ponds.

The INTEC New Percolation Ponds are permitted by DEQ to operate as a wastewater reuse facility under Wastewater Reuse Permit LA-000130-05 (DEQ 2012). The renewed permit became effective on March 14, 2012.

Wastewater Monitoring Results for the Wastewater Reuse Permit. Monthly samples were collected from:

- CPP-769 – influent to Sewage Treatment Plant
- CPP-773 – effluent from Sewage Treatment Plant prior to combining with service waste
- CPP-797 – combined effluent prior to discharge to the INTEC New Percolation Ponds.

As required by the permit, all samples are collected as 24-hour flow proportional composites, except pH and total coliform, which are collected as grab samples. The permit specifies the parameters that must be monitored for each location, but the permit does not set discharge limits for any of the parameters monitored at CPP-769, CPP-773, or CPP-797. Instead, monitoring results are compared to the primary and secondary constituent

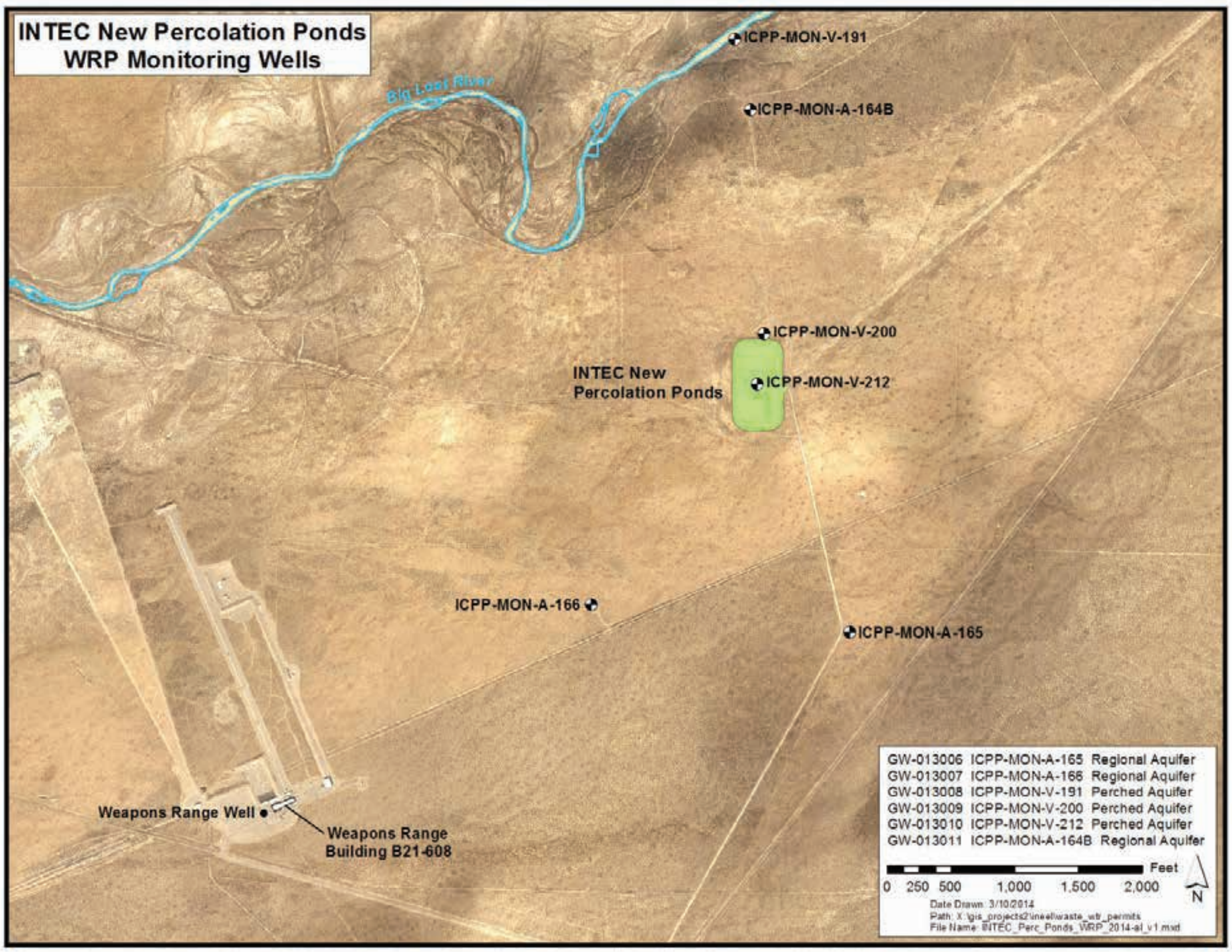


Figure 5-2. Permit Groundwater Monitoring Locations for INTEC New Percolation Ponds (Weapons Range Well is not a permitted well and is shown for location reference only).

standards in "Ground Water Quality Standards" (IDAPA 58.01.11.200) and historical data collected at these three monitoring points. For the 2014 reporting year, the monitoring results for all of the samples were within their expected concentrations. The monitoring results (minimum, maximum, and mean) for CPP-769, CPP-773, and CPP-797 are presented in Tables C-3, C-4, and C-5, respectively.

The permit specifies maximum daily and yearly hydraulic loading rates for the INTEC New Percolation Ponds. The permit limit for maximum daily flow is 11.356 million L (3 MG) and 4,145 million L (1,095 MG) for yearly total flow to the INTEC New Percolation Ponds. In 2014, the maximum daily flow was 3,380 million L (0.893 MG), both and the yearly total flow to the INTEC New Percolation Ponds was 788 million L (208,111 MG), both below the permit limits.

Groundwater Monitoring Results for the Wastewater Reuse Permit. To measure potential impacts to groundwater from the INTEC New Percolation Ponds, the permit requires that groundwater samples be collected from six monitoring wells as shown in Figure 5-2 and listed in Table 5-4.

The permit requires that groundwater samples be collected semiannually during April/May and September/October and lists which parameters must be analyzed. Contaminant concentrations in the compliance wells are limited by primary constituent standards and secondary constituent standards specified in IDAPA 58.01.11, "Ground Water Quality Rule." All permit-required samples are collected as unfiltered samples, except aluminum, iron, manganese, and silver. The results of dissolved concentrations (i.e., filtered samples) of these four parameters are used for secondary constituent standard compliance determinations.

Table 5-4. INTEC New Percolation Ponds Wastewater Reuse Permit Monitoring Wells.

Well	Purpose	Location (see Figure 5-2)
Aquifer Wells		
ICPP-MON-A-164B (GW-013011)	Background, noncompliance point	Upgradient of the New Percolation Ponds
ICPP-MON-A-165 (GW-013006)	Permit compliance point	Downgradient of the New Percolation Ponds
ICPP-MON-A-166 (GW-013007)	Permit compliance point	Downgradient of the New Percolation Ponds
Perched Water Wells		
ICPP-MON-V-191 (GW-013008)	Background, noncompliance point	North of the New Percolation Ponds and just south of the Big Lost River
ICPP-MON-V-200 (GW-013009)	Permit compliance point	Adjacent to (north of) the New Percolation Ponds
ICPP-MON-V-212 (GW-013010)	Permit compliance point	Adjacent to (between) the New Percolation Ponds

Table C-6 shows the 2014 water table elevations and depth to water table, determined prior to purging and sampling, and the analytical results for all parameters specified by the permit for the aquifer wells. Table C-7 presents similar information for the perched water wells. Perched water well ICPP-MON-V-191 was dry during the 2014 reporting year, and, therefore, samples could not be collected.

As Table C-6 shows, all of the permit-required parameters associated with the aquifer wells were below their respective primary constituent standards and secondary constituent standards during the 2014 reporting year. As Table C-7 shows, all of the permit-required parameters associated with the perched water wells were below their respective primary constituent standards or secondary constituent standards during the 2014 reporting year.

5.2.5 Materials and Fuels Complex Industrial Waste Ditch and Industrial Waste Pond

Description. The wastewater reuse permit issued by DEQ for the MFC Industrial Waste Ditch and Pond became effective May 1, 2010. The MFC Industrial Waste Pond was first excavated in 1959 and has a design capacity of 285 MG at a maximum water depth of 13 ft (Figure 5-3).

Industrial wastewater discharged to the pond via the Industrial Waste Pipeline consists primarily of noncontact cooling water, boiler blowdown, cooling tower blowdown and drain, air wash flows, and steam condensate.

Wastewater composed of intermittent reverse osmosis effluent, and discharge to a laboratory sink flows from the MFC-768 Power Plant to Ditch C via the Industrial Waste Water Underground Pipe.

Wastewater Monitoring Results for the Wastewater Reuse Permit. The industrial wastewater reuse permit requires monthly sampling of the effluent to the pond discharged to the Industrial Waste Pipeline. The permit requires quarterly samples of the discharge to Ditch C from the Industrial Waste Water Underground Pipe. The permit sets monthly concentration limits for total suspended solids (100 mg/L) and total nitrogen (20 mg/L), and the results of those permit-limited parameters are summarized in Table 5-5. During 2014, the sample for total suspended solids collected from the wastewater underground pipe in June exceeded the permit limit. The confirmation samples collected in July and August were 6 mg/L and 4 mg/L, respectively. The DEQ was notified of the exceedance (Miller 2014b) and the system was evaluated. The cause of the elevated total suspended solids was never determined; the discharge rate from the pipe is typically 1 gal/min. or less, so no impacts to the infiltration capacity of the ditch or pond is expected. The minimum, maximum, and median results of all parameters monitored are presented in Tables C-8 and C-9.

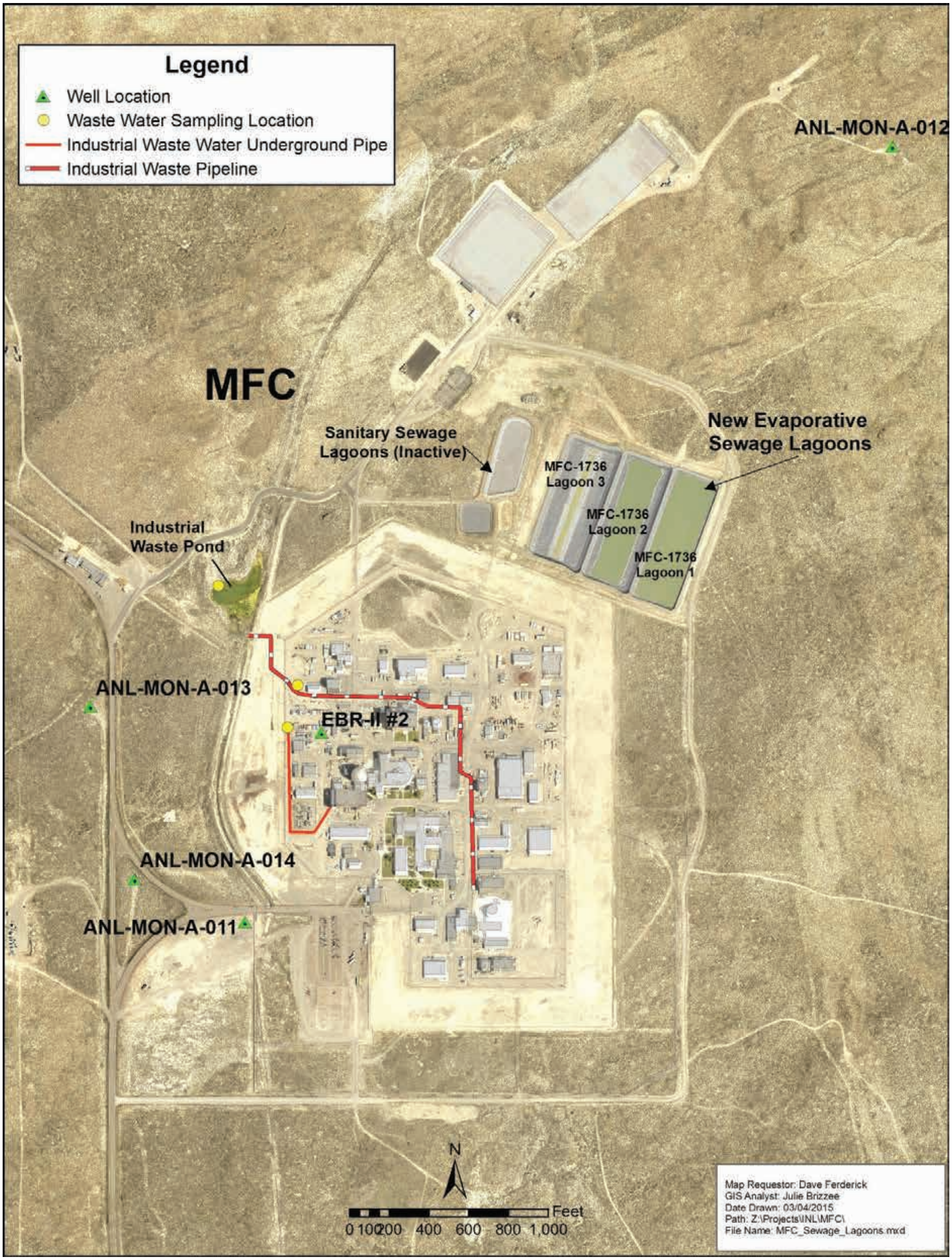


Figure 5-3. Wastewater and Groundwater Sampling Locations at the MFC.

Table 5-5. Total Nitrogen and Total Suspended Solids Effluent Monitoring Results in Discharges to the MFC Industrial Waste Pond (2014).[a]

Parameter	Minimum	Maximum	Median	Permit Level
Industrial Waste Pipeline				
Total nitrogen[b] (mg/L)	2.126	3.078	2.22	20
Total suspended solids (mg/L)	4 U[c]	7.7	4 U	100
Industrial Waste Water Underground Pipe				
Total nitrogen[b] (mg/L)	4.875	8.98	<5.03	20
Total suspended solids[d] (mg/L)	4 U	182	4 U	100

a. Duplicate samples were collected at both locations in February, and the results for the duplicate samples are included in the data summary.
b. Total nitrogen is calculated as the sum of total Kjeldahl nitrogen and nitrate + nitrite, as nitrogen.
c. U flag indicates the result was below detection limit.
d. Includes confirmation sample collected in July 2014.

Groundwater Monitoring Results for the Wastewater Reuse Permit. To measure potential impacts from the Industrial Waste Pond, the permit requires groundwater monitoring in April/May and September/October at one upgradient and two downgradient wells (Figure 5-3).

The analytical results are summarized in Table C-10. Analyte concentrations in the downgradient wells were indistinguishable from background levels in the upgradient well.

5.3 Liquid Effluent Surveillance Monitoring

The following sections discuss results of liquid effluent surveillance monitoring performed at each wastewater reuse permitted facility.

5.3.1 Advanced Test Reactor Complex

The effluent to the CWP receives a combination of process water from various ATR Complex facilities. Table C-11 lists wastewater surveillance monitoring results for those parameters with at least one detected result. Radionuclides detected in groundwater samples are summarized in Table C-12. The tritium concentrations are below the Idaho groundwater primary constituent standard for tritium (20,000 pCi/L), which is the same as the Environmental Protection Agency (EPA) health-based MCL for tritium in drinking water (40 CFR 141).

5.3.2 Central Facilities Area

The effluent from the CFA Sewage Treatment Facility is monitored according to the wastewater reuse permit. No wastewater was land-applied in 2014, so no effluent samples were collected at the treatment facility.

5.3.3 Idaho Nuclear Technology and Engineering Center

In addition to the permit-required monitoring summarized in Section 5.2.4, surveillance monitoring was conducted at the INTEC Sewage Treatment Plant, prior to discharge into the INTEC New Percolation Ponds, and the groundwater with respect to the INTEC New Percolation Ponds. Table C-13 summarizes the results for the field parameters collected at CPP-769, CPP-773, and CPP-797, Table C-14 summarizes the results of radiological monitoring at CPP-773 and CPP-797, and Table C-15 summarizes the results of radiological monitoring at groundwater Wells ICPP-MON-A-165, ICPP-MON-A-166, ICPP-MON-V-200, and ICPP-MON-V-212.

The results of all field parameters were within their expected historical concentration levels.

Samples were collected from the CPP-773 effluent in April and September 2014 and analyzed for specific gamma-emitting radionuclides, gross alpha, gross beta, and total strontium activity. As shown in Table C-14, no gamma, gross alpha, or total strontium was detected in any of the samples collected at CPP-773 in 2014. The gross beta results were within their expected historical concentrations.

Twenty-four hour flow proportional samples were collected from the CPP-797 wastewater effluent and composited daily into a monthly sample. The monthly composite samples were analyzed for specific gamma emitting radionuclides, gross alpha, gross beta, and total strontium activity. As shown in Table C-14, no gamma or total strontium was detected in any of the samples collected at CPP-797 in 2014. The gross alpha and gross beta results were within their expected historical concentrations.

Groundwater samples were collected from aquifer wells ICPP-MON-A-165 and ICPP-MON-A-166 and perched water wells ICPP-MON-V-200 and ICPP-MON-V-212 in April and September 2014 and analyzed for gross alpha and gross beta. As shown in Table C-15, gross alpha was not detected in any of the four monitoring wells, and gross beta results were within their expected historical concentrations.

5.3.4 Materials and Fuels Complex

The Industrial Waste Pond is sampled quarterly for gross alpha, gross beta, gamma spectroscopy, and tritium (Figure 5-3). Annual samples are collected for selected isotopes of americium, curium, iron, strontium, plutonium, and uranium. Table C-16 summarizes the results for analytes detected in at least one sample. The estimated concentration of 2.31 pCi/L of cesium-137 in August is probably related to the high sediment load in the pond water from a heavy storm. Cesium-137 was not detected in the samples collected in January, June, and November.

5.4 Drinking Water Monitoring

The INL and ICP contractors monitor drinking water to ensure it is safe for consumption and to demonstrate that it meets federal and state regulations. Drinking water parameters are regulated by the state of Idaho under authority of the Safe Drinking Water Act (40 CFR 141, 142). Parameters with primary MCLs must be monitored at least once every three years. Parameters with secondary MCLs are monitored every three years based on a recommendation by the EPA (40 CFR 143). Many parameters require more frequent sampling during an initial period to establish a baseline, and subsequent monitoring frequency is determined from the baseline results.

Currently, the INL Site has 12 drinking water systems. The INL contractor and ICP contractor monitor these systems to ensure a safe working environment. The INL contractor monitors nine of these drinking water systems, ICP contractor monitors two, and Naval Reactors Facility has one. According to the "Idaho Rules for Public Drinking Water Systems" (IDAPA 58.01.08), INL Site drinking water systems are classified as either nontransient or transient, noncommunity water systems. The five INL contractor transient, noncommunity water systems are at the Experimental Breeder Reactor I (EBR-I), Gun Range (Live Fire Test Range), Critical Infrastructure Test Range Complex (CITRC), Test Area North/Technical Support Facility (TAN/TSF), and the Main Gate. The four remaining INL contractor water systems are classified as nontransient, noncommunity water systems. These systems are located at CFA, MFC, ATR Complex, and TAN/Contained Test Facility (CTF). The two ICP contractor nontransient, noncommunity water systems are INTEC and the Radioactive Waste Management Complex (RWMC), which also supplies drinking water to the Advanced Mixed Waste Treatment Project facilities.

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

Because of historic or problematic contaminants in the drinking water systems, the INL contractor and the ICP contractor monitor certain parameters more frequently than required by regulation. For example, bacterial analyses are conducted monthly rather than quarterly at all nine INL contractor drinking water systems and at the two ICP contractor drinking water systems during months of operation. Because of known groundwater plumes near two INL contractor drinking water wells and one ICP contractor drinking water well, additional sampling is conducted for tritium at CFA, for trichloroethylene at TAN/TSF, and for carbon tetrachloride at RWMC.

During 2014, DEQ performed Sanitary Surveys on all INL Site drinking water systems (except EBR-I). No deficiencies were identified in any of the systems.

5.4.1 INL Site Drinking Water Monitoring Results

During 2014, the INL contractor collected 307 routine samples and 17 quality control samples from nine INL Site drinking water systems. In addition to routine samples, the INL contractor also collected 34 nonroutine samples after a water main was repaired, a building put into service, or maintenance repairs. The laboratories used to analyze the drinking water samples are shown in Table 11-1. Drinking water systems at EBR-I, CITRC, Gun Range, MFC, ATR Complex, and TAN/CTF were well below drinking water limits for all regulatory parameters; therefore, they are not discussed further in this report. In addition, all water systems were sampled for nitrates. All water systems results were less than the MCL of 5 mg/L. The highest results were 3.89 mg/L at CFA and 2.05 mg/L at MFC. No compliance samples were positive (present) for bacteria in 2014.

Total trihalomethanes (TTHMs) and haloacetic acids (HAA5s) which are disinfectant by-products, were sampled at CFA, MFC, ATR Complex, and TAN/CTF with the highest concentration of TTHMs being 8.2 ppb at TAN/CTF and 13.7 ppb for HAA5s at MFC. The MCL is 100 ppb for TTHMs and 60 ppb for HAA5s.

Lead and copper were sampled at CFA, MFC, ATR Complex, and TAN/CTF. The highest concentration of lead detected was 7 ppb at CFA and the highest concentration of copper detected was 206 ppb at CFA and MFC. The MCL for lead is 15 ppb and copper is 1,300 ppb.

Total coliform bacteria was detected at the ATR Complex back-up water system and once at the Main Gate water system during 2014. These samples were construction/surveillance samples, not compliance.

Table 5-6 summarizes monitoring results for 2014. The quality control program associated with these data is discussed in Section 11.3.2.4.

5.4.2 Central Facilities Area

The CFA water system serves approximately 500 people daily. Since the early 1950s, wastewater containing tritium was disposed of to the eastern Snake River Plain aquifer through injection wells and infiltration ponds at INTEC and the ATR Complex. This wastewater migrated south-southwest and is the suspected source of tritium contamination in the CFA water supply wells. Disposing of wastewater through injection wells was discontinued in the mid-1980s. In general, tritium concentrations in groundwater have been decreasing (Figure 5-4) because of changes in disposal techniques, diffusion, dispersion, recharge conditions, and radioactive decay. The laboratory used by the INL contractor for tritium analysis is shown in Table 11-1. Quality control is discussed in Section 11.3.2.4.

Prior to 2007, compliance samples for the CFA water distribution system were collected semiannually from well CFA #1 at CFA-651 and well CFA #2 at CFA-642, and quarterly from the distribution manifold at CFA-1603. Because the results were consistently below the MCL for tritium, the INL contractor decreased the tritium sampling frequency to semiannually at the CFA- 1603 manifold and annually at the wells. During 2014, CFA# 1 well pumped almost 10 MG of water and

Table 5-6. Summary of INL Site Drinking Water Results (2014).

Constituent	Maximum Contaminant Level	ATR-Complex	CFA	CITRC	EBR-1	GUN RANGE	MAIN GATE	MFC	TAN CTF	TAN TSF
Gross Alpha	15 pCi/L	ND–2.51	ND	ND-3.70	ND-1.91	ND-2.27	ND	ND-1.92	1.88-2.11	ND
Gross Beta	50 pCi/L screening or 4 mrem	ND	4.69-7.04	2.94-6.22	4.09-4.26	2.54-5.83	3.48-4.84	3.52-4.02	ND-7.03	2.82-5.10
Tritium	20,000 pCi/L	ND	3,370-3,600	ND	ND	620-650	ND	ND	ND	ND
Arsenic	10 ppb	2	2	2	1	<1	2	2	3	2
Copper[a]	1,300 ppb	127	206	NA	NA	NA	NA	206	186	NA
Fluoride	4 mg/L	0.3	0.2	0.3	0.2	0.2	0.2	0.68	0.2	0.2
Lead[a]	15 ppb	3	7	NA	NA	NA	NA	3	2	NA
Nitrate	10 mg/L	ND	3.89	1.10	ND	ND	ND	2.05	ND	ND
TTHMs	80 ppb	4.6	5.7	8.2	NA	1.5	NA	9.6	8.2	4.5
HAA5s	60 ppb	ND	1.6	3.0	NA	ND	NA	1.2	ND	ND
VOCs	5 ppb most of them	ND	ND	ND	ND	ND	ND	ND	ND	ND

a. Treatment technique action level, the concentration of a contaminant which, if exceeded, triggers treatment or other requirements that a water system must follow.

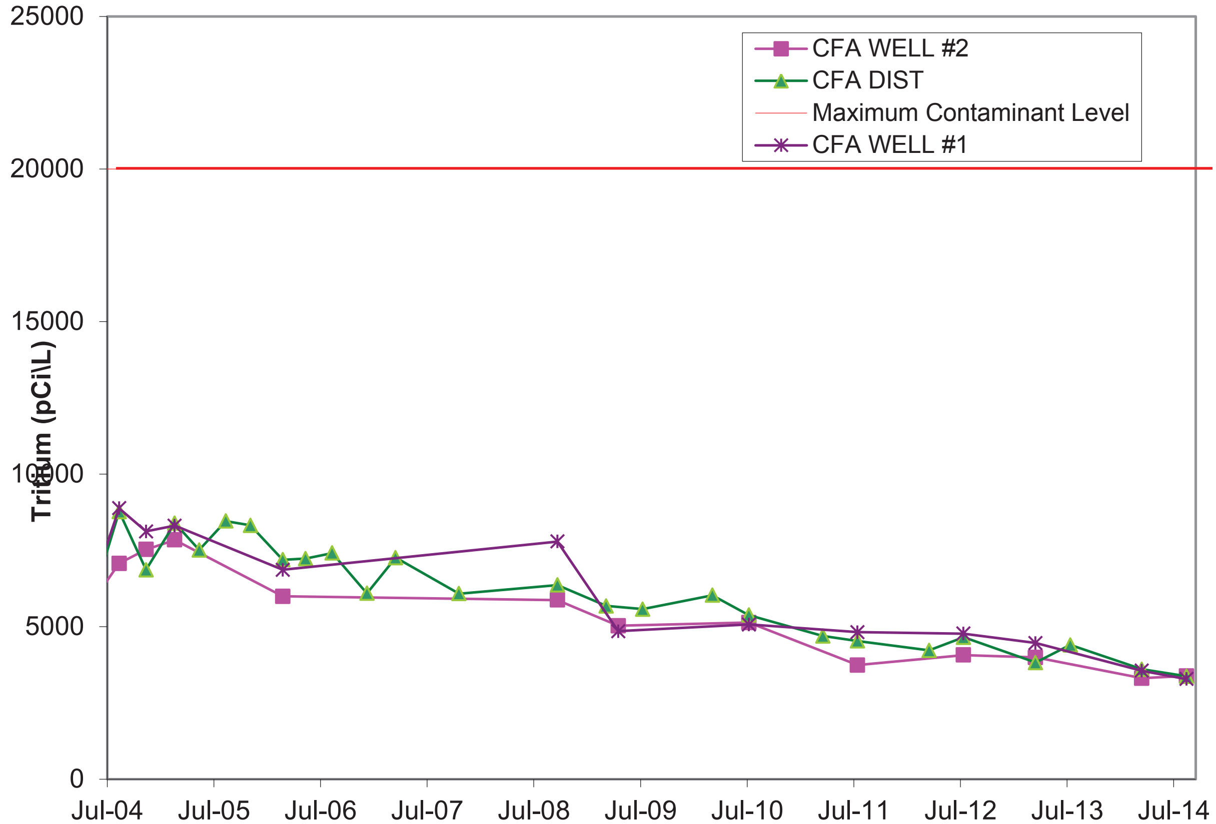


Figure 5-4. Tritium Concentrations in CFA Well and Distribution System (2002 – 2014). ***Note: October 2011-2013, only CFA #1 Well was used. In 2014, Well #2 supplied 80 percent of the CFA drinking water.***

was used to supply approximately 20 percent of drinking water at CFA. CFA# 2 well pumped 42.4 MG of water to supply approximately 80 percent of the drinking water.

CFA Worker Dose. Because of the potential impacts to workers at CFA from an upgradient plume of radionuclides in the eastern Snake River Plain aquifer, the potential effective dose equivalent from radioactivity in water was calculated. For the 2014 dose calculation, it was assumed that each worker's total daily water intake would come from the CFA drinking water distribution system. This assumption overestimates the actual dose, because workers typically consume only about half their total intake during working hours and typically work only 240 days rather than 365 days per year. The estimated annual effective dose equivalent to a worker from consuming all their drinking water at CFA during 2014 was 0.18 mrem (1.8 µSv). This value is below the EPA standard of 4 mrem/yr for public drinking water systems.

5.4.3 Idaho Nuclear Technology and Engineering Center

Drinking water for INTEC is supplied by two wells, CPP-04 and ICPP-POT-A-012, located north of the facility. A disinfectant residual (chlorine) is maintained throughout the distribution system. In 2014, drinking water samples were collected from the point of entry to the distribution system (CPP-614) and from various buildings throughout the distribution system. The analytical laboratories used to analyze the INTEC drinking water samples are presented in Table 11-1. Results are presented in Tables C-17 and C-18 and are discussed below.

Four compliance samples and 42 surveillance samples were collected from various buildings throughout the distribution system at INTEC and analyzed for total coliform and E. coli. The results for all 46 samples were reported as absent.

On June 6, 2014, compliance samples were collected from CPP-626, CPP-652, CPP-655, CPP-659, CPP-663, CPP-666, CPP-698, CPP-1604, CPP-1650, and CPP-1686 and analyzed for lead and copper by EPA Method 200.8. None of the ten samples exceeded the lead action level of 0.015 mg/L or the copper action level of 1.3 mg/L.

One compliance sample was collected at CPP-614 on June 25, 2014, and analyzed for nitrate as N by EPA Method 353.2. The result was 0.6 mg/L and below the nitrate MCL of 10 mg/L.

One compliance sample was collected at CPP-1666 on August 13, 2014, and analyzed for total trihalomethanes by EPA Method 524.2. The result was 0.0042 mg/L and below its MCL of 0.080 mg/L.

One compliance sample was collected at CPP-1666 on August 13, 2014, and analyzed for haloacetic acids by EPA Method 552.2. Haloacetic acids were not detected (<0.002 mg/L) in the sample. The MCL for haloacetic acids is 0.060 mg/L.

A surveillance sample was collected at CPP-614 on January 13, 2014, and analyzed for gross alpha and gross beta. Both results were reported as non-detects. Another surveillance sample was collected on July 24, 2014, and analyzed for gross alpha, gross beta, tritium, and strontium-90 (^{90}Sr). Gross beta was detected at 5.72 pCi/L, but less than its screening level of 50 pCi/L. Gross alpha, tritium, and ^{90}Sr were all reported as non-detects.

Three quality control samples (one field duplicate and two performance evaluation samples) were collected. The results are summarized in Section 11.3.2.4.

5.4.4 Radioactive Waste Management Complex

The RWMC production well is located in Building WMF-603 and is the source of drinking water for RWMC and the Advanced Mixed Waste Treatment Project. A disinfectant residual (chlorine) is maintained throughout the distribution system. Historically, carbon tetrachloride, total xylenes, and other volatile organic compounds (VOCs) had been detected in samples collected at the WMF-603 production well and at WMF-604, the point of entry into the RWMC drinking water distribution system. In July 2007, a packed tower air stripping treatment system was placed into operation to remove the VOCs from the groundwater prior to human consumption.

In 2014, drinking water samples were collected from the source (WMF-603), from the point of entry to the distribution system (WMF-604), and from various buildings throughout the distribution system. Samples were also collected from comfort stations WMF-TR-12, WMF-TR-13, WMF-TR-29, and the associated potable water transfer tank (PW-TK-RW01). The analytical laboratories used to analyze the RWMC drinking water samples are presented in Table 11-1. Results are presented in Tables C-19 and C-20 and are discussed below.

Four compliance samples and 24 surveillance samples were collected from various buildings at RWMC and analyzed for total coliform and E. coli. The results for all 28 samples were reported as absent. Fifteen surveillance samples were collected from the comfort stations and the potable water transfer tank and analyzed for total coliform and E. coli. The results for all 15 samples were reported as absent.

One compliance sample was collected at WMF-604 on June 25, 2014, and analyzed for nitrate as N by EPA Method 353.2. The result was 1 mg/L and below the nitrate MCL of 10 mg/L.

On June 13, 2014, compliance samples were collected from WMF-601, WMF-604, WMF-610, WMF-613, WMF-617, WMF-620, WMF-637, WMF-646, WMF-658, and WMF-678 and analyzed for lead and copper by EPA Method 200.8. None of the ten samples exceeded the lead action level of 0.015 mg/L or the copper action level of 1.3 mg/L.

Two surveillance samples were collected at WMF-604 on January 13, 2014, and July 24, 2014, and analyzed for gross alpha and gross beta. Gross alpha was not detected in any of the samples, and gross beta was not detected in the January sample. Gross beta was detected at 5.2 pCi/L (±1.03) but below the screening level of 50 pCi/L in the July sample.

Four compliance samples were collected at WMF-604 and analyzed for VOCs by EPA Method 524.2. Total xylenes were detected in the April 30, 2014, sample (0.6 µg/L) and the October 8, 2014 sample (0.5 µg/L), but were below the total xylene MCL of 10,000 µg/L. Total xylenes were not detected (<0.5 µg/L) in the other two samples collected at WMF-604 on February 5, 2014, and July 30, 2014. Carbon tetrachloride and trichloroethylene were not detected (<0.5 µg/L) in any of the samples. No other VOCs were detected in any of the samples.

Four surveillance samples were collected at the WMF-603 production well and analyzed for VOCs by EPA Method 524.2. Total xylenes were not detected (<0.5 µg/L) in any of the samples. Carbon tetrachloride was detected in all four samples and ranged in concentration from 5.0 µg/L to 5.7 µg/L. Trichloroethylene was also detected in all four samples and ranged in concentration from 2.4 µg/L to 3.0 µg/L.

Two compliance samples were collected at WMF-645 and WMF-678 on August 13, 2014, and analyzed for total trihalomethanes by EPA Method 524.2. The result for the sample collected at WMF-645 was 0.0030 mg/L, and the result for the sample collected at WMF-678 was 0.0035 mg/L. Both results were below the total trihalomethanes MCL of 0.080 mg/L.

Two compliance samples were collected at WMF-645 and WMF-678 on August 13, 2014, and analyzed for haloacetic acids by EPA Method 552.2. Haloacetic acids were not detected (<0.002 mg/L) in either sample. The MCL for haloacetic acids is 0.060 mg/L.

Twenty-one quality control samples (three field blanks, eight field duplicates, five trip blanks, and five performance evaluation samples) were collected. The results are summarized in Section 11.3.2.4.

5.4.5 Test Area North/Technical Support Facility

Well TSF #2 supplies drinking water to less than 25 employees at TSF. The facility is served by a chlorination system. TSF #2 is sampled for surveillance purposes only (not required by regulations), and the distribution system is the point of compliance (required by regulations).

In the past, trichloroethylene contamination has been a concern at TSF. The principal source of this contamination was an inactive injection well (TSF-05). Although regulations do not require sampling well TSF #2, samples are collected to monitor trichloroethylene concentrations due to the historical contamination. Since mid-2006, concentrations appear to be declining, but this will have to be confirmed with the collection of additional data.

Figure 5-5 illustrates the trichloroethylene concentrations in both well TSF #2 and the distribution system. Table 5-7 summarizes the trichloroethylene concentrations at TSF #2 and the distribution system. The mean concentration at the distribution system for 2014 was less than the reporting limit of 0.5 µg/L (10 percent of the MCL).

5.5 Waste Management Surveillance Surface Water Sampling

In compliance with DOE Order 435.1, the ICP contractor collects surface water runoff samples at the RWMC Subsurface Disposal Area (SDA) from the location shown in Figure 5-6. Near the end of 2009, a lift station was installed, and the sampling point is now at the lift station. Surface water is collected to determine if radionuclide concentrations exceed administrative control levels or if concentrations have increased significantly compared to historical data. A field blank is also collected for comparison. Because of changes in the area and the change to the lift station as the sampling point, samples were collected monthly the first quarter during 2011 and then quarterly during the remainder of 2011 to more closely monitor these changes. Samples have been collected quarterly since 2012.

Radionuclides could be transported outside the RWMC boundaries via surface water runoff. Surface water runs off the SDA only during periods of rapid snowmelt or heavy precipitation. At these times, water may be pumped out of the SDA retention basin into a drainage canal, which directs the flow outside RWMC. The canal also carries runoff from outside RWMC that has been diverted around the SDA.

Table 5-8 summarizes the specific alpha and beta results of human-made radionuclides. No human-made gamma-emitting radionuclides were detected. The americium-241, plutonium-239/240, and ^{90}Sr concentrations are approximately the same as those detected in previous years and are well below the DOE Derived Concentration Standards. The ICP contractor will sample quarterly during 2015, when water is available, and evaluate the results to identify any potential abnormal trends or results that would indicate the need to conduct further investigation.

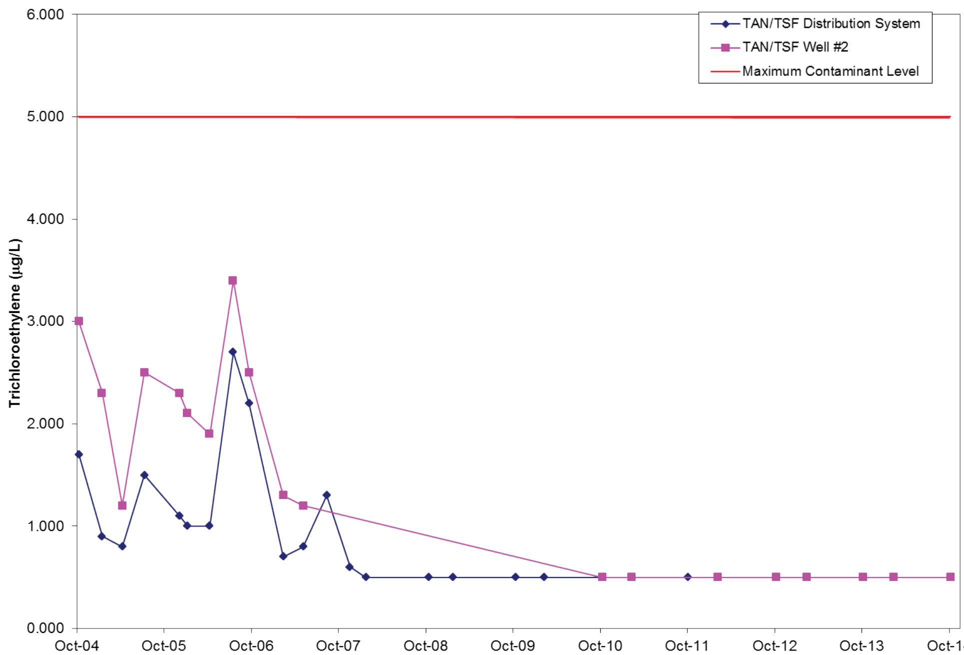


Figure 5-5. Trichloroethylene Concentrations in TSF Drinking Water Well and Distribution System (2002 – 2014).

Table 5-7. Trichloroethylene Concentrations at TAN/TSF Well #2 and Distribution System (2014).

Location	Number of Samples	Trichloroethylene Concentration (µg/L)			
		Minimum	Maximum	Mean	MCL[a]
TAN/TSF #2 (612)	2	<0.5	<0.5	<0.5	NA[b]
TAN/TSF Distribution (610)	2	<0.5	<0.5	<0.5	5.0

a. MCL = Maximum contaminant level (see Table A-3).
b. NA = Not applicable. Maximum contaminant level applies to the distribution system only.

Table 5-8. Radionuclides Detected in Surface Water Runoff at the RWMC SDA (2014).

Parameter	Maximum Concentration[a] (pCi/L)	% Derived Concentration Standard[b]
Americium-241	0.487 ± 0.042	0.29
Plutonium-239/240	0.217 ± 0.021	0.16
Strontium-90	0.375 ± 0.061	0.03

a. Result ±1s. Results shown are >3s.
b. See Table A-2.

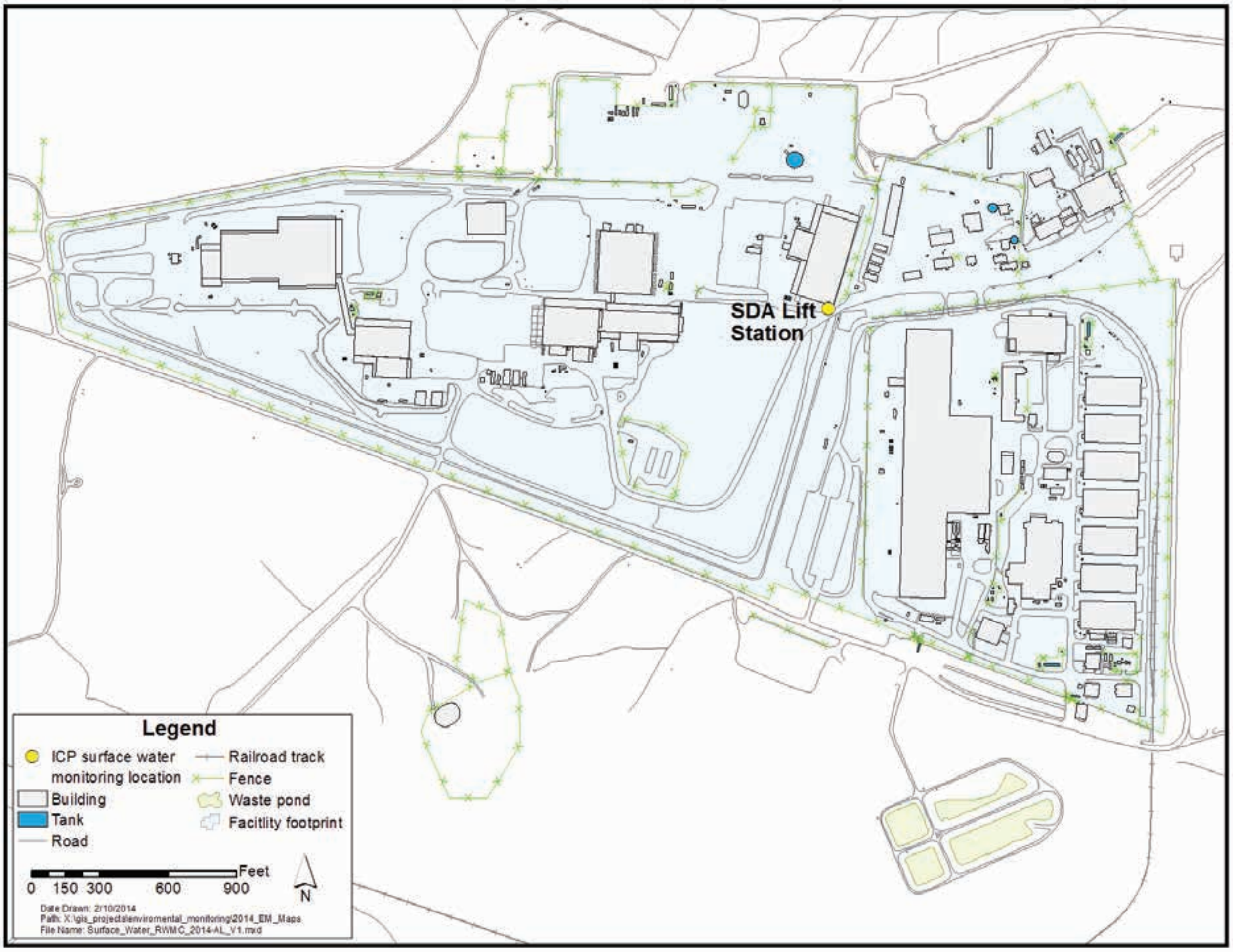


Figure 5-6. Surface Water Sampling Location at RWMC SDA.

REFERENCES

40 CFR 141, 2014, "National Primary Drinking Water Regulations," *Code of Federal Regulations*, Office of the Federal Register.

40 CFR 142, 2014, "National Primary Drinking Water Regulations Implementation," *Code of Federal Regulations*, Office of the Federal Register.

40 CFR 143, 2014, "National Secondary Drinking Water Regulations," *Code of Federal Regulations*, Office of the Federal Register.

DEQ, 2012, "Municipal and Industrial Wastewater Reuse Permit LA-000130-05, Idaho Nuclear Technology and Engineering Center New Percolation Ponds," ICP PER-143, Idaho Department of Environmental Quality, March 14, 2012.

DOE Order 435.1, 2011, "Radioactive Waste Management," Change 2, U.S. Department of Energy.

DOE Order 458.1, 2011, "Radiation Protection of the Public and the Environment," Administrative Change 3, U.S. Department of Energy.

DOE-ID, 2014, *Idaho National Laboratory Site Environmental Monitoring Plan*, DOE/ID-10-11088, Rev. 3, U.S. Department of Energy Idaho Operations Office, February 2014.

ICP, 2015a, *2014 Wastewater Reuse Site Performance Report for the Idaho Nuclear Technology and Engineering Center New Percolation Ponds (LA-000130-05)*, RPT-1341, Idaho Cleanup Project.

ICP, 2015b, *2014 Radiological Monitoring Results Associated with the Idaho Nuclear Technology and Engineering Center New Percolation Ponds*, RPT-1342, Idaho Cleanup Project.

IDAPA 58.01.08, 2014, "Idaho Rules for Public Drinking Water Systems," Idaho Administrative Procedures Act, Idaho Department of Environmental Quality.

IDAPA 58.01.11, 2014, "Ground Water Quality Rule," Idaho Administrative Procedures Act, Idaho Department of Environmental Quality.

IDAPA 58.01.11.200, 2014, "Ground Water Quality Standards," Idaho Administrative Procedures Act, Idaho Department of Environmental Quality.

IDAPA 58.01.16, 2014, "Wastewater Rules," Idaho Administrative Procedures Act, Idaho Department of Environmental Quality.

IDAPA 58.01.17, 2014, "Recycled Water Rule," Idaho Administrative Procedures Act, Idaho Department of Environmental Quality.

INL, 2013, *Industrial Wastewater Reuse Permit Renewal Application for the Advanced Test Reactor Cold Waste Pond*, INL/MIS-12-25957, Idaho National Laboratory.

INL, 2014, *Recycled Water Reuse Permit Renewal Application for the Central Facilities Area Sewage Treatment Plant*, INL/EXT-14-32752, Idaho National Laboratory.

INL, 2015a, *2014 Radiological Monitoring Results Associated with the Advanced Test Reactor Complex Cold Waste Pond*, INL/EXT-15-34084, Idaho National Laboratory.

INL, 2015b, *2014 Annual Wastewater Reuse Report for the Idaho National Laboratory Site's Central Facilities Area Sewage Treatment Plant*, INL/EXT-14-33914, Idaho National Laboratory.

INL, 2015c, *2014 Annual Industrial Wastewater Reuse Report for the Idaho National Laboratory Site's Advanced Test Reactor Complex Cold Waste Pond*, INL/EXT-15-34083, Idaho National Laboratory.

INL, 2015d, *2014 Annual Industrial Wastewater Reuse Report for the Idaho National Laboratory Site's Materials and Fuels Complex Industrial Waste Ditch and Industrial Waste Pond*, INL/EXT-15-34062, Idaho National Laboratory.

INL, 2015e, *Radiological Monitoring Results for Groundwater Samples Associated with the Industrial Wastewater Reuse Permit for the Materials and Fuels Complex Industrial Waste Ditch and Pond: November 1, 2013 - October 31, 2014*, INL/EXT-15-34063, Idaho National Laboratory.

Miller, T. A., INL, to E. Neher, DEQ, October 28, 2014a, "Transmittal of the Idaho National Laboratory Recycled Water Reuse Permit Renewal Application for the Materials and Fuels Complex Industrial Waste Ditch and Industrial Waste Pond and Application Forms," CCN 234270.

Miller, T. A., INL, to G. Eager, DEQ, August 14, 2014b, "Idaho National Laboratory Materials and Fuels Complex Industrial Waste Pond Wastewater Reuse Permit (WRU-I-0160-01), Exceedance of the 100 mg/L Permit Limit for Total Suspended Solids," CCN 233768.

Miller, T. A., INL, to T. Rackow, DEQ, February 23, 2015, "Idaho National Laboratory Central Facilities Area Sewage Treatment Plant Closure Plan for Lagoon #3 and Wastewater Land Application Area," CCN 235243.

Neher, E., DEQ, to R. Boston, DOE-ID, November 20, 2014, "RE: I-161-02 INL ATR Cold Waste Ponds, Final Permit," CCN 234522.

Desert Paintbrush

2014

6. Environmental Monitoring Program - Eastern Snake River Plain Aquifer and Offsite Surface Water

Elko cryptantha
Cryptantha interrupta

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

USGS sampled 26 groundwater monitoring wells and one perched well in 2014 for 61 purgeable (volatile) organic compounds in groundwater at the INL Site. Several purgeable organic compounds continue to be found by the USGS in monitoring wells, including production wells, at the INL Site.

Groundwater surveillance monitoring required in area-specific Records of Decision under the Comprehensive Environmental Response, Compensation, and Liability Act was performed at Waste Area Group (WAG) 1, WAG 2, WAG 3, WAG 4, WAG 7, and WAG 9 in 2014. In WAG 1, remediation of the trichloroethene plume at Test Area North continued in 2014.

Drinking water and springs were sampled by the Environmental Surveillance, Education, and Research contractor in the vicinity of the INL Site and analyzed for gross alpha and gross beta activity, and tritium. Some locations were co-sampled with the state of Idaho Department of Environmental Quality INL Oversight Program. Results were consistent with historical measurements and do not indicate any impact from INL Site releases. The Big Lost River was not sampled in 2014 because the river contained no water at any time during the year.

6. ENVIRONMENTAL MONITORING PROGRAM – EASTERN SNAKE RIVER PLAIN AQUIFER AND OFFSITE SURFACE WATER

This chapter discusses the hydrogeology of the Idaho National Laboratory (INL) Site and presents results from eastern Snake River Plain aquifer studies conducted by the INL contractor, Idaho Cleanup Project (ICP) contractor, and the U.S. Geological Survey (USGS). Results are compared for informational purposes to the following:

- State of Idaho groundwater primary and secondary constituent standards (Idaho Administrative Procedures Act 58.01.11)
- U.S. Environmental Protection Agency (EPA) health-based maximum contaminant levels (MCLs) for drinking water (40 Code of Federal Regulations 141)
- U.S. Department of Energy (DOE) Derived Concentration Standards for ingestion of water (DOE Order 458.1).

Results also are reviewed to determine compliance with all the applicable regulatory guidelines, and if exceedances are reported, regulatory agencies are notified so appropriate actions can be addressed.

Finally, this chapter presents the Environmental Surveillance, Education, and Research (ESER) contractor's surface water and offsite drinking water monitoring results.

6.1 Summary of Monitoring Programs

The USGS INL Project Office performs groundwater monitoring, analyses, and studies of the eastern Snake River Plain aquifer under and adjacent to the INL Site. USGS utilizes an extensive network of strategically placed monitoring wells on the INL Site (Figures 6-1 and 6-2) and at locations throughout the eastern Snake River Plain. Chapter 3, Section 3.1, summarizes the USGS routine groundwater surveillance program. In 2014, USGS personnel collected and analyzed over 1,200 samples for radionuclides and inorganic constituents, including trace elements and 37 samples for purgeable organic compounds. USGS samples are analyzed by the National Water Quality Laboratory and the Radiological and Environmental Sciences Laboratory.

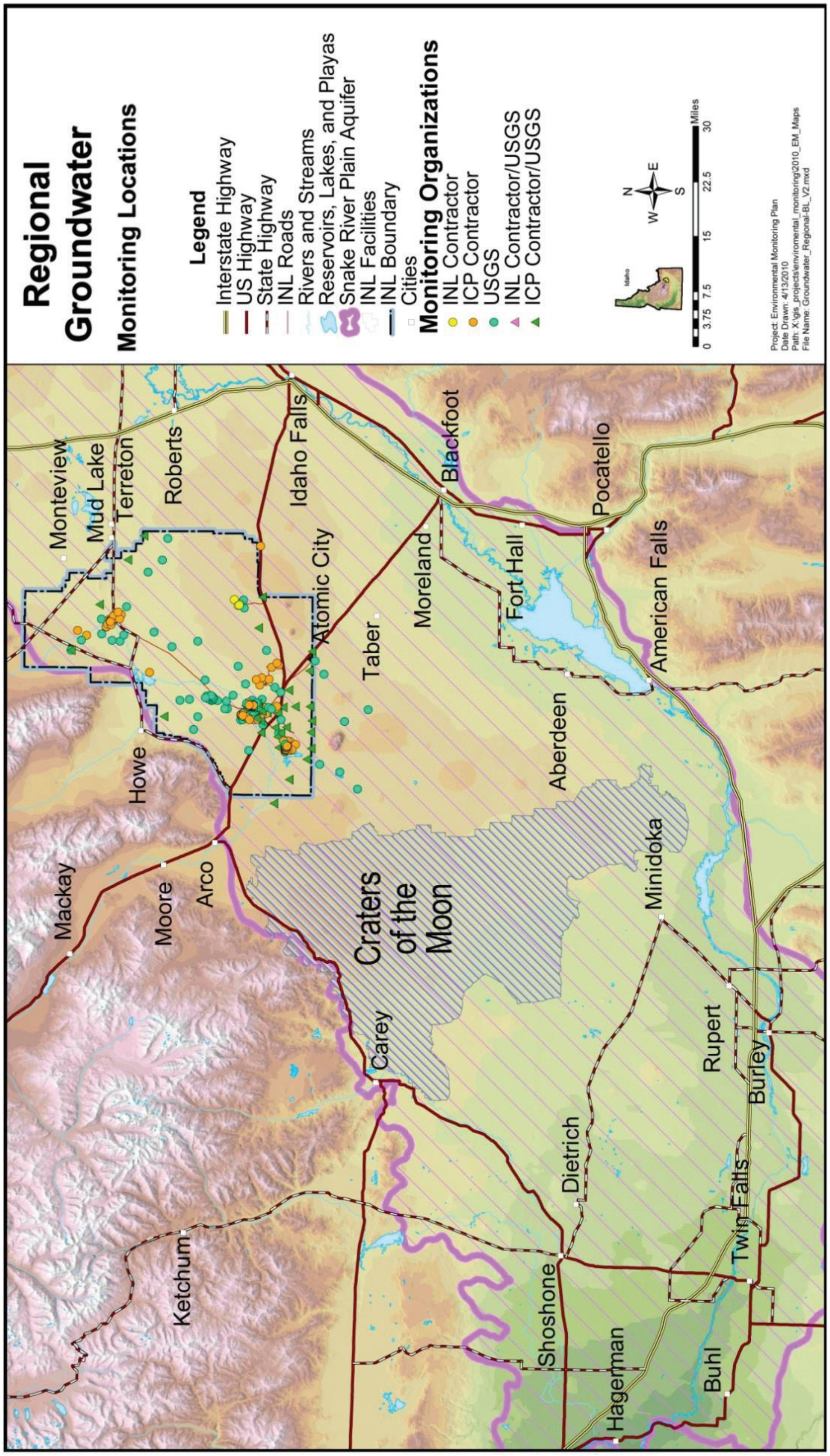


Figure 6-1. Regional Groundwater Monitoring Locations.

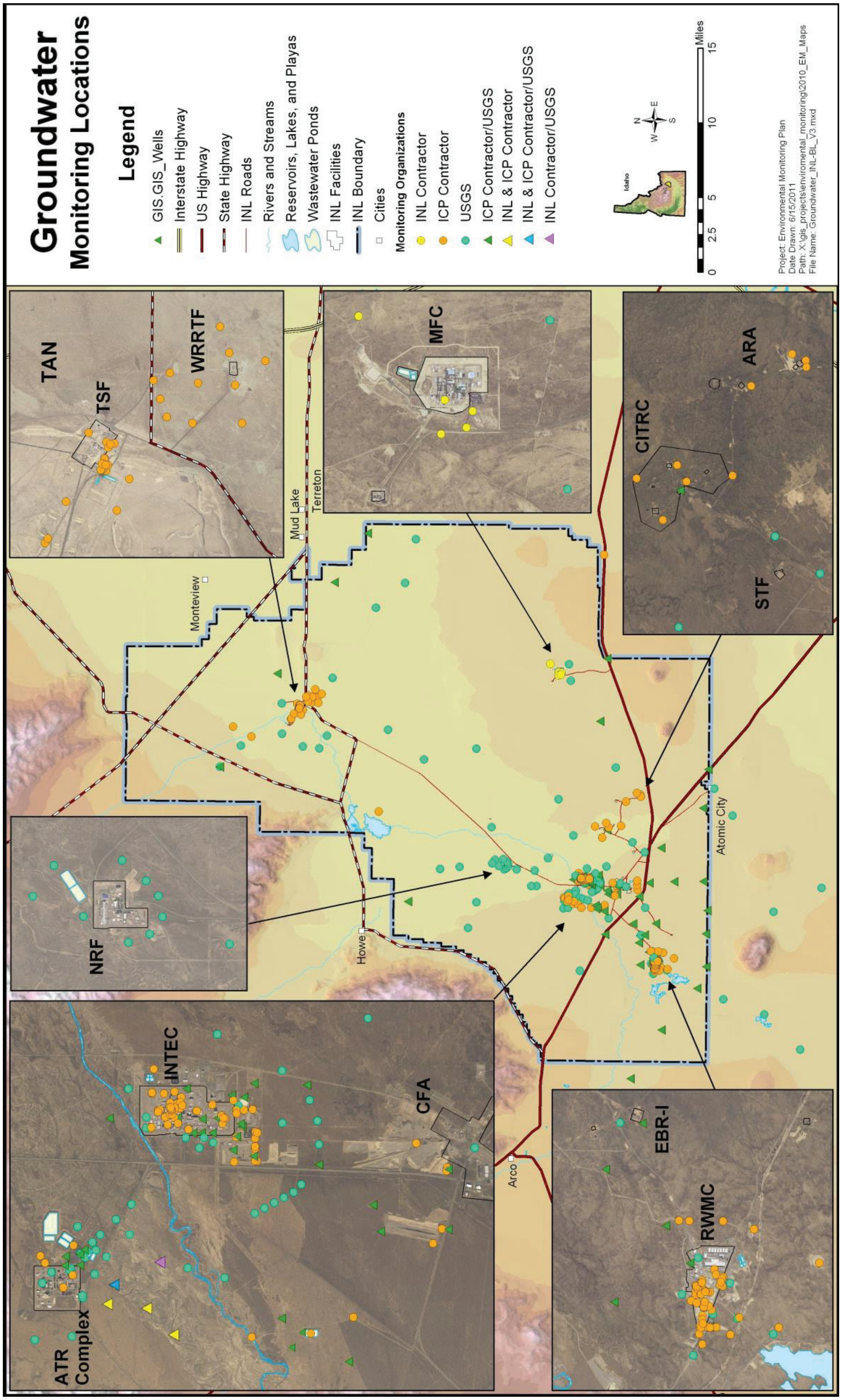


Figure 6-2. INL Site Groundwater Monitoring Locations.

As detailed in Chapter 3, Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) activities at the INL Site are divided into 10 Waste Area Groups (WAGs) (Figure 6-3). Each WAG addresses specific groundwater contaminants. WAG 10 has been designated as the INL Site-wide WAG and addresses the combined impact of the individual contaminant plumes.

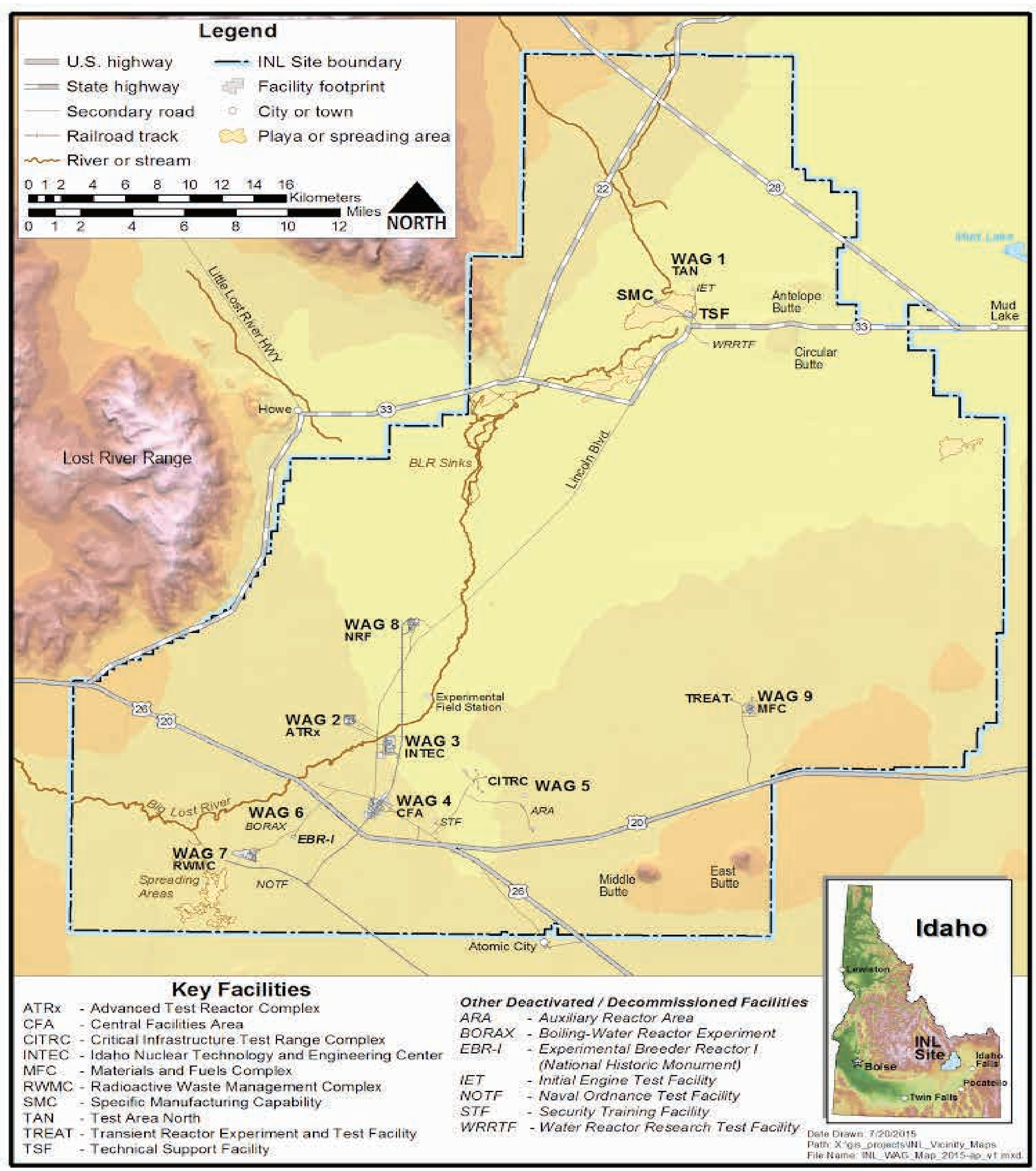


Figure 6-3. Map of the INL Site Showing Locations of Facilities and Corresponding WAGs.

The ESER contractor collects drinking water samples off the INL Site, as well as samples from natural surface waters. This includes the Big Lost River, which occasionally flows through the INL Site, and springs downgradient of the INL Site.

Table 6-1 presents the various groundwater, drinking water, and surface water monitoring activities performed on and around the INL Site. Details may be found in the *Idaho National Laboratory Site Environmental Monitoring Plan* (DOE-ID 2014a) and the *Idaho National Laboratory Groundwater Monitoring Contingency Plan Update* (DOE-ID 2012a).

6.2 Hydrogeology of the Idaho National Laboratory Site

The INL Site occupies approximately 2,300 km^2 (890 mi^2) at the northwestern edge of the eastern Snake River Plain, with the INL Site boundaries coinciding with the Mud Lake sub-basin and the Big Lost Trough. The eastern Snake River Plain aquifer was formed by a unique sequence of tectonic, volcanic, and sedimentary processes associated with the migration of the North American tectonic plate southwestward across the Yellowstone hot spot, or mantle plume (Geslin et al. 1999). Most of the basalt lava flows that host the aquifer and comprise the overlying vadose zone are very porous and permeable due to emplacement processes and fracturing during cooling. Rubble zones between lava flows and cooling fractures allow very rapid flow of water in the saturated zone, rapid infiltration of water and contaminants, and deep penetration of air into the vadose zone. Alluvial, eolian, and lacustrine sediments interbedded within the basalt sequence are generally fine-grained, commonly serving as aquitards below the water table, and affecting infiltration and contaminant transport in the vadose zone (Smith 2004).

The subsiding eastern Snake River Plain and the high elevations of the surrounding recharge areas comprise a large drainage basin that receives enormous amounts of precipitation and feeds high quality groundwater into the aquifer. A northeast–southwest-directed extension of the eastern Snake River Plain produces significant anisotropy to the hydraulic conductivity of the rocks (Smith 2004).

The Big Lost Trough receives sediment primarily from Basin and Range fluvial systems of the Big Lost River, Little Lost River, and Birch Creek. The Big Lost Trough contains a more-than-200-m (650-ft)-thick succession of lacustrine, fluvial, eolian, and playa sediments, recording high-frequency Quaternary climatic fluctuations interbedded with basalt flows. Alternating deposition of clay-rich lacustrine sediments and sandy fluvial and eolian sediments in the central part of the basin was in response to the interaction of fluvial and eolian systems with Pleistocene Lake Terreton, which also, in part, is responsible for the modern day Mud Lake.

Numerous studies suggest the hydraulic gradient of the eastern Snake River Plain aquifer is to the south/southwest (Figure 6-4), with velocities ranging from 0.5 to 6.1 m/day (2 to 20 ft/day). This velocity is much faster than most studied aquifers and is attributed to the eastern Snake River Plain architecture and porous media.

6.3 Hydrogeologic Data Management

Over time, hydrogeologic data at the INL Site have been collected by a number of organizations, including USGS, current and past contractors, and other groups. The INL Site Hydrogeologic Data Repository maintains and makes the data generated by these groups available to users and researchers.

The ICP Site Sample and Analysis Management Program was established to provide consolidated environmental sampling activities and analytical data management. The Sample and Analysis Management Program provides a single point of contact for obtaining analytical laboratory services and managing cradle-to-grave analytical data records.

The USGS data management program involves putting all data in the National Water Information System, which is available on the internet at: http://waterdata.usgs.gov/id/nwis/qw.

6.4 Aquifer Studies of the Idaho National Laboratory Site and the Eastern Snake River Plain Aquifer

The eastern Snake River Plain aquifer serves as the primary source for drinking water and crop irrigation in the Upper Snake River Basin. A description of the hydrogeology of the INL Site and water movement in the aquifer is given in Section 6.2. Further information may be found in numerous USGS publications. Some of these publications can be accessed at http://id.water.usgs.gov/projects/INL/pubs.html or requested from the USGS INL Project Office by calling (208) 526-2438. During 2014, USGS INL Project Office personnel published five documents covering hydrogeologic conditions and monitoring

Table 6-1. Monitoring of the Eastern Snake River Plain Aquifer and Surface Water On and Around the INL Site.

	Monitoring Activity				
Area/Facility	**Groundwater Quality (Radiological)**	**Groundwater Quality (Nonradiological)**	**CERCLA Groundwater Monitoring**	**Offsite Drinking Water[a]**	**Surface Water[b]**
ICP Contractor					
Advanced Test Reactor Complex			●		
Central Facilities Area			●		
Idaho Nuclear Technology and Engineering Center			●		
Test Area North			●		
Radioactive Waste Management Complex			●		
INL Site Outside of Facilities			●		
INL Contractor					
Materials and Fuels Complex			●		
Environmental Surveillance, Education, and Research Program					
INL Site/Distant				●	●
U.S. Geological Survey					
INL Site/Distant	●	●			●

a. Compliance monitoring of INL Site drinking water is discussed in Chapter 5. Results of surveillance of drinking water samples collected off the INL Site are reported in this chapter.
b. Liquid effluent, waste pond, and surface water runoff monitoring is addressed in Chapter 5. Surveillance of natural surface waters (rivers and springs) by the Environmental Surveillance, Education, and Research Program is presented in this chapter. Surface water samples are also collected by the U.S. Geological Survey (see http://id.water.usgs.gov/projects/INL/monitor.html) but are not discussed in this report.

at the INL Site. The abstracts to these reports are presented in Chapter 10.

6.5 U.S. Geological Survey Radiological Groundwater Monitoring at the Idaho National Laboratory Site

Historic waste disposal practices have produced localized areas of radiochemical contamination in the eastern Snake River Plain aquifer beneath the INL Site. The Idaho Nuclear Technology and Engineering Center (INTEC) used direct injection as a disposal method up to 1984. This wastewater contained elevated concentrations of tritium, strontium-90 (^{90}Sr), and iodine-129 (^{129}I). Injection at INTEC was discontinued in 1984 and the injection well was sealed in 1989. When direct injection ceased, INTEC wastewater was directed to shallow percolation ponds, where the water infiltrated into the subsurface. Disposal of low- and intermediate-level radioactive waste solutions to the percolation ponds ceased in 1993 with the installation of the Liquid Effluent Treatment and Disposal Facility. The old percolation ponds were taken out of service to be closed, and the new INTEC percolation ponds went into operation in August 2002.

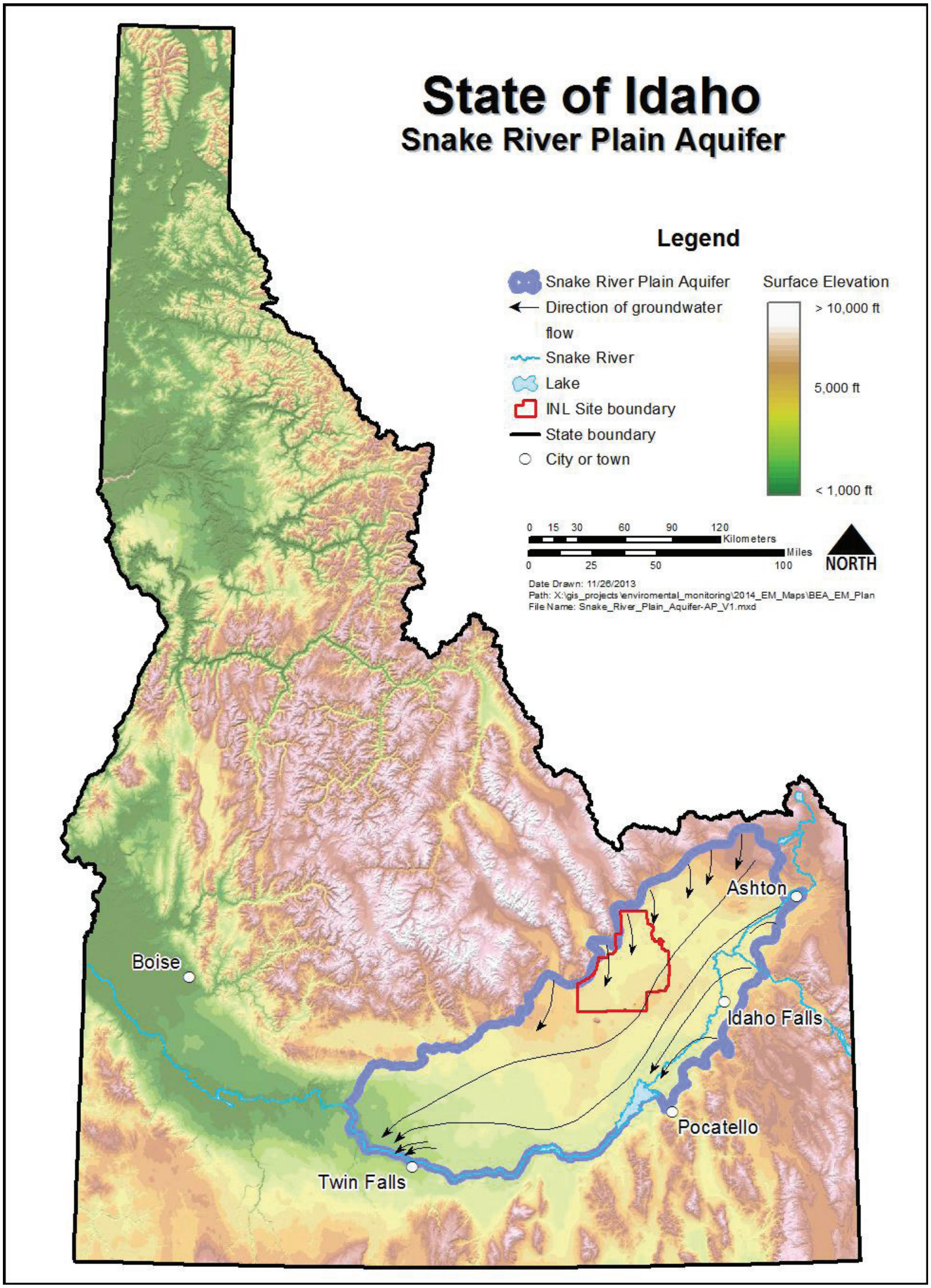


Figure 6-4. Location of the INL Site in Relation to the Eastern Snake River Plain Aquifer.

The Advanced Test Reactor (ATR) Complex, formerly known as the Test Reactor Area and the Reactor Technology Complex, also had a disposal well but primarily discharged contaminated wastewater to a shallow percolation pond. The ATR Complex pond was replaced in 1993 by a flexible, plastic (Hypalon®)-lined evaporative pond, designed to prevent radioactive wastewater from reaching groundwater.

The average combined rate of tritium wastewater disposed of at ATR Complex and INTEC was highest from 1952 to 1983 (910 Ci/yr [3.37×10^{13} Bq/yr]), decreased during 1984 to 1991 (280 Ci/yr [1.04×10^{13} Bq/yr]), and continued to decrease during 1992 to 1995 (107 Ci/yr [3.96×10^{12} Bq/yr]). From 1952 to 1998, the INL Site disposed of about 93 Ci (3.44×10^{12} Bq) of ^{90}Sr at ATR Complex and about 57 Ci (2.11×10^{12} Bq) at INTEC. Wastewater containing ^{90}Sr was never directly discharged to the aquifer at ATR Complex; however, at INTEC, a portion of the ^{90}Sr was injected directly to the aquifer. From 1996 to 1998, the INL Site disposed of about 0.03 Ci (1.11×10^{9} Bq) of ^{90}Sr to the INTEC infiltration ponds (Bartholomay et al. 2000). An additional 18,100 Ci (6.70×10^{14} Bq) of ^{90}Sr was reported to have leaked at the INTEC Tank Farm (Cahn et al. 2006).

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

Tritium – Because tritium is equivalent in chemical behavior to hydrogen, a key component of water, it has formed the largest plume of any of the radiochemical pollutants at the INL Site. The configuration and extent of the tritium contamination area, based on the most recent published USGS data (2011), are shown in Figure 6-5 (Davis et al. 2013). The area of contamination within the 0.5-pCi/L contour line decreased from about 103 km^2 (40 mi^2) in 1991 to about 52 km^2 (20 mi^2) in 1998 (Bartholomay et al. 2000).

The area of elevated tritium concentrations near CFA likely represents water originating at INTEC some years earlier when larger amounts of tritium were disposed. This source is further supported by the fact that there are no known sources of tritium contamination to groundwater at CFA.

Two monitoring wells downgradient of ATR Complex (USGS-065) and INTEC (USGS-114) have continually shown the highest tritium concentrations in the aquifer over recent time (Figure 6-6). For this reason, these two wells are considered representative of maximum concentration trends in the rest of the aquifer. The average tritium concentration in USGS-065 near ATR Complex remained about the same from 2,760 ± 110 pCi/L in 2013 to 2,800 ± 90 pCi/L in 2014; the tritium concentration in USGS-114 south of INTEC decreased from 7,250 ± 160 pCi/L in 2013 to 6,330 ± 140 in 2014.

The Idaho primary constituent standard for tritium (20,000 pCi/L) in groundwater is the same as the EPA MCL for tritium in drinking water. The values in both Wells USGS-065 and USGS-114 dropped below this limit in 1997 as a result of radioactive decay (tritium has a half-life of 12.3 years), ceased tritium disposal, advective dispersion, and dilution within the aquifer. A recent report by the USGS (Davis et al. 2015) indicated that water quality trends for tritium in all but one well at the INL Site showed decreasing or no trends.

Strontium-90 – The configuration and extent of ^{90}Sr in groundwater, based on the latest published USGS data, are shown in Figure 6-7 (Davis et al. 2013). The contamination originates from INTEC from historic injection of wastewater. No ^{90}Sr was detected by USGS in the eastern Snake River Plain aquifer near ATR Complex during 2014. All ^{90}Sr at ATR Complex was disposed to infiltration ponds in contrast to the direct injection that occurred at INTEC. At ATR Complex, ^{90}Sr is retained in surficial sedimentary deposits, interbeds, and perched groundwater zones. The area of ^{90}Sr contamination from INTEC is approximately the same as it was in 1991.

The ^{90}Sr trend over the past 20 years (1994 to 2014) in Wells USGS-047, USGS-057 and USGS-113 is shown in Figure 6-8. Concentrations in Well USGS-047 have varied through time but indicate a general decrease. Concentrations in Wells USGS-057 and USGS-113 also have generally decreased through this period. The general decrease is probably the result of radioactive decay (^{90}Sr has a half-life of 29.1 years), discontinued ^{90}Sr disposal, advective dispersion, and dilution within the aquifer. The variability of concentrations in some wells was thought to be due, in part, to a lack of recharge from the Big Lost River that would dilute the ^{90}Sr. Other reasons also may include increased disposal of other chemicals into the INTEC percolation ponds that may have changed the affinity of ^{90}Sr on soil and rock surfaces, causing it to

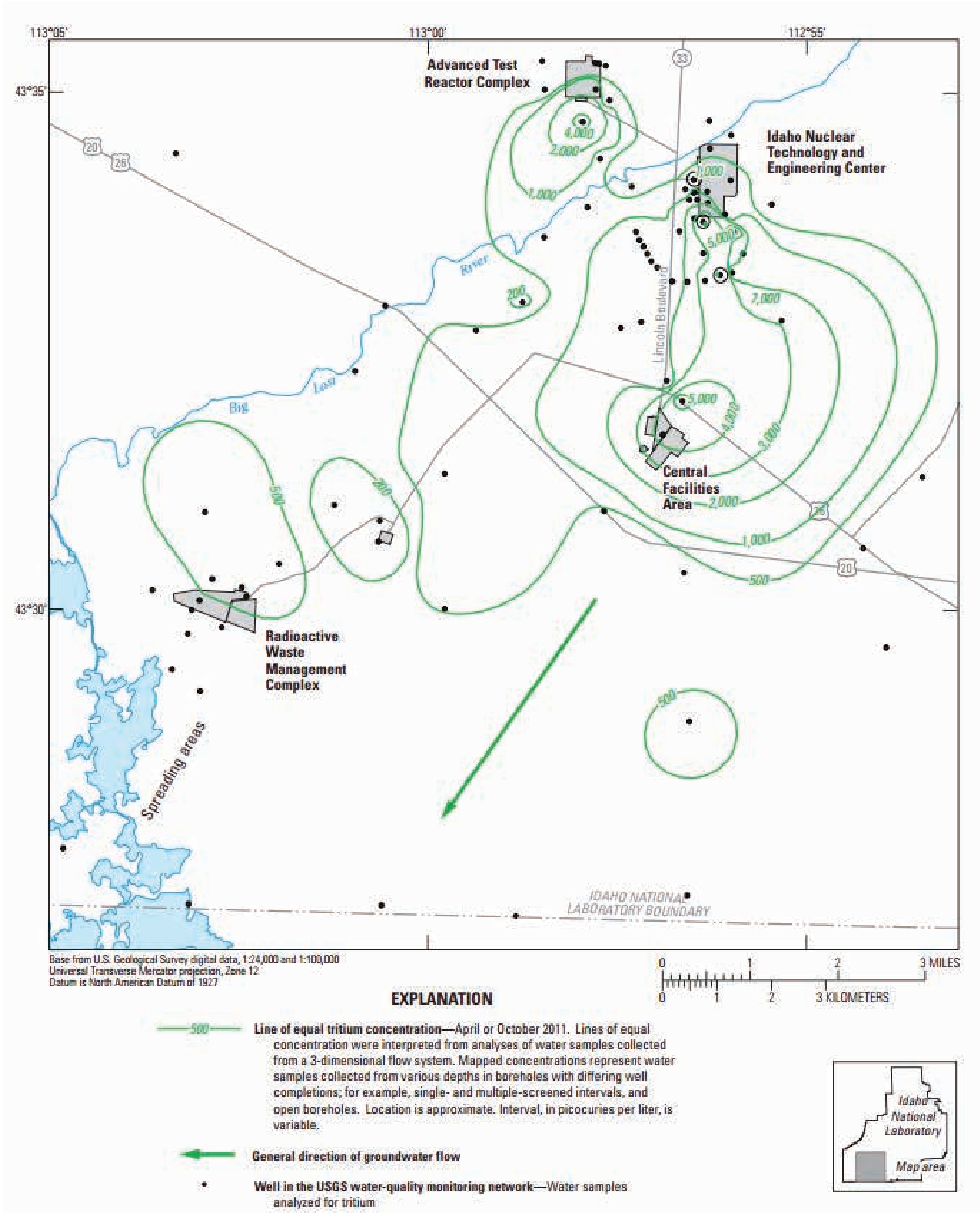


Figure 6-5. Distribution of Tritium in the Eastern Snake River Plain Aquifer on the INL Site in 2011 (from Davis et al. 2013).

become more mobile (Bartholomay et al. 2000). A recent report by the USGS (Davis et al. 2015) indicated that water quality trends for ^{90}Sr in all but two perched water wells at the INL Site showed decreasing or no trends.

Summary of other USGS Radiological Groundwater Monitoring – USGS collects samples annually from select wells at the INL Site for gross alpha, gross beta, gamma spectroscopy analyses, and plutonium and americium isotopes (Table 3-6). Results for wells sampled in 2014 are available at http://waterdata.usgs.gov/id/nwis/. Monitoring results for 2009 to 2011 are summarized in Davis et al. (2013). During 2009 to 2011,

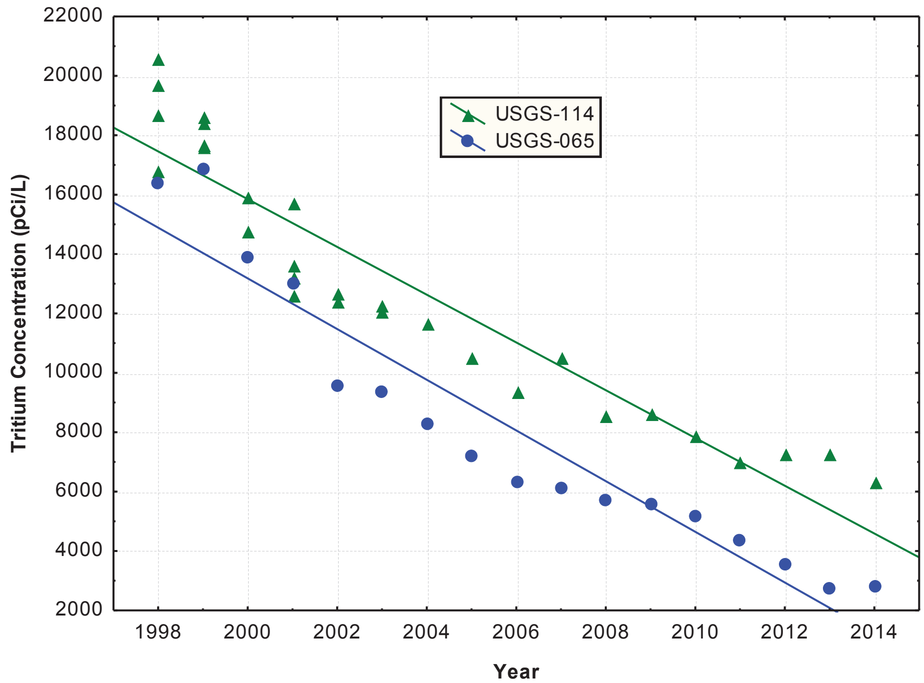


Figure 6-6. Long-term Trend of Tritium in Wells USGS -065 and -114 (1998 – 2014).

concentrations of cesium-137 (^{137}Cs) were greater than or equal to the reporting level in eight wells and concentrations of plutonium-238, plutonium-239/240, and americium-241 in all samples analyzed were less than the reporting level. In 2009, reportable concentrations of gross alpha radioactivity were observed in 13 of the 52 wells and ranged from 2.7 ± 0.9 to 4.3 ± 1.4 pCi/L. The change in the amount of reportable concentrations was attributed to increasing the sensitivity of the analyses and changing the radionuclide reported for gross alpha radioactivity (Davis et al. 2013). During 2010-11, concentrations of gross-alpha particle radioactivity in 52 wells sampled were less than the reporting level. Beta particle radioactivity exceeded the reporting level in 43 of 52 wells sampled, and concentrations ranged from 1.9 ± 0.6 to 19 ± 1.7 pCi/L (Davis et al. 2013).

USGS periodically has sampled for ^{129}I in the eastern Snake River Plain aquifer, and monitoring programs from 1977, 1981, 1986, 1990, 1991, 2003, and 2007 were summarized in Mann et al. (1988), Mann and Beasley (1994), and Bartholomay (2009). The USGS sampled for ^{129}I in wells at the INL Site in the fall of 2011 and in the spring and summer of 2012, and results were published in Bartholomay (2013). Average concentrations of 15 wells sampled in 1990 to 1991, 2003, 2007, and 2011 to 2012 decreased from 1.15 pCi/L in 1990 to 1991 to 0.173 pCi/L in 2011-12. The maximum concentration in 2011 was 1.02 ± 0.04 pCi/L in a monitoring well southeast of INTEC, the drinking water standard for ^{129}I is 1 pCi/L. Concentrations around INTEC showed slight decreases from samples collected in previous sample periods, and the decreases are attributed to the discontinued disposal and to dilution and dispersion in the aquifer. The configuration and extent of ^{129}I in groundwater, based on the 2011-12 USGS data (most current to date), are shown in Figure 6-9 (Bartholomay 2013).

6.6 U.S. Geological Survey Nonradiological Groundwater Monitoring at the Idaho National Laboratory Site

USGS collects samples annually from select wells at the INL Site for chloride, sulfate, sodium, fluoride, nitrate, chromium, and selected other trace elements, and purgeable organic compounds (Table 3-6). Davis et al. (2013) provides a detailed discussion of results for samples collected during 2009 – 2011. Chromium had a concentration at the MCL of 100 µg/L in Well 65 in 2009 (Davis et al. 2013), but its concentration was below the MCL in 2014 at 69.1 µg/L and the long term trend has been decreasing in this well (Davis et al. 2015, Appendix D). Concentrations of chloride, nitrate, sodium, and sulfate historically have been above background concentrations in many wells at the INL Site, but concentrations

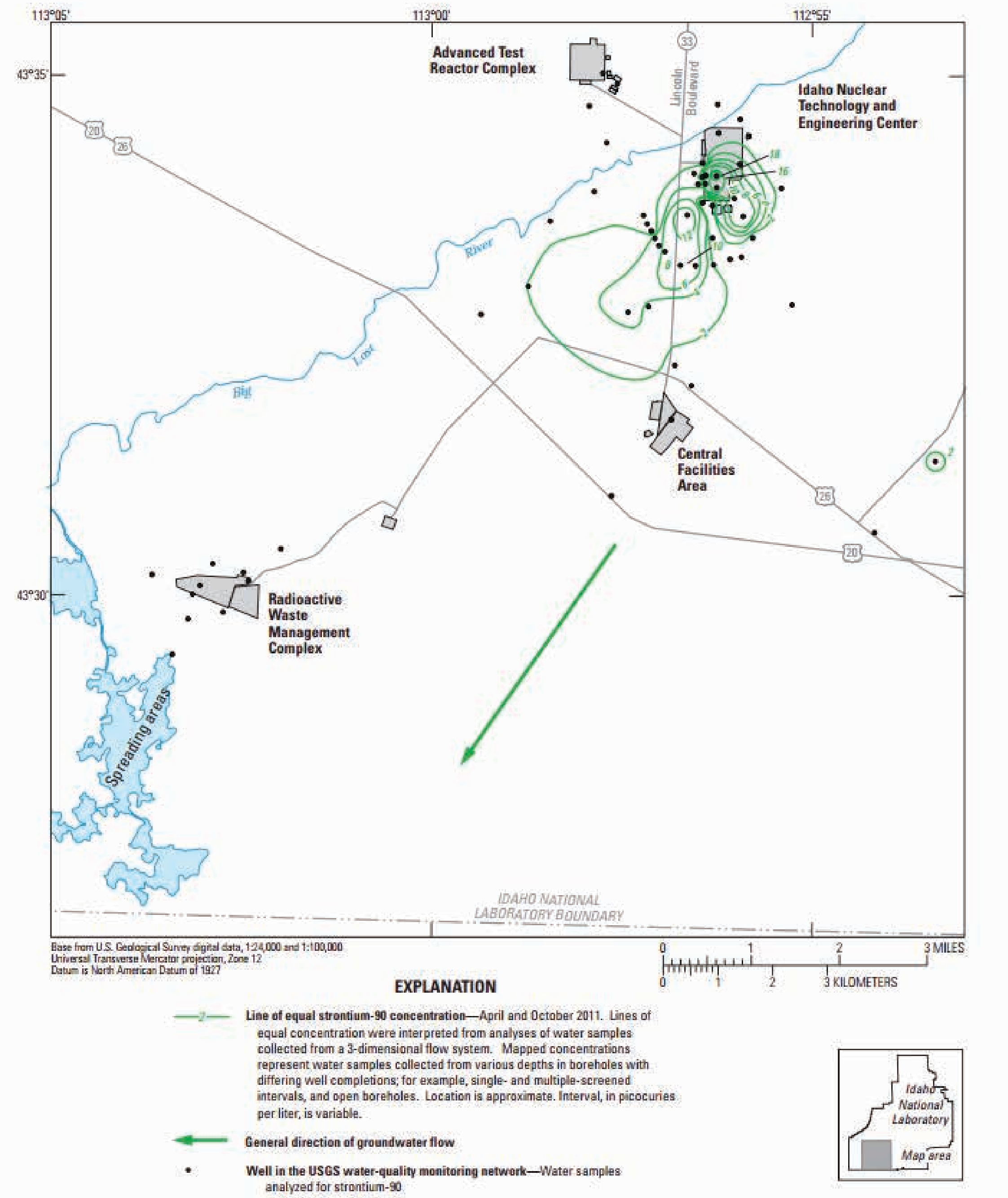


Figure 6-7. Distribution of ^{90}Sr in the Eastern Snake River Plain Aquifer on the INL Site in 2011 (from Davis et al. 2013).

were below established MCLs or secondary MCLs in all wells during 2011 (Davis et al. 2013).

Volatile organic compounds (VOCs) are present in water from the eastern Snake River Plain aquifer because of historical waste-disposal practices at the INL. The VOCs were used for degreasing, decontamination, and other activities at INL Site facilities. USGS sampled for purgeable (volatile) organic compounds in groundwater at the INL Site during 2014. Samples from 26 groundwater monitoring wells and one perched well were collected and submitted to the USGS National Water Quality Laboratory in Lakewood, Colorado, for analysis of 61 purgeable organic compounds. USGS reports describe the methods used to collect the water samples and ensure sampling and analytical quality (Mann 1996; Bartholo-

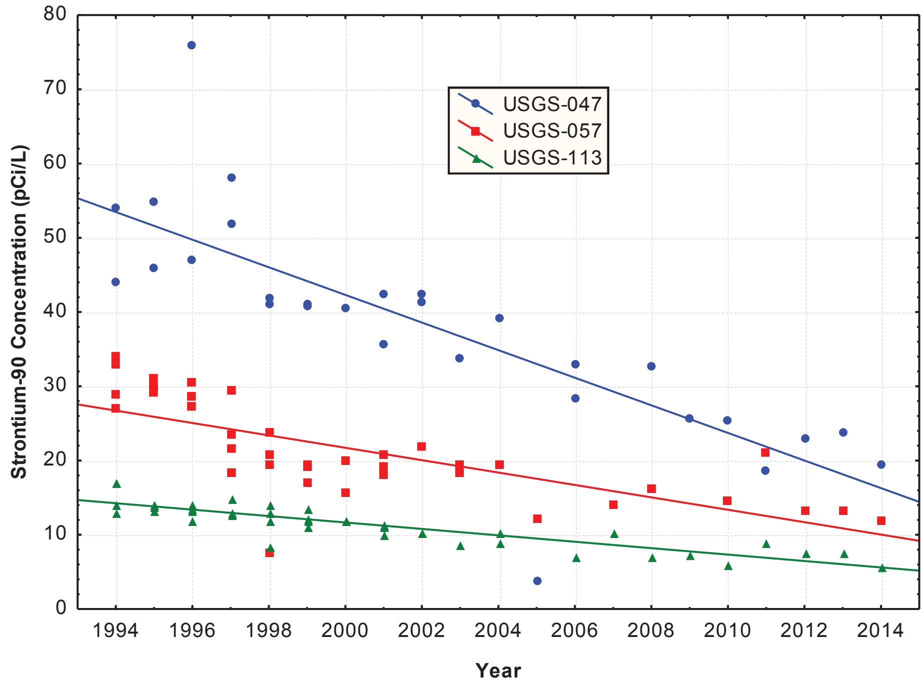


Figure 6-8. Long-term Trend of ^{90}Sr in Wells USGS-047,-057 and -113 (1994 – 2014).

may et al. 2003; Knobel et al. 2008, Bartholomay et al. 2014). Eight purgeable organic compounds were detected above the laboratory reporting level of 0.2 or 0.1 µg/L in at least one well on the INL Site (Table 6-2).

Historically, concentrations of VOCs in water samples from several wells at and near the RWMC exceeded the reporting levels (Bartholomay et al. 2000). However, concentrations for all VOCs except tetracholoromethane (also known as carbon tetrachloride) were less than the MCL for drinking water (EPA 2013). The production well at the Radioactive Waste Management Complex (RWMC) was monitored monthly for tetrachloromethane during 2014, and concentrations exceeded the MCL of 5 µg/L during all 12 months (Table 6-3). Concentrations have routinely exceeded the MCL for carbon tetrachloride in drinking water (5 µg/L) since 1998. (Note: VOCs are removed from the production well water prior to human consumption – see Section 5.4.4). Trend test results for carbon tetrachloride concentrations in water from the RWMC production well indicate a statistically significant increase in concentrations has occurred since 1987. Davis et al. (2013) indicated that more recent data collected since 2005 may be showing indications that concentrations are leveling off in the RWMC production well. To further test this statement, a trend analyses was run on the dataset from 2005 through 2012 (Davis et al. 2015). The trend test on that dataset still shows a positive increase, but the trend is not considered significant. The lack of a more recent significant increasing trend may indicate that engineering practices designed to reduce VOC concentration movement to the aquifer are having a positive effect.

Tetrachloromethane also exceeded the MCL in one sample collected from USGS-87, just north of the RWMC. Concentrations of tetrachloromethanefrom this well and from USGS-120, just south of the RWMC, have had an increasing trend since 1987, but have decreased through time at USGS-88.

Trichloroethene (TCE) exceeded the MCL of 5 µg/L from one sample collected from Well GIN 2 at Test Area North (TAN) (Table 6-2). There is a known groundwater TCE plume being treated at TAN, as discussed in more detail in Section 6.7.1.

6.7 Comprehensive Environmental Response, Compensation, and Liability Act Groundwater Monitoring During 2014

CERCLA activities at the INL Site are divided into WAGs that roughly correspond to the major facilities, with the addition of the INL Site-wide WAG 10. Locations of the various WAGs are shown on Figure 6-3. The following subsections provide an overview of ground-

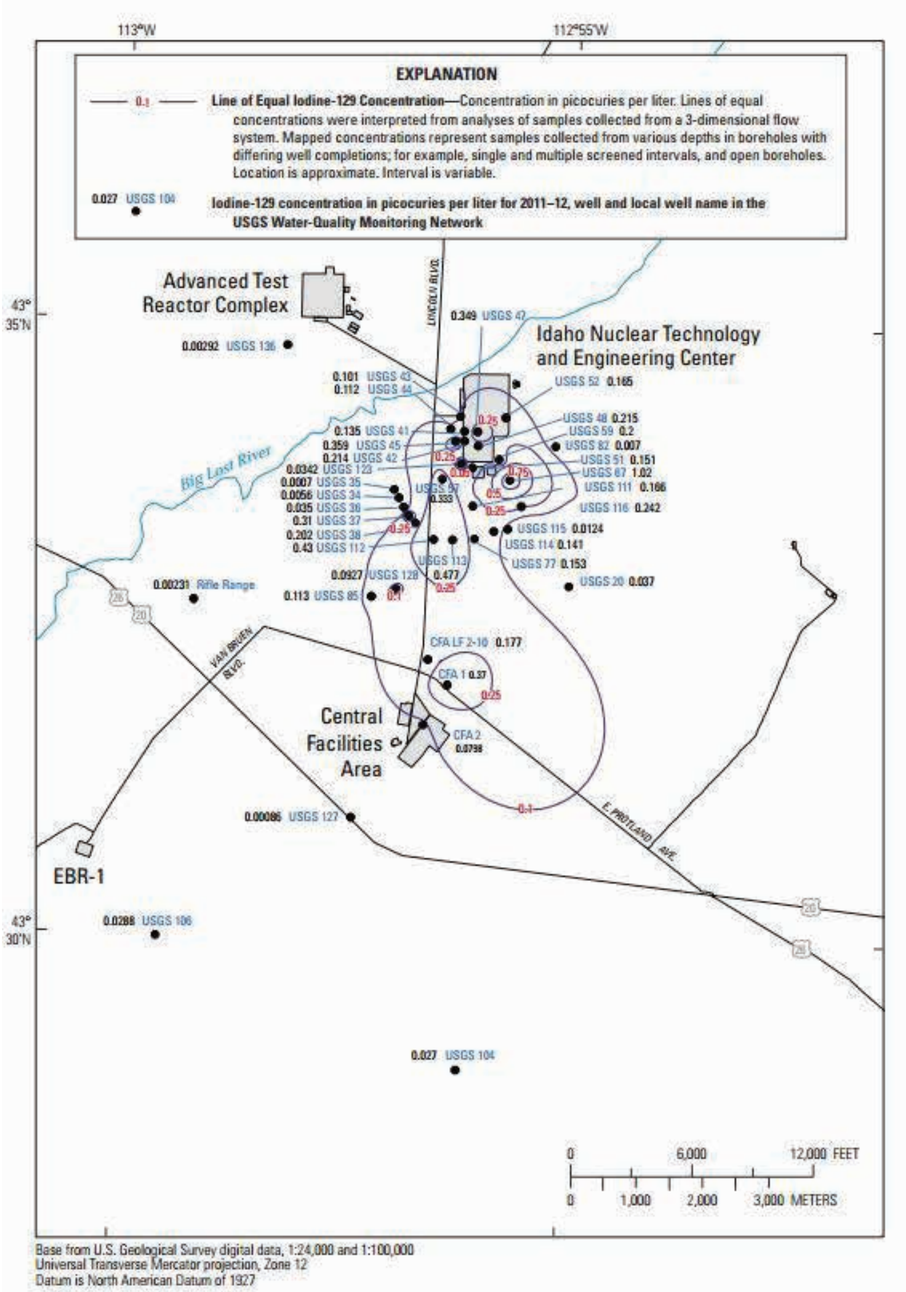


Figure 6-9. Distribution of ^{129}Iodine in the Snake River Plain Aquifer on the INL Site in 2011-12 (from Bartholomay 2013).

water sampling results. More detailed discussions of the CERCLA groundwater sampling can be found in the WAG-specific monitoring reports within the CERCLA Administrative Record at http://ar.inel.gov. WAG 8 is managed by the Naval Reactors Facility and is not discussed in this report.

6.7.1 Summary of Waste Area Group 1 Groundwater Monitoring Results

Groundwater is monitored at WAG 1 to measure the progress of the remedial action at TAN. The groundwater plume at TAN has been divided into three zones for the three different remedy components. The three remedy components work together to remediate the entire plume.

Table 6-2. Purgeable Organic Compounds in Annual USGS Groundwater Well Samples (2014).

Constituent[a]	GIN 2	RWMC-M7S	USGS-087	USGS-88	USGS-120
Tetrachloromethane (µg/L) (MCL=5)[b]	ND[c]	4.90	5.62	0.598	0.433
Trichloromethane (µg/L) (MCL=80)	0.124	0.999	0.363	0.413	ND
1,1,1-Trichloroethane (µg/L) (PCS=200)[d]	ND	0.372	0.184	ND	ND
Tetrachloroethene (µg/L) (MCL=5)	2.42	0.413	0.215	ND	ND
Trichloroethene (µg/L) (PCS=5)	9.49	2.37	1.10	0.430	ND

a. USGS 77 contains 0.118 µg/L 1,1, dichloroethene.
b. MCL = maximum contaminant level from Environmental Protection Agency in micrograms per liter (40 CFR 141).
c. ND = not detected.
d. PCS = primary constituent standard values from IDAPA 58.01.11.

The monitoring program and the results are summarized by plume zone in the following paragraphs.

Hot Spot Zone (TCE concentrations exceeding 20,000 µg/L) — In situ bioremediation (ISB) was used in the hot spot (TSF-05) to create conditions favorable for naturally occurring anaerobic bacteria in the aquifer to break down chlorinated ethene contaminants. The hot spot concentration was defined using data from 1997 (Figure 6-10) and is not reflective of current concentrations. With regulatory agency concurrence, an ISB rebound test began in July 2012 because the amount of contactable residual source in the aquifer had declined to the point of diminishing return from ISB injections.

In 2014, an ISB rebound test was in progress. All through 2014, anaerobic conditions created by ISB remained in the hot spot area, and TCE concentrations were near or below MCLs in all the former ISB injection wells. After background aquifer conditions are re-established, the effectiveness of the ISB part of the remedy will be evaluated (DOE-ID 2015a).

Data from Wells TAN-28, TAN-30A, TAN-1860, and TAN-1861 located downgradient of the hot spot are used to determine if ISB operations have reduced the downgradient flux of contaminants. Trends in TCE concentrations at Wells TAN-30A and TAN-1861 generally indicate that flux from the hot spot has been reduced at these wells, but the flux has not been reduced sufficiently at Wells TAN-28 and TAN-1860. The ISB rebound test determined that the cause of the higher TCE concentrations in TAN-28 and TAN-1860 was an untreated source area in the aquifer. Additional wells are planned to address this source.

Medial Zone (TCE concentrations between 1,000 and 20,000 µg/L) — A pump and treat system has been used in the medial zone. The pump and treat system involves extracting contaminated groundwater, circulating the groundwater through air strippers to remove VOCs like TCE, and reinjecting treated groundwater into the aquifer. The New Pump and Treat Facility was generally operated Monday through Thursday, except for shut downs due to maintenance. All 2014 Pump and Treat Facility compliance samples were below the discharge limits. TCE concentrations used to define the medial zone are based on data collected in 1997 before remedial actions started (Figure 6-10) and do not reflect current concentrations. TCE concentrations in the medial zone wells are significantly lower than the historically defined range of 1,000 to 20,000 µg/L. The TCE concentrations in Wells TAN-33, TAN-36, and TAN-44 are used as an indicator of groundwater TCE concentrations that migrate past the New Pump and Treat Facility extraction wells and were less than 70 µg/L in 2014.

Table 6-3. Purgeable Organic Compounds in Monthly Production Well Samples at the RWMC (2014).

Constituent	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec
Tetrachloromethane (µg/L) (MCL=5)[a]	8.23	7.96	E6.45[d]	E8.33	6.29	6.09	SS[e]	5.96	5.20	5.17	5.51	6.24
Trichloromethane (µg/L) (MCL=80)[b]	2.26	2.51	2.73	E3.70	2.04	1.84	SS	1.61	1.97	1.64	1.61	1.96
Tetrachloroethene (µg/L) (PCS=5)[c]	0.384	0.328	0.419	0.453	0.407	0.398	SS	0.309	0.339	0.278	0.325	0.336
1,1,1-Trichloroethane (µg/L) (PCS=200)	0.484	0.489	E0.573	E0.654	0.559	0.508	SS	0.324	0.393	0.306	0.330	0.385
Trichloroethene (µg/L) (PCS=5)	3.77	3.82	4.36	4.85	2.80	2.47	SS	2.99	3.31	2.65	2.89	3.34

a. MCL = maximum contaminant level values from the Environmental Protection Agency (40 CFR 141).
b. The MCL for total trihalomethanes is 100 µg/L This MCL is based on concentrations of bromodichloromethane, dibromochloromethane, tribromomethane and trichloromethane.
c. PCS = primary constituent standard values from IDAPA 58.01.11
d. SS = samples ruined in shipping
e. E = estimated. Analytes that are detected between the long-term method detection limit and the Laboratory Reporting Limit, and pass detection criteria for USGS National Water Quality Laboratory data are estimated. (Davis et al., 2013)

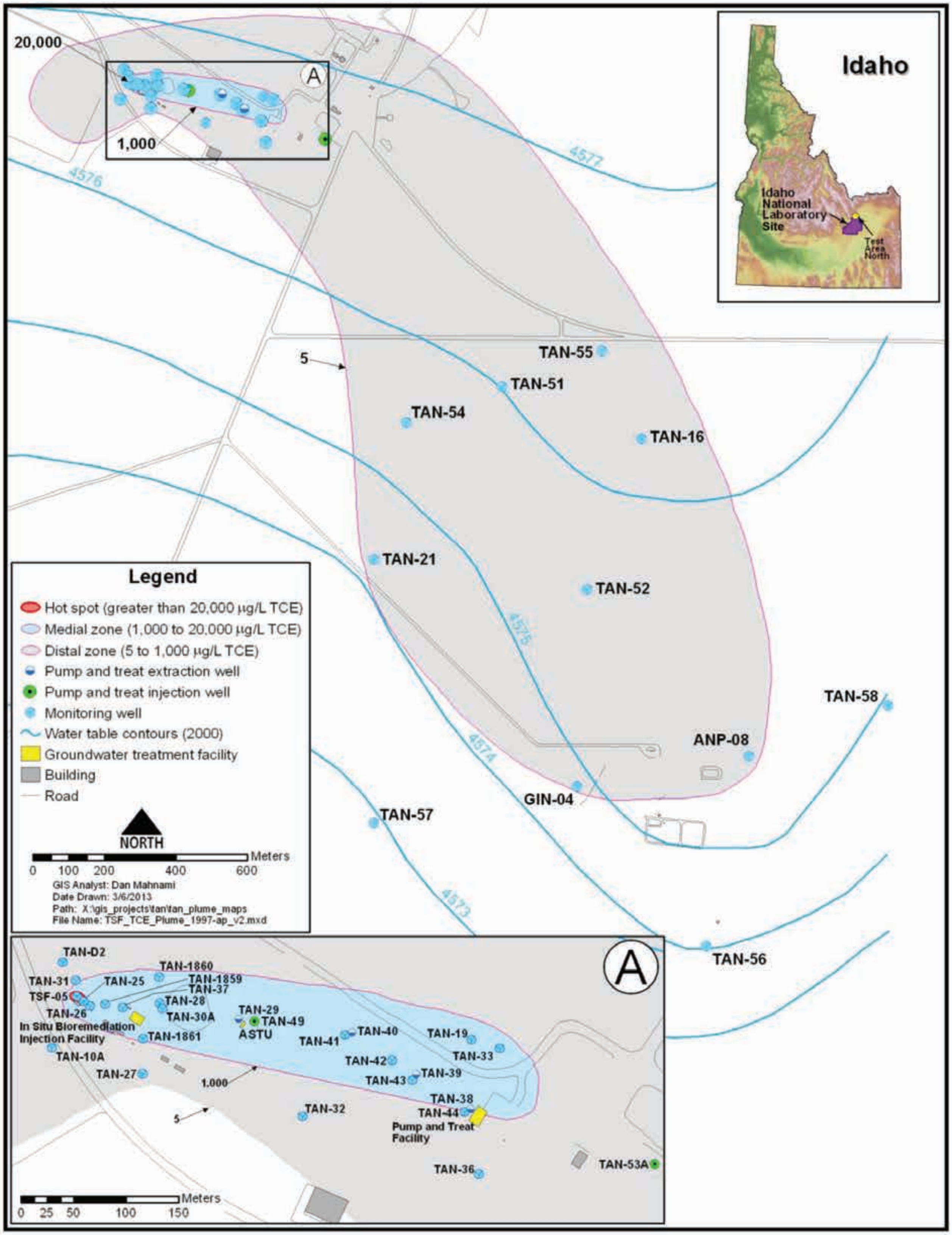


Figure 6-10. Trichloroethene Plume at TAN in 1997.

Distal Zone (TCE concentrations between 5 and 1,000 µg/L) — Monitored natural attenuation is the remedial action for the distal zone of the plume as defined by 1997 TCE concentrations (Figure 6-10). Monitored natural attenuation is the sum of physical, chemical, and biological processes that act without human intervention to reduce the mass, toxicity, mobility, volume, or concentration of contaminants in groundwater. Institutional controls are in place to protect current and future users from health risks associated with groundwater contamination until concentrations decline through natural attenuation to below the MCL.

TCE data collected in 2014 from the distal zone wells indicate that all wells are consistent with the model predictions, but additional data are needed to confirm that the monitored natural attenuation part of the remedy is on track for all wells in the distal portion of the plume. The TCE data from the plume expansion wells suggest that the plume has expanded but is within the limits allowed in the Record of Decision Amendment (DOE-ID 2001).

Radionuclide Monitoring — Strontium-90 and ^{137}Cs are expected to decline below their respective MCLs before 2095. However, ^{90}Sr and ^{137}Cs data at wells in the source area show elevated concentrations compared to those before starting ISB. The elevated ^{90}Sr and ^{137}Cs concentrations are due to elevated concentrations of competing cations (calcium, magnesium, sodium, and potassium) for adsorption sites in the aquifer leading to enhanced ^{90}Sr and ^{137}Cs mobility. The elevated cation concentrations are due to ISB activities.

Strontium-90 and ^{137}Cs trends will be evaluated as competing cation concentrations decline toward background conditions during the ISB rebound test to determine if they will meet the remedial action objective of declining below MCLs by 2095.

6.7.2 Summary of Waste Area Group 2 Groundwater Monitoring Results

Groundwater samples were collected from seven aquifer wells at WAG 2, ATR Complex, during 2014. The locations of the wells sampled for WAG 2 are shown on Figure 6-11. Aquifer samples were analyzed for ^{90}Sr, gamma-emitting radionuclides (cobalt-60), tritium, and chromium (filtered). The data for the October 2014 sampling event will be included in the Fiscal Year 2015 Annual Report for WAG 2 when it is finalized. The October 2014 sampling data are summarized in Table 6-4.

No analyte occurred above its MCL. The highest chromium concentration occurred in Well USGS-065 at 74.2 µg/L and was below the MCL of 100 µg/L. The chromium concentration in Well TRA-07 was also elevated at 74 µg/L. Although chromium increased in both TRA-07 and USGS-065 in 2014, the chromium concentrations in both wells are still in long-term downward trends.

Tritium was the only radionuclide analyte detected in the aquifer and was below the MCL of 20,000 pCi/L in all wells sampled. The highest tritium concentration was 8,150 pCi/L in TRA-07. In the past Well TRA-08 had detections of ^{90}Sr, but ^{90}Sr has been below detection limits since October 2010.

Chromium and tritium concentrations in the aquifer have declined faster than predicted by the WAG 2 models used for the Operable Unit 2-12 Record of Decision and the revised modeling performed after the first five-year review (DOE-NE-ID 2005).

The October 2014 eastern Snake River Plain aquifer water table map prepared for the vicinity of ATR Complex was consistent with previous maps showing similar groundwater flow directions. Water levels in the vicinity

Table 6-4. WAG 2 Aquifer Groundwater Quality Summary for 2014.

Analyte	MCL[a]	Background[b]	Maximum	Minimum	Number of Wells above MCL
Chromium (filtered) (µg/L)	100	2–3	74.2	1.87	0
Sr-90 (pCi/L)	8	0	ND[c]	ND	0
Tritium (pCi/L)	20,000	75–150	8,150	ND	0

a. MCL = maximum contaminant level.
b. Background concentrations are from Knobel et al. (1992), except tritium, which is from Orr et al. (1991).
c. ND = not detected.

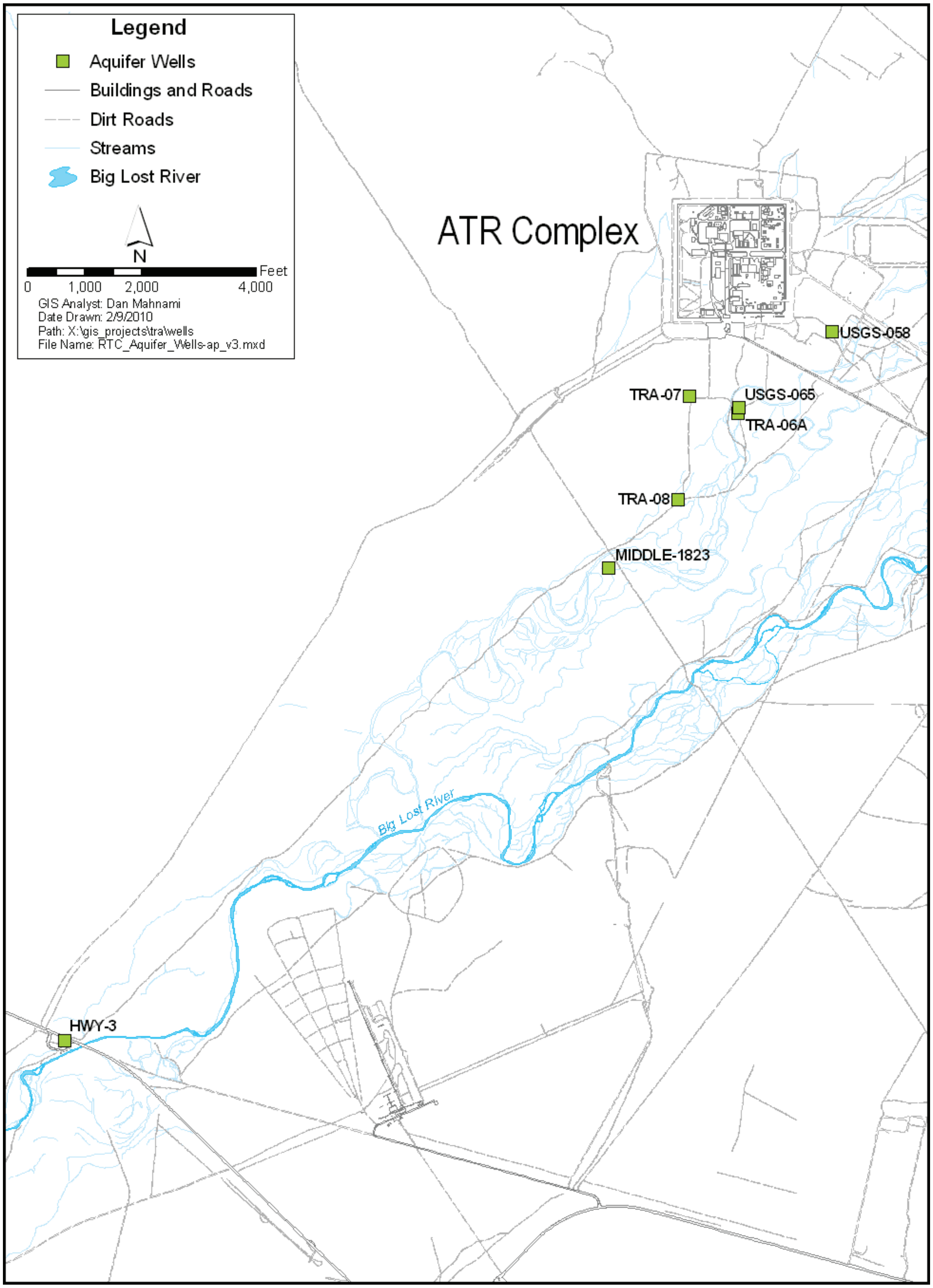


Figure 6-11. Locations of WAG 2 Aquifer Monitoring.

of ATR Complex fell approximately 1.3 feet on average from October 2013 to October 2014.

6.7.3 Summary of Waste Area Group 3 Groundwater Monitoring Results

At INTEC, groundwater samples were collected from 13 eastern Snake River Plain aquifer monitoring wells during 2014 (Figure 6-12). Groundwater samples were analyzed for a suite of radionuclides and inorganic constituents, and the data are summarized in the 2014 annual report (DOE-ID 2015b). Table 6-5 summarizes the maximum concentrations observed, along with the number of MCL exceedances reported for each constituent.

Strontium-90, technetium-99 (^{99}Tc), and nitrate exceeded their respective drinking water MCLs in one or more of the eastern Snake River Plain aquifer monitoring wells at or near INTEC, with ^{90}Sr exceeding its MCL by the greatest margin. Strontium-90 concentrations remained above the MCL (8 pCi/L) at six of the well locations sampled. During 2014, the highest ^{90}Sr level in eastern Snake River Plain aquifer groundwater was at monitoring Well ICPP-2021-AQ (14.5 ± 1.29 pCi/L) located southeast of the INTEC Tank Farm. All well locations showed similar or slightly lower ^{90}Sr levels compared to those reported during the previous sampling events.

As in the past, ^{99}Tc was detected above the MCL (900 pCi/L) in two monitoring wells within INTEC, but concentrations were below the MCL at all other locations. During 2014, the highest ^{99}Tc level in eastern Snake River Plain aquifer groundwater was at monitoring Well ICPP-MON-A-230 (1,060 ± 60.8 pCi/L) located north of the INTEC Tank Farm. All wells sampled showed stable or declining trends from the previous reporting period.

Nitrate was detected in all wells sampled during this reporting period. The highest concentration was reported at Well ICPP-2021-AQ (14.1 mg/L as N). This was the only location where the nitrate concentration exceeded the MCL (10 mg/L as N). This well is located relatively close to the Tank Farm, and shows groundwater quality impacts attributed to past releases of Tank Farm liquid waste. Nitrate concentrations are similar or slightly lower than observed in previous years.

Iodine-129 concentrations were below detection limits at most well locations. The only locations where ^{129}I was reported above detection limits were Wells ICPP-2021-AQ (0.836 ± 0.147 pCi/L) and USGS-067 (0.745 ± 0.186 pCi/L). After allowing for analytical uncertainty, none of the wells showed an increase in ^{129}I concentration since the previous reporting period.

Tritium was detected in nearly all of the wells sampled, but none of the groundwater samples exceeded the tritium MCL (20,000 pCi/L). The highest tritium concentrations in groundwater were reported at Well USGS-51, near the former percolation ponds (3,400 ± 377 pCi/L), and Well ICPP-2021-AQ, southeast of the Tank Farm (3,320 ± 368 pCi/L). Tritium concentrations have declined at nearly all locations over the past few years.

During the reporting period, no plutonium isotopes were detected in any of the eastern Snake River Plain aquifer groundwater samples. Uranium-238 was detected at all eastern Snake River Plain aquifer well locations, with the highest concentration at Well ICPP-MON-A-230 (1.12 ± 0.158 pCi/L) north of the Tank Farm. The uranium-238 (^{238}U) results are consistent with background concentrations reported for eastern Snake River Plain aquifer groundwater. Similarly, uranium-234 (^{234}U) also was detected in all groundwater samples, with concentrations ranging as high as 2.24 ± 0.262 pCi/L at Well ICPP-MON-A-230. Uranium-234 is the daughter product of alpha decay of the long-lived, naturally occurring ^{238}U. Uranium results were consistent with background concentrations reported for Snake River Plain aquifer groundwater. Ratios of ^{234}U/^{238}U were similar to background ^{234}U/^{238}U activity ratios of 1.5 to 3.1 reported for the eastern Snake River Plain aquifer.

Uranium-235 was detected in one of the groundwater samples: ICPP-MON-A-230 (0.106 ± 0.048 pCi/L). An evaluation of uranium in groundwater near RWMC indicates that eastern Snake River Plain aquifer background ^{235}U activities are generally less than 0.15 pCi/L (95 percent upper tolerance limit). Reported ^{235}U concentrations in groundwater at INTEC have historically been slightly above the background level, which is consistent with limited uranium impacts to groundwater from past operations at INTEC.

The 2014 groundwater contour map is similar in shape to the maps prepared for previous years, although water elevations vary slightly from year to year in response to wet-dry climate cycles. Groundwater levels declined during 2000–2005 as a result of the drought during this period. However, as a result of near normal precipitation during 2005–2014 and corresponding periods of flow of the Big Lost River, groundwater levels have remained relatively constant during this period.

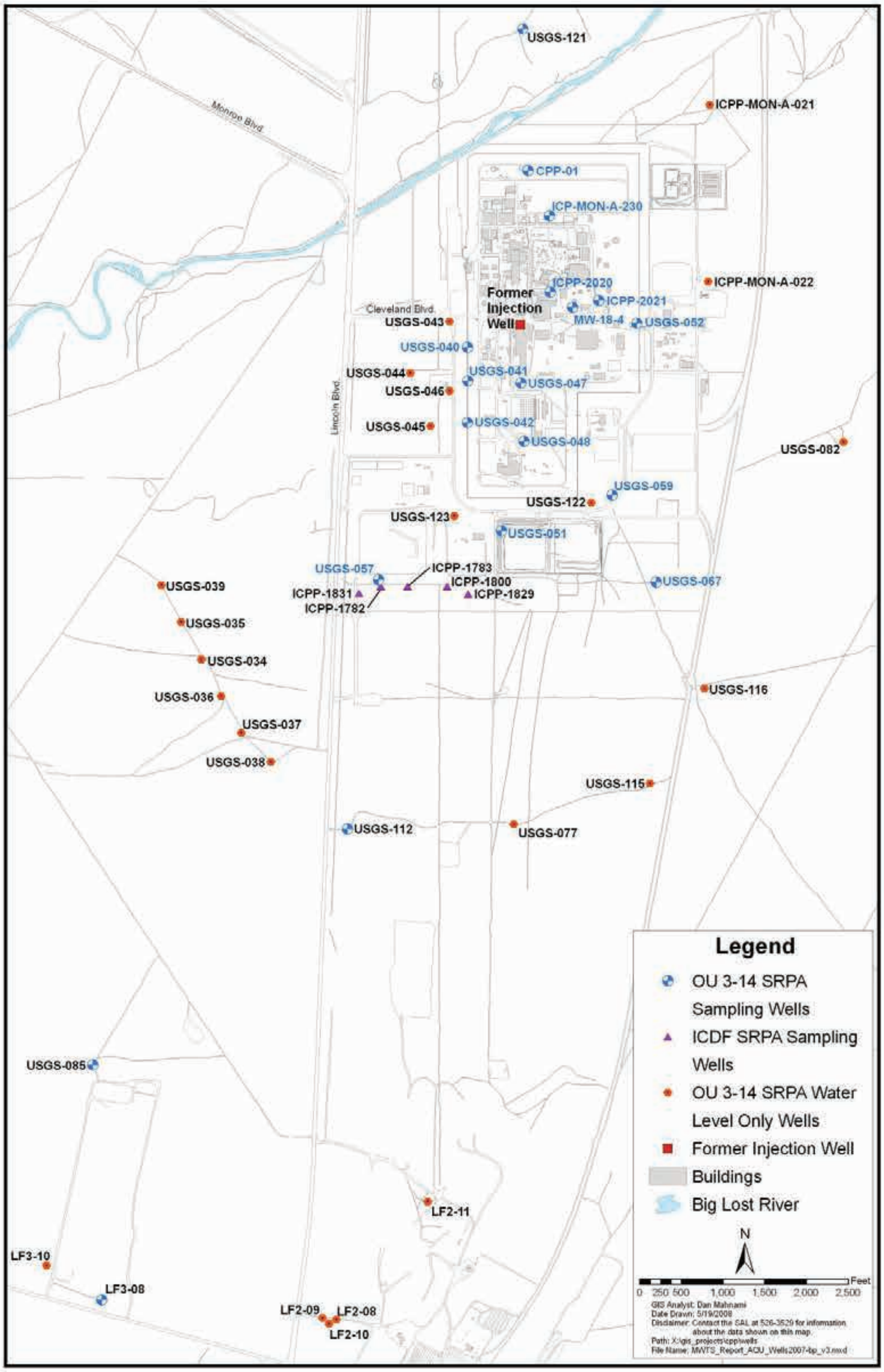


Figure 6-12. Locations of WAG 3 Monitoring Wells.

Table 6-5. Summary of Constituents Detected in WAG 3 Aquifer Monitoring Wells (FY 2014).

Constituent	EPA MCL[a]	Units	Snake River Plain Aquifer Groundwater – March 2014		
			Maximum Reported Value[b]	Number of Results[c]	Results > MCL[c]
Gross alpha	15	pCi/L	2.59 ± 0.951 UJ	15	0
Gross beta	NA[d]	pCi/L	628 ± 12.9	15	NA[d]
Cesium-137	200	pCi/L	5.73 ± 2.45 UJ	15	0
Strontium-90	8	pCi/L	**14.5 ± 1.29**[e]	15	6
Technetium-99	900	pCi/L	**1,060 ± 60.8**	15	3
Iodine-129	1	pCi/L	0.836 ± 0.147	15	0
Tritium	20,000	pCi/L	3,400 ± 377	15	0
Plutonium-238	15	pCi/L	ND[f]	15	0
Plutonium-239/240	15	pCi/L	ND	15	0
Uranium-233/234	15	pCi/L	2.24 ± 0.262	15	0
Uranium-235	15	pCi/L	0.106 ± 0.048 J	15	0
Uranium-238	15	pCi/L	1.12 ± 0.158	15	0
Alkalinity	NA	mg/L	151	15	NA
Calcium	NA	mg/L	64.8	15	NA
Chloride	250	mg/L	135 J	15	0
Magnesium	NA	mg/L	22.7	15	NA
Nitrate (as N)	10	mg/L	**14.1 J**	15	1
Potassium	NA	mg/L	4.72	15	NA
Sodium	NA	mg/L	32	15	NA
Sulfate	250	mg/L	41.2	15	0
Total dissolved solids	500	mg/L	456	15	0

a. EPA = Environmental Protection Agency; MCL = maximum contaminant level.
b. Data-qualifier flags: J = estimated value; UJ = not detected, quantitation limit is an estimate.
c. Includes field duplicates.
d. NA = not applicable.
e. **Bolded** values exceed MCL.
f. ND = constituent not detected in any sample.

6.7.4 Summary of Waste Area Group 4 Groundwater Monitoring Results

The WAG 4 groundwater monitoring consists of two different components: (1) CFA landfill monitoring and (2) monitoring of a nitrate plume south of CFA. Groundwater monitoring for the CFA landfills consisted of sampling seven wells for metals (filtered), volatile organic compounds (VOCs), and anions (nitrate, chloride, fluoride, and sulfate) and two wells for VOCs only in accordance with the long-term monitoring plan (DOE-ID 2013). Four wells south of CFA were sampled for nitrate and other anions to monitor a nitrate plume downgradient of CFA. The CFA monitoring well locations are shown on Figure 6-13. Analytes detected in groundwater are compared to regulatory levels in Table 6-6. A complete list of the groundwater sampling results is contained in the 2014 Monitoring Report (DOE-ID 2015c).

In the CFA nitrate plume monitoring wells south of CFA, one well, CFA-MON-A-002, continued to exceed the groundwater MCL of 10 mg/L-N for nitrate. Nitrate concentrations increased in 2014 to 15.3 mg/L-N in CFA-MON-A-002, but overall the data exhibit a downtrend since 2006.

The nitrate concentration of 8.35 mg/L-N in Well CFA-MON-A-003 is below the MCL and within its historic range of 8 to 11 mg/L-N. Except for a 2005 spike, nitrate concentrations in Well CFA-MON-A-003 have been relatively consistent since monitoring started in 1995.

In 2014, chloroform, toluene, and acetone were the VOCs detected downgradient from the CFA landfills. The source of the chloroform, toluene, and acetone in the groundwater is uncertain because the soil gas samples do not indicate a source in the landfills for these compounds that appears capable of causing the groundwater contamination.

A comparison of the maximum detected concentrations for filtered metals to background and the defined regulatory levels shows that all metals, except iron, were below MCLs, secondary maximum contaminant levels (SMCLs), or action levels in all the landfill wells. Iron concentrations of 705 and 462 µg/L in Wells CFA-1932 and LF3-08, respectively, were above the SMCL. However, these iron concentrations are inconsistent with the high dissolved oxygen levels (5.06 and 5.6 mg/L) in these wells and pH readings of 7.65 to 8.65. Although precautions were taken to guard against filter breakthrough like monitoring backpressure, it is possible that particles less than 0.45 microns may have gone through the filter, or the filter may have experienced a minor breakthrough.

Water-level measurements taken in the CFA area in 2014 suggest that after the sharp drop in water levels from 2000 to 2005, water levels appear to be stabilizing because they have changed little since 2005. A water table map produced from water levels collected in August 2014 was consistent with previous maps in terms of gradients and groundwater flow directions (DOE-ID 2015c).

6.7.5 Summary of Waste Area Group 5 Groundwater Monitoring Results

Groundwater was not monitored for WAG 5 in 2014. Groundwater monitoring for WAG 5 was concluded in November 2006 in accordance with the recommendations from the first five-year review (DOE-NE-ID 2007).

6.7.6 Summary of Waste Area Group 6 Groundwater Monitoring Results

Independent groundwater monitoring is not performed for WAG 6. Groundwater monitoring in the vicinity of WAG 6 is conducted in accordance with the WAG 10 site-wide monitoring requirements, as discussed in Section 6.7.9.

6.7.7 Summary of Waste Area Group 7 Groundwater Monitoring Results

Groundwater samples collected from monitoring wells in the vicinity of RWMC in November 2014 were analyzed for radionuclides, inorganic constituents, VOCs, and 1,4-dioxane. Of the 275 analyses performed, 12 met reportable criteria established in the Operable Unit 7 13/14 Field Sampling Plan (Forbes and Holdren 2014). Table 6-7 lists contaminants of concern that were detected above regional background concentrations, MCLs, or quantitation limits.

Carbon tetrachloride and TCE were detected at concentrations above the reporting limit (1 µg/L) at several locations. Carbon tetrachloride slightly exceeded its MCL (5 µg/L) at one monitoring location, Well M7S, located northeast of the RWMC (Figure 6-14), but the concentration at this well showed little change from results reported during the previous year. At Well M15S, located east of RWMC (Fig. 6-14), increasing trends were observed for both carbon tetrachloride and trichloroethylene (Figure 6-15), but neither compound exceeded its MCL (5 µg/L).

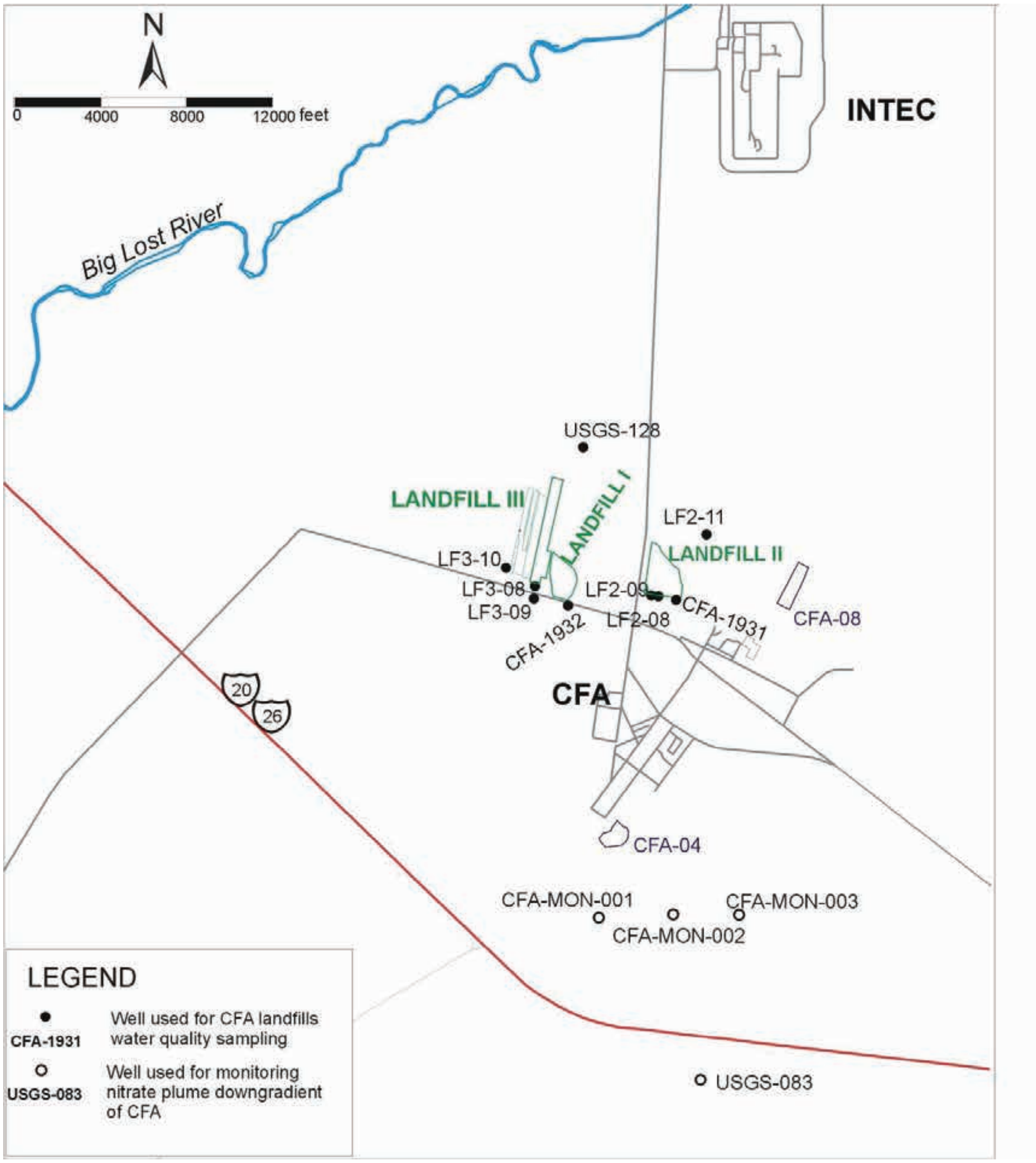


Figure 6-13. Locations of WAG 4/CFA Monitoring Wells Sampled in 2014.

Radionuclides and inorganic analytes were not detected above reporting thresholds in groundwater samples in 2014. In general, radionuclide concentrations in the aquifer at RWMC are relatively stable or trending slightly downward. As in previous years, groundwater level measurements in RWMC-area monitoring wells during 2014 indicate groundwater flow to the south-southwest (Figure 6-16).

6.7.8 Summary of Waste Area Group 9 Groundwater Monitoring Results

Five wells (four monitoring and one production) at the Materials and Fuels Complex are sampled twice a year for selected radionuclides, metals, total organic carbon, total organic halogens, and other water quality parameters as required under the WAG 9 Record of Decision (Figure 6-17; ANL-W 1998). The reported con-

Table 6-6. Comparison of WAG 4 Groundwater Sampling Results to Regulatory Levels (2014).

Compound	MCL[a] or SMCL[b]	Maximum Detected Value	Number of Wells above MCL or SMCL
Downgradient Central Facilities Area Wells			
Chloride (mg/L)	*250*[c]	68.5	0
Fluoride (mg/L)	2	0.218	0
Sulfate (mg/L)	*250*	31.6	0
Nitrate/nitrite (mg-N/L)	10	**15.3**[d]	1
Central Facilities Area Landfill Wells			
Anions			
Chloride (mg/L)	*250*	73.2	0
Fluoride (mg/L)	2	0.20	0
Sulfate (mg/L)	*250*	39.8	0
Nitrate/nitrite (mg-N/L)	10	2.57	0
Common Cations			
Calcium (µg/L)	None	58,500	NA[e]
Magnesium (µg/L)	None	16,100	NA
Potassium (µg/L)	None	4,740	NA
Sodium (µg/L)	None	31,900	NA
Inorganic Analytes			
Antimony (µg/L)	6	ND[f]	0
Aluminum (µg/L)	*50–200*	183	0
Arsenic (µg/L)	10	ND	0
Barium (µg/L)	2,000	102	0
Beryllium (µg/L)	4	ND	0
Cadmium (µg/L)	5	ND	0
Chromium (µg/L)	100	94.8	0
Copper (µg/L)	*1,300/1,000*	2.26	0
Iron (µg/L)	300	705	2
Lead (µg/L)	15[c]	0.595	0
Manganese (µg/L)	50	6.03	0
Mercury (µg/L)	2	ND	0
Nickel (µg/L)	None	177	NA
Selenium (µg/L)	50	1.87	0
Silver (µg/L)	100	ND	0
Thallium (µg/L)	2	ND	0
Vanadium (µg/L)	None	4.18	NA
Zinc (µg/L)	*5,000*	36.2	0
Detected Volatile Organic Compounds			
Acetone	None	4.58	NA
Chloroform (µg/L)	100	0.89	0
Toluene (µg/L)	1,000	2.46	0

a. MCL = maximum contaminant level.
b. SMCL = secondary maximum contaminant level.
c. Numbers in *italics* are for the secondary MCL.
d. **Bold** values exceed an MCL or a secondary SMCL.
e. NA = not applicable.
f. ND = not detected.

Table 6-7. Summary of WAG 7 Aquifer Sampling and Analyses for Relevant Analytes in 2014.

Analyte	Number of Wells Sampled	Number of Analyses[a]	Number of Reportable Detections[a, b]	Concentration Maximum[a]	Number of Detections Greater Than MCL[a]	MCL[c]
Carbon tetrachloride	10	14	7	5.61 µg/L	2	5 µg/L
Trichloroethylene	10	14	5	2.97 µg/L	0	5 µg/L

a. Includes field duplicate samples collected for quality control purposes.
b. Reported results are contaminants of concern at concentrations greater than regional background concentrations or quantitation limits. Background concentrations of carbon tetrachloride and trichloroethylene in the Snake River Plain Aquifer are essentially zero; therefore, laboratory quantitation limits are used as reporting limits.
c. MCL = maximum contaminant level. MCLs are from "National Primary Drinking Water Regulations" (40 CFR 141).

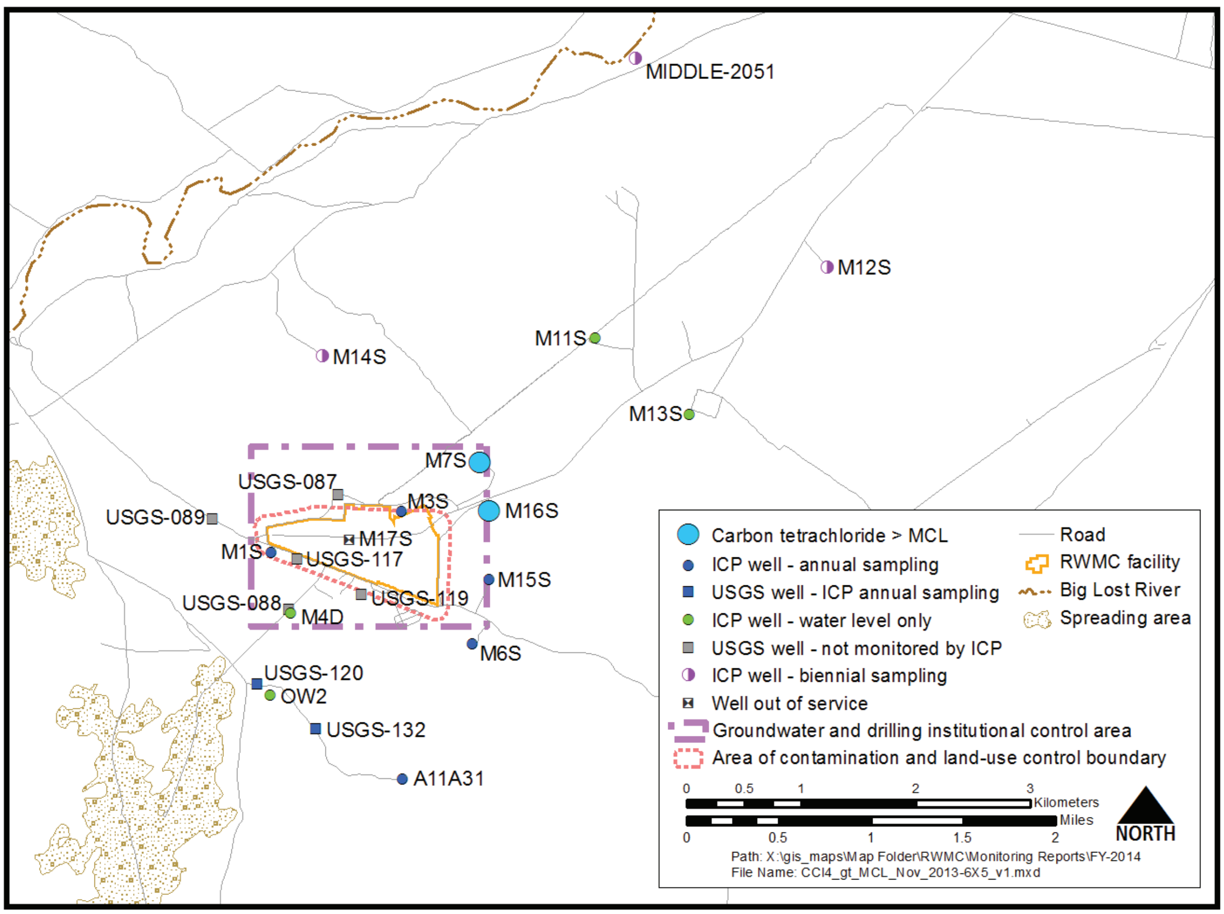


Figure 6-14. Location of Aquifer Monitoring Wells Showing Locations Where Carbon Tetrachloride Exceeded the MCL in November 2014.

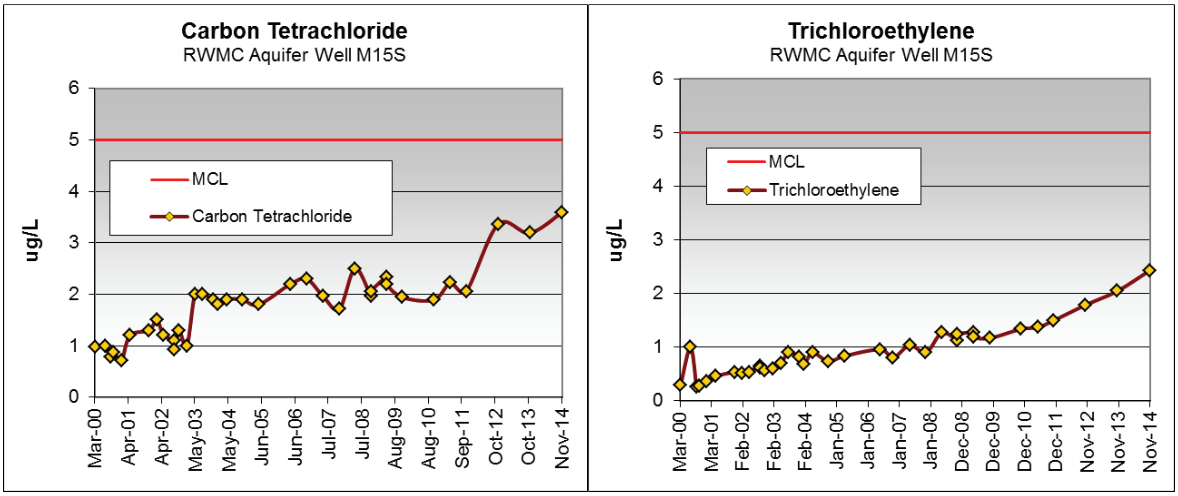


Figure 6-15. Concentration History of Carbon Tetrachloride and Trichloroethylene in Well M15S.

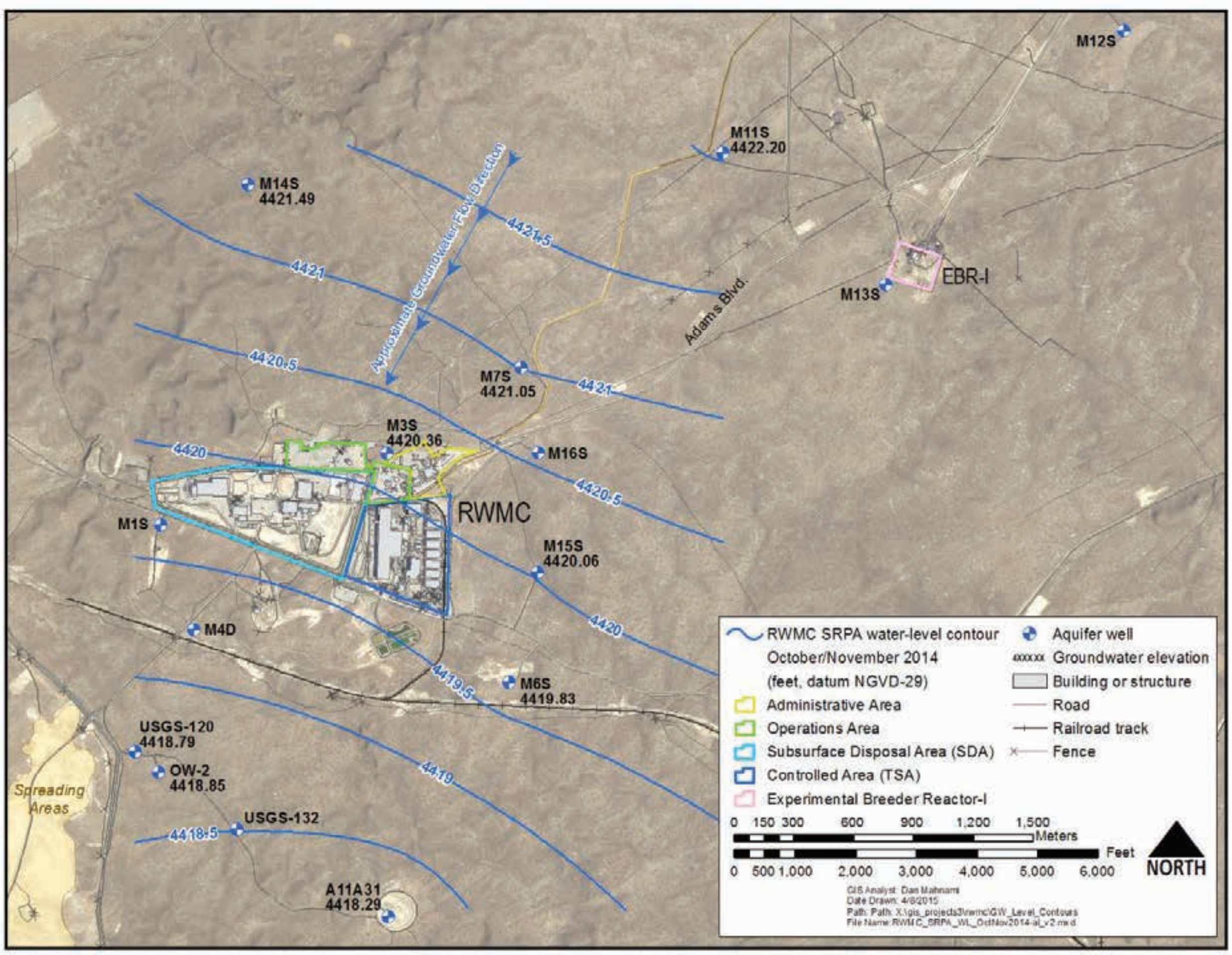


Figure 6-16. Groundwater-level Contours in the Aquifer Near the Radioactive Waste Management Complex Based on October/November 2014 Measurements.

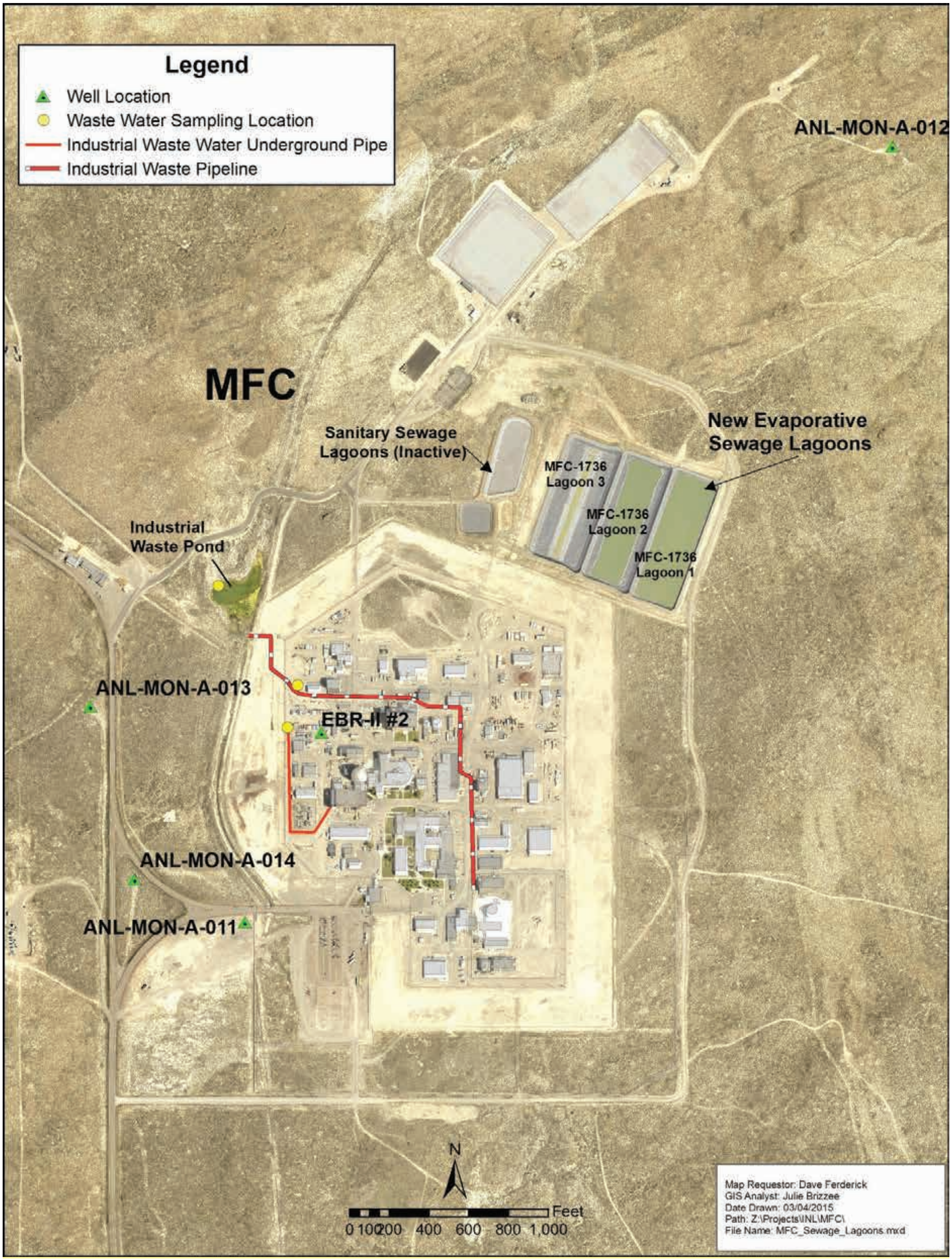


Figure 6-17. Locations of WAG 9 Wells Sampled in 2014.

centrations of analytes that were detected in at least one sample are summarized in Table 6-8. Overall, the data show no discernable impacts from activities at the Materials and Fuels Complex.

6.7.9 Summary of Waste Area Group 10 Groundwater Monitoring Results

In accordance with the Operable Unit 10-08 monitoring plan (DOE-ID 2014b), groundwater samples are collected every two years at the locations shown on Figure 6-18. In 2014, no WAG 10 groundwater sampling occurred. The next WAG 10 groundwater sampling event is scheduled for 2015.

6.8 Offsite Drinking Water Sampling

As part of the offsite monitoring program performed by the ESER contractor, drinking water samples were collected off the INL Site for radiological analyses in 2014. Two locations, Shoshone and Minidoka, which are downgradient of the INL Site, were co-sampled with the state of Idaho Department of Environmental Quality (DEQ) INL Oversight Program (IOP) in May and November. One upgradient location, Mud Lake, was also co-sampled with IOP. ESER also collected samples at Atomic City, Craters of the Moon, Howe, Idaho Falls, and the public rest area at Highway 20/26. A control sample of bottled water was also obtained. The samples were analyzed for gross alpha and beta activities and for tritium. The ESER contractor results are shown in Table 6-9. IOP results are reported quarterly and annually and can be accessed at http://www.deq.idaho.gov/inl-oversight.

Gross alpha activity was detected in only one sample (Craters of the Moon) at just above the minimum detectable concentration. Gross beta activity was detected in all but one drinking water sample collected by ESER, but not in either sample of the bottled water. Gross beta activity has been measured at these levels historically in offsite drinking water samples. The results are below the screening MCL of 8 pCi/L for ^{90}Sr. This MCL is extremely conservative because the radionuclides contributing to the gross beta activity are most likely naturally-occurring decay products of thorium and uranium, which are present in the aquifer, and not ^{90}Sr, which is a man-made radionuclide.

Tritium was detected in some of the drinking water samples (including one of the control samples) collected in 2014. The results were within historical measurements and well below the EPA MCL of 20,000 pCi/L

6.9 Surface Water Sampling

Surface water was co-sampled with DEQ IOP in May and November 2014 at three springs located downgradient of the INL Site: Alpheus Springs near Twin Falls; Clear Springs near Buhl; and a trout farm near Hagerman (see Figure 6-19). ESER contractor results are shown in Table 6-10. Gross alpha activity was detected in one sample, a duplicate sample collected at Alpheus Spring. Gross beta activity was detected in all surface water samples. The highest result was measured at Alpheus Springs. Alpheus Springs has historically shown higher results, occasionally above 8 pCi/L as it was in May 2014, and is most likely due to natural decay products of thorium and uranium that dissolve into water as it passes through the surrounding basalts of the eastern Snake River Plain aquifer.

Tritium was detected in two of the seven surface water samples collected by the ESER contractor. Concentrations were similar to those found in the drinking water samples and in other liquid media such as precipitation.

The Big Lost River is an intermittent, ephemeral body of water that flows only during periods of high spring runoff and releases from the Mackay dam, which impounds the river upstream of the INL Site. The river flows through the INL Site and enters a depression, where the water flows into the ground, called Big Lost River Sinks (see Figure 6-19). The river then mixes with other water in the eastern Snake River Plain Aquifer. Water in the aquifer then emerges about 100 miles (160 km) away at Thousand Springs near Hagerman and other springs downstream of Twin Falls. The ESER contractor did not collect surface water samples from the Big Lost River on the INL Site in 2014 because the river contained no water at any time during the year.

Table 6-8. Comparisons of Detected Analytes to Drinking Water Standards at WAG 9 Monitoring Wells (2014).

Well:	ANL-MON-A-011		ANL-MON-A-012		ANL-MON-A-013		ANL-MON-A-014		EBR-II[a] No. 2		PCS/SCS[b]
Sample Date:	**04/22/14**	**10/01/14**	**05/27/14**	**09/30/14**	**04/22/14**	**09/30/14**	**04/21/14**	**09/30/14**	**04/23/14**	**10/01/14**	
Radionuclides[c]											
Gross alpha (pCi/L)	ND[d]	ND	1.52 ± 0.384	ND	2.12 ± 0.745J	ND	3.4 ± 1.06	ND (ND)[f]	ND	ND	15 pCi/L
Gross beta (pCi/L)	4.52 ± 1.12	5.04 ± 0.827	3.11 ± 0.591	4.43 ± 0.761	4.94 ± 1.09	3.17 ± 0.848	5.6 ± 0.971	4.17 ± 0.964 (5.14 ± 0.891)	7.65 ± 1.27	ND	4 mrem/yr
Uranium-233/234 (pCi/L)	1.14 ± 0.165	1.35 ± 0.163	1.09 ± 0.172	1.48 ± 0.178	1.42 ± 0.203	1.28 ± 0.153	1.21 ± 0.205	1.49 ± 0.183 (1.32 ± 0.171)	1.31 ± 0.191	1.51 ± 0.179	186,000
Uranium-238 (pCi/L)	0.602 ± 0.112	0.469 ± 0.0822	0.656 ± 0.126	0.573 ± 0.0954	0.693 ± 0.13	0.578 ± 0.0911	0.806 ± 0.159	0.615 ± 0.103 (0.553 ± 0.0971)	0.654 ± 0.122	0.687 ± 0.106	9.9
Metals											
Aluminum (µg/L)	76.2	8.22	32.7	14.3	74.5	79.1	25.9	5.88 (8.77)	5.08	6.96	200
Antimony (µg/L)	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	1.36	0.4 U	0.4 U	0.4 U	0.4 U	6
Arsenic (µg/L)	2.17	2.17	2.09	2.09	2.3	2.17	2.17	2.22 (2.19)	2.29	2.16	50
Barium (µg/L)	37.4	32.8	35.4	35.6	36.8	34.8	36.8	33.5 (33.3)	35.1	33.3	2,000
Calcium (mg/L)	38.4	35.9	37.4	36.6	38.5	37.7	37.9	35.9 (36)	36.9	36.3	NE[e]
Chromium (µg/L)	3.65	2.5 U	5.2	2.71	5.01	6.24	3.25	2.5 U (2.5 U)	2.5 U	2.5 U	100
Copper (µg/L)	36.5	2.5 U	64.8	5	9.36	2.5 U	19	8.14 (2.5 U)	5.43	3.3	1,300
Iron (µg/L)	**1470**[g] [50 U][f]	240 [50 U]	**518** [51.4]	218 [50 U]	**633** [75]	**2210** [64.4]	**434** [54]	110 (133) [50 U (50 U)]	229 [52.6]	58.8 [52.6]	300
Lead (µg/L)	1.73	0.5 U	4.8	0.5 U	0.594	2.03	1.43	0.5 U (0.5 U)	7.83	1.2	15
Magnesium (mg/L)	11.8	11.5	11.5	11.3	12	11.8	11.9	11.6 (11.7)	11.8	11.6	NE
Manganese (µg/L)	17.2	2.5 U	9.86	4.65	13.2	36.3	15.7	2.5 U (2.5 U)	4.77	2.5 U	
Nickel (µg/L)	2.5 U	2.5 U	2.5 U	2.5 U	2.5 U	2.71	2.5 U	2.5 U (2.5 U)	26.3	2.5 U	NE
Potassium (mg/L)	3.27	3.09	3.28	3.27	3.28	3.32	3.32	3.11 (3.12)	3.29	3.11	NE
Selenium (µg/L)	0.5 U	0.504	0.5 U	0.5 U	0.5 U	0.506	0.5 U	0.5 U (0.52)	0.5 U	0.574	50
Sodium (mg/L)	17.6	17.0	17.6	17.2	18.9	18.1	17.9	17.1 (17.2)	17.8	17.1	NE
Vanadium (µg/L)	5.21	4.58	4.4	4.43	5.73	5.27	4.75	4.44 (4.75)	4.6	4.42	NE
Zinc (µg/L)	30.8	2.79	57.7	7.13	7.18	9.12	9.39	2.5 U (2.5 U)	313	13.8	5,000
Anions											
Chloride (mg/L)	19.9	17.9	16.2	17.5	20.3	17.5	18.6	18 (18)	20.1	18	250
Nitrate-as nitrogen (mg/L)	2.31	2.03	1.98	2.00	2.26	2.03	2.3	2.04 (2.01)	2.27	1.96	10
Phosphorus (mg/L)	0.106	0.01 U	0.0126	0.01 U	0.0118	0.0138	0.01 U	0.01 U (0.01 U)	0.01 U	0.01 U	NE
Sulfate (mg/L)	18.7	16.9	16.6	16.9	20.6	17.7	19.3	17.5 (17.5)	19.2	17.1	250

Table 6-8. Comparisons of Detected Analytes to Drinking Water Standards at WAG 9 Monitoring Wells (2014). (cont.)

Water Quality Parameters											
Alkalinity (mg/L)	139	140	141	143	142	145	139	143 (140)	141	140	NE
Bicarbonate alkalinity (mg/L)	139	140	141	143	142	145	139	143 (140)	141	140	NE
Total dissolved solids (mg/L)	224	239	235	240	239	240	227	234 (247)	225	237	500
Total organic carbon (mg/L)	1 U	0.459	1 U	0.474	1 U	0.556	1 U	0.497 (0.448)	1 U	0.53	NE

a. EBR-II = Experimental Breeder Reactor II.
b. PCS = primary constituent standard; SCS = secondary constituent standard.
c. Result ± 1s.
d. ND = not detected. J = estimated concentration. U = not detected at the concentration shown.
e. NE = not established. A primary or secondary constituent standard has not been established for this constituent.
f. Results in parentheses are field duplicate. Results in brackets are filtered (i.e., dissolved) concentrations.
g. Concentrations shown in bold are above the Ground Water Quality Rule SCS. Filtered sample results, shown in brackets, are below the SCS.

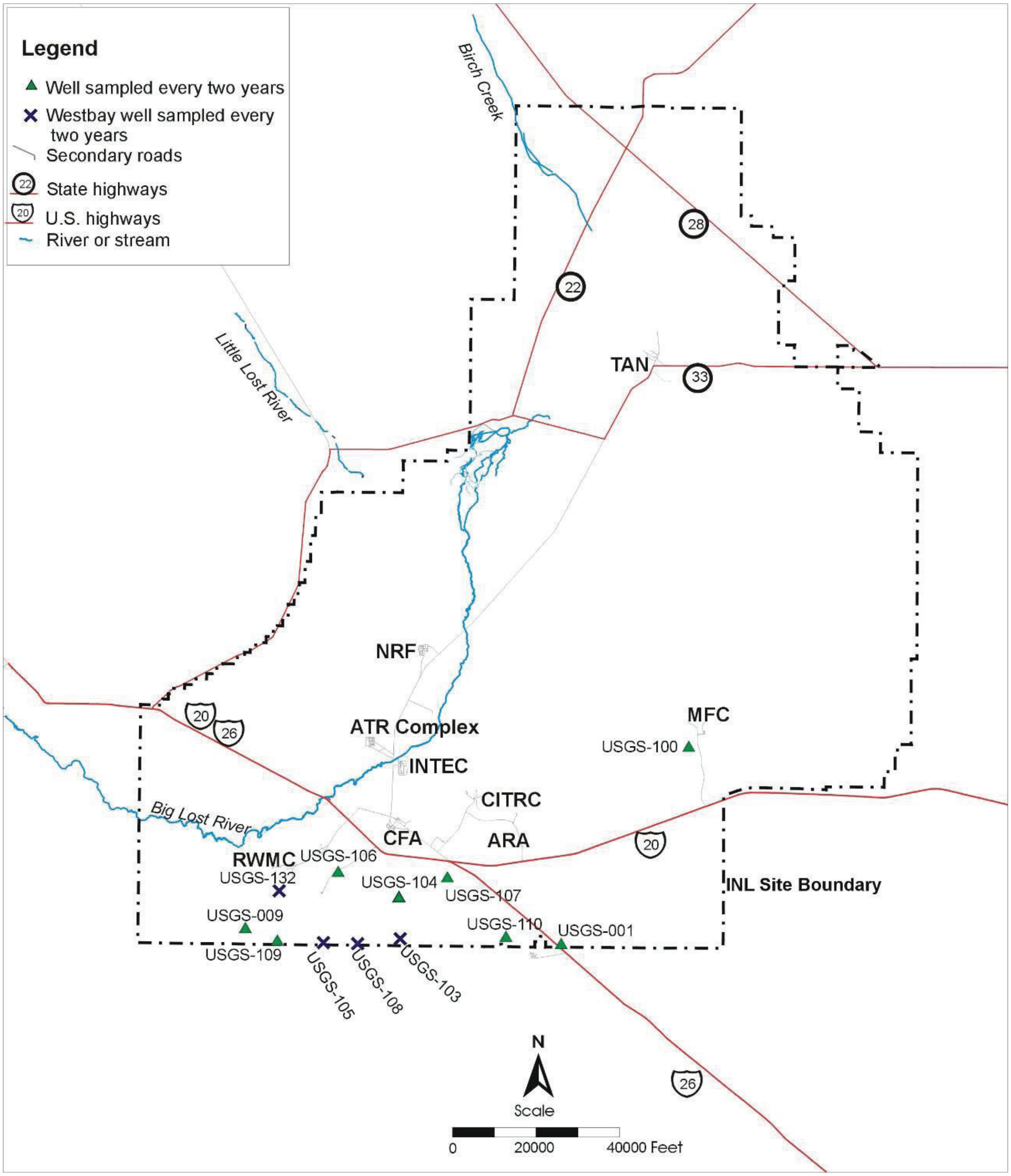


Figure 6-18. Locations and Sampling Frequency for Wells Sampled for Operable Unit 10-08.

Table 6-9. Gross Alpha, Gross Beta, and Tritium Concentrations in Offsite Drinking Water Samples Collected by the ESER Contractor in 2014.

Location	Sample Results (pCi/L)[a]		
Gross Alpha			
	Spring	*Fall*	*EPA MCL*[b]
Atomic City	ND[c]	ND	15 pCi/L
Control (bottled water)	ND	ND	15 pCi/L
Craters of the Moon	2.48 ± 0.51	ND	15 pCi/L
Howe	ND	ND	15 pCi/L
Idaho Falls	ND	ND	15 pCi/L
Minidoka	ND	ND	15 pCi/L
Mud Lake (Well #2)	ND	ND	15 pCi/L
Rest Area (Highway 20/26)	ND	ND	15 pCi/L
Shoshone (duplicate in Spring)	ND (ND)	ND	15 pCi/L
Gross Beta			
	Spring	*Fall*	*EPA MCL*
Atomic City	4.42 ± 0.51	4.42 ± 0.50	4 mrem/yr (8 pCi/L ^{90}Sr)[d]
Control (bottled water)	ND	ND	4 mrem/yr (8 pCi/L ^{90}Sr)
Craters of the Moon	3.39 ± 0.50	2.37 ± 0.47	4 mrem/yr (8 pCi/L ^{90}Sr)
Howe	3.82 ± 0.44	1.82 ± 0.47	4 mrem/yr (8 pCi/L ^{90}Sr)
Idaho Falls	5.31 ± 0.49	3.12 ± 0.51	4 mrem/yr (8 pCi/L ^{90}Sr)
Minidoka	3.33 ± 0.52	3.64 ± 0.51	4 mrem/yr (8 pCi/L ^{90}Sr)
Mud Lake (Well #2)	3.15 ± 0.47	3.59 ± 0.46	4 mrem/yr (8 pCi/L ^{90}Sr)
Rest Area (Highway 20/26)	1.83 ± 0.48	1.69 ± 0.48	4 mrem/yr (8 pCi/L ^{90}Sr)
Shoshone (duplicate in Spring)	2.92 ± 0.51 (3.96 ± 0.50)	ND	4 mrem/yr (8 pCi/L ^{90}Sr)
Tritium			
	Spring	*Fall*	*EPA MCL*
Atomic City	ND	ND	20,000 pCi/L
Control (bottled water)	71 ± 21	ND	20,000 pCi/L
Craters of the Moon	103 ± 22	78 ± 23	20,000 pCi/L
Howe	ND	109 ± 24	20,000 pCi/L
Idaho Falls	63 ± 21	78 ± 23	20,000 pCi/L
Minidoka	102 ± 21	ND	20,000 pCi/L
Mud Lake (Well #2)	79 ± 21	ND	20,000 pCi/L
Rest Area (Highway 20/26)	139 ± 22	93 ± 24	20,000 pCi/L
Shoshone (duplicate in Spring)	ND (86 ± 21)	ND	20,000 pCi/L

a. Result ± 1s.
b. EPA = Environmental Protection Agency; MCL = Maximum Contaminant Level.
c. ND = not detected (results < 3s).
d. The MCL for gross beta activity is not established. However, the EPA drinking water standard of 4 mrem/y for public drinking water systems is applied a conservative screening level of 8 pCi/L (the MCL for ^{90}Sr) is used.

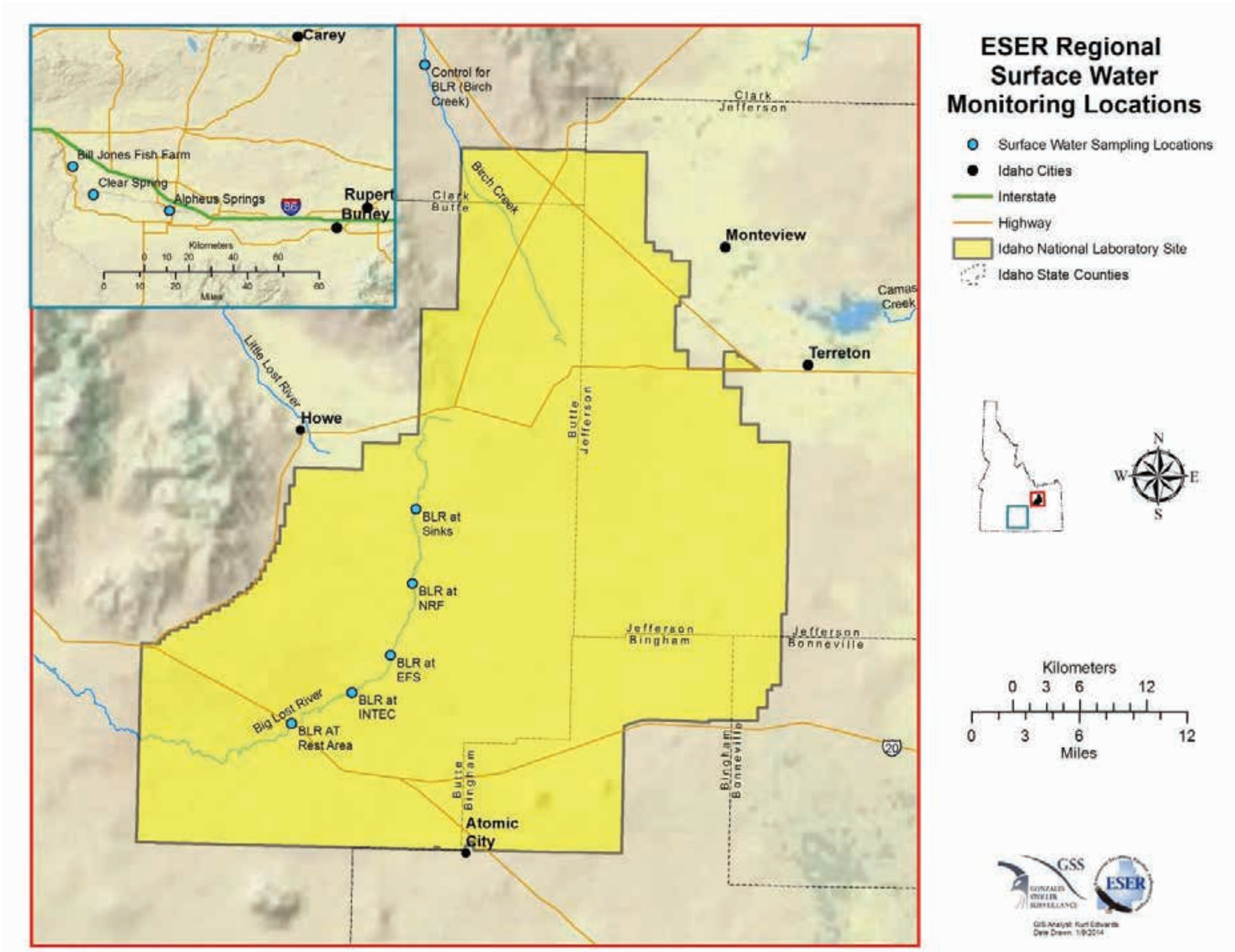


Figure 6-19. Detailed Map of ESER Program Surface Water Monitoring Locations.

Table 6-10. Gross Alpha, Gross Beta, and Tritium Concentrations in Surface Water Samples Collected by the ESER Contractor in 2014.

Location	Sample Results (pCi/L)[a]		
Gross Alpha			
	Spring[b]	***Fall***[b]	***EPA MCL***[c]
Alpheus Springs-Twin Falls (duplicate in Fall)	ND[d]	ND (2.24 ± 0.60)	15 pCi/L
Clear Springs-Buhl	ND	ND	15 pCi/L
Bill Jones Hatchery-Hagerman	ND	ND	15 pCi/L
Gross Beta			
	Spring	***Fall***	***EPA MCL***
Alpheus Springs-Twin Falls (duplicate in Fall)	10.60 ± 0.56	5.18 ± 0.54 (7.40 ± 0.57)	4 mrem/yr (8 pCi/L ^{90}Sr)[e]
Clear Springs-Buhl	3.80 ± 0.54	2.89 ± 0.50	4 mrem/yr (8 pCi/L ^{90}Sr)
Bill Jones Hatchery-Hagerman	3.23 ± 0.50	4.74 ± 0.49	4 mrem/yr (8 pCi/L ^{90}Sr)
Tritium			
	Spring	***Fall***	***EPA MCL***
Alpheus Springs-Twin Falls (duplicate in Fall)	ND	84 ± 23 (ND)	20,000 pCi/L
Clear Springs-Buhl	ND	ND	20,000 pCi/L
Bill Jones Hatchery-Hagerman	ND	70 ± 23	20,000 pCi/L

a. Result ± 1s.
b. The springs and hatchery were sampled on May 20 and November 19, 2013.
c. EPA = Environmental Protection Agency; MCL = Maximum Contaminant Level.
d. ND = not detected (result < 3s).
e. The MCL for gross beta activity is not established. However, the EPA drinking water standard of 4 mrem/yr for public drinking water systems is applied and a conservative screening level of 8 pCi/L (the MCL for ^{90}Sr) is used. It is conservative because it is highly unlikely that the gross beta activity is due to ^{90}Sr and more likely due to naturally occurring radionuclides in the sample.

REFERENCES

40 CFR 141, 2014, "National Primary Drinking Water Regulations," *Code of Federal Regulations*, Office of the Federal Register.

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

Bartholomay, R. C., Tucker, B. J., Davis, L. C., and Green, M. R., 2000, *Hydrologic conditions and distribution of selected constituents in water, Snake River Plain aquifer, Idaho National Engineering and Environmental Laboratory, Idaho, 1996 through 1998: U.S. Geological Survey Water-Resources Investigations Report 2000-4192* (DOE/ID–22167), 52 p., http://pubs.er.usgs.gov/publication/wri004192.

Bartholomay, R. C., L. L Knobel, and J. P. Rousseau, 2003, *Field Methods and Quality-Assurance Plan for Quality-of-Water Activities*, U.S. Geological Survey Open-File Report 2003-42 (DOE/ID 22182), U.S. Geological Survey.

Bartholomay, R. C., 2009, *Iodine-129 in the Snake River Plain Aquifer at and near the Idaho National Laboratory, Idaho*, 2003 and 2007, U.S. Geological Survey Scientific Investigations Report 2009-5088 (DOE/ID-22208), U.S. Geological Survey.

Bartholomay, R. C., 2013, *Iodine-129 in the Snake River Plain Aquifer at and near the Idaho National Laboratory, Idaho, 2010-12*, U.S. Geological Survey Scientific Investigations Report 2013-5195 (DOE/ID-22225), U.S. Geological Survey.

Bartholomay, R. C., Maimer, N. V., and Wehnke, A. J., 2014, *Field methods and quality-assurance plan for water-quality activities and water-level measurements, U.S. Geological Survey, Idaho National Laboratory, Idaho: U.S. Geological Survey Open-File Report 2014–1146* (DOE/ID-22229), 64 p. http://pubs.usgs.gov/of/2014/1146/

Cahn, L. S., M. A. Abbott, J. F. Keck, P. Martian, A. L. Schafer, and M. C. Swenson, 2006, *Operable Unit 3-14 Tank Farm Soil and Groundwater Remedial Investigation/Baseline Risk Assessment*, DOE/NE-ID-11227, Rev. 0., U. S. Department of Energy Idaho Operations Office.

Davis, L. C., Bartholomay, R. C., and Rattray, G. W., 2013, *An update of hydrologic conditions and distribution of selected constituents in water, eastern Snake River Plain aquifer and perched groundwater zones, Idaho National Laboratory, Idaho, emphasis 2009-11*, U.S. Geological Survey Scientific Investigations Report 2013-5214 (DOE/ID-22226), U.S. Geological Survey.

Davis, L. C., Bartholomay, R. C., Fisher, J. C., and Maimer, N. V., 2015, *Water-quality characteristics and trends for selected wells possibly influenced by wastewater disposal at the Idaho National Laboratory, Idaho, 1981–2012: U.S. Geological Survey Scientific Investigations Report 2015–5003* (DOE/ID-22233), 110 p., http://dx.doi.org/10.3133/sir20155003

DOE Order 458.1, 2011, "Radiation Protection of the Public and the Environment," Administrative Change 2, Chapter III, "Derived Concentration Guides for Air and Water," U.S. Department of Energy.

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

DOE-ID, 2012a, *Idaho National Laboratory Groundwater Monitoring and Contingency Plan Update*, DOE/ID-11034, Rev. 2, U.S. Department of Energy Idaho Operations Office.

DOE-ID, 2013, *Long-term Monitoring and Field Sampling Plan for the Central Facilities Area Landfills I, II, and III under Operable Unit 4-12*, DOE/ID-11374, Rev. 1, U.S. Department of Energy Idaho Operations Office, August 2013.

DOE-ID, 2014a, *Idaho National Laboratory Site Environmental Monitoring Plan*, DOE/ID-10-11088, Rev. 4, U.S. Department of Energy Idaho Operations Office, February 2014.

DOE-ID, 2014b, *Post-Record of Decision Groundwater Monitoring and Field Sampling Plan for Operable Unit 10-08*, DOE/ID-11420, Rev. 1, U.S. Department of Energy Idaho Operations Office, October 2014.

DOE-ID, 2015a, *Annual Report for the Final Groundwater Remediation, Test Area North, Operable Unit 1-07B, Fiscal Year 2014*, DOE/ID-11521, Rev. 0, U.S. Department of Energy Idaho Operations Office. May 2015.

DOE-ID, 2015b, *Fiscal Year 2014 Annual Report for Operable Unit 3-14, Tank Farm Soil and INTEC Groundwater*, DOE/ID-11526, Rev. 0, U.S. Department of Energy Idaho Operations Office, July 2015.

DOE-ID, 2015c, *Central Facilities Area Landfills I, II, and III Annual Monitoring Report – 2014*, DOE/ID-11523, Rev. 0, U.S. Department of Energy Idaho Operations Office, March 2014.

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

DOE-NE-ID, 2007, *Five-Year Review of CERCLA Response Actions at the Idaho National Laboratory*, DOE/NE-ID 11201, Rev. 3, U.S. Department of Energy Idaho Operations Office, February 2007.

EPA, 2013, Protection of environment—Code of federal regulations 40, part 141, subpart G, national primary drinking water regulations, maximum contaminant levels and maximum residual disinfectant levels: Washington, D.C., Office of the Federal Register, National Archives and Records Administration, accessed August 21, 2013, at http://www.ecfr.gov/cgi-bin/retrieveECFR?gp=&SID=3a944d5fa8add d9792af65c5d71a0ccc&n=40y24.0.1.1.3&r=PART&ty=HTML#40:24.0.1.1.3.7.

Forbes, Jeff and K. Jean Holdren, 2014, *Field Sampling Plan for Operable Unit 7-13/14 Aquifer Monitoring*, DOE/ID-11492, Idaho Cleanup Project, August 2014.

Geslin, J. K., P. K. Link, and C. M. Fanning, 1999, "High-precision Provenance Determination Using Detrital-zircon Ages and Petrography of Quaternary Sands on the Eastern Snake River Plain Idaho," Geology, Vol. 27, No. 4, pp. 295 – 298.

IDAPA 58.01.11, 2014, "Ground Water Quality Rule," Idaho Administrative Procedures Act. Knobel, L. L., B. R. Orr, and L. D. Cecil, 1992, "Summary of Concentrations of Selected Radiochemical and Chemical Constituents in Groundwater from the Snake River Plain Aquifer, Idaho: Estimated from an Analysis of Previously Published Data," *Journal of Idaho Academy of Science*, Vol. 28, No. 1, pp. 48-61, June 1992.

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

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

Mann, L. J., E. W. Chew, E. J. S. Morton, and R. B. Randolph, 1988, *Iodine-129 in the Snake River Plain Aquifer at the Idaho National Engineering Laboratory, Idaho*, U.S. Geological Survey Water-Resources Investigations Report 88-4165 (DOE/ID -22076), U.S. Geological Survey.

Mann, L. J., and T. M. Beasley, 1994, *Iodine-129 in the Snake River Plain Aquifer at and near the Idaho National Engineering Laboratory, Idaho, 1990-91*, U.S. Geological Survey Water-Resources Report 94-4053, U.S. Geological Survey.

Smith, R. P. 2004, "Geologic Setting of the Snake River Plain Aquifer and Vadose Zone," *Vadose Zone Journal*, Vol. 3. pp. 47 – 58.

2014

7. Environmental Monitoring Programs - Agricultural Products, Wildlife, Soil, and Direct Radiation

Shaggy Fleabane
Erigeron pumilus

Idaho National Laboratory (INL) Site-released radionuclides may be assimilated by agricultural products and game animals which humans may then consume. These media are thus sampled because of the potential transfer of radionuclides to people through food chains. Radionuclides may also be deposited on soils and can be measured on the surface with detectors or in the laboratory through radioanalysis of samples. Direct radiation measurements detect ionizing radiation in the environment.

Some human-made radionuclides were detected at low levels in agricultural products (milk, lettuce, alfalfa, and elk forage) collected in 2014. The results could not be directly linked to operations at the INL Site and are likely due to natural production in the atmosphere, in the case of tritium, or to the presence of fallout radionuclides in the environment, in the instances of strontium-90 and cesium-137. All measurements were well below regulatory limits established for protection of human health.

No human-made radionuclides were detected in tissue samples of two road-killed animals sampled in 2014. Five human-made radionuclides (cobalt-60, zinc-65, selenium-75, strontium-90, and cesium-137) were detected in some tissue samples of waterfowl collected on ponds in the vicinity of the Advanced Test Reactor Complex at the INL Site.

Soil samples were collected off the INL Site in 2014. Strontium-90, cesium-137, and plutonium-239/240 were detected at levels that suggest that global fallout is the source of these radionuclides. Cesium-137 and strontium-90 concentrations in soil are decreasing over time, as would be expected with radioactive decay. Cesium-137 was also measured in all INL Site surface soils surveyed using an in-situ gamma detector. Other anthrogenic radionuclides (cobalt-60, antimony-125, cesium-134, uranium-238, and americium-241) were occasionally detected at areas of known contamination from historic activities on the INL Site. These measurements are performed annually at and around specific INL Site facilities.

Direct radiation measurements made at boundary and distant locations were consistent with background levels. The average annual dose equivalent from external exposure was estimated to be 127 mrem at both boundary and distant locations. Radiation measurements taken in the vicinity of waste storage and soil contamination areas near INL Site facilities were consistent with previous measurements. Direct radiation measurements using a radiometric scanner system at the Radioactive Waste Management Complex and the Idaho Comprehensive Environmental Response, Compensation, and Liability Act disposal facility were near background levels.

7. ENVIRONMENTAL MONITORING PROGRAMS – AGRICULTURAL PRODUCTS, WILDLIFE, SOIL, AND DIRECT RADIATION

This chapter summarizes results of environmental monitoring of agricultural products, wildlife, soil, and direct radiation on and around the Idaho National Laboratory (INL) Site during 2014. Details of these programs may be found in the *Idaho National Laboratory Site Environmental Monitoring Plan* (DOE-ID 2014). The INL, Idaho Cleanup Project (ICP), and Environmental Surveillance, Education, and Research Program (ESER) contractors monitor soil, vegetation, biota, and direct radiation on and off the INL Site to comply with applicable U.S. Department of Energy (DOE) orders and other requirements. The focus of INL and ICP contractor monitoring is on the INL Site, particularly on and around facilities (Table 7-1). The ESER contractor's primary responsibility is to monitor the presence of contaminants in media off the INL Site which may originate from INL Site releases (Table 7-1).

7.1 Agricultural Products and Biota Sampling

Agricultural products and game animals are sampled by the ESER contractor because of the potential transfer of radionuclides to people through food chains (Figure 3-1).

Table 7-1. Environmental Monitoring of Agriculture Products, Biota, Soil, and Direct Radiation at the INL Site.

Area/Facility[a]	Media							
	Agricultural Products (milk, lettuce, alfalfa, wheat, and potatoes)	Biota (waterfowl, large game animals)	Biota (vegetation)	CERCLA Ecological	Soil	In-Situ Gamma Spectrometry	Direct Radiation (global positioning radiometric scanner)	Direct Radiation
Environmental Surveillance, Education, and Research Program Contractor								
INL Site/Regional	•	•	•	•	•			•
Idaho National Laboratory Contractor								
INL Site						•		•
Regional								•
Idaho Cleanup Project Contractor								
RWMC			•		•			•

a. INL Site = Idaho National Laboratory Site facility areas and areas between facilities. RWMC = Radioactive Waste Management Complex.

7.1.1 Milk

Milk is sampled to monitor the pathway from potentially contaminated, regionally grown feed to cows to milk, which is then ingested by humans. During 2014, the ESER contractor collected 136 milk samples at various locations off the INL Site (Figure 7-1) and from commercially-available milk from outside the state of Idaho. The number and location of the dairies can vary from year to year as farmers enter and leave the business. Milk samples were collected weekly in Idaho Falls and monthly at other locations around the INL Site. All samples were analyzed for gamma-emitting radionuclides, including iodine-131 (^{131}I) and cesium-137 (^{137}Cs). During the second and fourth quarters, samples were analyzed for strontium-90 (^{90}Sr) and tritium.

Iodine is an essential nutrient and is readily assimilated by cows eating plants containing the element. Iodine-131 is of particular interest because it is produced by nuclear reactors or weapons, is readily detected, and, along with cesium-134 (^{134}Cs) and ^{137}Cs, can dominate the ingestion dose regionally after a severe nuclear event such as the Chernobyl accident (Kirchner 1994) or the 2011 accident at Fukushima in Japan. Iodine-131 has a short half-life (eight days) and therefore does not persist in the environment. Past releases from experimental reactors at the INL Site and fallout from atmospheric nuclear weapons tests and Chernobyl are no longer present. A small amount of ^{131}I (approximately 1.8 mCi in 2014) is still released by the Advanced Test Reactor (ATR) at the INL Site but is not detected in air samples collected at the INL Site boundary (Chapter 4). Iodine-131 was not detected in any milk sample during 2014.

Cesium-137 is chemically analogous to potassium in the environment and behaves similarly. It has a half-life of about 30 years and tends to persist in soil. If in soluble form it can readily enter the food chain through plants. It is widely distributed throughout the world from historic nuclear weapons detonations, which occurred between 1945 and 1980, and has been detected in all environmental media at the INL Site. Regional sources include releases from INL Site facilities and resuspension of previously contaminated soil particles. Cesium-137 was not reported in any milk samples collected in 2014.

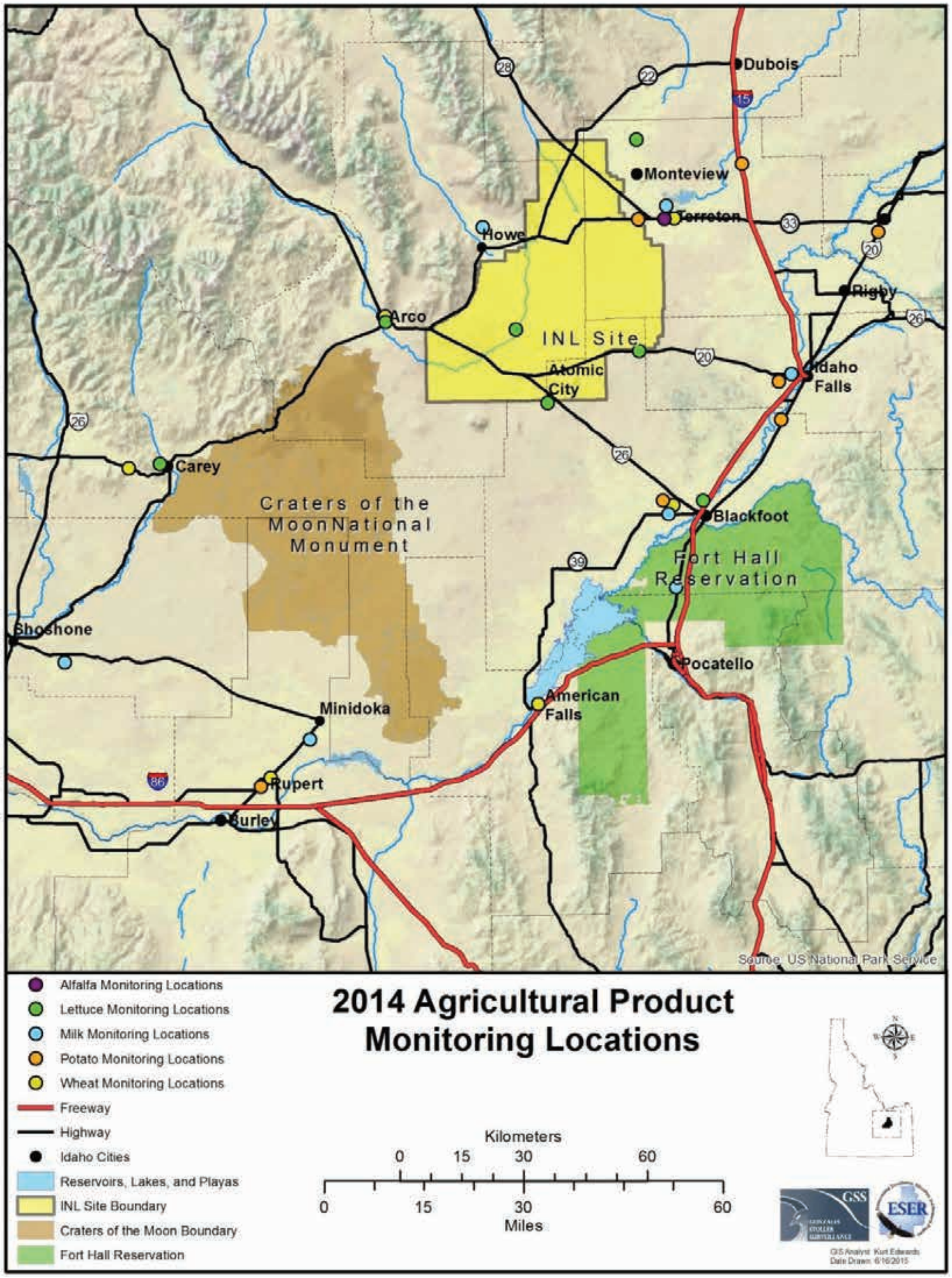


Figure 7-1. Locations of Agricultural Product Samples Collected (2014).

Strontium-90 is an important radionuclide because it behaves like calcium and can deposit in bones. Strontium-90, like ^{137}Cs, is produced in high yields from nuclear reactors or detonations of nuclear weapons. It has a half-life of 28 years and can persist in the environment. Strontium tends to form compounds that are more soluble than ^{137}Cs, and is therefore comparatively mobile in ecosystems. Strontium-90 was detected in 13 of the 16 milk samples analyzed, including the two control samples from outside the state. Concentrations ranged from 0.14 pCi/L at Howe to 0.66 pCi/L at Terreton (Figure 7-2). Overall, concentrations were somewhat lower in 2014 than in the two previous years but all these levels were consistent with historical levels and with levels reported by the U.S. Environmental Protection Agency (EPA) as resulting from worldwide fallout deposited on soil and taken up by cows through ingestion of grass. Results from EPA Region 10 (which includes Idaho) of a limited data set of eight samples collected over a 10-year period (2004-2013) ranged from 0 to 0.96 pCi/L (EPA 2015).

DOE has established Derived Concentration Standards (DCSs) for radionuclides in air and water. A DCS is the concentration of a radionuclide in air or water that would result in a dose of 100 mrem from ingestion, inhalation, or immersion in a gaseous cloud for one year. There is no established DCS for foodstuffs such as milk. For reference purposes, the DCS for ^{90}Sr in water is 1,100 pCi/L. The maximum observed value in milk samples (0.66 pCi/L) is, therefore, approximately 0.06 percent of this DCS for drinking water.

Tritium, with a half-life of about 12 years, is an important radionuclide because it is a radioactive form of hydrogen, which combines with oxygen to form tritiated water. The environmental behavior of tritiated water is like that of water, and it can be present in surface water, precipitation, and atmospheric moisture. Tritium is formed by natural processes, as well as by reactor operation and nuclear weapons testing. Tritium enters the food chain through surface water that animals drink, as well as from plants that contain water. Tritium was detected in 6 of 16 milk samples analyzed at concentrations ranging from 68 pCi/L in Idaho Falls to 141 pCi/L in Dietrich. These concentrations are similar to those of previous years and are consistent with those found in atmospheric moisture and precipitation samples. The DCS for tritium in water is 19,000 pCi/L. The maximum observed value in milk samples is about 0.7 percent of the DCS.

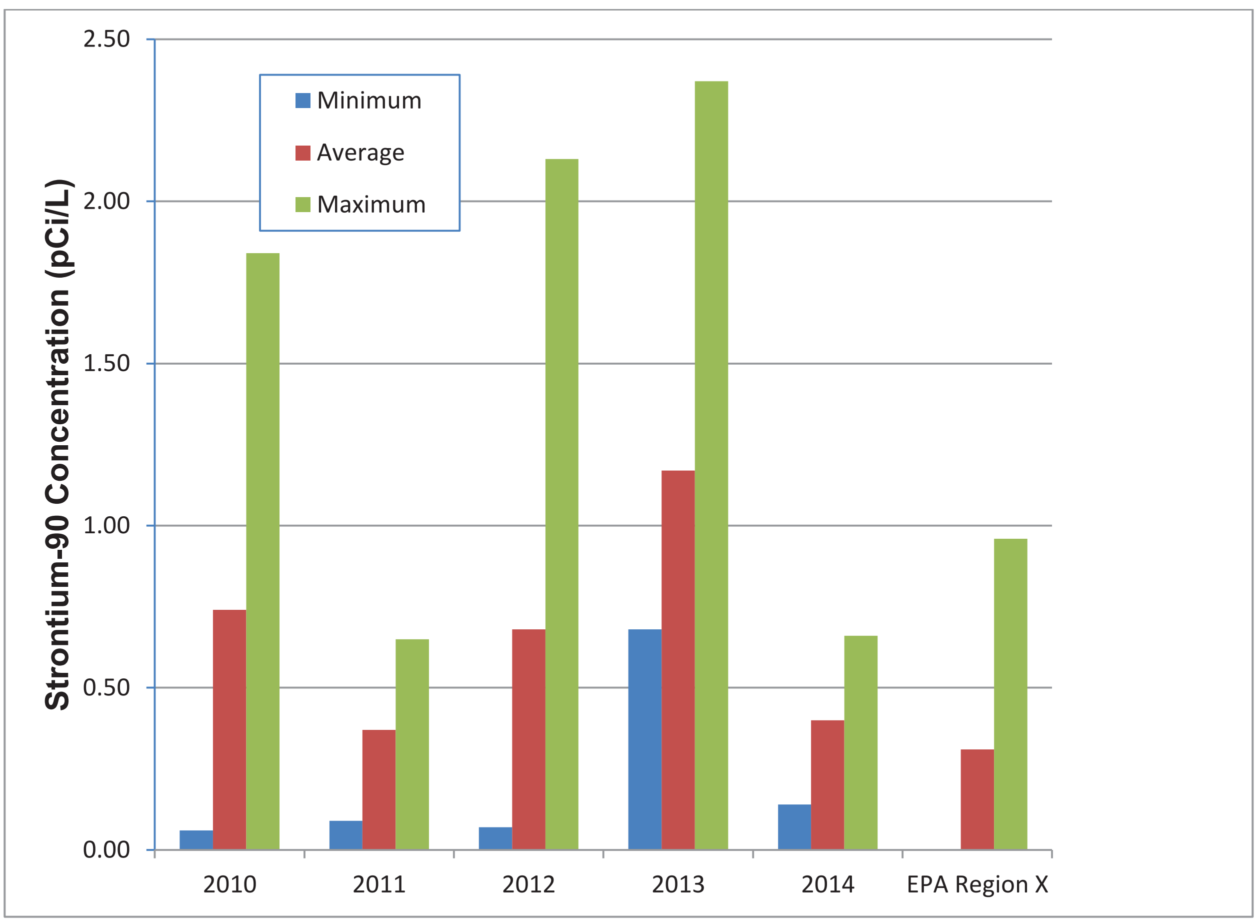


Figure 7-2. Strontium-90 Concentrations in Milk (2010 – 2014).

7.1.2 Lettuce

Lettuce was sampled in 2014 because radionuclides in air can be deposited on soil and plants, which can then be ingested by people (Figure 3-1). Uptake of radionuclides by plants may occur by root uptake from soil or absorption of deposited material on leaves. For most radionuclides, uptake by foliage is the dominant process for contamination of plants (Amaral et al. 1994). For this reason, green leafy vegetables like lettuce have higher concentration ratios of radionuclides to soil than other kinds of plants. The ESER contractor collects lettuce samples every year from areas on and adjacent to the INL Site. The number and locations of gardens have changed from year to year depending on whether or not vegetables were available. Some home gardens were replaced with portable lettuce planters (Figure 7-3) because the availability of lettuce from home gardens was unreliable at some key locations. Also, the planters can be placed and lettuce collected at areas previously unavailable to the public, such as on the INL Site and near air samplers. The planters can allow radionuclides deposited from air to accumulate on the soil and plant surfaces throughout the growth cycle. The planters are placed in the spring, filled with soil, sown with lettuce seed, and self-watered through a reservoir.

Five lettuce samples were collected from portable planters at Arco, Atomic City, the Experimental Field Station, the Federal Aviation Administration Tower, and Monteview. In addition, samples were obtained from home gardens at Blackfoot and Carey. A control sample from an out-of-state location was obtained, and a duplicate sample was collected at Monteview. The samples were analyzed for ^{90}Sr and gamma-emitting radionuclides. Strontium-90 was detected in all of the lettuce samples collected locally, but was not found in the control sample purchased at the grocery store. This may reflect the method used to grow the commercial lettuce. The maximum ^{90}Sr concentration of 58 pCi/kg, measured in the lettuce sample from Carey, was in the lower middle of the range of concentrations detected in the past five years (0-164 pCi/kg). These results were most likely from fallout from past weapons testing and not INL Site operations. Strontium-90 is present in the

Figure 7-3. Portable Lettuce Planter.

environment as a residual of fallout from above-ground nuclear weapons testing, which occurred between 1945 and 1980. Figure 7-4 shows the average and range of all measurements (including those below detection levels) from 2010 through 2014. No other human-made radionuclides were detected in any of the lettuce samples. Although ^{137}Cs from nuclear weapons testing fallout is measureable in soils, the ability of vegetation such as lettuce to incorporate cesium from soil in plant tissue is much lower than for strontium (Fuhrmann et al. 2003; Ng et al. 1982; Schulz 1965). In addition, the availability of ^{137}Cs to plants depends highly on soil properties, such as clay content or alkalinity, which can act to bind the radionuclide (Schulz 1965). Soils in southeast Idaho tend to be moderately to highly alkaline. Strontium, on the other hand, has a tendency to form compounds that are comparatively soluble. These factors could help explain why ^{90}Sr was detected in lettuce and ^{137}Cs was not.

7.1.3 Grain

Grain (including wheat and barley) is sampled because it is a staple crop in the region. The ESER contractor collected nine grain samples from areas surrounding the INL Site in 2014 and obtained one commercially-available sample from outside the state of Idaho. The locations were selected because they are typically farmed for grain and are encompassed by the air surveillance network. Exact locations may change as growers rotate their crops. No human-made, gamma-emitting radionuclides were found in any samples.

One of the ten grain samples collected in 2014 contained a detectable concentration of ^{90}Sr. This sample was from Arco and had a concentration of 11 pCi/kg. The concentrations of ^{90}Sr sometimes measured in grain are generally less than those measured in lettuce and the frequency of detections is much lower. Agricultural

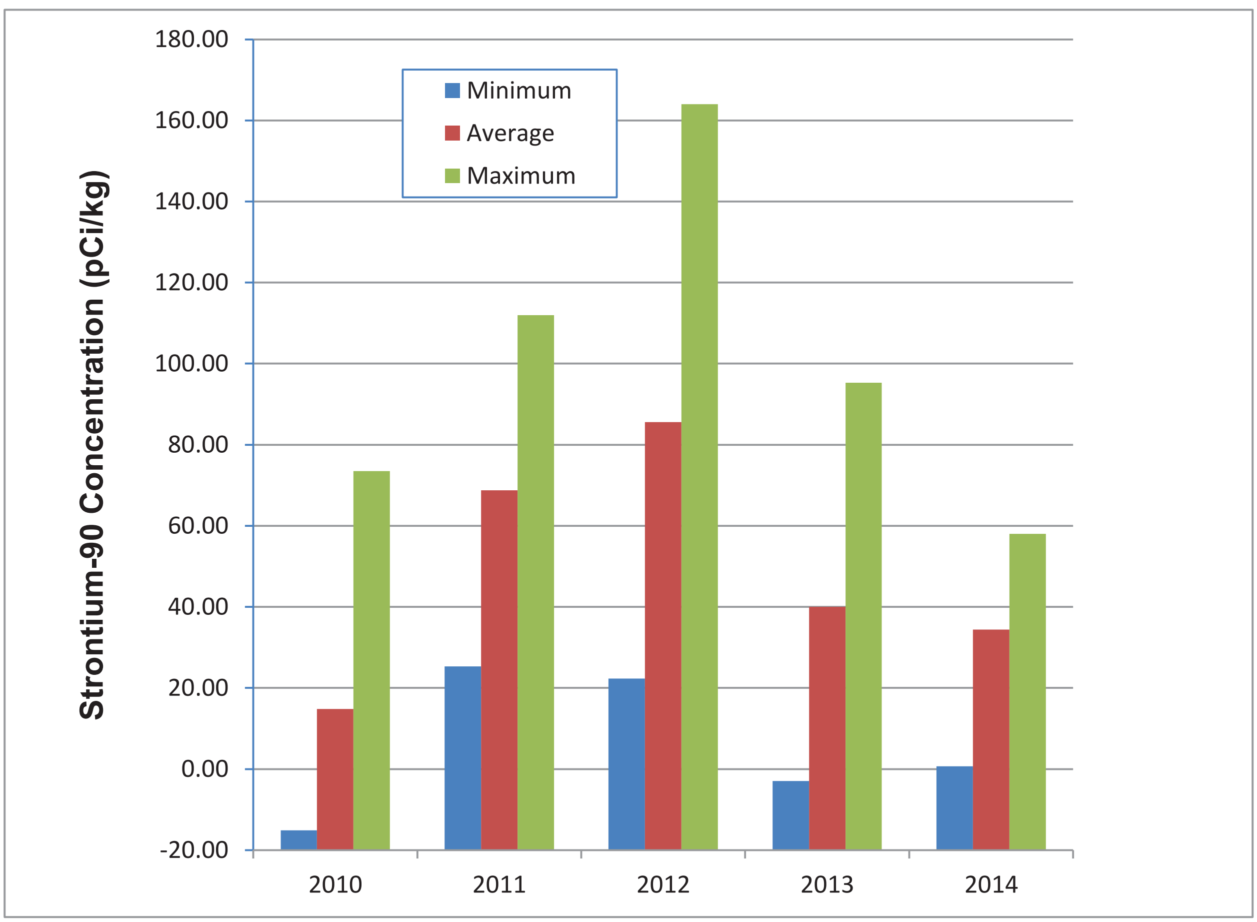


Figure 7-4. Strontium-90 Concentrations in Lettuce (2010 – 2014).

products such as fruits and grains are naturally lower in radionuclides than green, leafy vegetables (Pinder et al. 1990). As discussed in Section 7.1.2, strontium in soil from fallout is more bioavailable to plants than cesium.

7.1.4 Potatoes

Potatoes are collected because they are one of the main crops grown in the region and are of special interest to the public. Because they are not exposed to airborne contaminants, they are not typically considered a key part of the ingestion pathway. Potatoes were collected by the ESER contractor at eight locations in the vicinity of the INL Site (including a duplicate) and obtained from one location outside eastern Idaho. None of the nine potato samples collected during 2014 contained a detectable concentration of any human-made, gamma-emitting radionuclides. Strontium-90 was detected in one sample from Hamer at a concentration of 33.3 pCi/kg. This radionuclide is present in the soil as a result of worldwide fallout from nuclear weapons testing, but it is only occasionally detected in potato samples. This is because potatoes, like grain, are generally less efficient at removing radioactive elements from soil than leafy vegetables such as lettuce.

7.1.5 Alfalfa

In addition to analyzing milk, the ESER contractor began collecting data in 2010 on alfalfa consumed by milk cows. This was in response to the DOE Headquarters Independent Oversight Assessment of the Environmental Monitoring program at the INL Site conducted during that year. The assessment team commented, with reference to the milk sampling program, that the ESER contractor should consider sampling locally grown alfalfa offsite, along with collection of alfalfa usage data. Questionnaires were sent to each milk provider concerning what they feed their cows. All of the dairies feed their cows locally-grown alfalfa. A sample of alfalfa was collected in June from a location in the Mud Lake/Terreton area, the agricultural area where the highest potential offsite air concentration was calculated by the National Oceanic and Atmospheric Administration Air Resources Laboratory – Field Research Division (see Figure 8-5). (Note: The highest offsite air concentration used for estimating doses was located south of the INL Site; however, there is no agriculture conducted there.) The sample was divided into three subsamples and analyzed for gamma-emitting radionuclides and ^{90}Sr. No human-made gamma-emitting radionuclides were detected in any of the subsamples. Strontium-90 was found in one of the three subsamples at a level just above the detection limit and was just below the detection limit in the other two subsamples. This has been the case in each year alfalfa sampling has been conducted, indicating there may be some ^{90}Sr taken up by alfalfa but the levels are very near the lower limit of detection. The measured value of 72 pCi/kg is similar to results from the first three years of sampling and similar to typical concentrations in lettuce.

7.1.6 Large Game Animals

Muscle and thyroid samples were collected by the ESER contractor from two game animals (one pronghorn and one elk) accidentally killed on INL Site roads. A liver sample was also obtained from the pronghorn. The samples were analyzed for ^{137}Cs because it is an analogue of potassium and is readily incorporated into muscle and organ tissues. Thyroids were analyzed for ^{131}I because when assimilated by higher animals, it selectively concentrates in the thyroid gland and is, thus, an excellent bioindicator of atmospheric releases.

No ^{131}I was detected in any of the thyroid samples. No ^{137}Cs or other human-made gamma-emitting radionuclides were found in any of the muscle or liver samples.

In 1998 and 1999, four pronghorn, five elk, and eight mule deer muscle samples were collected as background samples from hunters across the western United States, including three from central Idaho, three from Wyoming, three from Montana, four from Utah, and one each from New Mexico, Colorado, Nevada, and Oregon (DOE-ID 1999). Each background sample had small, but detectable, ^{137}Cs concentrations in its muscle. These concentrations likely can be attributed to the ingestion of plants containing radionuclides from fallout associated with above-ground nuclear weapons testing. Allowing for radioactive decay since the time of the study, background measurements would be expected to range from about 3.5 to 10.5 pCi/kg in 2014. With the exception of an immature deer sampled in 2008 that had elevated ^{137}Cs concentrations, all detected values have been within this range.

7.1.7 Waterfowl

Waterfowl are collected each year by the ESER contractor at ponds on the INL Site and at a location off the INL Site. Three samples from wastewater ponds located at the ATR Complex and one sample from ponds near the Materials and Fuels Complex (MFC) plus three control samples were analyzed for gamma-emitting radionuclides, ^{90}Sr, and actinides (americium-241 [^{241}Am], plutonium-238 [^{238}Pu], and plutonium-239/240 [$^{239/240}$Pu]).

These radionuclides were selected because they are often measured in liquid effluents from some INL Site facilities (Chapter 5). Each sample was divided into the following three sub-samples: 1) edible tissue (muscle, gizzard, heart, and liver), 2) external portion (feathers, feet, and head), and 3) all remaining tissue.

A total of five human-made radionuclides were detected in the samples from at least one of the ducks collected at the ATR Complex ponds. These included ^{137}Cs, cobalt-60 (^{60}Co), selenium-75 (^{75}Se), ^{90}Sr, and zinc-65 (^{65}Zn). All of these were also detected in the edible tissues of at least one duck, with the exception of ^{90}Sr (Figure 7-5). Selenium-75 has been detected historically in the Test Reactor Area (TRA) low-level waste disposal pond (Halford et al. 1980, Halford et al. 1982, Warren et al. 2001), which was replaced by the hypalon-lined evaporation pond at the ATR Complex in 1993. This was the first time it has been measured in waterfowl since the current pond has been installed. The DOE Radiological Sciences and Environmental Laboratory confirmed the detection. Selenium-75 is an activation product (from As-75) with a half-life of 120 days and bioaccumulates in tissue (a concentration ratio [waterfowl tissue/water] of 1900 is reported in ICRP 2009). ATR Complex performs monthly sampling and analysis of wastewater disposed to the pond and did not detect ^{75}Se in any of the samples. It is postulated that the source is sediment in the ATR Complex pond. Sediment samples will be collected when the pond receives a new liner to help confirm this.

No human-made radionuclides were found in the sample from MFC. In the control ducks, $^{239/240}$Pu was detected in one sample just above the detection limit (in the edible portion) and ^{90}Sr was detected in the edible and remainder portions of one of the ducks.

Because more human-made radionuclides were found in ducks from ATR Complex than other locations and at higher levels, it is assumed that the evaporation pond associated with this facility is the source of these radionuclides. Many of these radionuclides are also present in other onsite and/or offsite sources these birds may have been exposed to, so sources other than the ATR Complex cannot be ruled out. The ducks were not taken directly from the two-celled hypalon-lined radioactive wastewater evaporation pond, but rather from an adjacent sewage lagoon. However, the ducks probably also

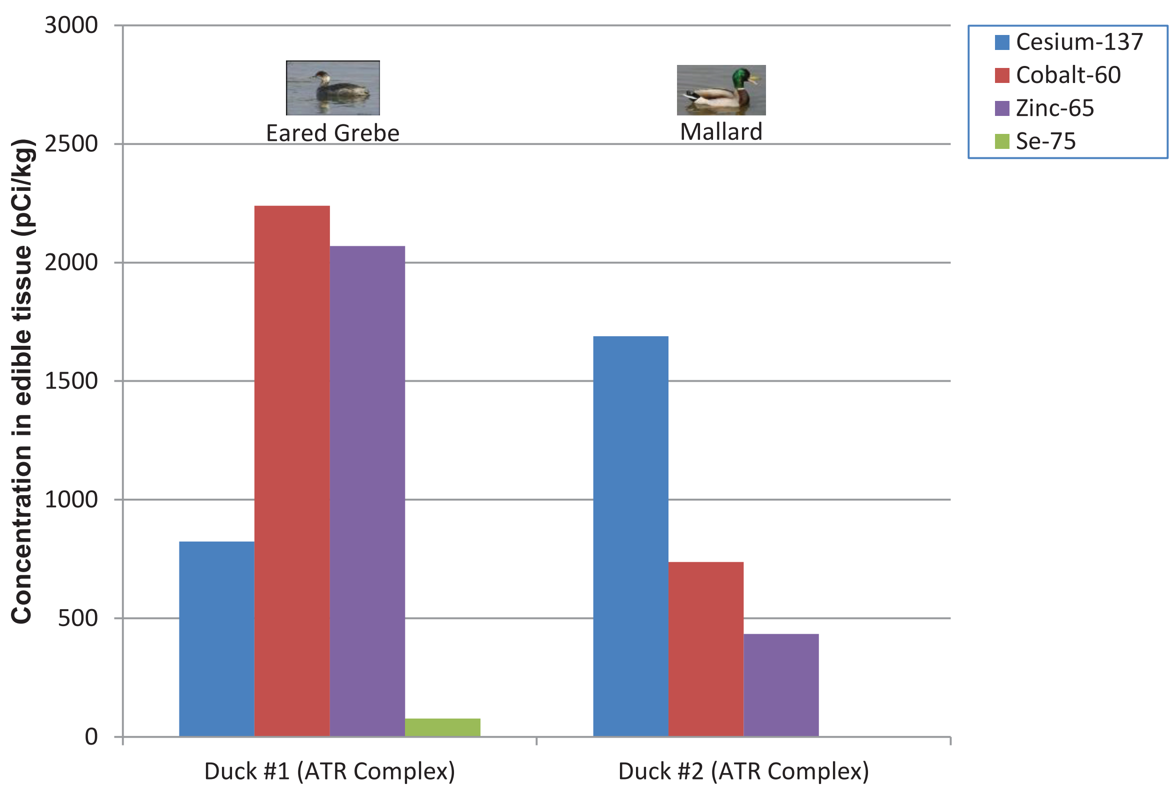


Figure 7-5. Radionuclide Concentrations Detected in Edible Tissues of Waterfowl Collected from ATR Complex (2014).

spent time at the evaporation pond. Potential doses from consuming these ducks are discussed further in Chapter 8.

7.2 Soil Sampling and In Situ Gamma Spectrometry

7.2.1 Soil Sampling off the INL Site

Above-ground nuclear weapons testing resulted in many radionuclides being distributed throughout the world via atmospheric deposition. Cesium-137, ^{90}Sr, ^{238}Pu, $^{239/240}$Pu, and ^{241}Am can be detected in soil because of global fallout but could also be present from INL Site operations. These radionuclides are of particular interest because of their abundance resulting from nuclear fission events (e.g., ^{137}Cs and ^{90}Sr) or from their persistence in the environment due to long half-lives (e.g., $^{239/240}$Pu, with a half-life of 24,110 years). Soil samples are collected by the ESER contractor every two years (in even-numbered years). Soil sampling locations are shown in Figure 7-6. A new location was added in 2010 at Frenchman's Cabin located at the southern boundary of the INL Site. This location has been the site of the maximally exposed individual for EPA dose calculations performed to comply with EPA requirements during recent years (see Chapter 8). Soil samples are analyzed for gamma-emitting radionuclides, ^{90}Sr, ^{241}Am, and plutonium isotopes.

Soil was sampled by the ESER contractor in 2014. No ^{241}Am or ^{238}Pu was detected in any sample. Cesium-137 was above the detection limit in all the samples collected, and ^{90}Sr was present in half the samples. Plutonium-239/240 was above the detection limit in 6 out of 14 samples analyzed. Results for ^{137}Cs, $^{239/240}$Pu, and ^{90}Sr from 1975, when sampling began, to 2014 are presented in Figure 7-7.

Above-ground nuclear weapons testing has been extremely limited since 1975, and no tests have occurred since 1980, so no ^{137}Cs and ^{90}Sr have been deposited on soil from sources outside the INL Site in that time. It would be expected that the concentrations of these two radionuclides would decrease over time from the levels measured in 1975 at a rate consistent with their approximate 30-year half-lives unless the INL Site was having an impact. Figure 7-7 shows that ^{137}Cs follows the expected decay line fairly closely. Strontium-90 has been tracking below the expected line during the past several sampling cycles. This may be because the samples represent the top 12.5 cm (5 in.) of soil and some of the ^{90}Sr may have migrated to deeper levels, or it is possible that some of the ^{90}Sr may have been taken up by vegetation. No accumulation of either radionuclide on soil by operations at the INL Site is indicated.

No particular trend is indicated in the graph of $^{239/240}$Pu concentrations over time in Figure 7-7. This is consistent with the long half-life of the radionuclide, but the graph also does not indicate any accumulation over time from INL Site operations.

7.2.2 Wastewater Reuse Permit Soil Sampling at Central Facilities Area

The Idaho Department of Environmental Quality issued a permit for the CFA Sewage Treatment Plant on March 17, 2010. The permit required soil sampling in the wastewater land application area in 2010 and 2013. No soil samples were collected in 2014.

7.2.3 In-Situ Gamma Spectrometry

In-situ gamma spectrometry using portable high purity germanium detectors is a technique that measures the gamma-ray fluence rate from a gamma-emitting source for the purpose of obtaining the activity or concentration of radioactive materials (Shebell et al. 2003). The most common application of in-situ gamma-ray spectrometry has been the measurement of gamma-emitting radionuclides, such as ^{137}Cs, in surface soils. The technique is a rapid and cost effective way to assay surface soil for gamma-emitting radionuclides, especially as part of site characterization. Results in this report are those that were true positive detects. This means that the reported isotopic concentration was greater than three times the reported uncertainty for that isotope.

The INL contractor performed 65 (including duplicates) field-based gamma spectrometry measurements in 2014 using several HPGe detector measurement systems based on the methodology described in the Environmental Measurements Laboratory Procedures Manual (DOE 1997). A summary of 2014 measured results, historical mean background values, and 99% upper threshold values based on grab sampling is presented in Table 7-2. Cesium-137 was detected at most measurement locations except at some collocated air monitoring stations (Blackfoot, Sugar City, and IRC). Based on the lack of spatial trends, the presence of ^{137}Cs at most collocated air monitor stations does not appear to be associated with the INL Site. Appendix D shows facility maps with the positive detected measurements. Historical reports note the presence of low concentrations of ^{241}Am in the surface soils surrounding RWMC (Markham, Puphal, and

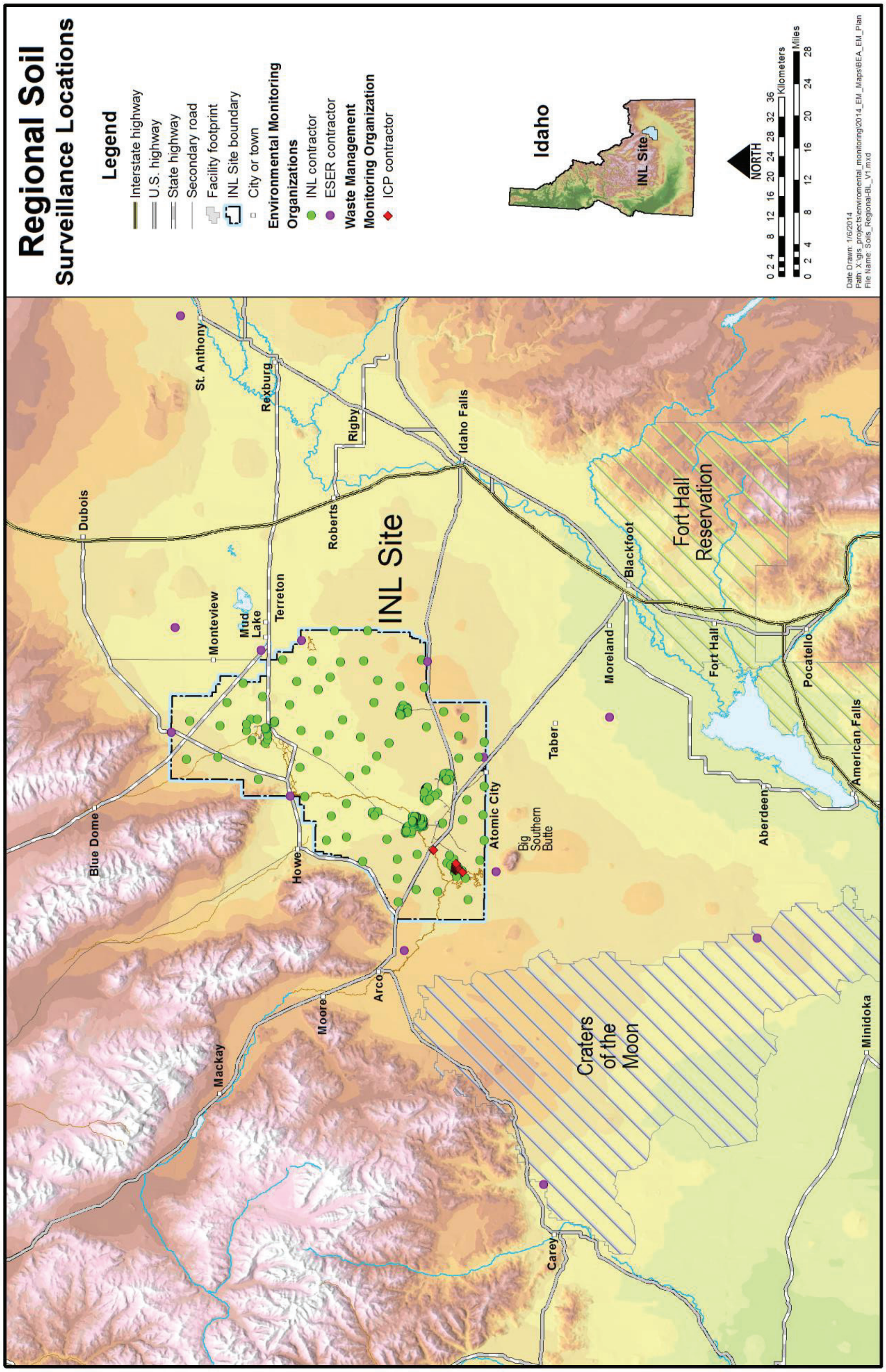


Figure 7-6. Soil Sampling Locations.

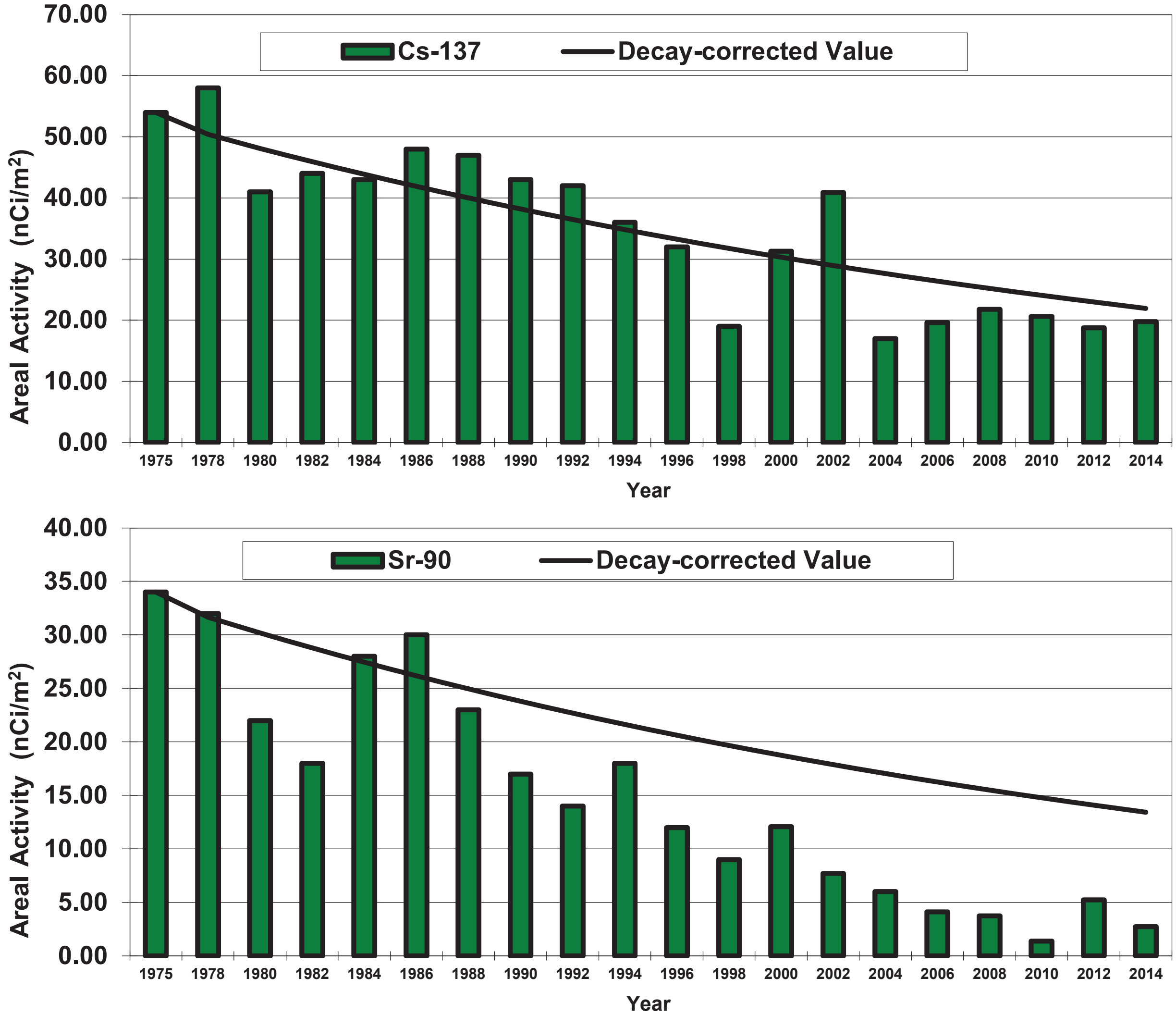


Figure 7-7. Mean Activities in Surface (0 – 12 cm [0 – 5 in.]) Soils off the INL Site (1975 – 2014).

Filer, 1978). As in previous years, positive detections of ^{241}Am were noted at several locations along the east and north boundary areas at RWMC. The 2014 and prior year in-situ detections are likely partly due to the shine from above ground waste storage and disposal operations sites. To investigate this potential, BEA, the INL contractor, performed two sets of shielded/unshielded HPGe measurements at points along the east RWMC fence and noted that the ^{241}Am concentration values dropped by a factor of 2-3 when using shielding. Table 7-2 and Figure D-6 include only the shielded results. All INTEC results showed positive detections of ^{137}Cs and most showed positive detections of ^{134}Cs. At ARA-I seven positive detected results for ^{137}Cs were noted. At MFC, ^{137}Cs was detected at all locations. Positive detections for ^{134}Cs were noted at seven locations along with a single detection of ^{60}Co. At TAN-SMC, there were six ^{137}Cs positive detects, along with three detections of ^{134}Cs and one ^{125}Sb. At NRF there were also positive detections of ^{137}Cs and ^{134}Cs. Although some of the measured concentrations of the man-made radionuclides exceed the 95 percent/99 percent Upper Concentration Limit, the values are consistent with previously observed levels. Additionally, the locations of the positive detections are near existing operational facilities and because the concentrations are consistent with previously observed levels the activity is attributed to historical releases. Other positive detections occurred near inactive facilities, or facilities that have been removed such as ARA and TAN, and are attributed to residual contamination from historical releases.

Table 7-2. In-Situ Gamma Scan Results for INL Site Locations (2014) (all values in pCi/g).

Location/Positive Detection	Number of Observations	Minimum	Maximum	Mean	INL Mean[a]	95%/99% UTL[a,b] Background Value
ARA Cesium-134	4	0.04	0.06	0.05	-	-
ARA Cesium-137	6	0.13	3.02	1.14	0.44	1.61
INTEC Cesium-134	11	0.03	0.08	0.05	-	-
INTEC Cesium-137	14	0.44	3.54	1.29	0.44	1.61
Air Monitors Cesium-134	8	0.04	0.05	0.04	-	-
Air Monitors Cesium-137	17	0.02	0.97	0.19	0.44	1.61
Air Monitors Cobalt-60	1	-	0.01	-	-	-
MFC Cobalt-60	1	-	0.05	-	-	-
MFC Cesium-134	7	0.04	0.06	0.04	-	-
MFC Cesium-137	9	0.12	0.49	0.20	0.44	1.61
NRF Cesium-134	1	-	0.06	-	-	-
NRF Cesium-137	1	-	0.33	-	0.44	1.61
RWMC Americium-241[c]	1	-	0.6	-	-	-
RWMC Cesium-134	5	0.03	0.09	0.06	-	-
RWMC Cesium-137	9	0.12	3.13	0.56	0.44	1.61
TAN-SMC Cesium-134	3	0.04	0.06	0.05	-	-
TAN-SMC Cesium-137	6	0.11	0.96	0.35	0.44	1.61
TAN-SMC Antimony-125	1	-	0.8	-	-	-

a. INL Mean background and upper tolerance limit (UTL) values are from INEL-94/0250, Rev 1. August 1996. "Background Dose Equivalent Rates and Surficial Soil Metal and Radionuclide Concentrations at the Idaho National Engineering Laboratory" (Rood, et al. 1996).

b. 95%/99% UTL values give 95% confidence of encompassing the smallest 99% of the background concentrations.

c. Only shielded measurements are listed.

The anthropogenic radionuclides detected in INL Site soils in 2014 included ^{137}Cs, ^{134}Cs, ^{60}Co, ^{125}Sb, and ^{241}Am. Cesium-137 has a half-life of 30.0 years and originates as a fallout fission product from nuclear weapons testing or from past effluent or stack releases. Cesium-137 is strongly retained on clay soils, which limits plant uptake and it is not readily soluble in fresh water. Cesium-137 human metabolism resembles that of potassium, so it can be uniformly distributed in the body. The mean background concentration of ^{137}Cs at the INL is documented to be 0.44 pCi/g and the upper threshold limit is 1.61 pCi/g based on results from historical grab sampling of soils. Cesium-134 is a fission product produced in nuclear reactors and has a half-life of 2.1 years. Cobalt-60 is an activation product produced in reactors and has a half-life of 5.3 years. Antimony-125 is a fission product produced in nuclear reactors and has a half-life of 2.76 years. Americium-241 is a decay product of ^{241}Pu and has a half-life of 432 years. Americium-241 does not occur in nature; however, some americium may be found in the environment as the result of atmospheric testing of nuclear weapons and disposal of wastes.

7.3 Direct Radiation

Thermoluminescent dosimeters (TLDs) measure cumulative exposures in air (in milliRoentgen or mR) to ambient ionizing radiation. TLDs detect changes in ambient exposures attributed to handling, processing, transporting, or disposing of radioactive materials. TLDs are sensitive to beta energies greater than 200 kilo-electron volts (keV) and to gamma energies greater than 10 keV. The TLD packets contain four lithium fluoride chips and are placed about 1 m (about 3 ft) above the ground at specified locations (Figure 7-8). The four chips provide replicate measurements at each location.

Beginning with the May 2010 distribution of dosimeters, the INL contractor began using optically stimulated luminescence dosimeters (OSLDs) collocated with the traditional TLDs. The last set of TLD results were from November 2012. Similar to TLDs, OSLDs measure the ambient dose equivalent (in mrem).

InLight® OSLDs, manufactured and analyzed by Landauer Inc., were used by the INL contractor in 2014. Each OSLD contains four aluminum oxide detectors that are sensitive to ionizing radiation ranging in energy from 5 keV to 20 MeV, with a minimum ambient dose equivalent reporting of 5 mrem. The primary advantage of the OSLD technology to the traditional TLD is that the non-destructive reading of the OSLD allows for dose verification (i.e., the dosimeter can be read multiple times without destruction of the accumulated signal inside the aluminum oxide chips). TLDs, on the other hand, are heated and once the energy is released, they cannot be reread. The sampling periods for 2014 were from November 2013 to April 2014 and May 2014 to November 2014.

The 2014 results for OSLDs collected by the INL contractor are provided in Appendix D. Locations of the dosimeters maintained on the INL Site are shown in Figures D-8 through D-23. The results for these locations are displayed in the figures. The OSLD data are reported in units of ambient dose equivalent (mrem).

Dosimeters on the INL Site are placed at facility perimeters, concentrated in areas likely to show the highest gamma radiation readings. Other dosimeters on the INL Site are located near radioactive materials storage areas and along roads. For decades, the number and locations of INL Site area dosimeters have been relatively constant; however, factors affecting potential exposures have changed. These changes include a reduced number of operating nuclear reactors, personnel, and waste shipments; decontamination and demolition of numerous buildings and facilities; and remediation of radionuclide-contaminated ponds and soil areas. Because of these changes and because years of TLD exposures at many established locations were equivalent to natural background, the INL contractor reduced the number of INL Site dosimetry locations while still measuring area exposures. Additional monitoring locations have been added near select Research and Education Campus facilities in Idaho Falls. These locations include the Systems Analysis Facility (IF-627), IRC Laboratory Building (IF-603), IRC Physics Lab (IF-638), and the Portable Isotopic Neutron Spectroscopy facility (IF-675).

The OSLD's are received from the manufacturer in Glenwood, Illinois, and placed in the field. After the field monitoring period, they are returned for analysis. Transit badges are always shipped with the field badges. The dose received by the transport control badges is an indicator of dose received during shipment. The 2014 reported values were primarily below 150 mrem which is the upper range of historical background. There were fourteen on-site measurements above 150 mrem. The majority of these were within historic levels for the locations. Three were above historic levels with the maximum on-site measurement of 215.3 mrem at location RWMC O-41. The other locations above historic levels were RWMC O-13A with 155 mrem and TRA O-10 with 203.7 mrem. These locations are near controlled radioactive material areas where movement and storage of materials affect the exposure rate.

For the RWMC locations a paired t-test analysis was performed comparing the 2014 OSLD data to the 2013 OSLD data for the ten sampling locations at RWMC. The result of the test demonstrates that there is a statistically significant difference between the two data sets. Further analysis was performed to compare the three year average (2011 through 2013, inclusive) to the 2014 results. In this instance, the t-test concludes that there is not a statistically significant difference when comparing the 2014 data to the three year average. The individual values for locations O-13A and O-41 for 2014 are 17.3 percent and 12 percent higher, respectively, relative to the 2013 values. These slight increases are likely due to routine operations and waste storage and handling activities at RWMC. Although these individual values exceed the averages of the three prior years, when the data are considered collectively, there is not a statistically significant difference, as indicated by the results of the t-test. See Figure D-20.

For the TRA location a paired t-test analysis was performed comparing the 2014 OSLD data to the 2013 OSLD data for the seven sampling locations at ATR Complex. The result of the test demonstrates that the difference in the median values between the two data sets is not great enough to exclude the possibility that the difference is due to sampling variability; there is not a statistically significant difference. Specific to sampling location TRA O-10, there was an increase of approximately 43 percent relative to 2013, and the 2014 value of 203.7 mrem is also greater than the average of 163.9 mrem for the three years prior (i.e., 2011 through 2013). This increase is likely due to routine operations at ATR Com-

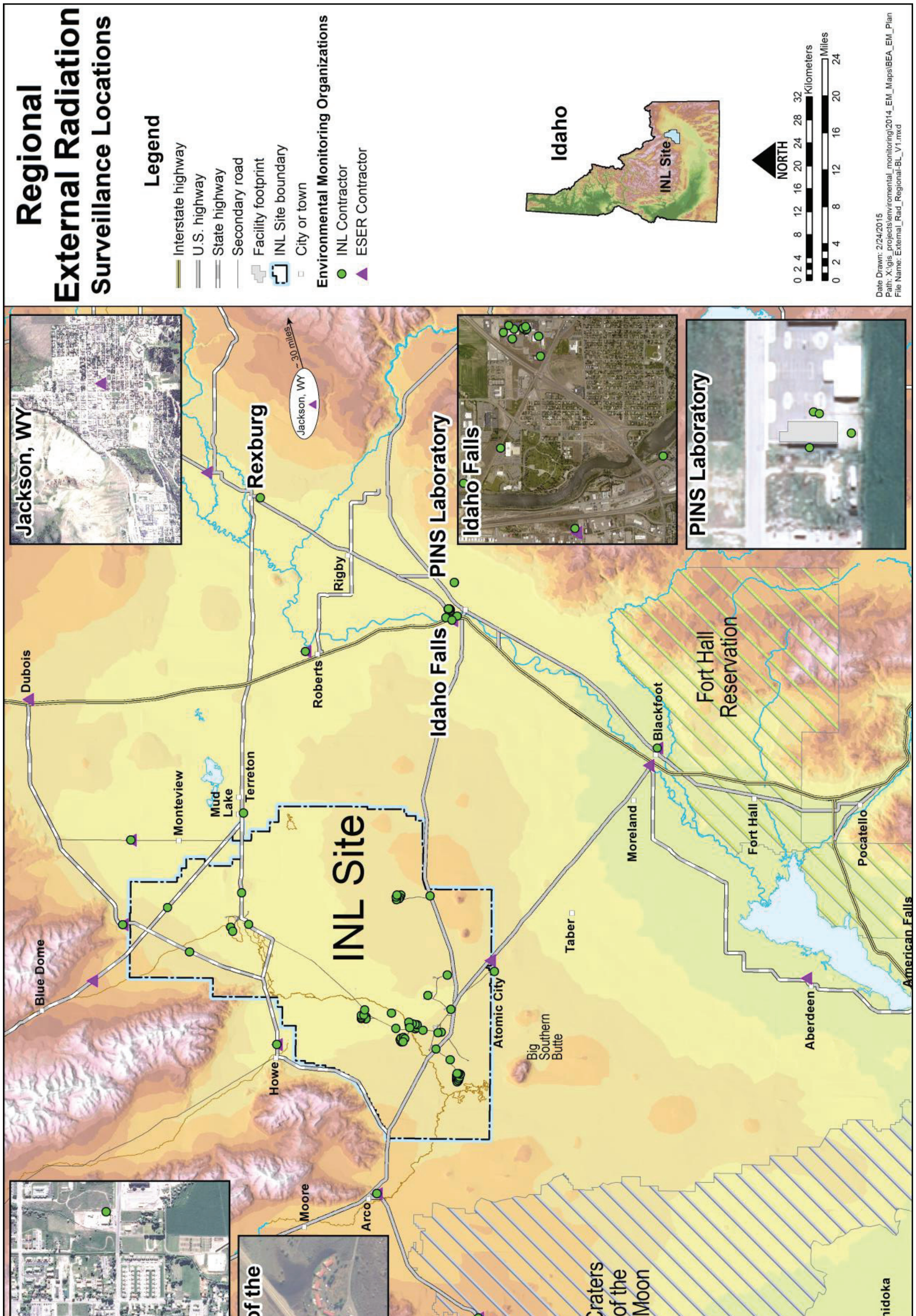


Figure 7-8. Regional Direct Radiation Monitoring Locations.

plex. It should also be noted that at locations TRA O-11 and TRA O-13, the 2014 OSLD values of 194.3 mrem and 156.6 mrem, respectively, are significantly lower than the previous three years' maximum values of 271.4 mrem and 472 mrem, respectively. See Figure D-9.

No off-site measurements were above 150 mrem.

All neutron dosimeters collected in 2014 were reported "M" (dose equivalents below the minimum measurable quantity of 10 mrem). The INL contractor is following the recommendations of the dosimetry provider to prevent environmental damage to the neutron dosimetry by wrapping each with aluminum foil. To keep the foil intact, the badge is inserted into an ultraviolet protective cloth pouch when deployed.

The ESER contractor deployed OSLDs in November 2011 and ran a side-by-side field comparison with TLDs during 2012, 2013, and 2014. Idaho State University also conducted a laboratory study, as well as, analyzed results from the field study for the ESER contractor. The purpose of these studies was to investigate the feasibility of replacing TLDs exclusively with OSLDs.

The 2014 ESER results from the Blackfoot location were considered to be invalid and were not included in the tables and calculations. At the start of the 2014 sampling period, the dosimeter was moved from an area that was becoming inaccessible. The results for the first half of the year were found to be about twice the average for the other locations. A subsequent survey with a handheld radiation meter found an area of gravel in the vicinity of the dosimeter with radiation readings about double the average value for background radiation. This was likely due to naturally-occurring radioactive elements in the gravel material. The dosimeter was relocated to an area with normal background readings during the second half of the year.

The measured cumulative environmental radiation exposure in milliroentgens (mR) for locations off the INL Site from November 2013 through October 2014 is shown in Table 7-3 for TLDs maintained by the ESER contractor. For purposes of comparison, annual exposures for both the ESER and INL contractors from 2010 through 2013 also are included for each location. Table 7-4 shows the cumulative radiation doses measured using OSLDs for both the ESER contractor and INL contractor for 2014. Available data for the three previous years are also included for comparison purposes.

The mean annual exposure measured using TLDs from distant locations in 2014 was 124 mR. The boundary location average was 123 mR. The average annual dose equivalent resulting from external exposure was estimated by converting the exposure measured in free air (mR) to dose equivalent (in mrem) by the factor of 1.03 reported for ^{137}Cs radiation by American National Standards Institute (1983). The average annual dose for all dosimeters was thus estimated to be 127 mrem.

Using OSLDs, the mean annual ambient dose for distant locations was estimated at 109 mrem for the ESER contractor and 123 mrem for the INL contractor. For boundary locations, the mean annual ambient doses were 106 mrem (ESER contractor) and 120 mrem (INL contractor). Using the data for both contractors and both sample groups the overall average ambient dose measured by OSLDs was 113 mrem in 2014.

Table 7-5 summarizes the calculated effective dose a hypothetical individual would receive on the Snake River Plain from various natural background radiation sources (cosmic and terrestrial). This table includes the latest recommendations of the National Council on Radiation Protection and Measurements (NCRP) in *Ionizing Radiation Exposure of the Population of the United States* (NCRP 2009).

The terrestrial natural background radiation exposure estimate is based on concentrations of naturally occurring radionuclides found in soil samples collected from 1976 through 1993, as summarized by Jessmore et al. (1994). Concentrations of naturally occurring radionuclides in soil do not change significantly over this relatively short period. Data indicated the average concentrations of ^{238}U, thorium-232 (^{232}Th), and potassium-40 (^{40}K) were 1.5, 1.3, and 19 pCi/g, respectively. The calculated external dose equivalent received by a member of the public from ^{238}U plus decay products, ^{232}Th plus decay products, and ^{40}K based on the above-average area soil concentrations were 21, 28, and 27 mrem/yr, respectively, for a total of 76 mrem/yr (Mitchell et al. 1997). Because snow cover can reduce the effective dose Idaho residents receive from soil, a correction factor must be made each year to the estimated 76 mrem/yr. In 2014, this resulted in a reduction in the effective dose from soil to a value of 75 mrem.

The cosmic component varies primarily with increasing altitude. Using Figure 3.4 in NCRP Report No. 160 (NCRP 2009), it was estimated that the annual cosmic radiation dose near the INL Site is about 57 mrem. Cos-

Table 7-3. Annual Environmental Radiation Exposures Using TLDs (2009 – 2014).

Location	2010		2011		2012		2013		2014	
	ESER[a]	INL[b] Contractor	ESER	INL Contractor	ESER	INL Contractor	ESER	INL Contractor	ESER	INL Contractor
	(mR)									
Distant Group										
Aberdeen	130	133	126	128	129	135	129	NA	130	NA
Blackfoot[c]	113	NA	112	NA	120	NA	119	NA	NA[d]	NA
Craters of the Moon	121	135	119	118	122	136	122	NA	125	NA
Dubois[c]	104	NA	100	NA	107	NA	109	NA	108	NA
Idaho Falls	124	121	124	118	127	133	125	NA	126	NA
Jackson[c]	102	NA	101	NA	102	NA	104	NA	102	NA
Minidoka	114	119	116	115	115	129	121	NA	118	NA
Mountain View	120	114	121	114	113	124	114	NA	113	NA
Rexburg/Sugar City	152	128	138	124	150	135	153[e]	NA	156	NA
Roberts	--[f]	143	134	133	139	149	138	NA	135	NA
Mean	120	126	119	121	122	134	122	NA	124	NA
Boundary Group										
Arco	128	129	130	130	126	134	128	NA	119	NA
Atomic City	127	122	121	123	132	132	129	NA	132	NA
Birch Creek Hydro	--[g]	NA	109	112	113	119	115	NA	116	NA
Blue Dome[c]	105	NA	105	NA	107	NA	109	NA	109	NA
Howe	117	119	111	114	122	127	122	NA	125	NA
Monteview	119	128	112	116	122	131	118	NA	122	NA
Mud Lake	134	138	134	132	138	142	134	NA	136	NA
Mean	122	127	116	121	123	131	122	NA	123	NA

a. ESER = Environmental Surveillance, Education, and Research.
b. INL = Idaho National Laboratory.
c. The INL contractor does not sample at this location.
d. The dosimeter was in an area with elevated natural radioactivity levels for part of the year and does not represent background values. See text for further explanation.
e. Dosimeter was moved to Sugar City in July 2013.
f. Dosimeter was missing at one of the collection times.
g. Reader malfunctioned during measurement of dosimeter.

Table 7-4. Annual Environmental Radiation Doses Using OSLDs (2011 – 2014).

Location	2011[a]		2012[a]		2013[a]		2014[a]	
	ESER[b]	INL[c] Contractor	ESER	INL Contractor	ESER	INL Contractor	ESER	INL Contractor
	mrem							
Aberdeen	NA	140	115	140	113	125	112	-[d]
Blackfoot[d]	NA	NA	113	NA	107	NA	NA[e]	NA
Craters of the Moon	NA	131	108	141	100	118	109	124
Dubois[d]	NA	NA	96	NA	90	NA	95	NA
Idaho Falls	NA	113	117	132	113	111	103	119
Jackson[d]	NA	NA	88	NA	81	NA	89	NA
Minidoka	NA	131	101	129	99	111	104	-[d]
Mountain View	NA	117	102	125	103	105	104	111
Rexburg/Sugar City	NA	127	135	139	140[f]	114	147	121
Roberts	NA	157	135	147	125	128	118	140
Mean	NA	131	111	136	108	116	109	123
Arco	NA	137	117	134	112	112	117	127
Atomic City	NA	120	119	138	112	116	113	123
Birch Creek Hydro	NA	125	105	118	96	106	101	108
Blue Dome[d]	NA	NA	96	NA	86	NA	84	NA
Howe	NA	135	112	--[g]	104	103	104	116
Monteview	NA	120	110	131	100	106	102	117
Mud Lake	NA	147	122	131	115	131	122	129
Mean	NA	132	112	130	104	112	106	120

a. INL contractor measurements do not have transit dose subtracted. See Section 7.3 for further details.
b. ESER = Environmental Surveillance, Education, and Research.
c. INL = Idaho National Laboratory.
d. The INL contractor does not sample at this location.
e. The dosimeter was in an area with elevated natural radioactivity levels for part of the year and does not represent background values. See text for further explanation.
f. Dosimeter was moved to Sugar City in July 2013.
Dosimeter missing at collection time.

mic radiation may vary slightly because of solar cycle fluctuations and other factors.

Based on this information, the sum of the terrestrial and cosmic components of external radiation dose to a person residing on the Snake River Plain in 2014 was estimated to be 132 mrem/yr. This is slightly higher than the 127 mrem/yr measured at offsite locations by the ESER contractor using TLD data. Measured values are very close, and within normal variability, of the calculated background doses. Therefore, it is unlikely that INL Site operations contributed to background radiation levels at distant locations in 2014.

The component of background dose that varies the most is inhaled radionuclides. According to the NCRP, the major contributor of effective dose received by a member of the public from ^{238}U plus decay products is short-lived decay products of radon (NCRP 2009). The amount of radon in buildings and groundwater depends, in part, upon the natural radionuclide content of soil and rock of the area. The amount of radon also varies among

Table 7-5. Calculated Effective Dose from Natural Background Sources (2014).

Source of Radiation Dose	Total Average Annual Dose	
	Calculated (mrem)	Measured[a] (mrem)
External irradiation		
Terrestrial	75[b]	NA[c]
Cosmic	57[d]	NA
Subtotal	132	127
Internal irradiation (primarily ingestion)[e]		
Potassium-40	15	
Thorium-232 and uranium-238	13	
Others (carbon-14 and rubidium-87)	1	
Internal irradiation (primarily inhalation)[d]		
Radon-222 (radon) and its short-lived decay products	212	
Radon-220 (thoron) and its short-lived decay products	16	
Total	389	

a. Calculated by converting the average annual external exposure (124 mR) measured by the ESER contractor at distant locations to dose equivalent (mrem) using a conversion factor of 1.03 (ANSI 1983).
b. Estimated using concentrations of naturally-occurring radionuclide concentrations in soils in the Snake River Plain.
c. NA indicates terrestrial and cosmic radiation parameters were not measured individually but were measured collectively using thermoluminescent devices.
d. Estimated from Figure 3-4 of NCRP Report No. 160.
e. Values reported for average American adult in Table 3.14 of NCRP Report No. 160.

buildings of a given geographic area depending upon the materials each contains, the amount of ventilation and air movement, and other factors. The United States average of 212 mrem/yr was used in Table 7-5 for this component of the total background dose. The NCRP also reports that the average dose received from thoron, a decay product of ^{232}Th, is 16 mrem.

People also receive an internal dose from ingestion of ^{40}K and other naturally-occurring radionuclides in environmental media. The average ingestion dose to an adult living in the U.S. was reported in NCRP Report No. 160 to be 29 mrem/yr (NCRP 2009).

With all of these contributions, the total background dose to an average individual living in southeast Idaho was estimated to be approximately 389 mrem/yr (Table 7-5). This value was used in Table 8-4 to calculate background radiation dose to the population living within 50 miles of INL Site facilities.

7.4 Waste Management Surveillance Sampling

For compliance with DOE Order 435.1, "Radioactive Waste Management" (2007), vegetation and soil are sampled at RWMC, and direct surface radiation is measured at RWMC and the Idaho Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) Disposal Facility.

7.4.1 Vegetation Sampling at the Radioactive Waste Management Complex

At RWMC, vegetation is collected from four major areas (see Figure 7-9) and a control location approximately seven miles south of the Subsurface Disposal

Area (SDA) at the base of Big Southern Butte. Russian thistle is collected in even-numbered years if available. Due to construction activities, there was an insufficient amount of Russian thistle to collect in 2014.

7.4.2 Soil Sampling at the Radioactive Waste Management Complex

The ICP contractor samples soil every three years. The triennial soil sample was previously collected in 2012, and the next samples will be collected in 2015.

7.4.3 Surface Radiation Survey at the Radioactive Waste Management Complex and the Idaho CERCLA Disposal Facility

Surface radiation surveys are performed to characterize gamma radiation levels near the ground surface at waste management facilities. Comparing the data from these surveys year to year helps to determine whether radiological trends exist in specific areas. This type of survey is conducted at the RWMC SDA to complement air and soil sampling, and at the Idaho CERCLA Disposal Facility to complement air sampling. The SDA contains legacy waste that is in the process of being removed for repackaging and shipment to an offsite disposal facility. The Idaho CERCLA Disposal Facility consists of a landfill and evaporation ponds that serve as the consolidation points for CERCLA-generated waste within the INL site boundaries.

A vehicle-mounted Global Positioning Radiometric Scanner (GPRS) system (Rapiscan Model GPRS-111[1]) is used to conduct these soil surface radiation (gross gamma) surveys to detect trends in measured levels of surface radiation. The GPRS system consists of two scintillator gamma detectors, housed in two separate metal cabinets, and a Trimble[1] global positioning system receiver mounted on a rack located above the front bumper of a pickup truck. The detectors are about 36 inches

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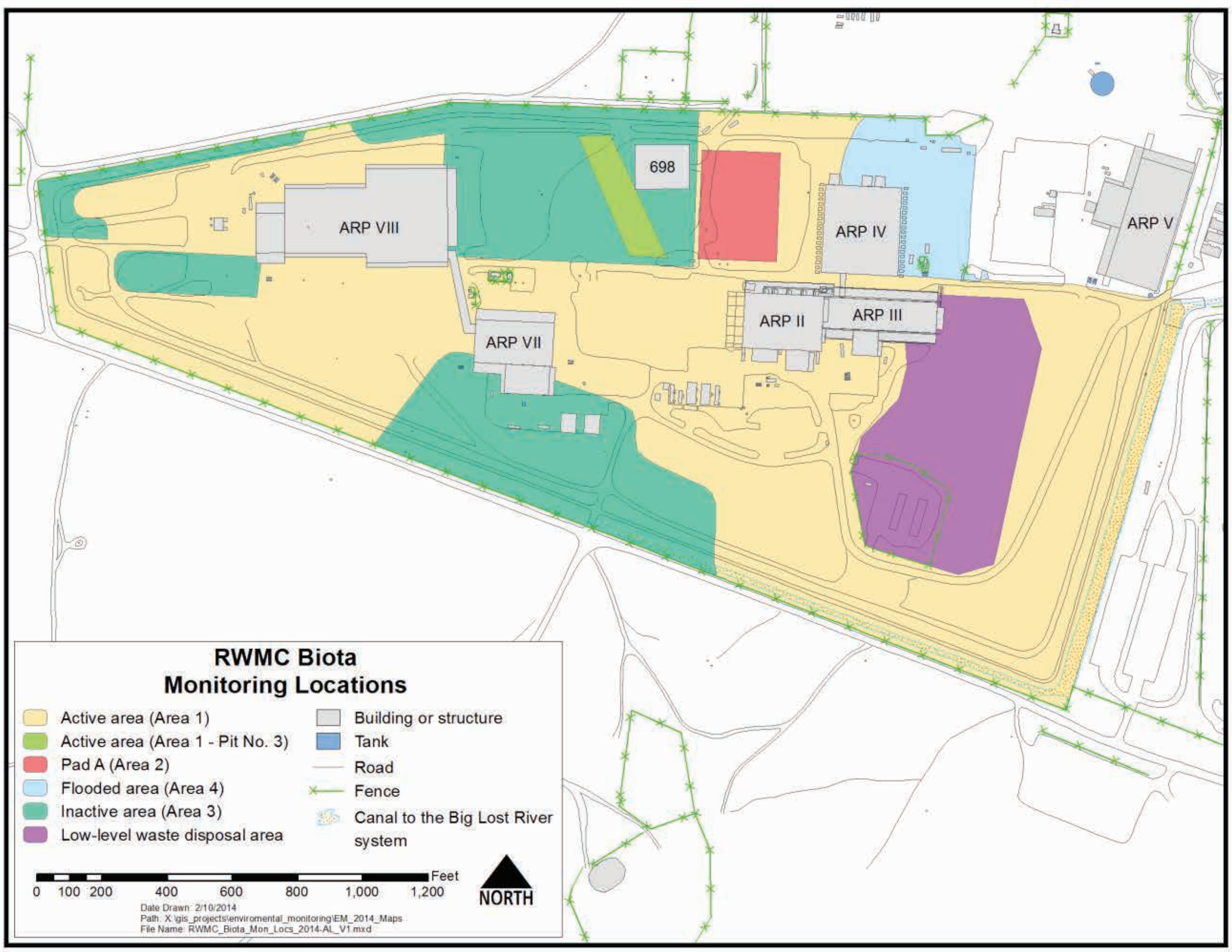


Figure 7-9. Four Vegetation Sampling Areas at the RWMC.

above-ground. The detectors and the global positioning system receiver are connected to a system controller and to a laptop computer located inside the cabin of the truck. The GPRS system software displays the gamma counts per second from the detectors and the latitude and longitude of the system in real time on the laptop screen. The laptop computer also stores the data files collected for each radiometric survey. During radiometric surveys, the pickup truck is driven 5 miles per hour (7 feet per second), and the GPRS system collects latitude, longitude, and gamma counts per second from both detectors. Data files generated during the radiological surveys are saved and transferred to the ICP spatial analysis laboratory for mapping after the surveys are completed. The maps indicate areas where survey counts were at or near background and areas where survey counts are above background.

Figure 7-10 shows a map of the area that was surveyed at RWMC in 2014. Due to heavy rain in August, subsidence restrictions were put in place. Some areas that had been surveyed in previous years could not be accessed due to the subsidence restrictions. Although readings vary slightly from year to year, the 2014 results for most areas are comparable to previous years' measurements. The active low-level waste pit was covered during 2009, and as a result of the reduced shine, elevated measurements from the buried waste in pits and trenches are more visible. Average background values near or around areas that were radiometrically scanned at the INL were generally below 750 counts per second. Most of the 2014 RWMC gross gamma radiation measurements were at background levels. The 2014 maximum gross gamma radiation measurement on the SDA was 17,414 counts per second, compared to the 2013 measurement of 16,337 counts per second. The maximum readings generally have been measured in a small area at the western end of the soil vault row SVR-7, and the size of that area has not increased.

The area that was surveyed at the Idaho CERCLA Disposal Facility is shown in Figure 7-11. The readings at the Idaho CERCLA Disposal Facility vary from year

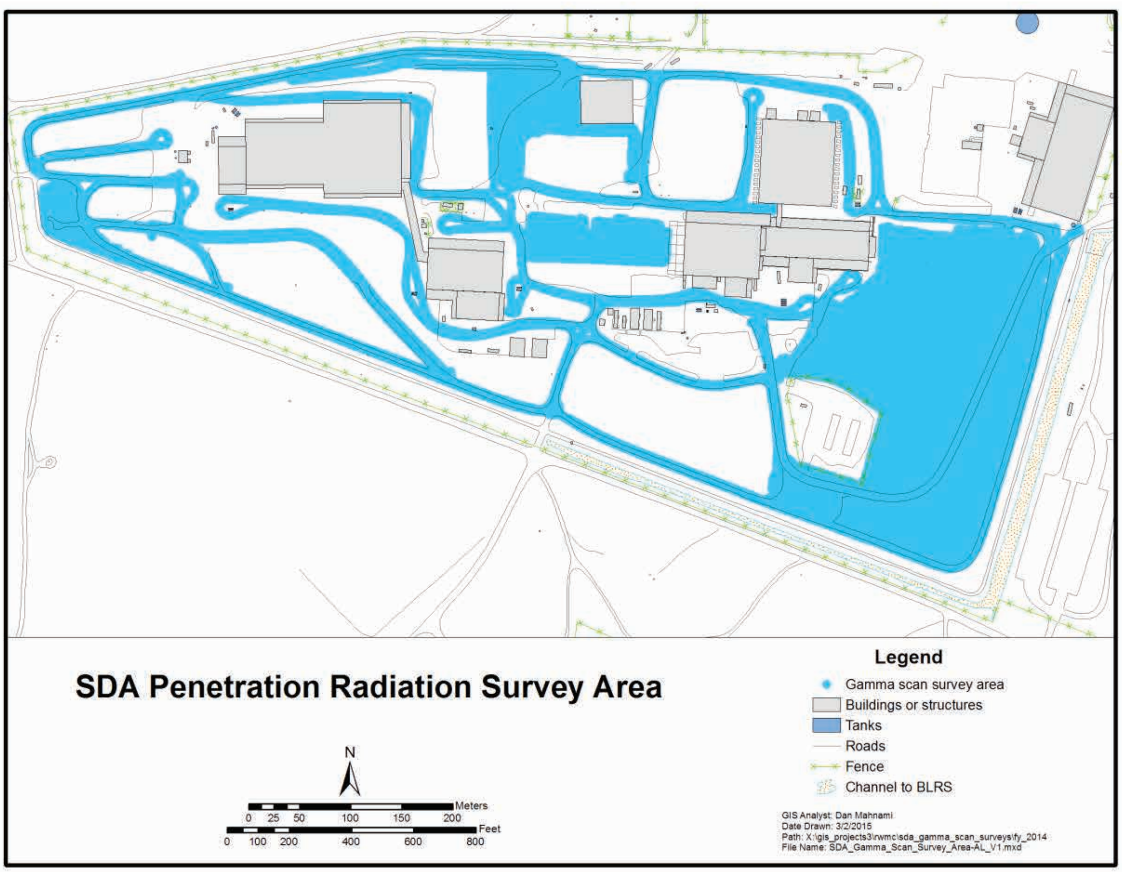


Figure 7-10. Subsurface Disposal Area Surface Radiation Survey Area (2014).

to year. These variations are related to the disposal and burial of new CERCLA remediation wastes in accordance with the Idaho CERCLA Disposal Facility waste placement plan (EDF-ER-286). In 2014, the readings were either at background or slightly above background levels (approximately 300 counts/second), which is expected until the facility is closed and capped.

7.5 CERCLA Ecological Monitoring

Ecological monitoring at the INL Site was conducted in accordance with the Record of Decision for Operable Unit 10-04 (DOE-ID 2002) developed under the CERCLA (42 USC § 9601 et seq., 1980). The selected remedy was no action with long-term ecological monitoring to reduce uncertainties in the INL Site-wide ecological risk assessment.

Six years of data and observations from 2003 through 2008 detected minimal effects at the population level (Van Horn et al. 2012). Differences between areas near facilities and background areas were slight, and may be attributable wholly or partly to natural variability. Because monitoring substantially reduced uncertainties in the INL Site-wide ecological risk assessment and increased confidence that the no action decision is protective, further ecological monitoring under CERCLA is not required. To validate the conclusion that further ecological monitoring under CERCLA is not required, ecological sampling results and the latest changes in ecological data (e.g., screening and toxicity values) were used to produce waste area group-level ecological risk assessments. Refined ecological risks were presented in a summary report (VanHorn 2013). Several individual release sites within the waste area groups were recommended for further evaluation in the next 5-year review (planned to cover 2010 through 2014) to ensure the remedial action is protective of ecological receptors.

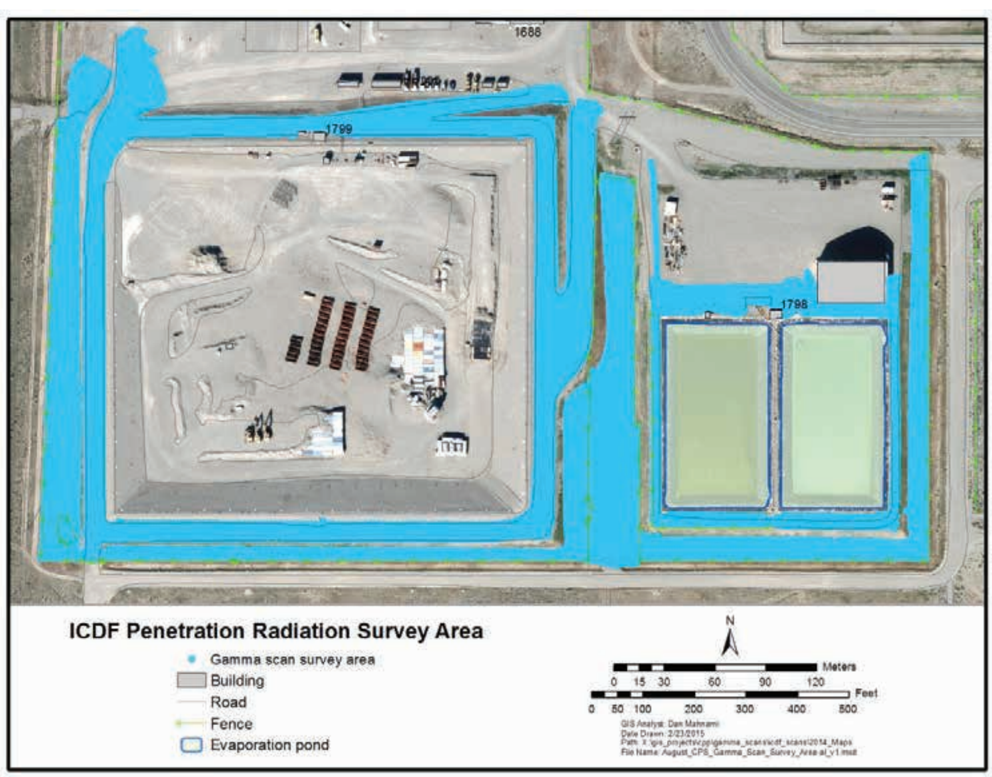


Figure 7-11. Idaho CERCLA Disposal Facility Surface Radiation Survey Area (2014).

REFERENCES

42 USC § 9601 et seq., 1980, "Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (CERCLA/Superfund)," United States Code.

Amaral, E. C. S., H. G. Paretzke, M. J. Campos, M. A. Pires do Rio, and M. Franklin, 1994, "The Contribution of Soil Adhesion to Radiocaesium Uptake by Leafy Vegetables," *Radiation and Environmental Biophysics*, Vol. 33, pp. 373-379.

ANSI, 1983, American National Standard for Dosimetry – Personnel Dosimetry Performance - Criteria for Testing, ANSI/HPS N13.11-1983, *American National Standards Institute, Inc.*

DOE, 1997, *EML Procedures Manual*, HASL-300, Vol. 1, 28th Edition, available at http://www.eml.st.dhs.gov/publications/procman.cfm, Environmental Measurements Laboratory, U.S. Department of Energy.

DOE Order 435.1, 2011, "Radioactive Waste Management," Change 2, U.S. Department of Energy.

DOE-ID, 1999, *Idaho National Engineering and Environmental Laboratory Site Environmental Report for Calendar-Year 1999*, DOE/ID-12082 (99), U.S. Department of Energy Idaho Operations Office.

DOE-ID, 2002, *Record of Decision, Experimental Breeder Reactor-1/Boiling Water Reactor Experiment Area and Miscellaneous Sites*, DOE/ID-10980, U.S. Department of Energy Idaho Operations Office.

DOE-ID, 2014, *Idaho National Laboratory Site Environmental Monitoring Plan*, DOE/ID-10-11088, Rev. 4, U.S. Department of Energy Idaho Operations Office, February 2014.

EDF-ER-286, 2014, "ICDF Waste Placement Plan," Rev. 7, Idaho Cleanup Project.

EPA, 2015, *RadNet – Tracking Environmental Radiation Nationwide*, http://www.epa.gov/narel/radnet/, U.S. Environmental Protection Agency, Web page updated and visited April 14, 2015.

Fuhrmann, M., M. Lasat, S. Ebbs, J. Cornish, and L. Kochian, 2003, "Uptake and Release of Cesium-137 by Five Plant Species as Influenced by Soil Amendments in Field Experiments," *Journal of Environmental Quality*, Vol. 32.

Halford, D. K., J. B. Millard, and O. D. Markham, 1980, "Radionuclide Concentrations in Waterfowl Using a Liquid Radioactive Waste Disposal Area and the Potential Radiation Dose to Man," *Health Physics*, Vol 40 (February), pp. 172-181.

Halford, D. K., O. D. Markham, and R. Dickson, 1982, "Radiation Doses to Waterfowl Using a Liquid Radioactive Waste Disposal Area", *Journal of Wildlife Management*, Vol. 46, No. 4, October 1982.

ICRP, 2009, *ICRP Publication 114: Environmental Protection: Transfer Parameters for Reference Animals and Plants*, Annals of the International Commission on Radiological Protection (ICRP), December 2009.

Jessmore, P. J., L. A. Lopez, and T. J. Haney, 1994, *Compilation and Evaluation of INEL Radiological and Environmental Sciences Laboratory Surface Soil Sample Data for Use in Operable Unit 10-06 Baseline Risk Assessment*, EGG-ER-11227, Rev. 0, Idaho National Engineering Laboratory.

Kirchner, G., 1994. "Transport of Cesium and Iodine Via the Grass-Cow-Milk Pathway After the Chernobyl Accident," *Health Physics*, Vol. 66, No. 6.

Markham, O. D., K. W. Puphal, and T. D. Filer, 1978, *Plutonium and Americium Contamination near a Transuranic Storage Area in Southeastern Idaho*, Journal of Environmental Quality, Vol. 7, No. 3, July-September 1978.

Mitchell, R. G., D. Peterson, D. Roush, R. W. Brooks, L. R. Paulus, and D. B. Marton, 1997, *Idaho National Engineering and Environmental Laboratory Site Environmental Report for Calendar Year 1996*, DOE/ID-12082(96), August 1997.

NCRP, 2009, *Exposure of the Population in the United States and Canada from Natural Background Radiation*, NCRP Report No. 160, National Council on Radiation Protection.

Ng, Y. C., C. S. Colsher, and S. E. Thompson, 1982, *Soil-to-plant Concentration Factors for Radiological Assessments*, NUREG/CR-2975, Lawrence Livermore National Laboratory.

Pinder, J. E. III, K. W. McLeod, D. C. Adriano, J. C. Corey, and L. Boni, 1990, “Atmospheric Deposition, Resuspension and Root Uptake of Pu in Corn and Other Grain-Producing Agroecosystems Near a Nuclear Fuel Facility,” *Health Physics*, Vol. 59, pp. 853-867.

Schulz, R. K., 1965, “Soil Chemistry of Radionuclides,” *Health Physics*, Vol. 11, No. 12, December 1965.

Shebell, P., S. Faller, M. Monetti, F. Bronson, R. Hagenauer, C. L. Jarrell, D. Keefer, J. R. Moos, N. Panzarino, R. T. Reiman, B. J. Sparks, and M. Thisell, 2003, “An In Situ Gamma- Ray Spectrometry Intercomparison,” *Health Physics*, Vol. 85, No. 6, pp. 662-677.

Swift, C. E., Ph.D., 1997, *Salt Tolerance of Various Temperate Zone Ornamental Plants, Area Extension Agent*, Colorado State University.

VanHorn, R. L., L. S. Cahn, V. M. Kimbro, and K. J. Holdren, 2012, *Operable Unit 10-04 Long Term Ecological Monitoring Report for Fiscal Years 2003 to 2008*, DOE/ID-11390, Rev. 1, Idaho Cleanup Project.

VanHorn, Robin L., 2013, *Refined Waste Area Group Ecological Risk Assessments at the INL Site*, RPT-969, Rev. 1, Idaho Cleanup Project, August 2013.

Warren, R. W., S. J. Majors, and R. C. Morris, 2001, *Waterfowl Uptake of Radionuclides from the TRA Evaporation Ponds and Potential Dose to Humans Consuming Them*, Stoller-ESER-01-40, Environmental Surveillance, Education and Research.

Shaggy Fleabane

8. Dose to the Public and Biota

Silvery Lupine
Lupinus argenteus

The potential radiological dose to the public from Idaho National Laboratory (INL) Site operations was evaluated to determine compliance with pertinent regulations and limits. The Clean Air Act Assessment Package 88-PC computer program is required by the U.S. Environmental Protection Agency to demonstrate compliance with the Clean Air Act. The dose to the hypothetical, maximally exposed individual in 2014, as determined by this program, was 0.0365 mrem (0.365 µSv), well below the applicable standard of 10 mrem (100 µSv) per year. The maximum potential population dose to the approximately 318,528 people residing within an 80-km (50-mi) radius of any INL Site facility was also evaluated. The population dose was calculated using reported releases, an air dispersion model developed by the National Oceanic and Atmospheric Administration Air Resources Laboratory-Field Research Division, and methodology recommended by the Nuclear Regulatory Commission. For 2014, the estimated potential population dose was 0.607 person-rem (6.07×10^{-3} person-Sv). This dose is about 0.0005 percent of that expected from exposure to natural background radiation of 123,907 person-rem (1,239 person-Sv). Using the maximum radionuclide concentrations in collected waterfowl and large game animals, a maximum potential dose from ingestion was calculated. The maximum potential dose to an individual was calculated to be 0.032 mrem (0.32 µSv) for ingestion of waterfowl.

The potential doses to aquatic and terrestrial biota from contaminated soil and water were evaluated using a graded approach. Initially, the potential doses were screened using maximum concentrations of radionuclides detected in soil and effluents at the INL Site. Results of the screening calculations indicate that contaminants released from INL Site activities do not have an adverse impact on plants or animal populations. In addition, maximum concentrations of radionuclides measured in waterfowl accessing INL Site ponds were used to estimate internal doses to the waterfowl. These calculations indicate that the potential doses to waterfowl do not exceed the Department of Energy limits for biota.

No unplanned releases occurred from the INL Site in 2014, and, therefore, no doses were associated with unplanned releases.

8. DOSE TO THE PUBLIC AND BIOTA

It is the policy of the U.S. Department of Energy (DOE), "To implement sound stewardship practices that are protective of the air, water, land, and other natural and cultural resources impacted by DOE operations and by which DOE cost-effectively meets or exceeds compliance with applicable environmental, public health, and resource protection laws, regulations, and DOE requirements" (DOE Order 436.1). DOE Order 458.1 further states, "It is also a DOE objective that potential exposures to members of the public be as far below the limits as is reasonably achievable..." This chapter describes the potential dose to members of the public and biota from operations at the Idaho National Laboratory (INL) Site, based on 2014 environmental monitoring measurements.

8.1 Possible Exposure Pathways to the Public

Air, soil, groundwater, agricultural products, and biota are routinely sampled to document the amount of radioactivity in these media and to determine if radioactive materials have been transported off the INL Site. The air pathway is the primary way people living beyond the INL Site boundary could be exposed to releases from INL Site operations (Figure 8-1).

Airborne radioactive materials are rapidly carried from the source and dispersed by winds. The concentrations from routine releases are too small to measure at locations around the INL Site, so atmospheric dispersion models were used to estimate the downwind concentration of air pollutants and the potential doses from these projected offsite concentrations. Conservative doses were also calculated from ingestion of meat from wild game animals and waterfowl that access the INL Site. Ingestion doses were calculated from concentrations of radionuclides measured in game animals killed by vehicles on roads at the INL Site and in waterfowl harvested from ponds on the INL Site that had detectable levels of human-made radionuclides. External exposure to radiation in the environment (primarily from naturally-

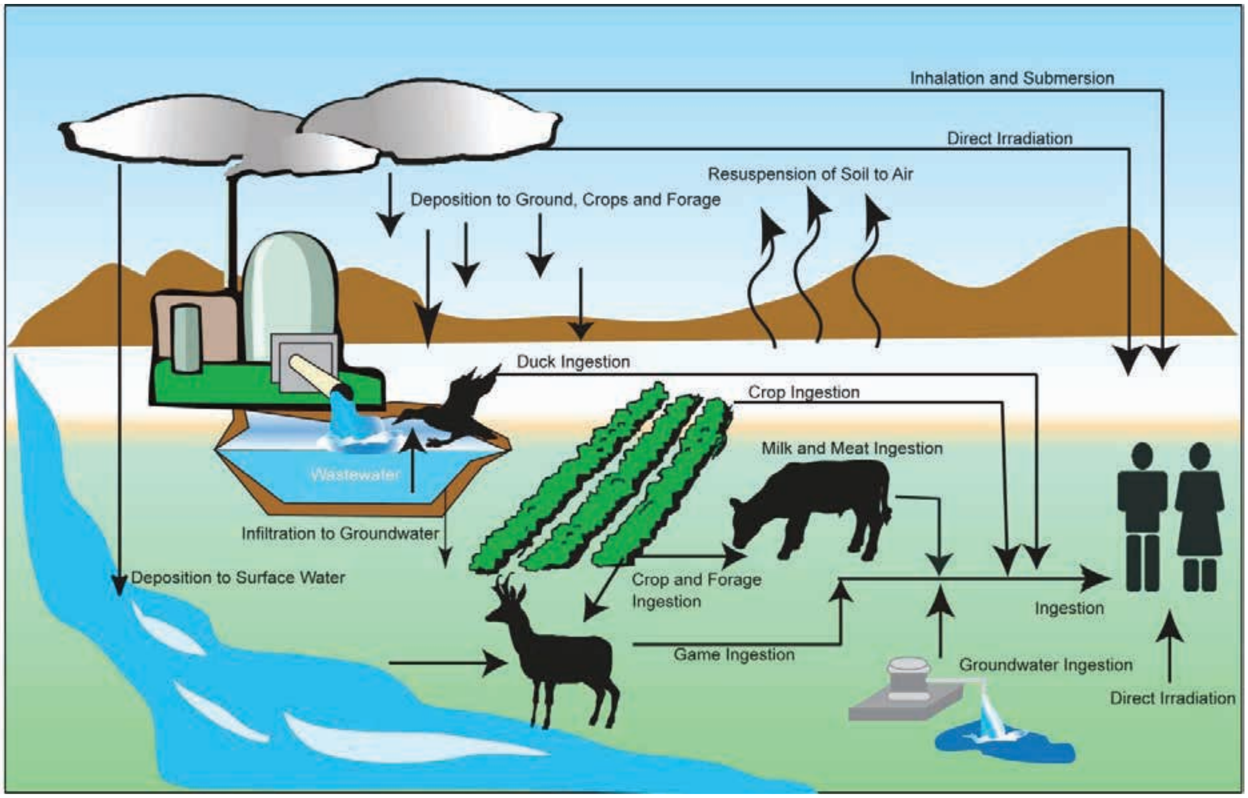


Figure 8-1. Potential Exposure Pathways to Humans from the INL Site.

occurring radionuclides) was measured directly using thermoluminescent dosimeters and optically stimulated luminescence dosimeters.

Water pathways were not considered major contributors to dose, because no surface water flows off the INL Site and no radionuclides associated with INL Site releases have been measured in public drinking water wells.

8.2 Dose to the Public from INL Site Air Emissions

The potential doses from INL Site air emissions were estimated using the amounts reported to be released by the facilities. During 2014, doses were calculated for the radionuclides and data presented in Table 4-2 and summarized in Table 8-1. Although noble gases were the radionuclides released in the largest quantities, they contributed very little to the cumulative dose (affecting immersion only) largely because of their short half-lives and the fact that they are not incorporated into the food supply. Some of the radionuclides that contributed the most to the overall estimated dose (strontium-90 [^{90}Sr], iodine-129 [^{129}I], cesium-137 [^{137}Cs], americium-241 [^{241}Am], and plutonium [Pu] isotopes) are typically associated with airborne particulates and were a very small fraction of the total amount of radionuclides reported.

Two kinds of dose estimates were made using the release data:

- **The effective dose to the hypothetical maximally exposed individual (MEI)**, as defined by the National Emission Standards for Hazardous Air Pollutants (NESHAPs) regulations. The Clean Air Act Assessment Package computer code (CAP88-PC) (EPA 2007) was used to predict the maximum downwind concentration at the nearest offsite receptor location and estimate the dose to the MEI.
- **The collective effective dose (population dose) for the population within 80 km (50 mi) of any INL Site facility.** For this calculation the MDIFFH (Sagendorf et al. 2001) was used to model air transport and dispersion. The population dose was estimated using dispersion values from the model projections to comply with DOE Order 458.1.

The dose estimates considered immersion dose from direct exposure to airborne radionuclides, internal dose

Table 8-1. Summary of Radionuclide Composition of Idaho National Laboratory Site Airborne Effluents (2014).

	Curies[a] Released										
Facility[b]	Tritium	^{85}Kr	Noble Gases[c] ($T_{1/2} < 40$ days)	Short-lived Fission and Activation Products[d] ($T_{1/2} < 3$ hours)	Fission and Activation Products[e] ($T_{1/2} > 3$ hours)	Total Radioiodine[f]	Total Radiostrontium[g]	Total Uranium[h] Ci	Plutonium[i]	Other Actinides[j]	Other[k]
ATR Complex	3.60E+02	1.60E-08	9.31E+02	4.93E-01	7.24E-02	4.95E-03	7.03E-02	1.73E-09	2.67E-05	1.83E-04	7.14E-08
CFA	6.80E-01	—	—	6.10E-06	5.88E-07	1.61E-09	3.50E-13	7.56E-08	1.11E-10	1.83E-08	8.81E-12
CITRC	—	—	—	—	9.50E-07	—	—	—	—	—	—
INTEC	1.20E+02	8.63E+02	—	—	1.06E-02	2.20E-02	8.41E-03	3.32E-07	4.32E-03	1.16E-05	—
MFC	2.02E-01	1.34E-03	—	6.25E-07	1.33E-03	5.12E-03	3.53E-06	7.78E-06	8.87E-07	3.34E-06	—
NRF	1.50E-02	4.60E-02	—	—	9.80E-.01	3.85E-05	5.50E-05	—	—	—	—
RWMC	7.80E+01	5.78E-19	—	2.28E-10	5.23E-02	—	5.98E-08	9.94E-05	2.61E-03	3.45E-03	2.50E-08
TAN	3.26E-02	—	—	—	—	—	1.02E-06	9.27E-11	—	—	—
Total	**5.59E+02**	**8.63E+02**	**9.31E+02**	**4.93E-01**	**1.12E**	**3.21E-02**	**7.88E-02**	**1.08E-04**	**6.96E-03**	**3.65E-03**	**9.64E-08**

a. One curie (Ci)= 3.7 x 10^{10} becquerels (Bq).

b. ATR Complex = Advanced Test Reactor Complex; CFA = Central Facilities Area; CITRC = Critical Infrastructure Test Range Complex; INTEC = Idaho Nuclear Technology and Engineering Center; MFC = Materials and Fuels Complex; NRF = Naval Reactors Facility; RWMC = Radioactive Waste Management Complex (including AMWTP = Advanced Mixed Waste Treatment Project); TAN = Test Area North (including SMC = Specific Manufacturing Capability).

c. Noble gases with half-lives less than 40 days released from the INL Site are: ^{39}Ar, ^{41}Ar, ^{85m}Kr, ^{87}Kr, ^{88}Kr, ^{127}Xe, ^{129m}Xe, ^{131m}Xe, ^{133}Xe, ^{133m}Xe, ^{135}Xe, ^{135m}Xe, and ^{138}Xe. (Ar = argon, Kr = krypton, and Xe = xenon.)

d. Fission products and activation products ($T_{1/2}$<3 hours) = ^{136m}Ba, ^{137m}Ba, ^{139}Ba, ^{141}Ba, ^{212}Bi, ^{83}Br, ^{60m}Co, ^{138}Cs, ^{67}Cu, ^{179m}Hf, ^{114}In, ^{142}La, ^{56}Mn, ^{93}Mo, ^{99}Mo, ^{97}Nb, ^{212}Po, ^{216}Po, ^{144}Pr, ^{144m}Pr, ^{88}Rb, ^{89}Rb, ^{103m}Rh, ^{106m}Rh, ^{219}Rn, ^{126m}Sb, ^{129}Te, ^{208}Tl, ^{187}W, ^{90}Y, ^{91m}Y, ^{92}Y, etc. See Table HI-1 for more information.

e. Fission products and activation products ($T_{1/2}$>3 hours) = ^{14}C, ^{144}Ce, ^{58}Co, ^{51}Cr, ^{134}Cs, ^{137}Cs, ^{152}Eu, ^{154}Eu, ^{155}Eu, ^{55}Fe, ^{175}Hf, ^{181}Hf, ^{203}Hg, ^{22}Na, ^{24}Na, ^{95}Nb, ^{63}Ni, ^{147}Pm, ^{224}Ra, ^{188}Re, ^{103}Ru, ^{106}Ru, ^{124}Sb, ^{125}Sb, ^{127}Sb, ^{46}Sc, ^{151}Sm, ^{182}Ta, ^{99}Tc, ^{99m}Tc, ^{65}Zn, ^{95}Zr, etc. See Table HI-1 for more information.

f. Total radioiodine = ^{125}I, ^{128}I, ^{129}I, ^{131}I, ^{132}I, ^{133}I, ^{134}I, and ^{135}I.

g. Total radiostrontium = ^{85}Sr, ^{89}Sr, ^{90}Sr, ^{91}Sr, and ^{92}Sr.

h. Total uranium = ^{232}U, ^{233}U, ^{234}U, ^{235}U, ^{236}U, ^{237}U, and ^{238}U.

i. Total plutonium = ^{236}Pu, ^{237}Pu, ^{238}Pu, ^{239}Pu, ^{240}Pu, ^{241}Pu, and ^{242}Pu.

j. Other actinides = ^{227}Ac, ^{241}Am, ^{243}Am, ^{249}Cf, ^{242}Cm, ^{243}Cm, ^{244}Cm, ^{245}Cm, ^{246}Cm, ^{247}Cm, ^{248}Cm, ^{237}Np, ^{239}Np, ^{231}Pa, ^{234}Pa, ^{227}Th, ^{228}Th, ^{229}Th, ^{230}Th, ^{231}Th, ^{232}Th, and ^{234}Th. See Table HI-1 for more information.

k. Other = radioisotopes of other elements that are not noble gases, activation or fission products or actinides.

from inhalation of airborne radionuclides, internal dose from ingestion of radionuclides in plants and animals, and external dose from direct exposure to radionuclides deposited on soil (Figure 8-1.) The CAP88-PC computer code uses dose and risk tables developed by the U.S. Environmental Protection Agency (EPA). Population dose calculations were made using the MDIFF air dispersion model in combination with Nuclear Regulatory Commission dose calculation methods (NRC 1977), DOE effective dose coefficients for inhaled radionuclides (DOE 2011), EPA dose conversion factors for ingested radionuclides (EPA 2002), and EPA dose conversion factors for external exposure to radionuclides in the air and deposited on the ground surface (EPA 2002).

8.2.1 Maximally Exposed Individual Dose

The EPA NESHAPs regulation requires demonstrating that radionuclides other than radon released to air from any DOE nuclear facility do not result in a dose to the public of greater than 10 mrem/yr (40 Code of Federal Regulations [CFR] 61, Subpart H). This includes releases from stacks and diffuse sources such as resuspension of contaminated soil particles. EPA requires the use of an approved computer code such as CAP88-PC to demonstrate compliance with 40 CFR 61. CAP88-PC uses a modified Gaussian plume model to estimate the average dispersion of radionuclides released from up to six sources. It uses an average annual wind file, based on multiple-year meteorological data collected at the INL Site by National Oceanic and Atmospheric Administration Air (NOAA). Assessments are done for a circular grid of distances and directions from each source with a radius of 80 kilometers (50 miles) around the facility. The program computes radionuclide concentrations in air, rates of deposition on ground surfaces, concentrations in food and intake rates to people from ingestion of food produced in the assessment area. Estimates of the radionuclide concentrations in produce, leafy vegetables, milk and meat consumed by humans are made by coupling the output of the atmospheric transport models with the Nuclear Regulatory Commission Regulatory Guide 1.109 terrestrial food chain models.

The dose from INL Site airborne releases of radionuclides was calculated to the MEI to demonstrate compliance with NESHAPs and is published in the *National Emissions Standards for Hazardous Air Pollutants – Calendar Year 2014 INL Report for Radionuclides* (DOE-ID 2015). In order to identify the MEI, the doses at 63 locations were calculated and then screened for the maximum potential dose to an individual who might live at one of these locations. The highest potential dose was screened to be to a hypothetical person living at Frenchman's Cabin, located at the southern boundary of the INL Site (see Figure 4-2). This location is inhabited only during portions of the year, but it must be considered as a potential MEI location according to NESHAPs. An effective dose of 0.0365 mrem (0.365 µSv) was calculated for a hypothetical person living at Frenchman's Cabin during 2014.

Who is the maximally exposed individual?

The maximally exposed individual is a hypothetical individual who, because of proximity, activities, or living habits, could potentially receive the maximum possible dose of radiation from a given event or process. This individual lives outside the INL Site at the location where the highest concentration of radionuclides in air have been modeled using reported effluent releases. In 2014, this hypothetical person lived at Frenchman's Cabin, just south of the INL Site boundary (Figure 4-2).

Figure 8-2 compares the maximum individual doses calculated for 2005 through 2014. All of the doses are well below the whole body dose limit of 10 mrem (100 µSv) for airborne releases of radionuclides established by 40 CFR 61. The highest dose was estimated in 2008 and was attributed primarily to plutonium-241 which was reported to be released during the dismantling of facilities at Test Area North.

Although noble gases were the radionuclides released in the largest quantities (~76 percent of the total Ci released in 2014), they represented relatively smaller fractions of the cumulative dose from all pathways (affecting immersion only) largely because of their short half-lives and the fact that they are not incorporated into the food supply. For example, 36 percent of the total activity released was argon-41 (^{41}Ar) (Table 4-2), yet ^{41}Ar resulted in only 8 percent of the estimated dose. On the other hand, radionuclides typically associated with airborne particulates (^{241}Am, ^{137}Cs, ^{129}I, ^{239}Pu, ^{240}Pu and ^{90}Sr) were a tiny fraction (0.006 percent) of the total amount of radionuclides reported to be released (Table 4-2) yet resulted in approximately 60 percent percent of the estimated dose (Figure 8-3). The potential dose from ingesting or inhaling ^{241}Am is higher than that for other radionuclides because it is long-lived (432.2 years) and a small amount that enters the body can go to the bones,

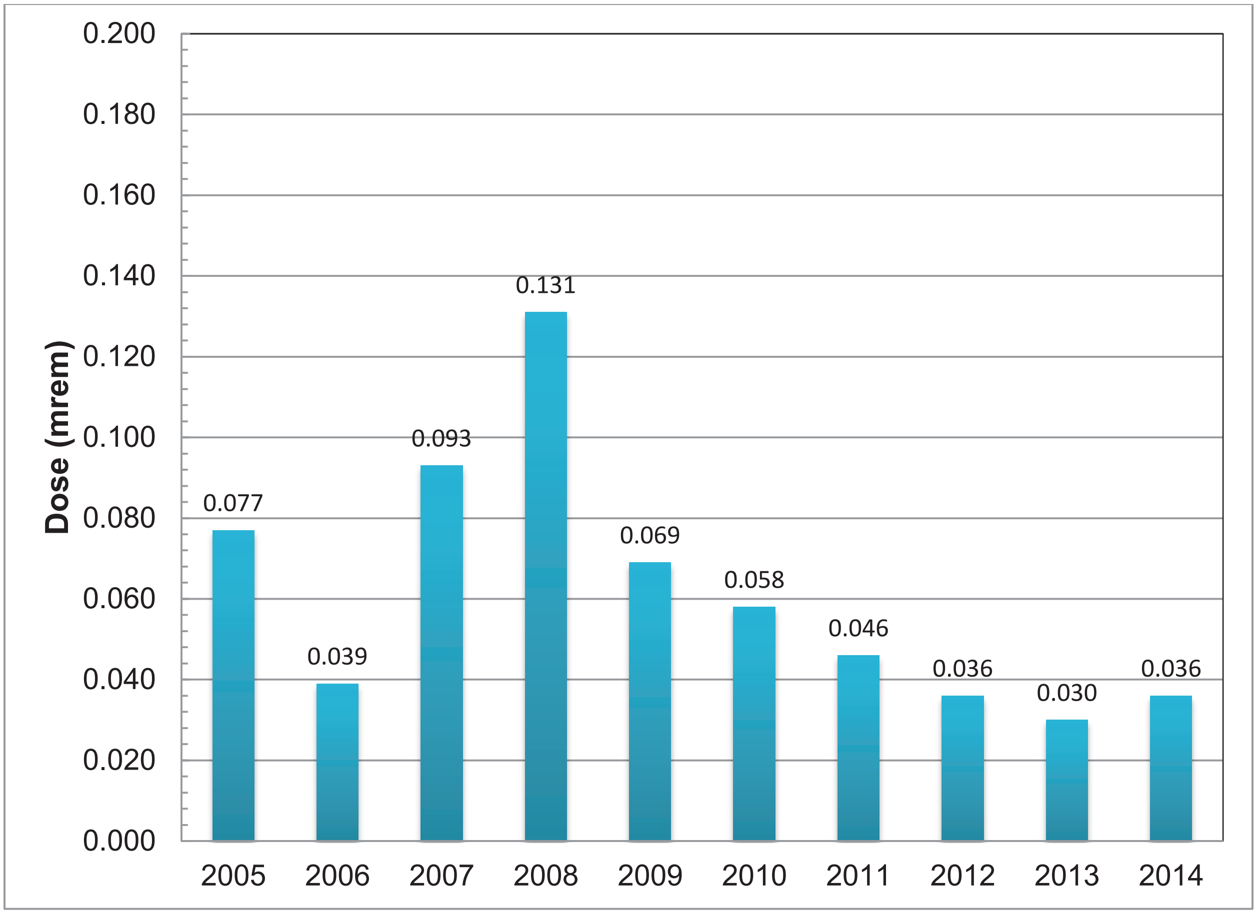


Figure 8-2. Maximum Individual Doses from INL Site Airborne Releases Estimated for 2005 – 2014.

where it can remain for many decades; a smaller amount can go into the liver and other organs, where it may remain for a few years as the body clears it. While in the body, ^{241}Am continues to expose the surrounding tissues to both alpha and gamma radiation. Tritium represented about 24 percent of the total activity released and contributed approximately 29 percent of the calculated dose to the MEI in 2014. Tritium interacts with the environment in a unique fashion because it may exchange with hydrogen atoms in water molecules in air. Tritium thus can follow water almost precisely through the environment. The dose calculations in CAP88-PC assume that doses from ingestion of food and water are directly proportional to modelled tritium concentrations in air.

Primary sources of the major radionuclides used to estimate the dose to the MEI (Figure 8-4) were identified during preparation of the annual NESHAP report (DOE-ID 2015) as follows:

- The dose from tritium emissions, which accounted for approximately 28.5 percent of the total dose to the MEI, was estimated to result mainly from ATR main stack emissions and fugitive (i.e., non-point source) releases from the Warm Waste Evaporation Pond at the ATR Complex, the Three Mile Island (TMI)-2 Independent Spent Storage Installation at INTEC, and the beryllium blocks at the RWMC.
- Emissions of ^{241}Am, ^{239}Pu, and ^{240}Pu were primarily from Accelerated Retrieval Projects (ARPs), most notably sludge repackaging at WMF-1617 (ARP-V), at the RWMC.
- The major source of ^{90}Sr and ^{137}Cs resulting in dose to the MEI was from the Warm Waste Evaporation Pond at the ATR Complex.
- Iodine-129 releases were primarily associated with the Three Mile Island-2 Independent Spent Storage Installation at Idaho Nuclear Technology and Engineering Center (INTEC).
- Airborne emissions of ^{41}Ar were the result of the operation of the Advanced Test Reactor (ATR) at the ATR Complex.

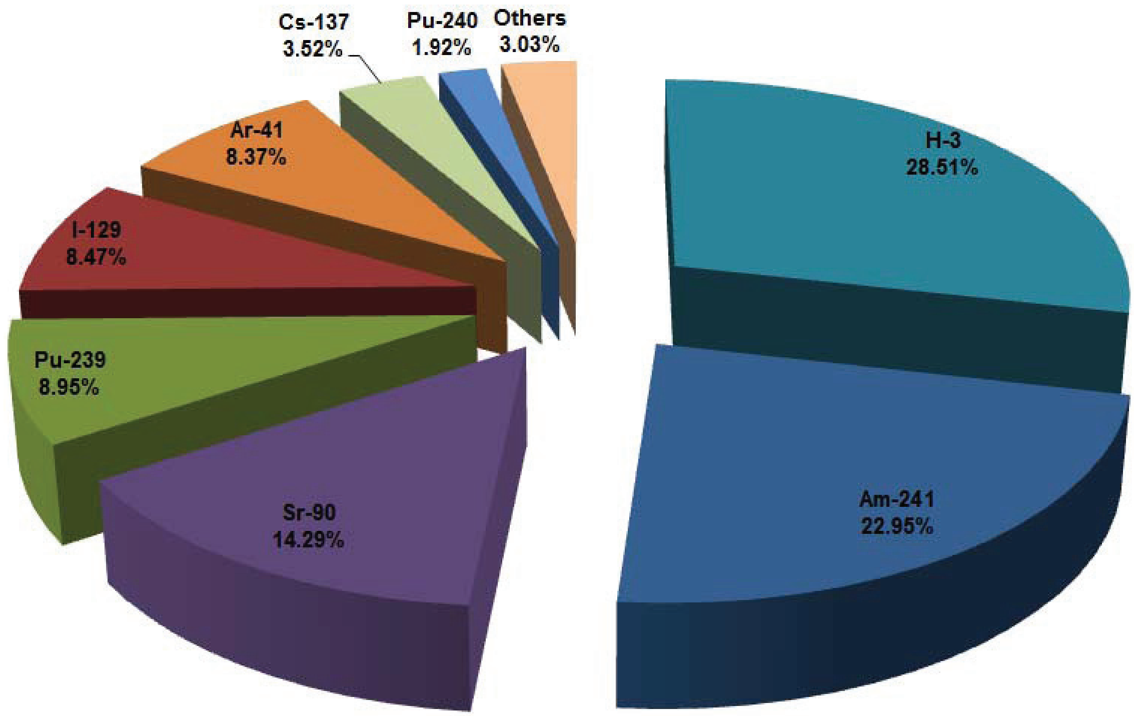


Figure 8-3. Radionuclides Contributing to Dose to MEI from INL Site Airborne Effluents as Calculated Using the CAP88-PC Model (2014).

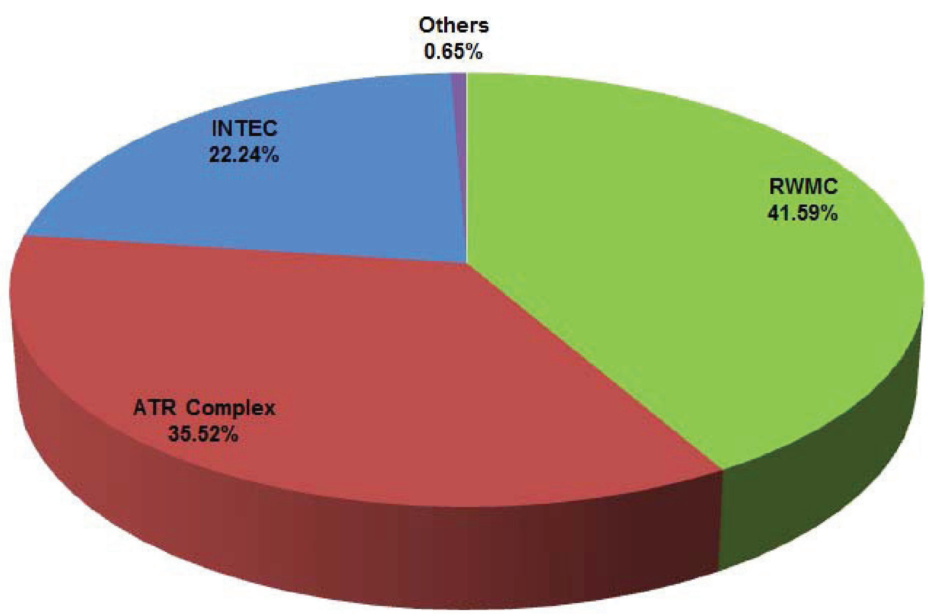


Figure 8-4. Percent Contributions, by Facility, to Dose to Maximally Exposed Individual from INL Site Airborne Effluents as Calculated Using the CAP88-PC Model (2014).

How do the MEI and Reference Resident differ?

The Reference Resident is used to estimate the collective dose to the public living around the INL Site, as required by DOE Order 458.1, while the MEI is used to show compliance with 40 CFR 61. Like the MEI, the Reference Resident is a hypothetical individual who lives a self-sufficient life at the location of the highest air concentration projected beyond the INL Site by the air dispersion model MDIFFH. The MDIFFH code is a puff trajectory model which uses hourly meteorological data collected from 34 meteorological stations on and around the INL Site. The dose to the MEI is estimated by CAP88-PC, which uses a simple mathematical model, the Gaussian plume model, and average annual wind data measured at one location to estimate the average annual dispersion of radionuclides.

8.2.2 Eighty Kilometer (50 Mile) Population Dose

The National Oceanic and Atmospheric Administration Air Resources Laboratory – Field Research Division (NOAA ARL-FRD) developed an air transport and dispersion model called MDIFFH, designed specifically for estimating impacts over periods of up to a year or more on and around the INL Site (Sagendorf et al. 2001). It is based on an earlier model called MESODIF and was developed by the NOAA ARL-FRD from field experiments in arid environments (e.g., the INL Site and the Hanford Site in eastern Washington). The model was used in the population dose calculations. A detailed description of the model and its capabilities may be found at http://www.noaa.inel.gov/capabilities/modeling/T&D.htm.

The NOAA ARL-FRD gathered meteorological data continuously at 34 meteorological stations during 2014 on and around the INL Site (see Section 4.5 and *Meteorological Monitoring*, a supplement to this Annual Site Environmental Report). The transport and dispersion of contaminants by winds was projected by the MDIFFH model using wind speeds and directions from the 1-hour Mesonet database for 2014. The model predicted average annual air concentrations, resulting from INL Site airborne effluent releases, at each of over 10,000 grid points on and around the INL Site (Figure 8-5).

The results were used to prepare a contour map showing calculated annual air concentrations called time integrated concentrations (TICs) (Figure 8-6). The higher numbers on the map represent higher annual average concentrations. So, for example, the annual air concentration resulting from INL Site releases was estimated to

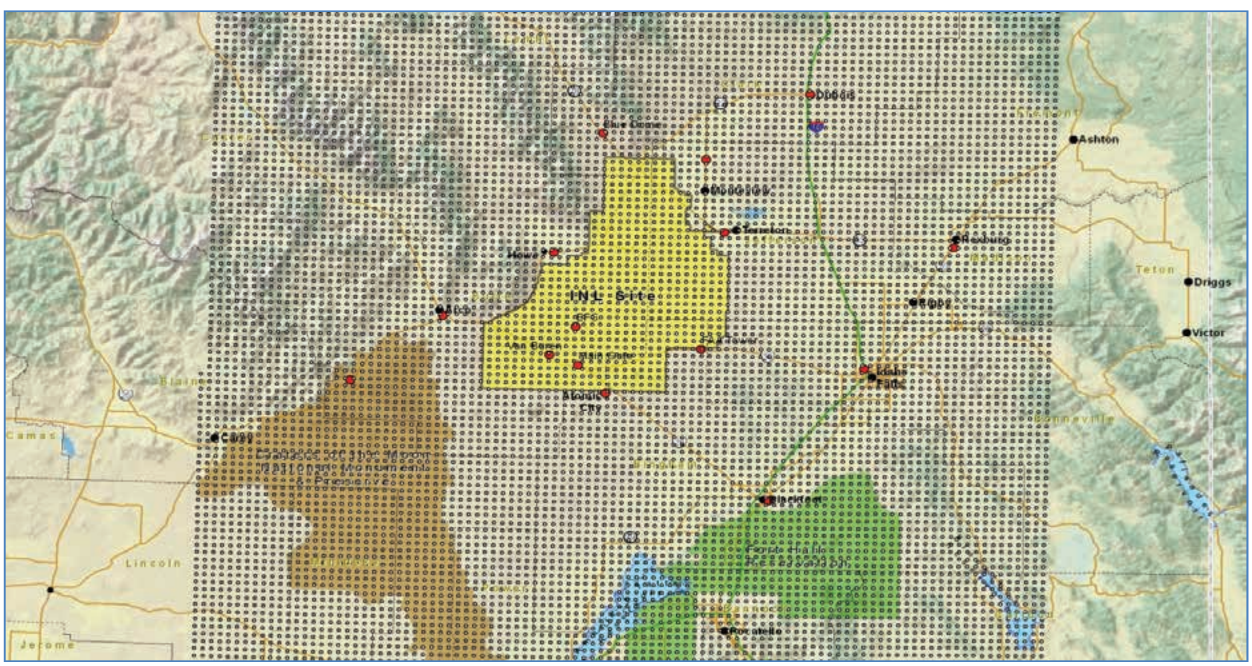


Figure 8-5. INL Site Mesoscale Grid Currently Used in MDIFFH Simulations of INL Site Air Dispersion Annual TICs. *Red circles represent current ESER air monitoring locations.*

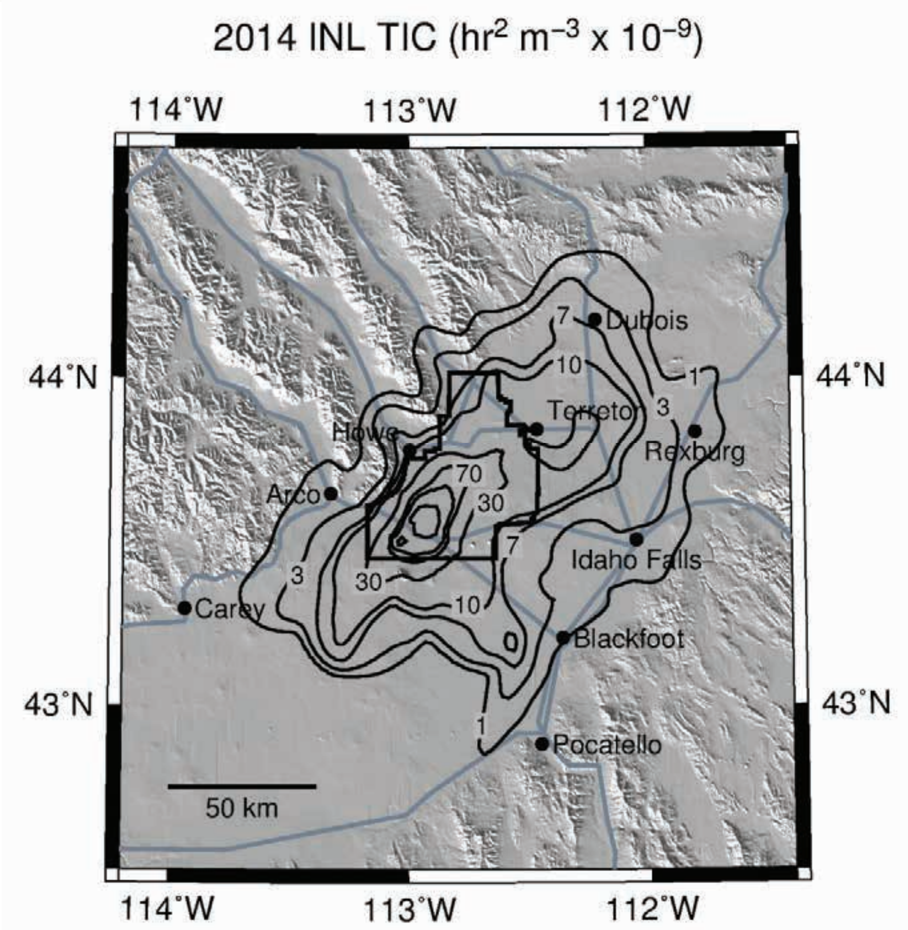


Figure 8-6. INL Site Time Integrated Concentrations (2014).

be nearly ten times higher at Mud Lake than at Dubois. The data used to prepare this map was also used to identify where an individual might be exposed to the highest air concentration during the year, and what the TIC at that location was. The TIC and radionuclide release rates (Table 4-2) were then used to calculate the dose to this individual (the Reference Resident) from each facility release of radionuclides. In 2014 the Reference Resident was projected by MDIFFH to live at Frenchman's Cabin at the southern boundary of the INL Site. Frenchman's Cabin is also the location of the MEI used by CAP88-PC in 2014.

The average time integrated air concentration modeled for each INL Site facility at Frenchman's Cabin was then input into an Excel workbook used to estimate doses with mathematical algorithms derived from the original AIRDOS-EPA computer code (Moore et al. 1979). AIRDOS-EPA is the basis for CAP88-PC. A detailed discussion of the dose calculation methodology may be found in Appendix B. The dose to the Reference Resident in 2014 was estimated to be 0.0538 mrem (0.538 µSv) per year.

The population of each census division was updated with data from the 2010 census extrapolated to 2014. The doses received by people living in each census division were calculated by multiplying the following four variables together:

- The release rate for each radionuclide (summarized in Table 8-1)
- The MDIFFH time integrated air concentration calculated for each location (a county census division)
- The population in each census division within that county division
- The dose calculated to be received by the individual exposed to the highest MDIFFH-projected time integrated air concentration (i.e., the Reference Resident).

The estimated dose at each census division was then summed over all census divisions to result in the 50-mi (80-km) population dose (Table 8-2). The estimated potential population dose was 0.607 person-rem (6.07 x 10^{-3} person-Sv) to a population of approximately 318,528. When compared with the approximate population dose of 123,907 person-rem (1,239 person-Sv) estimated to be received from natural background radiation, this represents an increase of about 0.0005 percent. The largest collective dose was in the Idaho Falls census division due to the larger population.

The largest contributors to the population dose were ^{241}Am, contributing about 35 percent of the total population dose, and ^{129}I, contributing 29 percent of the total. These were followed by ^{239}Pu and ^{90}Sr, contributing about 14 and 7 percent, respectively. Tritium contributed about 4 percent, with ^{41}Ar and ^{240}Pu at about 3 percent of the total population dose (Figure 8-7). The relative contributions of these radionuclides to population dose differ from the relative contributions of the same radionuclides to the MEI dose (Figure 8-3). For example, ^{129}I contributed about 7.5 percent of the dose to the MEI as compared to 29 percent of the population dose. This difference can be explained by the fact that a much higher air concentration of ^{129}I was projected at Frenchman's Cabin by the MDIFFH model than was calculated using the CAP88-PC code. Tritium was estimated to produce over 28 percent of the dose to the MEI, as compared to 4 percent of the population dose. The difference can be attributed mainly to a higher concentration of tritium projected by CAP88-PC at Frenchman's Cabin, as well as the use of dose conversion factors in the CAP88-PC code which are 1.5 – 2 times higher than the DOE dose conversion factors (DOE-ID 2011) used to estimate the dose to the Reference Resident. Other radionuclides, such as ^{90}Sr and ^{241}Am, resulted in slightly different doses to the MEI and the Reference Resident due to one or more factors: different air concentrations calculated by the two air dispersion models (CAP88-PC and MDIFFH), different dose conversion values and agricultural transfer factors used by CAP88-PC and DOE, and different algorithms used to estimate deposition.

For 2014, the RWMC contributed 52 percent of the total population dose. The INTEC contributed over 34 percent and the ATR Complex accounted for just over 12 percent. All other facilities contributed a total of just over 1 percent.

8.3 Dose to the Public from Ingestion of Wild Game from the INL Site

The potential dose an individual may receive from occasionally ingesting meat from game animals continues to be studied at the INL Site. These studies estimate the potential dose to individuals who may eat waterfowl that briefly reside at wastewater disposal ponds at the ATR Complex and Materials and Fuels Complex (MFC), and game animals that may reside on or migrate across the INL Site.

8.3.1 Waterfowl

Seven waterfowl were collected during 2014: three each from the ATR Complex wastewater ponds and a control location near American Falls Reservoir and one from the MFC wastewater ponds. The maximum potential dose from eating 225 g (8 oz) of duck meat collected in 2014 is presented in Table 8-3. Radionuclide concentrations used to determine these doses are reported in Figure 7-5. Doses from consuming waterfowl are conservatively based on the assumption that ducks are eaten immediately after leaving the pond and no radioactive decay occurs.

The maximum potential dose of 0.032 mrem (0.32 μSv) from these waterfowl samples is substantially below the 0.89 mrem (8.9 μSv) dose estimated from the most contaminated ducks taken from the evaporation ponds between 1993 and 1998 (Warren et al. 2001). These evaporation ponds have been remediated and are no longer available to waterfowl. The ducks were not collected directly from the wastewater disposal ponds at the ATR Complex but from sewage lagoons adjacent to them. However, they probably resided at all the ponds while they were in the area.

8.3.2 Big Game Animals

A study on the INL Site from 1972 to 1976 conservatively estimated the potential whole-body dose that could be received from an individual eating the entire muscle (27,000 g [952 oz]) and liver mass (500 g [17.6 oz]) of an antelope with the highest levels of radioactivity found in these animals was 2.7 mrem (27 μSv) (Markham et al. 1982). Game animals collected at the INL Site during the past few years have generally shown much lower concentrations of radionuclides. In 2014, neither game animal collected (one elk and one pronghorn) had a detectable concentration of ^{137}Cs or other human-made radionuclides. Therefore no dose would be associated with the consumption of these animals.

Table 8-2. Dose to Population within 80 Kilometers (50 miles) of INL Site Facilities (2014)

Census Division[a,b]	Population[c]	Population Dose	
		Person-rem	Person-Sv
Aberdeen	3429	1.53×10^{-3}	1.53×10^{-5}
Alridge	578	7.16×10^{-5}	7.16×10^{-7}
American Falls	7617	1.12×10^{-3}	1.12×10^{-5}
Arbon (part)	29	8.22×10^{-6}	8.22×10^{-8}
Arco	2596	5.14×10^{-2}	5.14×10^{-4}
Atomic City (division)	2685	2.50×10^{-2}	2.50×10^{-4}
Blackfoot	15,321	1.71×10^{-2}	1.71×10^{-4}
Carey (part)	1047	1.71×10^{-3}	1.71×10^{-5}
East Clark	80	1.56×10^{-4}	1.56×10^{-6}
East Madison (part)	275	1.71×10^{-4}	1.71×10^{-6}
Firth	3271	2.68×10^{-3}	2.68×10^{-5}
Fort Hall (part)	4431	3.18×10^{-3}	3.18×10^{-5}
Hailey-Bellevue (part)	5	8.15×10^{-11}	8.15×10^{-13}
Hamer	2350	4.47×10^{-2}	4.47×10^{-4}
Howe	374	1.54×10^{-2}	1.54×10^{-4}
Idaho Falls	103,208	1.55×10^{-1}	1.55×10^{-3}
Idaho Falls, west	1713	7.64×10^{-3}	7.64×10^{-5}
Inkom (part)	636	1.48×10^{-4}	1.48×10^{-6}
Island Park (part)	94	1.45×10^{-4}	1.45×10^{-6}
Leadore (part)	6	1.06×10^{-7}	1.06×10^{-9}
Lewisville-Menan	4235	2.13×10^{-2}	2.13×10^{-4}
Mackay (part)	1240	6.72×10^{-6}	6.72×10^{-8}
Moreland	10,473	4.90×10^{-2}	4.90×10^{-4}
Pocatello	70,267	3.67×10^{-2}	3.67×10^{-4}
Rexburg	27,857	5.39×10^{-2}	5.39×10^{-4}
Rigby	18,789	4.39×10^{-2}	4.39×10^{-4}
Ririe	18927	1.64×10^{-4}	1.64×10^{-6}
Roberts	1653	1.41×10^{-2}	1.41×10^{-4}
Shelley	8641	1.09×10^{-2}	1.09×10^{-4}
South Bannock (part)	323	1.05×10^{-4}	1.05×10^{-6}
St. Anthony (part)	2577	3.35×10^{-3}	3.35×10^{-5}
Sugar City	7043	1.88×10^{-2}	1.88×10^{-4}
Swan Valley (part)	6417	5.46×10^{-4}	5.46×10^{-6}
Ucon	6469	1.99×10^{-2}	1.99×10^{-4}
West Clark	874	1.76×10^{-3}	1.76×10^{-5}
Total	**318,528**	**0.607**	$\mathbf{6.07 \times 10^{-3}}$

a. The U.S. Census Bureau divides the country into four census regions and nine census divisions. The bureau also divides counties (or county equivalents) into census county divisions.

b. (Part) means only a part of the county census division lies within the 80-km (50-mi) radius of a major INL Site facility.

c. Population extrapolated to estimated 2014 values based on 2010 Census Report for Idaho.

Table 8-3. Maximum Annual Potential Dose from Ingestion of Edible Waterfowl Tissue Using INL Site Wastewater Disposal Ponds in 2014.[a]

Radionuclide	ATR Complex Maximum Dose (mrem/yr)	MFC Maximum Dose (mrem/yr)	Control Sample Maximum Dose (mrem/yr)
Cesium-137	1.91×10^{-2}	0	0
Cobalt-60	6.35×10^{-3}	0	0
Plutonium-239/240	0	0	3.38×10^{-4}
Selenium-75	1.65×10^{-4}	0	0
Strontium-90	0	0	1.24×10^{-3}
Zinc-65	6.80×10^{-3}	0	0
Total Dose	**3.24×10^{-2}**	**0**	**1.58×10^{-3}**

a. Effective dose from consuming 225 g (8 oz) of edible (muscle) waterfowl tissue. Dose conversion factors are from Federal Guidance Report No. 13 (EPA 2002).

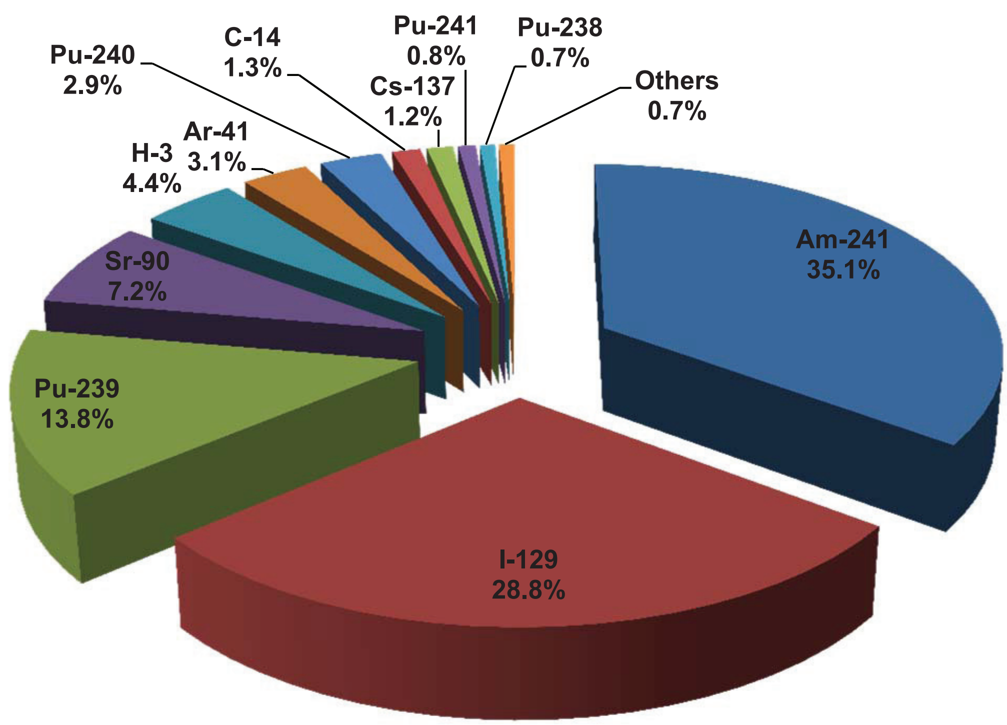


Figure 8-7. Radionuclides Contributing to Dose to the 50-Mile Population from INL Site Airborne Effluents as Calculated Using Excel Workbooks and Results of the MDIFFH Air Dispersion Model (2014).

The contribution of game animal consumption to the population dose has not been calculated because only a limited percentage of the population hunts game, few of the animals killed have spent time on the INL Site, and most of the animals that do migrate from the INL Site would have reduced concentrations of radionuclides in their tissues by the time they were harvested (Halford et al. 1983). The total population dose contribution from these pathways would, realistically, be less than the sum of the population doses from inhalation of air, submersion in air, ingestion of vegetables, and deposition on soil.

8.4 Dose to the Public from Drinking Contaminated Groundwater from the INL Site

Tritium has previously been detected in three U.S. Geological Survey monitoring wells located along the southern boundary of the INL Site (Mann and Cecil, 1990). These wells, located in an uninhabited area, have shown a historical downward trend in tritium detections. The maximum concentration (3,400 ± 200 pCi/L) is considerably less than the maximum contaminant level established by EPA for drinking water (20,000 pCi/L). The maximum contaminant level corresponds to a dose from the drinking water ingestion pathway of 4 mrem per year. An individual drinking water from these wells would hypothetically receive a dose of less than 0.2 mrem (2.0 µSv) in one year. Because no one uses these wells for drinking water, this is an unrealistic scenario and the groundwater ingestion pathway is not included in the total dose estimate to a MEI.

8.5 Dose to the Public from Direct Radiation Exposure along INL Site Borders

The direct radiation exposure pathway from gamma radiation to the public is monitored annually using thermoluminescent dosimeters and optically stimulated luminescence dosimeters (Figure 7-8). In 2014, the external radiation measured along the INL Site boundary was statistically equivalent to that of background radiation and, therefore, does not represent a dose resulting from INL Site operations.

8.6 Dose to the Public from All Pathways

DOE Order 458.1 establishes a radiation dose limit to a member of the general public from all possible pathways as a result of DOE facility operations. This limit is 100 mrem/yr (1 mSv/yr) above the dose from background radiation and includes the air transport, ingestion, and direct exposure pathways. For 2014, the only probable pathways from INL Site activities to a realistic MEI include the air transport pathway and ingestion of game animals.

The hypothetical individual, assumed to live on the southern INL Site boundary at Frenchman's Cabin (Figure 4-2), would receive a calculated dose from INL Site airborne releases reported for 2014 (Section 8.2.1). For this analysis, we also assumed that the same hypothetical individual would kill and eat a duck with the maximum radionuclide concentrations detected in 2014 (Figure 7-5). For this scenario, the duck would be killed at the nearby Mud Lake Wildlife Management Area. The duck would be killed soon after it left the INL Site. No dose was calculated from eating a big game animal because no human-made radionuclides were found in 2014.

The dose estimate for an offsite MEI from the air and game animal pathways is presented in Table 8-4. The total dose was conservatively estimated to be 0.069 mrem (0.69 µSv) for 2014. For comparison, the total dose received by the MEI in 2013 was calculated to be 0.066 mrem (0.66 µSv).

The total dose calculated to be received by the hypothetical MEI for 2014 (0.069 mrem [0.69 µSv]) represents about 0.018 percent of the dose expected to be received from background radiation (389 mrem [3.9 mSv], as shown in Table 7.5) and is well below the 100 mrem/yr (1 mSv/yr) limit above background established by DOE. As discussed in the Helpful Information section of this report, the 100 mrem limit is far below the exposure levels that cause acute health effects.

The dose received by the entire population within 80 km (50 mi) of INL Site facilities was calculated to be 0.607 person-rem. This is approximately 0.0005 percent of the dose (123,907 person-rem) expected from exposure to natural background radiation in the region.

8.7 Dose to Biota

8.7.1 Introduction

The impact of environmental radioactivity at the INL Site on nonhuman biota was assessed using *A Graded Approach for Evaluating Radiation Doses to Aquatic and Terrestrial Biota* (DOE 2002) and the associated software, RESRAD-Biota (DOE 2004). The graded approach includes a screening method and three more detailed levels of analysis for demonstrating compliance with standards for protection of biota.

Table 8-4. Contribution to Estimated Dose to a Maximally Exposed Individual by Pathway (2014).

Pathway	Dose to Maximally Exposed Individual (mrem)	Dose to Maximally Exposed Individual (mSv)	Percent of Applicable Dose Limit[a]	Estimated Population Dose (person-rem)	Estimated Population Dose (person-Sv)	Population within 80 km	Estimated Background Radiation Population Dose (person-rem)[b]
Air	3.65×10^{-2}	3.65×10^{-4}	3.65×10^{-1}	0.607	0.00607	318,528	123,907
Waterfowl ingestion	3.24×10^{-2}	3.24×10^{-4}	NA[c]	NA	NA	NA	NA
Big game animals	0	0	NA	NA	NA	NA	NA
Total pathways	**6.89×10^{-2}**	**6.89×10^{-4}**	**6.89×10^{-2}**	**NA**	**NA**	**NA**	**NA**

a. The EPA regulatory standard for the air pathway is 10 mrem/yr effective dose equivalent. The DOE limit for all pathways is 100 mrem/yr total effective dose equivalent.

b. The individual dose from background was estimated to be 389 mrem (3.9 mSv) in 2014 (Table 7-5).

c. NA = Not applicable.

The threshold of protection is assumed at the following absorbed doses: 1 rad/d (10 mGy/d) for aquatic animals, 0.1 rad/d (1 mGy/d) for terrestrial animals, and 1 rad/d (10 mGy/d) for terrestrial plants.

The graded approach begins the evaluation using conservative default assumptions and maximum values for all currently available data. This general screening level (Level 1 in RESRAD-Biota) provides generic limiting concentrations of radionuclides in environmental media termed "Biota Concentration Guides." Each Biota Concentration Guide is the environmental concentration of a given radionuclide in soil or water that, under the assumptions of the model, would result in a dose rate less than 1 rad/d (10 mGy/d) to aquatic animals or terrestrial plants or 0.1 rad/d (1 mGy/d) to terrestrial animals. If the sum of the measured maximum environmental concentrations divided by the biota concentration guides (the combined sum of fractions) is less than one, no negative impact to plant or animal populations is expected. No doses are calculated unless the screening process indicates a more detailed analysis is necessary. Failure at this initial screening step does not necessarily imply harm to organism populations. Instead, it is an indication that more realistic model assumptions may be necessary.

If the screening process indicates the need for a more site-specific analysis, an analysis is performed using site-representative parameters (e.g., distribution coefficients, bioconcentration factors) instead of the more conservative default parameters. This is Level 2 in RESRAD-Biota.

The next step in the graded approach methodology involves a site-specific analysis employing a kinetic modeling tool provided in RESRAD-Biota (Level 3). Multiple parameters which represent contributions to the organism internal dose (e.g., body mass, consumption rate of food/soil, inhalation rate, lifespan, biological elimination rates) can be modified to represent site- and organism-specific characteristics. The kinetic model employs equations relating body mass to internal dose parameters. At Level 3, bioaccumulation (the process by which biota concentrate contaminants from the surrounding environment) can be modeled to estimate the dose to a plant or animal. Alternatively, concentrations of radionuclides measured in the tissue of an organism can be input into RESRAD-Biota to estimate the dose to the organism.

The final step in the graded approach involves an actual site-specific biota dose assessment, which would involve a problem formulation, analysis, and risk characterization protocol similar to that recommended by EPA (1998). RESRAD-Biota cannot perform these calculations.

8.7.2 Terrestrial Evaluation

Of particular importance for the terrestrial evaluation portion of the 2014 biota dose assessment is the division of the INL Site into evaluation areas based on potential soil contamination and habitat types. For the INL Site, it is appropriate to consider specific areas that have been historically contaminated above background levels. Most of these areas have been monitored for radionuclides in soil since the early 1970s (Jessmore et al. 1994). In some of these areas, structures have been removed and areas cleaned to a prescribed, safe contamination level, but the soil may still have residual, measurable concentrations of radionuclides. These areas are associated with facilities shown in Figure 1-3 and include:

- Auxiliary Reactor Area
- ATR Complex
- Critical Infrastructure Test Range Complex
- INTEC
- Large Grid, a 24-mile radius around INTEC
- MFC
- Naval Reactors Facility
- RWMC
- Test Area North.

For the initial terrestrial evaluation, the most recently measured maximum concentrations of radionuclides in soil were used (Table 8-5.) The table includes laboratory analyses of soil samples collected in 2005, 2006, and 2012 by the INL and Idaho Cleanup Project contractors.

The INL contractor currently uses in situ gamma spectroscopy to determine levels of ^{137}Cs and other gamma-emitting radionuclides in surface soils. The results of these surveys (Table 7-2) are also included in Table 8-5.

Using the maximum radionuclide concentrations for all locations in Table 8-6, a screening level analysis was made of the potential terrestrial biota dose. The soil concentrations are conservative because background concentrations (see Table 7-2) were not subtracted. The analysis also assumed that animals have access to water in facility effluents and ponds. The maximum radionuclide concentrations reported in Appendix C were used to represent surface water concentrations. The combined sum of fractions was less than one for both terrestrial animals (0.213) and plants (0.00221) and passed the general screening test (Table 8-6).

Based on the results of the graded approach, there is no evidence that INL Site-related radioactivity in soil is harming terrestrial plant or animal populations.

8.7.3 Aquatic Evaluation

For the aquatic evaluation, maximum radionuclide concentrations reported in any pond or effluent at the INL Site and (see Appendix C) was used. Table C-16 (results for the MFC Industrial Waste Pond) is the only table which shows measurements of specific radionuclides in pond water (^{137}Cs, $^{233/234}$U, and ^{238}U). When "$^{233/234}$U" was reported, it was conservatively assumed that each radionuclide was present in equal concentrations. Potassium-40 reported in ponds was assumed to be of natural origin and was not included in the 2014 calculations.

The results shown in Table 8-7 indicate that INL Site-related radioactivity in ponds and liquid effluents is not harming aquatic biota. The combined sum of fractions was less than one for both aquatic animals (8.70E-02) and riparian animals (2.59E-03).

Tissue data from waterfowl collected on the ATR Complex ponds in 2014 were also available (Figure 7-5). Concentrations of radionuclides in tissue can be input into the RESRAD-Biota code at the Level 3 step to calculate the internal dose to biota. To confirm that doses to waterfowl from exposure to radionuclides in the vicinity of the ATR Complex are not harmful, a Level 3 analysis was performed using the maximum tissue concentrations shown in Figure 7-5. The waterfowl were assumed in the model to be riparian animals, accessing both aquatic and terrestrial environments in the area. External dose was calculated using the maximum radionuclide concentrations measured in soils around the ATR Complex.

Results of the dose evaluation to waterfowl using radionuclide concentrations measured in tissue are shown in Table 8-8. The estimated dose to waterfowl was calculated by RESRAD-Biota 1.5 to be 0.0005 rad/d (0.005 mGy/d). This dose is less than the standard of 1 rad/d (10 mGy/d). Based on these results, there is no evidence that impounded water at the INL Site is harming aquatic biota.

8.8 Doses from Unplanned Releases

No unplanned radioactive releases from the INL site were reported in 2014. As such, there are no doses associated with unplanned releases during 2014.

Table 8-5. Concentrations of Radionuclides in INL Site Soils, by Area.

Location[a]	Radionuclide	Detected Concentration (pCi/g)[b] Minimum	Maximum
ARA	Cesium-134	4.0×10^{-2}	6.0×10^{-2}
	Cesium-137	1.3×10^{-1}	3.02
	Strontium-90	2.10×10^{-1}	3.70×10^{-1}
	Plutonium-238	------	3.90×10^{-3}
	Plutonium-239/240	1.30×10^{-2}	1.80×10^{-2}
	Americium-241	5.50×10^{-3}	8.50×10^{-3}
ATR Complex	Cesium-137	2.00×10^{-1}	6.10×10^{-1}
	Strontium-90	------	5.82×10^{-2}
	Plutonium-238	5.90×10^{-3}	4.30×10^{-2}
	Plutonium-239/240	1.70×10^{-2}	2.18×10^{-2}
CITRC	Cesium-137	1.50×10^{-1}	1.90×10^{-1}
MFC	Cesium-134	4.00×10^{-2}	6.00×10^{-2}
	Cesium-137	1.20×10^{-1}	4.90×10^{-1}
	Cobalt-60	------	5.00×10^{-2}
	Plutonium-239/240	1.50×10^{-2}	2.90×10^{-2}
	Americium-241	4.30×10^{-3}	1.20×10^{-2}
INTEC	Cesium-134	------	8.00×10^{-2}
	Cesium-137	3.00×10^{-2}	3.54
	Strontium-90	4.90×10^{-1}	7.10×10^{-1}
	Plutonium-238	2.50×10^{-2}	4.30×10^{-2}
	Plutonium-239/240	1.10×10^{-2}	2.90×10^{-2}
	Americium-241	6.10×10^{-3}	8.10×10^{-3}
Air Monitors	Cesium-134	4.00×10^{-2}	5.00×10^{-2}
	Cesium-137	2.00×10^{-2}	9.70×10^{-1}
NRF	Cesium-134	------	6.00×10^{-2}
	Cesium-137	------	3.30×10^{-1}
	Plutonium-239/240	5.70×10^{-3}	1.60×10^{-2}
	Americium-241	4.30×10^{-3}	9.70×10^{-3}
RWMC	Cesium-134	3.00×10^{-2}	9.00×10^{-2}
	Cesium-137	1.20×10^{-1}	3.13
	Srontium-90	1.23×10^{-2}	1.78×10^{-1}
	Plutonium-238	2.19×10^{-3}	1.51×10^{-2}
	Plutonium-239/240	3.6×10^{-2}	5.25×10^{-1}
	Americium-241[d]	2.02×10^{-2}	4.63×10^{-1}
TAN/SMC	Cesium-134	4.00×10^{-2}	6.00×10^{-2}
	Cesium-137	1.10×10^{-1}	3.13
	Plutonium-239/240	1.25×10^{-2}	1.74×10^{-2}
	Americium-241	3.20×10^{-3}	5.70×10^{-3}
ALL	Cesium-134	3.00×10^{-2}	9.60×10^{-2}
	Cesium-137	2.00×10^{-2}	3.54
	Cobalt-60	------	5.00×10^{-2}
	Strontium-90	1.23×10^{-2}	7.10×10^{-1}
	Plutonium-238	2.19×10^{-3}	4.30×10^{-2}
	Plutonium-239/240	5.70×10^{-3}	5.25×10^{-1}
	Americium-241[d]	3.20×10^{-3}	4.63×10^{-1}

a. ARA = Auxiliary Reactor Area; ATR = Advance Test Reactor; CITRC = Critical Infrastructure Test Range Complex; Large Grid = A 24- mile radius around INTEC; MFC = Materials and Fuels Complex; INTEC = Idaho Nuclear Technology and Engineering Center; NRF = Naval Reactors Facility; RWMC = Radioactive Waste Management Complex; TAN/SMC = Test Area North/Specific Manufacturing Capability.

b. Legend:

a.	Results measured in 2014 using in situ gamma spectroscopy (see Table 7-2.)
b.	Results measured by laboratory analyses of soil samples collected in 2005
c.	Results measured by laboratory analyses of soil samples collected in 2006
d.	Results measured by laboratory analyses of soil samples collected in 2012.
e.	Result measured in 2013 using in situ gamma spectroscopy. Not measured in 2014.

c. ‘-----‘ indicates that only one measurement was taken and is reported as the maximum result.

d. The data were the results of laboratory analysis for Americium-241 in soil samples. In situ surveillance also detected Americium-241 (Fig. D-6). However, the maximum result was most likely due to shine from stored material containing Americium-241

Table 8-6. RESRAD Biota 1.5 Biota Dose Assessment (Screening Level) of Terrestrial Ecosystems on the INL Site (2014).

Terrestrial Animal						
	Water			Soil		
Nuclide	Concentration (pCi/L)	BCG[a] (pCi/L)	Ratio	Concentration (pCi/g)	BCG (pCi/g)	Ratio
Americium-241	0	2.02E+05	0.00E+00	0.463	3.89E+03	1.19E-04
Cobalt-60	0	1.19E+06	0.00E+00	0.05	6.92E+02	7.23E-05
Cesium-137	0	5.99E+05	0.00E+00	3.54	2.08E+01	1.71E-01
Plutonium-238	0	1.89E+05	0.00E+00	0.043	5.27E+03	8.16E-06
Plutonium-239	0	2.00E+05	0.00E+00	0.525	6.11E+03	8.59E-05
Strontium-90	0	5.45E+04	0.00E+00	0.71	2.25E+01	3.16E-02
Uranium-233	0.667	4.01E+05	1.66E-06	0	4.83E+03	0.00E+00
Uranium-234	0.667	4.04E+05	1.66E-06	0	5.13E+03	0.00E+00
Uranium-238	0.459	4.06E+05	1.13E-06	0	1.58E+03	0.00E+00
Summed	**-**	**-**	**4.44E-06**	**-**	**-**	**2.03E-01**
Terrestrial Plant						
	Water			Soil		
Nuclide	Concentration (pCi/L)	BCG (pCi/L)	Ratio	Concentration (pCi/g)	BCG (pCi/g)	Ratio
Americium-241	0	7.04E+08	0.00E+00	0.463	2.15E+04	2.15E-05
Cobalt-60	0	1.49E+07	0.00E+00	0.05	6.13E+03	8.16E-06
Cesium-137	0	4.93E+07	0.00E+00	3.54	2.21E+03	1.60E-03
Plutonium-238	0	3.95E+09	0.00E+00	0.043	1.75E+04	2.46E-06
Plutonium-239	0	7.04E+09	0.00E+00	0.525	1.27E+04	4.14E-05
Strontium-90	0	3.52E+07	0.00E+00	0.71	3.58E+03	1.98E-04
Uranium-233	0.667	1.06E+10	6.29E-11	0	5.23E+04	0.00E+00
Uranium-234	0.667	3.08E+09	2.17E-10	0	5.16E+04	0.00E+00
Uranium-238	0.459	4.28E+07	1.07E-08	0	1.57E+04	0.00E+00
Summed	**-**	**-**	**1.10-08**	**-**	**-**	**1.87E-03**

a. BCG = Biota Concentration Guide. Each radionuclide-specific BCG represents the limiting radionuclide concentration in an environmental medium which would not result in recommended dose standards for biota to be exceeded.

Table 8-7. RESRAD Biota 1.5 Assessment (Screening Level) of Aquatic Ecosystems on the INL Site (2014).

Aquatic Animal						
	Water			Sediment		
Nuclide	Concentration (pCi/L)	BCG[a] (pCi/L)	Ratio	Concentration (pCi/g)	BCG (pCi/g)	Ratio
Uranium-233	0.667	2.00E+02	3.34E-03	0.089	1.06E+07	3.15E-09
Uranium-234	0.667	2.02E+02	3.31E-03	0.089	3.08E+06	1.08E-08
Uranium-238	0.459	2.23E+02	2.06E-03	0.04045	4.28E+04	5.36E-07
Summed	-	-	**8.70E-03**	-	-	**5.50E-07**
Riparian Animal						
	Water			Sediment		
Nuclide	Concentration (pCi/L)	BCG (pCi/L)	Ratio	Concentration (pCi/g)	BCG (pCi/g)	Ratio
Uranium-233	0.667	6.76E+02	9.87E-04	0.0335	5.28E+03	6.32E-06
Uranium-234	0.667	6.83E+02	9.77E-04	0.0335	5.27E+03	6.33E-06
Uranium-238	0.459	7.56E+02	6.07E-04	0.02295	2.49E+03	9.22E-06
Summed	-	-	**2.57E-03**	-	-	**2.19E-05**

a. BCG = Biota Concentration Guide. Each radionuclide-specific BCG represents the limiting radionuclide concentration in an environmental medium which would not result in recommended dose standards for biota to be exceeded.

Table 8-8. RESRAD Biota 1.5 Assessment (Level 3 Analysis) of Aquatic Ecosystems on the INL Site Using Measured Waterfowl Tissue Data (2014).

Waterfowl Dose (rad/d)					
Nuclide	**Water[a]**	**Soil[b]**	**Sediment**	**Tissue[c]**	**Summed**
Americium-241	0.00E+00	3.26E-07	0.00E+00	0.00E+00	3.26E-07
Cesium-134	0.00E+00	5.37E-06	0.00E+00	1.54E-06	5.37E-06
Cesium-137	0.00E+00	7.67E-05	0.00E+00	1.67E-05	9.34E-05
Cobalt-60	0.00E+00	4.97E-06	0.00E+00	9.11E-05	9.61E-05
Plutonium-238	0.00E+00	1.76E-10	0.00E+00	0.00E+00	1.76E-10
Plutonium-239	0.00E+00	1.07E-09	0.00E+00	0.00E+00	1.07E-09
Selenium-75	0.00E+00	0.00E+00	0.00E+00	4.88E-07	4.88E-07
Strontium-90	0.00E+00	5.14E-07	0.00E+00	0.00E+00	5.14E-07
Uranium-233	9.85E-05	0.00E+00	6.28E-07	0.00E+00	9.91E-05
Uranium-234	9.75E-05	0.00E+00	6.21E-07	0.00E+00	9.81E-05
Uranium-238	5.96E-05	0.00E+00	4.15E-07	0.00E+00	6.61E-05
Zinc-65	0.00E+00	0.00E+00	0.00E+00	1.74E-05	1.47E-05
Total	**2.56E-04**	**8.74E-05**	**1.66E-06**	**1.26E-04**	**4.74E-04**

a. Only uranium isotopes were measured in the ATR Complex Cold Waste Pond. Hence, there were no doses calculated for other radionuclides in water and sediment.
b. External doses to waterfowl were calculated using soil concentrations. Maximum concentrations of radionuclides measured in soil at the ATR Complex were used (Table 8-5).
c. Internal doses to waterfowl were calculated using maximum concentrations in edible tissue shown in Figure 7-5.

Note: Selenium-75, uranium isotopes, and zinc-65 were not measured in soil.

REFERENCES

40 CFR 61, 2014, "National Emission Standards for Hazardous Air Pollutants," *Code of Federal Regulations*, Office of the Federal Register.

40 CFR 61, Subpart H, 2014, "National Emission Standards for Emissions of Radionuclides Other Than Radon from Department of Energy Facilities," *Code of Federal Regulations*, Office of the Federal Register.

DOE, 2002, *A Graded Approach for Evaluating Radiation Doses to Aquatic and Terrestrial Biota*, DOE-STD-1153-2002, U.S. Department of Energy, available from http://homer.ornl.gov/oepa/public/bdac/.

DOE, 2004, *RESRAD-BIOTA: A Tool for Implementing a Graded Approach to Biota Dose Evaluation*, DOE/EH-0676, U.S. Department of Energy, Interagency Steering Committee on Radiation Standards, available from http://homer.ornl.gov/oepa/public/bdac/.

DOE, 2011, *Derived Concentration Technical Standard, DOE-STD-1196-2011*, U.S. Department of Energy, available from http://www.hss.doe.gov/nuclearsafety/techstds/docs/standard/doe-std-1196-2011.pdf.

DOE Order 436.1, 2011, "Departmental Sustainability," U.S. Department of Energy. DOE Order 458.1, 2011, "Radiation Protection of the Public and the Environment," U.S. Department of Energy.

DOE-ID, 2015, *National Emissions Standards for Hazardous Air Pollutants – Calendar Year 2014 INL Report for Radionuclides*, DOE/ID-10890(13), U.S. Department of Energy Idaho Operations Office.

EPA, 2002, *Cancer Risk Coefficients for Environmental Exposure to Radionuclides*, Federal Guidance Report 13, EPA-402-R-99-001, U.S. Environmental Protection Agency.

EPA, 2007, *Clean Air Act Assessment Package-1988 (CAP88-PC)*, Version 3.0, http://www.epa.gov/radiation/assessment/CAP88/index.html, updated August 26, 2008, Web page visited July 13, 2009, U.S. Environmental Protection Agency.

Halford, D. K., O. D. Markham, and G. C. White, 1983, "Biological Elimination of Radioisotopes by Mallards Contaminated at a Liquid Radioactive Waste Disposal Area," *Health Physics*, Vol. 45, pp. 745 – 756, September.

Jessmore, P. J., L. A. Lopez, and T. J. Haney, 1994, *Compilation and Evaluation of the Idaho National Engineering Laboratory Radiological and Environmental Sciences Laboratory Surface Soil Sample Data for Use in Operable Unit 10-06 Baseline Risk Assessment*, EGG-ER-11227, Rev. 0, EG&G Idaho.

Mann, L. J. and Cecil, L. D., 1990, T*ritium in ground water at the Idaho National Engineering Laboratory, Idaho: U.S. Geological Survey Water-Resources Investigations 90-4090* (DOE/ID-22090), 35 p. http://pubs.er.usgs.gov/usgspubs/wri/wri904090

Markham, O. D., D. K. Halford, R. E. Autenrieth, and R. L. Dickson, 1982, "Radionuclides in Pronghorn Resulting from Nuclear Fuel Reprocessing and Worldwide Fallout," *Journal of Wildlife Management*, Vol. 46, No. 1, pp. 30 – 42, January.

Moore, R. E., C. F . Baes III, L. M. McDowell-Boyer, A. P. Watson, F. O. Hoffman, J. C. Pleasant, C. W. Miller, 1979, *AIRDOS-EPA: A Computerized Methodology for Estimating Environmental Concentrations and Dose to Man from Airborne Releases of Radionuclides*, EPA 520/1-79-009, EPA Office of Radiation Programs, Washington, D.C.

NRC, 1977, *Regulatory Guide 1.109 Calculation of Annual Doses to Man from Routine Releases of Reactor Effluents for the Purpose of Evaluating Compliance with 10 CFR Part 50, Appendix 1*, NRC 1.109, Rev. 1, U.S. Nuclear Regulatory Commission.

Sagendorf, J. F., R. G. Carter, and K. L. Clawson, 2001, *MDIFF Transport and Diffusion Models, NOAA Air Resources Laboratory, NOAA Technical Memorandum OAR ARL 238*, National Oceanic and Atmospheric Administration, available from http:// www.noaa.inel.gov/capabilities/modeling/MDIFFTechMemo.pdf.

Warren, R. W., S. J. Majors, and R. C. Morris, 2001, *Waterfowl Uptake of Radionuclides from the TRA Evaporation Ponds and Potential Dose to Humans Consuming Them*, Stoller-ESER-01-40, S.M. Stoller Corporation.

Silvery Lupine

2014

9. Monitoring Wildlife Populations

Dwarf Purple Monkeyflower
Mimulus nanus

Field data are routinely collected on several key groups of wildlife at the Idaho National Laboratory (INL) Site for information that can be used to prepare National Environmental Policy Act documents and to enable the U.S. Department of Energy, Idaho Operations Office (DOE-ID) to make informed decisions, based on species use of the INL Site and historical trends, for planning projects and complying with environmental policies and executive orders related to protection of wildlife. During 2014, midwinter eagle, sage-grouse, breeding bird, and bat surveys were conducted on the INL Site and are highlighted as follows: The midwinter eagle survey has been conducted every January, as part of the national Midwinter Bald Eagle Survey, since 1983. Along with identifying and documenting bald eagles, researchers also identify all raptors, golden eagles, ravens, and other selected bird species. Sage-grouse research has been conducted on the INL Site for over 30 years. When sage-grouse were petitioned for listing under the Endangered Species Act, DOE-ID recognized the need to reduce impacts to existing and future mission activities and to develop into a Candidate Conservation Agreement with the U.S. Fish and Wildlife Service to identify threats to the species and its habitat and develop conservation measures and objectives to avoid or minimize threats to sage-grouse. Since 2010, Environmental Surveillance, Education, and Research biologists have conducted surveys of sagegrouse leks along routes established by the Idaho Department of Fish and Game in the mid-1990s, as well as at other leks on the INL Site. The North American Breeding Bird Survey was developed in the 1960s by the U.S. Fish and Wildlife Service along with the Canadian Wildlife Service to document trends in bird populations. The U.S. Geological Survey manages the program in North America, which currently consists of over 4,100 routes with approximately 3,000 of these sampled annually. The INL Site has five permanent official Breeding Bird Survey routes, established in 1985, and eight additional routes which border INL Site facilities.

9. MONITORING WILDLIFE POPULATIONS

The Environmental Surveillance, Education, and Research Program (ESER) contractor has historically collected data on several key groups of wildlife that occupy the Idaho National Laboratory (INL) Site; including raptors, sage-grouse (*Centrocercus urophasianus*), breeding birds, and bats. These surveys provide the U.S. Department of Energy, Idaho Operations Office (DOE-ID) with an understanding of how these species use the INL Site, as well as provide context for historical trends of these wildlife. This information is often used in National Environmental Policy Act (NEPA 1970) documents and enables DOE-ID officials to make informed decisions for project planning, as well as maintaining up-to-date information on potentially sensitive species on the INL Site. These surveys also support DOE-ID's compliance with several regulations, policies and executive orders including the following:

- Migratory Bird Treaty Act (1918)
- Bald and Golden Eagle Protection Act (1940)
- Executive Order 11514 (1970); Protection and Enhancement of Environmental Quality—In furtherance of the purpose and policy of National Environmental Policy Act, directs federal agencies to monitor, evaluate, and control on a continuing basis their activities to protect and enhance the quality of the environment.
- Endangered Species Act (1973)
- Idaho National Laboratory Comprehensive Land Use and Environmental Stewardship Report (2011)
- Memorandum of Understanding between the United States Department of Energy and the United States Fish and Wildlife Service (2013): Regarding implementation of Executive Order 13186, responsibilities of federal agencies to protect migratory birds.
- Candidate Conservation Agreement (CCA) for Greater Sage-grouse on the Idaho National Laboratory Site (2014)—The CCA is a voluntary agreement between the U.S. Fish and Wildlife Service (FWS) and DOE-ID wherein DOE-ID commits to implement conservation measures to benefit greater sage-grouse, a candidate species for listing under the Endangered Species Act. The CCA also addresses threats to sage-grouse and their habitat and includes restrictions on activities that degrade

sagebrush (*Artemisia* spp.) (DOE-ID and USFWS 2014).

Herein, results were summarized from wildlife surveys conducted by the ESER contractor on the INL Site during 2014. The results and population trends reported in this document were based on field observations and do not necessarily represent comprehensive information about population abundance or occurrence of those species on the INL Site.

9.1 Midwinter Eagle Survey

Each January, hundreds of individuals throughout the United States count eagles along standardized, non-overlapping survey routes as part of the Midwinter Bald Eagle Survey (Steenhof et al. 2008). These surveys were coordinated from 1979 to 1992 by the National Wildlife Federation. After that time, the Bureau of Land Management's Raptor Research and Technical Assistance Center assumed responsibility for overseeing these surveys. That responsibility, however, shifted to the National Biological Survey (1993-1996) and later to the U.S. Geological Survey (USGS). In April 2007, the USGS established a partnership with the U.S. Army Corps of Engineers to maintain the long-term, national coordination of Midwinter Bald Eagle Survey data analysis and reporting (Steenhof et al. 2008).

The Midwinter Bald Eagle Surveys were originally established to provide an index of the total number of wintering bald eagles (*Haliaeetus leucocephalus*) in the lower 48 states, as well as to determine bald eagle distribution during a standardized survey period and to identify previously unrecognized areas of important winter habitat (Steenhof et al. 2008). Beginning in 1984, the National Wildlife Federation asked participants in each state to count bald eagles along standard routes. Survey routes were standardized as clearly described areas where bald eagles had been observed in the past. Currently, observers conduct surveys during the first two weeks of January each year, usually on one of two target days (Steenhof et al. 2008). Each state has a coordinator that is responsible for organizing local counts, enlisting survey participants, and compiling data. Size of survey routes vary from a single fixed point to 241 km (150 mi.) in length (Steenhof et al. 2008). The number of states participating in the Midwinter Bald Eagle Survey each year has ranged from 25 to 41, and the number of standard survey routes per state ranges from 1 to 84 (Steenhof et al. 2008).

On the INL Site, Midwinter Bald Eagle Surveys have taken place since 1983. During those years, two teams surveyed two established routes across the north and south of the INL Site in January (Figure 9-1). Along with identifying and documenting bald and golden eagles (*Aquila chrysaetos*), researchers on the INL Site also scan the landscape with binoculars and spotting scopes and identify and document other raptors, ravens (*Corvus corax*), shrikes (*Lanius* spp.), and black-billed magpies (*Pica hudsonia*) along each route (Figure 9-2). Global positioning system coordinates are collected for each observation, and all data are submitted to the regional coordinator of the USGS Biological Resource Division to be added to the nationwide database.

Two teams surveyed the two established routes across the north and south of the INL Site on January 14 (Figure 9-1). During those surveys, 109 birds were counted, which was lower than the number of individuals observed in 2013 and lower than the average count of 204 birds since 2001. The raven was the most abundant species observed (73 sightings), and the rough-legged hawk (*Buteo lagopus*) was the second most abundant species recorded (15 sightings). One bald eagle and seven golden eagles were observed. No rare or unusual species were documented during those surveys.

9.2 Sage-grouse

Populations of sage-grouse have declined in the last 50 years (Connelly et al. 2004, Garton et al. 2011), and the distribution of this species has been reduced to nearly half of its historic extent across western North America (Schroeder et al. 2004, Connelly et al. 2011a). Although the rate of decline of this species has slowed over the past several decades (Connelly et al. 2004, Garton et al. 2011), concern exists for populations of sage-grouse because of the reliance of this species on sagebrush habitat. Indeed, sagebrush-steppe ecosystems have been greatly altered during the past 150 years; and these areas are currently at risk from multiple threats, such as wildfires, mechanical treatments, agriculture, mining, oil and gas development, livestock grazing, and urbanization (Knick et al. 2003, Connelly et al. 2004). Healthy stands of sagebrush are necessary for sage-grouse to survive. Additionally, sage-grouse require a diverse understory of native forbs and grasses that provide protection from predators, and also provide chicks with high-protein insects necessary for growth (Connelly et al. 2011b).

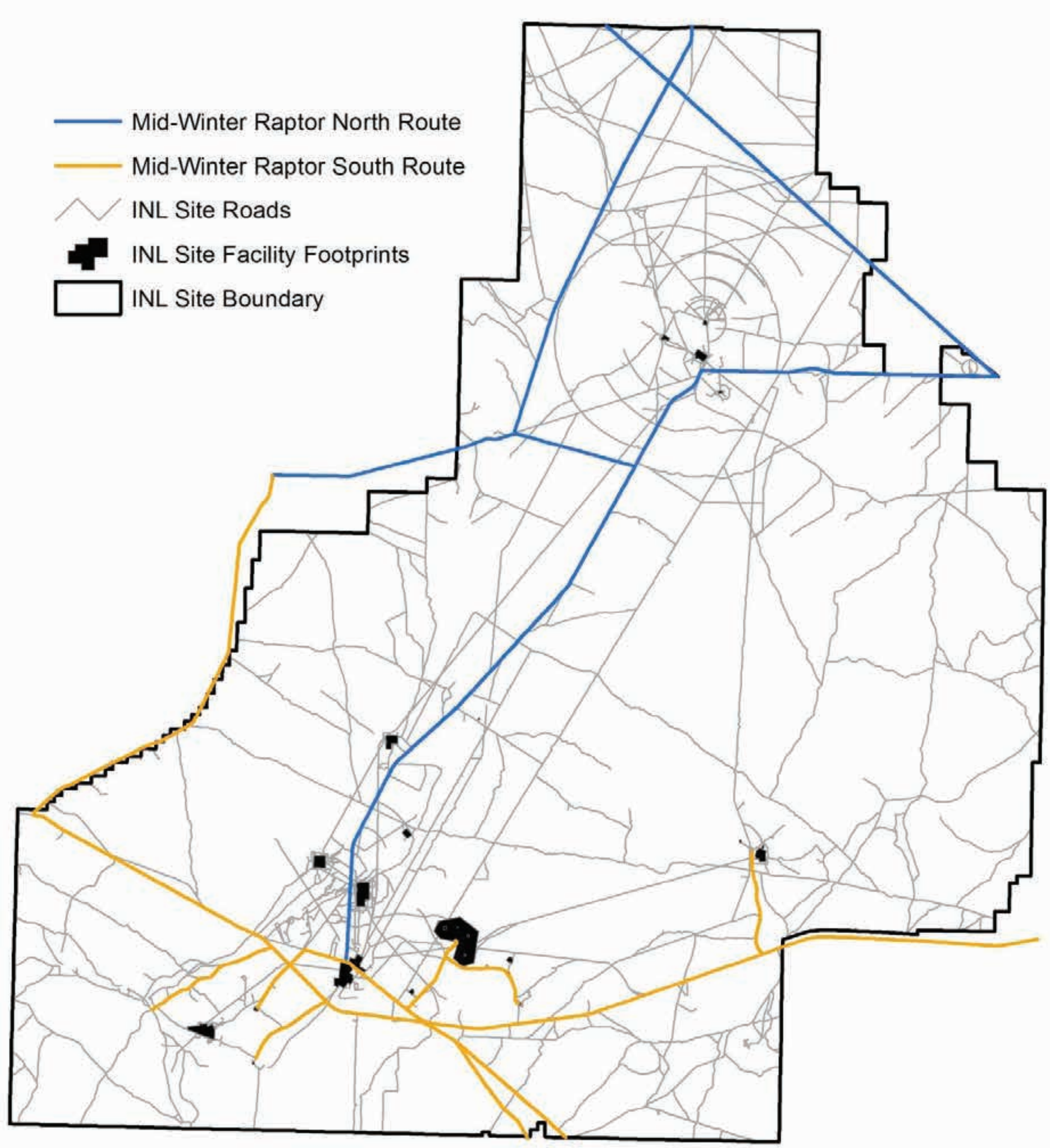


Figure 9-1. Routes for the Midwinter Bald Eagle Surveys on the INL Site. *On one day each January biologists survey about 122 miles (196 km) along roads for wintering raptors.*

DOE-ID has funded important sage-grouse research on the INL Site (Figure 9-3). Those studies covered diverse topics such as seasonal movements (Connelly and Ball 1982, Connelly et al. 1988), habitat use (Connelly and Ball 1982, Connelly 1982), and food habits of this species (Connelly and Ball 1987). Other research has documented the response of sage-grouse to different land-management practices (Connelly et al. 1981, Connelly 1982), identified leks in areas that were recently disturbed (Connelly and Ball 1979, Connelly et al. 1981), tracked potential movements of radionuclides off-Site by these birds (Connelly and Markham 1983), and documented the location of active leks on the INL Site (Connelly 1982).

When sage-grouse were petitioned for listing under the Endangered Species Act (Connelly et al. 2004),

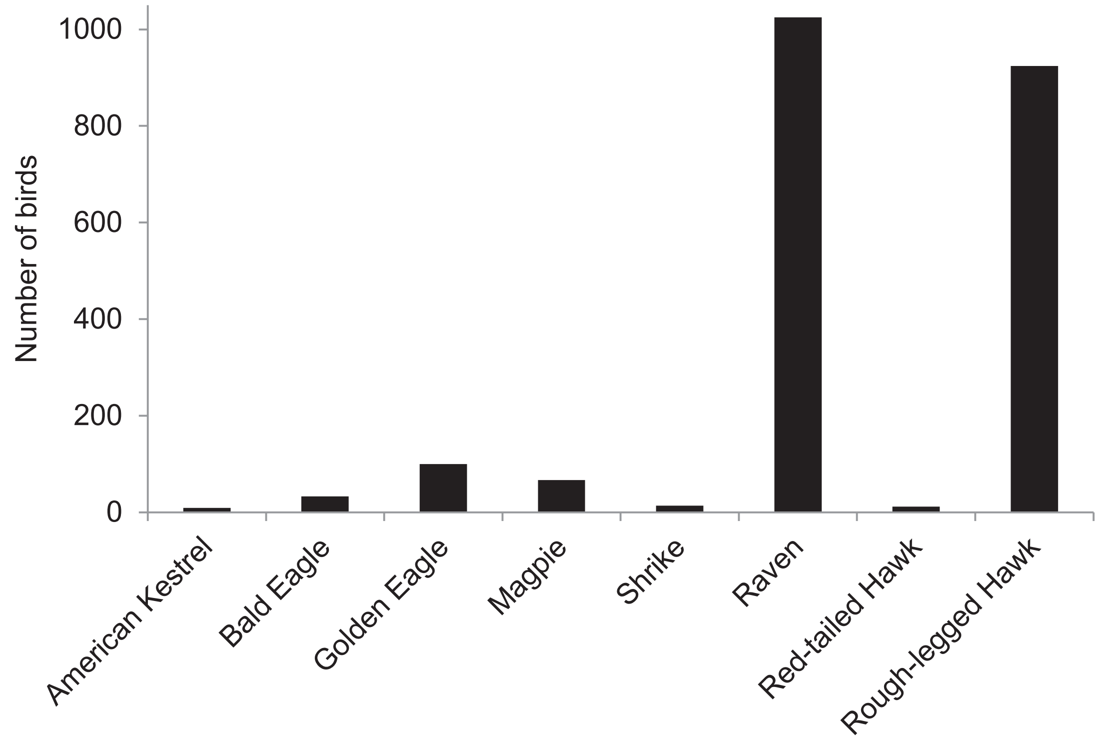


Figure 9-2. Number of Birds Observed during Midwinter Bald Eagle Surveys on the INL Site from 2004 to 2014. *Only birds that were observed on > 5 occasions during that time were included in this figure.*

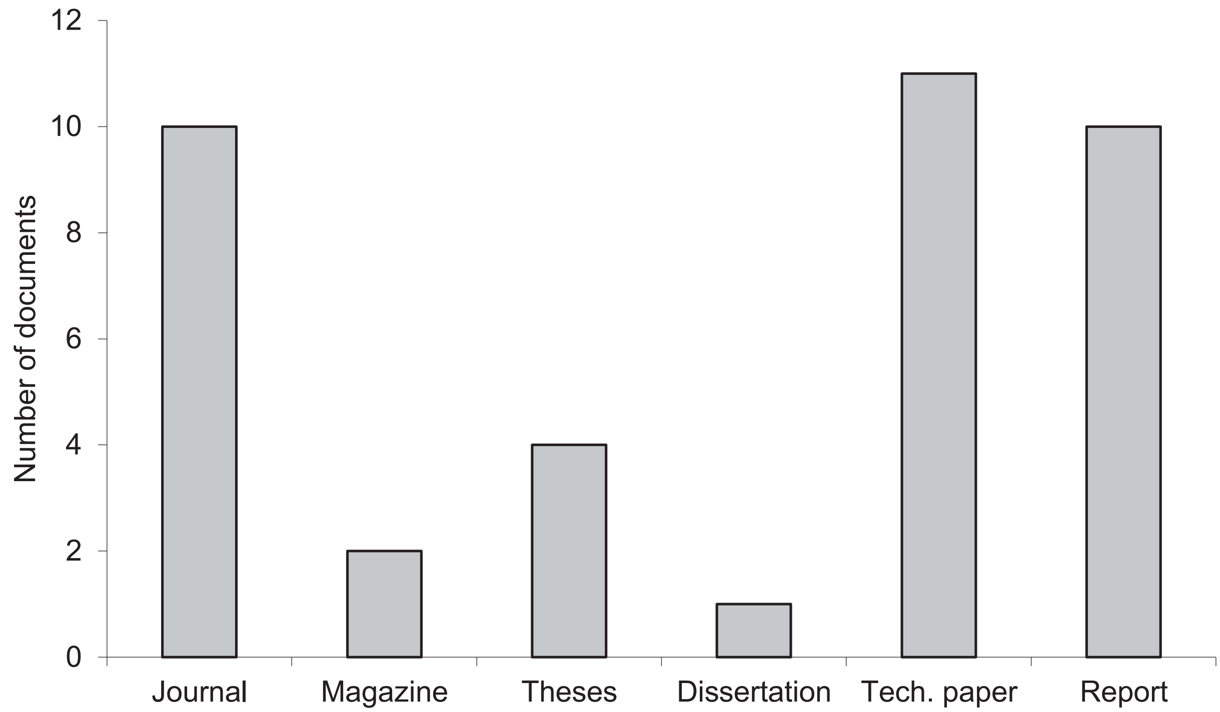


Figure 9-3. Number and Type of Publication Regarding Sage-grouse Research Conducted on the INL Site from 1976 to 2011.

DOE-ID recognized that to reduce impacts to existing and future mission activities on the INL Site they could develop a CCA with the FWS. A CCA is a voluntary agreement between the FWS and another federal agency, in which both partners identify threats to a species under consideration for listing and its key habitat, and develop conservation measures and objectives to avoid or minimize those threats. DOE-ID assigned the task of developing the CCA to the ESER contractor, which subcontracted the Wildlife Conservation Society to lead that effort (DOE-ID and FWS 2014). Subsequently, a field study was designed and implemented, and substantial data were collected concerning sage-grouse that occupy the INL Site (DOE-ID and FWS 2014). The CCA for sage-grouse was signed by DOE-ID and FWS in 2014 (DOE-ID and FWS 2014). The CCA establishes the Sage-grouse Conservation Area (SGCA) that limits infrastructure development and human disturbance in approximately 68 percent of remaining sagebrush-dominated communities on the INL Site (Figure 9-4).

Sage-grouse leks are important displaying and breeding areas that grouse return to each spring (Jenni and Hartzler 1978, Connelly 1981). Some leks may be used by sage-grouse for long periods of time; whereas others may be established after recent, small-scale disturbances occur (Connelly 1981). Leks and their surrounding breeding habitat are important for the survival of sage-grouse populations (Connelly et al. 2000), and counting displaying birds at these areas can be a relatively easy method to document trends in abundance of grouse (Jenni and Hartzler 1978, Connelly et al. 2003, Garton et al. 2011). Therefore, determining the locations of leks, documenting if they are actively attended by grouse, and then tracking the number of grouse across time at these locations can provide important information for sage-grouse management (Jenni and Hartzler 1978, Connelly et al. 2003, Garton et al. 2011).

Three lek routes (Lower Birch Creek, Tractor Flats, and Radioactive Waste Management Complex [RWMC]) were established on the INL Site by the Idaho Department of Fish and Game (IDFG) in the mid-1990s and have been monitored annually since that time using a protocol developed by the IDFG (Figure 9-4). Since 1999, the number of leks monitored across those routes has increased from 12 to 23. Employees of the IDFG surveyed the Lower Birch Creek route until 2010; thereafter, biologists from the ESER contractor have conducted these surveys.

In 2014, the following active leks were surveyed on the INL Site: 1) active leks ($n = 27$) located in the SGCA; 2) other active leks ($n = 20$) located in and out of the SGCA that were not on the three IDFG lek routes; 3) leks on the three IDFG routes that are surveyed annually on the INL Site (DOE-ID and USFWS 2014). ESER biologists surveyed those active leks using methods established by the IDFG for surveying sage-grouse leks (ESER Procedure RP-4 and ESER Procedure RP-6). At each lek, birds were observed from a location that provided good visibility of the lek. Birds were then counted on each lek four times over a 10-minute period and recorded the highest number of males and females observed at each lek. All of these surveys will allow DOE-ID to continue to track trends of breeding male sage-grouse at active leks on the INL Site to document if declines occur in the number of males at these leks (DOE-ID and USFWS 2014).

In 2014, ESER biologists surveyed all active leks in the SGCA at least 3 times ($\bar{x}= 5$ surveys, $SD = 1.5$, range = 3 to 7 surveys) to count sage-grouse using those areas. Three hundred fifty two males were counted at peak attendance during those surveys. ESER also surveyed the remaining active leks on the INL Site that were not in the SGCA. Of those active leks surveyed, an average of 4 times ($SD = 1.1$ surveys, range = 3 to 7 surveys). The number of lekking males at peak attendance on those leks was 264.

Sage-grouse lek route surveys began in late March and lasted throughout May 2014; ESER conducted at least five surveys on the Tractor Flats, RWMC, and Lower Birch Creek routes. The number of sage-grouse observed on the Tractor Flats route peaked on May 1 with 55 males. The number of birds observed on the RWMC route peaked on April 30 with 141 males; whereas the number of sage-grouse observed on the Lower Birch Creek route peaked at 64 males on April 3 and 21. Peak attendance by males was higher in 2014 than in 2013 on the Tractor Flats route, when 53 birds were observed. The number of males on the RWMC route increased compared with 110 birds observed in 2013, and the number of males on the Lower Birch Creek route increased compared with 48 birds observed in 2013. Survey data from these lek routes on the INL Site was provided to IDFG. Two new leks (INL 157 and INL 158) were discovered and documented while conducting surveys (Figure 9-4). The number of males observed on the Tractor Flats lek route in 2014 was similar to the number of birds

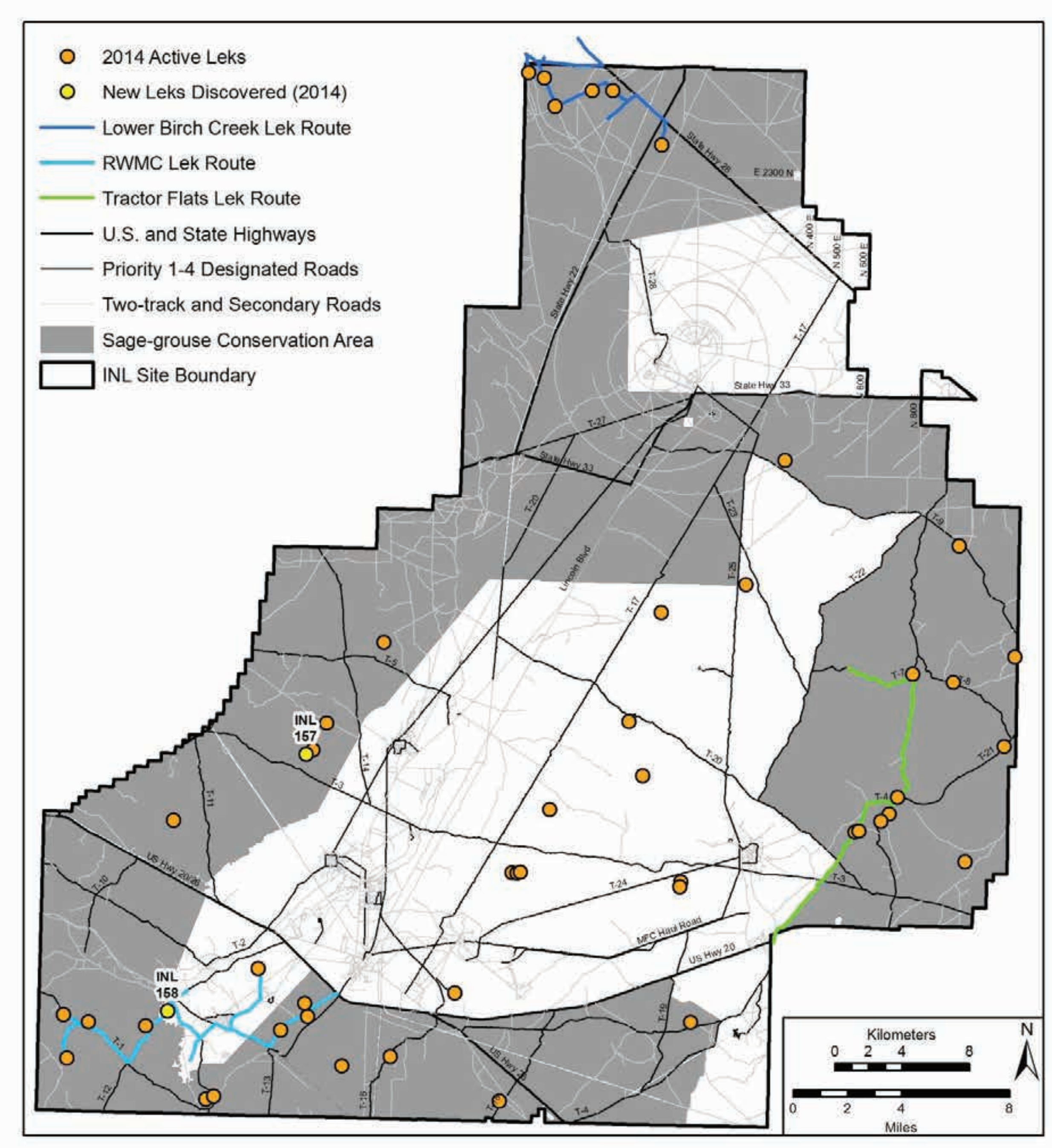


Figure 9-4. Location of the Sage-grouse Conservation Area, Lek Routes, and Active Sage-grouse Leks on the INL Site.

observed on that route since 2011 (Figure 9-5). However more male sage-grouse were observed on the RWMC and Lower Birch Creek routes than 2011 (Figure 9-5).

9.3 Breeding Bird Surveys

The North American Breeding Bird Survey (BBS) was developed by the FWS along with the Canadian Wildlife Service to document trends in bird populations. Pilot surveys began in 1965 and immediately expanded to cover the U.S. east of the Mississippi and Canada, and by 1968 included all of North America (Sauer and Link 2011). The BBS program in North America is managed by the USGS and currently consists of over 4,100 routes, with approximately 3,000 of these being sampled each year. BBS data provide long-term species abundance

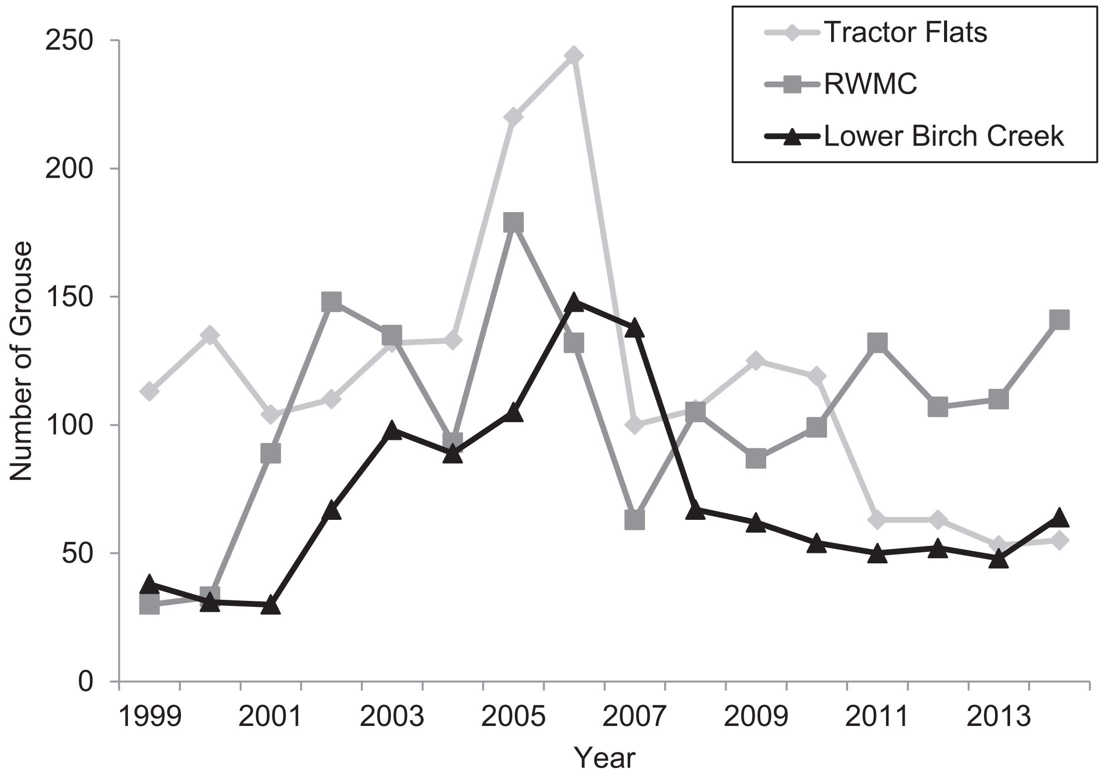


Figure 9-5. Number of Male Sage-grouse Observed at Peak Attendance across Three Lek Routes on the INL Site from 1999 to 2014.

and distribution trends across a broad-geographic scale. These data have been used to estimate population changes for hundreds of bird species, and they are the primary source for regional conservation programs and modeling efforts (Sauer and Link 2011). The BBS provides a wealth of information about population trends of birds in North America, and is the foundation for broad conservation assessments extending beyond local jurisdictional boundaries.

The INL Site has five permanent, official BBS routes originally established in 1985 (remote routes) and eight additional survey routes near INL Site facilities (facility routes; Figure 9-6). Facility routes were developed to monitor avifauna populations in proximity to anthropogenic activities and disturbances. The annual BBS provides land managers with information regarding the population trends of breeding birds relative to activities conducted on the INL Site.

In 2014, surveys were conducted from May 29 to June 27 along the 13 established routes. Two thousand, six hundred seventy seven birds from 38 species were documented during those surveys (Figure 9-7). Bird abundance was less than the 1985-2013 average of 4,824 birds, and the number of species was lower than the 27-year average of 57. Recent fires on the INL Site have reduced the amount of sagebrush habitat. Such reduction in habitat may have affected the total abundance of birds. Furthermore, other factors (i.e., observer or spring weather patterns) could influence bird abundance; therefore, additional years of data will be needed to compare 2014 results with those of previous surveys.

Compared with past surveys, similar patterns of bird abundance were observed among those species that are typically the most numerous. In 2014, the five species that were documented in greatest abundance were horned lark (*Eremophila alpestris, n* = 771), western meadowlark (*Sturnella neglecta, n* = 674), sage thrasher (*Oreoscoptes montanus, n* = 460), sage sparrow (*Amphispiza belli, n* = 208), and Brewer's sparrow (*Spizella breweri, n* = 125). During 28 years of breeding bird surveys on the INL Site these species have been the five most abundant 21 times, and in the remaining seven years they were among the six most abundant species.

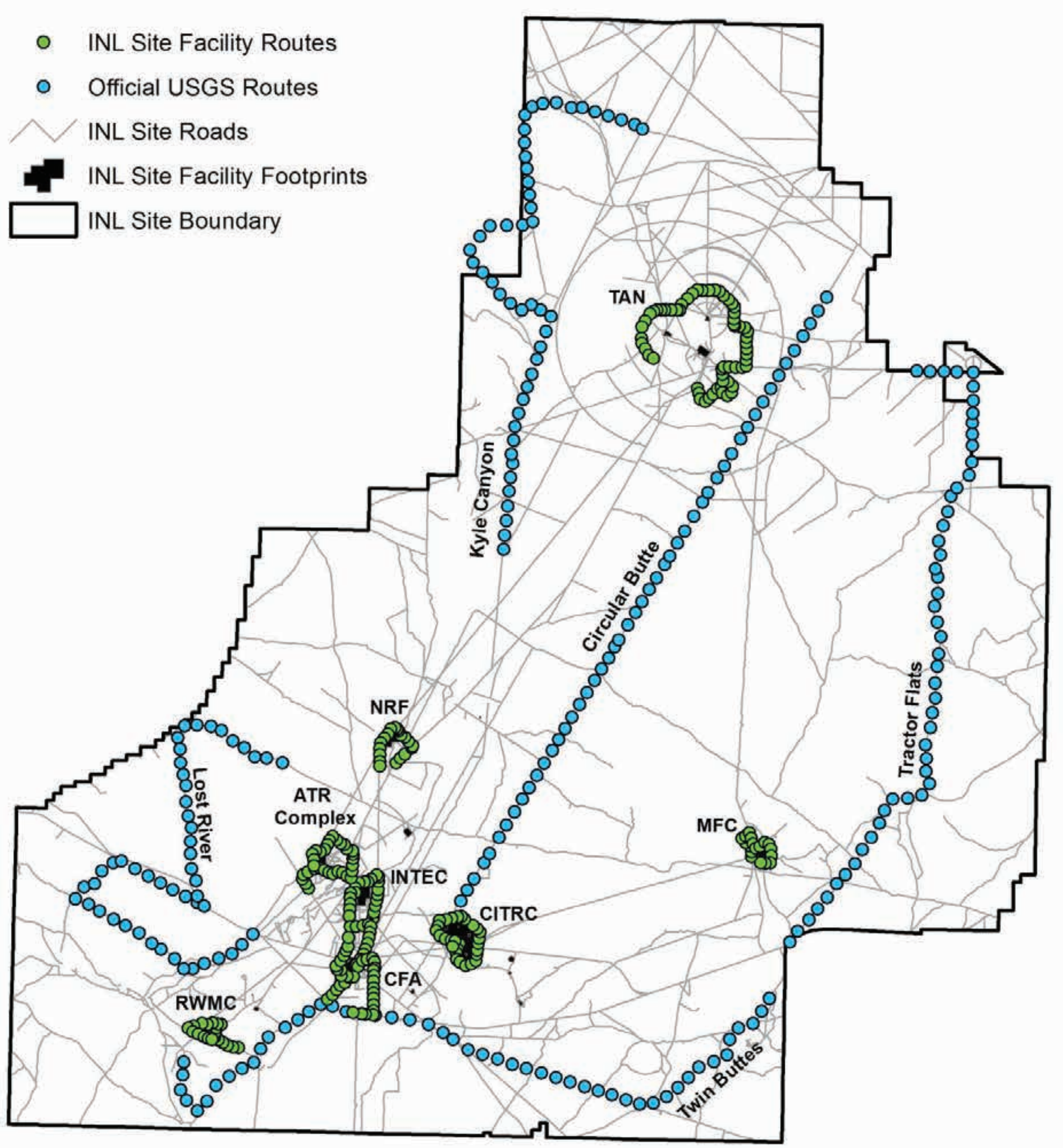


Figure 9-6. Location of Breeding Bird Survey Routes on the INL Site.

Species observed during the 2014 BBS that are considered species of conservation concern in Idaho included the Franklin's gull (*Larus pipixcan, n* = 2), ferruginous hawk (*Buteo regalis, n* = 8), long-billed curlew (*Numenius americanus, n* = 2), burrowing owl (*Athene cunicularia, n* = 2), and grasshopper sparrow (*Ammodramus savannarum, n* = 5). Data from the BBS were submitted to the USGS Patuxent Wildlife Research Center.

9.4 Bats

Bats have important roles in ecosystem functions (i.e., insect control, plant pollination, and seed dissemination), and these mammals provide important ecosystem services (Kunz and Reichard 2010, Cryan 2011). For example, insectivorous bats are very effective at suppressing populations of nocturnal insects, and some authors estimate the value of bats to the agricultural

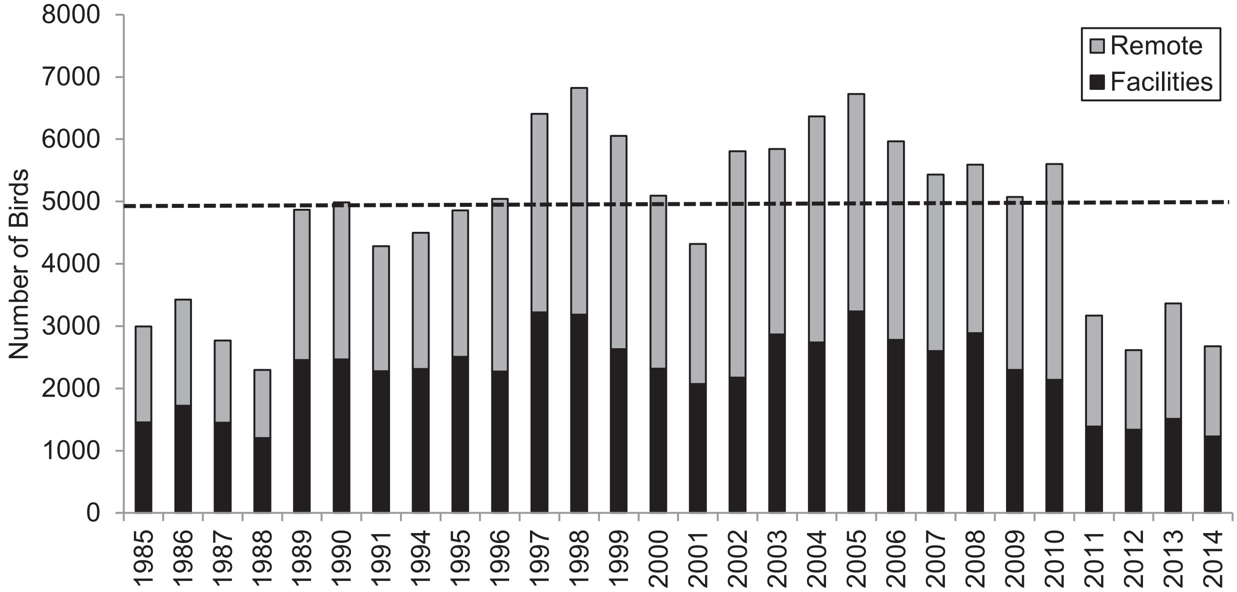


Figure 9-7. Number of Birds Observed during the Breeding Bird Survey on the INL Site. *The dashed black line indicates the mean number of birds observed from 1985 to 2014. No Breeding Bird Surveys were conducted on the INL Site in 1992 or 1993.*

industry in the USA at roughly $22.9 billion each year (Boyles et al. 2011). Moreover, insectivorous bats are effective top-down predators of forest insects (Boyles et al. 2011). Potential declines in populations of bats could have far-reaching consequences across ecosystems and biological communities (Miller 2001, Adams 2003, Blehert et al. 2009).

White-nose syndrome (WNS), wind-energy development, climate change, as well as human destruction and modification of hibernacula have impacted populations of bats. WNS has been identified as a recent major threat to many bats that hibernate in caves (Blehert et al. 2009; Foley et al. 2011; Kunz and Reichard 2010), and this disease has killed at least 5.5 to 6.7 million bats in seven species (Blehert et al. 2009; Foley et al. 2011). WNS has been considered as one of the greatest wildlife crises of the past century (Kunz and Reichard 2010), and many species of bats could be at risk of significant declines or extinction due to this disease (Kunz and Reichard 2010). Wind-energy development is expanding rapidly across the western USA, and unprecedented mortality rates of bats have occurred recently at many of these facilities (Arnett et al. 2008; Cryan 2011; Cryan and Barclay 2009). Additionally, the loss, modification, and disturbance of hibernacula by humans are also concerns for bat populations (Adams 2003).

Research and monitoring of bats have been conducted on the INL Site by contractors of DOE-ID periodically over the past several decades. During that time; four theses, three reports, and one publication have been produced by contractors, university researchers, and graduate students. The majority of that research and monitoring, however, occurred in the late 1980s and early 1990s. Of the 14 known species of bats that occur in Idaho, nine of those species are documented to occupy the INL Site during some part of the year (Table 9-1). Six of those species are likely migratory and use the Site seasonally; whereas, three are considered residents (Table 9-1). Many of these species are considered for different levels of protection by the FWS, Bureau of Land Management, Western Bat Working Group, and other conservation organizations (Table 9-1).

Currently, at least 17 out of 23 caves that are known to exist on the INL Site are used by several species of bats for winter hibernacula, as well as for summer day and night roosts. Lava caves are also essential habitat during most of the year for three resident species. Indeed, much of the information concerning bats on the INL Site comes from research that has centered on counting and trapping individuals at caves (Genter 1984, Wackenhut 1990, Bosworth 1994, Doering 1996). In addition to being used as roost and hibernation areas, caves also

Table 9-1. Bat Species and the Seasons and Areas They Occupy on the INL Site, as well as Threats to these Mammals.

Common and Scientific Name	Distribution, Habitat, and Seasonal Occurrence	Affected by WNS	Affected by Wind Energy
Big Brown Bat[a] (*Eptesicus fuscus*)†	Sitewide; buildings, caves, and lava tubes; year round	Yes	Yes
Hoary Bat[a] (*Lasiurus cinereus*)*	Patchy; riparian and junipers; summer and autumn	No	Yes
Little Brown Myotis[a] (*Myotis lucifugus*)*	Sitewide; roosts in buildings; summer and autumn	Yes	Yes
Pallid Bat[a] (*Antrozous pallidus*)*	Patchy; shrub lands; autumn	No	No
Red Bat (*Lasiurus blossevillii* or *L. borealis*)*	Patchy; caves; autumn	No	Yes
Silver-haired Bat[a] (*Lasionycteris noctivagans*)*	Patchy; riparian and junipers; summer and autumn	No	Yes
Townsend's Big-eared Bat[a] (*Corynorhinus townsendii*)†	Sitewide; caves and lava tubes; year round	Potentially	Potentially
Western Long-eared Myotis[a] (*Myotis evotis*)*	Southeast and northwest INL Site; caves and junipers; summer and autumn	Yes	Potentially
Western Small-footed Myotis[a] (*Myotis ciliolabrum*)†	Sitewide; buildings, caves, and lava tubes; year round	Yes	Potentially

a. These species are designated as Type 2 Idaho Special Status Species by the BLM.
† Resident species, *Migratory species

provide habitat for concentrated patches of insect prey for these mammals. Additionally, preliminary surveys indicate that caves may be used as stop-over habitat during fall migrations by previously undocumented forest bats, such as the hoary bat (*Lasiurus cinereus*) and possibly the western (*L. blossevillii*) or eastern red bat (*L. borealis*). Very little is known about the use of caves by migrating forest bats (Cryan 2011), and these areas may provide vital resources as bats traverse atypical habitats.

Anthropogenic structures (facilities, bridges, and culverts) are also used as habitat by bats on the INL Site. These areas, and their associated lands, occupy about 0.38 percent of the INL Site. Some of these facilities were constructed in the 1950s, and are surrounded by mature trees and wastewater ponds, which provide bats with vertical-structure habitat, water, and foraging areas. Indeed, during summer all resident and one migratory bat species use anthropogenic structures around facilities and near roads for roost sites (Keller et al. 1993, Haymond and Rogers 1997).

In 2014, ESER continued monitoring bat activity using acoustical detectors set at hibernacula and other important habitat features (caves and facility ponds) used by these mammals (Figure 9-8). Calls recorded by the acoustical equipment are currently being identified (Figure 9-9). Cursory examination of the call files indicates that big brown bats (*Eptesicus fuscus*), western small-footed myotis (*Myotis ciliolabrum*), silver-haired bats (*Lasionycteris noctivagans*), western long-legged myotis (*M. evotis*), Townsend's big-eared bats (*Corynorhinus townsendii*), hoary bats, and the little brown myotis (*M. lucifugus*) use areas near caves and the waste-water ponds at facilities. The results of our monitoring program will provide critical information regarding bat ecology and conservation on the INL Site.

Figure 9-8. A Passive-acoustical Monitoring Station for Bats with a Microphone Mounted at the Top. These Devices Record the Echolocation Calls of Bats.

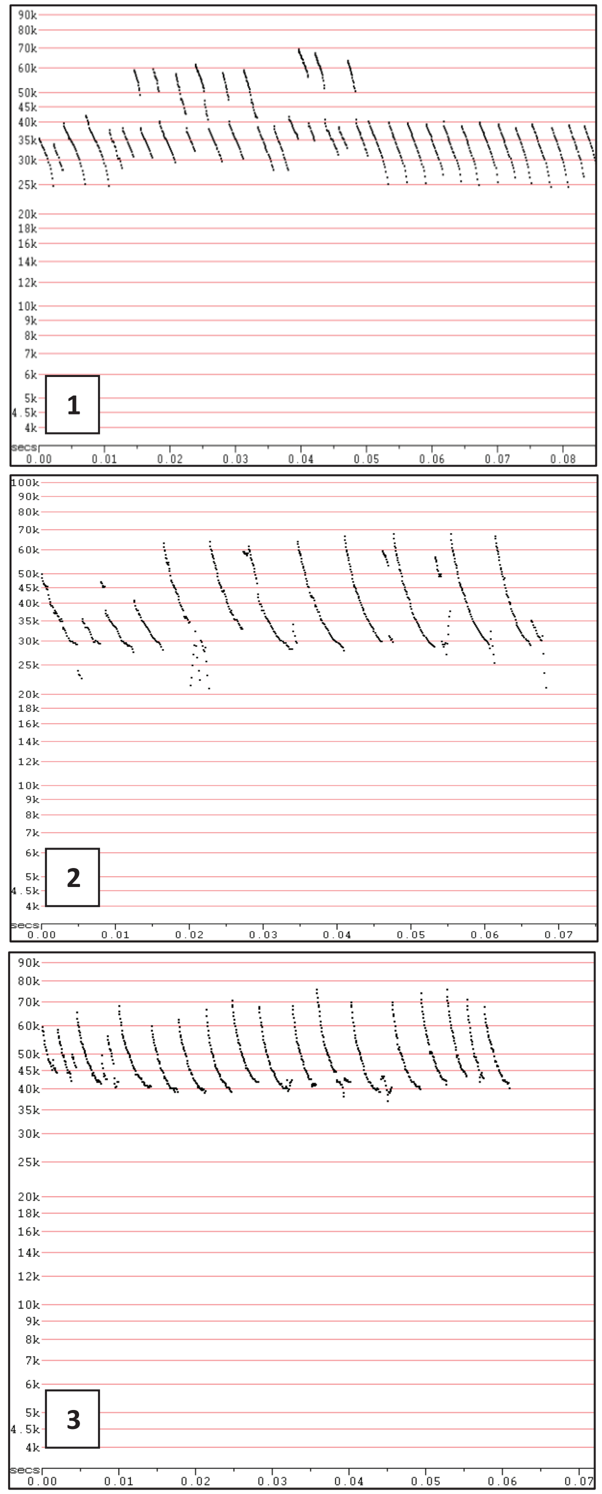


Figure 9-9. Echolocation Calls of Three Species of Bats Recorded by AnaBat Detectors (1 = Townsend's big-eared bat, 2 = big brown bat, 3 = western small-footed myotis) from Caves on the INL Site.

REFERENCES

Adams, R. A., 2003, *Bats of the Rocky Mountain West: natural history, ecology, and conservation*, University Press of Colorado, Boulder, Colorado.

Arnett, E. B., W. K. Brown, W. P. Erickson, J. K. Fiedler, B. L. Hamilton, T. H. Henry, A. Jain, G. D. Johnson, J. Kerns, R. R. Koford, C. P. Nicholson, T. J. O'Connell, M. D. Piorkowski, and R. D. Tankersley, 2008, Patterns of bat fatalities at wind energy facilities in North America, *Journal of Wildlife Management* 72:61-78.

BGEPA, 1940, Bald and Golden Eagle Protection Act, Public Law 86-70, Effective June 8, 1940, 92 Stat. 3114.

Blehert, D. S., A. C. Hicks, M. Behr, C. U. Meteyer, B. M. Berlowski-Zier, E. L. Buckles, J. T. H. Coleman, S. R. Darling, A. Gargas, R. Niver, J. C. Okoniewski, R. J. Rudd, and W. B. Stone, 2009, Bat white-nose syndrome: an emerging fungal pathogen? *Science* 323:227-227.

Bosworth, W. R., 1994, *Characteristics of winter activity in Plecotus townsendii in southeastern Idaho*, Idaho State University, Pocatello, ID. Thesis, 74 pages.

Boyles, J. G., P. M. Cryan, G. F. McCracken, and T. H. Kunz, 2011, Economic Importance of Bats in Agriculture, *Science*, 332:41-42.

Britzke, E. R., J. E. Duchamp, K. L. Murray, R. K. Swihart, and L. W. Robbins, 2011, Acoustic Identification of Bats in the Eastern United States: A Comparison of Parametric and Nonparametric Methods, *Journal of Wildlife Management*, 75:660-667.

Connelly, J. W. and I. J. Ball, 1979, *A preliminary report on the ecology of sage grouse on the Idaho National Engineering Laboratory Site*, pages 41-42 in Proceedings of the Symposium on the Idaho National Engineering Laboratory Ecology Programs, U.S. Department of Energy Radiological and Environmental Sciences Laboratory.

Connelly, J. W., W. J. Arthur, and O. D. Markham, 1981, Sage-grouse leks on recently disturbed sites, *Journal of Range Management* 34:153-154.

Connelly, J. W., 1982, *An ecological study of sage grouse in southeastern Idaho*, Ph.D. Dissertation. Washington State University, 84 pp.

Connelly, J. W. and I. J. Ball, 1982, *Movements, habitat use, and flocking behavior of sage grouse on Idaho's National Environmental Research Park,* page 27 in Idaho National Engineering Laboratory, Hanford Site and Los Alamos National Laboratory Symposium on Radioecology and Ecology. U.S. Department of Energy Idaho Operations Office.

Connelly, J. W. and O. D. Markham, 1983, Movements and radionuclide concentrations of sage-grouse in southeastern Idaho, *The Journal of Wildlife Management*, 47:169-177.

Connelly, J. W. and I. J. Ball, 1987, *The ecology of sage grouse on the Idaho National Engineering Laboratory Site*, pages 224-235, U.S. Department of Energy Idaho Operations Office, Idaho Falls, ID.

Connelly, J. W., H. W. Browers, and R. J. Gates, 1988, Seasonal movements of sage-grouse in southeastern Idaho, *The Journal of Wildlife Management*, 52:116-122.

Connelly, J. W., M. A. Schroeder, A. R. Sands, and C. E. Braun, 2000, Guidelines to manage sage grouse populations and their habitats, *Wildlife Society Bulletin* 28:967-985.

Connelly, J. W., K. P. Reese, and M. A. Schroeder, 2003, *Monitoring of Greater sage-grouse habitats and populations*, College of Natural Resources Experiment Station publication No. 979, University of Idaho, Moscow, Idaho, 49 pp.

Connelly, J. W., S. T. Knick, M. A. Schroeder, and S. J. Stiver, 2004, *Conservation Assessment of Greater Sage-grouse and Sagebrush Habitats*, Western Association of Fish and Wildlife Agencies, Cheyenne, WY.

Connelly, J. W., S. T. Knick, C. E. Braun, W. L. Baker, E. A. Beever, T. J. Christiansen, K. E. Doherty, E. O. Garton, C. A. Hagen, S. E. Hanser, D. H. Johnson, M. Leu, R. F. Miller, D. E. Naugle, S. J. Oyler-McCance, D. A. Pyke, K. P. Reese, M. A. Schroeder, S. J. Stiver, B. L. Walker, and M. J. Wisdom, 2011a, Conservation of greater sage-grouse: a synthesis of current trends and future management, pages 549-563 in greater sage-grouse: Ecology and Conservation of a Landscape Species and Its Habitats, *University of California Press, Berkely*, California.

Connelly, J. W., E. T. Rinkes, and C. E. Braun, 2011b, Characteristics of Greater Sage-grouse habitats: a landscape species at micro and macro scales, pages 69-83, Greater Sage-grouse: Ecology and Conservation of a Landscape Species and Its Habitats, *University of California Press*, Berkely, California.

Cryan, P. M. and R. M. R. Barclay, 2009, Causes of bat fatalities at wind turbines: hypotheses and predictions, *Journal of Mammalogy* 90:1330-1340.

Cryan, P. M., 2011, Wind turbines as landscape impediments to the migratory connectivity of bats, *Environmental Law* 41:355-370.

DOE-ID and USFWS. 2014, *Candidate conservation agreement for greater sage-grouse (Centrocercus urophasianus) on the Idaho National Laboratory Site*, DOE/ID-11514, U.S. Department of Energy Idaho Operations Office, Idaho Falls, Idaho.

DOE, 1996, Land and Facility Use Policy. DOE P 430.1, 9 July 1976.

Doering, R. W. 1996, *Thermal implications of roost site selection in hibernating Plecotus townsendii*, Idaho State University, Pocatello, ID. Thesis, 110 pages.

ESA, 1973, Endangered Species Act, Public Law 93–205, Approved Dec. 28, 1973, 87 Stat. 884, [As Amended Through Public Law 107–136, Jan. 24, 2002].

Executive Order No. 11514, 1970, Protection and Enhancement of Environmental Quality, March 7, 1970, 35 FR 4247.

Foley, J., D. Clifford, K. Castle, P. Cryan, and R. S. Ostfeld, 2011, Investigating and managing the rapid emergence of white-nose syndrome, a novel, fatal, infectious disease of hibernating bats," *Conservation Biology* 25:223-231.

Garton, E. O., J. W. Connelly, C. A. Hagen, J. S. Horne, A. Moser, and M. A. Schroeder, 2011, *Greater Sage-grouse population dynamics and probability of persistence*, Pages 293-381 in S. T. Knick and J. W. Connelly, editors. Greater Sage-Grouse: Ecology and Conservation of a Landscape Species and Its Habitats. University of California Press, Berkely, California.

Genter, D. L., 1986, Wintering bats of the upper Snake River Plain: occurrence in lava-tube caves, *Great Basin Naturalist* 46:241-244.

Haymond, S. and D. S. Rogers, 1997, Habitat use by summer populations of bats in sagebrush steppe. ESRF-017.

INL, 2011, *Idaho National Laboratory Comprehensive Land Use and Environmental Stewardship Report,* INL/EXT-05-00726, Rev. 1, INL Campus Development Office, North Wind, Inc., August 2011.

Jenni, D. A., and J. E. Hartzler, 1978, Attendance at a sage grouse lek: implications for spring censuses, *Journal of Wildlife Management* 42:46-52.

Keller, B. L., W. R. Bosworth, and R. W. Doering, 1993, *Final Technical Report: Bat Habitat Research*, DOE/ID/13142-T1.

Knick, S. T., D. S. Dobkin, J. T. Rotenberry, M. A. Schroeder, W. M. Vander Haegan, and C. Van Riper III, 2003, Teetering on the edge or too late? Conservation and research issues for avifauna of sagebrush habitats, *Condor* 105:611-634.

Kunz, T. and J. Reichard, 2010, *Status review of the little brown myotis (Myotis lucifugus) and determination that immediate listing under the endangered species act is scientifically and legally warranted*, Boston University Center for Ecology and Conservation.

MBTA, 1918, Migratory Bird Treaty Act, 16 USC 703 – 712.

Miller, B. W. 2001, A method for determining relative activity of free flying bats using a new activity index for acoustic monitoring, *Acta Chiropterologica* 3:93-105.

MOU, 1995, Memorandum of Understanding to Foster the Ecosystem Approach, between Council on Environmental Quality, Department of Agriculture, Department of the Army, Department of Commerce, Department of Defense, Department of Energy, Department of Housing and Urban Development, Department of the Interior, Department of Justice, Department of Labor, Department of State, Department of Transportation, Environmental Protection Agency, Office of Science and Technology Policy, December 15, 1995.

NEPA, 1970, National Environmental Policy Act, January 1, 1970, Public Law 91-190, 83 Stat. 852.

Research Procedure 4, 2012, Sage-grouse surveys. ESER Research Procedure 4, Gonzales-Stoller Surveillance, LLC, Idaho Falls, ID, 10 pp.

Research Procedure 6, 2014, Sage-grouse historical lek and lek discovery surveys. ESER Research Procedure 6, Gonzales-Stoller Surveillance, LLC, Idaho Falls, ID, 12 pp.

Sauer, J. R. and W. A. Link, 2011, Analysis of the North American Breeding Bird Survey using hierarchical models, *Auk* 128: 87-98.

Schroeder, M. A., C. L. Aldridge, A. D. Apa, J. R. Bohne, C. E. Braun, S. D. Bunnell, J. W. Connelly, P. A. Deibert, S. C. Gardner, M. A. Hilliard, G. D. Kobriger, S. M. McAdam, C. W. McCarthy, J. J. McCarthy, D. L. Mitchell, E. V. Rickerson, and S. J. Stiver, 2004, Distribution of Sage-Grouse in North America, *Condor* 106:363-376.

Steenhof K., L. Bond, and L. L. Dunn, 2008, *The midwinter bald eagle survey results and analysis 1986-2005*, U.S. Geological Survey, National Biological Information Infrastructure, and Northwest Alliance for Computational Science and Engineering, available at http://ocid.nacse.org/nbii/eagles/history.php.

Wackenhut, M. C., 1990, *Bat species overwintering in lava-tube caves in Lincoln, Gooding, Blaine, Bingham, and Butte Counties, Idaho with special reference to annual return of banded Plecotus townsendii*, Idaho State University, Pocatello, ID. Report, 64 pages.

Dwarf Purple Monkey Flower

2014

10. Environmental Research at the Idaho National Laboratory Site

Desert Evening-Primrose
Oenothera caespitosa

The Idaho National Laboratory Site was designated as a National Environmental Research Park in 1975. The National Environmental Research Park program was established in response to recommendations from citizens, scientists, and members of Congress to set aside land for ecosystem preservation and study. In many cases, these protected lands became the last remaining refuges of what were once extensive natural ecosystems. The National Environmental Research Parks provide rich environments for training researchers and introducing the public to ecological sciences. National Environmental Research Parks have been used to educate grade school and high school students and the general public about ecosystem interactions at U.S. Department of Energy sites; train graduate and undergraduate students in research related to site-specific, regional, national, and global issues; and promote collaboration and coordination among local, regional, and national public organizations, schools, universities, and federal and state agencies. During 2014, four ecological research projects were conducted on the Idaho National Environmental Research Park.

The United States Geological Survey has been studying the hydrology and geology of the eastern Snake River Plain and eastern Snake River Plain aquifer since 1949. The United States Geological Survey Idaho National Laboratory Project Office collects data from research and monitoring wells to create and refine hydrologic and geologic models of the aquifer, to track contaminant plumes in the aquifer and improve understanding of the complex relationships between the rocks, sediments and water that compose the aquifer. Five reports were published in 2014 by the Idaho National Laboratory Project Office.

10. ENVIRONMENTAL RESEARCH AT THE IDAHO NATIONAL LABORATORY SITE

This chapter summarizes ecological research performed at the Idaho National Environmental Research Park (Section 10.1) and research conducted on the eastern Snake River Plain (ESRP) and ESRP aquifer by the United States Geological Survey (USGS) (Section 10.2) during 2014.

10.1 Ecological Research at the Idaho National Environmental Research Park

The Idaho National Laboratory (INL) Site was designated as a National Environmental Research Park in 1975. The National Environmental Research Park Program was established in response to recommendations from citizens, scientists, and members of Congress to set aside land for ecosystem preservation and study. This has been one of the few formal efforts to reserve land on a national scale for ecological research and education. In many cases, these protected lands became the last remnants of what were once extensive natural ecosystems.

Five basic objectives guide activities on National Environmental Research Parks:

- Develop methods for assessing and documenting environmental consequences of human actions related to energy development
- Develop methods for predicting environmental consequences of ongoing and proposed energy development
- Explore methods for eliminating or minimizing predicted adverse effects from various energy development activities on the environment
- Train people in ecological and environmental sciences
- Educate the public on environmental and ecological issues.

National Environmental Research Parks provide rich environments for training researchers and introducing the public to the ecological sciences. They have been used to educate grade school and high school students and the general public about ecosystem interactions at U.S. Department of Energy (DOE) sites; train graduate and undergraduate students in research related to site-specific, regional, national, and global issues; and promote collaboration and coordination among local, regional, and national public organizations, schools, universities and federal and state agencies. Ecological research on National Environmental Research Parks is leading to better land-use planning, identifying sensitive areas on DOE sites so that restoration and other activities are compatible with ecosystem protection and management, and increased contributions to ecological science in general.

Ecological research was conducted at federal laboratories long before National Environmental Research Parks were established. For example, at the INL Site, ecological research began in 1950 with the establishment of the long-term vegetation (LTV) transect study. This is perhaps DOE's oldest ecological data set and one of the most intensive data sets for sagebrush steppe. In addition, in 1989, a long-term reptile monitoring study was initiated, which is the longest continuous study of its kind in the world. Also, in 1993, a protective cap biobarrier experiment was initiated, which evaluated the long-term performance of evapotranspiration caps and biological intrusion barriers. Those long-term plots are now being used to test hypotheses on the potential effects of climate change.

The Idaho National Environmental Research Park provides coordination of ecological research and information exchange at the INL Site. It facilitates ecological research on the INL Site by attracting new researchers to use the area, providing background data for new research projects, and assisting researchers to obtain access to the INL Site.

The Idaho National Environmental Research Park provides infrastructure support to ecological researchers through the Experimental Field Station and reference specimen collections. The Idaho National Environmental Research Park tries to foster cooperation and research integration by encouraging researchers to collaborate, developing interdisciplinary teams to address more complex problems, encouraging data sharing, and leveraging funding across projects to provide more efficient use of resources. It also integrates research results from many projects and disciplines and provides analysis of ecosystem-level responses. The Idaho National Environmental Research Park has developed a centralized ecological data repository to provide an archive for ecological data and to facilitate data retrieval for new research projects and land management decision making. It also provides interpretation of research results to land and facility managers to support compliance with natural resource laws including the National Environmental Policy Act, Endangered Species Act, Migratory Bird Treaty Act, and the Bald and Golden Eagle Protection Act.

A total of 18 undergraduate students, graduate students, post-doctoral students, faculty, and agency and contractor scientists participated in four research projects on the Idaho National Environmental Research Park in 2014. Several undergraduate students and technicians also gained valuable experience through participation in these research activities. The four projects include three graduate student research projects, with students and faculty from Idaho State University (ISU), Boise State University, and The College of Idaho. Other researchers represented the Environmental Surveillance, Education, and Research Program, and USGS Forest and Range Ecosystem Science Center.

One of the projects received funding from DOE-ID through the Environmental Surveillance, Education, and Research Program (ESER). In addition, all projects received in-kind support (logistics, badging, and training) from DOE-ID through ESER. Other funding sources included the National Science Foundation, Idaho State University (ISU), USGS – Forest and Rangeland Ecosystem Science Center, USGS – Northwest Climate Science Center, and the Orma J. Smith Museum of Natural History at The College of Idaho.

Most of the U.S. Department of Energy-Idaho Operations Office (DOE-ID)-funded research and much of the research funded by other agencies addresses land management issues applicable to the INL Site. These issues include preparing for potential Endangered Species Act listings, understanding wildland fire effects, minimizing invasive species impacts, and understanding long-term trends in plant community composition, sagebrush health, and potential effects of climate change.

Project abstracts are presented in Sections 10.1.1 through 10.1.4.

10.1.1 Long-Term Vegetation Transects – Monitoring Recovery on the T-17 Fire Plots

Investigators and Affiliations

- Amy D. Forman, Plant Ecologist, Environmental Surveillance, Education, and Research Program, Gonzales-Stoller Surveillance, Idaho Falls, ID.
- Jackie R. Hafla, Natural Resource Specialist, Environmental Surveillance, Education, and Research Program, Gonzales-Stoller Surveillance, Idaho Falls, ID.

- Roger D. Blew, Ecologist, Environmental Surveillance, Education, and Research Program, Gonzales-Stoller Surveillance, Idaho Falls, ID.

Funding Sources

- U.S. Department of Energy, Idaho Operations Office

Background

During the summer of 2011, LTV data were collected across all active LTV plots and data collection was completed in the first week of August. On August 25, the T-17 Fire burned 11 LTV plots along T-17 (Figure 10-1), providing a unique opportunity to monitor fire recovery on a number of plots which were recently sampled and had been well-characterized for decades prior to the fire. Previous fire recovery studies on the INL Site have been very useful for understanding general post-fire vegetation dynamics in local sagebrush steppe; however none of these studies were informed by detailed pre-fire vegetation data

Aforementioned fire ecology studies on the INL Site and from other southeast Idaho locations suggest that a plant community reestablishing after a fire will be a reflection of the community present before the fire, with the exception of big sagebrush (*Artemisia tridentata*; Ratzlaff and Anderson 1995, Buckwalter 2002, Blew and Forman 2010). Typically, native plant communities in good pre-burn ecological condition will return to diverse, native plant communities within a few growing seasons post-burn and can resist invasion and/or dominance by non-native species. Recommendations for management of burned areas on the INL Site were based on the results of these studies and lead to the following guidance (Blew and Forman 2010):

- Vegetation management strategies should focus on enhancing the vigor of native, herbaceous species, regardless of burn status, because areas with vigorous native perennial plant communities are at less risk for post-fire invasions and are less likely to require active restoration to establish a healthy plant community following a fire.
- Managing for vigor of perennial grasses should be the highest vegetation management priority on recently burned areas, because sagebrush and other shrubs that increase habitat value are more likely to establish on good condition sites than on sites with an abundance of non-natives.
- A healthy pre-fire plant community can increase the resilience of a site, allowing substantial post fire recovery, even under very adverse conditions like severe drought.

While these guidelines provide a solid overarching philosophy for long-term post-fire vegetation management, they offer little direction for specific scenarios which necessitate enhancing shrub recovery in the short term or identifying specific events or conditions which may shift the recovery trajectory of a plant community to a less desirable state. The studies on which post-fire guidelines are based were conducted entirely post-fire, and pre-burn conditions were extrapolated from general conditions reported for plant communities elsewhere on the INL Site. Monitoring post-fire vegetation composition and comparing it to pre-fire vegetation dynamics will yield information important for characterizing a specific burned site and evaluating its potential to return to a desirable state. This information will in turn be useful for prioritizing restoration efforts.

Ongoing conservation management efforts on the INL Site, including the Candidate Conservation Agreement for Greater Sage-grouse (DOE-ID and FWS 2014), require that post-fire vegetation management strategies address more specific targets and objectives than they have in the past. They will also require that an active restoration decision be made within a year or two subsequent to a fire. This monitoring effort will support prioritization by quantifying how the range of variability for recovering communities compares to range of variability in pre-burn communities, which can be used to address issues like determining the abundance at which cheatgrass shifts from being a minor, somewhat ephemeral component of a plant community to a truly invasive community dominant. Understanding not only the current condition of a site, but its status in terms of its potential historical range of variability can be a powerful tool for determining the need for active restoration.

Objectives

The primary objective of this post-fire monitoring effort is to follow short-term vegetation recovery patterns on the 11 plots burned in the 2011 T-17 Fire and to assess the extent to which post-fire plant communities recover. Specifically, we are interested in how quickly community dynamics reflect pre-burn range of variability and to what extent other factors like weather and non-native species influence vegetation recovery. We also hope to gain information useful for developing more specific guidelines for post-fire assessments of potential recovery to support conservation planning on the INL Site. Spe-

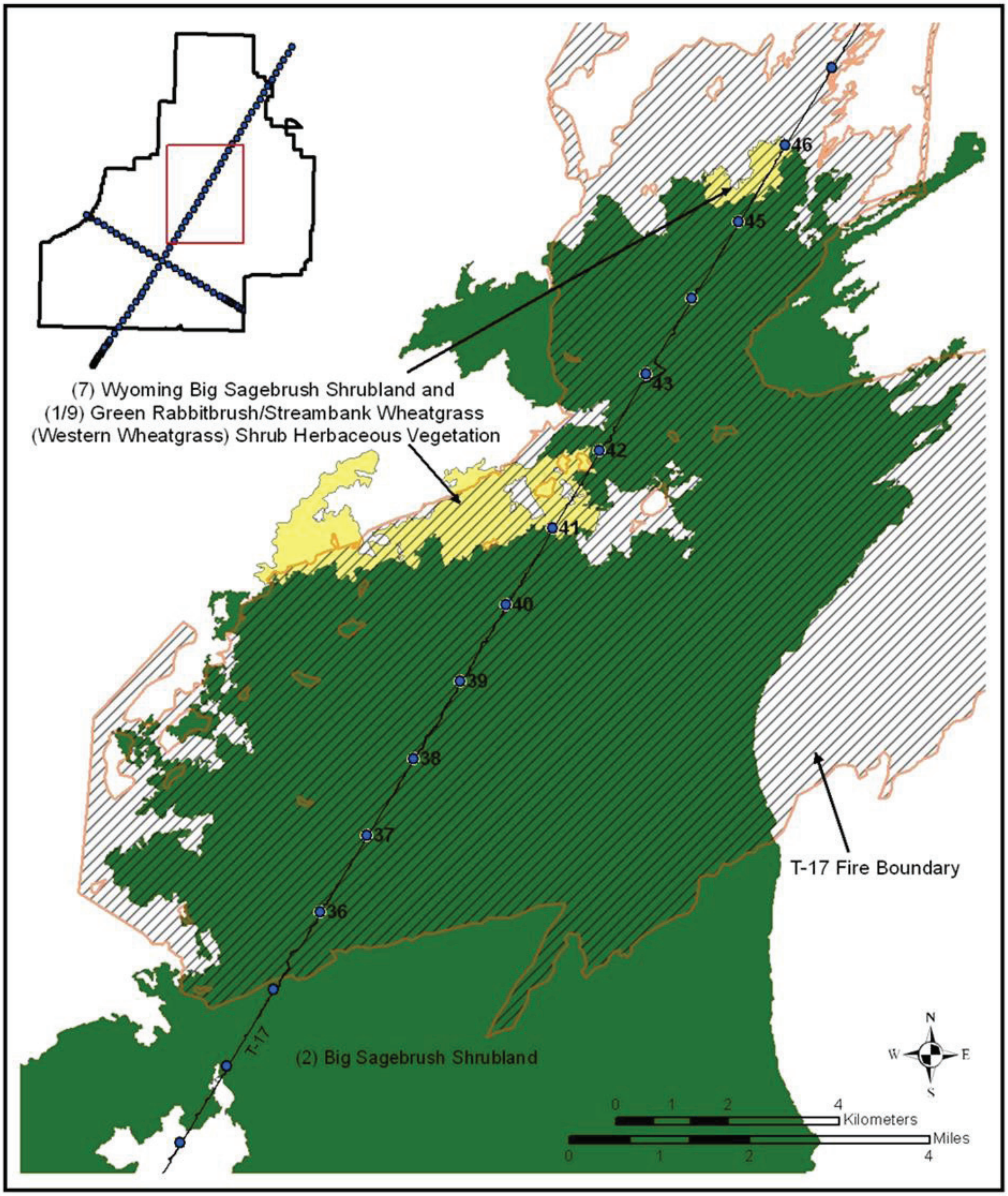


Figure 10-1. Location of 11 Long-term Vegetation Transect Plots which Burned during the 2011 T-17 Fire.
Vegetation classes represented are prior to the fire and are from Shive et al. (2011).

cific issues affecting post-fire recovery which can necessitate active restoration and can be monitored using this data set include; risk of post-fire cheatgrass dominance based on pre-fire abundance, effects of precipitation patterns on various native and non-native functional groups pre-and post-burn, and length of time fire induced vegetation compositional changes (other than loss of sagebrush) may persist.

Accomplishments through 2014

All active LTV plots were sampled for the 12th time during the summer of 2011 using the same standard techniques that have been used for estimating cover and density throughout the history of the LTV project. See Forman et al. (2010) for detailed sampling methodology. In 2012, 2013, and 2014 we sampled the 11 plots that burned in the T-17 during the same time frame (late-June to mid-July), within about one week of when they were sampled in 2011. Initial results comparing the plant community composition of each plot immediately prior to the fire to the composition of each plot almost one year after the fire are included in the most recent comprehensive LTV report (Forman et al. 2013). Data from 2013, the second post-fire growing season, and beyond, will be analyzed with the next full LTV effort.

Results

Initial results from data collected in 2011 and 2012 confirm that shrub and perennial forb cover are significantly reduced one year post-fire. However, cover from native, perennial graminoids was not significantly different post-fire than it was pre-fire (Table 10-1). This result indicates established perennial grasses readily resprout post-fire and it is particularly impressive given that total precipitation in spring and early summer of 2012 were far below average. Introduced annual and biennial cover, mostly from cheatgrass, was significantly lower post-fire than it was pre-fire (Table 10-1). This pattern has been noted in other post-fire data sets from the INL Site (Rew et al. 2012, Forman et al. 2013), but it is unclear whether reductions in abundance are from effects of the fire or are related to precipitation patterns that happen to coincide with post-fire recovery. It is also unknown whether post-fire reductions in cheatgrass are temporary and limited to a few seasons post-fire, or whether they persist and change the trajectory of a plant community long-term. See Forman et al. 2013 for more detailed results from comparison of the 2011 and 2012 data.

Plans for Continuation

Monitoring these 11 plots annually for the 5 years between comprehensive LTV sampling periods (2011 and 2016) will provide important and useful insight on the recovery of native species and on the redistribution and spread of introduced species following fire. Short-term annual data collection will also allow us to characterize the relative importance of precipitation on recovery, especially under more moderate conditions than occurred in 2012. Comparing recovery data over a five year period to historical vegetation dynamics should provide enough information to begin developing a basis for prioritizing restoration activities in burned areas elsewhere on the INL Site using short-term post-fire vegetation data. A comprehensive data analysis from monitoring the 11 LTV plots located in the T-17 burned area for five years post-fire will be included in the next LTV report, following complete LTV sampling in 2016.

Publications, Theses, Reports, etc.

Results summarizing data collected in 2011 and 2012 can be found in:

Forman, A. D., J. R. Hafla, and R. D. Blew. 2013. The Idaho National Laboratory Site Long-Term Vegetation Transects: Understanding Change

Table 10-1. Mean Absolute Cover by Functional Group and One-way Repeated Measures ANOVA Results Comparing Pre- and Post-fire Vegetation on 11 Long-term Vegetation Transect Plots at the INL Site.

	2011	2012	Significant
Native Shrubs	18.04	0.48	Yes
Native Perennial Graminoids	7.81	5.98	No
Native Perennial Forbs	1.60	0.74	Yes
Native Succulents	0.16	0.03	Yes
Native Annuals and Biennials	0.23	0.09	No
Introduced Annuals and Biennials	11.96	0.55	Yes

in Sagebrush Steppe. Environmental Surveillance, Education, and Research Program, Gonzales-Stoller Surveillance, LLC, Idaho Falls, ID. GSS-ESER-163.

10.1.2 Time Interval Photography Monitoring of Cinder Butte Snake Hibernaculum

Investigators and Affiliation

- Charles R. Peterson, Ph.D., Department of Biological Sciences, Idaho State University, Pocatello, ID
- Jeremy P. Shive, Environmental Surveillance, Education, and Research Program, Gonzales-Stoller Surveillance, LLC., Idaho Falls, ID
- David Bush, Department of Biological Sciences, Idaho State University, Pocatello, ID

Funding Sources

- Idaho State University Department of Biological Sciences
- Idaho National Environmental Research Park

Background

The T-17 wildland fire burned approximately 17,807 ha (44,000 acres) in 2011, including the area around Cinder Butte (Figure 10-2). The basalt outcropping near Cinder Butte supports multiple snake hibernacula, including the primary North den, which has been monitored by the ISU Herpetology Laboratory for over 15 years. Anecdotal field observations following the T-17 fire found there was a lot of soil and sand movement in the areas devoid of vegetation. The wind-blown sand was beginning to fill in the interspaces of the basalt rock and there was some concern whether access to the den would be restricted, and the individuals returning for winter hibernation would be stranded with no alternative refuge.

We used a Reconyx PC900 Hyperfire Professional IR camera positioned to image the main den opening and the surrounding vicinity of ledges and rock overhangs

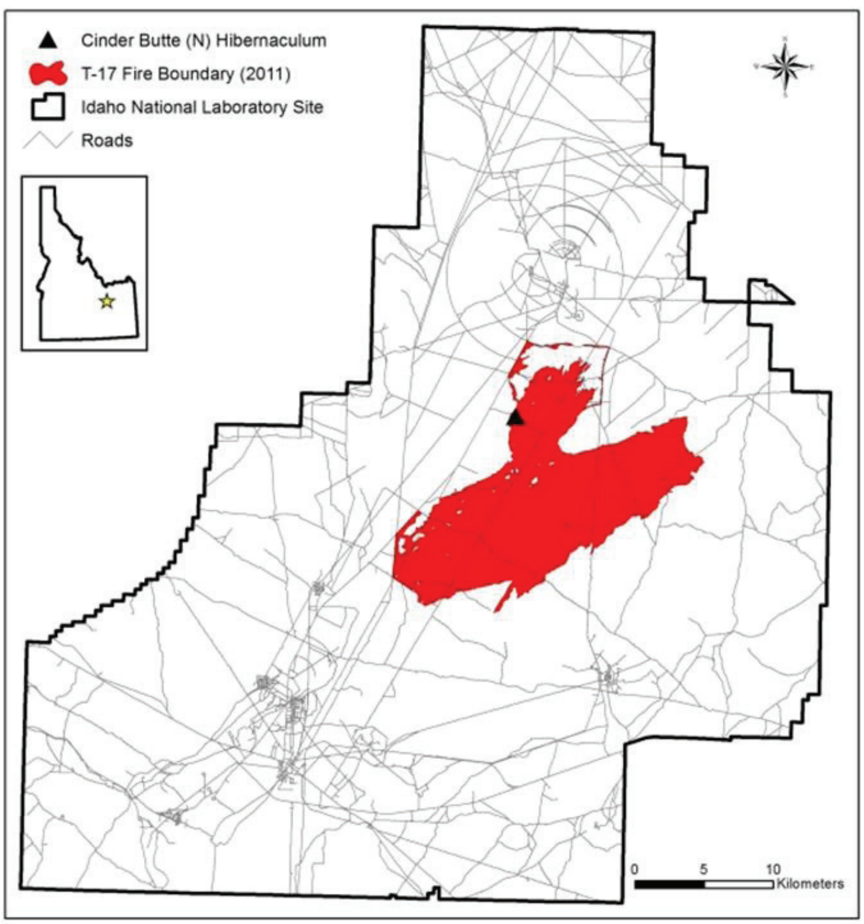


Figure 10-2. The INL Site Showing the Extent of the T-17 Wildland Fire and the Location of the Cinder Butte (North) Snake Hibernaculum.

where snakes are commonly observed (Figure 10-3). We also deployed temperature data loggers using snake physical models to record operative temperatures rather than just air temperature. The camera was configured to collect images on a one-minute fixed time interval from sunrise to sunset.

Objectives

The primary goal of monitoring the Cinder Butte snake hibernaculum is to document the continued use of the den site, and to identify which species of snakes remain present following the T-17 wildland fire. Additional objectives include comparing seasonal activity patterns with an established seasonal baseline to better understand if populations are increasing or decreasing, and to assess rates of detectability using various time-intervals to maximize accuracy and minimize sampling effort.

Accomplishments through 2014

In 2014, we collected over 82,000 images during the spring from 3/24 – 6/25, and over 32,000 images in the fall from 9/15 – 10/27. All images were initially reviewed once and each observation event was recorded. An observation event is defined as one snake observed for one or more consecutive images. If an individual moved out of view or retreated back into the den, it concluded the observation event even if an individual was seen back at the same spot minutes later. Because we cannot be sure it was the same individual, we treated each instance as a new observation event.

An Access database was designed to more efficiently store and manage the observation events recorded since 2013. The database provides a location to archive the monitoring data, and facilitate future data analyses of multiple seasons of image data.

Results

Time-interval photography continues to be an effective method for monitoring snake species at the Cinder Butte hibernaculum. All four species (Great Basin Rattlesnake, *Crotalus oreganus lutosus*; Gopher Snake, *Pituophis catenifer*; Striped Whipsnake, *Coluber taeniatus*; and Terrestrial Garter Snake, *Thamnophis elegans*) previously documented at the Cinder Butte hibernaculum by ISU Herpetology Laboratory were successfully detected and present during both spring and fall of 2014. There was only a single observation of a Terrestrial Garter Snake each season in 2014, and this species remains present despite seemingly limited number of individuals.

The camera was deployed earlier this spring compared to 2013, and we likely captured first emergence

Figure 10-3. An Example Time-interval Image Collected Showing the Main Den Opening and a Great Basin Rattlesnake Leaving the Den.

(i.e., the first snake to emerge from the hibernaculum following winter hibernation) on April 20. Even though air temperature was warm and there were many sunny days, no snakes were observed for the first three weeks of imaging. The last spring snake observation was made on June 5, when a Great Basin Rattlesnake head has visible near the ledge system above and right of the main den opening. Further analyses are planned to quantify the observations, however, there tended to be more Gopher Snakes observed early in the season with more Great Basin Rattlesnakes observed later in the season.

Fall imaging began on September 15, and we already had four observation events of Great Basin Rattlesnakes the first day. This suggests we missed the first return to the hibernaculum (i.e., the first individual to be observed returning to the hibernaculum before winter hibernation) and numerous individuals had already migrated back the hibernaculum before the imaging start date. Generally, there were more observation events for Great Basin Rattlesnakes in the fall compared to the spring.

Plans for Continuation

Once multiple seasons of data have been collected, a baseline of observation events can be established. Additional time interval photographic monitoring can be conducted in the future and compared to the established baseline to understand changes in population status of each species.

We would like to experiment with different camera settings to optimize the accuracy of snake detections while minimizing overall sample effort. Specifically, we want to test the omission error rate of the current time-interval setup. We plan to alter the time interval and capture an image every second (rather than every minute) from sunrise to sunset and essentially record a continuous sampling of the hibernaculum. Then that dataset would be artificially subsampled at different time intervals (e.g. 30-sec, 1-min, 2-min, etc.), and reviewed for observation events. This analysis will provide insight about how the time interval affects detection rates. If fewer images need to be collected, and detection rates do not vary considerably, we could minimize the required processing time.

We plan to model operative temps using physical snake models attached to a temperature datalogger. By comparing the internal camera system thermometer with the physical models, it will allow us to understand the relationship between camera measurements and the temperatures the snakes are more realistically experiencing at the den.

We also developed a laboratory exercise to incorporate undergraduate students from Idaho State University to assist with the image review process. Manually reviewing all of the images collected during a single season is the most time consuming step of the monitoring process. Comparisons between different observers have shown the omission error rate to be low, but there are observation events that were missed by both observers. If students prove to be effective conducting independent review of seasonal images, our observer error rate can be minimized while providing observation data for further analysis.

Publications, Reports, Theses, Etc.

Additional data analysis and statistical modeling are planned for 2015 but have not been initiated.

10.1.3 Ecosystem Responses of Sagebrush Steppe to Altered Precipitation, Vegetation and Soil Properties

Investigators and Affiliations

- Matthew J. Germino, Ph.D., Research Ecologist, United States Geological Survey, Forest and Rangeland Ecosystem Science Center, Boise Idaho
- Co-PI: Keith Reinhardt, Ph.D., Assistant Professor, Idaho State University, Pocatello, Idaho

Collaborators

- Lar Svenson, M.S., US Geological Survey, United States Geological Survey, Forest and Rangeland Ecosystem Science Center, Boise Idaho
- Kevin Feris, Ph.D., Assistant Professor, Boise State University, Boise, Idaho
- Kathleen Lohse, Ph.D., Assistant Professor, Idaho State University, Pocatello, Idaho
- Marie-Anne deGraff, Ph.D., Assistant Professor, Boise State University, Boise, Idaho
- David Hubler, Ph.D. candidate, Idaho State University, Pocatello, Idaho
- Patrick Sorenson, M.S., Boise State University, Boise, Idaho
- Patricia Xochi Campos, M.S. candidate, Boise State University, Boise Idaho

- Kate McAbee, M.S. candidate, Idaho State University, Pocatello, Idaho
- Andrew Bosworth, Science Teacher, Ririe, Idaho

Funding Sources

- Idaho Experimental Program to Stimulate Competitive Research, National Science Foundation
- U.S. Geological Survey, Forest and Rangeland Ecosystem Science Center
- U.S. Geological Survey, Northwest Climate Science Center
- In-kind facilities and infrastructure support from DOE-Idaho, logistics support through Gonzales-Stoller Surveillance, LLC.

Background

The INL Site and other landscapes having sagebrush steppe vegetation are experiencing a simultaneous change in climate and floristics that result from increases in exotic species. Determining the separate and combined/interactive effects of climate and vegetation change is important for assessing future changes on the landscape and for hydrologic processes.

This research uses the 72 experimental plots established and initially maintained for many years as the "Protective Cap Biobarrier Experiment" by Dr. Jay Anderson and the Stoller ESER program, and the experiment is also now referred to as the "INL Ecohydrology Study." We are evaluating long-term impacts of different plant communities commonly found throughout Idaho subject to different precipitation regimes and to different soil depths. Treatments of amount and timing of precipitation (irrigation), soil depth, and either native/perennial or exotic grass vegetation allow researchers to investigate how vegetation, precipitation and soil interact to influence soil hydrology and ecosystem biogeochemistry. This information will be used to improve a variety of models, as well as provide data for these models.

Objectives

The goal of this study is to assess the interactive and reciprocal effects of hydroclimate shifts and plant community composition on ecohydrological and biogeochemical processes, with the specific objectives to:

- Determine response of vegetation to timing of irrigation and soil depth, and conversely the influence of plant communities and vegetation type on deep soil water infiltration
- Investigate microbial communities and soil microbial enzymatic activity and soil aggregation/ porosity, to assess whether fundamental ecosystem changes to treatments are occurring and could feed back on water flow patterns
- Investigate changes in plant and soil nutrient pools and fluxes due to vegetation and precipitation differences.

Accomplishments through 2014

In 2014 we ended three major data collection efforts that provide key insight on biogeochemical responses to the main treatments of the experiment, and finished another study on the demographics of sagebrush responses to treatments. Mr. David Huber performed a stable isotope tracer study that will provide insight on how precipitation changes affect nitrogen transformation (e.g., denitrification, leaching) for his dissertation under Kathleen Lohse. Ms. Xochi Campos finished a multi-year study of decomposition rates using litter bags and soil incubations to assess impacts to respiratory efflux of carbon dioxide for her thesis under Ms. Marie Anne de Graff. Ms. Kate McAbee completed a year-long assessment of in-situ chamber measurement of soil and net-ecosystem flux of carbon dioxide as it relates to standing crop (biomass, and productivity) for her thesis under Keith Reinhardt. We also completed a detailed study of growth and survival of adult sagebrush as it relates to herbivory, and assessed seedling demographics, and assessed cheatgrass responses. We published a paper on sagebrush responses in Journal of Ecology and a project report with the USGS.

Results

Our preliminary data suggest differences in sagebrush growth and seedling establishment are occurring as a result of the precipitation treatments, and are accompanied by shifts in litter deposition and biogeochemical patterns. Winter precipitation increases net ecosystem exchange of carbon dioxide and carbon storage, although the response is largely in increases in biomass and not in soil carbon.

Plans for Continuation

We are currently focused on sustaining the treatments for up to several more years, and in the upcoming year we will consider final measurements and consider a plan for either terminating the treatments or downscaling them for a second-generation set of research questions (e.g., response of the communities to extended drought caused by ceasing irrigation). We expect the theses for Ms. Campos and McAbee and Dissertation for Mr. Huber to be published in 2015, when conclusive findings will be available.

Publications, Theses, Reports

Publications

Germino M. J., Reinhardt K. 2014. Desert shrub responses to experimental modification of precipitation seasonality and soil depth: relationship to the two-layer hypothesis and ecohydrological niche. Journal of Ecology. 102:989-997

Germino M. J., Reinhart K., Pilliod D., Debinski D. 2014. Sagebrush responses to climate – Final report to USGS NW-CSC, 52 pages. [nccwsc.usgs.gov/display-project/4f8c64d2e4b0546c0c397b46/5006eb3ee4b0abf7ce733f5a]

Presentations

Germino M. J. 2014, Climate, wildfire, and Great Basin Ecosystems. Next Steppe Conference. Boise ID, Nov 5.

McAbee K., K. Reinhardt, M. J. Germino. 2015. How do long-term changes in precipitation seasonality affect ecosystem carbon dynamics? Evidence from a 21-year, manipulative climate-change experiment. Great Basin Consortium (4th Annual), Boise ID, Feb 17-19.

Campos X., M. J. Germino, M. de Graaff, Precipitation effects plant litter quality and decomposition. Great Basin Consortium (4th Annual), Boise ID, Feb 17-19.

10.1.4 Studies of Ants and Ant Guests at the Idaho National Laboratory Site

Investigators and Affiliations

- William H. Clark, Orma J. Smith Museum of Natural History, The College of Idaho, Caldwell, Idaho 83605

Funding Sources

- Funding is by the principal investigator with some assistance and collaboration with the Orma J. Smith Museum of Natural History.

Background

Clark and Blom (2007) reported the first comprehensive annotated checklist of ants at the INL Site. This publication gives a starting point for additional research relating to ants, their natural history and ecology, and ant guests at INL Site. Ant guests (*myrmecophiles*) are organisms that live in close association with ants. These are generally mutualistic associations, but may also be commensal or parasitic. Much research remains to be done to better the understanding between ants and their guests.

Objectives

Immediate objectives are to locate living larvae of the ant guest beetle (*Philolithus elata*) (Coleoptera: Tenebrionidae) within nests of the harvester ant (*Pogonomyrmex salinus*) (Hymenoptera: Formicidae). These beetles have been documented from the harvester ant nests here in the past by Clark and Blom (unpublished data), but the larvae have not been previously described. Fresh larvae are needed for scanning electron microscopy to provide for a proper description of these organisms. The overall objective will be to document the interaction of this beetle with the ants.

Other observations on additional ant guests will be made as they are encountered. Information relating to the ants of INL Site will be documented as possible.

Accomplishments through 2014

During the fall of 2011, 100 nests of the harvester ant (*Pogonomyrmex salinus*) were selected and marked along Road T-17 near Circular Butte. These nests were then surveyed by INL archaeologists for cultural resources and approval was given for excavation of nests as needed. A total of 10 percent of the nests were excavated during late 2011 and no *Philolithus elatus* were found. Additional nests were excavated during the fall of 2012 and again no *Philolithus elatus* were found. We surveyed 41 nests during July 2013 and found *Philolithus elatus* larvae in six of the nests and pupae in two of the nests. During the fall of 2014 we examined more nests in the Circular Butte area and collected additional larvae and pupae which were preserved for study and photography. Addition SEM photographs have been taken of the immature states in preparation for description and publication.

Results

One ant guest taxa, a desert beetle (Coleoptera: Tenebrionidae: *Philolithus elatus*) (Figure 10-4) was collected in Pogonomyrmex salinus nests and is the subject of study and description (Clark, et al. in prep.). We have now taken preliminary photographs with light and scanning electron microscopy. The results will be published in Clark et al. (in prep) and have been presented in Clark et al. (2015). In addition, we are working on a publication relating to past research at the site involving cicadas and *Pogonomyrmex salinus* nests (Blom and Clark, in prep.).

An undescribed species of Jerusalem cricket (Orthoptera: Stenopelmatidae, Stenopelmatus sp.) has been found at the INL Site. The Stenopelmatus was found in the ant nests during previous field work. A series of live individuals including both males and females were needed for a proper species description. We collected 20 live specimens in July 2013 and additional specimens were collected during September 2014. In addition, one specimen was found in one of the excavated ant nests. They have been shipped to the specialist in the group for rearing and description. Both taxa will require more study during future visits to the INL Site.

Plans for Continuation

- Field research will continue into the foreseeable future.

Publications, Theses, Reports, Etc.

Three draft manuscripts are being prepared, so far, for this project:

Blom, P. E., and W. H. Clark. In Prep. Observations of cicada nymphs, *Okanagana annulata* Davis (Homoptera: Cicadidae) and the harvester ant *Pogonomyrmex salinus* Olsen (Hymenoptera: Formicidae) in southeastern Idaho. Manuscript being prepared for the *Western North American Naturalist*.

Clark, W. H., P. E. Blom, and P. J. Johnson. In Prep. *Philolithus elata* LeConte associated with *Pogonomyrmex salinus* Olsen nest soils in southeastern Idaho (Coleoptera, Tenebrionidae, Asidinae; Hymenoptera, Formicidae, Myrmicinae). Manuscript being prepared for the *Coleopterists Bulleti*n.

Clark, W. H., P. E. Blom, and P. J. Johnson. 2015. *Philolithus elatus* (LeConte) associated with *Pogonomyrmex salinus* Olsen nest soils in southeastern Idaho Poster for the Annual Idaho Academy of Science and Engineering Meetings, Boise, Idaho

Acknowledgments

Mary Clark assisted with the field work. Paul E. Blom has assisted with data analysis and detailed photographs of the immature beetles. Oregon Department of Agriculture assisted with the SEM.

Figure 10-4. Female *Phlolithus elatus* (LeConte) Found Ovipositing on Harvester Ant Nest in September 2014. *Note the long ovipositor she used to inset eggs into the ant mound. W.H. Clark Photo. Scale = beetle is approx. 3cm in length.*

Literature Cited for Section 10.1

Blew, R. D., and A. D. Forman, 2010 *Tin Cup fire recovery report*. STOLLER-ESER-143, Environmental Surveillance, Education, and Research Program, Idaho Falls, ID.

Buckwalter, S. P., 2002, *Postfire vegetation dynamics in sagebrush steppe on the eastern Snake River Plain, Idaho*. Idaho State University, Pocatello.

Clark, W. H., and P. E. Blom, 2007, Ants of the Idaho National Laboratory. *Sociobiology* 49(2):1-117.

Department of Energy, Idaho Operations Office (DOE-ID), and U.S. Fish and Wildlife Service (FWS). In review. *Candidate conservation agreement for greater sage-grouse (Centrocercus urophasianus) on the Idaho National Laboratory Site*. Idaho Falls, Idaho. GSS-ESER-153.

Forman, A. D., R. D. Blew, and J. R. Hafla, 2010, *The Idaho National Laboratory Site Long-Term Vegetation Transects: A comprehensive review*. STOLLER-ESER-126, Environmental Surveillance, Education, and Research Program, Idaho Falls, ID.

Forman, A. D., J. R. Hafla, and R. D. Blew, 2013, *The Idaho National Laboratory Site Long-Term Vegetation Transects: Understanding Change in Sagebrush Steppe*, Environmental Surveillance, Education, and Research Program, Gonzales-Stoller Surveillance, LLC, Idaho Falls, ID. GSS-ESER-163.

Ratzlaff, T. D., and J. E. Anderson, 1995, Vegetal recovery following wildfire in seeded and unseeded sagebrush steppe. *Journal of Range Management* 48:386-391.

Rew, L., B. Maxwell, M. Lavin, T. Brummer, and K. Taylor, 2012, *Survey, monitoring and predicting the occurrence and spread of native and non-native plant species at the Idaho National Laboratory*, Bozeman, MT.

Shive, J. P., A. D. Forman, K. Aho, J. R. Hafla, R. D. Blew, and K. T. Edwards, 2011, *Vegetation community classification and mapping of the Idaho National Laboratory Site.* GSS-ESER-144, Environmental Surveillance, Education, and Research Program, Idaho Falls, ID.

10.2 U.S. Geological Survey 2014 Publication Abstracts

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

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

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

Data gathered from these activities is used to create and refine hydrologic and geologic models of the aquifer, to track contaminant plumes in the aquifer and improve understanding of the complex relationships between the rocks, sediments and water that compose the aquifer. The USGS INL Project Office publishes reports about their studies, available through the USGS Publications Warehouse (http://id.water.usgs.gov/projects/INL/pubs.html.)

Five reports were published by the USGS INL Project Office in 2014. The abstracts of these studies and the publication information associated with each study are presented below.

10.2.1 Geochemistry of Groundwater in the Beaver and Camas Creek Drainage Basins, Eastern Idaho (Gordon W. Rattray and Michael L. Ginsbach)

The USGS, in cooperation with the DOE, is studying the fate and transport of waste solutes in the ESRP aquifer at the INL in eastern Idaho. This effort requires an understanding of the natural and anthropogenic geochemistry of groundwater at the INL and of the important physical and chemical processes controlling the geochemistry. In this study, the USGS applied geochemical modeling to investigate the geochemistry of groundwater in the Beaver and Camas Creek drainage basins, which provide groundwater recharge to the ESRP aquifer underlying the northeastern part of the INL.

Data used in this study include petrology and mineralogy from 2 sediment and 3 rock samples, and water-quality analyses from 4 surface-water and 18 groundwater samples. The mineralogy of the sediment and rock samples was analyzed with X-ray diffraction, and the mineralogy and petrology of the rock samples were examined in thin sections. The water samples were analyzed for field parameters, major ions, silica, nutrients, dissolved organic carbon, trace elements, tritium, and the stable isotope ratios of hydrogen, oxygen, carbon, sulfur, and nitrogen.

Groundwater geochemistry was influenced by reactions with rocks of the geologic terranes—carbonate rocks, rhyolite, basalt, evaporite deposits, and sediment comprised of all of these rocks. Agricultural practices near and south of Dubois and application of road anti-icing liquids on U.S. Interstate Highway 15 were likely sources of nitrate, chloride, calcium, and magnesium to groundwater.

Groundwater geochemistry was successfully modeled in the alluvial aquifer in Camas Meadows and the ESRP fractured basalt aquifer using the geochemical modeling code PHREEQC. The primary geochemical processes appear to be precipitation or dissolution of calcite and dissolution of silicate minerals. Dissolution of evaporite minerals, associated with Pleistocene Lake Terreton, is an important contributor of solutes in the Mud Lake-Dubois area. Oxidation-reduction reactions are important influences on the chemistry of groundwater at Camas Meadows and the Camas National Wildlife Refuge. In addition, mixing of different groundwaters or surface water with groundwater appears to be an important physical process influencing groundwater geochemistry in much of the study area, and evaporation may be an important physical process influencing the groundwater geochemistry of the Camas National Wildlife Refuge. The mass-balance modeling results from this study provide an explanation of the natural geochemistry of groundwater in the ESRP aquifer northeast of the INL, and thus provide a starting point for evaluating the natural and anthropogenic geochemistry of groundwater at the INL.

10.2.2 Evaluation of Quality-Control Data Collected by the U.S. Geological Survey for Routine Water-Quality Activities at the Idaho National Laboratory and Vicinity, Southeastern Idaho, 2002–08 (Gordon W. Rattray)

Quality-control samples were collected from 2002 through 2008 by the USGS, in cooperation with the DOE, to ensure data robustness by documenting the variability and bias of water-quality data collected at surface-water and groundwater sites at and near the Idaho National Laboratory. Quality-control samples consisted of 139 replicates and 22 blanks (approximately 11 percent of the number of environmental samples collected). Measurements from replicates were used to estimate variability (from field and laboratory procedures and sample heterogeneity), as reproducibility and reliability, of water-quality measurements of radiochemical, inorganic, and organic constituents. Measurements from blanks were used to estimate the potential contamination bias of selected radiochemical and inorganic constituents in water-quality samples, with an emphasis on identifying any cross contamination of samples collected with portable sampling equipment.

The reproducibility of water-quality measurements was estimated with calculations of normalized absolute difference for radiochemical constituents and relative standard deviation (RSD) for inorganic and organic constituents. The reliability of water-quality measurements was estimated with pooled RSDs for all constituents. Reproducibility was acceptable for all constituents except dissolved aluminum and total organic carbon. Pooled RSDs were equal to or less than 14 percent for all constituents except for total organic carbon, which had pooled RSDs of 70 percent for the low concentration range and 4.4 percent for the high concentration range.

Source-solution and equipment blanks were measured for concentrations of tritium, strontium-90, cesium-137, sodium, chloride, sulfate, and dissolved chromium. Field blanks were measured for the concentration of iodide. No detectable concentrations were measured from the blanks except for strontium-90 in one source solution and one equipment blank collected in September and October 2004, respectively. The detectable concentrations of strontium-90 in the blanks probably were from a small source of strontium-90 contamination or large measurement variability, or both.

Order statistics and the binomial probability distribution were used to estimate the magnitude and extent of any potential contamination bias of tritium, strontium-90, cesium-137, sodium, chloride, sulfate, dissolved chromium, and iodide in water-quality samples. These statistical methods indicated that, with (1) 87 percent confidence, contamination bias of cesium-137 and sodium in 60 percent of water-quality samples was less than the minimum detectable concentration or reporting level; (2) 92–94 percent confidence, contamination bias of tritium, strontium-90, chloride, sulfate, and dissolved chromium in 70 percent of water-quality samples was less than the minimum detectable concentration or reporting level; and (3) 75 percent confidence, contamination bias of iodide in 50 percent of water-quality samples was less than the reporting level for iodide. These results support the conclusion that contamination bias of water-quality samples from sample processing, storage, shipping, and analysis was insignificant and that cross-contamination of perched groundwater samples collected with bailers during 2002–08 was insignificant.

10.2.3 Completion Summary for Boreholes USGS 140 and USGS 141 near the Advanced Test Reactor Complex, Idaho National Laboratory, Idaho (Brian V. Twining, Roy C. Bartholomay, and Mary K. V. Hodges)

In 2013, the U.S. Geological Survey, in cooperation with the U.S. Department of Energy, drilled and constructed boreholes USGS 140 and USGS 141 for stratigraphic framework analyses and long-term groundwater monitoring of the eastern Snake River Plain aquifer at the Idaho National Laboratory in southeast Idaho. Borehole USGS 140 initially was cored to collect continuous geologic data, and then re-drilled to complete construction as a monitor well. Borehole USGS 141 was drilled and constructed as a monitor well without coring. Boreholes USGS 140 and USGS 141 are separated by about 375 feet (ft) and have similar geologic layers and hydrologic characteristics based on geophysical and aquifer test data collected. The final construction for boreholes USGS 140 and USGS 141 required 6-inch (in.) diameter carbon-steel well casing and 5-in. diameter stainless-steel well screen; the screened monitoring interval was completed about 50 ft into the eastern Snake River Plain aquifer, between 496 and 546 ft below land surface (BLS) at both sites. Following construction and data collection, dedicated pumps and water-level access lines were placed to allow for aquifer testing, for collecting periodic water samples, and for measuring water levels.

Borehole USGS 140 was cored continuously, starting from land surface to a depth of 543 ft BLS. Excluding surface sediment, recovery of basalt and sediment core at borehole USGS 140 was about 98 and 65 percent, respectively. Based on visual inspection of core and geophysical data, about 32 basalt flows and 4 sediment layers were collected from borehole USGS 140 between 34 and 543 ft BLS. Basalt texture for borehole USGS 140 generally was described as aphanitic, phaneritic, and porphyritic; rubble zones and flow mold structure also were described in recovered core material. Sediment layers, starting near 163 ft BLS, generally were composed of fine-grained sand and silt with a lesser amount of clay; however, between 223 and 228 ft BLS, silt with gravel was described. Basalt flows generally ranged in thickness from 3 to 76 ft (average of 14 ft) and varied from highly fractured to dense with high to low vesiculation.

Geophysical and borehole video logs were collected during certain stages of the drilling and construction process at boreholes USGS 140 and USGS 141. Geophysical logs were examined synergistically with the core material for borehole USGS 140; additionally, geophysical data were examined to confirm geologic and hydrologic similarities between boreholes USGS 140 and USGS 141 because core was not collected for borehole USGS 141. Geophysical data suggest the occurrence of fractured and (or) vesiculated basalt, dense basalt, and sediment layering in both the saturated and unsaturated zones in borehole USGS 141. Omni-directional density measurements were used to assess the completeness of the grout annular seal behind 6-in. diameter well casing. Furthermore, gyroscopic deviation measurements were used to measure horizontal and vertical displacement at all depths in boreholes USGS 140 and USGS 141.

Single-well aquifer tests were done following construction at wells USGS 140 and USGS 141 and data examined after the tests were used to provide estimates of specific-capacity, transmissivity, and hydraulic conductivity. The specific capacity, transmissivity, and hydraulic conductivity for well USGS 140 were estimated at 2,370 gallons per minute per foot [(gal/min)/ft)], 4.06 $\times 10^5$ feet squared per day (ft^2/d), and 740 feet per day (ft/d), respectively. The specific capacity, transmissivity, and hydraulic conductivity for well USGS 141 were estimated at 470 (gal/min)/ft, 5.95 $\times 10^4$ ft^2/d, and 110 ft/d, respectively. Measured flow rates remained relatively constant in well USGS 140 with averages of 23.9 and 23.7 gal/min during the first and second aquifer tests, respectively, and in well USGS 141 with an average of 23.4 gal/min.

Water samples were analyzed for cations, anions, metals, nutrients, volatile organic compounds, stable isotopes, and radionuclides. Water samples from both wells indicated that concentrations of tritium, sulfate, and chromium were affected by wastewater disposal practices at the Advanced Test Reactor Complex. Most constituents in water from wells USGS 140 and USGS 141 had concentrations similar to concentrations in well USGS 136, which is upgradient from wells USGS 140 and USGS 141.

10.2.4 Field Methods and Quality-Assurance Plan for Water-Quality Activities and Water-Level Measurements, U.S. Geological Survey, Idaho National Laboratory, Idaho (Roy C. Bartholomay, Neil V. Maimer, and Amy J. Wehnke)

Water-quality activities and water-level measurements by the personnel of the USGS INL Project Office coincide with the USGS mission of appraising the quantity and quality of the Nation's water resources. The activities are carried out in cooperation with the DOE Idaho Operations Office. Results of the water-quality and hydraulic head investigations are presented in various USGS publications or in refereed scientific journals and the data are stored in the National Water Information System database. The results of the studies are used by researchers, regulatory and managerial agencies, and interested civic groups.

In the broadest sense, quality assurance refers to doing the job right the first time. It includes the functions of planning for products, review and acceptance of the products, and an audit designed to evaluate the system that produces the products. Quality control and quality assurance differ in that quality control ensures that things are done correctly given the "state-of-the-art" technology, and quality assurance ensures that quality control is maintained within specified limits.

10.2.5 Measurement of Unsaturated Hydraulic Properties and Evaluation of Property-Transfer Models for Deep Sedimentary Interbeds, Idaho National Laboratory, Idaho (Kim S. Perkins, Benjamin B. Mirus, and Brittany D. Johnson)

Operations at the INL have the potential to contaminate the underlying ESRP aquifer. Methods to quantitatively characterize unsaturated flow and recharge to the ESRP aquifer are needed to inform water-resources management decisions at INL. In particular, hydraulic properties are needed to parameterize distributed hydrologic models of unsaturated flow and transport at INL, but these properties are often difficult and costly to obtain for large areas. The unsaturated zone overlying the ESRP aquifer consists of alternating sequences of thick fractured volcanic rocks that can rapidly transmit water flow and thinner sedimentary interbeds that transmit water much more slowly. Consequently, the sedimentary interbeds are of considerable interest because they primarily restrict the vertical movement of water through the unsaturated zone. Previous efforts by the USGS have included extensive laboratory characterization of the sedimentary interbeds and regression analyses to develop property-transfer models, which relate readily available physical properties of the sedimentary interbeds (bulk density, median particle diameter, and uniformity coefficient) to water retention and unsaturated hydraulic conductivity curves.

During 2013–14, the USGS, in cooperation with the U.S. Department of Energy, focused on further characterization of the sedimentary interbeds below the future site of the proposed Remote Handled Low-Level Waste facility, which is intended for the long-term disposal of low-level radioactive waste. Twelve core samples from the sedimentary interbeds from a borehole near the proposed facility were collected for laboratory analysis of hydraulic properties, which also allowed further testing of the property-transfer modeling approach. For each core sample, the steady-state centrifuge method was used to measure relations between matric potential, saturation, and conductivity. These laboratory measurements were compared to water-retention and unsaturated hydraulic conductivity parameters estimated using the established property-transfer models. For each core sample obtained, the agreement between measured and estimated hydraulic parameters was evaluated quantitatively using the Pearson correlation coefficient (r). The highest correlation is for saturated hydraulic conductivity (K_{sat}) with an r value of 0.922. The saturated water content (q_{sat}) also exhibits a strong linear correlation with an r value of 0.892. The curve shape parameter (λ) has a value of 0.731, whereas the curve scaling parameter (y_o) has the lowest r value of 0.528. The r values demonstrate that model predictions correspond well to the laboratory measured properties for most parameters, which supports the value of extending this approach for quantifying unsaturated hydraulic properties at various sites throughout INL.

References for Section 10.2

Bartholomay, R. C., Maimer, N. V ., and Wehnke, A. J., 2014, Field methods and quality-assurance plan for water-quality activities and water-level measurements, U.S. Geological Survey, Idaho National Laboratory, Idaho: U.S. Geological Survey Open-File Report 2014–1146 (DOE/ID-22230), 64 p. http://pubs.usgs.gov/of/2014/1146/

Perkins, K. S., Mirus, B. B., and Johnson, B. D., 2014, Measurement of unsaturated hydraulic properties and evaluation of property-transfer models for deep sedimentary interbeds, Idaho National Laboratory, Idaho: U.S. Geological Survey Scientific Investigations Report 2014–5206 (DOE/ID-22231), 16 p., http://pubs.usgs.gov/sir/2014/5206/.

Rattray, G. W., 2014, Evaluation of quality-control data collected by the U.S. Geological Survey for routine water-quality activities at the Idaho National Laboratory and vicinity, southeastern Idaho, 2002–08: U.S. Geological Survey Scientific Investigations Report 2014-5027 (DOE/ID-22228), 66 p. http://pubs.usgs.gov/sir/2014/5027/

Rattray, G. W. and Ginsbach, M. L, 2014, Geochemistry of groundwater in the Beaver and Camas Creek drainage basins, eastern Idaho: U.S. Geological Survey Scientific Investigations Report 2013-5226 (DOE/ID-22227), 70 p. http://pubs.usgs.gov/sir/2013/5226/

Twining, B. V., Bartholomay, R. C., and Hodges, M. K. V., 2014, Completion summary for boreholes USGS 140 and USGS 141 near the Advanced Test Reactor Complex, Idaho National Laboratory, Idaho: U.S. Geological Survey Scientific Investigations Report 2014-5098 (DOE/ID-22229), 40 p., plus appendixes http://pubs.usgs.gov/sir/2014/5098/.

Cushion Buckwheat
Eriogonum ovalifolium

11. QUALITY ASSURANCE

Quality assurance (QA) consists of the planned and systematic activities necessary to provide adequate confidence in the results of effluent monitoring and environmental surveillance programs (NCRP 2012). The main objective of an environmental monitoring program is to provide data of high quality so that the appropriate assessments and decisions based on those data can be made. This chapter presents information on specific measures taken by the effluent monitoring and environmental surveillance programs in 2014 to ensure the high quality of data collected and presented in this annual report as well as a summary of performance.

Required Criteria of a Quality Program

- Quality assurance program
- Personnel training and qualification
- Quality improvement process
- Documents and records
- Established work processes
- Established standards for design and verification
- Established procurement requirements
- Inspection and acceptance testing
- Management assessment
- Independent assessment

11.1 Quality Assurance Policy and Requirements

The primary policy, requirements, and responsibilities for establishing and maintaining plans and actions that ensure QA in U.S. Department of Energy (DOE) activities are provided in DOE Order 414.1D, "Quality Assurance" (i.e., QA Order), 10 Code of Federal Regulations (CFR) 830, Subpart A, "Quality Assurance Requirements" (i.e., QA Rule), and American Society of Mechanical Engineers NQA-1-2012, "Quality Assurance Requirement for Nuclear Facility Applications." The 10 criteria of a quality program specified by these regulations are shown in the box to the right. Additional QA program requirements in 40 CFR 61, Appendix B must be met for all radiological air emission sources continuously monitored for compliance with 40 CFR 61, Subpart H.

Each Idaho National Laboratory (INL) Site environmental monitoring organization incorporates QA requirements appropriate to its program to ensure that environmental samples are representative and complete and that data are reliable and defensible.

11.2 Program Elements and Supporting QA Processes

According to National Council on Radiation Protection and Measurements (2012), QA is an integral part of every aspect of an environmental monitoring program, from the reliability of sample collection through sample transport, storage, processing, and measurement, to calculating results and formulating the report. Uncertainties in the environmental monitoring process can lead to misinterpretation of data and/or errors in decisions based on these data. Every step in the radiological effluent monitoring and environmental surveillance should be evaluated for integrity and actions taken to evaluate and manage data uncertainty. These actions include proper planning, sampling and measurement, application of quality control (QC) procedures, and careful analysis of data used for decision making.

What is the difference between Quality Assurance and Quality Control in an environmental program?

Quality Assurance (QA) is an integrated system of management activities designed to ensure quality in the processes used to produce environmental data. The goal of QA is to improve processes so that results are within acceptable ranges.

Quality Control (QC) is a set of activities that provide program oversight (i.e., a means to review and control the performance of various aspects of the QA program). QC provides assurance that the results are what is expected.

The main elements of environmental monitoring programs implemented at the INL Site, as well as the QA processes/activities which support them, are shown in Figure 11-1 and are discussed below. Summaries of program-specific QC data are presented in Section 11.3. Documentation of the QA programs at the INL Site is provided in Section 11.4.

11.1.1 Planning

Environmental monitoring activities are conducted by a variety of organizations consisting of:

- INL
- Idaho Cleanup Project (ICP)
- Environmental Surveillance, Education, and Research (ESER) Program
- United States Geological Survey
- National Oceanic and Atmospheric Administration
- Advanced Mixed Waste Treatment Project.

Each INL Site monitoring organization determines sampling requirements using the U.S. Environmental Protection Agency (EPA) Data Quality Objective (DQO) process (EPA 2006) or its equivalent. During this process, the project manager determines the type, amount, and quality of data needed to meet regulatory requirements, support decision making, and address stakeholder concerns.

Environmental Monitoring Plan. The *Idaho National Laboratory Site Environmental Monitoring Plan* (DOE-ID 2014a) summarizes the various programs at the INL Site. It describes routine compliance monitoring of airborne and liquid effluents, environmental surveillance of air, water (surface, drinking and ground), soil, biota, agricultural products and external radiation, as well as ecological and meteorological monitoring on and in the vicinity of the INL Site. The plan includes the rationale for monitoring, the types of media monitored, where the monitoring is conducted, and information regarding access to analytical results.

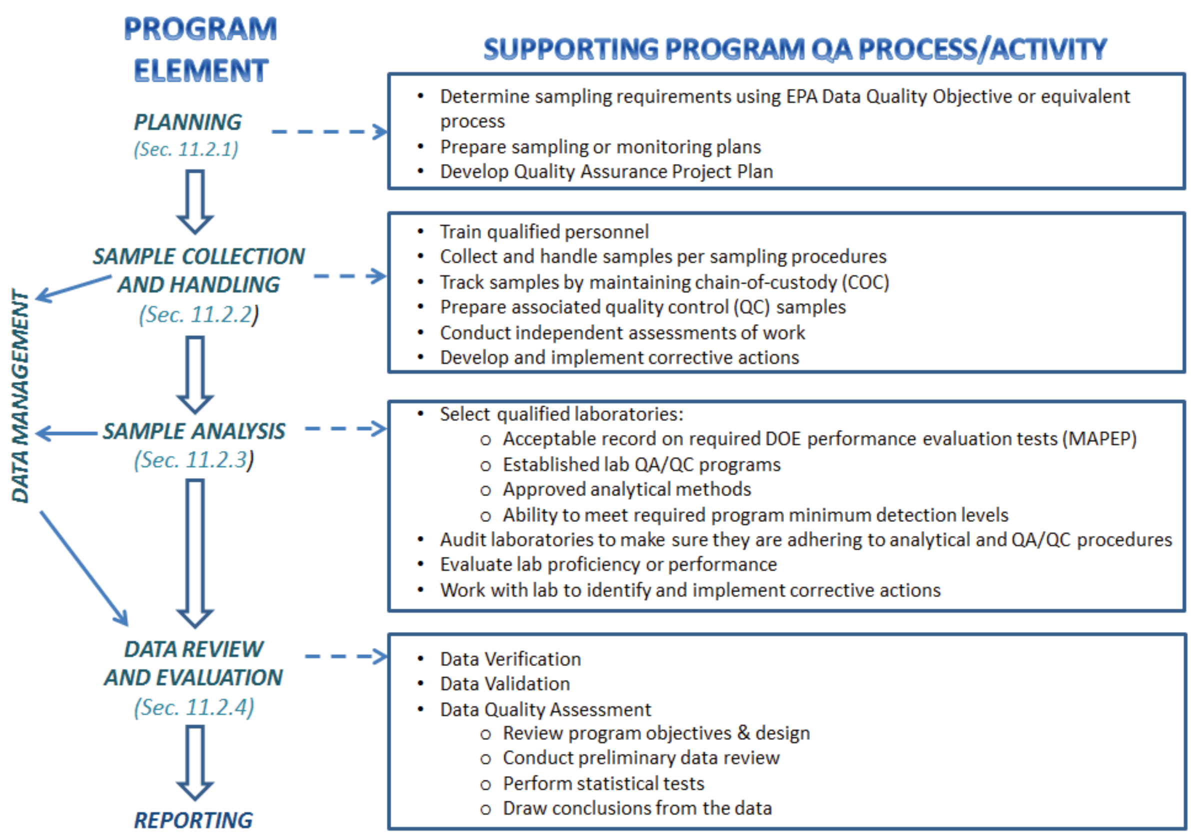


Figure 11-1. Flow of Environmental Monitoring Program Elements and Associated QA Processes and Activities.

Technical Basis Document for Environmental Monitoring and Surveillance at the INL Site. Many of the environmental monitoring programs at the INL Site were initiated in the early 1950s soon after the Atomic Energy Commission (now DOE) established the National Reactor Testing Station. The programs evolved as missions changed, regulatory requirements expanded, and technology advanced, but some core elements (such as selected monitoring locations) did not change as they were assessed to still be technically applicable. In 2010, an independent assessment of the INL Site environmental monitoring programs was performed by the DOE Office of Independent Oversight, within the Office of Health, Safety and Security (HSS) at the request of the DOE Idaho Operations Office (www.gsseser.com/Annuals/2010/PDFS/AppendixB.pdf). The purpose of the assessment was to evaluate the adequacy of the INL Site environmental monitoring and surveillance program in meeting the objectives of DOE Order 450.1A Sections 4(c)(2)(a-d) for protection of public health and the environment, and (c)(5-6) for conducting monitoring and assuring data quality, and DOE Order 5400.5 for assessing potential pathways of contaminant emissions that may impact the local environment and public living near the INL Site. (Note: DOE Order 450.1A was cancelled by DOE O 436.1 on May 11, 2011 and DOE Order 5400.1 was replaced by DOE O 458.1 on February 11, 2011.) Overall, the HSS concluded that the environmental monitoring and surveillance activities at the INL Site are comprehensive and meet the basic objectives of applicable DOE requirements. However, it was suggested that the effectiveness of the overall program in ensuring full understanding of potential environmental impacts could be optimized through various enhancements, most notably through a well-defined technical basis for each media sampled to support or defend the adequacy of protocols to meet current objectives (i.e., what is sampled, the frequency of sampling, the locations chosen, specific analytes being measured). The *Technical Basis for Environmental Monitoring and Surveillance at the Idaho National Laboratory Site (*DOE-ID 2014b) was prepared to address the areas for enhancement identified by the HSS assessment, emphasizing the scientific basis for the current radiological environmental surveillance activities. In support of this, formal DQOs are being prepared for the environmental surveillance programs conducted by the INL contractor and the ESER contractor on and off the INL.

Quality Assurance Project Plan. Implementation of QA elements for sample collection and data assessment activities are documented by each monitoring contractor using the approach recommended by the EPA. The EPA policy on QA plans is based on the national consensus standard ANSI/ASQC E4-1994, "Specifications and Guidelines for Quality Systems for Environmental Data Collection and Environmental Technology Programs." The EPA approach to data quality centers on the DQO process. DQOs are project dependent and are determined on the basis of the data users' needs and the purpose for which data are generated. Quality elements applicable to environmental monitoring and decision-making are specifically addressed in *EPA Requirements for Quality Assurance Project Plans* (EPA QA/R-5) (EPA 2001). These elements are categorized as follows:

- Project management
- Data generation and acquisition
- Assessment and oversight
- Data validation and usability.

A Quality Assurance Project Plan (QAPjP) documents the planning, implementation, and assessment procedures for a particular project, as well as any specific QA and QC activities. It integrates all the technical and quality aspects of the project in order to provide a "blueprint" for obtaining the type and quality of environmental data and information needed for a specific decision or use. Each environmental monitoring and surveillance program at the INL Site prepares a QAPjP.

11.2.2 Sample Collection and Handling

Strict adherence to program procedures is an implicit foundation of QA. In 2014, samples were collected and handled according to documented program procedures. Samples were collected by personnel trained to conduct sampling and properly process samples. Sample integrity was maintained through a system of sample custody records. Assessments of work execution were routinely conducted by personnel independent of the work activity and deficiencies were addressed by corrective actions, which are tracked in contractor-maintained corrective action tracking systems.

QC samples were also collected or prepared to check the quality of sampling processes. They included the collection of trip blanks, field blanks, split samples, and field duplicates, which are defined as follows:

Trip Blank. A sample of analyte-free media taken from the sample preparation area to the sampling site and returned to the analytical laboratory unopened. A trip blank is used to document contamination attributable to shipping and field handling procedures. This type of blank is useful in documenting contamination of volatile organics samples.

Field Blank. A clean analyte-free sample that is carried to the sampling site and then exposed to sampling conditions, returned to the laboratory, and treated as an environmental sample. A field blank is collected to assess the potential introduction of contaminants during sampling. This blank is used to provide information about contaminants that may be introduced during sample collection, storage, and transport.

Split Sample. A sample collected and later divided into two portions that are analyzed separately. The samples are taken from the same container and analyzed independently. Split samples are used to assess precision.

Field Replicates (duplicates or collocated samples). Two samples collected from a single location at the same time. Two separate samples are taken from the same source, stored in separate containers, and analyzed independently. In the case of air sampling, two air samplers are placed side by side and each filter is analyzed separately. Duplicates are useful in documenting the precision of the sampling process. Field duplicates also provide information on analytical variability caused by sample heterogeneity, collection methods and laboratory procedures (see Section 11.2.3).

11.2.3 Sample Analysis

Analytical laboratories used to analyze environmental samples collected on and off the INL Site are presented in Table 11-1.

Radiological analytical laboratories used for routine analyses of radionuclides in environmental media were selected by each environmental monitoring program based on each laboratory's capabilities to meet program objectives (such as ability to meet required detection limits) and past results in performance evaluation programs, such as the Mixed Analyte Performance Evaluation Program (MAPEP) described in Section 11.4. Continued acceptable performance in programs such as MAPEP is required to remain as the contracted laboratory.

Each laboratory's adherence to laboratory and QA procedures is checked through audits by representatives of the contracting environmental monitoring program. Subcontract laboratories used by the INL and ICP contractors are also audited by the DOE Consolidated Audit Program (DOECAP). This program uses trained and certified personnel to perform in-depth audits of subcontract laboratories to review:

- Personnel training and qualification
- Detailed analytical procedures
- Calibration of instrumentation
- Participation in an inter-comparison program
- Use of blind controls
- Analysis of calibration standards.

Precision is the degree of agreement among measured values. It represents an error among repeated measures of the same property under identical conditions. Results obtained from analyses of split or duplicate samples are compared and precision is expressed as standard deviation, variance, or range.

Audit results are maintained by the DOECAP. Laboratories are required to provide corrective action plans for audit findings and are closed when DOECAP approves the corrective action plan implemented by the laboratory.

Laboratory data quality is verified by a continuing program of internal laboratory QA/QC programs, participation in inter-laboratory crosschecks, replicate sampling and analysis, submittal of blind standard samples and blanks, and splitting samples with other laboratories.

Performance evaluation samples and blind spikes are used to measure measurement accuracy and are defined as follows:

Performance Evaluation Sample. A type of blind sample. The composition of performance evaluation samples is unknown to the analyst. Performance evalu-

Accuracy refers to the degree of agreement between a measured value and an accepted reference or true value. Two principal attributes of accuracy are precision and systematic error (bias). An accurate measurement is achieved with high precision and low systematic error (bias). Accuracy is monitored by performing measurements and evaluating results of control samples containing known quantities of the analytes of interest (performance evaluation sample or blind spike).

Table 11-1. Analytical Laboratories Used by INL Site Contractors and U.S. Geological Survey Environmental Monitoring Programs.

Contractor and Program	Laboratory	Type of Analysis
ICP Drinking Water Program	GEL Laboratories, LLC	Radiological
	Intermountain Analytical Service – EnviroChem	Microbiological
	UL LLC	Inorganic and organic
	Eurofins Eaton Analytical, Inc.	Inorganic and organic
ICP Environmental Program	ALS Laboratory Group – Fort Collins	Radiological
ICP Liquid Effluent Monitoring Program	ICP Wastewater Laboratory	Microbiological
	GEL Laboratories, LLC	Inorganic and radiological
ICP Groundwater Monitoring Program	GEL Laboratories, LLC	Inorganic, organic, radiological, and microbiological
	Southwest Research Institute	Inorganic, radiological, and microbiological
	Test America	Radiological, inorganic, and metals
INL Drinking Water Program	GEL Laboratories, LLC	Radiological
	Intermountain Analytical Service – EnviroChem	Inorganic
	Teton Microbiology Laboratory of Idaho Falls	Bacterial
	Eurofins Eaton Analytical, Inc.	Organic
INL Liquid Effluent and Groundwater Program	GEL Laboratories, LLC	Radiological
	Southwest Research Institute	Inorganic
INL Environmental Surveillance Program	ALS Laboratory Group – Fort Collins	Radiological
	Environmental Services In Situ Gamma Laboratory	I-131
	Landauer Inc.	Penetrating radiation (OSL and neutron dosimeters)
Environmental Surveillance, Education, and Research Program	Environmental Assessments Laboratory at Idaho State University	Gross radionuclide analyses (e.g., gross alpha and gross beta), OSL dosimetry, liquid scintillation counting (tritium), and gamma spectrometry
	ALS Laboratory Group – Fort Collins	Specific radionuclides (e.g. ^{90}Sr, ^{241}Am, ^{238}Pu, and $^{239/240}$Pu)
U.S. Geological Survey	DOE's Radiological and Environmental Sciences Laboratory	Radiological
	USGS National Water Quality Laboratory	Nonradiological and low-level tritium and stable isotopes
	Purdue Rare Isotope Measurement Laboratory	Low-level iodine-129
	TestAmerica Laboratories	Radiological and nonradiological for the USGS Naval Reactors Facility sample program
	Brigham Young University Laboratory of Isotope Geochemistry	Low-level tritium for the USGS Naval Reactors Facility sample program

ation samples are provided to evaluate the ability of the analyst or laboratory to produce analytical results within specified limits. Performance evaluation samples (submitted as double blind spikes) are required to assess analytical data accuracy. The DOE MAPEP program is an example of a performance evaluation program.

Blind Spike. Used to assess the accuracy of the analytical laboratories. Contractors obtain samples spiked with known amounts of radionuclides or nonradioactive substances from suppliers whose spiking materials are traceable to National Institute of Standards and Technology (NIST). These samples are then submitted to the laboratories with regular field samples using the same labeling and sample numbering system. The analytical results are expected to compare to the known value within a set of performance limits. Blind spikes are generally used to establish intra-laboratory or analyst-specific precision and accuracy or to assess the performance of all or a portion of the measurement system. A double blind spike is a sample submitted to evaluate performance with concentration and identity unknown to both the submitter and the analyst.

11.2.4 Data Review and Evaluation

Data generated from environmental monitoring or surveillance programs are evaluated in order to understand and sustain the quality of data collected. This allows the program to determine if the monitoring objectives established in the planning phase were achieved and determine if the laboratory is performing within QA/QC requirements.

An essential component of data evaluation is the availability of reliable, accurate, and defensible records for all phases of the program, including sampling, analysis, and data management.

Environmental data are first subject to data verification and data validation. These terms are discussed below:

Data verification. The act of reviewing, inspecting, testing, checking, auditing, or otherwise determining and documenting whether items, processes, services or documents conform to specified requirements. The data verification process involves checking for common errors associated with analytical data. A review is first conducted to ensure all data and sample documentation are present and complete. Additional sampling and analysis process information that may also be reviewed at this stage include sample preservation and temperature, defensible chain-of-custody documentation and integrity, analytical hold-time compliance, correct test method, adequate analytical recovery, correct minimum detection limit, possible cross-contamination, and matrix interference (i.e., analyses affected by dissolved inorganic/organic materials in the matrix).

Data validation. Confirmation by examination and provision of objective evidence that the particular requirements for a specified intended use are fulfilled. Validation involves a more extensive process than data verification. According to the *DOE Handbook – Environmental Radiological Monitoring and Environmental Surveillance* (DOE 2014a):

> Validation confirms that the required number of samples and types of data were collected in accordance with the sampling/monitoring plan; confirms the usability of the data for the intended end use via validation of analyses performed and data reduction and reporting; and ensures requirements were met such as detection limits, QC measurements, impacts of qualifiers, etc.

Data quality assessment. Data quality assessment includes reviewing data for accuracy, representativeness, and fit with historical measurements to ensure that the data will support their intended uses. A preliminary data assessment is also performed. The goal of the initial assessment is to determine the structure of the data—i.e., distribution of data (normal, lognormal, exponential, or nonparametric)—identify relationships/associations, trends or patterns between sample points/variables or over time; identify anomalies; and lastly, select the appropriate statistical tests for decision making.

11.3 Quality Control Results for 2014

Results of the QC measurements for specific DOE-contracted programs in 2014 are summarized in the following sections. QC sample data are used to monitor the analytical control on a given batch of samples and are indicators over time of potential biases in laboratory performance. Evaluation of data from routine analyses of QC samples are discussed for field duplicates, split samples, LCSs, blank analyses, matrix spikes, and proficiency testing programs. Summary tables are provided for the environmental surveillance programs administered by the ESER contractor, the INL Contractor, and the ICP contractor.

All DOE environmental monitoring programs must participate in performance evaluation programs, which are described in Section 11.3.1.

11.3.1 Performance Evaluation Programs

11.3.1.1 Mixed Analyte Performance Evaluation Program

The MAPEP (DOE 2014) is administered by DOE's Radiological and Environmental Sciences Laboratory (RESL). RESL has conducted the MAPEP program since 1994, through a performance-based performance evaluation program that tests the ability of the laboratories to correctly analyze for radiological, stable organic and inorganic constituents representative of those at DOE sites. MAPEP distributes samples of air filter, water, vegetation, and soil for radiological analysis during the first and third quarters. Series 30 was distributed in February 2014, and Series 31 was distributed in August 2014. DOE's RESL maintains accreditation to International Organization for Standardization (ISO) 17043 (2377.02) as a Performance Testing Provider, ISO 17025 (2377.01) as a Chemical Testing Laboratory, and ISO G34 (2377.03) as a Reference Material Producer by the American Association for Laboratory Accreditation.

Both radiological and nonradiological constituents are included in MAPEP. Results can be found at http://www.id.energy.gov/resl/mapep/mapepreports.html.

Laboratories that participate in MAPEP sometimes have results with a flag. MAPEP laboratory results may include the following flags:

- A = Result acceptable, bias ≤20 percent
- W = Result acceptable with warning, 20 percent < bias <30 percent
- N = Result not acceptable, bias >30 percent
- L = Uncertainty potentially too low (for information purposes only)
- H = Uncertainty potentially too high (for information purposes only)
- QL = Quantitation limit
- RW = Report warning
- NR = Not reported.

MAPEP issues a letter of concern to a participating laboratory for sequential unresolved failures. This is to help participants identify, investigate, and resolve potential quality issues (http://www.id.energy.gov/resl/mapep/handbookv13.pdf). A letter of concern is issued to any participating laboratory that demonstrates:

- "Not Acceptable" performance for a targeted analyte in a given sample matrix for the two most recent test sessions (e.g., plutonium-238 [^{238}Pu] in soil test 13 "+N" [+36 percent bias], ^{238}Pu in soil test 14 "-N" [-43 percent bias])
- "Not Acceptable" performance for a targeted analyte in two or more sample matrices for the current test session (e.g., cesium-137 [^{137}Cs] in water test 14 "+N" [+38 percent], ^{137}Cs in soil test 14 "+N" [+45 percent])
- Consistent bias, either positive or negative, at the "Warning" level (greater than ± 20 percent bias) for a targeted analyte in a given sample matrix for the two most recent test sessions (e.g., strontium-90 [^{90}Sr] in air filter test 13 "+W" [+26 percent], ^{90}Sr in air filter test 14 "+W" [+28 percent])
- Quality issues (flags other than "Acceptable") that were not identified by the above criteria for a targeted analyte in a given sample matrix over the last three test sessions (e.g., americum-241 [^{241}Am] in soil test 12 "-N" [-47 percent], ^{241}Am in soil test 13 "+W" [+24 percent], ^{241}Am in soil test 14 "-N" [-38 percent])
- Any other performance indicator and/or historical trending that demonstrate an obvious quality concern (e.g., consistent "false positive" results for ^{238}Pu in all tested matrices over the last three test sessions).

A more detailed explanation on MAPEP's quality concerns criteria can be found at www.inl.gov/resl/mapep/data/mapep_loc_final_3_.pdf.

11.3.1.2 National Institute of Standards and Technology

The DOE RESL participates in a Radiological Traceability Program administered through NIST. The RESL prepares requested samples for analysis by NIST to confirm their ability to adequately prepare sample material to be classified as NIST traceable. NIST also prepares several alpha-, beta- and gamma-emitting standards in all matrix types for analysis by the RESL to confirm their analytical capabilities. The RESL maintained NIST certifications in both preparation of performance evaluation material and analysis of performance evaluation samples in 2014. For further information on the RESL Radiological Traceability Program, go to: http://www.id.energy.gov/resl/rtp/rtp.html.

11.3.1.3 Other Programs

INL Site contractors participate in additional performance evaluation programs, including those administered by the International Atomic Energy Agency, EPA, and the American Society for Testing and Materials. Contractors are required by law to use laboratories certified by the state of Idaho or certified by another state whose certification is recognized by the state of Idaho for drinking water analyses. The Idaho Department of Environmental Quality (DEQ) oversees the certification program and maintains a list of approved laboratories. Where possible (i.e., the laboratory can perform the requested analysis), the contractors use state-approved laboratories for all environmental monitoring analyses.

11.3.2 Quality Control Data

11.3.2.1 Liquid Effluent Program Quality Control Data

INL Contractor

The INL contractor Liquid Effluent Monitoring (LEMP) and Groundwater Monitoring Programs (GWMP) have specific QA/QC objectives for analytical data. Goals are established for accuracy, precision, and completeness. The program submits field duplicates to provide information on variability caused by sample heterogeneity and collection methods. In 2014, field duplicates were collected at the Advanced Test Reactor Complex Cold Waste Pond, U.S. Geological Survey (USGS)-076, Materials and Fuels Complex Industrial Waste Pipeline and the Industrial Waste Water Underground Pipe, and well ANL-MON-A-014 at the Material and Fuels Complex.

For nonradiological analytes, if the reported concentration in the first sample and the duplicate exceeded the detection limit by a factor of five or more, the laboratory precision was evaluated by calculating the relative percent difference (RPD) using Equation 1.

$$RPD = \frac{|R1 - R2|}{(R1 + R2)/2} \, x \, 100 \qquad (1)$$

Where

R_1 = concentration of analyte in the first sample

R_2 = concentration of analyte in the duplicate sample.

The precision of the radiological results were considered acceptable if the RPD was less than or equal to 35 percent or if the following condition was met:

$$|R_1 - R_2| \leq 3(s_1^2 + s_2^2)^{1/2} \qquad (2)$$

Where

R_1 = concentration of analyte in the first sample

R_2 = concentration of analyte in the duplicate sample

s_1 = uncertainty (one standard deviation) associated with the laboratory measurement of the first sample

s_2 = uncertainty (one standard deviation) associated with the laboratory measurement of the duplicate sample.

The INL contractor LEMP and GWMP requires that the RPD from field duplicates be less than or equal to 35 for 90 percent of the analyses. Over 90 percent of the results for the duplicate samples were comparable to the original samples.

The goal for completeness is to collect 100 percent of all required compliance samples. This goal was met in 2014.

Accuracy was assessed using the results of the laboratory's control samples, initial and continuing calibration samples, and matrix spikes. As an additional check on accuracy, four performance evaluation samples (prepared by RESL) were submitted to the laboratory and analyzed for radiological constituents. The results for the spiked constituents were in agreement with the known spiked concentrations.

ICP Contractor

The ICP contractor LEMP has QA/QC objectives for analytical data. Goals are established for completeness, precision, and accuracy, and all analytical results are validated following standard EPA protocols. Three types of LEMP QC samples are submitted for analysis: field duplicates, equipment rinsates, and performance evaluation samples. Table 11-2 presents a summary of 2014 LEMP QC criteria and performance results.

Completeness. The ICP LEMP goal for completeness was to collect and successfully analyze 100 percent of all required compliance samples. This goal was not met in 2014. Ninety-eight percent of the samples were collected and analyzed. A total of 408 sample parameters were collected and submitted for analysis, with 399 parameters successfully analyzed. The analytical results for six parameters, the April 2014 total suspended solids

Table 11-2. 2014 ICP LEMP, WRP Groundwater Monitoring Program, and Drinking Water Program QA/QC Criteria and Performance.

ICP Liquid Effluent Monitoring Program	Criterion	2014 Performance
Completeness		
Compliance Samples Successfully Collected	100%	100%
Compliance Samples Successfully Analyzed	100%	98%
Surveillance Samples Collected and Successfully Analyzed	90%	100%
Precision		
Field Duplicates	90%	89%
Equipment Rinsates	90%	100%
Accuracy		
Performance Evaluation Samples	90%	90%
ICP WRP Groundwater Monitoring Program	**Criterion**	**2014 Performance**
Completeness		
Compliance Samples Successfully Collected	100%	100%
Compliance Samples Successfully Analyzed	100%	100%
Surveillance Samples Collected and Successfully Analyzed	90%	100%
Precision		
Field Duplicates	90%	100%
Equipment Rinsates	90%	94%
Field Blanks	90%	94%
Accuracy		
Performance Evaluation Samples	90%	88%
ICP Drinking Water Monitoring Program	**Criterion**	**2014 Performance**
Completeness		
Compliance Samples Successfully Collected	100%	100%
Compliance Samples Successfully Analyzed	100%	100%
Surveillance Samples Collected and Successfully Analyzed	90%	100%
Precision		
Field Duplicates	90%	100%
Field Blanks	100%	100%
Trip Blanks	100%	100%
Accuracy		
Performance Evaluation Samples	90%	95%

samples collected at CPP-769, CPP-773, and CPP-797, and the June 2014 total Kjeldahl nitrogen samples collected at CPP-769, CPP-773, and CPP-797, were rejected by the validator due to the accuracy of the data. The results for the May 2014 biochemical oxygen demand samples collected at CPP-769, CPP-773, and CPP-797 were also questionable based on historical data. A discussion of these nine results is provided in RPT-1341, 2014 Wastewater Reuse Site Performance Report for the *Idaho Nuclear Technology and Engineering Center New Percolation Ponds (LA-000130-05)* (ICP 2015).

The goal for completeness was to collect and successfully analyze 90 percent of the LEMP surveillance samples. This goal was exceeded in 2014; 100 percent of the samples were collected and analyzed. A total of 456 sample parameters were collected, and 456 parameters were successfully analyzed.

Field Duplicate Samples. To quantify measurement uncertainty from field activities, a nonradiological field duplicate sample is collected annually at CPP-769, CPP-773, and CPP-797 and analyzed for the permit-specific parameters. The RPD between the sample result and the field duplicate sample result (using only parameters with two detectable quantities) should be 35 percent or less for 90 percent of the parameters analyzed. Field duplicate samples were collected at CPP-769 and CPP-773 on March 12, 2014, and at CPP-797 on April 23, 2014. Eighty-nine percent of the results had a RPD of less than or equal to 35 percent.

A radiological field duplicate sample is collected annually at CPP-773 and analyzed for gross alpha, gross beta, total strontium activity, and gamma spectrometry. The mean difference determined from the sample result and the field duplicate sample result (using two statistically positive results) should be less than or equal to three for 90 percent of the parameters. A radiological field duplicate sample was collected from CPP-773 on September 23, 2014. Of the 24 parameters analyzed, only gross beta had two statistically positive results. The mean difference was calculated to be 0.12, which was less than the goal of three.

Equipment Rinsate Samples. Equipment rinsate samples are collected annually and are used to evaluate the effectiveness of equipment decontamination. Samples are collected after decontamination and prior to sampling. A rinsate sample was collected from the CPP-773 sampling equipment on June 18, 2014. Four of the five parameters analyzed were not detected, which indicated that the decontamination procedure was adequate. The result for the fifth parameter, total Kjeldahl nitrogen, was rejected by the validator who recommended that the data not be used due to low matrix spike recovery and exceeded laboratory duplicate sample criteria.

Performance Evaluation Samples. During 2014, performance evaluation samples were submitted to the laboratory with routine wastewater monitoring samples on March 12, June 18, September 17, and November 12. Eighty-nine percent of the results were within their QC performance acceptance limits, which was below the program goal of 90 percent. The laboratory was notified and was requested to investigate the results that were outside the QC performance acceptance limits. Summaries of the investigations for the March 12, June 18, and September 17 performance evaluation samples are provided in the 2014 Wastewater Reuse Report (ICP 2015). A summary of the laboratory's investigation for the November 12 performance evaluation samples follows.

The results for 18 of the 19 performance evaluation sample parameters submitted to the laboratory on November 12, 2014, were within their QC performance acceptance limits. The result for aluminum was 0.688 mg/L, and the QC performance acceptance limits for aluminum were 0.523 mg/L to 0.683 mg/L. Laboratory personnel indicated that aluminum was the only analyte not to meet the 87-114 percent criteria, missing at 114.9 percent. The slight high bias could be attributed to a biased high calibration for the analysis date. The initial calibration verification read 103.5 percent, well within the ± 5 percent criteria. The bracketing continuing calibration verifications were 105.3 percent and 107.4 percent, respectively, well within the ± 10 percent criteria, but on the high side of 100 percent. The method blank was a non-detect, and the LCS recovered at 106 percent. Had the 5 percent high bias been absent, the laboratory would have met the criteria. No corrective actions were identified by the laboratory for this issue.

11.3.2.2 Idaho Cleanup Project Contractor Wastewater Reuse Permit Groundwater Monitoring Quality Control Data

The ICP contractor Wastewater Reuse Permit (WRP) GWMP has specific QA/QC objectives for analytical data. Goals are established for completeness, precision, and accuracy, and all analytical results are validated following standard EPA protocols. Four types of QC samples are submitted for analysis: field duplicates, field blanks, equipment rinsates, and performance evaluation samples. Table 11-2 presents a summary of 2014 WRP GWMP QC criteria and performance results.

Completeness. The goal for completeness was to collect and successfully analyze 100 percent of all required compliance samples. This goal was met in 2014. A total of 240 sample parameters were collected and submitted for analysis, and 240 parameters were successfully analyzed. Some of the results were qualified during data validation, and the reported concentrations are provided in Tables C-6 and C-7. These qualified results are summarized in the 2014 Wastewater Reuse Report (ICP 2015).

The goal for completeness was to collect and successfully analyze 90 percent of the WRP GWMP surveillance samples. This goal was exceeded in 2014. Sixteen parameters, or 100 percent, were collected and successfully analyzed.

Field Duplicate Samples. To quantify measurement uncertainty from field activities, nonradiological field duplicate samples are collected semiannually and analyzed for the permit-specific parameters. The RPD between the sample result and the field duplicate sample result (using only parameters with two detectable quantities) should be 35 percent or less for 90 percent of the parameters analyzed. Field duplicate samples were collected from Well ICPP-MON-A-165 on April 9, 2014, and from Well ICPP-MON-A-166 on September 10, 2014. One hundred percent of the results had a RPD of less than or equal to 35 percent.

A radiological field duplicate sample is collected semiannually and analyzed for gross alpha and gross beta. A radiological field duplicate sample was collected from Well ICPP-MON-A-165 on April 9, 2014, and from Well ICPP-MON-A-166 on September 10, 2014. The mean difference determined from the sample result and the field duplicate sample result (using two statistically positive results) should be less than or equal to three for 90 percent of the parameters. Of the four parameters analyzed, only one gross beta sample had two statistically positive results. The mean difference was calculated to be 2.15, which was less than the goal of three.

Field Blank Samples. Field blanks were prepared as part of the April 9, 2014, and September 11, 2014, sampling events. All analytical results were below their respective detection/reporting limits for the April field blank, indicating that no contamination was introduced during sample collection, storage, and transport. For the September field blank, all analytical results were below their respective detection/reporting limits except for chromium (0.00189 mg/L), which was above its method detection limit of 0.001 mg/L. WRP GWMP personnel were notified of the detections.

Equipment Rinsate Samples. Equipment rinsates were collected on April 9, 2014, and September 11, 2014. All analytical results were below their respective detection/reporting limits for the April rinsate sample, indicating that proper decontamination procedures were followed. For the September rinsate sample, all analytical results were below their respective detection/reporting limits except for chromium (0.00226 mg/L) and total dissolved solids (47.1 mg/L). WRP GWMP personnel were notified of the detections.

Performance Evaluation Samples. Performance evaluation samples were submitted to the laboratory with routine groundwater monitoring samples on April 9, 2014, and September 10, 2014. Eighty-eight percent of the performance evaluation sample results were within their QC performance acceptance limits, but less than the program goal of 90 percent. The laboratory was requested to investigate the April 2014 mercury sample result and the September 2014 total Kjeldahl nitrogen, total phosphorus, biochemical oxygen demand, and mercury sample results that did not meet their acceptance criteria. Summaries of the laboratory investigations are provided in the 2014 Wastewater Reuse Report (ICP 2015).

11.3.2.3 Idaho Cleanup Project Contractor Waste Area Group 7 Groundwater Monitoring Quality Control Data

QA/QC samples and results for Waste Area Group (WAG) 1, WAG 3, and WAG 4 are discussed in the annual reports for Fiscal Year 2014 (DOE-ID 2015a; DOE-ID 2015b; DOE-IE 2016c) and for WAG 2 in the Fiscal Year 2015 report (DOE-ID 2015d).

For the Waste Group Area (WAG) 7 November 2014 groundwater monitoring sampling event at Radioactive Waste Management Complex (RWMC), the QA parameters of precision, representativeness, comparability, and sampling completeness met the project goals and DQOs as specified in the *Field Sampling Plan* (Forbes and Holdren 2014). The project objectives for accuracy were met with the exception of the performance evaluation and field QC samples described in the following paragraphs.

Double-blind performance evaluation samples containing known concentrations of selected radionuclides were prepared by RESL. The performance evaluation samples were submitted to the contract laboratory (GEL) along with the November 2014 RWMC aquifer groundwater samples to assess analytical performance.

The analytical results reported by GEL were within acceptable limits, except for cobalt-60, ^{238}Pu, and uranium-233/234 ($^{233/234}$U) in one sample. The results for cobalt-60 and $^{233/234}$U were biased high, with reported concentrations at 176 percent and 132 percent of the known (true) concentration, respectively, which were outside the acceptable range of 70 percent to 130 percent. For ^{238}Pu, however, the laboratory result was too low (48 percent of the known concentration). The analytical laboratory was notified of the unacceptable results for these three radionuclides and asked to perform further evaluation and take any necessary corrective actions. However, because these constituents have not historically been detected in the aquifer beneath the RWMC, these results do not adversely affect data usability for the November 2014 sampling event.

Although not a contaminant of concern for WAG 7, chloroform was detected slightly above the quantitation limit of 1 µg/L in samples from Well M7S (primary sample and field duplicate) and Well M15S. All of the field and trip blanks associated with these samples were determined to be contaminated with chloroform within the concentration range of 2.26 µg/L to 2.55 µg/L. The source of contamination was ascertained to be due to the presence of chloroform in the Fisher Environmental Grade water used to prepare the blanks, which, by product specification, may have contained as much as 2 to 3 µg/L of chloroform. This type of reagent water is not suitable for volatile organic blanks. To resolve the issue, project personnel procured a different brand of "organic-free" reagent water for future sampling events. In conclusion, although chloroform has historically been detected in low concentrations in the groundwater from Wells M7S and M15S, the chloroform results from these two wells were qualified with a "U" validation flag, meaning these results are considered non-detections due to detection in the field and trip blanks.

11.3.2.4 Drinking Water Program Quality Control Data

INL Contractor

The INL contractor Drinking Water Program has specific QA/QC objectives for analytical data. Drinking Water Program goals are established for precision of less than or equal to 35 percent for 90 percent of the analyses and 100 percent completeness. The Drinking Water Program submits field duplicates to provide information on analytical variability caused by sample heterogeneity, collection methods, and laboratory procedures.

For nonradiological analytes, if the reported concentration in the first sample and the duplicate exceeded the detection limit by a factor of five or more, the laboratory precision was evaluated by calculating the relative RPD.

The precision of the radiological results were considered acceptable if the RPD was less than or equal to 35 percent or if the condition of Equation 2 was met.

RPD was not calculated if either the sample or its duplicate was reported as nondetect. For 2014, the Drinking Water Program had 33 samples of radiological data with detectable quantities. Using the above criteria, 100 percent of the radiological data is comparable, meeting the RPD goal of less than or equal to 35 percent for 90 percent of the analyses.

Blind spike samples are used to determine the accuracy of laboratory analyses for concentrations of parameters in drinking water. Within each calendar year, the program lead determines the percentage of the samples collected (excluding bacteria samples) that are QA/QC samples, which include blind spikes. All blind spike percent recoveries must fall within the standards range.

Representativeness is ensured through use of established sampling locations, schedules, and procedures for field sample collections, preservation, and handling.

The DQOs address completeness for laboratory and field operations. The criterion for completeness by laboratories is that at least 90 percent of the surveillance and 100 percent of the compliance samples submitted annually must be successfully analyzed and reported according to specified procedures. Similarly, the criterion for field data collection under the INL Environmental Support and Services Monitoring Services is that at least 90 percent of the surveillance and 100 percent of the compliance samples must be successfully collected on an annual basis and reported according to the specified procedures. If a completeness criterion is not met, the problem will be evaluated, and it will be determined whether the quality of the remaining data is suspect and whether a corrective action is needed either in the field collection or laboratory analysis. These objectives were met.

Comparability is ensured through the use of (1) laboratory instructions for sample collection, preparation, and handling, (2) approved analytical methods for laboratory analyses, and (3) consistency in reporting procedures.

ICP Contractor

The ICP Drinking Water Monitoring Program (DWP) has specific quality QA/QC objectives for analytical data. Goals are established for completeness, precision, and accuracy, and all analytical results are validated or verified following standard EPA protocols. Four types of DWP QC samples are submitted for analysis: field duplicates, field blanks, trip blanks, and performance evaluation samples. Table 11-2 presents a summary of 2014 DWP QC criteria and performance results.

Completeness. The goal for completeness was to collect and successfully analyze 100 percent of all required compliance samples. This goal was met in 2014. A total of 61 parameters were collected and submitted for analysis, and 61 parameters were successfully analyzed. For the DWP surveillance samples, the goal for completeness was to collect and successfully analyze 90 percent of the samples. This goal was exceeded in 2014. A total of 83 parameters were collected, and 83 parameters, or 100 percent, were successfully analyzed.

Field Duplicate Samples. Field duplicate samples were collected on January 29, 2014, (volatile organic compounds [VOCs]), April 30, 2014, (VOCs), June 6, 2014, (lead and copper), June 13, 2014, (lead and copper), June 25, 2014, (nitrate), July 30, 2014, (VOCs), August 13, 2014, (total trihalomethanes and haloacetic acids), and October 8, 2014, (VOCs). The RPD determined from field duplicate samples should be 35 percent or less for 90 percent of the parameters analyzed. One hundred percent of the field duplicate sample results (with two detectable quantities) were within the program goal for RPD of less than or equal to 35 percent.

Radiological field duplicate samples were collected from WMF-604 on January 13, 2014, and analyzed for gross alpha and gross beta. None of the sample results were statistically positive, so a mean difference was not calculated. On July 24, 2014, radiological field duplicate samples were collected from CPP-614 and analyzed for gross alpha, gross beta, tritium, and ^{90}Sr. Of the four parameters analyzed, only the gross beta result was statistically positive. The mean difference was calculated to be 1.89, which was less than the goal of three.

Field Blank Samples. Field blanks were prepared as part of the January 29, 2014, April 30, 2014, and July 30, 2014, sampling events. One hundred percent of the analytical results were below their respective detection/reporting limits. The program goal of 100 percent was met in 2014.

Trip Blank Samples. Trip blanks were prepared as part of the January 29, 2014, April 30, 2014, July 30, 2014, August 13, 2014, and October 8, 2014, sampling events. One hundred percent of the analytical results were below their respective detection/reporting limits. The program goal of 100 percent was met in 2014.

Performance Evaluation Samples. Performance evaluation samples were submitted to the laboratory with routine drinking water samples on January 29, 2014, April 30, 2014, June 6, 2014, June 25, 2014, July 30, 2014, and August 13, 2014. The results for 77 of the 81 performance evaluation sample parameters (95 percent) were within their QC performance acceptance limits. The program goal of 90 percent was met in 2014. The laboratory was notified of the results that were outside the QC performance acceptance limits and was requested to investigate and provide any corrective actions, as necessary. Summaries of these investigations follow.

On April 30, 2014, a VOC performance evaluation sample was submitted to the laboratory. The result for trichloroethylene was 2.0 µg/L, which was outside its QC performance acceptance limit of 2.23 µg/L to 3.43 µg/L. The laboratory was contacted to investigate the issue but took no action. Laboratory personnel responded and considered the performance evaluation sample more of a proficiency test and not a QC sample. Laboratory personnel expressed that they were within EPA's quantitative acceptance limits of ± 40 percent when the concentration is less than 10 µg/L (see 40 CFR 141.24[f][17][i][D]). In addition, they expressed that they were performing adequately because it was within the QC performance acceptance limits for the July 30, 2014, performance evaluation sample. The laboratory was notified that the QC performance acceptance limits have been used in the past to independently assess laboratory performance.

On August 13, 2014, a total trihalomethanes performance evaluation sample was submitted to the laboratory. The results for three of the four sample parameters were outside their QC performance acceptance limits. The result for bromodichloromethane was 32.0 µg/L, and the QC performance acceptance limits were 33.0 µg/L to 51.1 µg/L. The result for bromoform was 14.0 µg/L, and the QC performance acceptance limits were 16.5 µg/L to 27.9 µg/L. The result for dibromochloromethane was 18.0 µg/L, and the QC performance acceptance limits were 22.4 µg/L to 35.1 µg/L. Laboratory personnel reviewed its QC for conformance with the analysis associated with the total trihalomethanes performance evaluation sample. The investigation concluded controls were validated with the instrument, calibrations and secondary stock standards, and all results passed from the continuing calibration, matrix spike, matrix spike duplicate, and low calibration samples. Calibration was performed on August 8, 2014, and no problems with the curves were reported. Instrument checks and the instrument maintenance journal were also reviewed, and no issues were noted. No corrective actions were identified by the laboratory for this issue.

11.3.2.5 Environmental Surveillance, Education, and Research Program Quality Control Data

Table 11-3 presents a summary of 2014 ESER QC analysis results.

Table 11-3. 2014 ESER Surveillance Program QA Elements.

QC Program Element - 2014	Criterion	Performance[a]
Scheduled samples completeness	98%	100.0%
Submitted Samples Analyzed By Lab	100%	100.0%
Accuracy		
Blind spike program[b]		
Idaho State University - Environmental Assessment Lab (EAL)	No absolute criterion - Looking for trends and lab issues to improve performance	91.1%
ALS Environmental Laboratory - Fort Collins (ALS)		86.7%
MAPEP - Series 30 and Series 31e		
EAL	No absolute criterion - Looking for trends and lab issues to improve performance	98.4%
ALS		100.0%
Precision		
Field duplicates		
EAL	Differences within 3 standard deviations (3σ) or within ± 20% RPD	96.4%
ALS		95.7%
Laboratory Split Sample		
EAL	Differences within 3σ or 20% ± RPD	100%
ALS	Duplicate Error Ratio (DER) <3	96.8%
Laboratory Control Sample (LCS)[c]		
ALS	LCS % recovery – Air ± 20% Soil, Lettuce, Grain ± 20% Milk, Alfalfa ± 25%	100%
Field Blanks		
EAL	No absolute criterion – ideally 100%	90.5%
ALS		94.1%
Method Quality Objective (MQO)		
EAL	No absolute criterion – ideally 100%	99.4%
ALS		99.0%

a. Sample matrices include: Water (Drinking, Surface, Precipitation), Air Filter, Milk, Soil, TLD/OSLD, Vegetation (Wheat, Alfalfa, Potato, Lettuce), and Waterfowl. Big Game (Deer, Elk, Antelope) are also sampled on an as notified case-by-case basis; these samples are not included in sample percent completeness.

b. MAPEP - Soil, Air, Water, Vegetation - Performance on ESER requested analytes
ISU-EAL - ESER requested analysis - Gamma Spec, Tritium, Gross Alpha and Gross Beta
ALS-FC - ESER requested analysis - Strontium-90, Americium-241, Plutonium-238, and Plutonium-239/240

c. LCS performance calculations are per the ESER QAPjP protocol. Using ALS-FC LCS recoveries the performance is 100%.

The ESER contractor met its completeness goals of greater than 98 percent in 2014. Four air samples were considered invalid because insufficient volumes were collected due to power interruptions (i.e., blown fuse and/or tripped breaker); one of the four had the air filter paper missing. A few milk samples were not collected in 2014, because they were not available for collection. All other samples were collected as planned.

Blind Spiked Samples. Accuracy is measured through the successful analysis of samples spiked with a known standard traceable to the NIST. Each analytical laboratory conducted an internal spike sample program using NIST standards to confirm analytical results.

As a check on accuracy, the ESER contractor provided blind spiked samples [prepared by personnel at RESL as described in Section 11.3.1.1 for soil, wheat, air particulate filter, milk, and water samples. All the acceptance criteria are for 3 sigma and ± 30 percent of the known values for respective sample matrices. This is a double blind "spiked" sample -meaning that neither the ESER Program nor the laboratories know the value of the radioisotope that is in the sample submitted to the laboratories for sample analysis.

The ESER Program sent 11 double blind spike or irradiated sample sets to the Idaho State University-Environmental Assessment Laboratory (ISU-EAL) laboratory during the 2014 calendar year for gamma spectroscopy analysis. The following matrices were spiked for the 2014 year: water, air particulate filters, milk, wheat, and soil. The ISU-EAL submitted sample results for 56 individual analytes that had recovery analysis completed by the RESL and 51 had an Agreement of "YES" and 5 had an Agreement "NO". This was a 91.1 percent (i.e. 51/56 x 100) performance in the ESER double blind spike program. There were two "False Positive" results for a soil sample analysis, but because this was close to the gamma spectroscopy instrument baseline, there was no further assessment needed by the ESER Program.

The ESER Program sent 8 double blind spike sample sets to the ALS-Fort Collins (ALS-FC) laboratory during the 2014 calendar year for radiochemical analysis. The following matrices were spiked for the 2014 year: water, air particulate filters, milk, wheat, and soil. The ALS-FC submitted sample results for 15 individual analytes that had recovery analysis completed by the RESL and 13 had an Agreement of "YES" and 2 had an Agreement "NO". This was a 86.7 percent (i.e. 13/15 x 100) performance in the ESER double blind spike program. There was an Agreement "NO" on an AP Filter analysis for ^{90}Sr, with a 53 percent recovery of the known amount of the spike. There was a follow-up with the ALS-FC and they reported that there may have been splattering when drying the counting planchet, which contributed to the low recovery. There was an Agreement "NO" on a Milk sample analysis for ^{90}Sr, with a 66 percent recovery of the known amount of the spike. A previous milk sample had a good spike recovery and no further assessment was performed. The low spike recovery could be due to not getting a representative sample aliquot from the original sample container.

The ISU-EAL recounts a number of samples of each media type as another measure of precision. The lab tests each recount using both the 20 percent criterion and the 3σ criterion. All recounts were within acceptable limits.

MAPEP. Each laboratory also participated in the MAPEP by analyzing performance evaluation samples provided by that program, as discussed in Section 11.6.1. ISU-EAL analytes of interest to the ESER Surveillance Program are: tritium (^{3}H), gross alpha and gross beta, and multiple gamma spectroscopy radioisotopes. All analytes of interest are "A" (Acceptable), unless noted below. The MAPEP Series 30 (March 2014) and MAPEP Series 31 (August 2014) Flag Results for ISU-EAL are summarized below:

- MAPEP Series 30- "N" (Not Acceptable) for cesium-134 gamma spectroscopy soil sample. False positive test.
- MAPEP Series 31 - "W" (Acceptable with Warning) for cesium-134 gamma spectroscopy vegetation sample.

ALS-FC analytes of interest to the ESER Surveillance Program are: ^{90}Sr, ^{241}Am, ^{238}Pu, $^{239/240}$Pu. All analytes of interest are "A" (Acceptable), unless noted below. The MAPEP Series 30 (March 2014) and MAPEP Series 31 (August 2014) Flag Results for ALS-FC are summarized below:

- MAPEP Series 30 "W" (Acceptable with Warning) for ^{90}Sr vegetation sample.
- MAPEP Series 31"A" (Acceptable) – For All analytes of interest.

Field Duplicate Samples. Field duplicate samples were collected for air, milk, lettuce, potatoes, alfalfa, and grain to help assess data precision and sampling bias. Most duplicate data were associated with the air sampling program. Duplicate air samplers were operated at two locations (Main Gate and Idaho Falls) adjacent to regular air samples. The objective was to have data close enough to conclude that there was minor sampling bias between the samplers and acceptable laboratory precision. The ESER QA program establishes that sample results should agree within three standard deviations (Equation 2). Any variation outside the predetermined criterion could be due to one of the samplers not operating correctly (e.g., a leak in one sampling system) or not operating within the same operating parameters (e.g., flow rate, sampling time). In addition, any variation outside the predetermined criterion could be attributed to inhomogeneous distribution of a contaminant in the sample medium so that true replication is not possible. The sample and duplicate results agreed with each in over 95 percent of all environmental samples collected during 2014, indicating acceptable precision.

Laboratory Split Sample (Laboratory Duplicate Sample). The analytical laboratories split and analyzed a number of agriculture product, precipitation, and atmospheric moisture samples to assess agreement within the 20 percent or the 3σ criterion. The latter criterion was applied in nearly all cases. All but one split sample analyses (^{90}Sr in the fourth quarter waterfowl) met acceptance criteria in 2014, indicating acceptable precision.

Laboratory Control Sample (LCS). LCSs are run with each radioanalytical batch by the ALS-FC laboratory as part of their internal quality program. The ALS-FC passed all of their LCS controls for 2014 using their criteria of ± 25 percent. Using the ESER Program LCS criteria there was 1 LCS that did not pass; it was for a AP Filter sample for ^{90}Sr analysis and was -11.9 percent, the ESER LCS criteria is ± 10 percent.

Field Blanks. Field blank samples were submitted with each set of samples to test for the introduction of contamination during the process of field collection, laboratory preparation, and laboratory analysis. Ideally, blank results should be within two standard deviations of zero and preferably within one standard deviation. In 2014, over 90 percent of blanks were within one to two standard deviations of zero.

Method Quality Objective (MQO). MQOs are a Multi-Agency Radiological Laboratory Analytical Protocol based process that is performance based using data quality indicators that pertains to actual ESER Program historical analytical data to created MQOs by sample media and analyte(s) for those sample media. MQOs were mostly met by the ISU-EAL and the ALS-FC during the 2014 sample year. There were a few exceptions that occurred; that are most-likely due to random statistical errors occurring during analyses.

Minimum Detectable Concentration (MDC). MDC issues with soil samples at the ALS-FC are currently being addressed for the following analytes: ^{90}Sr, ^{241}Am, ^{238}Pu and $^{239/240}$Pu. Soil samples are prepared using a pyrosulfate fusion technique before being analyzed. This method has a limiting factor in the amount of soil sample that actually can be analyzed (~1.5 gm). Therefore the ESER MDCs for soil samples in 2014 were about three times what was expected because it was assumed that a 5-gm sample could be analyzed. This does not appear to impact the plutonium and ^{241}Am results, because they have rarely detected at lower MDCs. However, ^{90}Sr is not infrequently detected at background levels in soil. We are working with the laboratory to resolve this issue and may reanalyze the 2014 samples for ^{90}Sr.

11.3.2.6 INL Environmental Surveillance Program Quality Assurance/Quality Control Data

The INL contractor analytical laboratories analyzed all Surveillance Monitoring Program samples as specified in the statements of work. These laboratories participate in a variety of intercomparison QA programs, which verify all the methods used to analyze environmental samples. The programs include the DOE MAPEP and the EPA National Center for Environmental Research QA Program. The Surveillance Monitoring Program met its completeness and precision goals. Samples were collected and analyzed as planned from all available media. The Environmental Surveillance Program submitted duplicate, blank, and QC samples with routine samples for analyses as required. Results concluded the laboratories met the performance objectives specified by MAPEP and the National Center for Environmental Research.

An employee at the contract laboratory who had just returned to work after an extended vacation inadvertently switched four samples for the week of January 9, 2014. The mistake was discovered during the compositing process. Because it was unclear if additional samples for that week got mixed, no regular samples were added to the quarterly composite, and while that week's data appear to agree with historical values, because of the mix up, the affected data have been flagged as "J" or estimated quantities. The laboratory instituted a corrective action plan to prevent recurrence.

As an additional check on accuracy, the INL contractor provided blind spiked samples prepared by personnel at the RESL for air filter samples, which are composited by location quarterly and analyzed by gamma spectroscopy. During 2014 the results ranged from "Acceptable" to "Not Acceptable" for various gamma emitting radionuclides, with all results appearing to have a low bias as compared with the known concentrations. Possible reasons for the bias were identified both in procedure and in sample geometry versus the standard geometry. A double-sided tape being used to secure the filters to the counting planchettes during weekly gross alpha beta counting may have been removing some of the spiked activity from the filters. The standard geometry of dry stacked filters did not well match the liquid geometry used by the laboratory. INL personnel worked with the laboratory to resolve this issue in 2014 by instituting a total dissolution of the composited filters, matching the standard, and including the double-sided tape in the dissolution process.

11.3.2.7 ICP Environmental Surveillance for Waste Management Quality Control Data

Table 11-4 summarizes the 2014 ICP Environmental Surveillance Program for Waste Management QC analysis results.

Completeness. The ICP Environmental Surveillance Program for Waste Management completeness goal is 90 percent. For air samples, completeness was 98.5 percent in 2014. On April 1, 2014, one of the air samplers had failed. After noting that the life span of all the air samplers had been exceeded, all the surveillance air samplers were replaced with new samplers in July.

For surface water, 100 percent of samples were collected.

Blind Spike Samples. The ICP contractor submitted air and water blind spike samples to ALS Laboratory Group for analysis in 2014 to check laboratory accuracy. These samples were prepared at RESL, as described in Section 11.3.1.1. All blind spike samples showed satisfactory agreement except for the following:

- ***Ambient Air*** – The results for two performance evaluation samples analyzed for gamma-emitting radionuclides were "not acceptable." Upon investigating, laboratory personnel suggested that the two samples had been switched. When the results were compared to the other sample, the known activity was in 100 percent agreement.

  The result for one of two performance evaluation samples analyzed for radiochemistry received a "not acceptable" evaluation for ^{234}U. Laboratory personnel investigated and found nothing conclusive; this result may be a statistical false positive. The second performance evaluation sample was reported well within acceptable range.

- ***Surface Water*** – The result for ^{238}Pu and ^{239}Pu received an "unacceptable" evaluation for one of two blind spike samples. The result was not within ±30 percent of the known value, and the difference between the laboratory result and the known value was not within 3 sigma. The ^{238}Pu and ^{239}Pu results were low. In reviewing their procedures, laboratory personnel noted the regions of interest for ^{238}Pu and ^{239}Pu were set correctly, and the chemical yield was running at 75 percent, which is average, or even a little above. Only 3,000 mL of the 4,000-mL sample was used, possibly resulting in sample inhomogeneity. The laboratory was requested to analyze the other 1,000-mL sample, but it had been used for ^{90}Sr analysis. To avoid this issue in the future, the laboratory agreed to analyze the entire sample.

  The same sample received an "unacceptable" evaluation for ^{234}U, even though ^{232}U was in agreement with the expected activity. The result for ^{234}U was high. The chemical yield was 57.5 percent, which is slightly lower than typical for isotopic uranium analysis. If more ^{234}U was lost than ^{232}U through chemical separation, the ^{234}U result could have been biased high. CH2M-WG Idaho, LLC will monitor future blind spike samples for similar issues.

Laboratory Intercomparison QA Programs. ALS Laboratory Group participated in a variety of intercomparison QA programs, which verify all the methods used to analyze environmental samples. The programs include the DOE MAPEP and the EPA National Center for Environmental Research QA Program. The laboratory met the performance objectives specified by these two intercomparison QA programs.

Field Duplicate/Replicate Samples. A replicate air sampler is set adjacent to a regular sampler. The results of the two samples are compared using the mean difference, and the results should be less than or equal to three. For ambient air, when comparing analysis of the regular sample to the replicated sample, an average performance rate of 96 percent was achieved. Table 11-4 compares the various analyses results.

Table 11-4. 2014 ICP Environmental Surveillance Program QA Elements.

QC Program Element - 2014	Criterion	Performance
Completeness		
Samples Collected		
Air	90%	98.5%
Surface Water	90%	100%
Samples Analyzed		
Air	90%	100%
Surface Water	90%	100%
Accuracy		
Performance Evaluation Samples		
Air[a]	Ideally 100%	96%
Surface Water	Ideally 100%	85%
Precision		
Field Replicates/Duplicates		
Air	MD[b] > 3	
-Gross Alpha/Beta (Bi-weekly)	Ideally 100%	95.8%
-Gamma Spectrometry (Monthly)	Ideally 100%	100%
-Isotopic (Quarterly)	Ideally 100%	92.9%
Surface Water	MD $\leq$ 3	
-Gamma Spectrometry	Ideally 100%	100%
-Isotopic	Ideally 100%	78.6%
Laboratory Control Sample		
Air	LSC % Recovery ±25%	100%
Surface Water	LSC % Recovery ±25%	100%
Field Blanks		
Air	Ideally 100% within 2α	90.3%
Surface Water	Ideally 100% within 2α	94.0%

a. Includes all results for gamma spectrometry and isotopic analysis.

b. Mean difference.

For surface water, field duplicates are taken as a QC check. Surface water samples are taken quarterly. In 2014, field duplicates were taken during the third- and fourth-quarter sampling. All duplicate samples analyzed for gamma spectrometry compared at 100 percent. For isotopic analysis, the third-quarter duplicate comparison results performed at 100 percent. These third-quarter samples were taken in August after significant rainfall. The fourth-quarter comparison results for isotopic analysis performed at 57 percent. This was most likely due to an errant particle collected in one sample and not in the other. Errant particles can occur in a sample when the water level in the lift station where the samples are taken is shallow, due to low rainfall or snowmelt, and particulates settled at the bottom. These particulates can be disturbed and collected in one sample and not in the other.

Laboratory Control Samples. All laboratory LSC recoveries were within their acceptance range of ± 25 percent recovery, indicating that the laboratory's radiochemical procedure is capable of recovering the radionuclide of interest.

Field Blanks. In 2014, the majority of the field blanks were within two standard deviations of zero for both air and water. See Table 11-4 for details.

Representativeness and Comparability. Representativeness is the degree to which data accurately and precisely represent characteristics of a population, parameter variations at a sampling point, a process condition, or an environmental condition. Comparability expresses the confidence with which one data set can be compared to another data set measuring the same property. Both of these are ensured through the use of technical procedures and sampling procedures for sample collection and preparation, approved analytical methods for laboratory analyses, and consistency in reporting procedures.

Surveillances. Periodic surveillances of procedures and field operations are conducted to assess the representativeness and comparability of data. In August 2014, the ICP QA Program performed a triennial surveillance on the air sampling program. No findings were noted. Strengths were noted in sample collection and sample preparation for shipment to the off-site laboratory.

Procedures. Various QC processes designed to evaluate precision, accuracy, representativeness, completeness, and comparability of data are implemented in detailed procedures. All sampling procedures were reviewed in 2014 and are being updated to provide instructions for new equipment, clarify procedures, and implement updates in DOE guidelines.

11.3.2.8 U.S. Geological Survey Water Sampling Quality Control Data

Water samples are collected in accordance with a QA plan for quality-of-water activities by personnel assigned to the USGS INL project office; the plan was revised in 2014 (Bartholomay et al. 2014). Additional QA is assessed with QA/QC duplicates, blind replicates, replicates, source solution blanks, equipment blanks, field blanks, splits, trip blanks, and spikes (Bartholomay et al. 2014). Evaluations of QA/QC data collected by USGS can be found in Wegner (1989), Williams (1996), Williams (1997), Williams et al. (1998); Bartholomay and Twining (2010), Rattray (2012), Davis et al. (2013) and Rattray (2014). During 2014, the USGS collected 17 replicate samples, six field blank samples, one equipment blank sample, one source solution blank, one spike sample, and one trip blank sample. Evaluation of results will be summarized in future USGS reports.

11.3.2.9 In Situ Gamma Spectroscopy Quality Control Data

High purity Germanium detectors used for in situ gamma spectroscopy measurements are calibrated yearly using NIST-traceable radioactive sources in a laboratory setting. These calibrations are performed using a fixed geometry, long count time procedure. Collected calibration spectra are stored and then analyzed using a standard peak search peak fit algorithm. Energy calibration is performed to establish a linear relationship between peak positions and spectrum channels. The same calibration spectrum is then used to establish a relationship between the peak widths and peak energies. Finally, the detector efficiency is established, and a mathematical fit of efficiency versus gamma ray energy is established. The peak energy, peak width, and efficiency parameters for each detector are stored and used for all subsequent daily QC checks.

Prior to daily field use, each detector undergoes a QC check. This is performed using the same NIST-traceable source as above. The overall activity of the measured source is compared to the certified (NIST) value.

During field measurements, the position of the naturally occurring ^{40}K gamma ray peak is checked to make certain that energy drift has not occurred during field spectrum acquisition.

Table 11-5. ICP Environmental Program Procedures.

Document/Media Type	Document No.[a] and Title
Requirement Documents	PRD-5030, Environmental Requirements for Facilities, Processes, Materials, and Equipment
	MCP-3480, Environmental Instructions for Facilities, Processes, Materials, and Equipment
Data and Validation Documents	PLN-491, Laboratory Performance Evaluation Program Plan
	PLN-1401, Transferring Integrated Environmental Data Management System Revised Data to the Environmental Data Warehouse
	GDE-201, Inorganic Analyses Data Validation for Sample and Analysis Management
	GDE-204, Guide to Assessment of Radionuclide Analysis of Performance Evaluation Samples
	GDE-205, Radioanalytical Data Validation
	GDE-206, Obtaining Laboratory Services for Sample Analysis
	GDE-234, Generating Sampling and Analysis Plan Tables for Environmental Sampling Activities
	GDE-239, Validation of Volatile Organic Compounds Data Analyzed Using Gas Chromatography/Mass Spectrometry
	GDE-240, Validation of Gas and Liquid Chromatographic Organic Data
	GDE-241, Validation of Semivolatile Organic Compounds Data Analyzed Using Gas Chromatography/Mass Spectrometry
	GDE-7003, Levels of Analytical Method Data Validation
	MCP-1298, Sample and Analytical Data Management Process for the Sample and Analysis Management
Sampling Documents	MCP-9439, Environmental Sampling Activities at the INL
Groundwater Documents	PLN, 1305, Wastewater Reuse Permit Groundwater Program Plan
	SPR-162, Measuring Groundwater Levels and Sampling Groundwater
	TPR-6539, Calibrating and Using the Hydrolab Quanta Water Quality Multiprobe
	TRP-7582, Well Inspection/Logging Using Down-Hole Cameras
Liquid Effluent Documents	PLN-729, Idaho Cleanup Project Liquid Effluent Monitoring Program Plan
	SPR-101, Liquid Effluent Sampling
	TPR-6539, Calibrating and Using the Hydolab Quanta Water Quality Multiprobe
Drinking Water Documents	PLN-730, Idaho Cleanup Project Drinking Water Program Plan
	SPR-188, Collecting Water Samples for Radiological Analysis

Table 11-5. ICP Environmental Program Procedures. (cont.)

Document/Media Type	Document No.[a] and Title
	SPR-189, Routine Collection of Samples for Coliform Bacteriological Analysis SPR-190, Sampling of Public Water Systems TPR-6555, Cross Connection Inspections and Backflow Prevention Assembly Testing
Surveillance Documents	PLN-720, Environmental Surveillance Program Plan Biota SPR-106, Biotic Monitoring Air SPR-107, Waste Management Low-Volume Suspended Particulate Air Monitoring SPR-193, NESHAP Ambient Air Sampling for Accelerated Retrieval Project and RCRA Inorganic Sludge Processing Operations Soil SPR-110, Surface Soil Sampling Surface Water SPR-213, Surface Water Sampling at Radioactive Waste Management Complex Surface Radiation TPR-6525, Surface Radiation Surveys Using the Global Positioning Radiometric Scanner
Gamma Documents	TPR-7485, Filling Gamma Detector with Liquid Nitrogen TPR-7859, Shipping Screen Gamma Scan TPR-7860, Germanium Detector Calibration and Performance Testing Using Gamma Vision-32
Documentation Documents	MCP-9227, Environmental and Regulatory Services Logkeeping Practices MCP-9235, Reporting Requirements of the Liquid Effluent Monitoring and Wastewater Land Application Permit Groundwater Monitoring Program
Sample Management Documents	MCP-9228, Managing Nonhazardous Samples MCP-1394, Managing Hazardous Samples

a. GDE = Guide
MCP = Management Control Procedure
PLN = Plan
PRD = Program Requirements Documents
SPR = Sampling Procedure
TPR = Technical Procedure

In addition, approximately 10 percent of field measurements are repeated with a different detector so that the two measurements can be compared. Finally, very long time acquisitions are performed at selected field locations in order to assure stability in the measurements. Results from these measurements are also compared to regular count time results at those locations. Software analysis of field spectra is addressed in several publications, including HASL-300 (www.orau.org/ptp/PTP percent20library/library/DOE/EML/hasl300/HASL300/TOC.htm) and ICRU Report No. 53 (ICRU 1994).

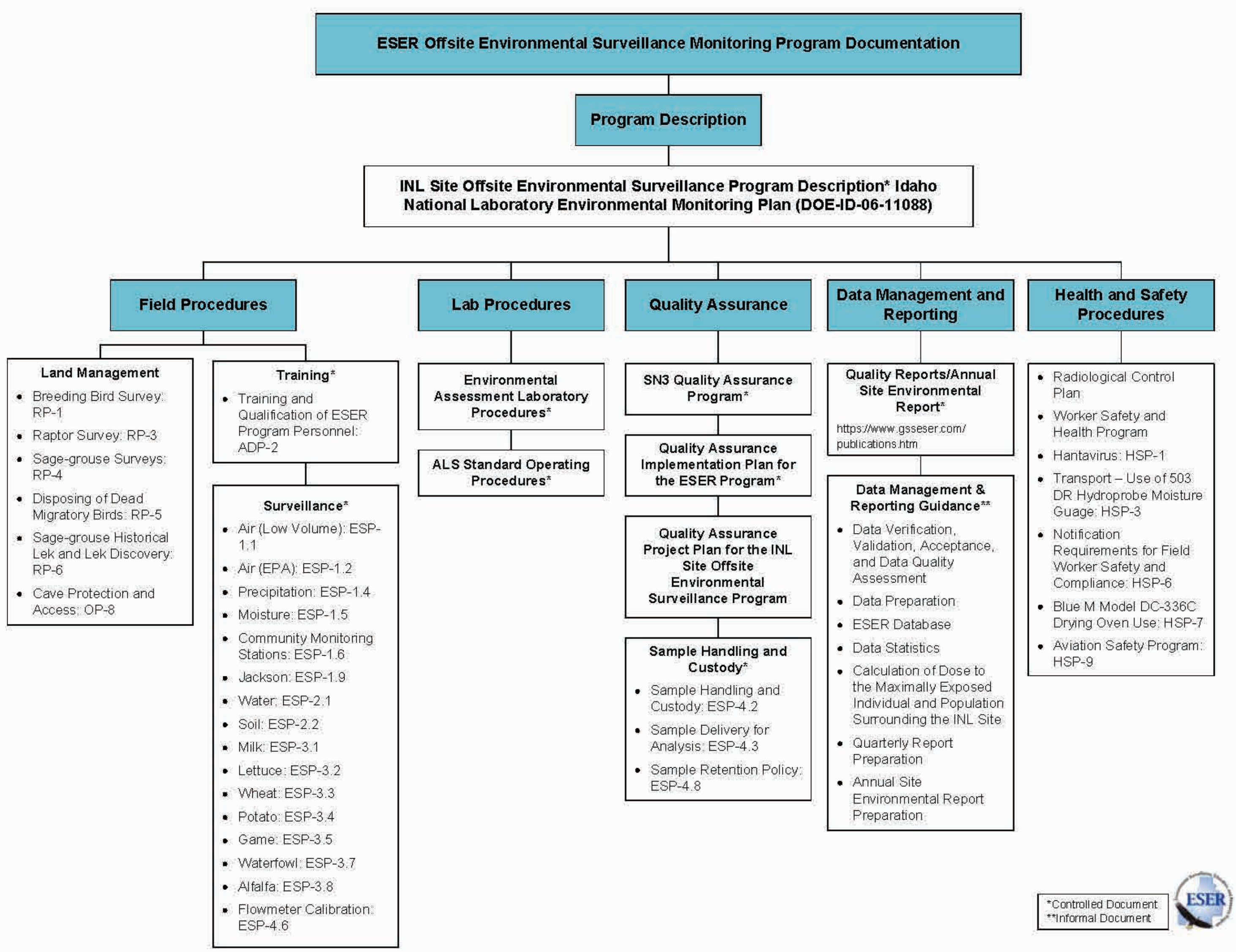
11.4. Environmental Monitoring Program Quality Assurance Program Documentation

The following sections summarize how each monitoring organization at the INL Site implements QA requirements. An overview of the ICP contractor, ESER contractor, and INL contractor environmental monitoring program documentation is presented in Table 11-5, Figure 11-2, and Figure 11-3, respectively.

11.4.1 Idaho National Laboratory Contractor

The INL contractor integrates applicable requirements from *Manual 13A—Quality Assurance Laboratory*

Figure 11-2. ESER Program Offsite Environmental Surveillance Documentation.



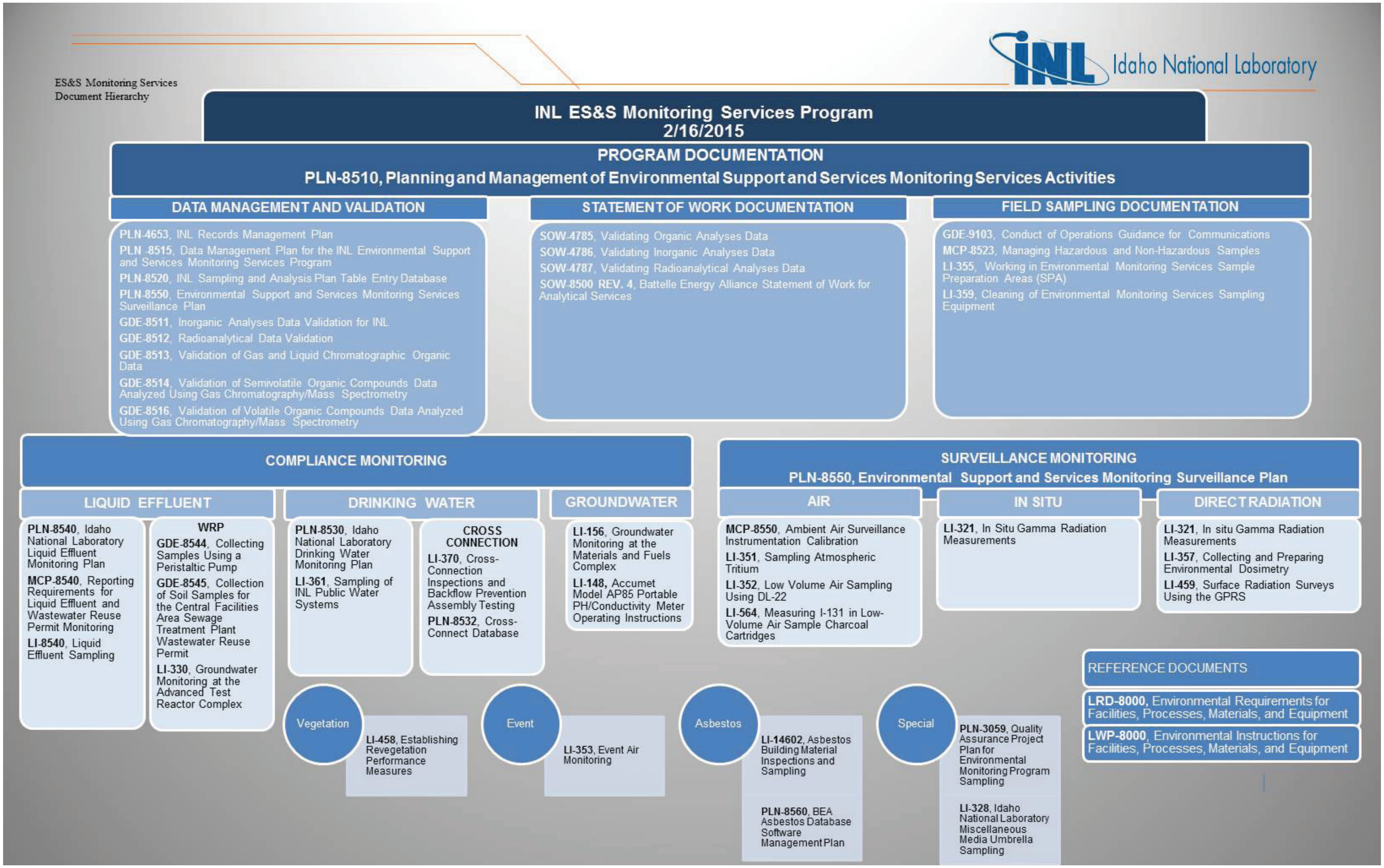


Figure 11-3. INL Environmental Support and Services Program Documentation.

Requirements Documents (INL 2014) into the implementing monitoring program plans and procedures for non-Comprehensive Environmental Response, Compensation, and Liability Act monitoring activities. The program plans address the QA elements as stated in *EPA Requirements for Quality Assurance Project Plans* (EPA QA/R-5) (EPA 2001) to ensure that the required standards of data quality are met.

In addition, the INL contractor uses a documented approach for collecting, assessing, and reporting environmental data. Environmental and effluent monitoring are conducted in accordance with plan (PLN)-8510, "Planning and Management of Environmental Support and Services Monitoring Services Activities," PLN-8515, "Data Management Plan for the INL Environmental Support and Services Monitoring Services Program," and PLN-8550, "Environmental Support and Services Monitoring Services Surveillance Plan" in order to ensure that analytical work for environmental and effluent monitoring supports DQOs.

11.4.2 Idaho Cleanup Project Contractor

All Comprehensive Environmental Response, Compensation, and Liability Act monitoring activities at the INL Site are conducted in accordance with the *Quality Assurance Project Plan for Waste Area Groups 1, 2, 3, 4, 5, 6, 7, 10 and Removal Actions* (DOE-ID 2009). The QAPjP was written in accordance with *Guidance for Conducting Remedial Investigations and Feasibility Studies Under CERCLA* (EPA 1988).

In addition, the ICP contractor uses the following program plans for environmental monitoring and surveillance:

- PLN-720, "Environmental Surveillance Program Plan"
- PLN-729, "Idaho Cleanup Project Liquid Effluent Monitoring Program Plan"
- PLN-730, "Idaho Cleanup Project Drinking Water Program Plan"
- PLN-1305, "Wastewater Reuse Permit Groundwater Monitoring Program Plan."

11.4.3 Advanced Mixed Waste Treatment Project

The Advanced Mixed Waste Treatment Project maintains a QA program in accordance with 40 CFR 61, Appendix B, as required of all radiological air emission sources continuously monitored for compliance with 40 CFR 61, Subpart H. The QA requirements are documented in AMWTP-PD-EC&P-02, *Quality Assurance Project Plan for the WMF 676 NESHAPs Stack Monitoring System*.

11.4.4 Environmental Surveillance, Education, and Research Program

The ESER Program maintains a QA program consistent with the requirements of 10 CFR 830, Subpart A, and DOE Order 414.1D that is implemented through the *ESER Quality Management Plan for the Environmental Surveillance, Education and Research Program*. The ESER Program also has a QA Implementation Plan that provides requirements, responsibilities, and authority for implementing the Stoller NQA-1 2008 QA Program under a graded and tailored approach to all work activities. Additional QA requirements for monitoring activities are provided in the ESER *Quality Assurance Project Plan for the INL Offsite Environmental Surveillance Program*. Analytical laboratories used by the ESER Program maintain their own QA programs consistent with DOE requirements.

11.4.5 U.S. Geological Survey

Field Methods and Quality-Assurance Plan for Water-Quality Activities and Water-Level Measurements, (Bartholomay et al. 2014) defines procedures and tasks performed by project-office personnel that ensure the reliability of water quality and water level data. The plan addresses all elements needed to ensure:

- Reliability of the water-quality and water-level data
- Compatibility of the data with data collected by other organizations at the INL Site
- That data meet the programmatic needs of DOE and its contractors and the scientific and regulatory communities.

The USGS conducts performance audits on field personnel collecting samples and of the analytical laboratories that analyze their environmental monitoring samples, with the exception of the DOE RESL. The RESL is assessed by the American Association of Laboratory Accreditation as an ISO 17025 Chemical Testing Laboratory. In addition, the USGS routinely evaluates its QC data and publishes analyses in USGS reports.

11.4.6 National Oceanic and Atmospheric Administration

The National Oceanic and Atmospheric Administration *Quality Program Plan, NOAA Air Resources Laboratory Field Research Division* (NOAA-ARLFRD 1993) addresses the requirements of DOE Order 414.1D, and is consistent with American Society of Mechanical Engineers. Implementing procedures include regular independent system and performance audits, written procedures and checklists, follow-up actions, and continuous automated and visual data checks to ensure representativeness and accuracy. The plan and implementing procedures provide the framework to ensure that the INL Meteorological Monitoring Network meets the elements of "Environmental Regulatory Guide for Radiological Effluent Monitoring and Environmental Surveillance" (DOE/EH-0173T).

All the meteorological sensors in the Air Resources Laboratory Field Research Division tower network are inspected, serviced, and calibrated semiannually as recommended by American Nuclear Society guidelines of ANSI/ANS 3.11 2005. Unscheduled service also is performed promptly whenever a sensor malfunctions.

11.5 Duplicate Sampling Among Organizations

The ESER contractor, INL contractor, and the DEQ INL Oversight Program (OP) collected air monitoring data throughout 2013 at four common sampling locations: the distant locations of Craters of the Moon National Monument and Idaho Falls, and on the INL Site at the Experimental Field Station and Van Buren Boulevard Gate. Results are compared in the INL OP Annual Report for 2013, available at: http://www.deq.idaho.gov/inl-oversight/monitoring/reports.aspx.

DEQ-INL OP also uses a network of passive electret ionization chambers (EICs) on and around the INL to cumulatively measure radiation exposure. These measurements are then used to calculate an average exposure rate for the quarterly monitoring period. Radiation monitoring results obtained by DEQ-INL OP are compared with radiation monitoring results reported by the DOE and its INL contractors for these same locations to determine whether the data are comparable. DEQ-INL OP has placed several EICs at locations monitored by DOE contractors, using TLD. Ambient penetrating radiation measurements during 2013 showed 90 percent of the INL contractor's annual average OSLD and 80 percent of the ESER contractor's TLD measurements agreed within 20 percent RPD with results from DEQ-INL OP's collocated EICs, meeting the program's objective.

The DEQ-INL OP also collects surface water and drinking water samples at select downgradient locations in conjunction with the ESER contractor. Samples are collected at the same place and time, using similar methods. Sample-by-sample comparisons are provided in the INL OP Annual Report for 2013. The Annual Report for 2014 has not been issued at this time.

REFERENCES

40 CFR 61, 2013, Appendix B, "Test Methods, Method 114, Test Methods for Measuring Radionuclide Emissions from Stationary Sources, *Code of Federal Regulations*, Office of the Federal Register.

40 CFR 61, 2013, Subpart H, "National Emission Standards for Emissions of Radionuclides Other Than Radon from Department of Energy Facilities," *Code of Federal Regulations*, Office of the Federal Register.

40 CFR 141.24, 2014, "Organic Chemicals, Sampling and Analytical Requirements," *Code of Federal Regulations,* Office of the Federal Register.

AMWTP-PD-EC&P-02, current revision, "Quality Assurance Project Plan for the WMF-676 NESHAPs Stack Monitoring System," Advanced Mixed Waste Treatment Project.

ANSI/ANS 3.11 2005, 2005, "Determining Meteorological Information at Nuclear Facilities," American National Standards Institute/American Nuclear Society.

ANSI/ASQC E4-1994, 1994, "Specifications and Guidelines for Quality Systems for Environmental Data Collection and Environmental Technology Programs," American National Standards Institute/American Society for Quality Control.

American Society of Mechanical Engineers NQA-1, 2012, "Quality Assurance Requirements for Nuclear Facility Applications," American Society of Mechanical Engineers.

Bartholomay, R. C., N. V. Maimer, and A. J. Wehnke, 2014, *Field methods and quality-assurance plan for water-quality activities and water-level measurements*, *U.S. Geological Survey*, Idaho National Laboratory, Idaho: U.S. Geological Survey Open-File Report 2014–1146 (DOE/ID-22230), 64 p. http://pubs.usgs.gov/of/2014/1146/.

Bartholomay, R. C. and B. V. Twining, 2010, *Chemical Constituents in Groundwater from Multiple Zones in the Eastern Snake River Plain Aquifer at the Idaho National Laboratory, Idaho, 2005-08*, U.S. Geological (DOE/ID- 22211), U.S. Geological Survey, Available at http://pubs.usgs.gov/sir/2010/5116/.

Davis, L. C., Bartholomay, R. C., and Rattray, G. W., 2013, *An update of hydrologic conditions and distribution of selected constituents in water, eastern Snake River Plain aquifer and perched groundwater zones, Idaho National Laboratory, Idaho, emphasis 2009–11: U.S. Geological Survey Scientific Investigations Report 2013–5214*, (DOE/ID-22226), 90 p. http://pubs.usgs.gov/sir/2013/5214/.

DOE, 2014, "Mixed Analyte Performance Evaluation Program," U.S. Department of Energy, Available at http://www.id.energy.gov/resl/mapep/mapep.html.

DOE, 2015, *Environmental Radiological Effluent Monitoring and Environmental Surveillance*, DOE Handbook, DOE-HDBK-1216-2015, U.S. Department of Energy.

DOE Order 414.1D, 2011, "Quality Assurance," U.S. Department of Energy.

DOE Order 450.1, 2003, "Environmental Protection Program," (Archived), U.S. Department of Energy.

DOE/EH-0173T, 1991, "Environmental Regulatory Guide for Radiological Effluent Monitoring and Environmental Surveillance," U.S. Department of Energy.

DOE-ID, 2009, *Quality Assurance Project Plan for Waste Area Groups 1, 2, 3, 4, 5, 6, 7, 10 and Removal Actions*, DOE/ID 10587, Rev. 10, U.S. Department of Energy Idaho Operations Office.

DOE-ID, 2014a, *Idaho National Laboratory Site Environmental Monitoring Plan*, DOE/ID-11088 Revision 4, February 2014.

DOE-ID, 2014b, *The Technical Basis for Environmental Monitoring and Surveillance at the Idaho National Laboratory Site*, DOE/ID-11485, Feb 2014.

DOE-ID, 2015a, *Annual Report for the Final Groundwater Remediation, Test Area North, Operable Unit 1-BIB*, Fiscal Year 2014, Appendixes A, B, and C, DOE/ID-11521, Rev. 0, April 2015.

DOE-ID, 2015b, *Fiscal Year 2014 Annual Report for Operable Unit 3-14, Tank Farm Soil and INTEC Groundwater*, Appendix C, DOE/ID-11526, Rev. 0, July 2015.

DOE-ID, 2015c, *Central Facilities Area Landfills, I, II, and III Annual Monitoring Report - Fiscal Year 2014*, Appendix B, DOE/ID-11523, Rev. 0, March 2015.

DOE-ID, 2015d, *Annual Groundwater Monitoring Status Report for Waste Area Group 2 for Fiscal Year 2015*, Appendix B, DOE/ID-11532, Rev. 0, Draft.

DOECAP, 2012, *Continuing Audit of ALS Environmental Laboratory*, Fort Collins, Colorado, ALS 120517-ALSC, U.S. Department of Energy Consolidated Audit Program.

EPA, 1988, *Guidance for Conducting Remedial Investigations and Feasibility Studies Under CERCLA*, EPA/540/G89/004, Office of Emergency and Remedial Response, U.S. Environmental Protection Agency.

EPA, 2001, EPA Requirements for Quality Assurance Project Plans (EPA QA/R-5), EPA/240/B-01/003, U.S. Environmental Protection Agency.

EPA, 2006, Guidance on Systematic Planning Using the Data Quality Objectives Process (EPA QA/G-4), EPA/240/B-06/001 February 2006.

ESER, current revision, "Quality Management Plan for the Environmental Surveillance, Education and Research Program," Environmental Surveillance, Education and Research Program, Gonzales-Stoller Surveillance, LLC.

ESER, current revision, "Quality Assurance Project Plan for the INL Offsite Environmental Surveillance Program," Environmental Surveillance, Education and Research Program, Gonzales-Stoller Surveillance, LLC.

Forbes, J. R. and K. J. Holdren, 2014, *Field Sampling Plan for Operable Unit 7-13/14 Aquifer Monitoring*, DOE/ID-11492, Rev. 1, U.S. Department of Energy Idaho Operations Office, August 2014.

ICP, 2015, *2014 Wastewater Reuse Site Performance Report for the Idaho Nuclear Technology and Engineering Center New Percolation Ponds (LA-000130-05)*, RPT-1341, Rev. 0, Idaho Cleanup Project.

INL, 2014, Manual 13A–Quality Assurance Laboratory Requirements Documents, Idaho National Laboratory.

International Commission on Radiation Units and Measurements (ICRU), 1994, Gamma-Ray Spectrometry in the Environment (Report 53).

National Council on Radiation Protection and Measurements (NCRP), 2012, Design of Effective Radiological Effluent Monitoring and Environmental Surveillance Programs, NCRP Report No. 169.

NOAA-ARLFRD, 1993, *Quality Program Plan*, NOAA Air Resources Laboratory Field Research Division, National Oceanic and Atmospheric Administration-Air Resources Laboratory Field Research Division.

PLN-720, 2012, "Environmental Surveillance Program Plan," Rev. 9, Idaho Cleanup Project.

PLN-729, 2012, "Idaho Cleanup Project Liquid Effluent Monitoring Program Plan," Rev. 9, Idaho Cleanup Project.

PLN-730, 2013, "Idaho Cleanup Project Drinking Water Program Plan," Rev. 13, Idaho Cleanup Project.

PLN-1305, 2012, "Wastewater Reuse Permit Groundwater Monitoring Program Plan," Rev. 14, Idaho Cleanup Project.

PLN-8510, 2010, "Planning and Management of Environmental Support and Services Monitoring Services Activities," Idaho National Laboratory.

PLN-8515, 2010, "Data Management Plan for the INL Environmental Support and Services Monitoring Services Program," Idaho National Laboratory.

PLN-8550, "Environmental Support and Services Monitoring Services Surveillance Plan," Idaho National Laboratory.

Rattray, G. W., 2012, *Evaluation of Quality-Control Data Collected by the U.S. Geological Survey for Routine Water-Quality Activities at the Idaho National Laboratory, Idaho, 1996–2001*, U.S. Geological Survey Scientific Investigations Report 2012-5270 (DOE/ID-22222), 74 p.

Rattray, G. W., 2014, *Evaluation of Quality-Control Data Collected by the U.S. Geological Survey for Routine Water-Quality Activities at the Idaho National Laboratory and vicinity, southeastern Idaho, 2002-08*, U.S. Geological Survey Scientific Investigations Report 2014-5027 (DOE/ID-22228), 66 p.

Wegner, S. J., 1989, *Selected Quality Assurance Data for Water Samples Collected by the U.S. Geological Survey, Idaho National Engineering Laboratory, 1980-1988*, U.S. Geological Survey Water-Resources Investigations Report 89-4168, U.S. Geological Survey, Available at http://pubs.er.usgs.gov/.

Williams, L. M., 1996, *Evaluation of Quality Assurance/Quality Control Data Collected by the U.S. Geological Survey for Water-Quality Activities at the Idaho National Engineering Laboratory, Idaho, 1989 through 1993*, U.S. Geological Survey Water-Resources Investigations Report 96-4148 (DOE/ID-22129), U.S. Geological Survey, Available at http://pubs.er.usgs.gov/.

Williams, L. M., 1997, *Evaluation of Quality Assurance/Quality Control Data Collected by the U.S. Geological Survey for Water-Quality Activities at the Idaho National Engineering Laboratory*, Idaho, 1994 through 1995, U.S. Geological Survey Water-Resources Investigations Report 97-4058 (DOE/ID-22136), U.S. Geological Survey, Available at http://pubs.er.usgs.gov/.

Williams, L. M., R. C. Bartholomay, and L. J. Campbell, 1998, *Evaluation of Quality Assurance/Quality Control Data Collected by the U.S. Geological Survey from Wells and Springs between the Southern Boundary of the Idaho National Engineering and Environmental Laboratory and the Hagerman Area, Idaho, 1989 through 1995*, U.S. Geological Survey Water-Resources Investigations Report 98-4206 (DOE/ID-22150), U.S. Geological Survey, Available at http://pubs.er.usgs.gov/.

Appendix A. Environmental Statutes and Regulations

The following environmental statutes and regulations apply, in whole or in part, to the Idaho National Laboratory (INL) or at the INL Site boundary:

- 36 CFR 79, 2014, "Curation of Federally-Owned and Administered Archeological Collections," U.S. Department of the Interior, National Park Service, *Code of Federal Regulations*, Office of the Federal Register
- 40 CFR 50, 2014, "National Primary and Secondary Ambient Air Quality Standards," U.S. Environmental Protection Agency, *Code of Federal Regulations*, Office of the Federal Register
- 40 CFR 61, 2014, "National Emission Standards for Hazardous Air Pollutants," U.S. Environmental Protection Agency, *Code of Federal Regulations*, Office of the Federal Register
- 40 CFR 61, Subpart H, 2014, "National Emission Standards for Emissions of Radionuclides Other Than Radon from Department of Energy Facilities," *Code of Federal Regulations*, Office of the Federal Register.
- 40 CFR 112, 2014, "Oil Pollution Prevention," U.S. Environmental Protection Agency, *Code of Federal Regulations*, Office of the Federal Register
- 40 CFR 122, 2014, "EPA Administered Permit Programs: the National Pollutant Discharge Elimination System," U.S. Environmental Protection Agency, *Code of Federal Regulations*, Office of the Federal Register
- 40 CFR 141, 2014, "National Primary Drinking Water Regulations," U.S. Environmental Protection Agency, *Code of Federal Regulations*, Office of the Federal Register
- 40 CFR 142, 2014, "National Primary Drinking Water Regulations Implementation," *Code of Federal Regulations*, Office of the Federal Register.
- 40 CFR 143, 2014, "National Secondary Drinking Water Regulations," *Code of Federal Regulations*, Office of the Federal Register.
- 40 CFR 260, 2014, "Hazardous Waste Management System: General," U.S. Environmental Protection Agency, *Code of Federal Regulations*, Office of the Federal Register
- 40 CFR 261, 2014, "Identification and Listing of Hazardous Waste," U.S. Environmental Protection Agency, *Code of Federal Regulations*, Office of the Federal Register
- 40 CFR 262, 2014, "Standards Applicable to Generators of Hazardous Waste," U.S. Environmental Protection Agency, *Code of Federal Regulations*, Office of the Federal Register
- 40 CFR 263, 2014, "Standards Applicable to Transporters of Hazardous Waste," U.S. Environmental Protection Agency, *Code of Federal Regulations*, Office of the Federal Register
- 40 CFR 264, 2014, "Standards for Owners and Operators of Hazardous Waste Treatment, Storage, and Disposal Facilities," U.S. Environmental Protection Agency, *Code of Federal Regulations*, Office of the Federal Register
- 40 CFR 265, 2014, "Interim Status Standards for Owners and Operators of Hazardous Waste Treatment, Storage, and Disposal Facilities," U.S. Environmental Protection Agency, *Code of Federal Regulations*, Office of the Federal Register
- 40 CFR 267, 2014, "Standards for Owners and Operators of Hazardous Waste Facilities Operating under a Standardized Permit," U.S. Environmental Protection Agency, *Code of Federal Regulations*, Office of the Federal Register
- 43 CFR 7, 2014, "Protection of Archeological Resources," U.S. Department of the Interior, National Park Service, *Code of Federal Regulations*, Office of the Federal Register
- 50 CFR 17, 2014, "Endangered and Threatened Wildlife and Plants," U.S. Department of the Interior, Fish and Wildlife Service, *Code of Federal Regulations*, Office of the Federal Register
- 50 CFR 226, 2014, "Designated Critical Habitat," U.S. Department of Commerce, National Marine Fisheries Service, *Code of Federal Regulations*, Office of the Federal Register

- 50 CFR 402, 2014, "Interagency Cooperation – Endangered Species Act of 1973, as Amended," U.S. Department of the Interior, Fish and Wildlife Service, *Code of Federal Regulations*, Office of the Federal Register
- 50 CFR 424, 2014, "Listing Endangered and Threatened Species and Designating Critical Habitat," U.S. Department of the Interior, Fish and Wildlife Service, *Code of Federal Regulations*, Office of the Federal Register
- 50 CFR 450–453, 2014, "Endangered Species Exemption Process," U.S. Department of the Interior, Fish and Wildlife Service, *Code of Federal Regulations*, Office of the Federal Register
- 42 USC § 9601 et seq., 1980, "Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (CERCLA/Superfund)," United States Code.
- DOE Order 231.1B, 2011, "Environment, Safety, and Health Reporting," Change 2, U.S. Department of Energy
- DOE Order 435.1, 2001, "Radioactive Waste Management," Change 2, U.S. Department of Energy
- DOE Order 436.1, 2011, "Departmental Sustainability," U.S. Department of Energy
- DOE Order 458.1, 2011, "Radiation Protection of the Public and the Environment," U.S. Department of Energy
- DOE Standard 1196-2011, 2011, "Derived Concentration Technical Standard," U.S. Department of Energy
- Executive Order 11514, 1970, "Protection and Enhancement of Environmental Quality"
- Executive Order 11988, 1977, "Floodplain Management"
- Executive Order 11990, 1977, "Protection of Wetlands"
- Executive Order 12344, 1982, " Naval Nuclear Propulsion Program."
- Executive Order 12580, 1987, "Superfund Implementation"
- Executive Order 12856, 1993, "Federal Compliance With Right-to-Know Laws and Pollution Prevention Requirements"
- Executive Order 12873, 1993, "Federal Acquisition, Recycling, and Waste Prevention"
- Executive Order 13101, 1998, "Greening the Government Through Waste Prevention, Recycling, and Federal Acquisition"
- Executive Order 13423, 2007, "Strengthening Federal Environmental, Energy, and Transportation Management"
- Executive Order 13514, 2009, "Federal Leadership in Environmental, Energy, and Economic Performance"
- IDAPA 58.01.01, 2014, "Rules for the Control of Air Pollution in Idaho," Idaho Administrative Procedures Act, Idaho Department of Environmental Quality
- IDAPA 58.01.02, 2014, "Water Quality Standards," Idaho Administrative Procedures Act, Idaho Department of Environmental Quality
- IDAPA 58.01.03, 2014, "Individual/Subsurface Sewage Disposal Rules," Idaho Administrative Procedures Act, Idaho Department of Environmental Quality
- IDAPA 58.01.05, 2014, "Rules and Standards for Hazardous Waste," Idaho Administrative Procedures Act, Idaho Department of Environmental Quality
- IDAPA 58.01.06, 2014, "Solid Waste Management Rules," Idaho Administrative Procedures Act, Idaho Department of Environmental Quality
- IDAPA 58.01.08, 2014, "Idaho Rules for Public Drinking Water Systems," Idaho Administrative Procedures Act, Idaho Department of Environmental Quality
- IDAPA 58.01.11, 2014, "Ground Water Quality Rule," Idaho Administrative Procedures Act, Idaho Department of Environmental Quality
- IDAPA 58.01.15, 2014, "Rules Governing the Cleaning of Septic Tanks," Idaho Administrative Procedures Act, Idaho Department of Environmental Quality
- IDAPA 58.01.16, 2014, "Wastewater Rules," Idaho Administrative Procedures Act, Idaho Department of Environmental Quality.

- IDAPA 58.01.17, 2014, "Recycled Water Rules," Idaho Administrative Procedures Act, Idaho Department of Environmental Quality

U.S. Department of Energy (DOE) Order 458.1 Ch. 3 provides the principal requirements for protection of the public and environment at the INL Site. The DOE public dose limit is shown in Table A-1, along with the Environmental Protection Agency statute for protection of the public, for the airborne pathway only.

Derived Concentration Standards are established to support DOE Order 458.1 in DOE Standard 1196-2011 (DOE-STD-1196-2011), "Derived Concentration Technical Standard." These quantities represent the concentration of a given radionuclide in either water or air that results in a member of the public receiving 100 mrem (1 mSv) effective dose following continuous exposure for one year for each of the following pathways: ingestion of water, submersion in air, and inhalation. The Derived Concentration Standards used by the environmental surveillance programs at the INL Site are shown in Table A-2. The most restrictive Derived Concentration Standard is listed when the soluble and insoluble chemical forms differ. The Derived Concentration Standards consider only inhalation of air, ingestion of water, and submersion in air.

The Environmental Protection Agency National Ambient Air Quality Standards may be found at http://www.epa.gov/air/criteria.html

Water quality standards are dependent on the type of drinking water system sampled. Tables A-4 through A-6 list maximum contaminant levels set by the Environmental Protection Agency for public drinking water systems in 40 Code of Federal Regulations 141 (2014) and the Idaho groundwater quality values from IDAPA 58.01.11 (2012).

Table A-1. Radiation Standards for Protection of the Public in the Vicinity of DOE Facilities.

Radiation Standard	Effective Dose Equivalent (mrem/yr)	(mSv/yr)
DOE standard for routine DOE activities (all pathways)	100[a]	1
EPA standard for site operations (airborne pathway only)	10	0.1

a. The effective dose equivalent for any member of the public from all routine DOE operations, including remedial activities, and release of naturally occurring radionuclides shall not exceed this value. Routine operations refer to normal, planned operations and do not include accidental or unplanned releases.

Table A-2. Derived Concentration Standards for Radiation Protection.

Derived Concentration Standard[a]			Derived Concentration Standard		
Radionuclide	In Air (µCi/ml)	In Water (µCi/ml)	Radionuclide	In Air (µCi/ml)	In Water (µCi/ml)
Gross Alpha[b]	3.4×10^{-14}	1.7×10^{-7}	Antimony-125	3.1×10^{-10}	2.7×10^{-5}
Gross Beta[c]	2.5×10^{-11}	2.5×10^{-8}	Iodine-129[f]	3.8×10^{-10}	3.3×10^{-7}
Tritium (tritiated water)	2.1×10^{-7}	1.9×10^{-3}	Iodine-131[f]	2.3×10^{-9}	1.3×10^{-6}
Carbon-14	6.6×10^{-10}	6.2×10^{-5}	Iodine-132[f]	3.0×10^{-8}	9.8×10^{-5}
Sodium-24	7.0×10^{-9}	7.2×10^{-5}`	Iodine-133[f]	7.2×10^{-9}	6.0×10^{-6}
Argon-41[d]	1.4×10^{-8}	__	Iodine-135[f]	1.6×10^{-8}	3.0×10^{-5}
Chromium-51	9.4×10^{-8}	7.9×10^{-4}	Xenon-131m[d]	2.4×10^{-6}	__
Manganese-54	1.1×10^{-9}	4.4×10^{-5}	Xenon-133[d]	6.3×10^{-7}	__
Cobalt-58	1.7×10^{-9}	3.9×10^{-5}	Xenon-133m[d]	6.6×10^{-7}	__
Cobalt-60	1.2×10^{-10}	7.2×10^{-6}	Xenon-135[d]	7.8×10^{-8}	__
Zinc-65	1.6×10^{-9}	8.3×10^{-6}	Xenon-135m[d]	4.5×10^{-8}	__
Krypton-85[d]	3.6×10^{-6}	__	Xenon-138[d]	1.6×10^{-8}	__
Krypton-85m[d,e]	1.3×10^{-7}	__	Cesium-134	1.8×10^{-10}	2.1×10^{-6}
Krypton-87[d]	2.2×10^{-8}	__	Cesium-137	9.8×10^{-11}	3.0×10^{-6}
Krypton-88[d]	8.8×10^{-9}	__	Cesium-138	7.5×10^{-8}	3.1×10^{-4}
Rubidium-88[d]	1.2×10^{-8}	3.2×10^{-4}	Barium-139	5.8×10^{-8}	2.4×10^{-4}
Rubidium-89[d]	1.5×10^{-9}	6.6×10^{-4}	Barium-140	6.2×10^{-10}	1.1×10^{-5}
Strontium-89	4.6×10^{-10}	1.1×10^{-5}	Cerium-141	9.9×10^{-10}	4×10^{-5}
Strontium-90	2.5×10^{-11}	1.1×10^{-6}	Cerium-144	7.1×10^{-11}	5.5×10^{-6}
Yttrium-91m	3.1×10^{-7}	2.7×10^{-3}	Plutonium-238	3.7×10^{-14}	1.5×10^{-7}
Zirconium-95	6.3×10^{-10}	3.1×10^{-5}	Plutonium-239	3.4×10^{-14}	1.4×10^{-7}
Technetium-99m	1.7×10^{-7}	1.4×10^{-3}	Plutonium-240	3.4×10^{-14}	1.4×10^{-7}
Ruthenium-103	1.3×10^{-9}	4.2×10^{-5}	Plutonium-241	1.8×10^{-12}	7.6×10^{-6}
Ruthenium-106	5.6×10^{-11}	4.1×10^{-6}	Americium-241	4.1×10^{-14}	1.7×10^{-7}

a. Derived concentration standards are from DOE-STD-1196-2011 (*Derived Concentration Technical Standard)* and support the implementation of DOE Order 458.1. They are based on a committed effective dose equivalent of 100 mrem/yr (1 mSv) for ingestion or inhalation of a radionuclide during one year. Inhalation values shown represent the most restrictive lung retention class.

b. Based on the most restrictive human-made alpha emitter (^{239}Pu).

c. Based on the most restrictive human-made beta emitter (^{90}Sr).

d. The DCS for air immersion is used because or there is no inhaled air DCG established for the radionuclide.

e. An "m" after the number refers to a metastable form of the radionuclide.

f. Particulate aerosol form in air.

Table A-3. Environmental Protection Agency Maximum Contaminant Levels for Public Drinking Water Systems and State of Idaho Groundwater Quality Standards for Radionuclides and Inorganic Contaminants.

Constituent	Maximum Contaminant Levels	Groundwater Quality Standards
Gross alpha (pCi/L)	15	15
Gross beta (mrem/yr)	4	4
Beta/gamma emitters	Concentrations resulting in 4 mrem total body or organ dose equivalent	4 mrem/yr effective dose equivalent
Radium-226 plus -228 (pCi/L)	5	5
Strontium-90 (pCi/L)	8	8
Tritium (pCi/L)	20,000	20,000
Uranium (µg/L)	30	30
Arsenic (mg/L)	0.01	0.05
Antimony (mg/L)	0.006	0.006
Asbestos (fibers/L)	7 million	7 million
Barium (mg/L)	2	2
Beryllium (mg/L)	0.004	0.004
Cadmium (mg/L)	0.005	0.005
Chromium (mg/L)	0.1	0.1
Copper (mg/L)	1.3	1.3
Cyanide (mg/L)	0.2	0.2
Fluoride (mg/L)	4	4
Lead[a] (mg/L)	0.015	0.015
Mercury (mg/L)	0.002	0.002
Nitrate (as N) (mg/L)	10	10
Nitrite (as N) (mg/L)	1	1
Nitrate and Nitrite (both as N) (mg/L)	--[b]	10
Selenium (mg/L)	0.05	0.05
Thallium (mg/L)	0.002	0.002

a. Treatment technique action level, the concentration of a contaminant which, if exceeded, triggers treatment or other requirements that a water system must follow.

b. No maximum contaminant level for this constituent.

Table A-4. Environmental Protection Agency Maximum Contaminant Levels for Public Drinking Water Systems and State of Idaho Groundwater Quality Standards for Organic Contaminants.

Constituent	Maximum Contaminant Levels (mg/L)	Groundwater Quality Standards (mg/L)
Benzene	0.005	0.005
Carbon tetrachloride	0.005	0.005
m-Dichlorobenzene	__	0.6
o-Dichlorobenzene	0.6	0.6
p-Dichlorobenzene	0.075	0.075
1,2-Dichloroethane	0.005	0.005
1,1-Dichloroethylene	0.007	0.007
cis-1,2-Dichloroethylene	0.07	0.07
trans-1,2-Dichloroethylene	0.1	0.1
Dichloromethane	0.005	0.005
1,2-Dichloropropane	0.005	0.005
Ethylbenzene	0.7	0.7
Monochlorobenzene	0.1	0.1
Styrene	0.1	0.1
Tetrachloroethylene	0.005	0.005
Toluene	1.0	1.0
1,2,4-Trichlorobenzene	0.07	0.07
1,1,1-Trichloroethane	0.2	0.2
1,1,2-Trichloroethane	0.005	0.005
Trichloroethylene	0.005	0.005
Vinyl chloride	0.002	0.002
Xylenes (total)	10.0	10.0
Bromate	0.01	__
Bromodichloromethane	__	0.1
Bromoform	__	0.1
Chlorodibromomethane	__	0.1
Chloroform	__	0.002
Chlorite	1.0	__
Haloacetic acids (HAA5)	0.06	__
Total Trihalomethanes (TTHMs)	0.08	0.1

Table A-5. Environmental Protection Agency Maximum Contaminant Levels for Public Drinking Water Systems and State of Idaho Groundwater Quality Standards for Synthetic Organic Contaminants.

Constituent	Maximum Contaminant Levels (mg/L)	Groundwater Quality Standards (mg/L)
Alachlor	0.002	0.002
Atrazine	0.003	0.003
Carbofuran	0.04	0.04
Chlordane	0.002	0.002
Dibromochloropropane	0.0002	0.0002
2,4-D	0.07	0.07
Ethylene dibromide	0.00005	0.00005
Heptachlor	0.0004	0.0004
Heptachlor epoxide	0.0002	0.0002
Lindane	0.0002	0.0002
Methoxychlor	0.04	0.04
Polychlorinated biphenyls	0.0005	0.0005
Pentachlorophenol	0.001	0.001
Toxaphene	0.003	0.003
2,4,5-TP (silvex)	0.05	0.05
Benzo(a)pyrene	0.0002	0.0002
Dalapon	0.2	0.2
Di(2-ethylhexyl) adipate	0.4	0.4
Di(2-ethylhexyl) phthalate	0.006	0.006
Dinoseb	0.007	0.007
Diquat	0.02	0.02
Endothall	0.1	0.1
Endrin	0.002	0.002
Glyphosate	0.7	0.7
Hexachlorobenzene	0.001	0.001
Hexachlorocyclopentadiene	0.05	0.05
Oxamyl (vydate)	0.2	0.2
Picloram	0.5	0.5
Simazine	0.004	0.004
2,3,7,8-TCDD (dioxin)	3×10^{-8}	3×10^{-8}

Table A-6. Environmental Protection Agency National Secondary Drinking Water Regulations and State of Idaho Groundwater Quality Standards for Secondary Contaminants.

Constituent	Secondary Standards[a]	Groundwater Quality Standards
Aluminum (mg/L)	0.05 to 0.2	0.2
Chloride (mg/L)	250	250
Color (color units)	15	15
Foaming agents (mg/L)	0.5	0.5
Iron (mg/L)	0.3	0.3
Manganese (mg/L)	0.05	0.05
Odor (threshold odor number)	3 threshold odor number	3
pH	6.5 to 8.5	6.5 to 8.5
Silver (mg/L)	0.1	0.1
Sulfate (mg/L)	250	250
Total dissolved solids (mg/L)	500	500
Zinc (mg/L)	5	5

a. The Environmental Protection Agency (EPA) has not established National Primary Drinking Water Regulations that set mandatory water quality standards (maximum contaminant levels) for these constituents because these contaminants are not considered a risk to human health. EPA has established National Secondary Drinking Water Regulations that set secondary maximal contaminant levels as guidelines to assist public water systems in managing their drinking water for aesthetic considerations, such as taste, color, and odor.

Appendix B. Cultural Resource Reviews Performed at the INL Site (2014)

In 2014, 41 projects located at the INL Site and at DOE facilities in Idaho Falls were reviewed for potential impacts to cultural resources. Table B-1 provides a summary of the cultural resource reviews performed.

Table B-1. Cultural Resource Reviews Performed at the INL Site in 2014.

Project #	Project Name	INL CRM[a] Activities	Acres Surveyed	Cultural Resources Identified
BEA-14-01	Small Naval Reactors Facility Projects	Archive reviews, limited field survey, avoidance of known resource locations, and documentation	1 previously surveyed (>10 years ago)	2 previously recorded
BEA-14-02	Willow Creek Building Pedestrian Bridge Replacement (Idaho Falls)	Environmental Checklist reviews, limited field survey, and documentation	0.5	None
BEA-14-03	Arco Naval Proving Ground	Field reconnaissance and documentation (See also Project # H001)	Vehicle survey and light pedestrian recon of 170 acres	Multiple structures, linear elements, and landscape features
BEA-14-04	Monroe Gravel Pit	Environmental Checklist review, limited field survey, avoidance of known resource locations, and documentation	2 previously surveyed (>10 years ago)	1 previously recorded site
BEA-14-05	Small National and Homeland Security Projects	Environmental Checklist reviews, limited field survey, and documentation	0.5	None
BEA-14-06	U.S. Forest Service Forest Inventory	Environmental Checklist review, limited field survey, and documentation	2	None
BEA-14-07	Syringa Wireless Fiber Optic Lines	Archive review and recommendations for future project	None	None
BEA-14-08	U.S. Geologic Survey Wells #142 and 143	Environmental Checklist review, limited field surveys, and documentation	2	None
BEA-14-09	Idaho Transportation Department U.S. Highway 20/26 Turnout Developments (in cooperation with Bureau of Land Management)	Archive reviews, field survey, avoidance of known resource locations, and documentation	10 previously surveyed (>10 years ago)	4 previously recorded sites
BEA-14-10	Materials and Fuels Complex Fire Waterline Replacement	Environmental Checklist review, field survey, and documentation	6	None
BEA-14-11	Spreading Area B Soil Profiles	Archive review, limited field survey, and documentation	1 previously surveyed (>10 years ago)	None

Table B-1. Cultural Resource Reviews Performed at the INL Site in 2014. (cont.)

Project #	Project Name	INL CRM[a] Activities	Acres Surveyed	Cultural Resources Identified
BEA-14-12	Shelley-New Sweden Parking Lot Flood Control	Environmental Checklist review, limited field survey, and documentation	0.5	None
BEA-14-13	Idaho Transportation Department U.S. Highway 20/26 Intersection Developments (in cooperation with Bureau of Land Management	Archive reviews, limited field survey, and documentation	0.5 (previously surveyed (>10 years ago)	None
BEA-14-14	National Security Test Range Shelter	Environmental Checklist review, and documentation	0.5 previously surveyed (<10 years ago)	None
BEA-14-15	Nile Avenue Road Construction and Expansion of T-28 South Gravel Pit	Investigation of unauthorized ground disturbance and damage to known resource locations, documentation, and employee awareness training	None	2 previously recorded sites and 1 newly recorded site
BEA-14-16	Geothermal Research Area	Archive review and recommendations for future project	None	None
BEA-14-17	CWI DD&D, Routine Maintenance, Small Projects	Environmental Checklist reviews, and documentation	None	None
BEA-14-18	Middle Butte Cave Bat Studies	Cultural resource monitoring of project activities	None	1 sensitive cave site
BEA-14-19	Idaho Falls Facilities Small Projects	Environmental Checklist reviews, limited field surveys, and documentation	0.25	None
BEA-14-H001	Sitewide – Demolition/Excess Facilities/Footprint Reduction; CF-661, CF-629, CF-1605,CF-674, CF-688, CF-689, CF-686, CF-601, CF-663, CF-676, CF-621, CF-622, CF-623, CF-624, CF-671, CF-664, CF-695, CF-619, CF-625, CF-690, TRA-669, TRA-689, TAN-601, B25-601	INL CRMP[b] based cultural resource review of each individual facility prior to start of work; some facilities on the list are exempt/not eligible for listing on the National Register and as such may be removed without further cultural review, for those facilities that are eligible for listing, mitigation based on property type (Signature Property, Level I, II, or II) as outlined in the CRMP.	NA[c]	NA

Table B-1. Cultural Resource Reviews Performed at the INL Site in 2014. (cont.)

Project #	Project Name	INL CRM[a] Activities	Acres Surveyed	Cultural Resources Identified
Architectural BEA-14-H002	ATR Complex – Relocation of existing relief valve test stand – TRA-670, TRA-605	INL CRMP based cultural resource review of each individual facility prior to start of work; both facilities eligible for listing on the national Register, mitigation based on property type (Signature Property, Level I, II, or II)	NA	NA
Architectural BEA-14-H003	Demolition/Footprint Reductions combined with BEA-14-001	See BEA-14-H001	NA	NA
Architectural BEA-14-H004	MFC – oxygen analyzer, networked balance, halon removal, wet sprinkler installation, trailer lease and removal – MFC-785	Exempt activities	NA	NA
Architectural BEA-14-H005	ATR Complex – Fire Sprinklers/NFPA – TRA-640, TRA-671	Project activities will create non-adverse impacts	NA	NA
Architectural BEA-1-H006	Demolition/Footprint Reduction combined with BEA-14-H001	See BEA-14-H001	NA	NA
Architectural BEA-14-H007	EBR-I Circuit breaker repaid and upgrad – EBR-I-601	Project activities will create non-adverse impacts	NA	NA
Architectural BEA-14-H008	Sitewide R&D activities	INL CRMP based cultural resource review of each individual facility prior to start of work; some facilities on the list are exempt/not eligible for listing on the National Register and as such may be removed without further cultural review; for those facilities that are eligible for listing, mitigation based on property type (Signature Property, Level I, II or II) as outlined in the CRMP	NA	NA

Table B-1. Cultural Resource Reviews Performed at the INL Site in 2014. (cont.)

Project #	Project Name	INL CRM[a] Activities	Acres Surveyed	Cultural Resources Identified
Architectural BEA-14-H009	MFC and ATR Complex – Roof replacements – MFC-720, MFC-721, MFC-776 (ZPPR), TRA-670, MFC-768, MFC, MFC-704 (FMF)	Project activities will create non-adverse impacts	NA	NA
Architectural BEA-14-H010	ATR Complex – replacement of Primary Coolant Pump circuit breaker – 670-E-1, 670-E-2	Exempt activity	NA	NA
Architectural BEA-14-H011	MFC/TREAT – Fire Water System Upgrade – MFC-785, MFC-755, MFC-754	Exempt activity	NA NA	NA NA
Architectural BEA-14-H012	MFC-Fire Sprinklers/NFPA – MFC-782	Exempt activity	NA	NA
Architectural BEA-14-H013	MFC – Plasma Hearth Process Secondary Confinement System – demolition – MFC-720	Exempt activity	NA	NA
Architectural BEA-14-H014	MFC/ZPPR – ZPPR DSA implementation – MFC-775, MFC-777	Exempt activities	NA	NA
Architectural BEA-14-H015	ATR Complex – LED Message Electronic – TRA-658, TRA-641	Exempt activity	NA	NA
Architectural BEA-14-H016	ATR Complex – Conference Room/Divider Walls/NFPA – TRA-653	Project activities will create non-adverse impacts	NA	NA
Architectural BEA-14-H017	CFA – Electric Heat/CFA-671 Boilers – CFA-671, CFA-601, CFA-622, CFA-623, CFA-674	Exempt activities	NA	NA

Table B-1. Cultural Resource Reviews Performed at the INL Site in 2014. (cont.)

Project #	Project Name	INL CRM[a] Activities	Acres Surveyed	Cultural Resources Identified
Architectural BEA-14-H018	ATR Complex – Green Room Mill Replacement – TRA-653, TRA-670	INL CRMP based cultural resource review of each individual facility prior to start of work; TRA-670 eligible for listing on the National Register, mitigation based on property type (Signature Property; Level I, II, or II) as outlined in the CRMP	NA	NA
Architectural BEA-14-H019	MFC – Ladder replacements and platform modifications – MFC-785, MFC-752, MFC-777, MFC-792, MFC-709, MFC-793	Exempt activities	NA	NA
Architectural BEA-14-H020	ATR Complex – Cubicle DTC filtration system – ATR-670-HVE-1735	Exempt activities	NA	NA
Architectural BEA-14-H021	MFC – Removal – MFC-755, MFC-755A, MFC-755B	Exempt buildings	NA	NA
Architectural BEA-14-H022	ATR Complex – Viewing Windows Replacement – ATR (TRA-670)	INL CRMP based cultural resource review prior to start of work; TRA-670 eligible for listing on the National Register, mitigation based on property type (Signature Property, Level I, II, or II) as outlined in the CRMP.	NA	NA
Architectural BEA-14-H023	MFC – Fire Suppression System – MFC-765	Exempt activities	NA	NA
Architectural BEA-14-H024	ATR Complex – Loop 2E Pressurizer Repair Replacement – TRA-670	Exempt activity	NA	NA

a. CRM = Cultural Resource Management
b. CRMP = Cultural Resource Management Plan
c. NA = Not applicable

Blue Penstemon

Appendix C. Addendum

Table C-1. Advanced Test Reactor Complex Cold Waste Pond Effluent Permit-Required Monitoring Results (January to November 2014).[a]

Parameter	Minimum	Maximum	Median
Arsenic (mg/L)	0.005 U[b]	0.0067	0.005 U
Barium (mg/L)	0.0447	0.144	0.0765
Cadmium (mg/L)	0.001 U	0.001 U	0.001 U
Chloride (mg/L)	9.87	40.6	21.6
Chromium (mg/L)	0.00303	0.0119	0.00615
Cobalt (mg/L)	0.0025 U	0.0025 U	0.0025 U
Conductivity (µS/cm)	424	1349	457
Copper (mg/L)	0.00238	0.0057	0.00417
Fluoride (mg/L)	0.154	0.553	0.282
Iron (mg/L)	0.0646	0.248	0.1235
Manganese (mg/L)	0.0025 U	0.00775	0.0025 U
Mercury (mg/L)	0.0002 U	0.0002 U	0.0002 U
Nitrate + Nitrite as Nitrogen (mg/L)	0.677	3.01	1.623
Nitrogen, Total Kjeldahl Nitrogen (TKN) (mg/L)	0.1 U	0.569	0.1 U
Selenium (mg/L)	0.000823	0.00393	0.002215
Silver (mg/L)	0.005 U	0.005 U	0.005 U
Solids, Total Dissolved (mg/L)	236	1080	565
Sulfate (mg/L)	22.8	549	231.1

a. Duplicate samples were collected in June and the results for the duplicate samples are included in the summary.

b. U qualifier indicates the result was below the detection limit.

Table C-2. Advanced Test Reactor Complex Cold Waste Pond Industrial Wastewater Reuse Permit Monitoring Well Results (2014).

Well Name	USGS-065 (GW-016102)		TRA-07 (GW-016103)		USGS-076 (GW-016104)		TRA-08 (GW-016105)		Middle-1823 (GW-016106)		PCS/SCS[a]
Sample Date	**04/09/14**	**10/07/14**	**04/09/14**	**10/16/14**	**04/08/14**	**10/07/14**	**04/07/14**	**10/06/14**	**04/08/14**	**10/06/14**	
Water Table Depth (ft below ground surface)	475.6	477.04	484.13	485.74 {485.62}[b]	483.85	485.22	489.7	491.06	493.54	494.92	NA[c]
Water Table Elevation (above mean sea level in ft)[d]	4452.92	4451.48	4451.01	4449.4 {4449.52}[b]	4449.39	4447.99	4449.36	4448	4449.33	4447.95	NA
Borehole Correction Factor (ft)[e]	NA	NA	0.06	0.06	NA	NA	0.63	0.63	NA	NA	NA
pH	7.31	7.47	7.38	7.61	7.33	7.75	7.52	7.86	7.34	7.52	6.5 to 8.5 (SCS)
Total Kjeldahl nitrogen (mg/L)	0.1 U[f]	0.1 U	0.1 U	0.1 U	0.1 U [0.1 U][g]	0.1 U	0.1 U	0.121	0.1 U	0.131	NA
Nitrite nitrogen (mg/L)	0.05 U	0.05 U	0.05 U	0.05 U	0.05 U [0.05 U]	0.05 U	0.05 U	0.05 U	0.05 U	0.05 U	1 (PCS)
Nitrate nitrogen (mg/L)	1.46	1.40	1.0	0.958	1.01 [1.01]	0.996	0.968	0.925	0.96	0.922	10 (PCS)
Total nitrogen[h] (mg/L)	<1.61	<1.55	<1.15	<1.108	<1.16 [<1.16]	<1.146	<1.118	<1.096	<1.11	<1.103	NA
Total dissolved solids (mg/L)	410	443	424	449	241 [243]	267	254	259	249	270	500 (SCS)
Aluminum (mg/L)	0.0113 (0.00957)[i]	0.0194 (0.0159)	**0.568**[j] (0.0174)	**1.980** (0.0105)	0.00656 [0.00647] (0.00774) [(0.0631)]	0.00626 (0.00596)	0.0855 (0.016)	**0.350** (0.00669)	0.124 (0.00377)	0.0853 (0.0033)	0.2 (SCS)
Antimony (mg/L)	0.0004 U	0.0004 U	0.0004 U	0.0004 U	0.0004 U [0.0004 U]	0.0004 U	0.0004 U	0.0004 U	0.0004 U	0.0004 U	0.006 (PCS)
Arsenic (mg/L)	0.00138	0.00115	0.00141	0.00136	0.00173 [0.00176]	0.00147	0.00186	0.0016	0.00186	0.00159	0.05 (PCS)
Barium (mg/L)	0.0423	0.0427	0.0621	0.0944	0.0667 [0.0667]	0.0677	0.0765	0.054	0.0599	0.0626	2 (PCS)
Cadmium (mg/L)	0.00025 U	0.00025 U	0.00025 U	0.00025 U	0.00025 U [0.00025 U]	0.00025 U	0.00025 U	0.00025 U	0.00025 U	0.00025 U	0.005 (PCS)
Chloride (mg/L)	19.8	20.0	21.1	20.8	13.7 [13.7]	13.0	11.6	11.5	12.1	11.4	250 (SCS)

Table C-2. Advanced Test Reactor Complex Cold Waste Pond Industrial Wastewater Reuse Permit Monitoring Well Results (2014). (cont.)

Well Name	USGS-065 (GW-016102)		TRA-07 (GW-016103)		USGS-076 (GW-016104)		TRA-08 (GW-016105)		Middle-1823 (GW-016106)		PCS/SCS[a]
Sample Date	04/09/14	10/07/14	04/09/14	10/16/14	04/08/14	10/07/14	04/07/14	10/06/14	04/08/14	10/06/14	
Cobalt (mg/L)	0.0025 U	0.0025 U	0.0025 U	0.0025 U	0.0025 U [0.0025 U]	0.0025 U	0.0025 U	0.0025 U	0.0025 U	0.0025 U	NA
Copper (mg/L)	0.0025 U	0.0025 U	0.0228	0.0121	0.0025 U [0.0025 U]	0.0025 U	0.00944	0.00315	0.00896	0.0025 U	1.3 (PCS)
Fluoride (mg/L)	0.234	0.221	0.212	0.213	0.158 [0.155]	0.185	0.175	0.203	0.156	0.197	4 (PCS)
Iron (mg/L)	0.260 (0.0589)	0.163 (0.0860)	**0.575** (0.0941)	**2.030** (0.0789)	0.050 U [0.0588] (0.0519) [(0.0583)]	0.149 (0.0785)	**0.534** (0.0657)	**0.563** (0.0773)	0.141 (0.0506)	0.154 (0.0743)	0.3 (SCS)
Manganese (mg/L)	0.0025 U (0.0025 U)	0.0025 U (0.0025 U)	0.00784 (0.0025 U)	0.0285 (0.0025 U)	0.0025 U [0.0025 U] (0.0025 U) [(0.0025 U)]	0.00311 (0.0025 U)	0.0125 (0.0025 U)	0.00954 (0.0025 U)	0.00348 (0.0025 U)	0.00516 (0.00296)	0.05 (SCS)
Mercury (mg/L)	0.0002 U	0.0002 U	0.0002 U	0.0002 U	0.0002 U [0.0002 U]	0.0002 U	0.0002 U	0.0002 U	0.0002 U	0.0002 U	0.002 (PCS)
Selenium (mg/L)	0.00197	0.00163	0.00153	0.00122	0.00134 [0.00137]	0.00102	0.00137	0.00116	0.00124	0.00102	0.05 (PCS)
Silver (mg/L)	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U [0.005 U]	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U	0.1 (SCS)
Sulfate (mg/L)	161	155	160	151	33.6 [33.8]	33.6	49	47.8	35.8	34.0	250 (SCS)

a. Primary constituent standards (PCS) and secondary constituent standards (SCS) in groundwater referenced in the Ground Water Quality Rule, IDAPA 58.01.11.200.01.a and b.

b. Water level recorded on October 6, 2014 while attempting to collect a groundwater sample. Because of insufficient water volume, the groundwater sample could not be collected.

c.NA- Not applicable.

d. Elevation data provided using the North American Vertical Datum of 1988 (NAVD 88).

e. The United States Geological Survey performed gyroscopic surveys on Wells TRA-07 and TRA-08 circa 2002 to 2005. The surveys revealed these two wells were not perfectly straight or vertical which can cause the water level measurements to be greater than the true distance from the measuring point on the well to the water table. The water table elevations for these two wells have been adjusted using the borehole correction factors that were determined from the gyroscopic surveys.

f. U qualifier indicates that the result was reported as below the instrument detection limit by the analytical laboratory.

g. Results shown in brackets are the results from field duplicate samples.

h. Total nitrogen is calculated as the sum of the TKN, nitrite nitrogen, and nitrate nitrogen. For results reported below the instrument detection limit, the detection limit for that parameter is used in the calculation. The resulting total nitrogen is then reported as a less than (<) number.

i. Filtered sample results for aluminum, iron, and manganese, shown in parentheses, are used for permit compliance determinations.

j. Concentrations shown in bold are above the Ground Water Quality Rule SCS.

Table C-3. Idaho Nuclear Technology and Engineering Center Sewage Treatment Plant Influent Monitoring Results at CPP-769 (2014).

Parameter	Minimum	Maximum	Mean
Biochemical oxygen demand (5-day) (mg/L)	75.8	251	179.6
Nitrate + nitrite, as nitrogen (mg/L)	-0.0185 U[a]	0.012 U	0.0006 U
Total Kjeldahl nitrogen (mg/L)	44.8	152	85.5
Total phosphorus (mg/L)	4.32	15	7.06
Total suspended solids (mg/L)	32	494	208

a. U flag indicates the analyte was analyzed for, but not detected above the method detection limit.

Table C-4. Idaho Nuclear Technology and Engineering Center Sewage Treatment Plant Effluent Monitoring Results at CPP-773 (2014).

Parameter	Minimum	Maximum	Mean
Biochemical oxygen demand (5-day) (mg/L)	8.2	18.9	11.6
Nitrate + nitrite, as nitrogen (mg/L)	0.6	6	2.9
pH (standard units)[a]	7.19	8.84	7.87
Total coliform (colonies/100 mL)[a]	88	1,483	456
Total Kjeldahl nitrogen (mg/L)	7.8	28.5	17.5
Total phosphorus (mg/L)	2.69	5.75	4.11
Total suspended solids (mg/L)	3.5	32.4	13.3

a. As required by the permit, the results for this parameter were obtained from a grab sample.

Table C-5. Idaho Nuclear Technology and Engineering Center New Percolation Ponds Effluent Monitoring Results at CPP-797 (2014).

Parameter	Minimum	Maximum	Mean
Aluminum (mg/L)	0.068 U[a]	0.138	0.081
Arsenic (mg/L)	0.005 U	0..0071	0.0052
Biochemical oxygen demand (5-day) (mg/L)	-0.0457 U	2.74	1.01
Cadmium (mg/L)	0.001 U	0.001 U	0.001 U
Chloride (mg/L)	13.9	35.6	17.2
Chromium (mg/L)	0.0054 U	0.0077	0.0059
Conductivity (µS/cm)	369	459	393
Copper (mg/L)	0.003 U	0.0114	0.0055
Fluoride (mg/L)	0.161	0.272	0.214
Iron (mg/L)	0.03 U	0.093	0.046
Manganese (mg/L)	0.002 U	0.0023	0.002
Mercury (mg/L)	0.000067 U	0.000067 U	0.000067 U
Nitrate + nitrite, as nitrogen (mg/L)	0.88	2.29	1.42
pH (standard units)[b]	7.39	8.13	7.70
Selenium (mg/L)	0.0015 U	0.0022	0.0016
Silver (mg/L)	0.001 U	0.0022	0.0011
Sodium (mg/L)	9.1	18.3	13.2
Total coliform (colonies/100 mL)[b]	3	94	21
Total dissolved solids (mg/L)	194	260	224
Total Kjeldahl nitrogen (mg/L)	0.1	1.3	0.4
Total phosphorus (mg/L)	0.574	0.985	0.766
Total suspended solids (mg/L)	0.3 U	1.9	0.9

a. U flag indicates the analyte was analyzed for, but not detected above the method detection limit.

b. As required by the permit, the results for this parameter were obtained from a grab sample.

Table C-6. Idaho Nuclear Technology and Engineering Center New Percolation Ponds Aquifer Monitoring Well Groundwater Results (2014).

	ICPP-MON-A-165 (GW-013006)		ICPP-MON-A-166 (GW-013007)		ICPP-MON-A-164B (GW-013011)		
Sample Date	**4/9/2014**	**9/10/2014**	**4/9/2014**	**9/10/2014**	**4/9/2014**	**9/10/2014**	**PCS/SCS[a]**
Depth to water (ft below brass cap)	503.9	505.32	511.04	512.52	502.97	504.39	NA[b]
Water table elevation (at brass cap in ft)[c]	4,449.01	4,447.59	4,448.5	4,447.02	4,449.20	4,447.78	NA
Aluminum (mg/L)[d]	0.068 U[e]	0.068 U	0.068 U	0.068 U	0.068 U	0.068 U	0.2
Arsenic (mg/L)	0.0017 U	0.0017 U	0.0017 U	0.0017 U	0.0017 U	0.0017 U	0.05
Biochemical oxygen demand (mg/L)	-0.208 UJ[f]	-0.482 UJ	0.052 UJ	-0.542 UJ	3.42	3.46	NA
Cadmium (mg/L)	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.005
Chloride (mg/L)	41.4	40.1	9.9	9.26	9.48	9.7	250
Chromium (mg/L)	0.0108	0.0289	0.00516	0.00556	0.00946	0.0104	0.1
Coliform, fecal (colonies/100 mL)	0	0	0	0	0	0	<1 col/100 mL
Coliform, total (colonies/100 mL)	0	0	0	0	0	0	1 col/100 mL
Copper (mg/L)	0.003 U	0.003 U	0.003 U	0.003 U	0.003 U	0.003 U	1.3
Fluoride (mg/L)	0.225	0.229	0.288	0.305	0.238	0.2	4
Iron (mg/L)[d]	0.030 U	0.030 U	0.172	0.030 U	0.030 U	0.030 U	0.3
Manganese (mg/L)[d]	0.002 U	0.002 U	0.0217	0.0111	0.002 U	0.002 U	0.05
Mercury (mg/L)	0.000067 U	0.000067 U	0.000067 U	0.000067 U	0.000067 U	0.000067 U	0.002
Nitrate, as nitrogen (mg/L)	1.06	1.18	0.257	0.338[g] J[h]	0.68	0.874	10
Nitrite, as nitrogen (mg/L)	0 U	0 U	0 U	0[g] UJ	0 U	0 U	1
pH (standard units)	7.75	7.97	7.68	8.02	7.87	7.97	6.5–8.5
Selenium (mg/L)	0.0015 U	0.0015 U	0.0015 U	0.0015 U	0.0015 U	0.0015 U	0.05
Silver (mg/L)[d]	0.001 U	0.001 U	0.001 U	0.001 U	0.00114	0.001 U	0.1
Sodium (mg/L)	16.4	16	9.74	8.59	9.33	9.35	NA
Total dissolved solids (mg/L)	254	290	187	149	194	227	500
Total Kjeldahl nitrogen (mg/L)	0.013 U	0.00638[i] UJ	-0.0761 U	0.0106[i] U	0.0364	0.0343[i] J	NA

Table C-6. Idaho Nuclear Technology and Engineering Center New Percolation Ponds Aquifer Monitoring Well Groundwater Results (2014). (cont.)

	ICPP-MON-A-165 (GW-013006)		ICPP-MON-A-166 (GW-013007)		ICPP-MON-A-164B (GW-013011)		
Sample Date	**4/9/2014**	**9/10/2014**	**4/9/2014**	**9/10/2014**	**4/9/2014**	**9/10/2014**	**PCS/SCS[a]**
Total phosphorus (mg/L)	0.0573	0.0170[i] J	0.0496	0.0209[i] J	0.0536	0.0222[i] J	NA

a. Primary constituent standards (PCS) and secondary constituent standards (SCS) in groundwater referenced in IDAPA 58.01.11.200.01.a and b.

b. NA—Not applicable.

c. Water level elevations referenced to North American Vertical Datum of 1988 (NAVD 88).

d. The results of dissolved concentrations of this parameter are used for secondary constituent standard compliance determinations.

e. U flag indicates the analyte was analyzed for, but not detected above the method detection limit.

f. UJ flag indicates the material was analyzed for, but was not detected. The associated value is an estimate and may be inaccurate or imprecise.

g. Sample was analyzed outside the 48-hour holding time.

h. J flag indicates the material was analyzed for and was detected at or above the applicable detection limit. The associated value is an estimate and may be inaccurate or imprecise.

i. Sample was reanalyzed outside the 28-day holding time.

Table C-7. Idaho Nuclear Technology and Engineering Center New Percolation Ponds Perched Water Monitoring Well Groundwater Results (2014).

	ICPP-MON-V-191 (GW-013008)		ICPP-MON-V-200 (GW-013009)		ICPP-MON-V-212 (GW-013010)		
Sample Date	**4/10/2014**	**9/11/2014**	**4/10/2014**	**9/11/2014**	**4/10/2014**	**9/11/2014**	**PCS/SCS[a]**
Depth to water (ft below brass cap)	Dry[b]	Dry[b]	111.06	116.82	236.68	236.43	NA[c]
Water elevation at brass cap (ft)[d]			4,841.91	4,836.15	4,721.66	4,721.91	NA
Aluminum (mg/L)[e]			0.068 U[f]	0.068 U	0.068 U	0.068 U	0.2
Arsenic (mg/L)			0.00697	0.00636	0.00171	0.00215	0.05
Biochemical oxygen demand (mg/L)			-0.124 UJ[g]	-0.957 UJ	-1.03 UJ	-0.987 UJ	NA
Cadmium (mg/L)			0.001 U	0.001 U	0.001 U	0.001 U	0.005
Chloride (mg/L)			42.3	21.1	40.9	37	250
Chromium (mg/L)			0.00432	0.00639	0.0134	0.0054	0.1
Coliform, fecal (colonies/100 mL)			0	0	0	0	<1 col/100 mL
Coliform, total (colonies/100 mL)			0	0	0	0	1 col/100 mL
Copper (mg/L)			0.003 U	0.003 U	0.003 U	0.003 U	1.3
Fluoride (mg/L)			0.217	0.245	0.301	0.307	4
Iron (mg/L)[e]			0.030 U	0.030 U	0.208	0.030 U	0.3
Manganese (mg/L)[e]			0.002 U	0.002 U	0.00456	0.002 U	0.05
Mercury (mg/L)			0.000067 U	0.000067 U	0.000067 U	0.000067 U	0.002
Nitrate, as nitrogen(mg/L)			1.78	1.31	1.79	1.76	10
Nitrite, as nitrogen (mg/L)			0 U	0 U	0 U	0 U	1
pH (standard units)			7. 51	7.76	7.77	8.02	6.5–8.5
Selenium (mg/L)			0.0015 U	0.0015 U	0.0015 U	0.00153	0.05
Silver (mg/L)[e]			0.001 U	0.001 U	0.001 U	0.001 U	0.1
Sodium (mg/L)			22.3	21.7	45.3	41.1	NA
Total dissolved solids (mg/L)			254	249	296	284	500
Total Kjeldahl nitrogen (mg/L)			0.0289	0.0383[h] J[i]	0.0141 U	0.0219[h] UJ	NA

Table C-7. Idaho Nuclear Technology and Engineering Center New Percolation Ponds Perched Water Monitoring Well Groundwater Results (2014). (cont.)

	ICPP-MON-V-191 (GW-013008)		ICPP-MON-V-200 (GW-013009)		ICPP-MON-V-212 (GW-013010)		
Sample Date	**4/10/2014**	**9/11/2014**	**4/10/2014**	**9/11/2014**	**4/10/2014**	**9/11/2014**	**PCS/SCS[a]**
Total phosphorus (mg/L)			0.174	0.141[h] J	0.0815	0.0237[h] J	NA

a. Primary constituent standards (PCS) and secondary constituent standards (SCS) in groundwater referenced in IDAPA 58.01.11.200.01.a and b.

b. Perched water Well ICPP-MON-V-191was dry in April and September 2014.

c. NA—Not applicable.

d. Water level elevations referenced to North American Vertical Datum of 1988 (NAVD 88).

e. The results of dissolved concentrations of this parameter are used for secondary constituent standard compliance determinations.

f. U flag indicates the analyte was analyzed for, but not detected above the method detection limit.

g. UJ flag indicates the material was analyzed for, but was not detected. The associated value is an estimate and may be inaccurate or imprecise.

h. Sample was reanalyzed outside the 28-day holding time.

i. J flag indicates the material was analyzed for and was detected at or above the applicable detection limit. The associated value is an estimate and may be inaccurate or imprecise.

Table C-8. Materials and Fuels Complex Industrial Waste Pipeline Monitoring Results (2014).[a]

Parameter	Minimum	Maximum	Median
Arsenic (mg/L)	0.005 U[b]	0.005 U	0.005 U
Barium (mg/L)	0.0325	0.0478	0.0367
Cadmium (mg/L)	0.001 U	0.001 U	0.001 U
Chloride (mg/L)	19.5	67.7	27.5
Chromium (mg/L)	0.0025 U	0.0118	0.0025 U
Fluoride (mg/L)	0.566	0.72	0.628
Iron[c] (mg/L)	0.025 U	0.713	0.110
Lead (mg/L)	0.00025 U	0.0017	0.00029
Manganese (mg/L)	0.0025 U	0.0116	0.0025 U
Mercury (mg/L)	0.0002 U	0.0002 U	0.0002 U
Nitrate + Nitrite as Nitrogen (mg-N/L)	2.02	2.8	2.1
Nitrogen, Total Kjeldahl Nitrogen (TKN) (mg/L)	0.1 U	0.292	0.1 U
pH (standard units)	7.39	8.19	7.75
Phosphorus, Total (mg/L)	0.0496	0.397	0.2
Selenium (mg/L)	0.0005 U	0.0036	0.000516
Silver (mg/L)	0.005 U	0.005 U	0.005 U
Sodium (mg/L)	18.8	46.4	24.1
Sulfate (mg/L)	16.8	22.6	18.1
Solids, Total Dissolved (mg/L)	225	362	260
Zinc (mg/L)	0.0076	0.071	0.0135

a. Duplicate samples were collected in February and the results for the duplicate samples are included in the data summary.

b. U qualifier indicates the result was below the detection limit.

c. Permit-required analyte for groundwater monitoring but not for effluent monitoring.

Table C-9. Materials and Fuels Complex Industrial Waste Water Underground Pipe Monitoring Results (2014).[a]

Parameter	Minimum	Maximum	Median
Arsenic (mg/L)	0.005 U[b]	0.00625	0.005 U
Barium (mg/L)	0.0666	0.101	0.0877
Cadmium (mg/L)	0.001 U	0.001 U	0.001 U
Chloride (mg/L)	38.7	68.2	45.1
Chromium (mg/L)	0.0033	0.00844	0.00377
Fluoride (mg/L)	1.32	1.84	1.57
Iron[c] (mg/L)	0.025 U	0.957	0.105
Lead (mg/L)	0.00025 U	0.0011	0.00052
Manganese (mg/L)	0.0025 U	0.022	0.0025 U
Mercury (mg/L)	0.0002 U	0.0002 U	0.0002 U
Nitrate + Nitrite as Nitrogen (mg/L)	4.24	7.9	4.93
Nitrogen, Total Kjeldahl Nitrogen (TKN) (mg/L)	0.1 U	1.53	0.635
pH (standard units)	7.62	8.6	8.29
Phosphorus, total	0.839	1.65	1.46
Selenium (mg/L)	0.00104	0.00159	0.0013
Silver (mg/L)	0.005 U	0.005 U	0.005 U
Sodium (mg/L)	39.8	74.2	44.9
Sulfate (mg/L)	35.4	60.6	40.6
Solids, Total Dissolved (mg/L)	508	698	589
Zinc (mg/L)	0.009	0.0201	0.0126

a. Duplicate samples were collected in February and the results for the duplicate samples are included in the data summary.

b. U qualifier indicates the result was below the detection limit.

c. Permit-required analyte for groundwater monitoring but not for effluent monitoring.

Table C-10. Summary of Groundwater Quality Data Collected for the Wastewater Reuse Permit for the MFC Industrial Waste Ditch and Pond.

Well Name	ANL-MON-A-012 (GW-016001)		ANL-MON-A-013 (GW-016002)		ANL-MON-A-014 (GW-016003)		
Sample Date	**05/27/2014**	**09/30/2014**	**04/22/2014**	**09/30/2014**	**04/21/2014**	**09/30/2014**	**PCS/SCS[a]**
Water Table Depth (ft bgs)	659.55	661.11	647.18	649.46	646.24	648.61	NA[b]
Water Table Elevation (ft above mean sea level)[c]	4473.15	4471.59	4473.19	4470.91	4471.84	4469.47	NA
pH	7.61	7.66	7.48	7.52	7.44	7.52	6.5 to 8.5 (SCS)
Temperature (°C)	14.9	12.9	13.2	12.8	13.7	13.0	None
Conductivity (µS/cm)	381	369	397	379	388	369	None
Nitrate nitrogen (mg/L)	1.98	2.0	2.26	2.03	2.3	2.04 [2.01][d]	10 (PCS)
Phosphorus (mg/L)	0.0126	0.01 U[e]	0.0118	0.0138	0.01 U	0.01 U [0.01 U]	None
Total dissolved solids (mg/L)	235	240	239	240	227	234 [247]	500 (SCS)
Sulfate (mg/L)	16.6	16.9	20.6	17.7	19.3	17.5 [17.5]	250 (SCS)
Arsenic (µg/L)	2.09	2.09	2.3	2.17	2.17	2.22 [2.19]	50 (PCS)
Barium (µg/L)	35.4	35.6	36.8	34.8	36.8	33.5 [33.3]	2,000 (PCS)
Cadmium (µg/L)	0.25 U	0.25 U	0.25 U	0.25 U	0.25 U	0.25 U [0.25 U]	5 (PCS)
Chloride (mg/L)	16.2	17.5	20.3	17.5	18.6	18.0 [18.0]	250 (SCS)
Chromium (µg/L)	5.2	2.71	5.01	6.24	3.25	2.5 U [2.5 U]	100 (PCS)

Table C-10. Summary of Groundwater Quality Data Collected for the Wastewater Reuse Permit for the MFC Industrial Waste Ditch and Pond. (cont.)

Well Name	ANL-MON-A-012 (GW-016001)		ANL-MON-A-013 (GW-016002)		ANL-MON-A-014 (GW-016003)		
Sample Date	05/27/2014	09/30/2014	04/22/2014	09/30/2014	04/21/2014	09/30/2014	PCS/SCS[a]
Iron (µg/L)	**518** (51.4)[f]	218 (50 U)	**633** (75)	**2,210** (64.4)	**434** (54)	110 [133] (50 U) [(50 U)]	300 (SCS)
Lead (µg/L)	4.8	0.5 U	0.594	2.03	1.43	0.5 U [0.5 U]	15 (PCS)
Manganese (µg/L)	9.86	4.65	13.2	36.3	15.7	2.5 U [2.5 U]	50 (SCS)
Mercury (µg/L)	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U [0.2 U]	2 (PCS)
Selenium (µg/L)	0.5 U	0.5 U	0.5 U	0.506	0.5 U	0.5 U [0.52]	50 (PCS)
Silver (µg/L)	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U [5.0 U]	100 (SCS)
Sodium (µg/L)	17,600	17,200	18,900	18,100	17,900	17,100 [17,200]	None
Zinc (µg/L)	57.7	7.13	7.18	9.12	9.39	2.5 U [2.5 U]	5,000 (SCS)

a. Primary Constituent Standard (PCS) or Secondary Constituent Standard (SCS) from IDAPA 58.01.11 (Ground Water Quality Rule).
b. NA-Not applicable.
c. Elevations are given in the National Geodetic Vertical Datum of 1929.
d. Concentrations shown in brackets are the results from field duplicate samples.
e. U qualifier indicates the result was reported as below the instrument detection limit by the analytical laboratory.
f. Concentrations shown in parentheses are from filtered samples.

Table C-11. Advanced Test Reactor Complex Cold Waste Pond Surveillance Monitoring Results (January to November 2014).[a]

Parameter	Minimum	Maximum	Median
Aluminum (mg/L)	0.025 U[b]	0.0261	0.025 U
Antimony (mg/L)	0.00025 U	0.0014	0.000413
Lead (mg/L)	0.00025 U	0.000371	0.00025 U
Nickel (mg/L)	0.0025 U	0.00306	0.0025 U
Sodium (mg/L)	9.2	35.8	18
Zinc (mg/L)	0.0025 U	0.0037	0.0025 U
Gross alpha (pCi/L ± 1s)	-4.45 ± 1.18 U	2.38 ± 0.664	NC[c]
Gross beta (pCi/L ± 1s)	1.33 ± 0.748 U	15.7 ± 1.38	NC
pH	7.2	7.86	7.43
Potassium-40 (pCi/L ± 1s)	-26.5 ± 12.9 U	31.9 ± 10.5	NC

a. Only parameters with at least one detected result are shown.

b. U qualifier indicates the result was below the detection limit.

c. NC —not calculated

Table C-12. Radioactivity Detected in Surveillance Groundwater Samples Collected at the Advanced Test Reactor Complex (2014).

Monitoring Well	Sample Date	Parameter	Sample Result (pCi/L)
USGS-065	04/09/14	Gross Alpha	ND
		Gross Beta	5.73 (± 0.547)[a]
		Tritium	2,330 (± 277)
	10/07/14	Gross Alpha	ND[b]
		Gross Beta	8.17 (± 1.25)
		Tritium	2,450 (± 298)
TRA-07	04/09/14	Gross Alpha	ND
		Gross Beta	6.96 (± 0.578)
		Tritium	5,490 (± 581)
	10/16/14	Gross Alpha	2.82 (± 0.987)
		Gross Beta	8.06 (± 1.33)
		Tritium	6,580 (± 695)
TRA-08	04/07/14	Gross Alpha	ND
		Gross Beta	3.49 (± 0.554)
		Tritium	1,050 (± 160)
	10/06/14	Gross Alpha	ND
		Gross Beta	3.51 (± 0.923)
		Tritium	1,100 (± 182)
USGS-076	04/08/14	Gross Alpha	ND ND[c]
		Gross Beta	2.2 (± 0.53) ND[c]
		Tritium	471 (± 119) ND[c]
	10/07/14	Gross Alpha	ND
		Gross Beta	ND
		Tritium	ND
Middle-1823	04/08/14	Gross Alpha	ND
		Gross Beta	4.46 (± 0.531)
		Tritium	672 (± 136)
	10/06/14	Gross Alpha	ND
		Gross Beta	2.94 (± 0.797)
		Tritium	1,000 (± 177)

a. One sigma uncertainty shown in parentheses.
b. ND–Not detected.
c. Analytical result from field duplicate sample collected on April 8, 2014.

Table C-13. Field Parameter Results for Idaho Nuclear Technology and Engineering Center (2014).

Parameter	Minimum	Maximum	Mean
Influent to INTEC Sewage Treatment Plant (CPP-769)			
Conductivity (µS/cm) (grab)	657	1,700	972
pH (standard units) (grab)	7.78	8.38	8.09
Temperature (ºC) (grab)	13.34	26.99	18.57
Effluent from INTEC Sewage Treatment Plant (CPP-773)			
Conductivity (µS/cm) (grab)	772	983	872
pH (standard units) (composite)	7.57	8.96	8.15
Temperature (ºC) (grab)	2.74	26.58	13.12
Effluent to INTEC New Percolation Ponds (CPP-797)			
Conductivity (µS/cm) (grab)	371	444	392
pH (standard units) (composite)	7.32	8.13	7.75
Temperature (ºC) (grab)	10.45	23.25	16.48

Table C-14. Liquid Effluent Radiological Monitoring Results for the Idaho Nuclear Technology and Engineering Center (2014).

Sample Date	Gamma Emitters[a] (pCi/L)	Gross Alpha[b] (pCi/L)	Gross Beta[b] (pCi/L)	Total Strontium (pCi/L)
Effluent from INTEC Sewage Treatment Plant (CPP-773)				
April 2014	ND[c]	ND	14.30 (± 0.76)	ND
September 2014	ND	ND	28.70 (± 1.16)	ND
Effluent to INTEC New Percolation Ponds (CPP-797)				
January 2014	ND	ND	6.12 (±1.04)	ND
February 2014	ND	ND	5.49 (±0.56)	ND
March 2014	ND	ND	4.29 (±1.09)	ND
April 2014	ND	ND	4.12 (±0.96)	ND
May 2014	ND	ND	6.02 (±0.61)	ND
June 2014	ND	2.53 (± 0.39)	8.60 (±0.63)	ND
July 2014	ND	ND	7.71 (±1.11)	ND
August 2014	ND	ND	5.83 (±0.83)	ND
September 2014	ND	ND	5.63 (±1.24)	ND
October 2014	ND	ND	5.64 (±1.05)	ND
November 2014	ND	ND	8.06 (±0.63)	ND
December 2014	ND	ND	5.90 (±0.60)	ND

a. Gamma emitting radionuclides include americium-241, antimony-125, cerium-144, cesium-134, cesium-137, cobalt-58, cobalt-60, europium-152, europium-154, europium-155, manganese-54, niobium-95, potassium-40, radium-226, ruthenium-103, ruthenium-106, silver-108m, silver-110m, uranium-235, zinc-65, and zirconium-95.

b. Detected results are shown along with the reported 1-sigma uncertainty.

c. ND—No radioactivity was detected. The result was not statistically positive at the 95% confidence interval and was below its minimum detectable activity.

Table C-15. Groundwater Radiological Monitoring Results for the Idaho Nuclear Technology and Engineering Center (2014).

Monitoring Well	Sample Date	Gross Alpha[a] (pCi/L)	Gross Beta[a] (pCi/L)
ICPP-MON-A-165	4/9/2014	ND[b]	3.60 (±0.66)
	9/10/2014	ND	3.61 (±0.63)
ICPP-MON-A-166	4/9/2014	ND	ND
	9/10/2014	ND	4.11 (±0.55)
ICPP-MON-V-200	4/10/2014	ND	4.67 (±0.61)
	9/11/2014	ND	3.76 (±0.74)
ICPP-MON-V-212	4/10/2014	ND	9.60 (±0.75)
	9/11/2014	ND	6.92 (±0.80)

a. Detected results are shown along with the reported 1-sigma uncertainty.
b. ND—No radioactivity was detected. The result was not statistically positive at the 95% confidence interval and was below its minimum detectable activity.

Table C-16. Monitoring Results for Material and Fuels Complex Industrial Waste Pond (2014).[a]

Parameter	Minimum	Maximum	Median
Cesium-137 (pCi/L ± 1s)	-0.365 ± 0.596 U[b]	2.31 ± 0.776 J[c]	Not calculated
Gross beta (pCi/L ± 1s)	1.1 ± 0.59 U	23.9 ± 1.21	Not calculated
Potassium-40 (pCi/L ± 1s)	6.2 ± 9.63 U	39.8 ± 14.5 J[c]	Not calculated
Uranium-233/234 (pCi/L ± 1s)[d]	0.667 ± 0.084	0.667 ± 0.084	Not calculated
Uranium-238 (pCi/L ± 1s)[d]	0.459 ± 0.0655	0.459 ± 0.0655	Not calculated

a. Only parameters with at least one detected result are shown.
b. U qualifier indicates the result was below the detection limit.
c. J qualifier indicates the result is greater than the minimum detectable activity but less than 3s
d. Parameter was analyzed in August only; therefore, the minimum and maximum are the same.

Table C-17. 2014 Compliance Monitoring Results for the INTEC Drinking Water System – PWS#6120012.

Contaminant Sampled	# Samples Collected	Frequency	Average Result	Range Detected	MCL or Action Level
Total Coliform	4	1 per quarter	Absent	Absent	No more than 1 sample during a quarter is total coliform positive
Lead	10	1 every 3 years	0.0013 mg/L	0.001 – 0.0025 mg/L	0.015 mg/L
Copper	10	1 every 3 years	0.0973 mg/L	0.0073 – 0.45 mg/L	1.3 mg/L
Nitrate	1	1 per year	0.6 mg/L	NA	10 mg/L (as nitrogen)
Total Trihalomethanes	1	1 per year	0.0042 mg/L	NA	0.080 mg/L
Haloacetic Acids	1	1 per year	< 0.002 mg/L	NA	0.060 mg/L

Table C-18. 2014 Surveillance Monitoring Results for the INTEC Drinking Water System – PWS #6120012.

Contaminant Sampled	# Samples Collected	Frequency	Average Result	Range Detected	MCL or Action Level
Total Coliform	42	2 – 3 per month	Absent	Absent	No more than 1 sample during a quarter is total coliform positive
Gross Alpha	2	2 per year	ND	NA	15 pCi/L
Gross Beta	2	2 per year	5.72 pCi/L	ND – 5.72 pCi/L	50 pCi/L screening or 4 mrem
Tritium	1	1 per year	185 pCi/L U	NA	20,000 pCi/L
Strontium-90	1	1 per year	0.548 pCi/L U	NA	8 pCi/L

Table C-19. 2014 Compliance Monitoring Results for the RWMC Drinking Water System – PWS#6120018.

Contaminant Sampled	# Samples Collected	Frequency	Average Result	Range Detected	MCL or Action Level
Total Coliform	4	1 per quarter	Absent	Absent	No more than 1 sample during a quarter is total coliform positive
Lead	10	1 every 3 years	<0.001 mg/L	<0.001 - <0.001 mg/L	0.015 mg/L
Copper	10	1 every 3 years	0.0824 mg/L	0.01 – 0.19 mg/L	1.3 mg/L
Nitrate	1	1 per year	1.0 mg/L	NA	10 mg/L (as nitrogen)
Total Trihalomethanes	2	1 per year	0.00325 mg/L	0.003 – 0.0035 mg/L	0.080 mg/L
Haloacetic Acids	2	1 per year	< 0.002 mg/L	<0.002 - <0.002 mg/L	0.060 mg/L
Xylenes (total)	4	1 per quarter	0.00055 mg/L	<0.0005 – 0.0006 mg/L	10 mg/L
VOCs	1	1 ever 3 years	<0.005 mg/L	<0.002 - <0.005 mg/L	0.002 – 10 mg/L

Table C-20. 2014 Surveillance Monitoring Results for the RWMC Drinking Water System – PWS#6120018.

Contaminant Sampled	# Samples Collected	Frequency	Average Result	Range Detected	MCL or Action Level
Total Coliform	24	1 per month	Absent	Absent	No more than 1 sample during a quarter is total coliform positive
VOCs	7	1 per quarter	0.00334 mg/L	<0.0005 – 0.0057 mg/L	0.002 – 10 mg/L
Gross Alpha	2	2 per year	ND	NA	15 pCi/L
Gross Beta	2	2 per year	5.2 pCi/L	ND – 5.2 pCi/L	50 pCi/L screening or 4 mrem

Appendix D. In Situ Soil and Onsite Dosimeter Measurements and Locations

Figure D-1. In Situ Soil Measurements at Auxiliary Reactor Area (ARA) (2014).

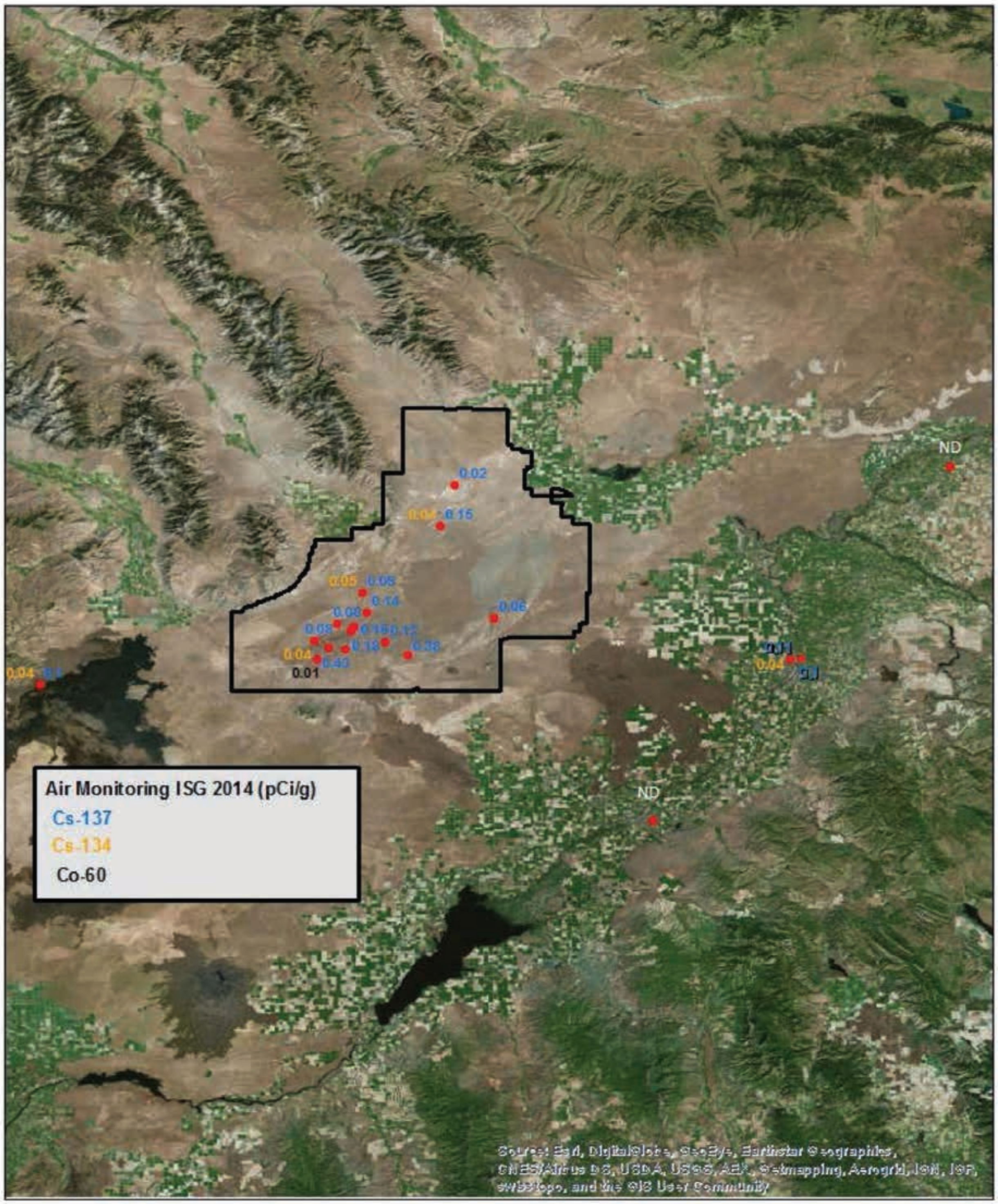


Figure D-2. In Situ Soil Measurements at Air Monitor Locations (2014).

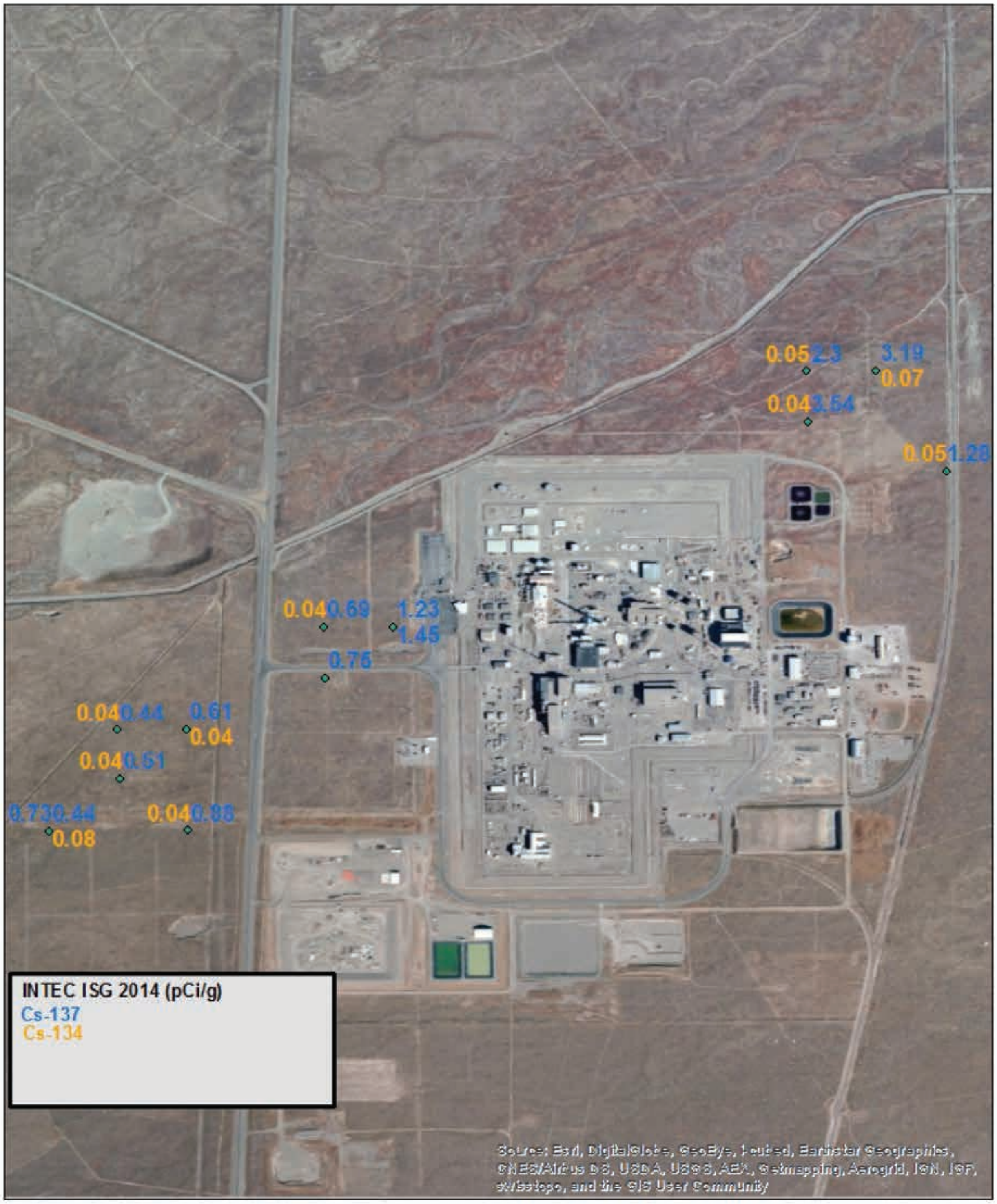


Figure D-3. In Situ Soil Measurements at Idaho Nuclear Technology and Engineering Center (INTEC) (2014).

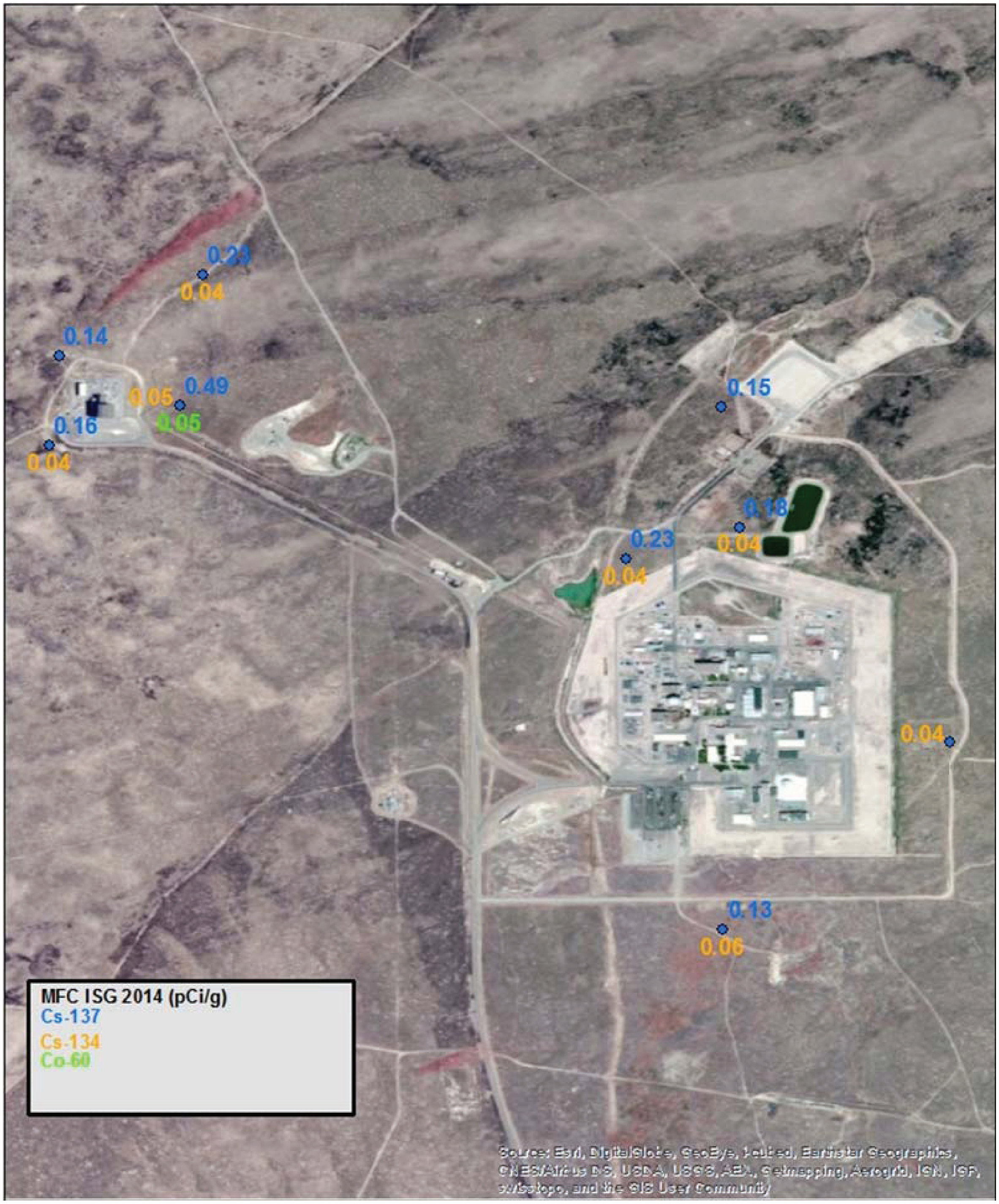


Figure D-4. In Situ Soil Measurements at Materials and Fuels Complex (MFC) (2014).

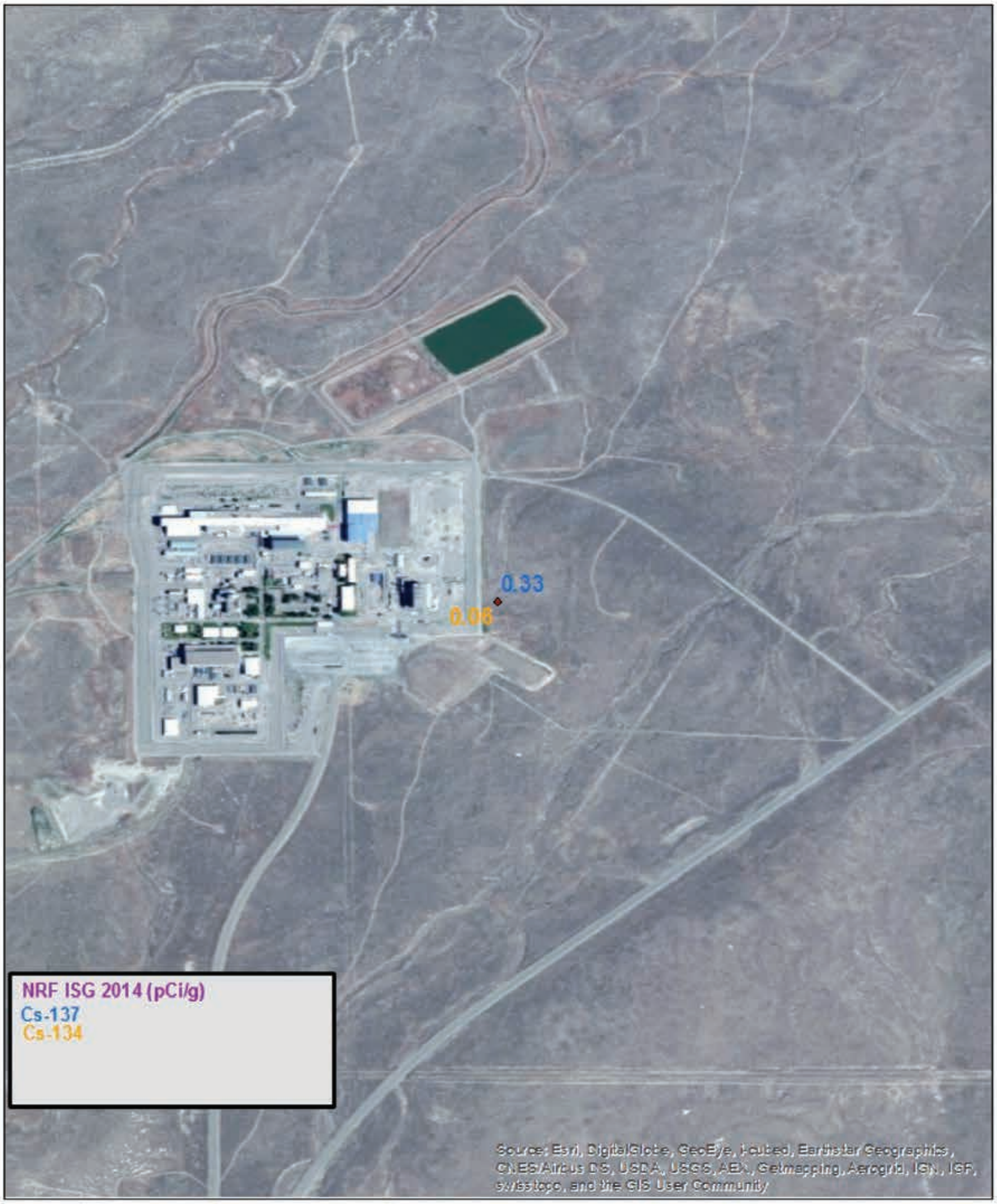


Figure D-5. In Situ Soil Measurements at Naval Reactors Facility (NRF) (2014).

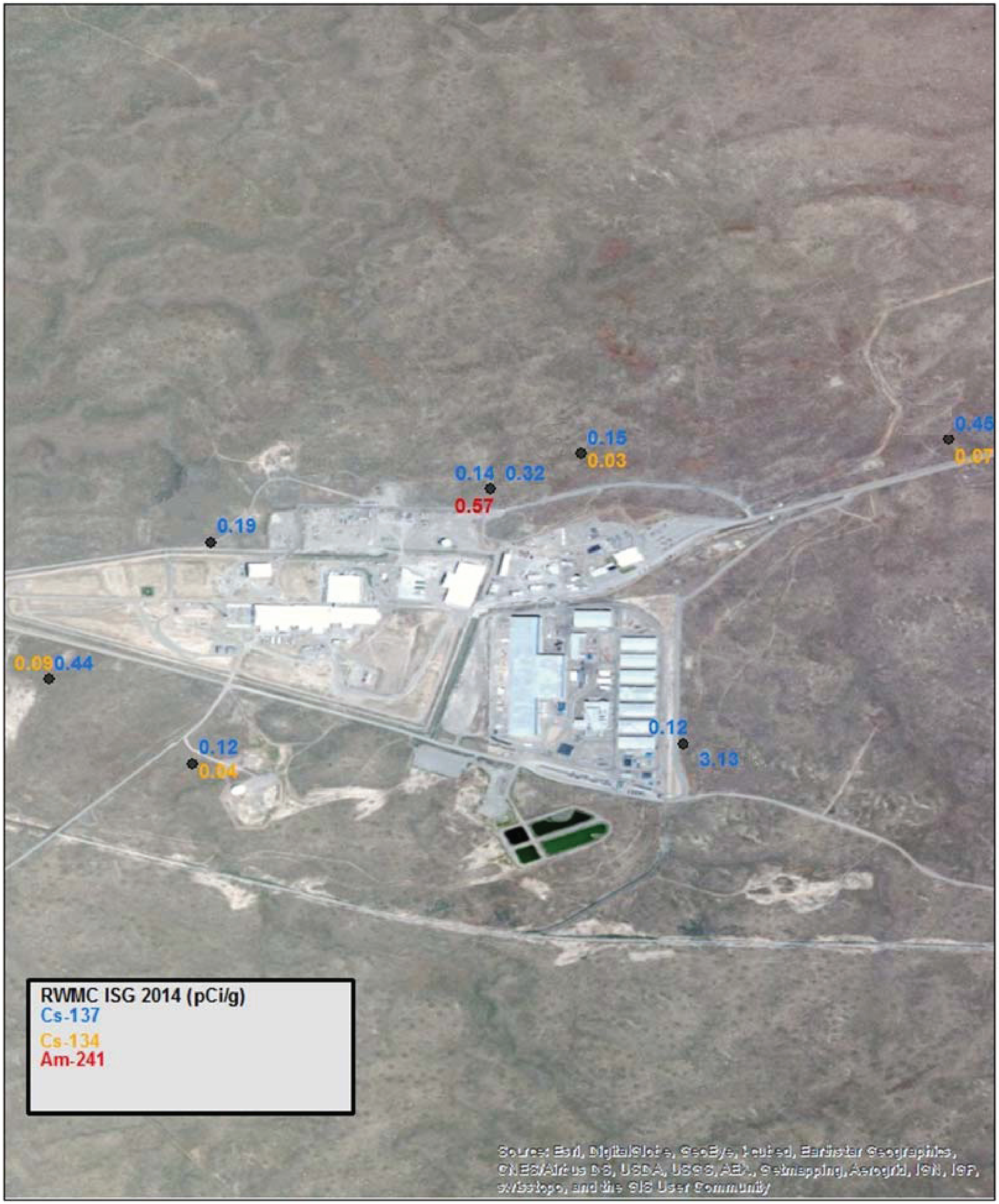


Figure D-6. In Situ Soil Measurements at Radioactive Waste Management Complex (RWMC) (2014).

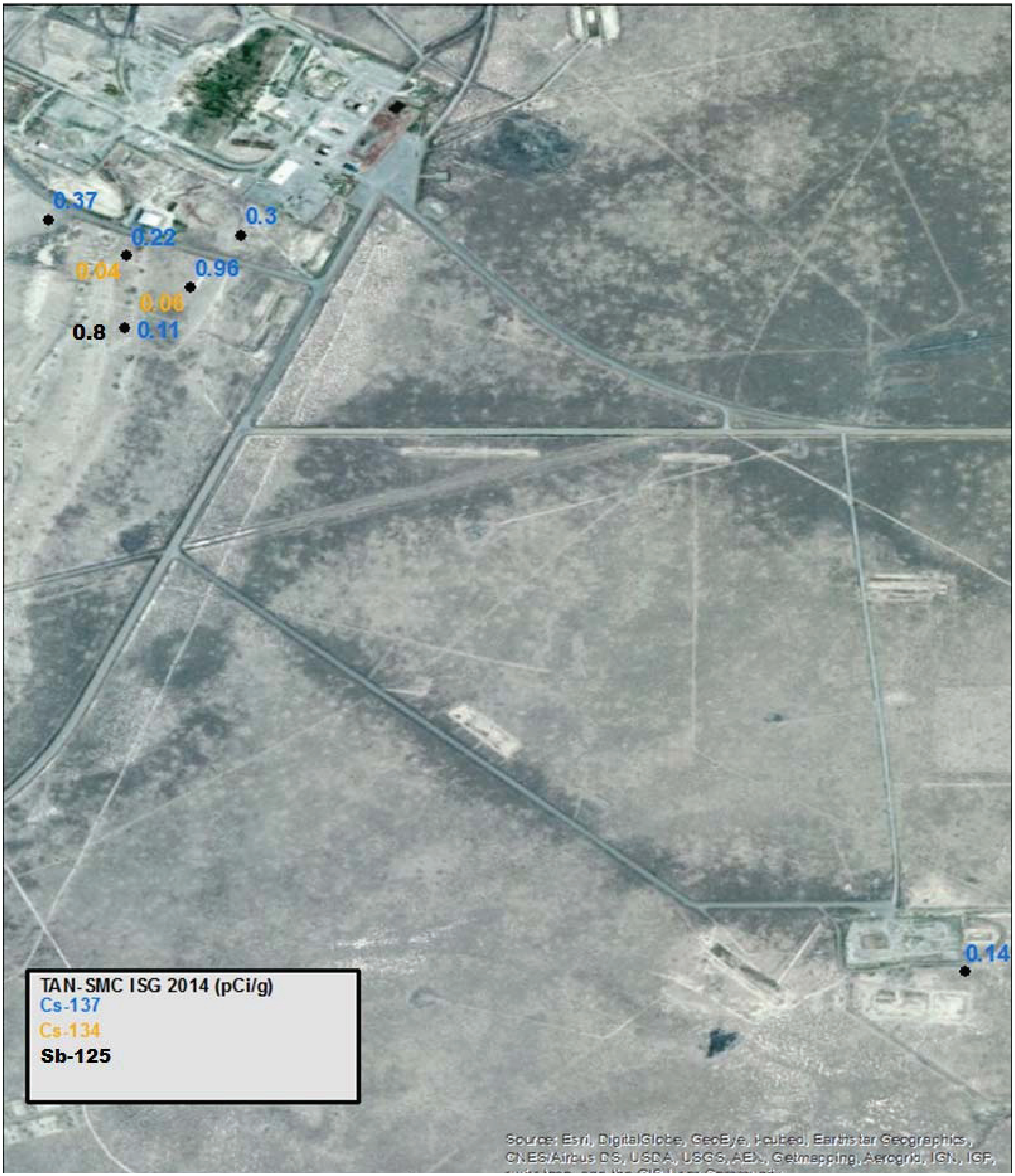


Figure D-7. In Situ Soil Measurements at Test Area North (TAN) (2014).

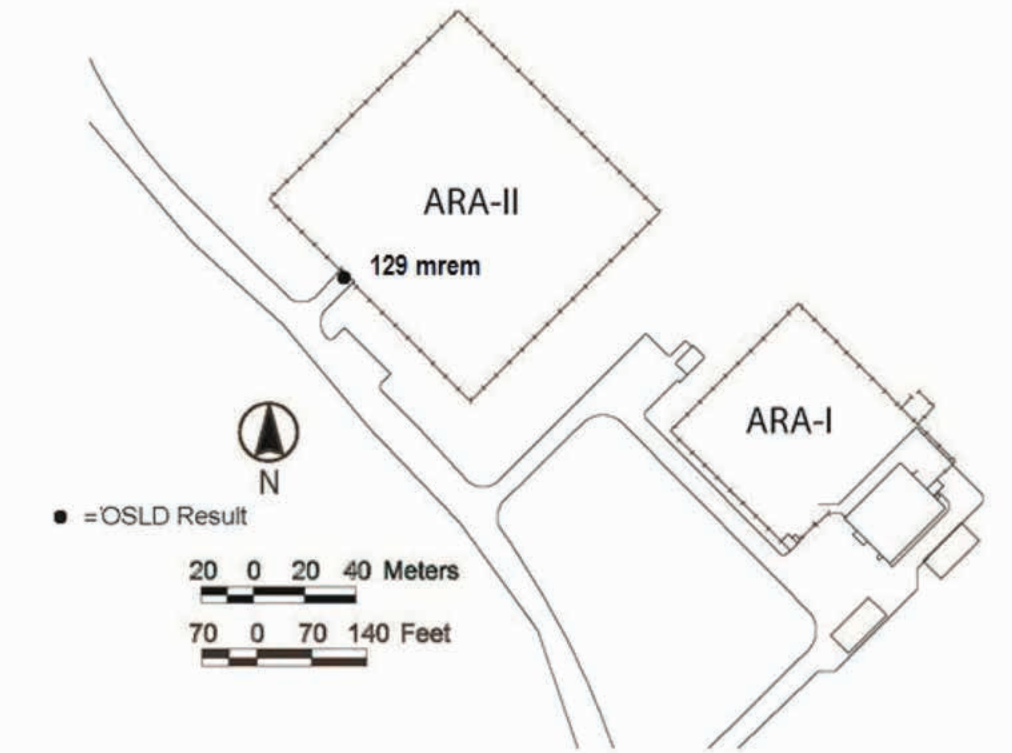


Figure D-8. Environmental Radiation Measurements at Auxiliary Reactor Area (ARA) (2014).

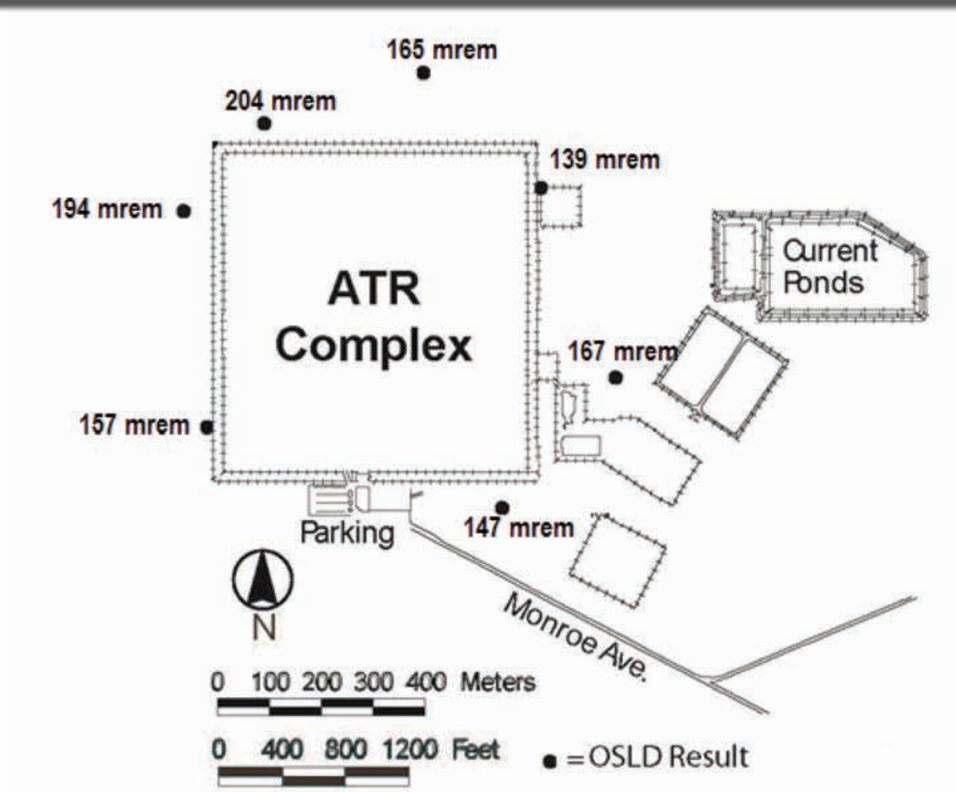


Figure D-9. Environmental Radiation Measurements at Advanced Test Reactor (ATR) Complex (2014).

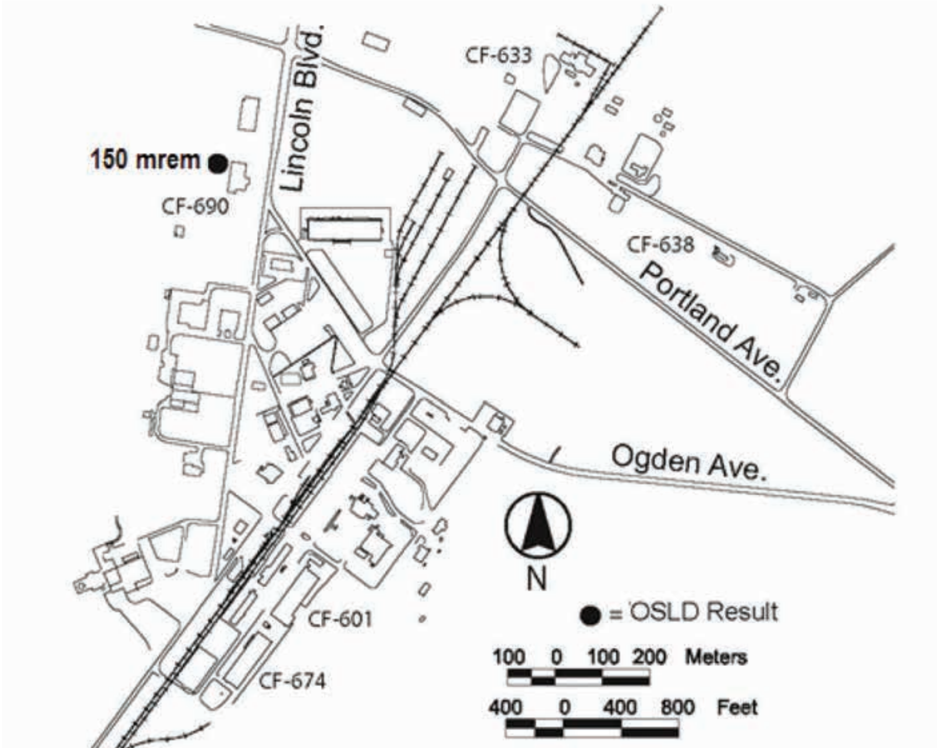


Figure D-10. Environmental Radiation Measurements at Central Facilities Area (CFA) (2014).

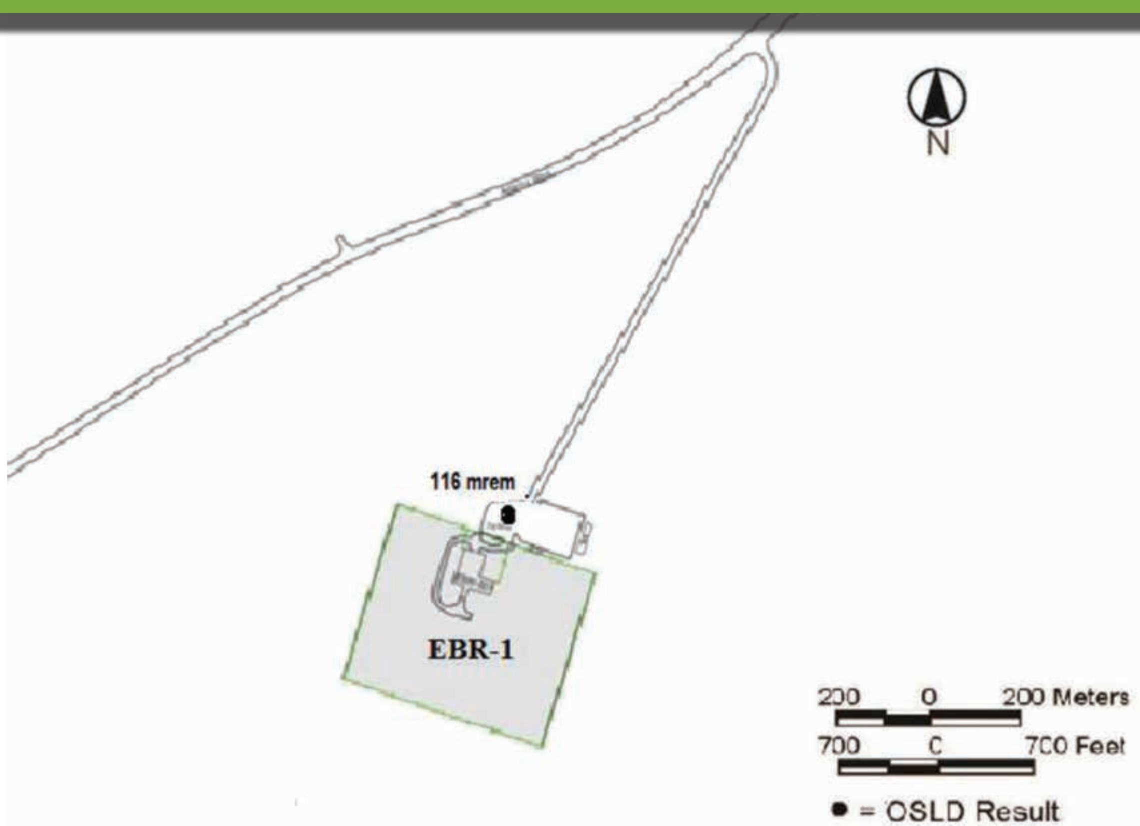


Figure D-11. Environmental Radiation Measurements at Experimental Breeder Reactor-I (EBR-1) (2014).

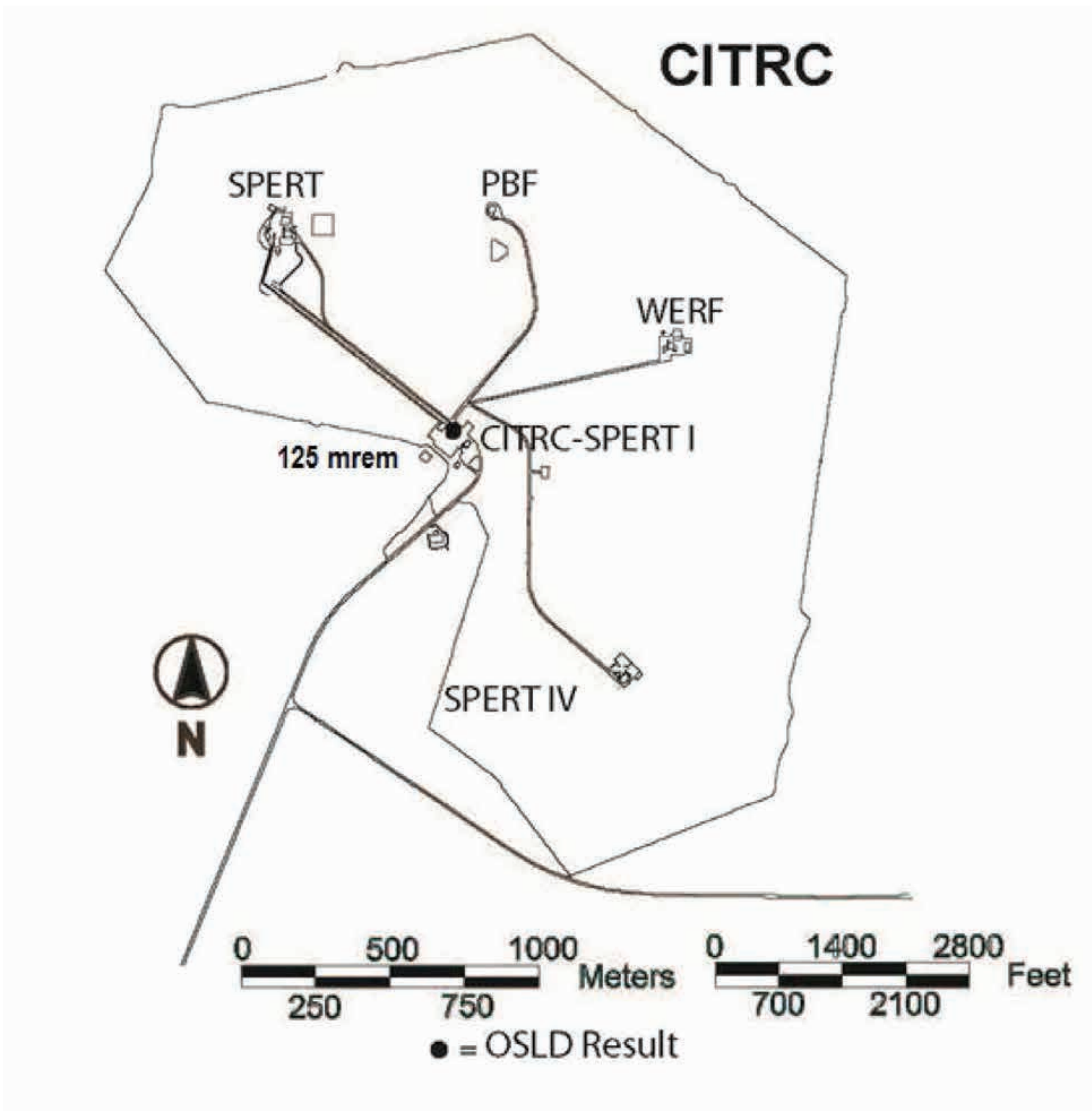


Figure D-12. Environmental Radiation Measurements at Critical Infrastructure Test Range Complex (CITRC) (2014).

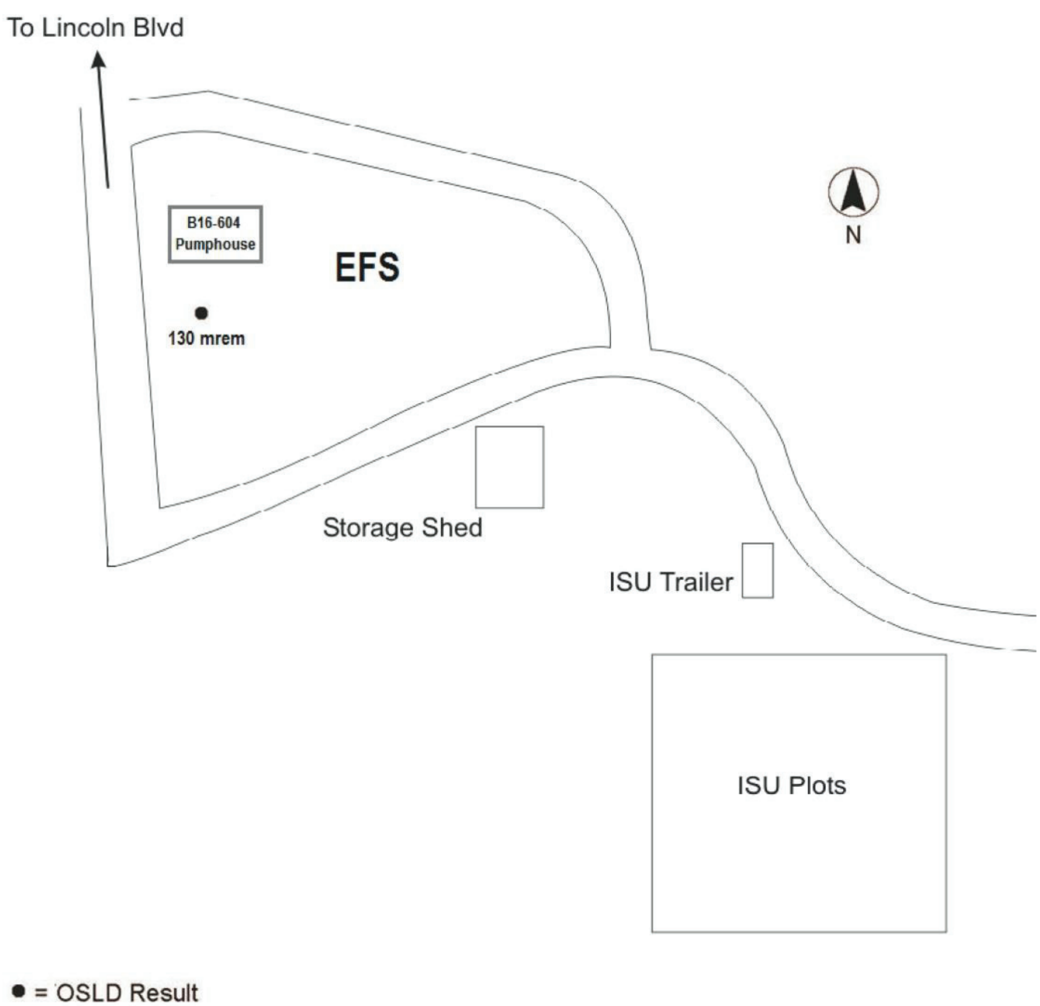


Figure D-13. Environmental Radiation Measurements at Experimental Field Station (EFS) (2014).

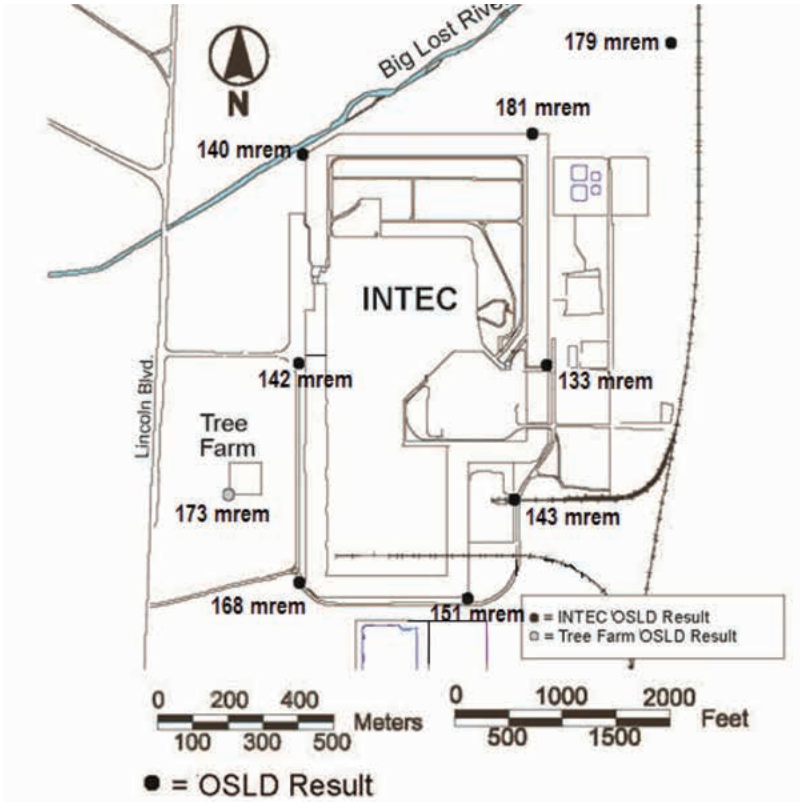


Figure D-14. Environmental Radiation Measurements at Idaho Nuclear Technology and Engineering Center (INTEC) (2014).

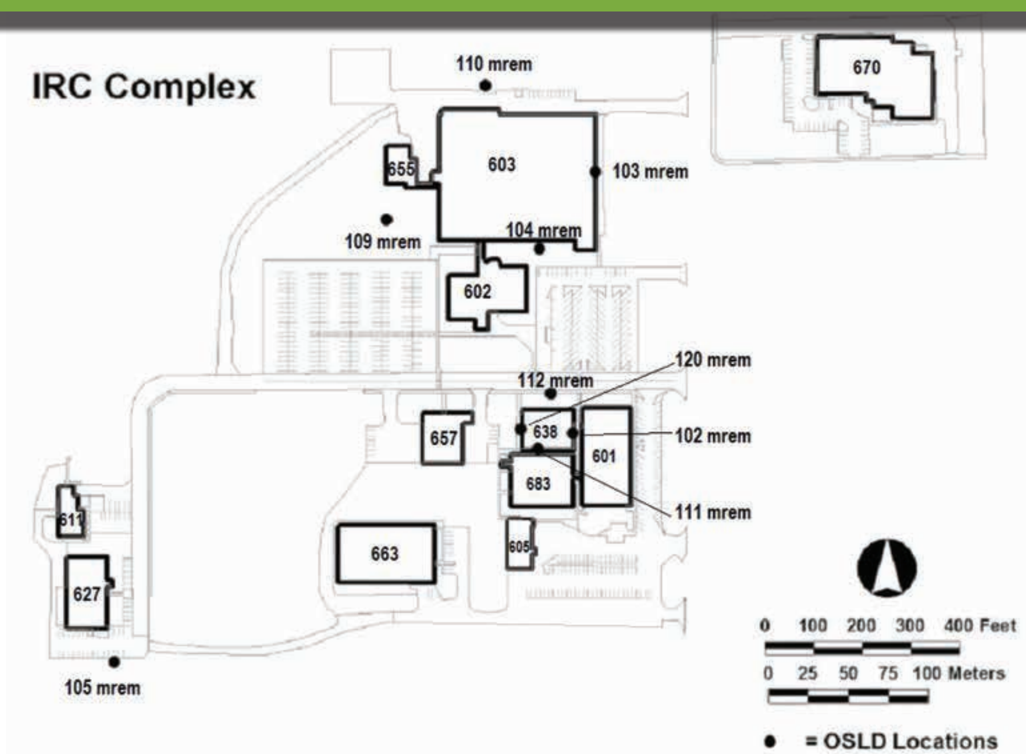


Figure D-15. Environmental Radiation Measurements at IRC Complex (2014).

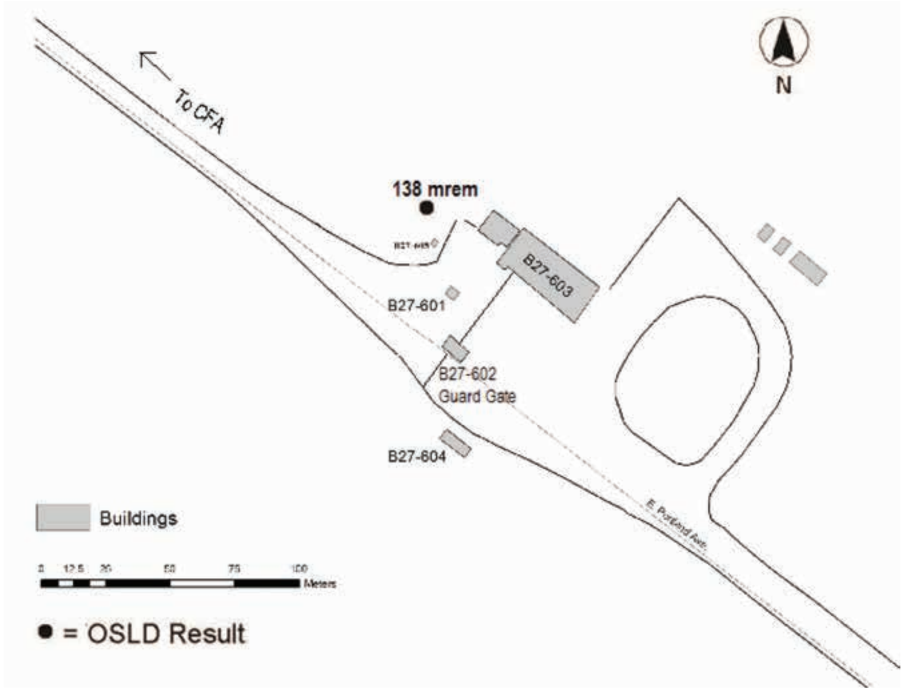


Figure D-16. Environmental Radiation Measurements at Main Gate (2014).

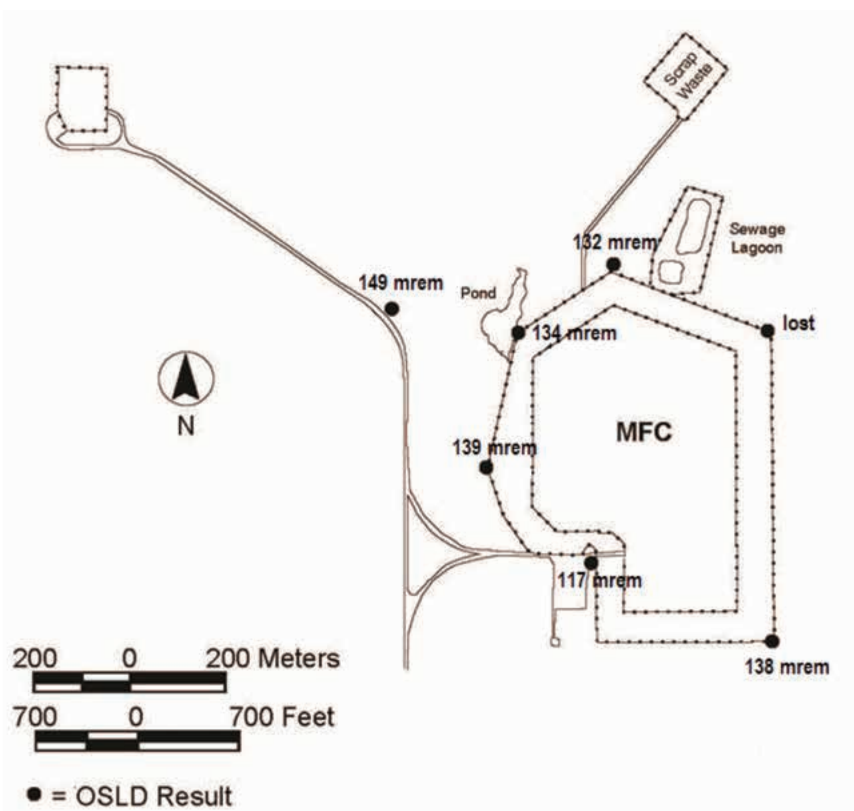


Figure D-17. Environmental Radiation Measurements at Materials and Fuels Complex (MFC) (2014).

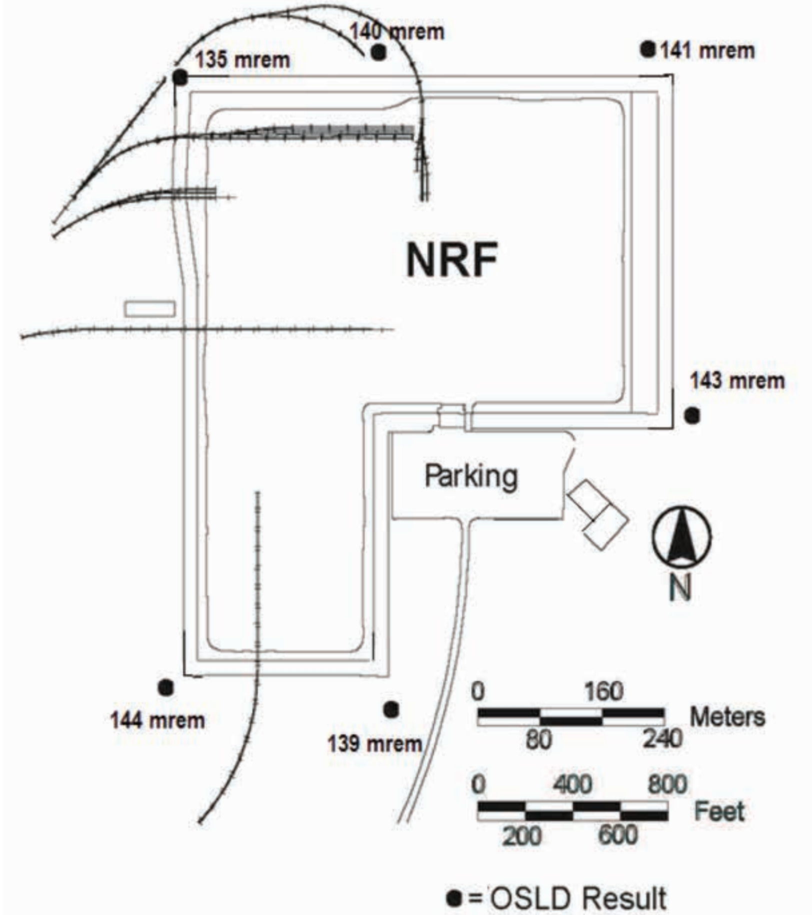


Figure D-18. Environmental Radiation Measurements at Naval Reactors Facility (NRF) (2014).

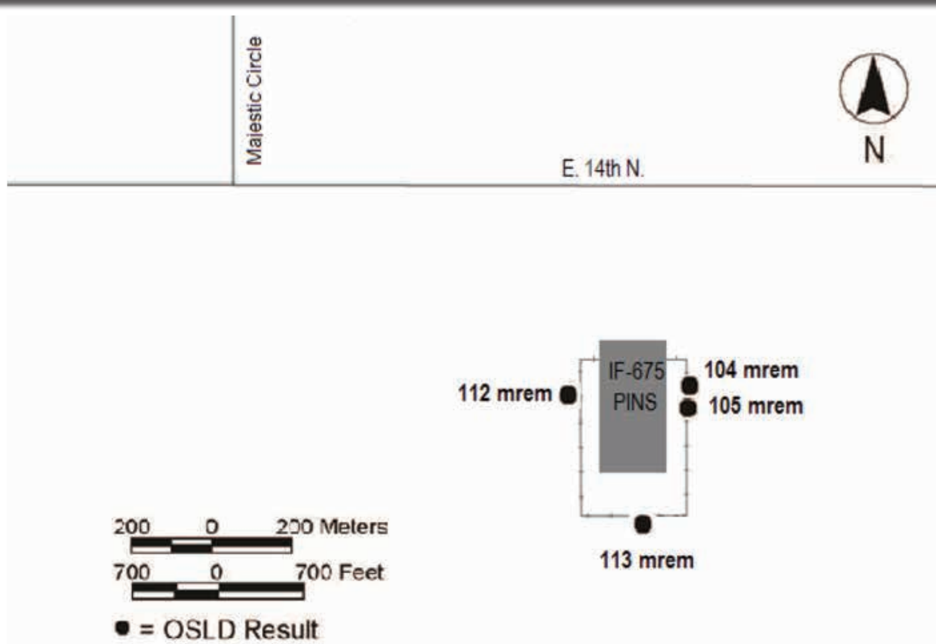


Figure D-19. Environmental Radiation Measurements at IF-675 PINS Facility (2014).

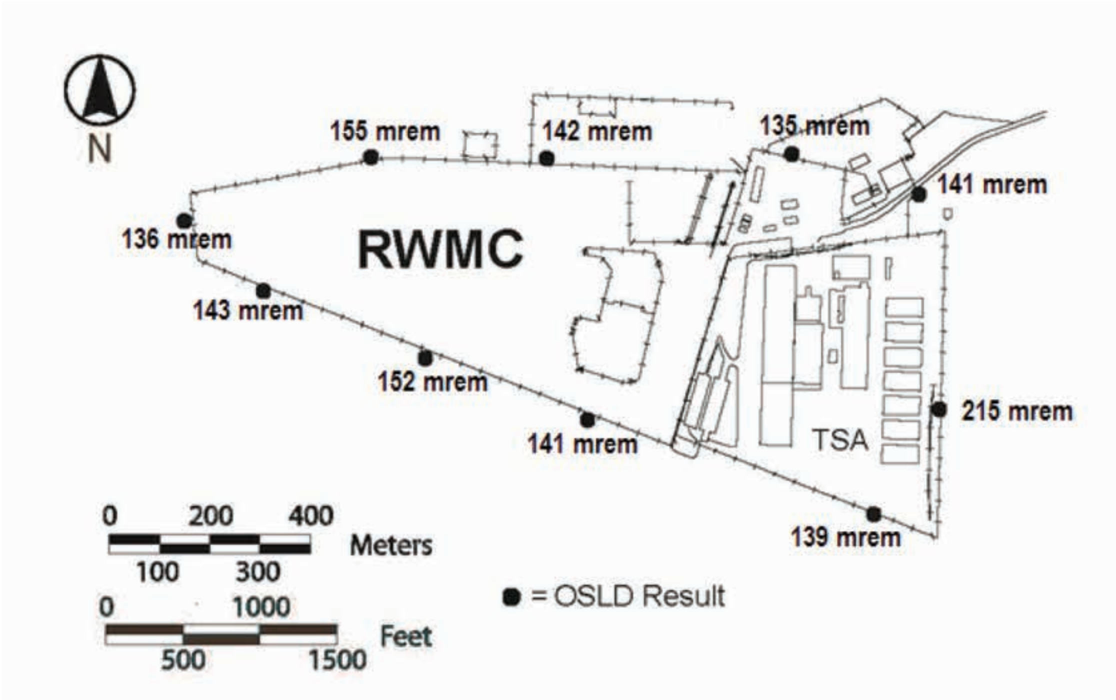


Figure D-20. Environmental Radiation Measurements at Radioactive Waste Management Complex (RWMC) (2014).

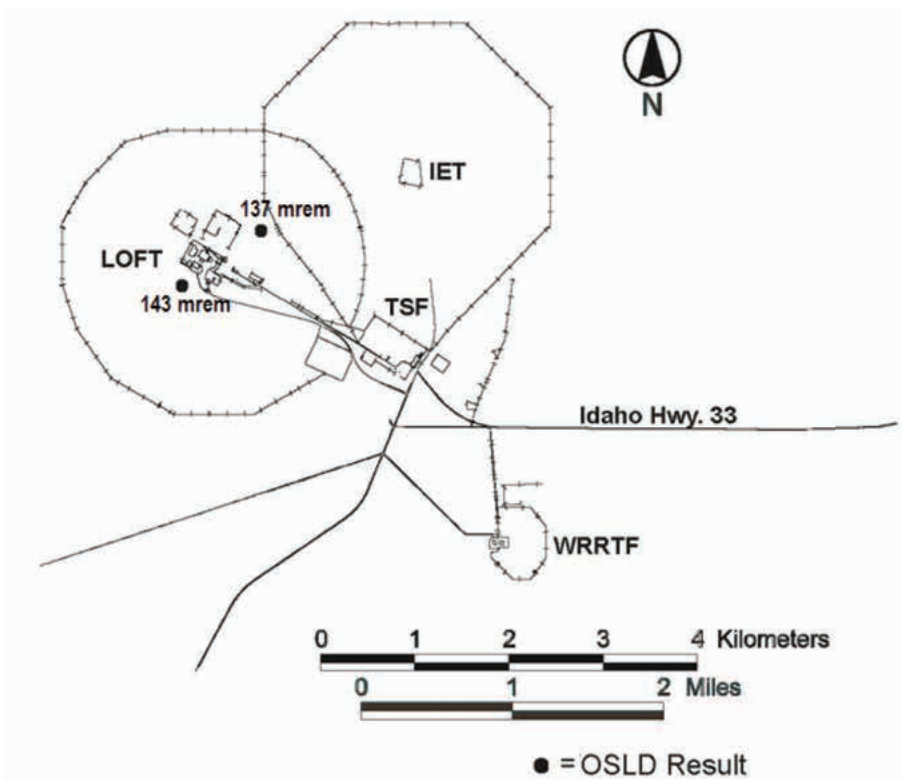


Figure D-21. Environmental Radiation Measurements at Test Area North (TAN) (2014).

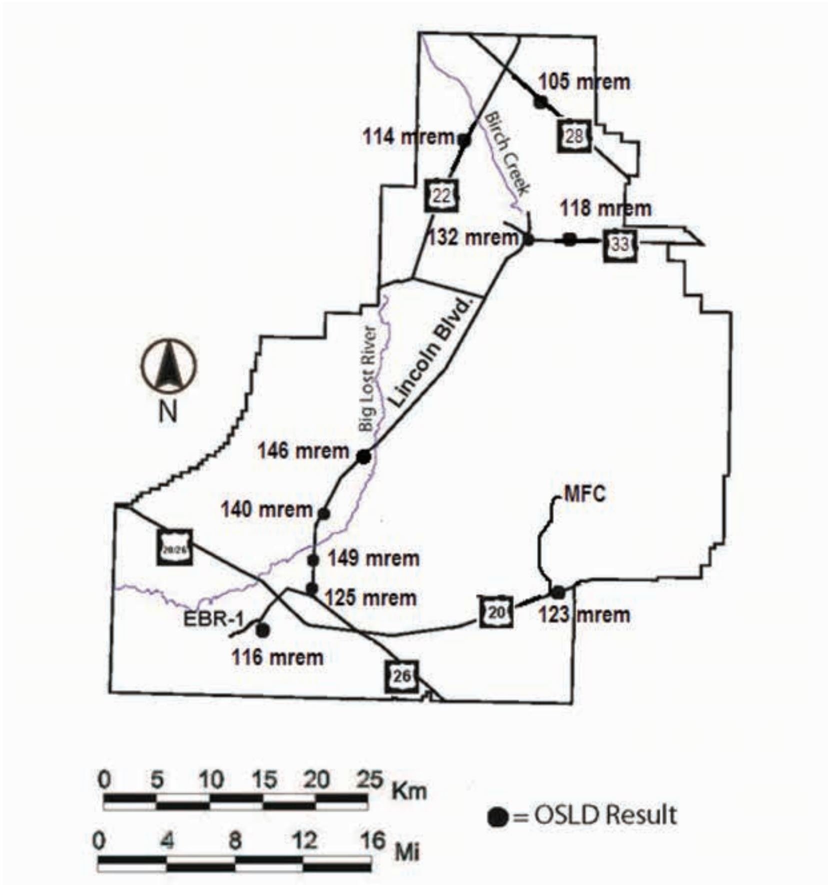


Figure D-22. Environmental Radiation Measurements at Sitewide Locations (2014).

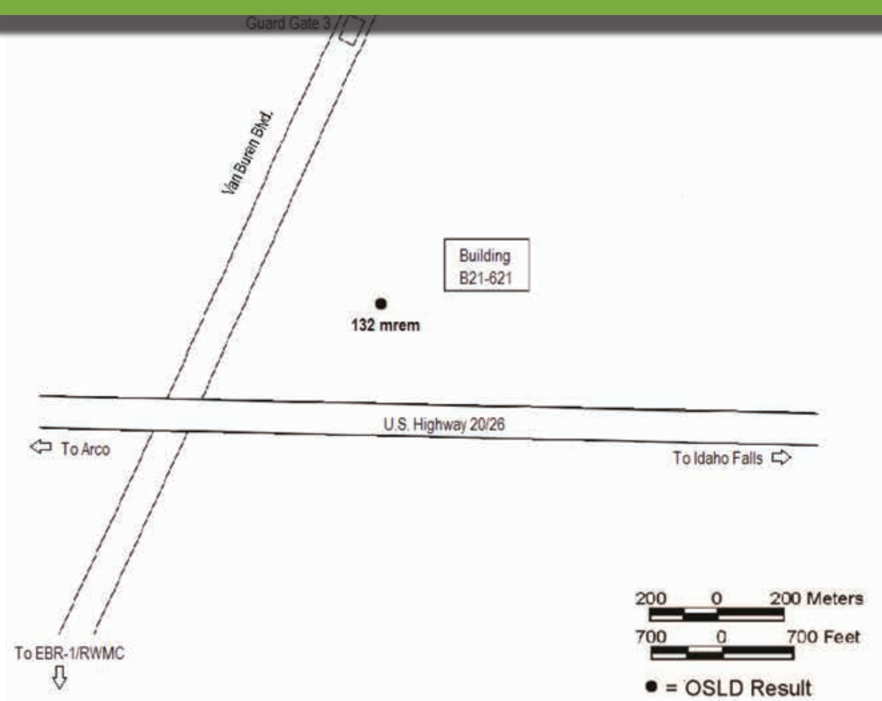


Figure D-23. Environmental Radiation Measurements at Van Buren Location (2014).

Table D-1. INL Contractor Environmental Radiation Measurements (November 2013 through October 2014).

Location	November 2013-April 2014 (OSLD), mrem ± 2σ	May 2014-October 2014 (OSLD), mrem ± 2σ
ANL O-7	64.9 ± 6.5	74 ± 7.4
ANL O-12	55.6 ± 5.6	61.2 ± 6.1
ANL O-13	64.9 ± 6.5	73 ± 7.3
ANL O-15	78 ± 7.8	NA
ANL O-17	65 ± 6.5	66.5 ± 6.7
ANL O-18	64.6 ± 6.5	69.3 ± 6.9
ANL O-9	73.8 ± 7.4	74.8 ± 7.5
ARA I & II O-1	61.6 ± 6.2	67.3 ± 6.7
CFA O-1	71.8 ± 7.2	77.8 ± 7.8
EBR I O-1	54.8 ± 5.5	61.5 ± 6.2
EFS O-1	63.3 ± 6.3	66.4 ± 6.6
Hwy20 Mile O-276	59.8 ± 6.0	62.7 ± 6.3
Hwy22 T28 O-1	57.1 ± 5.7	56.8 ± 5.7
Hwy28 N2300 O-2	53.6 ± 5.4	51.6 ± 5.2
Hwy33 T17 O-3	58.4 ± 5.8	59.9 ± 6.0
ICPP O-9	84.6 ± 8.5	94.8 ± 9.5
ICPP O-15	85.5 ± 8.6	95.1 ± 9.5
ICPP O-17	67.9 ± 6.8	72.4 ± 7.2
ICPP O-19	71.7 ± 7.2	69.8 ± 7.0
ICPP O-21	79.7 ± 8.0	87.9 ± 8.8
ICPP O-23	74.9 ± 7.5	75.9 ± 7.6
ICPP O-25	67.1 ± 6.7	75.5 ± 7.6
ICPP O-26	60.6 ± 6.1	72 ± 7.2
ICPP TreeFarm O-3	80.7 ± 8.1	92.1 ± 9.2
IF-603E O-2	49.5 ± 5.0	53.7 ± 5.4
IF-603N O-1	52.5 ± 5.3	57.3 ± 5.7
IF-603S O-3	51.4 ± 5.1	52.1 ± 5.2
IF-603W O-4	49.8 ± 5.0	58.9 ± 5.9
IF-616N O-36	new location	60 ± 6.0
IF-627 O-30	49.9 ± 5.0	55.4 ± 5.5
IF-638E O-2	49.4 ± 4.9	52.7 ± 5.3
IF-638N O-1	55.7 ± 5.6	55.8 ± 5.6
IF-638S O-3	54.9 ± 5.5	55.8 ± 5.6
IF-638W O-4	57.0 ± 5.7	63.2 ± 6.3
IF-665W O-37	new location	56.3 ± 5.6
IF-675D O-33	49.7 ± 5.0	54.3 ± 5.4
IF-675E O-31	52.3 ± 5.2	52.6 ± 5.3
IF-675S O-34	57.0 ± 5.7	56.2 ± 5.6
IF-675W O-35	54.2 ± 5.4	57.5 ± 5.8
IF-IRC O-39	new location	60.3 ± 6.0
LincolnBlvd O-1	60.2 ± 6.0	64.9 ± 6.5
LincolnBlvd O-3	71.4 ± 7.1	77.9 ± 7.8
LincolnBlvd O-5	69.0 ± 6.9	71.1 ± 7.1
LincolnBlvd O-9	72.5 ± 7.3	73.2 ± 7.3

Table D-1. INL Contractor Environmental Radiation Measurements (November 2013 through October 2014). (cont.)

Location	November 2013-April 2014 (OSLD), mrem ± 2σ	May 2014-October 2014 (OSLD), mrem ± 2σ
Lincoln Blvd O-25	69.4 ± 6.9	63 ± 6.3
Main Gate O-1	70.3 ± 7.0	67.4 ± 6.7
NRF O-4	68.8 ± 6.9	72.5 ± 7.3
NRF O-5	70.3 ± 7.0	70.1 ± 7.0
NRF O-12	68.2 ± 6.8	75 ± 7.5
NRF O-16	65.8 ± 6.6	69.6 ± 7.0
NRF O-19	69.4 ± 6.9	74.1 ± 7.4
NRF O-20	63.8 ± 6.4	74.9 ± 7.5
PBF SPERT O-1	58.5 ± 5.9	66.4 ± 6.6
RWMC O-39	68.8 ± 6.9	72.4 ± 7.2
RWMC O-41	106.9 ± 10.7	108.4 ± 10.8
RWMC O-43	67.9 ± 6.8	70.9 ± 7.1
RWMC O-46	64.8 ± 6.5	70.5 ± 7.1
RWMC O-9A	69.1 ± 6.9	72.4 ± 7.2
RWMC O-13A	71.1 ± 7.1	83.9 ± 8.4
RWMC O-17A	64.2 ± 6.4	71.3 ± 7.1
RWMC O-21A	72.0 ± 7.2	70.9 ± 7.1
RWMC O-25A	68.4 ± 6.8	83.7 ± 8.4
RWMC O-29A	63.5 ± 6.4	77 ± 7.7
TAN LOFT O-6	68.3 ± 6.8	74.3 ± 7.4
TAN LOFT O-7	72.0 ± 7.2	64.7 ± 6.5
TRA O-2	71.2 ± 7.1	75.4 ± 7.5
TRA O-4	85.4 ± 8.5	81.3 ± 8.1
TRA O-6	61.4 ± 6.1	77.6 ± 7.8
TRA O-8	80.8 ± 8.1	84.4 ± 8.4
TRA O-10	97.0 ± 9.7	106.7 ± 10.7
TRA O-11	94.4 ± 9.4	99.9 ± 10.0
TRA O-13	78.9 ± 7.9	77.7 ± 7.8
VANB O-1	63.5 ± 6.4	68.5 ± 6.9
Arco O-1	63.2 ± 6.3	64.1 ± 6.4
Atomic City O-2	62.5 ± 6.3	60.2 ± 6.0
Howe O-3	56.4 ± 5.6	59.1 ± 5.9
Monteview O-4	55.4 ± 5.5	61.8 ± 6.2
Mud Lake O-5	62.3 ± 6.2	66.5 ± 6.7
Aberdeen O-8	64.0 ± 6.4	location ended
Blackfoot O-9	53.9 ± 5.4	57.2 ± 5.7
Craters of Moon O-7	55.8 ± 5.6	68.1 ± 6.8
Idaho Falls O-10	58.2 ± 5.8	61 ± 6.1
IF-IDA O-38	new location	56.3 ± 5.6
Minidoka O-11	57.3 ± 5.7	location ended
Reno Ranch O-6	52.8 ± 5.3	55 ± 5.5
Rexburg O-12	56.5 ± 5.7	64 ± 6.4
Roberts O-13	68.9 ± 6.9	71.5 ± 7.2

Appendix E. Glossary

A

accuracy: A measure of the degree to which a measured value or the average of a number of measured values agrees with the “true” value for a given parameter; accuracy includes elements of both bias and precision.

actinides: The elements of the periodic table from actinium forward, including the naturally occurring radionuclides thorium and uranium, and the human-made radionuclides plutonium and americium.

alpha radiation: The emission of alpha particles during radioactive decay. Alpha particles are identical in makeup to the nucleus of a helium atom and have a positive charge. Alpha radiation is easily stopped by materials as thin as a sheet of paper and has a range in air of approximately an inch. Despite its low penetration ability, alpha radiation is densely ionizing and, therefore, very damaging when ingested or inhaled.

ambient dose equivalent: Since the effective dose cannot be measured directly with a typical survey instrument or a dosimeter, approved simulation quantities are used to approximate the effective dose (see **dose, effective**). The ambient dose equivalent is the quantity recommended by the International Commission on Radiation Units and Measurements to approximate the effective dose received by a human from external exposure to ambient ionizing radiation.

anthropogenic radionuclide: Radionuclide produced as a result of human activity (human-made).

aquifer: A geologic formation, group of formations or part of a formation capable of yielding a significant amount of groundwater to wells or springs.

aquifer well: A well that obtains its water from below the water table.

B

background radiation: Radiation from cosmic sources; naturally occurring radioactive materials, including radon (except as a decay product of source or special nuclear material), and global fallout as it exists in the environment from the testing of nuclear explosive devices. It does not include radiation from source, byproduct, or special nuclear materials regulated by the Nuclear Regulatory Commission. The typically quoted average individual exposure from background radiation is 360 millirems per year.

basalt: The most common type of solidified lava; a dense, dark grey, fine-grained, igneous rock that is composed chiefly of plagioclase, pyroxene, and olivine; often displaying a columnar structure.

becquerel (Bq): A quantitative measure of radioactivity. This is an alternate measure of activity used internationally. One becquerel of activity is equal to one nuclear decay per second. There are 3.7×10^{10} Bq in 1 Curie (Ci).

beta radiation: Radiation comprised of charged particles emitted from a nucleus during radioactive decay. A negatively charged beta particle is identical to an electron. A positively charged beta particle is called a positron. Beta radiation is slightly more penetrating than alpha, and it may be stopped by materials such as aluminum or Lucite panels. Naturally occurring radioactive elements, such as potassium-40, emit beta radiation.

bias: The tendency for an estimate to deviate from an actual or real event. Bias may be the tendency for a model to over- or under-predict.

bioremediation: The process of using various natural or introduced microbes or both to degrade, destroy or otherwise permanently bond contaminants contained in soil or water or both.

biota concentration guide: The limiting concentration of a radionuclide in soil, sediment, or water that would not cause dose limits for protection of populations of aquatic and terrestrial biota to be exceeded.

blank: Used to demonstrate that cross contamination has not occurred. See **field blank**, **laboratory blank**, **equipment blank**, and **reagent blank**.

blind sample: Contains a known quantity of some of the analytes of interest added to a sample media being collected. A blind sample is used to test for the presence of compounds in the sample media that interfere with the analysis of certain analytes.

butte: A steep-sided and flat-topped hill.

C

calibration: The adjustment of a system and the determination of system accuracy using known sources and instrument measurements of higher accuracy.

chain of custody: A method for documenting the history and possession of a sample from the time of collection, through analysis and data reporting, to its final disposition. An item is considered to be in a person's custody if the item is (1) in the physical possession of that person, (2) within direct view of that person, or (3) placed in a secured area or container by that person.

comparability: A measure of the confidence with which one data set or method can be compared to another.

composite sample: A sample of environmental media that contains a certain number of sample portions collected over a time period. The samples may be collected from the same location or different locations. They may or may not be collected at equal intervals over a predefined period (e.g., quarterly).

completeness: A measure of the amount of valid data obtained from a measurement system compared to the amount that was expected under optimum conditions.

confidence interval: A statistical range with a specified probability that a given parameter lies within the range.

contaminant: Any physical, chemical, biological, radiological substance, matter, or concentration that is in an unwanted location.

contaminant of concern: Contaminant in a given media (usually soil or water) above a risk level that may result in harm to the public or the environment. At the INL Site, a contaminant that is above a 10^{-6} (1 in 1 million) risk value.

control sample: A sample collected from an uncontaminated area that is used to compare INL Site analytical results to those in areas that could not have been impacted by INL Site operations.

cosmic radiation: Penetrating ionizing radiation, both particulate and electromagnetic, that originates in outer space. Secondary cosmic rays, formed by interactions in the earth's atmosphere, account for about 45 to 50 millirem of the 300 millirem of natural background radiation that an average member of the U.S. public receives in a year.

curie (Ci): The original unit used to express the decay rate of a sample of radioactive material. The curie is equal to that quantity of radioactive material in which the number of atoms decaying per second and is equal to 37 billion (3.7×10^{10}). It is based on the rate of decay of atoms within one gram of radium. It is named for Marie and Pierre Curie who discovered radium in 1898. The curie is the basic unit of radioactivity used in the system of radiation units in the United States, referred to as "traditional" units. (See also **becquerel**)

D

data gap: An area between all available data and the conclusions that are drawn from the data where the existing data are sparse or nonexistent. An example would be inferring the interactions in the environment of one radionuclide that has not been studied from a chemically similar radionuclide that has been studied.

data validation: A systematic review of a data set to identify outliers or suspect values. More specifically, data validation refers to the systematic process of independently reviewing a body of analytical data against established criteria to provide assurance that the data are acceptable for their intended use. This process may use appropriate statistical techniques to screen out impossible or highly unlikely values.

data verification: The scientific and statistical evaluation of data to determine if data obtained from environmental operations are of the right type, quality, and quantity to support their intended use. Data verification also includes documenting those operations and the outcome of those operations (e.g., data do or do not meet specified requirements). Data verification is not synonymous with data validation.

decay products: Decay products are also called "daughter products." They are radionuclides that are formed by the radioactive decay of parent radionuclides. In the case of radium-226, for example, nine successive different radioactive decay products are formed in what is called a "decay chain." The chain ends with the formation of lead-206, which is a stable nuclide.

derived concentration standard (DCS): The concentration of a radionuclide in air or water that, under conditions of continuous exposure for one year by a single pathway (e.g., air inhalation or immersion, water ingestion), would result in an effective dose of 100 mrem (1 mSv). U.S. Department of Energy Order 458.1 "Radiation Protection of the Public and the Environment" establishes this limit and DOE Standard DOE-STD-1196-2011, "Derived Concentration Technical Standard" provides the numerical values of DCSs.

deterministic effect: Health effect, the severity of which varies with the dose and for which a threshold is believed to exist. Deterministic effects generally result from the receipt of a relatively high dose over a short time period. Skin erythema (reddening) and radiation-induced cataract formation is an example of a deterministic effect (formerly called a nonstochastic effect).

diffuse source: A source or potential source of pollutants that is not constrained to a single stack or pipe. A pollutant source with a large areal dimension.

diffusion: The process of molecular movement from an area of high concentration to one of lower concentration.

direct radiation: External radiation from radioactive plumes or from radionuclides deposited on the ground or other surfaces.

dispersion: The process of molecular movement by physical processes.

dispersion coefficient: An empirical concentration, normalized to a unit release rate, used to estimate the concentration of radionuclides in a plume at some distance downwind of the source. The National Oceanic and Atmospheric Administration, using data gathered continuously at meteorological stations on and around the INL Site and the MDIFF air dispersion model, prepared the dispersion coefficients for this report.

dose: A general term used to refer to the effect on a material that is exposed to radiation. It is used to refer either to the amount of energy absorbed by a material exposed to radiation (see **dose, absorbed**) or to the potential biological effect in tissue exposed to radiation (see **dose, equivalent** and **dose, effective**). See also: **dose, population**.

dose, absorbed: The amount of energy deposited in any substance by ionizing radiation per unit mass of the substance. It is expressed in units of rad or gray (Gy) (1 rad = 0.01 gray).

dose, effective (*E*): The summation of the products of the equivalent dose received by specified tissues and organs of the body, and tissue weighting factors for the specified tissues and organs, and is given by the expression:

$$E = \sum_T w_T \sum_R w_R D_{T,R} \quad or \quad E = \sum_T w_T H_T$$

where H_T or $w_R D_{T,R}$ is the equivalent dose in a tissue or organ, T, and w_T is the tissue weighting factor. The effective dose is expressed in the SI unit Sievert (Sv) or conventional unit rem (1 rem = 0.01 Sv). (See **dose, equivalent** and **weighting factor**).

dose, equivalent (H_T): The product of absorbed dose in tissue multiplied by a quality factor, and then sometimes multiplied by other necessary modifying factors, to account for the potential for a biological effect resulting from the absorbed dose. For external dose, the equivalent dose to the whole body is assessed at a depth of 1 cm in tissue; the equivalent dose to the lens of the eye is assessed at a depth of 0.3 cm in tissue, and the equivalent dose to the extremity and skin is assessed at a depth of 0.007 cm in tissue. Equivalent dose is expressed in units of rems (or sieverts). It is expressed numerically in rems (traditional units) or sieverts (SI units). (See **dose, absorbed** and **quality factor**).

dose, population or collective: The sum of the individual effective doses received in a given time period by a specified population from exposure to a specified source of radiation. Population dose is expressed in the SI unit person-sievert (person-Sv) or conventional unit person-rem. (1 person-Sv = 100 person-rem). (See **dose, effective**).

dosimeter: Portable detection device for measuring the total accumulated exposure to ionizing radiation.

dosimetry: The theory and application of the principles and techniques involved in the measurement and recording of radiation doses.

drinking water: Water for the primary purpose of consumption by humans.

duplicate sample: A sample collected from the same sampling location using the same equipment and sampling technique and placed into an identically prepared and preserved container. Duplicate samples are analyzed independently as an indication of gross errors in sampling techniques.

E

eastern Snake River Plain aquifer: One of the largest groundwater "sole source" resources in the United States.

It lies beneath a rolling topography extending some 308 km (191 mi) from Ashton to King Hill, Idaho, and ranges in width from 64 to 130 km (40 to 80 mi). The plain and aquifer were formed by repeated volcanic eruptions that were the result of a geologic hot spot beneath the earth's crust.

ecosystem: The interacting system of a biologic community and its nonliving environment.

effluent: Any liquid discharged to the environment, including storm water runoff at a site or facility.

effluent waste: Treated wastewater leaving a treatment facility.

electrometallurgical treatment: The process of treating spent nuclear fuel using metallurgical techniques.

environment: Includes water, air, and land and the interrelationship that exists among and between water, air, and land and all living things.

environmental indicators: Animal and plant species that are particularly susceptible to decline related to changes, either physical or chemical, in their environment.

environmental media: Includes air, groundwater, surface water, soil, flora, and fauna.

environmental monitoring: Sampling for contaminants in air, water, sediments, soils, agricultural products, plants, and animals, either by direct measurement or by collection and analysis of samples. It is a combination of two distinct activities (effluent monitoring and environmental surveillance) that together provide information on the health of an environment.

equipment blank: Sample prepared by collecting uncontaminated water passed over or through the sampling equipment. This type of blank sample is normally collected after the sampling equipment has been used and subsequently cleaned. An equipment blank is used to detect contamination introduced by the sampling equipment either directly or through improper cleaning.

exposure: The interaction of an organism with a physical or chemical agent of interest. Examples of such agents are radiation (physical) and carbon tetrachloride (chemical).

exposure pathway: The mechanism through which an organism may be exposed to a contaminant. An example is the surface water pathway, whereby an organism may be exposed to a contaminant through the consumption of surface water containing that contaminant.

external dose or exposure: That portion of the dose received from radiation sources outside the body (i.e., external sources).

extremely hazardous chemical: A substance listed in the appendices to 40 CFR 355, "Emergency Planning and Notification."

F

fallout: Radioactive material made airborne as a result of aboveground nuclear weapons testing that has been deposited on the earth's surface.

field blank: A blank used to provide information about contamination that may be introduced during sample collection, storage, and transport. A known uncontaminated sample, usually deionized water, is exposed to ambient conditions at the sampling site and subjected to the same analytical or measurement process as other samples.

fissile material: Although sometimes used as a synonym for fissionable material, this term has acquired a more restricted meaning. Namely, any material that is fissionable by thermal (slow) neutrons. The three primary fissile materials are uranium-233, uranium-235, and plutonium-239.

fission: The splitting of the nucleus of an atom (generally of a heavy element) into at least two other nuclei and the release of a relatively large amount of energy. Two or three neutrons are usually released during this type of transformation.

fission products: The nuclei (fission fragments) formed by the fission of heavy elements, plus the nuclides formed by the subsequent decay products of the radioactive fission fragments.

fissionable material: Commonly used as a synonym for fissile material, the meaning of this term has been extended to include material that can be fissioned by fast neutrons, such as uranium-238.

flood plain: Lowlands bordering a river that are subject to flooding. A flood plain is comprised of sediments carried by rivers and deposited on land during flooding.

G

gamma radiation: A form of electromagnetic radiation, like radio waves or visible light, but with a much shorter wavelength. It is more penetrating than alpha or beta radiation, capable of passing through dense materials such as concrete.

gamma spectroscopy: An analysis technique that identifies specific radionuclides that emit gamma radiation. It measures the particular energy of a radionuclide's gamma radiation emissions. The energy of these emissions is unique for each radionuclide, acting as a fingerprint to identify a specific radionuclide.

gross alpha activity: The total radioactivity due to alpha particle emission as inferred from measurements on a dry sample. See **alpha radiation**.

gross beta activity: The total radioactivity due to beta particle emission as inferred from measurements on a dry sample. See **beta radiation**.

groundwater: Water located beneath the surface of the ground (subsurface water). Groundwater usually refers to a zone of complete saturation containing no air.

H

half-life: The time in which one-half of the activity of a particular radioactive substance is lost due to radioactive decay. Measured half-lives vary from millionths of a second to billions of years. Also called physical or radiological half-life.

hazardous air pollutant: See **hazardous substance**.

hazardous chemical: Any hazardous chemical as defined under 29 CFR 1910.1200 ("Hazard Communication") and 40 CFR 370.2 ("Definitions").

hazardous material: Material considered dangerous to people or the environment.

hazardous substance: Any substance, including any isomers and hydrates, as well as any solutions and mixtures containing these substances, designated as such under Section 311 (b) (2)(A) of the *Clean Water Act*; any toxic pollutant listed under Section 307 (a) of the *Clean Water Act*; any element, compound, mixture, solution, or substance designated pursuant to Section 102 of the *Comprehensive Environmental Response, Compensation and Liability Act*; any hazardous waste having the characteristics identified under or listed pursuant to Section 3001 of the *Solid Waste Disposal Act*; any hazardous air pollutant listed under Section 112 of the *Clean Air Act*; and any imminently hazardous chemical substance or mixture with respect to which the U.S. Environmental Protection Agency Administrator has taken action pursuant to Section 7 of the *Toxic Substances Control Act*. The term does not include petroleum, including crude oil or any fraction thereof that is not otherwise specifically listed or designated in the first paragraph, and does not include natural gas, natural gas liquids, liquefied natural gas, or synthetic gas usable for fuel (or mixtures of natural gas and such synthetic gas).

hazardous waste: A waste that is listed in the tables of 40 CFR 261 ("Identification and Listing Hazardous Waste") or that exhibits one or more of four characteristics (corrosiveness, reactivity, flammability, and toxicity) above a predefined value.

high-level radioactive waste: Waste material resulting from the reprocessing of spent nuclear fuel, including both liquid and solid materials containing enough radioactivity to require permanent isolation from the environment.

hot spot: (1) In environmental surveillance, a localized area of contamination or higher contamination in an otherwise uncontaminated area. (2) In geology, a stationary, long-lived source of magma coming up through the mantle to the earth's surface. The hot spot does not move, but remains in a fixed position. As the crust of the earth moves over a hot spot, volcanic eruptions occur on the surface.

I

infiltration: The process of water soaking into soil or rock.

influent waste: Raw or untreated wastewater entering a treatment facility.

inorganic: Relating to or belonging to the class of compounds not having a carbon basis; hydrochloric and sulfuric acids are called inorganic substances.

ionizing radiation: Any radiation capable of displacing electrons from atoms or molecules, thereby producing ions. Some examples are alpha, beta, gamma, x-rays, neutrons and light. High doses of ionizing radiation may produce severe skin or tissue damage.

isopleth: A line on a map connecting points having the same numerical value of some variable.

isotope: Two or more forms of an element having the same number of protons in the nucleus (or the same atomic number), but having different numbers of neutrons in the nucleus (or different atomic weights). Isotopes of a single element possess almost identical chemical properties. Examples of isotopes are plutonium-238, plutomium-239, and plutonium-241; each acts chemically like plutonium but have 144, 145, and 146 neutrons, respectively.

L

laboratory blank: A sample, usually deionized water, that is intended to contain none of the analytes of interest and is subjected to the same analytical or measurement process as other samples to establish a zero baseline or laboratory background value. Laboratory blanks are run before and after regular samples are analyzed to measure contamination that may have been introduced during sample handling, preparation, or analysis. A laboratory blank is sometimes used to adjust or correct routine analytical results.

liquid effluent: A liquid discharged from a treatment facility.

M

management and operating (M&O) contract: An agreement under which the government contracts for the operation, maintenance, or support, on its behalf, of a government-owned or -controlled research, development, special production, or testing establishment wholly or principally devoted to one or more major programs of the contracting federal agency.

matrices/matrix/media: Refers to the physical form (solid, liquid, or gas) or composition (soil, filter, groundwater, or air) of a sample.

maximally exposed individual (MEI): A hypothetical member of the public whose location and living habits tend to maximize his or her radiation dose, resulting in a dose higher than that received by other individuals in the general population.

millirem (mrem): A unit of radiation dose that is equivalent to one one-thousandth of a rem.

millisievert (mSv): The International System of Units (SI) for radiation dose and effective dose equivalent. The SI equivalent of the millirem (1 millisievert = 100 millirem).

minimum detection concentration (MDC): The lowest concentration to which an analytical parameter can be measured with certainty by the analytical laboratory performing the measurement. While results below the MDC are sometimes measurable, they represent values that have a reduced statistical confidence associated with them (less than 95 percent confidence).

multi-media: Covering more than one environmental media (e.g., an inspection that reviews groundwater, surface water, liquid effluent, and airborne effluent data).

N

natural background radiation: Radiation from natural sources to which people are exposed throughout their lives. Natural background radiation is comprised of several sources, the most important of which are:

- *Cosmic radiation:* Radiation from outer space (primarily the sun)
- *Terrestrial radiation:* Radiation from radioactive materials in the crust of the earth
- *Inhaled radionuclides:* Radiation from radioactive gases in the atmosphere, primarily radon-222.

natural resources: Land, fish, wildlife, biota, air, water, groundwater, drinking water supplies, and other such resources belonging to, managed by, held in trust by, appertaining to, otherwise controlled by the United States, any state or local government, any foreign government, or Indian tribe.

noble gas: Any of the chemically inert gaseous elements of the helium group in the periodic table.

noncommunity water system: A public water system that is not a community water system. A noncommunity water system is either a transient noncommunity water system or a nontransient noncommunity water system.

nontransient noncommunity water system: A public water system that is not a community water system and that regularly serves at least 25 of the same persons over six months per year. These systems are typically schools, offices, churches, factories, etc.

O

organic: Relating or belonging to the class of chemical compounds having a carbon basis; hydrocarbons are organic compounds.

optically stimulated luminescence dosimeter (OSLD): Used to measure direct penetrating gamma radiation through the absorption of energy from ionizing radiation by trapping electrons that are excited to a higher energy band. The trapped electrons in the OSLD are released by exposure to green light from a laser.

P

perched water well: A well that obtains its water from a water body above the water table.

performance evaluation sample: Sample prepared by adding a known amount of a U.S. Environmental Protection Agency reference compound to reagent water and submitting it to the analytical laboratory as a field duplicate or field blank sample. A performance evaluation sample is used to test the accuracy and precision of the laboratory's analytical method.

person-rem: Sum of the doses received by all individuals in a population.

pH: A measure of hydrogen ion activity. A low pH (0 – 6) indicates an acid condition; a high pH (8 – 14) indicates a basic condition. A pH of 7 indicates neutrality.

playa: A depression that is periodically inundated with water and will retain such water over time. An intermittent or seasonal water body.

plume: A body of contaminated groundwater or polluted air flowing from a specific source. The movement of a groundwater plume is influenced by such factors as local groundwater flow patterns, the character of the aquifer in which groundwater is contained, and the density of contaminants. The movement of an air contaminant plume is influenced by the ambient air motion, the temperatures of the ambient air and of the plume, and the density of the contaminants.

PM_{10}: Particle with an aerodynamic diameter less than or equal to 10 microns.

pollutant: 1) Pollutant or contaminant as defined by Section 101(33) of the *Comprehensive Environmental Response, Compensation, and Liability Act* (CERCLA), shall include, but not be limited to, any element, substance, compound, or mixture, including disease-causing agents, which after release into the environment and upon exposure, ingesting, inhalation, or assimilation into an organism, either directly from the environment or indirectly by ingestion through food chains, will or may reasonably be anticipated to cause death, disease, behavioral abnormalities, cancer, genetic mutation, physiological malfunctions (including malfunctions in reproduction), or physical deformation, in such organisms or their offspring. The term does not include petroleum, including crude oil or any fraction thereof which is not otherwise specifically listed or designated as a hazardous substance under Section 101(14) (A) through (F) of CERCLA, nor does it include natural gas, liquefied natural gas, or synthetic gas of pipeline quality (or mixtures of natural gas and such synthetic gas). For purposes of the National Oil and Hazardous Substances Pollution Contingency Plan, the term pollutant or contaminant means any pollutant or contaminant that may present an imminent and substantial danger to public health or welfare of the United States. 2) Any hazardous or radioactive material naturally occurring or added to an environmental media, such as air, soil, water, or vegetation.

polychlorinated biphenyl: Any chemical substance that is limited to the biphenyl molecule that has been chlorinated to varying degrees or any combination of substances that contain such substance.

precision: A measure of mutual agreement among individual measurements of the same property. Precision is most often seen as a standard deviation of a group of measurements.

public water system: A system for the provision to the public of water for human consumption through pipes or other constructed conveyances, if such system has at least 15 service connections or regularly serves an average of at least 25 individuals daily at least 60 days out of the year. Includes any collection, treatment, storage, and distribution facilities under control of the operator of such system and used primarily in connection with such system and any collection or pretreatment storage facilities not under such control that are used primarily in connection with such system. Does not include any special irrigation district. A public water system is either a community water system or a noncommunity water system.

purgeable organic compound: An organic compound that has a low vaporization point (volatile).

Q

quality assurance (QA): Those planned and systematic actions necessary to provide adequate confidence that a facility, structure, system, or component will perform satisfactorily and safely in service. Quality assurance includes quality control. If quality is the degree to which an item or process meets or exceeds the user's requirements, then quality assurance is those actions that provide the confidence that quality was in fact achieved.

quality control (QC): Those actions necessary to control and verify the features and characteristics of a material, process, product, service, or activity to specified requirements. The aim of quality control is to provide quality that is satisfactory, adequate, dependable, and economic.

quality factor: The factor by which the absorbed dose (rad or gray) must be multiplied to obtain a quantity that expresses, on a common scale for all ionizing radiation, the biological damage (rem or sievert) to the exposed tissue. It is used because some types of radiation, such as alpha particles, are more biologically damaging to live tissue than other types of radiation when the absorbed dose from both is equal. The term, quality factor, has now been replaced by "radiation weighting factor" in the latest system of recommendations for radiation protection.

R

rad: short for radiation absorbed dose; a measure of the energy absorbed by any material.

radioactivity: The spontaneous transition of an atomic nucleus from a higher energy to a lower energy state. This transition is accompanied by the release of a charged particle or electromagnetic waves from the atom. Also known as activity.

radioactive decay: The decrease in the amount of any radioactive material with the passage of time due to the spontaneous emission from the atomic nuclei of either alpha or beta particles, often accompanied by gamma radiation.

radioecology: The study of the behavior and the effects of radioactive materials on the environment. Also includes the use of radioisotopes to study the structure and function of ecosystems and their component parts.

radionuclide: A type of atom that emits energy in the form of photons or particles (radiation) during transformation.

radiotelemetry: The tracking of animal movements through the use of a radio transmitter attached to the animal of interest.

reagent blank: A sample of any reagent used for sample preparation subjected to the same analytical or measurement process as a normal sample. A reagent blank is used to show that the reagent used in sample preparation does not contain any of the analytes of interest.

rehabilitation: The planting of a variety of plants in an effort to restore an area's plant community diversity after a loss (e.g., after a fire).

relative percent difference: A measure of variability adjusted for the size of the measured values. It is used only when the sample contains two observations, and it is calculated by the equation:

$$RPD = \frac{|R1 - R2|}{(R1 + R2)/2} \; x\, 100$$

where R1 and R2 are the duplicate sample measurement results.

release: Spilling, leaking, pumping, pouring, emitting, emptying, discharging, injecting, escaping, leaching, dumping, or disposing of a hazardous substance, pollutant, or contaminant into the environment.

rem (Roentgen Equivalent Man): A unit in the traditional system of units that measures the effects of ionizing radiation on humans.

reportable quantity: Any *Comprehensive Environmental Response, Compensation, and Liability Act* hazardous substance, the reportable quantity for which is established in Table 302.4 of 40 CFR 302 ("Designation, Reportable Quantities, and Notification"), the discharge of which is a violation of federal statutes and requires notification of the regional U.S. Environmental Protection Agency administrator.

representativeness: A measure of a laboratory's ability to produce data that accurately and precisely represent a characteristic of a population, a parameter variation at a sampling point, a process condition, or an environmental condition.

reprocessing: The process of treating spent nuclear fuel for the purpose of recovering fissile material.

resuspension: Windblown reintroduction to the atmosphere of material originally deposited onto surfaces from a particular source.

rhyolite: A usually light-colored, fine-grained, extrusive igneous rock that is compositionally similar to granite.

risk: In many health fields, risk means the probability of incurring injury, disease, or death. Risk can be expressed as a value that ranges from zero (no injury or harm will occur) to one (harm or injury will definitely occur).

risk assessment: The identification and quantification of the risk resulting from a specific use or occurrence of a chemical, taking into account the possible harmful effects on individuals or society of using the chemical in the amount and manner proposed and all the possible routes of exposure. Quantification ideally requires the establishment of dose-effect and dose-response relationships in likely target individuals and populations.

roentgen (R): The amount of ionization produced by gamma radiation in air. The unit of roentgen is approximately numerically equal to the unit of rem.

S

shielding: The material or process used for protecting workers, the public, and the environment from exposure to radiation.

sievert (Sv): A unit for assessing the risk of human radiation dose, used internationally. One sievert is equal to 100 rem.

sigma uncertainty: The uncertainty or margin of error of a measurement is stated by giving a range of values likely to enclose the true value. These values follow from the properties of the normal distribution, and they apply only if the measurement process produces normally distributed errors, e.g., the quoted standard errors are easily converted to 68.3 percent (one sigma), 95.4 percent (two sigma), or 99.7 percent (three sigma) confidence intervals; usually are denoted by error bars on a graph or by the following notations:

- measured value ± uncertainty
- measured value (uncertainty).

sink: Similar to a playa with the exception that it rapidly infiltrates any collected water.

spent nuclear fuel: Uranium metal or oxide and its metal container that have been used to power a nuclear reactor. It is highly radioactive and typically contains fission products, plutonium, and residual uranium.

split sample: A single sample, usually divided by the analytical laboratory, split into two separate samples. Each sample is prepared and analyzed independently as an indication of analytical variability and comparability.

spreading areas: At the INL Site, a series of interconnected low areas used for flood control by dispersing and evaporating or infiltrating water from the Big Lost River.

stabilization: The planting of rapid growing plants for the purpose of holding bare soil in place.

standard: A sample containing a known quantity of various analytes. A standard may be prepared and certified by commercial vendors, but it must be traceable to the National Institute of Standards and Technology.

stochastic effect: Effect that occurs by chance and which may occur without a threshold level of dose, whose probability is proportional to the dose and whose severity is independent of the dose. In the context of radiation protection, the main stochastic effect is cancer.

storm water: Water produced by the interaction of precipitation events and the physical environment (buildings, pavement, ground surface).

surface radiation: See **direct radiation**. Surface radiation is monitored at the INL Site at or near waste management facilities and at the perimeter of Site facilities.

surface water: Water exposed at the ground surface, usually constrained by a natural or human-made channel (stream, river, lake, ocean).

surveillance: Parameters monitored to observe trends but not required by a permit or regulation.

T

thermoluminescent dosimeter (TLD): A device used to measure radiation dose to occupational workers or radiation levels in the environment. A dosimeter is made of one or more lithium fluoride chips that measure cumulative exposure to ionizing radiation. Lithium fluoride absorbs the energy of radiation and releases it as light when heated.

total effective dose (TED): The sum of the effective dose (for external exposures) and the committed effective dose.

total organic carbon: A measure of the total organic carbon molecules present in a sample. It will not identify a specific constituent (e.g., benzene), but will detect the presence of a carbon-bearing molecule.

toxic chemical: Chemical that can have toxic effects on the public or environment above listed quantities. See also **hazardous chemical**.

traceability: The ability to trace history, application, or location of a sample standard and like items or activities by means of recorded identification.

transient noncommmunity water system: A water system that is not a community water system, and serves 25 nonresident persons per day for six months or less per year. These systems are typically restaurants, hotels, large stores, etc.

transuranic (TRU): Elements on the periodic table with an atomic number greater than uranium (>92). Common isotopes of transuranic elements are neptunium-239 and plutonium-238.

transuranic waste: Waste containing more than 100 nanocuries of alpha-emitting transuranic isotopes (radionuclide isotopes with atomic numbers greater than uranium [92]) per gram of waste with half-lives greater than 20 years.

tritium: A radioactive isotope of hydrogen, having three times the mass of ordinary hydrogen.

V

vadose zone: That part of the subsurface between the ground surface and the water table.

W

water quality parameter: Parameter commonly measured to determine the quality of a water body or sample (i.e., specific conductivity, pH, temperature, dissolved oxygen content).

weighting factor (w_T): A multiplier that is used for converting the equivalent dose to a specific organ or tissue (T) into what is called the effective dose. The goal of this process was to develop a method for expressing the dose to a portion of the body in terms of an equivalent dose to the whole body that would carry with it an equivalent risk in terms of the associated fatal cancer probability. The equivalent dose to tissue (H_T) is multiplied by the appropriate tissue weighting factor to obtain the effective dose (E) contribution from that tissue. (See **dose, equivalent** and **dose, effective**).

wetland: An area inundated or saturated by surface water or groundwater at a frequency and duration sufficient to support, and that under normal circumstances do support, a prevalence of vegetation typically adapted for life in saturated soil conditions. Wetlands generally include playa lakes, swamps, marshes, bogs, and similar areas as sloughs, prairie potholes, wet meadows, prairie river overflows, mudflats, and natural ponds.

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