Prepared in cooperation with the U.S. Department of Energy
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Radiochemical and Chemical Constituents in Water from Selected Wells and Springs from the Southern Boundary of the Idaho National Engineering and Environmental Laboratory to the Hagerman Area, Idaho, 2002

Open-File Report 2004-1004

U.S. Department of the Interior
U.S. Geological Survey

Cover: Well discharge to a spilling pond on Snake River Plain.

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U.S. GEOLOGICAL SURVEY

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U.S. DEPARTMENT OF ENERGY
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Idaho Falls, Idaho
October 2003

U.S. DEPARTMENT OF THE INTERIOR

GALE A. NORTON, Secretary

U.S. GEOLOGICAL SURVEY

CHARLES G. GROAT, Director

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CONVERSION FACTORS

Multiply	By	To Obtain
inch (in.)	25.4	millimeter (mm)
foot (ft)	0.3048	meter (m)
mile (mi)	1.609	kilometer (km)
gallon (gal)	3.785	liter
picocurie per liter (pCi/L)	0.037	becquerel per liter (Bq/L)

For temperature, degrees Celsius (°C) may be converted to degrees Fahrenheit (°F) by using the formula
°F = (1.8) (°C) + 32.

Sea Level: in this report, “sea level” refers to the National Geodetic Vertical Datum of 1929, a geodetic datum derived from a general adjustment of the first-order level nets of the United States and Canada, formerly called “Sea Level Datum of 1929.”

Abbreviated units used in report: µS/cm (microsiemens per centimeter at 25°C), mg/L (milligrams per liter),
µg/L (micrograms per liter).

Radiochemical and Chemical Constituents in Water from Selected Wells and Springs from the Southern Boundary of the Idaho National Engineering and Environmental Laboratory to the Hagerman Area, Idaho, 2002

By Gordon W. Rattray, U.S. Geological Survey, and Linford J. Campbell, Idaho Department of Water Resources

Abstract

The U.S. Geological Survey, Idaho Department of Water Resources, and the State of Idaho INEEL Oversight Program, in cooperation with the U.S. Department of Energy, sampled water from 17 sites as part of the sixth round of a long-term project to monitor water quality of the eastern Snake River Plain aquifer from the southern boundary of the Idaho National Engineering and Environmental Laboratory to the Hagerman area. The samples were collected from eight irrigation wells, three domestic wells, one stock well, one dairy well, one commercial well, one observation well, and two springs and analyzed for selected radiochemical and chemical constituents. One quality-assurance sample, a sequential replicate, also was collected and analyzed.

Many of the radionuclide and inorganic-constituent concentrations were greater than the reporting levels and most of the organic-constituent concentrations were less than the reporting levels. However, none of the reported radiochemical- or chemical-constituent concentrations exceeded the maximum contaminant levels for drinking water established by the U.S. Environmental Protection Agency. Statistical evaluation of the replicate sample pair indicated that, with 95 percent confidence, 132 of the 135 constituent concentrations of the replicate pair were equivalent.

INTRODUCTION

The Idaho National Engineering and Environmental Laboratory (INEEL), a U.S. Department of Energy (DOE) facility, lies above the north-central part of the eastern Snake River Plain (ESRP) aquifer (fig. 1). Since the early 1950's, waste and wastewater from nuclear industrial processes have been disposed of and discharged to the subsurface at the INEEL. Until 1984, wastewater containing radiochemical and chemical wastes generated at the INEEL was discharged to both ponds and wells. Since 1984, however, most waste and wastewater has been discharged primarily to infiltration ponds (Pittman and others, 1988, p. 20). Currently, aqueous wastes are discharged to infiltration ponds or lined evaporation ponds, with such disposal carried out in accordance with appropriate wastewater discharge permits.

Ground water from the ESRP aquifer supplies southeastern Idaho with a large water supply for domestic and industrial uses. However, public concern about aqueous waste-disposal practices at the INEEL, and the effect of these practices on the water quality of the ESRP aquifer in areas downgradient from the INEEL, led the DOE to request that the U.S. Geological Survey (USGS) conduct studies of the water quality of the aquifer between the southern boundary of the INEEL and the Minidoka-Twin Falls-Hagerman area (fig. 2). One study was a one-time sampling effort in the eastern part of the A & B Irrigation District in Minidoka County (Mann and Knobel, 1990). Another study, discontinued after 2001, involved sampling for tritium from 19 springs on the north side of the Snake River in the Twin Falls-Hagerman area (Mann, 1989; Mann and Low, 1994; Twining, 2002). A third study, from which the results in this report are a part, is an ongoing annual sampling program between the southern boundary of the INEEL and the Minidoka-Twin Falls-Hagerman area. This study is being conducted by the USGS, the Idaho Department of Water Resources, and the State of Idaho INEEL Oversight Program (INEEL OP) in cooperation with the DOE.

The initial round of sampling for the third study involved analyzing water samples collected from 55 sites during August and September 1989 (Wegner and Campbell, 1991). Subsequent rounds of sampling have involved collecting and analyzing water samples annually from about one-third of the sites. This sampling format ensures that all of the sites are sampled over a 3-year period. In 2002, for budgetary reasons, the total number of sampling sites was reduced to 46. Because water-quality results from eliminated sites generally were similar to those of nearby sites preserved in the sampling program, the impact on overall water-quality information is

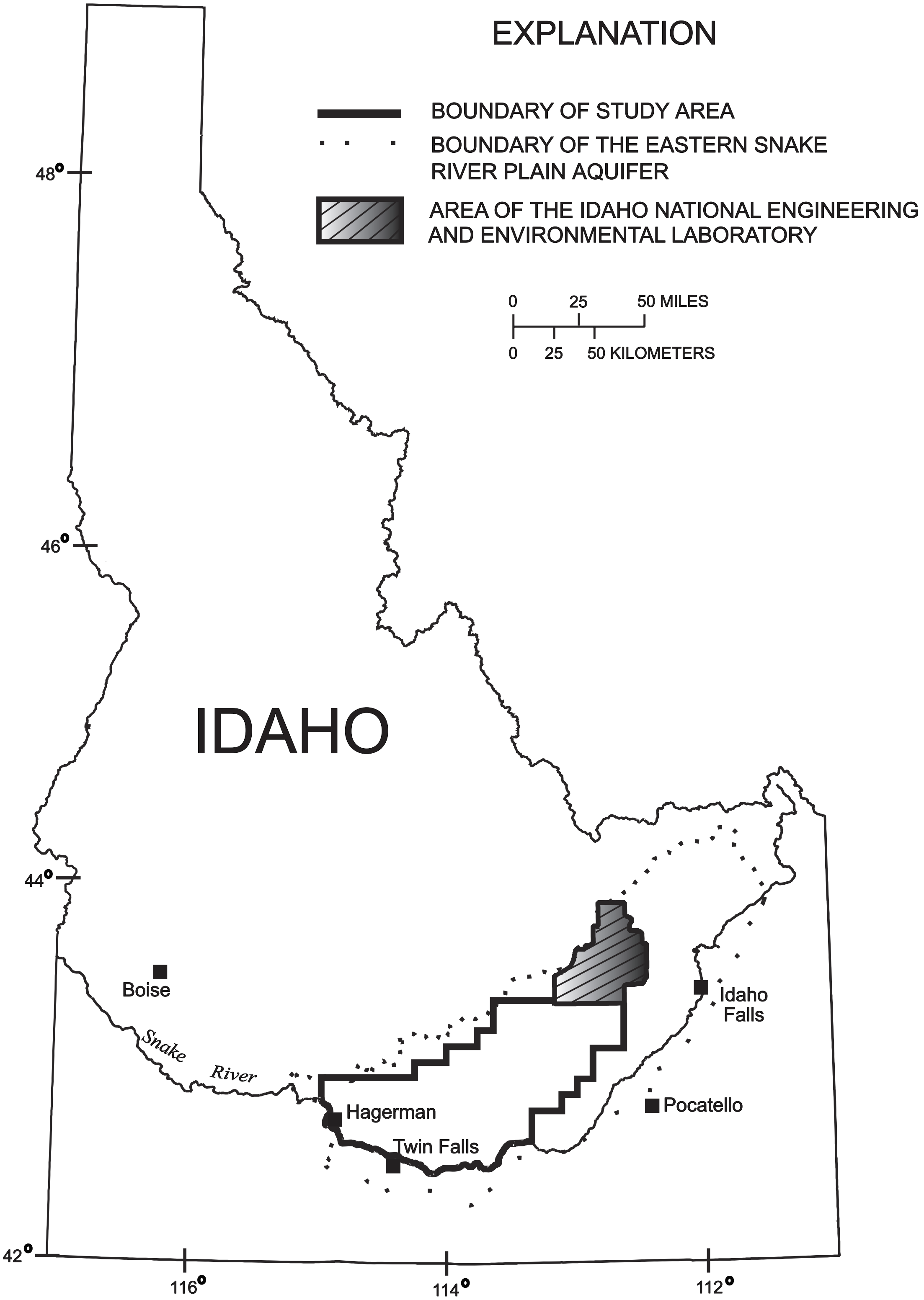

Figure 1. Location of the study area, between the Idaho National Engineering and Environmental Laboratory and Hagerman, Idaho.

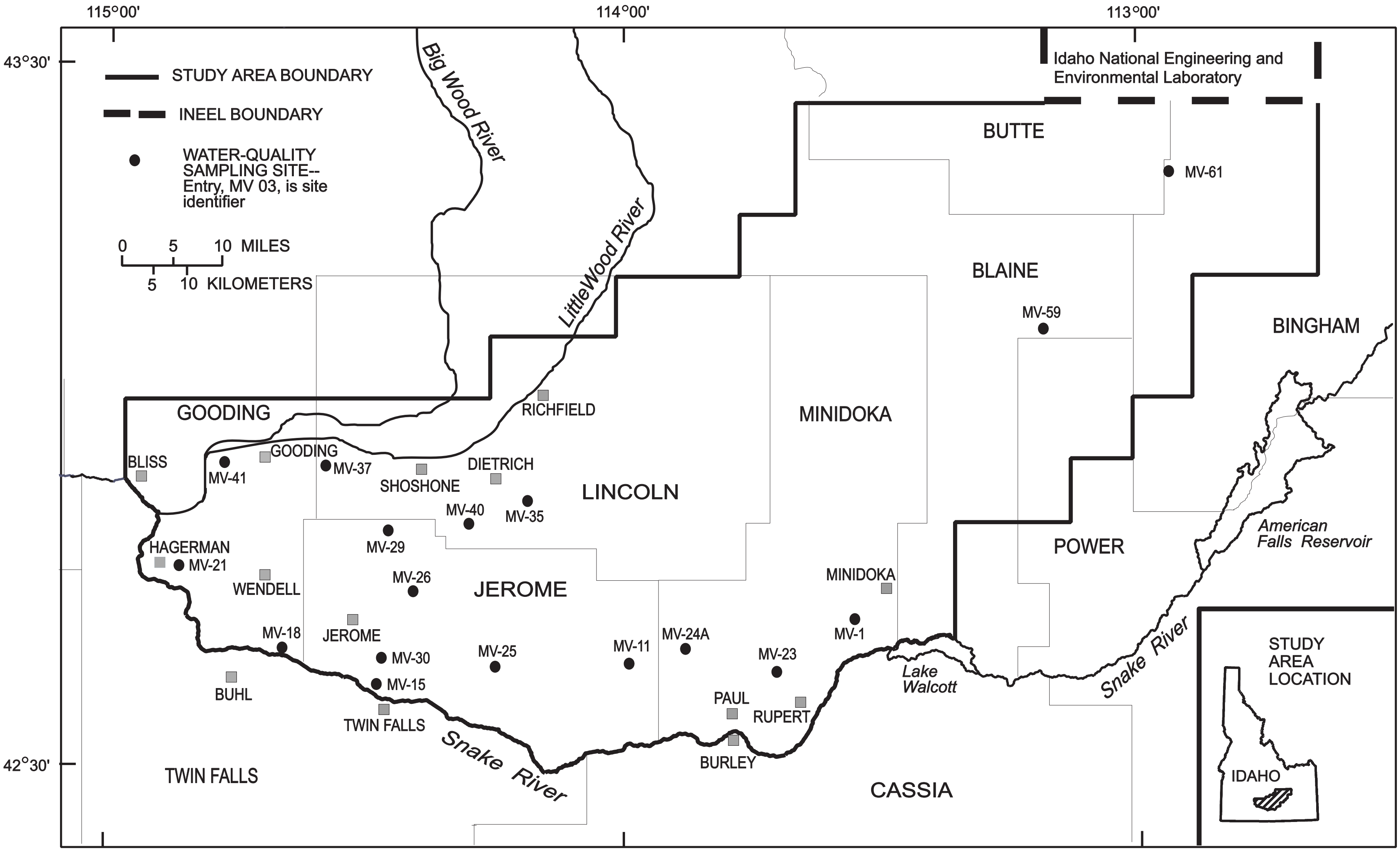

Figure 2. Location of selected water-quality sampling sites on the eastern Snake River Plain.

expected to be negligible. Data for a variety of radiochemical and chemical constituents from the sampling rounds have been published in reports by Bartholomay, Edwards, and Campbell (1992, 1993, 1994a, 1994b); Bartholomay, Williams, and Campbell (1995, 1996, 1997b, 1998); Bartholomay, Twining, and Campbell (1999, 2000, 2001); and Twining, Rattray, and Campbell (2003). An evaluation of the results from this study from 1989 through 1992 was published by Bartholomay, Williams, and Campbell (1997a).

Water samples collected by the USGS from 17 sites in 2002 (fig. 2) were analyzed by the USGS National Water Quality Laboratory (NWQL) for radionuclides, trace elements, common ions, nutrients, purgeable organic compounds, insecticides, and herbicides. Water samples were also collected by the INEEL OP and sent to the Environmental Monitoring Laboratory at Idaho State University (ISU-EML) for radionuclide analyses. One quality-assurance (QA) sample, a sequential replicate, also was collected and analyzed.

Geohydrologic Setting

The ESRP is a northeast-trending structural basin about 200 mi long and 50 to 70 mi wide. The basin, bounded by faults on the northwest and downwarping and faulting on the southeast, has been filled with basaltic lava flows interbedded with terrestrial sediments (Whitehead, 1986). Thickness of individual basalt flows averages 20 to 25 ft, and aggregate thickness is as much as several thousand feet in places. Alluvial fan deposits are composed primarily of sand and gravel whereas, in areas where streams were dammed by basalt flows, the sediments are predominantly silt and clay (Garabedian, 1986). Rhyolitic lava rocks and tuffs are exposed locally at the surface and may exist at depth under most of the eastern plain. A 10,365-ft-deep test hole at the INEEL penetrated about 2,160 ft of basalt and sediment and 8,205 ft of tuffaceous and rhyolitic volcanic rocks (Mann, 1986).

The ESRP aquifer is recharged by seepage from the upper reaches of the Snake River, tributaries and canals, infiltration from irrigation and precipitation, and underflow from tributary valleys on the perimeter of the plain. Discharge from the aquifer is primarily by pumpage for irrigation and spring flow to the Snake River (Mann and Knobel, 1990). Discharge from springs in the ESRP has fluctuated during the nearly 100 years of flow monitoring as a result of changes in water use, irrigation practices, and precipitation (Kjelstrom, 1992, p. 2).

Movement of water in the aquifer generally is from the northeast to southwest. Water moves horizontally through basalt interflow zones and vertically through joints and interfingering edges of the interflow zones. Infiltration of surface water, heavy pumpage, geologic conditions, and seasonal fluxes of recharge and discharge locally affect the movement of ground water (Garabedian, 1986).

Acknowledgments

The authors thank the well owners for granting permission to collect the water samples. The authors are grateful for technical review of the manuscript by Flint Hall of the INEEL OP and LeRoy L. Knobel of the USGS.

METHODS AND QUALITY ASSURANCE

The methods used in sampling and analyzing for selected chemicals generally followed the guidelines established by the USGS (Goerlitz and Brown, 1972; Stevens and others, 1975; Wood, 1981; Claassen, 1982; W.L. Bradford, USGS, written commun., 1985; Wershaw and others, 1987; Fishman and Friedman, 1989; Faires, 1992; Fishman, 1993; Zaugg and others, 1995; and Wilde and others, 1998, 1999, 2002). The methods used in the field and QA practices are described in the following sections.

Site Selection

Water samples were collected at 17 sites (fig. 2). The sites include eight irrigation wells, three domestic wells, one stock well, one dairy well, one commercial well, one observation well, and two springs. Criteria for site selection were geographic location, ease of sample collection, and long-term access.

Sample Containers and Preservatives

Sample containers and preservatives differ depending on the constituent(s) to be analyzed. Water samples analyzed by the NWQL were collected and preserved in accordance with laboratory requirements specified by Timme (1995). Water samples analyzed by ISU-EML were collected in accordance with the INEEL OP sample collection procedures. Sample containers, preservatives, and other treatments are summarized in table 1.

Sample Collection

Most irrigation wells were sampled from spigots in discharge lines, but some were sampled from stilling ponds at the pump discharge point. A peristaltic pump was used to transfer water from the stilling pond to sample bottles. Domestic, stock, dairy, and commercial wells were sampled from spigots closest to the pumps. The observation well was sampled from a 1/4-in. sample port connected to the discharge line. All the wells either were pumping on arrival of the sampling team or were started on arrival and pumped long enough to ensure that pressure tanks and pumping systems had been thoroughly flushed as evidenced by stable pH, specific conductance, and water-temperature measurements. The springs were sampled as near the source as possible, and a peristaltic pump was used to fill the sample bottles with water from the springs.

Chemical and physical characteristics monitored at the sample-collection sites included pH, specific conductance, and water temperature. These characteristics were monitored during pumping using methods described by Wood (1981) and Hardy and others (1989). A water sample was collected after measurements of these characteristics indicated probable physical and chemical stability. After collection, sample containers were sealed with laboratory film, labeled, and packed into ice chests for shipment to the NWQL. The samples collected for ISU-EML were stored until they were hand-delivered to the laboratory.

The sites sampled, site types, sample collection dates, and field measurements of pH, specific conductance, and water temperature are shown in table 2. These measurements ranged from 7.4 to 8.3 for pH, from 286 to 1,009 µS/cm for specific conductance, and from 13.6 to 16.5°C for water temperature.

Conditions at the sampling site during sample collection were recorded in a field logbook and a chain-of-custody record was used to track the samples from the time of collection until delivery to the analyzing laboratory. These records are available for inspection at the USGS INEEL Project Office. Records for samples analyzed by ISU-EML are maintained at the ISU laboratory.

Quality Assurance

Internal quality control and overall QA practices used by the NWQL are described in reports by Friedman and Erdmann (1982), Jones (1987), and Pritt and Raese (1995). Water samples analyzed by the NWQL were collected and handled in accordance with a QA plan for quality-of-water activities conducted by personnel at the INEEL Project Office. The plan was finalized in June 1989, revised in 1992 and 1996 (Mann, 1996), and is available for inspection at the USGS INEEL Project Office. Water samples analyzed by the ISU-EML were collected and handled in accordance with procedures described by Hall (2002).

Approximately 10 percent of the water samples collected in this sampling program were QA samples. An evaluation of QA results, for samples collected between 1989 through 1995, was presented by Williams and others (1998). In 2002, one QA sample was collected (MV-8, which is a sequential replicate of MV-1). An evaluation of the statistical equivalency of this replicate sample pair is presented below. In addition, the INEEL OP has published a statistical comparison of analytical results from duplicate water samples collected by the USGS and the INEEL OP (INEEL OP, 2003).

RADIOCHEMICAL CONSTITUENTS

Water samples were analyzed for tritium, strontium-90, gross alpha-particle and gross beta-particle radioactivity, and the gamma-emitting radionuclides cesium-137 and potassium-40. The samples were analyzed using methods described by Thatcher and others (1977). The U.S. Environmental Protection Agency (EPA) maximum contaminant levels (MCL's) for selected radionuclides and for types of radioactivity in drinking water are listed in table 3.

An analytical uncertainty, **s**, is calculated by the analyzing laboratory for each radionuclide concentration or radioactivity measurement. This report presents the analytical uncertainty as 2**s**. Guidelines for interpreting analytical results are based on an extension of the method described by Currie (1984). In radiochemical analyses, laboratory measurements are made on a target sample and a prepared blank. Instrument signals for the sample and blank vary randomly. Therefore, it is essential to distinguish between two key aspects of the problem of detection: (1) the instrument signal for the sample must be greater than the signal for the blank to make the decision that there was detection; and (2) an estimation must be made of the minimum concentration that will yield a sufficiently large signal to make the correct decision for detection or nondetection most of the time. The first aspect of the problem is a qualitative decision based on signals and a definite criterion for detection. The second aspect of the problem is an estimation of the detection capabilities of a complete measurement process that includes hypothesis testing.

For radionuclide analyses in this sampling program, the critical level for detection of a constituent is defined as 1.6**s**. A radionuclide concentration or radioactivity measurement that is above this critical level is determined as being detected in the sample. Given a large number of samples, as many as 5 percent of the samples with measured concentrations equal to or greater than 1.6**s**, which were determined as containing the radionuclide or radioactivity, might not contain the radioactive constituent. These measurements are referred to as false positives and are errors of the first type in hypothesis testing.

A concentration that equals 3**s** represents a measurement at the minimum detectable concentration. For samples containing a true concentration of 3**s** or greater, there is a 95-percent-or-more probability that the radioactive constituent will be determined as being present in the sample. Given a large number of samples, as many as 5 percent of the samples with true concentrations greater than or equal to 3**s** could be determined as not containing the radionuclide or radioactivity. These measurements are referred to as false negatives and are errors of the second type in hypothesis testing.

More false negative than false positive measurements are made on samples containing true radionuclide concentrations between 1.6**s** and 3**s**, and there is a greater-than-5-percent probability of false negative results for these samples. At 1.6**s**, the probability of a false negative is about 50 percent.

These guidelines are based on counting statistics alone and do not include systematic or random errors inherent in laboratory procedures. The values 1.6**s** and 3**s** vary slightly with background or blank counts and with the number of gross counts for individual analyses. The use of the critical level and minimum detectable concentration aids the reader in the interpretation of analytical results and does not represent absolute concentrations of radioactivity that may or may not have been detected. In this report, if the concentration of a selected radionuclide was equal to or greater than 3**s**, the concentration is considered to be above a "reporting level." The reporting level should not be confused with the analytical method detection limit, which is based on laboratory procedures. At small concentrations, the reporting level approaches the analytical method detection limit; however, at larger concentrations, they may be significantly different.

Many analytical results of environmental radioactivity measurements are at or near zero. If the true concentration for a given radionuclide is zero, a given set of analytical results for that radionuclide should be distributed about zero, with an equal number of negative and positive measurements. Negative analytical results occur if the radioactivity measured in a water sample is less than the radioactivity measured in a background or blank sample (American Society for Testing and Materials, 1992, p. 126; Knobel and others, 1992, p. 51).

Tritium

Tritium, a radioactive isotope of hydrogen, is formed in nature by interactions of cosmic rays with gases in the upper atmosphere. Tritium also is produced in thermonuclear detonations and is a waste product of nuclear industrial processes. At the INEEL, discharge of industrial wastewater resulted in tritium concentrations in the aquifer by 1961 that exceeded the 20,000 pCi/L MCL for tritium (Mann and Cecil, 1990). Since 1961 tritium concentrations in the aquifer have generally decreased (Mann and Cecil, 1990) and by 1998 tritium concentrations in all aquifer samples from the INEEL were less than the MCL (Bartholomay, Tucker, Davis, and Greene, 2000). However, while concentrations of tritium were decreasing the areal distribution of tritium in the aquifer was increasing, and by 1983 tritium was detected in water from wells along the southern boundary of the INEEL, 8 to 9 miles south of the discharge location (Pittman and others, 1988). This corresponds to an apparent transport velocity for tritium of 4 to 5 feet per day.

Ground-water samples collected in the study area in 2002 for tritium analysis were submitted to the NWQL and the ISU-EML, laboratories located in Lakewood, CO, and Pocatello, ID, respectively. The NWQL and ISU-EML both use an electrolytic enrichment liquid-scintillation counting method; in addition, the ISU-EML performs a second set of analyses using a standard liquid-scintillation counting method. The analytical method detection limit for the NWQL was 1 pCi/L for a 1,000-minute counting period; for the ISU-EML the analytical method detection limits were 150 pCi/L (standard method) and less than 25 pCi/L (enrichment method) for 200-minute counting periods.

Concentrations of tritium in water samples analyzed by the NWQL ranged from -0.3±1.0 to 47.7±3.2 pCi/L; 16 of the concentrations exceeded the reporting level (table 4). Concentrations of tritium in water samples analyzed by the ISU-EML using the enrichment method ranged from 2±6 to 44±7 pCi/L; 15 of the concentrations exceeded the reporting level (table 4). Background concentrations of tritium in ground water in Idaho generally range from 0 to 40 pCi/L (Knobel and others, 1992).

Strontium-90

Strontium-90 is a fission product that was widely distributed in the environment during atmospheric weapons tests. Strontium-90 generally is present in ground water as a result of these tests and from nuclear industry waste-disposal practices. Because strontium-90 sorbs onto sediment material in the aquifer it is not expected to move past its current location at the INEEL (Bartholomay, 1998). Concentrations of dissolved strontium-90 in all of the water samples were less than the reporting level and ranged from -0.033±0.17 to 0.223±0.34 pCi/L (table 4).

Gross Alpha-Particle Radioactivity

Gross alpha-particle radioactivity is a measure of the total radioactivity given off as alpha particles during the radioactive decay process; however, laboratories normally report the radioactivity as if it were all given off by one radionuclide. In this report, concentrations in pCi/L are reported as dissolved thorium-230 by the NWQL and as total thorium-230 by the ISU-EML.

The concentration of gross alpha-particle radioactivity in water samples analyzed by the NWQL ranged from 0.95±1.88 to 7.27±3.93 pCi/L; two of the concentrations were greater than the reporting level (table 5). Concentrations of gross alpha-particle radioactivity in water samples analyzed by the ISU-EML ranged from -0.9±2.2 to 5.2±2.2 pCi/L; six of the concentrations were greater than the reporting level (table 5). The largest concentration, 7.27±3.93 pCi/L, was below the 15 pCi/L MCL for gross alpha-particle radioactivity (table 3).

Gross Beta-Particle Radioactivity

Gross beta-particle radioactivity is a measure of the total radioactivity given off as beta particles during the radioactive decay process. Laboratories normally report this radioactivity as if it were all given off by one radionuclide. In this report, concentrations in pCi/L are reported as dissolved cesium-137 by the NWQL and as total cesium-137 by the ISU-EML. The MCL for gross beta-particle and gamma radioactivity is 4 mrem/yr (table 3). (The average annual concentrations of tritium and strontium-90 in public drinking-water supplies that produce a 4-mrem/yr dose are 20,000 and 8 pCi/L, respectively (table 3). Gross beta-particle radioactivity measurements should not be compared directly with these concentrations).

Concentrations of gross beta-particle radioactivity in all of the water samples analyzed by the NWQL were greater than the reporting level (table 5) and ranged from 3.65±1.17 to 12.29±3.96 pCi/L. Concentrations of gross beta-particle radioactivity in water samples analyzed by the ISU-EML ranged from 1.1±0.8 to 5.5±1.0 pCi/L; 17 of the concentrations were greater than the reporting level (table 5).

Cesium-137 and Potassium-40

Concentrations of cesium-137 and potassium-40 in the water samples were determined with gamma spectrometry. Cesium-137 is a fission product of uranium-235, uranium-233, or plutonium-239. Potassium makes up approximately 2.6 percent of the Earth's continental crust, and 0.0118 percent of all potassium is the naturally occurring radioactive isotope potassium-40 (Eisenbud and Gesell, 1997).

Concentrations of cesium-137 in water samples ranged from -0.8±2.0 to 2.9±2.1 pCi/L; all of the concentrations were less than the reporting level (table 6). The concentrations of potassium-40 in water samples ranged from -27±53 to 81±44 pCi/L; four of the concentrations were greater than the reporting level (table 6).

CHEMICAL CONSTITUENTS

Chemical constituents analyzed from the water samples included trace elements, common ions, nutrients, purgeable organic compounds, insecticides, and herbicides. For chemical constituents, minimum reporting levels (MRL's), laboratory reporting levels (LRL's), and long-term method detection limits (LT-MDL's) are used to determine when a chemical constituent has been detected with sufficient confidence.

The MRL is the smallest measured concentration of a constituent that may be reliably reported using a given analytical method (Timme, 1995). In this report, MRL's are used only with purgeable organic compounds. The LRL is determined such that "the probability of falsely reporting a non-detection for a sample that contained an analyte at a concentration equal to or greater than the LRL is predicted to be less than or equal to 1 percent" (Childress and others, 1999, p. 19). This is known as a false negative and is an error of the second type in hypothesis testing. The LT-MDL is determined by calculating the standard deviation of a large sample population (at least 24 measurements) of spiked sample measurements over an extended period of time (often one year). The probability "of falsely reporting a concentration at or greater than the LT-MDL for a sample that did not contain the analyte is predicted to be less than or equal to 1 percent" (Childress and others, 1999, p. 19). This is known as a false positive and is an error of the first type in hypothesis testing.

Trace Elements

Water samples were analyzed for selected dissolved trace elements including barium, chromium, iron, lead, lithium, manganese, mercury, strontium, and zinc. The maximum or secondary MCL's and LRL's for these trace elements are shown in table 7 and the measured concentrations are shown in table 8.

Barium: Concentrations of barium ranged from 10 to 137 µg/L. All of these concentrations were greater than the LRL of 0.9 µg/L. The MCL for barium is 2,000 µg/L.

Chromium: The concentration of chromium in all samples was greater than, equal to, or estimated to be slightly less than the LRL of 0.8 µg/L. Concentrations ranged from an estimated 0.6 to 4.1 µg/L. The MCL for chromium is 100 µg/L.

Iron: Concentrations of iron in 16 of the 18 samples were less than the LRL of 10 µg/L. The two concentrations that exceeded the LRL were estimated at 5.7 and 8.7 µg/L. The secondary MCL for iron is 300 µg/L.

Lead: Concentrations of lead in seven samples ranged from an estimated 0.6 to 1.3 µg/L. Three of these concentrations exceeded the LRL of 1 µg/; all other sample concentrations were less than the LRL. Lead has an EPA action level of 15 µg/L.

Lithium: Concentrations of lithium in all samples were greater than the LRL of 3.9 µg/L. The concentrations ranged from 6 to 46 µg/L. No MCL for lithium has been established.

Manganese: The concentration of manganese in one sample was estimated at 0.8 µg/L. Concentrations in all other samples were reported as less than the LRL of 2 µg/L. The secondary MCL for manganese is 50 µg/L.

Mercury: The concentrations of mercury in all samples were less than the LRL of 0.011 µg/L. The MCL for mercury is 2 µg/L.

Strontium: Concentrations of strontium in all samples were greater than the LRL of 0.6 µg/L and ranged from 120 to 429 µg/L. No MCL for strontium has been established.

Zinc: Concentrations of zinc in seven samples ranged from an estimated 16 to 238 µg/L. All other concentrations were less than the LRL for zinc of 24 µg/L. The secondary MCL for zinc is 5,000 µg/L.

Common Ions

Water samples were analyzed for dissolved common ions including calcium, magnesium, silica, and sodium. The LRL's for these ions are shown in table 9. No MCL's have been established for these ions. The concentrations of dissolved common ions are shown in table 10.

Calcium: Concentrations of calcium in all samples were greater than the LRL of 0.012 mg/L and ranged from 25 to 78 mg/L.

Magnesium: Concentrations of magnesium in all samples were greater than the LRL of 0.008 mg/L and ranged from 12 to 32 mg/L.

Silica: Concentrations of silica in all samples were greater than the LRL of 0.13 mg/L and ranged from 30 to 42 mg/L.

Sodium: Concentrations of sodium in all samples were greater than the LRL of 0.09 mg/L and ranged from 12 to 80 mg/L.

Nutrients

Water samples were analyzed for dissolved ammonia (as nitrogen), nitrite (as nitrogen), nitrite plus nitrate (as nitrogen), and orthophosphate (as phosphorus). The MCL's and the LRL's are shown in table 9. Concentrations of nutrients are shown in table 10.

Ammonia (as nitrogen): Concentrations of ammonia (as nitrogen) in all samples were reported as less than 0.04 and were less than the laboratory reporting level of 0.041 mg/L.

Nitrite (as nitrogen): Concentrations of nitrite (as nitrogen) in all samples were less than the LRL of 0.008 mg/L. The maximum contaminant level is 1 mg/L.

Nitrite plus nitrate (as nitrogen): Concentrations of nitrite plus nitrate (as nitrogen) in all samples were greater than the LRL of 0.047 mg/L and ranged from 0.5 to 7.8 mg/L. The MCL is 10 mg/L.

Orthophosphate (as phosphorus): Concentrations of orthophosphate (as phosphorus) ranged from an estimated 0.009 to 0.074 mg/L. Seven of these concentrations exceeded the LRL for orthophosphate of 0.018 mg/L.

Purgeable Organic Compounds

Water samples were analyzed for concentrations of 61 purgeable organic compounds. The MCL's and MRL's of these compounds are shown in table 11. Concentrations of trichloromethane were 0.2276, 1.527, and 0.3126 µg/L in water samples from wells MV-24A, MV-26, and MV-30, respectively. The concentration of bromodichloromethane in water from well MV-26 was 0.2944 µg/L. All samples had a total trihalomethane (tthm) concentration that was less than the MCL for tthm of 100 µg/L. All other concentrations of purgeable organic compounds in the water samples were less than the indicated MRL's.

Insecticides

Water samples were analyzed for concentrations of 19 insecticides. The MCL's, LRL's, and LT-MDL's for these compounds are shown in table 12. Concentrations of insecticides in all samples were less than the indicated LRL's.

Herbicides

Water samples were analyzed for concentrations of 28 herbicides. The MCL's, LRL's, and LT-MDL's for these compounds are shown in table 13. Estimated and reported concentrations ranged from 0.0031 to 0.0206 µg/L for atrazine, 0.0026 to 0.0195 µg/L for deethyl atrazine, and 0.0029 to 0.0155 µg/L for simazine. One estimated value of 0.0038 µg/L for metolachlor was reported; all other values of metolachlor were less than the LRL (table 14). These estimated and reported concentrations were all less than the indicated MCL's. All other concentrations of herbicides in the water samples were less than the indicated LRL's.

STATISTICAL EQUIVALENCY OF THE REPLICATE PAIR OF SAMPLES

A determination of the statistical equivalency of concentrations of chemical constituents in the replicate sample pair was performed following the method outlined by Williams (1996). With this method concentrations of the replicate pair were determined for their statistical equivalence within a specified confidence level. The determination of equivalency was performed by determining the standard deviate, Z. After the Z-value was calculated, the level of significance of the result was evaluated (calculation of the level of significance assumes that the sample population is distributed normally). For this report concentrations from replicate samples are considered equivalent if the results are within two standard deviations of each other. At this confidence level (95-percent) the level of significance, determined from a standard normal probability curve, is 0.05 for a two-tailed test and corresponds to a Z-value of 1.96.

The equation used to determine Z was adapted from Volk (1969), where:

$$Z = \frac{|x - y|}{\sqrt{(S_x)^2 + (S_y)^2}} \qquad (1)$$

where

x is the result of the routine water-quality sample,
y is the result of the sequential replicate sample,
S_x is the standard deviation of x, and
S_y is the standard deviation of y.

The standard deviations used in equation 1 were calculated by the analyzing laboratory for radionuclides and approximated from NWQL-determined most probable deviations for inorganic constituents (Ted Struzeski, personal commun., NWQL, 2003) and relative standard deviations for organic constituents (Donna Rose, volatile organic compounds; Jim Madsen, pesticides; personal communs., NWQL, 2003).

Constituent concentrations in the replicate pair were considered statistically equivalent when the calculated Z-value was less than or equal to 1.96. Constituent concentrations were also considered statistically equivalent, although Z-values were not calculated, when the concentration of both samples was reported as less than the LRL or MRL or when one sample had a concentration reported as less than the LRL and the other sample had an estimated concentration that was less than the LRL (a result may be estimated for a variety of laboratory-specific reasons; for instance, the result may lie outside the calibrated range of the instrument; estimated results have increased uncertainty (Childress and others, 1999, p. 8–10)). The constituent concentrations of the replicate samples analyzed by the NWQL, with the exception of orthophosphorous, were all statistically equivalent. The Z-value for orthophosphorous was 3.54 (one estimated concentration was used to calculate this value, however). The constituent concentrations of the replicate samples analyzed by the ISU-EML were considered statistically equivalent for tritium, cesium-137 and potassium-40. Concentrations for both gross alpha-particle and gross beta-particle radioactivity, however, had Z-values of 4.24 and 4.01, respectively, and were not equivalent. Of the 135 constituents analyzed from the replicate sample pair, statistical comparison indicates that 132 of the concentration pairs were equivalent.

SUMMARY

The U.S. Geological Survey, Idaho Department of Water Resources, and the State of Idaho INEEL Oversight Program, in cooperation with the Department of Energy, sampled water from 17 sites as part of the sixth round of a long-term project to monitor water quality of the eastern Snake River Plain aquifer from the southern boundary of the Idaho National Engineering and Environmental Laboratory to the Hagerman area. The samples were collected from eight irrigation wells, three domestic wells, one stock well, one dairy well, one commercial well, one observation well, and two springs. One quality-assurance sample also was collected. Water samples were analyzed for selected radiochemical and chemical constituents.

Concentrations of radionuclides in water samples ranged from -0.3±1.0 to 47.7±3.2 pCi/L for tritium (electrolytic enrichment technique), -0.0337±0.17 to 0.223±0.34 pCi/L for strontium-90, -0.9±2.2 to 7.27±3.93 pCi/L for gross alpha-particle radioactivity (reported as dissolved thorium-230), 1.1±0.8 to 12.29±3.96 pCi/L for gross beta-particle radioactivity (reported as dissolved cesium-137), -0.8±2.0 to 2.9±2.1 pCi/L for cesium-137, and -27±53 to 81±44 pCi/L for potassium-40. None of these sample concentrations exceeded a U.S. Environmental Protection Agency maximum contaminant level (MCL) for drinking water.

Concentrations of trace elements in the water samples ranged from 10 to 137 µg/L for barium, 0.6 to 4.1 µg/L for chromium, <10 µg/L for iron, 0.6 to 1.3 µg/L for lead, 6 to 46 µg/L for lithium, 0.8 to <2 µg/L for manganese, <0.011 µg/L for mercury, 120 to 429 µg/L for strontium, and 16 to 238 µg/L for zinc. Concentrations of common ions in the water samples ranged from 25 to 78 mg/L for calcium, 12 to 32 mg/L for magnesium, 30 to 42 mg/L for silica, and 12 to 80 mg/L for sodium. Nutrient concentrations in water samples ranged from <0.04 mg/L for ammonia (as nitrogen), <0.008 mg/L for nitrite (as nitrogen), 0.5 to 7.8 mg/L for nitrite plus nitrate (as nitrogen), and 0.009 to 0.074 mg/L for orthophosphate (as phosphorus). None of these concentrations exceeded an established drinking water MCL, secondary MCL, or the U.S. Environmental Protection Agency action level for lead.

Concentrations of most purgeable organic compounds in water samples were less than the minimum reporting levels (MRL's). However, three concentrations of trichloromethane (0.2276, 1.527, and 0.3126 µg/L) and one concentration of bromodichloromethane (0.2944 µg/L) exceeded the MRL's. The MCL for total trihalomethanes, 100 µg/L, was not exceeded in any water samples. Concentrations of insecticides were all less than their LRL's. Four herbicides, however, had concentrations or estimated concentrations that were greater than their LRL's. Concentrations of these herbicides ranged from 0.0031 to 0.0206 µg/L for atrazine, 0.0026 to 0.0195 µg/L for deethyl atrazine, and 0.0029 to 0.0155 µg/L for simazine. One estimated value of 0.0038 µg/L was reported for metolachlor. None of these concentrations exceeded an established MCL for drinking water.

Statistical analysis of the replicate sample pair indicated that, with 95 percent confidence, 132 of the 135 constituent concentrations of the replicate sample pair were statistically equivalent. The three constituent concentrations that were not equivalent were orthophosphorous (analyzed by the NWQL) and gross alpha-particle and gross beta-particle radioactivity (analyzed by the ISU-EML).

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Table 1. Containers and preservatives used for water-sample collection.

[Abbreviations: L, liter; mL, milliliter; µm, micrometer; °C, degrees Celsius. Chemical formulas: HNO_3, nitric acid; HCl, hydrochloric acid. Chilled samples were shipped by overnight- delivery mail. Analyzing laboratory: NWQL, U.S. Geological Survey National Water Quality Laboratory; ISU-EML, Idaho State University Environmental Monitoring Laboratory]

Constituent or type of constituent	Container		Preservative		Other treatment	Analyzing laboratory
	Type	Size	Type	Size		
Tritium	Polyethylene	1 L	None	None	None	NWQL
	Polyethylene	1 L	None	None	None	ISU-EML
Strontium-90	Polyethylene, acid rinsed	1 L	HNO_3	4 mL	0.45-µm filter	NWQL
Other radionuclides	Polyethylene, acid rinsed	2 L	HNO_3	4 mL	.45-µm filter	NWQL
	Polyethylene	2 L	None	None	None	ISU-EML
Trace elements and common ions	Polyethylene, acid rinsed	250 mL	HNO_3	2 mL	.45-µm filter	NWQL
	Polyethylene	250 mL	None	None	.45-µm filter	NWQL
	Polyethylene	250 mL	None	None	None	NWQL
Mercury	Glass, acid rinsed	250 mL	HCl	2 mL	.45-µm filter	NWQL
Nutrients	Polyethylene, brown	125 mL	None	None	.45-µm filter, chill 4°C	NWQL
Purgeable organic compounds	Glass, amber, septum vial	40 mL	None	None	Chill 4°C	NWQL
Pesticides	Glass, amber, baked	1 L	None	None	Chill 4°C	NWQL

Table 2. Results of field measurements of water for pH, specific conductance, and temperature from selected wells and springs, eastern Snake River Plain.

[See figure 2 for location of sites. Site type: I, irrigation; QA, quality assurance (MV-8 is a replicate of MV-1); Sp, spring; D, dairy; H, domestic; C, commercial; S, stock; O, observation. Date sampled: month/day/year. Units: pH, negative base-10 logarithm of hydrogen-ion activity in moles per liter; specific conductance, microsiemens per centimeter at 25°C (degrees Celsius); temperature in degrees Celsius, °C; The National Secondary Drinking Water Standard for pH is 6.5-8.5 (U.S. Environmental Protection Agency, 2003)

Site identifier	Site ID	Site type	Date sampled	pH	Specific conductance	Temperature
MV-1	424313113343501	I	6/24/02	7.9	586	13.6
MV-8	433000113000001	QA	6/24/02	7.9	586	13.6
MV-11	4240211135900	I	6/25/02	7.4	858	13.6
MV-15	13091500	Sp	8/6/02	7.8	601	15.8
MV-18	13093400	Sp	8/6/02	8.0	664	14.6
MV-21	424807114505701	D	8/6/02	7.7	343	16.5
MV-23	424037113423201	I	6/24/02	7.7	691	14.5
MV-24A	424224113484302	H	8/5/02	7.6	1,009	15.2
MV-25	423945114110301	H	8/6/02	7.6	706	13.9
MV-26	424359114240901	I	8/5/02	7.9	453	13.6
MV-29	42482411463801	I	8/7/02	8.0	342	14.1
MV-30	423935114263701	C	8/5/02	7.7	658	14.8
MV-35	425307114122301	I	8/6/02	8.1	286	14.3
MV-37	425726114344901	H	8/7/02	7.4	472	15.0
MV-40	425104114180001	I	6/25/02	8.0	324	14.5
MV-41	425619114454101	I	8/6/02	7.4	716	14.0
MV-59	430805113102401	S	6/24/02	8.3	308	16.3
MV-61	432019112563201	O	8/8/02	8.0	388	14.8

Table 3. Maximum contaminant levels for selected radionuclides and types of radioactivity in drinking water.

[The maximum contaminant levels (MCL's) were established pursuant to the recommendations of the U.S. Environmental Protection Agency (2003) for community water systems and are included for comparison with results from this study. MCL's given for strontium-90 and tritium are concentrations assumed to produce a total body or organ dose of 4 millirem per year (mrem/yr) of beta-particle radiation. The MCL given for gross alpha-particle radioactivity excludes radon and uranium. Abbreviation: pCi/L, picocurie per liter]

Radionuclide or type of radioactivity	Maximum contaminant level
Tritium	20,000 pCi/L
Strontium-90	8 pCi/L
Gross alpha-particle radioactivity	15 pCi/L
Gross beta-particle and gamma radioactivity	4 mrem/yr

Table 4. Concentrations of tritium and strontium-90 in water from selected wells and springs, eastern Snake River Plain1

[See figure 2 for location of sites. Analyses were performed by the U.S. Geological Survey National Water Quality Laboratory (NWQL) and Idaho State University Environmental Monitoring Laboratory (ISU-EML) using the following methods: tritium by standard liquid scintillation counting (ISU-EML) and electrolytic enrichment liquid scintillation counting (both laboratories); strontium-90 by gas proportional counting. Analytical results and uncertainties—for example -0.0337±0.17—in picocuries per liter. Analytical uncertainties are reported as 2**s**. Concentrations that exceed the reporting level of 3**s** are shown in boldface type. Symbol: *, quality-assurance sample (MV-8 is a replicate of MV-1). ISU-EML results for MV-1, -8, -11, -18, -23 (nonenrichment method only), -29 (enrichment method only), -40, and -59 are averages of lab split samples or lab recounts]

Site identifier	Tritium, NWQL (Enrichment)	Tritium, ISU-EML (Enrichment)	Tritium, ISU-EML	Strontium-90, NWQL
MV-1	**26.9±1.9**	**28±7**	0±90	-.0337±0.17
MV-8*	**27.8±1.9**	**30±7**	10±90	.114±0.19
MV-11	**43±2.6**	**44±7**	0±90	.0686±0.18
MV-15	**35.5±2.6**	**35±7**	50±90	.159±0.16
MV-18	**33.9±2.6**	**29±5**	-20±64	.0156±0.16
MV-21	**8.0±1.0**	**17±6**	-10±90	.0827±0.16
MV-23	**31.0±1.9**	**40±5**	30±90	.0683±0.20
MV-24A	**47.7±3.2**	**34±8**	-30±90	.105±0.22
MV-25	**37.1±2.6**	**32±8**	40±90	-.00291±0.15
MV-26	**5.8±1.0**	**10±6**	-40±90	.223±0.34
MV-29	1.3±1.0	3±3	-30±64	-.0255±0.16
MV-30	**37.1±2.6**	**36±6**	30±90	.0409±0.19
MV-35	**2.9±1.0**	8±6	-40±90	.0696±0.16
MV-37	**36.5±2.6**	**33±7**	50±90	.122±0.18
MV-40	**5.8±1.0**	**16±7**	40±90	.131±0.20
MV-41	**35.5±2.6**	**37±6**	60±90	.108±0.16
MV-59	-.3±1.0	2±6	-60±90	.0726±0.20
MV-61	**16.3±1.3**	**24±6**	0±90	-.0115±0.15

Table 5. Concentrations of gross alpha-particle and gross beta-particle radioactivity in water from selected wells and springs, eastern Snake River Plain.

[See figure 2 for location of sites. Analyses were performed by the U.S. Geological Survey National Water Quality Laboratory (NWQL) and the Idaho State University Environmental Monitoring Laboratory (ISU-EML) using a residue procedure. Analytical results and uncertainties—for example 5.77±3.69—in picocuries per liter. Analytical uncertainties are reported as 2**s**. Concentrations that equal or exceed the reporting level of 3**s** are shown in boldface type. Symbols: *, quality-assurance sample (MV-8 is a replicate of MV-1); E, estimated result (a result may be estimated for a variety of laboratory-specific reasons; for instance, the result may lie outside the calibrated range of the instrument; estimated results have increased uncertainty (Childress and others, 1999, pp. 8-10)). ISU-EML gross alpha-particle and gross beta-particle results for MV-11, MV-18 and MV-29 are averages of lab split samples]

Site identifier	Gross alpha-particle, as dissolved thorium-230, NWQL	Gross alpha-particle, as total thorium-230, ISU-EML	Gross beta-particle, as dissolved cesium-137, NWQL	Gross beta-particle, as total cesium-137, ISU-EML
MV-1	**5.77±3.69**	-.9±1.6	**9.67±2.50**	**2.8±0.9**
MV-8*	4.89±3.79	**4.2±1.8**	**10.11±2.55**	**5.5±1.0**
MV-11	5.91±5.81	1.8±1.6	**10.50±3.07**	**5.15±0.8**
MV-15	4.22±3.91	0.6±1.6	**10.68±2.47 E**	**3.6±1.0**
MV-18	1.99±4.72	**2.15±1.3**	**8.90±2.95**	**2.8±0.7**
MV-21	1.95±2.11	1.0±1.4	**4.37±1.35**	**2.7±0.8**
MV-23	2.56±3.65	-.9±2.2	**8.62±2.86**	**4.0±1.1**
MV-24A	5.10±4.63	2.1±2.4	**12.29±3.96**	**5.1±1.2**
MV-25	3.52±3.19	**4.2±2.2**	**10.67±2.92**	**4.0±1.1**
MV-26	2.15±2.10	0.4±1.4	**4.54±1.85**	**3.1±0.9**
MV-29	3.16±2.33	-.2±0.9	**3.81±1.32**	**2.1±0.6**
MV-30	**7.27±3.93**	1.0±2.0	**7.80±2.66**	**4.7±1.0**
MV-35	1.75±1.88	1.5±1.2	**3.65±1.17**	1.1±0.8
MV-37	3.23±2.99	.6±1.6	**5.44±1.82 E**	**3.5±0.9**
MV-40	1.42±2.07	.7±1.5	**4.06±1.18**	**1.6±0.8**
MV-41	3.22±6.56	**5.2±2.2**	**8.35±3.20**	**4.3±1.1**
MV-59	.95±1.88	**3.3±1.2**	**4.71±1.18**	**2.3±0.8**
MV-61	1.97±2.32	**3.4±1.4**	**4.77±1.49**	**1.4±0.9**

Table 6. Concentrations of cesium-137 and potassium-40 in water from selected wells and springs, eastern Snake River Plain.

[See figure 2 for location of sites. Analyses were performed by the Idaho State University Environmental Monitoring Laboratory using gamma spectrometry. Analytical results and uncertainties—for example -0.8±1.8—in picocuries per liter. Analytical uncertainties are reported as 2**s**. Concentrations that equal or exceed the reporting level of 3**s** are shown in boldface type. Symbol: *, quality-assurance sample (MV-8 is a replicate of MV-1). Results for MV-11, MV-18, and MV-29 are averages of lab split samples]

Site identifier	Cesium-137	Potassium-40
MV-1	-.8±1.8	**81±44**
MV-8*	-.2±1.4	35±43
MV-11	.3±1.1	-16±38
MV-15	.5±1.6	27±42
MV-18	.3±1.0	**54±30**
MV-21	.3±1.5	-9±40
MV-23	-.2±1.3	20±43
MV-24A	1.4±2.3	-5±54
MV-25	2.9±2.1	**77±44**
MV-26	.4±2.3	2±53
MV-29	-.4±1.1	**64±30**
MV-30	-.2±1.6	6±42
MV-35	.4±1.4	-11±41
MV-37	.6±1.7	-27±53
MV-40	-.8±2.0	11±58
MV-41	.4±1.7	-18±40
MV-59	.6±1.7	20±43
MV-61	-.7±2.0	-5±41

Table 7. Maximum or secondary maximum contaminant levels and laboratory reporting levels of selected trace elements in drinking water.

[The maximum contaminant levels (MCL's) were established pursuant to the recommendations of the U.S. Environmental Protection Agency (2003) for community water systems and are included for comparison with results from this study Secondary maximum contaminant levels—in brackets—are from U.S. Environmental Protection Agency (2003). Units are in micrograms per liter (µg/L). Symbols: *, lead has an action level of 15 µg/L; **, MCL has not been established]

Trace element	Maximum or secondary maximum contaminant level	Laboratory reporting level
Barium	2,000	.9
Chromium	100	.8
Iron	[300]	10
Lead	*	1
Lithium	**	3.9
Manganese	[50]	2
Mercury	2	.011
Strontium	**	.6
Zinc	[5,000]	24

Table 8. Concentrations of dissolved trace elements in water from selected wells and springs, eastern Snake River Plain1

[See figure 2 for location of sites. Analyses were performed by the U.S. Geological Survey National Water Quality Laboratory. Analytical results in micrograms per liter. Symbols: <, concentration is less than the laboratory reporting level (used to indicate that the detection of the constituent is unclear); *, quality- assurance sample (MV-8 is a replicate of MV-1); E, estimated result (a result may be estimated for a variety of laboratory-specific reasons; for instance, the result may lie outside of the calibrated range of the instrument; estimated results have increased uncertainty (Childress and others, 1999, pp. 8-10))]

Site identifier	Barium	Chromium	Iron	Lead	Lithium	Manganese	Mercury	Strontium	Zinc
MV-1	63	.8 E	<10	<1	38	<2	<.011	294	<24
MV-8*	63	.8 E	<10	<1	39	<2	<.011	294	<24
MV-11	102	1.4	<10	<1	46	<2	<.011	429	<24
MV-15	72	1.0	<10	<1	29	<2	<.011	276	<24
MV-18	54	1.3	<10	<1	39	<2	<.011	306	<24
MV-21	18	3.2	<10	<1	14	<2	<.011	156	<24
MV-23	93	3.0	5.7 E	.7 E	36	<2	<.011	336	166
MV-24A	137	1.1	<10	1.3	45	<2	<.011	394	32
MV-25	57	.6 E	<10	1.3	27	<2	<.011	273	82
MV-26	25	2.1	<10	1.3	29	<2	<.011	211	<24
MV-29	18	3.0	8.7 E	<1	20	<2	<.011	156	<24
MV-30	65	1.2	<10	.6 E	31	<2	<.011	303	16 E
MV-35	11	3.5	<10	<1	10	<2	<.011	132	<24
MV-37	49	.6 E	<10	<1	6	<2	<.011	205	82
MV-40	15	3.5	<10	<1	10	<2	<.011	144	<24
MV-41	67	.8	<10	<1	8	<2	<.011	306	<24
MV-59	10	4.0	<10	.8 E	13	<2	<.011	120	238
MV-61	20	4.1	<10	.9 E	24	.8 E	<.011	165	54

Table 9. Maximum contaminant levels and laboratory reporting levels of selected common ions and nutrients in drinking water.

[The maximum contaminant levels (MCL's) were established pursuant to the recommendations of the U.S. Environmental Protection Agency (2003) for community water systems and are included for comparison with results from this study. Laboratory reporting levels (LRL's) are from the U.S. Geological Survey National Water Quality Laboratory web site (http://nwql.cr.usgs.gov/usgs/ltmdl). Units are in milligrams per liter (mg/L). Symbol: **, MCL has not been established]

Constituent	Maximum contaminant level	Laboratory reporting level
Calcium	**	.012
Magnesium	**	.008
Silica	**	.13
Sodium[1]	**	.09
Ammonia (as nitrogen)	**	.041
Nitrite (as nitrogen)	1	.008
Nitrate (as nitrogen)	10	.047[2]
Orthophosphate (as phosphorus)	**	.018

[1] Idaho Department of Health and Welfare (1989) recommends an optimum concentration of 20 mg/L for public drinking-water supplies.

[2] Nitrite plus nitrate (as nitrogen)

Table 10. Concentrations of dissolved common ions and nutrients in water from selected wells and springs, eastern Snake River Plain.

[See figure 2 for location of sites. Analyses were performed by the U.S. Geological Survey National Water Quality Laboratory. Analytical results in milligrams per liter. Symbols: <, concentration is less than the laboratory reporting level (used to indicate that the detection of the constituent is unclear); *, quality-assurance sample (MV-8 is a replicate of MV-1); E, estimated result (a result may be estimated for a variety of laboratory-specific reasons; for instance, the result may lie outside the calibrated range of the instrument; estimated results have increased uncertainty (Childress and others, 1999, pp 8-10))]

Site identifier	Calcium	Magnesium	Silica	Sodium	Ammonia (as nitrogen)	Nitrite (as nitrogen)	Nitrite plus nitrate (as nitrogen)	Orthophosphate (as phosphorus)
MV-1	50	19	39	37	<.04	<.008	1.1	.019
MV-8*	50	19	39	37	<.04	<.008	1.2	.015 E
MV-11	78	29	37	52	<.04	<.008	5.5	.016 E
MV-15	56	19	40	34	<.04	<.008	1.9	.012 E
MV-18	59	23	38	35	<.04	<.008	2.4	.023
MV-21	31	15	34	15	<.04	<.008	1.0	.016 E
MV-23	76	22	30	32	<.04	<.008	5.7	.044
MV-24A	76	32	35	80	<.04	<.008	7.8	.021
MV-25	60	26	37	45	<.04	<.008	3.9	.074
MV-26	42	16	33	21	<.04	<.008	1.0	.009 E
MV-29	31	14	33	15	<.04	<.008	.5	.013 E
MV-30	63	21	37	37	<.04	<.008	2.4	.015 E
MV-35	25	12	32	12	<.04	<.008	.5	.013 E
MV-37	54	17	31	17	<.04	<.008	1.9	.012 E
MV-40	30	14	33	14	<.04	<.008	.6	.02
MV-41	64	27	42	42	<.04	<.008	2.7	.062
MV-59	25	13	35	16	<.04	<.008	.7	.010 E
MV-61	37	15	32	16	<.04	<.008	1.1	<.02

Table 11. Maximum contaminant levels and minimum reporting levels of selected purgeable organic compounds in drinking water.

[Analyses were performed by the U.S. Geological Survey National Water Quality Laboratory (NWQL). Abbreviations: MCL, maximum contaminant level; MRL, minimum reporting level. MCL's were established pursuant to the recommendations of the U.S. Environmental Protection Agency (1994; 2000, p. 419) for community water systems and are included for comparison with results from this study. MRL's are from the NWQL website (http://nwql.cr.usgs.gov/usgs/ltmdl). Units are in micrograms per liter (µg/L). Symbol: **, MCL has not been established. Abbreviation: tthm, total trihalomethanes (trihalomethane analyses in this report include bromodichloromethane, dibromochloromethane, tribromomethane, and trichloromethane); MCL for tthm is 100 µg/L (U.S. Environmental Protection Agency, 2003)]

Purgeable organic compounds	MCL	MRL
Acrylonitrile	**	2.5
Benzene	5	.1
Bromobenzene	**	.2
Bromochloromethane	**	.2
Bromodichloromethane	tthm	.1
Bromomethane	**	.3
n-Butylbenzene	**	.2
sec-Butylbenzene	**	.2
tert-Butylbenzene	**	.2
1,1,2-Trichlorotrifluoroethane (CFC-113)	**	.1
Chlorobenzene	100	.1
Chloroethane	**	.2
Chloromethane	**	.2
2-Chlorotolulene	**	.2
4-Chlorotolulene	**	.2
Dibromochloromethane	tthm	.2
1,2-Dibromo-3-chloropropane (DBCP)	0.2	1
Dibromomethane	**	.2
1,2-Dibromoethane	**	.2
1,2-Dichlorobenzene	600	.1
1,3-Dichlorobenzene	**	.1
1,4-Dichlorobenzene	75	.1
Dichlorodifluoromethane	**	.2
1,1-Dichloroethane	**	.1
1,2-Dichloroethane	5	.2
1,1-Dichloroethene	7	.1
cis-1,2-Dichloroethene	70	.1
trans-1,2-Dichloroethene	100	.1
Dichloromethane	5	.2
1,2-Dichloropropane	5	.1
1,3-Dichloropropane	**	.2
2,2-Dichloropropane	**	.2
1,1-Dichloropropene	**	.2
cis-1,3-Dichloropropene	**	.2
trans-1,3-Dichloropropene	**	.2
Ethylbenzene	700	.1
Hexachlorobutadiene	**	.2
Isopropylbenzene	**	.2
4-Isopropyltoluene	**	.2
Methyl tert-butylether	**	.2
Napthalene	**	.5
n-Propylbenzene	**	.2
Styrene	100	.1

Table 11. Maximum contaminant levels and minimum reporting levels of selected purgeable organic compounds in drinking water. —Continued

Purgable organic compounds	MCL	MRL
1,1,1,2-Tetrachloroethane	**	.2
1,1,2,2-Tetrachloroethane	**	.2
Tetrachloroethene	5	.1
Tetrachloromethane (Carbon tetrachloride)	5	.2
Tolulene	1,000	.1
Tribromomethane (Bromoform)	tthm	.2
1,2,3-Trichlorobenzene	**	.2
1,2,4,-Trichlorobenzene	70	.2
1,1,1-Trichloroethane	200	.1
1,1,2-Trichloroethane	5	.2
Trichloroethene	5	.1
Trichlorofluoromethane	**	.2
Trichloromethane (Chloroform)	tthm	.1
1,2,3-Trichloropropane	**	.2
1,2,4-Trimethylbenzene	**	.2
1,3,5-Trimethylbenzene	**	.2
Vinyl chloride	2	.2
Xylenes, total ortho, meta, and para	10,000	.2

Table 12. Maximum contaminant levels, laboratory reporting levels, and long-term method detection levels of selected insecticides in drinking water.

[Analyses were performed by the U.S. Geological Survey National Water Quality Laboratory (NWQL). Abbreviations: MCL, maximum contaminant level; LRL, laboratory reporting level; LT-MDL, long-term method detection level. MCL's were established pursuant to the recommendations of the U.S. Environmental Protection Agency (2000, p. 420-421) for community water systems and are included for comparison with results from this study. LRL's and LT-MDL's are from the NWQL web site (http://nwql.cr.usgs.gov/usgs/ltmdl). Units are in micrograms per liter (µg/L). Symbol: **, MCL has not been established]

Insecticides	MCL	LRL	LT-MDL
Azinphos, methyl-	**	.05	.02
Carbaryl (Sevin)	**	.041	.021
Carbofuran	40	.02	.01
Chlorpyrifos (Dursban)	**	.005	.003
DDE, p,p'-	**	.0025	.0013
Diazinon	**	.005	.003
Dieldrin	**	.0048	.0024
Disulfoton (Disyston)	**	.021	.011
Ethoprophos	**	.005	.002
Fonofos	**	.0027	.0013
HCH, alpha-	**	.0046	.0023
Lindane (HCH, gamma-)	.2	.004	.002
Malathion	**	.027	.014
Parathion	**	.01	.005
Parathion, methyl-	**	.006	.003
Permethrin, cis-	**	.006	.003
Phorate	**	.011	.006
Propargite	**	.023	.011
Terbufos	**	.017	.009

Table 13. Maximum contaminant levels, laboratory reporting levels, and long-term method detection levels of selected herbicides in drinking water.

[Analyses were performed by the U.S. Geological Survey National Water Quality Laboratory (NWQL). Abbreviations: MCL, maximum contaminant level; LRL, laboratory reporting level; LT-MDL, long-term method detection level. MCL's were established pursuant to the recommendations of the U.S. Environmental Protection Agency (2000, p. 420-421) for community water systems and are included for comparison with results from this study. LRL's and LT-MDL's are from the NWQL web site (http://nwql.cr.usgs.gov/usgs/ltmdl). Units are in micrograms per liter (µg/L). Symbol: **, MCL has not been established]

Herbicides	MCL	LRL	LT-MDL
Acetochlor	**	.006	.003
Alachlor	2	.0045	.0022
Atrazine	3	.007	.004
Atrazine, deethyl- (CIAT)	**	.006	.003
Benfluralin	**	.01	.005
Butylate	**	.002	.001
Cyanazine	**	.018	.009
Dacthal (DCPA)	**	.003	.0015
2,6-Diethylaniline	**	.006	.003
EPTC (Eptam)	**	.002	.001
Ethalfluralin	**	.009	.005
Linuron	**	.035	.018
Metolachlor	**	.013	.006
Metribuzin	**	.006	.003
Molinate	**	.0016	.0008
Napropamide	**	.007	.003
Pebulate	**	.0041	.0021
Pendimethalin	**	.022	.011
Prometon	**	.015	.007
Pronamide (Propyzamide)	**	.0041	.0021
Propachlor	**	.01	.005
Propanil	**	.011	.005
Simazine	4	.005	.002
Tebuthiuron	**	.016	.008
Terbacil	**	.034	.017
Thiobencarb	**	.0048	.0024
Triallate	**	.0023	.0012
Trifluralin	**	.009	.005

Table 14. Concentrations of selected herbicides in water from selected wells and springs, eastern Snake River Plain.

[See figure 2 for location of sites. Analyses were performed by the U.S. Geological Survey National Water Quality Laboratory. Units are in micrograms per liter (µg/L). Symbols: <, concentration less than the laboratory reporting level (used to indicate that the detection of the constituent is unclear); *, quality-assurance sample (MV-8 is a replicate of MV-1); E, estimated result (a result may be estimated for a variety of laboratory-specific reasons; for instance, the result may lie outside the calibrated range of the instrument; estimated results have increased uncertainty (Childress and others, 1999, pp. 8-10)). Concentrations of herbicides listed in table 13, but not in table 14, were less than the laboratory reporting level in all samples]

Site identifier	Atrazine	Deethyl atrazine	Metolachlor	Simazine
MV-1	<.007	.0026 E	<.013	<.005
MV-8*	.0031 E	.0027 E	<.013	<.005
MV-11	.0116	.0142 E	<.013	.0063
MV-15	<.007	.0043 E	<.013	<.005
MV-18	.0042 E	.0064 E	<.013	<.005
MV-21	.0037 E	.0041 E	<.013	<.005
MV-23	.0206	.0140 E	<.013	.0155
MV-24A	.0106	.0115 E	<.013	.0055
MV-25	.0119	.0069 E	.0038 E	.0029 E
MV-26	<.007	<.006	<.013	<.005
MV-29	<.007	<.006	<.013	<.005
MV-30	.0032 E	.0046 E	<.013	<.005
MV-35	<.007	<.006	<.013	<.005
MV-37	<.007	.0054 E	<.013	<.005
MV-40	<.007	<.006	<.013	<.005
MV-41	.0099	.0195 E	<.013	<.005
MV-59	<.007	<.006	<.013	<.005
MV-61	<.007	<.006	<.013	<.005