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, 1998

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CONVERSION FACTORS AND ABBREVIATED UNITS

Multiply	By	To Obtain
foot (ft)	0.3048	meter
mile (mi)	1.609	kilometer
millirem per year (mrem/yr)	0.010	millisievert per year
picocurie per liter (pCi/L)	0.037	becquerel per liter
square mile (mi^2)	2.590	square kilometer

Temperature can be converted from degrees Celsius (°C) to degrees Fahrenheit (°F) by the equation: $°F = (°C \times 1.8) + 32$.

Abbreviated units used in report: mL (milliliter); L (liter); µg/L (microgram per liter); mg/L (milligram per liter); µm (micrometer); and µS/cm (microsiemens per centimeter) at 25 degrees Celsius.

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***By* Roy C. Bartholomay *and* Brian V. Twining, U.S. Geological Survey, *and* Linford J. Campbell, Idaho Department of Water Resources**

Abstract

The U.S. Geological Survey and the Idaho Department of Water Resources, in cooperation with the U.S. Department of Energy, sampled 18 sites as part of the fourth round of a long-term project to monitor water quality of the Snake River Plain aquifer from the southern boundary of the Idaho National Engineering and Environmental Laboratory to the Hagerman area. The samples were analyzed for selected radiochemical and chemical constituents. The samples were collected from 2 domestic wells, 12 irrigation wells, 2 stock wells, 1 spring, and 1 public supply well. Two quality-assurance samples also were collected and analyzed.

None of the reported radiochemical or chemical constituent concentrations exceeded the established maximum contaminant levels for drinking water. Many of the radionuclide- and inorganic-constituent concentrations were greater than the respective reporting levels. Most of the organic-constituent concentrations were less than the reporting levels.

INTRODUCTION

Recently, the public has expressed concern about waste-disposal practices at the Idaho National Engineering and Environmental Laboratory (INEEL) and the effect these practices might have had on the water quality of the Snake River Plain aquifer. The U.S. Department of Energy (DOE) requested that the U.S. Geological Survey (USGS) conduct two studies to respond to the public's concern and to gain a greater understanding of the radiochemical and chemical quality of water in the aquifer. The first study described a one-time sampling effort in the eastern part of the A & B Irrigation District in Minidoka County (Mann and Knobel, 1990). The second study, an ongoing annual sampling effort in the area between the southern boundary of the INEEL and Hagerman (fig. 1), is being conducted with the Idaho Department of Water Resources (IDWR) in cooperation with the DOE. The first round of sampling for the second study involved analyzing water samples collected from 55 sites during August and September 1989 (Wegner and Campbell, 1991). The second round of sampling involved analyzing water samples collected from 19 of the initial 55 sites in 1990 (Bartholomay and others, 1992), another 18 of the initial 55 sites in 1991 (Bartholomay and others, 1993), and the remaining 18 sites in 1992 (Bartholomay and others, 1994a). An evaluation of data collected during the first four years of the study is found in Bartholomay, Williams, and Campbell (1997a). The third round of sampling involved analyzing water samples collected from 19 of the initial 55 sites in 1993 (Bartholomay and others, 1994b), another 18 of the initial 55 sites during 1994 (Bartholomay and others, 1995), another 17 of the initial 55 sites during 1995 (Bartholomay and others, 1996), and one final site during 1996 (Bartholomay, Williams, and Campbell, 1997b). The first part of the fourth round of sampling involved analyzing water samples collected from 19 of the initial 55 sites in 1996 (Bartholomay, Williams, and Campbell, 1997b), and another 18 of the initial 55 sites during 1997

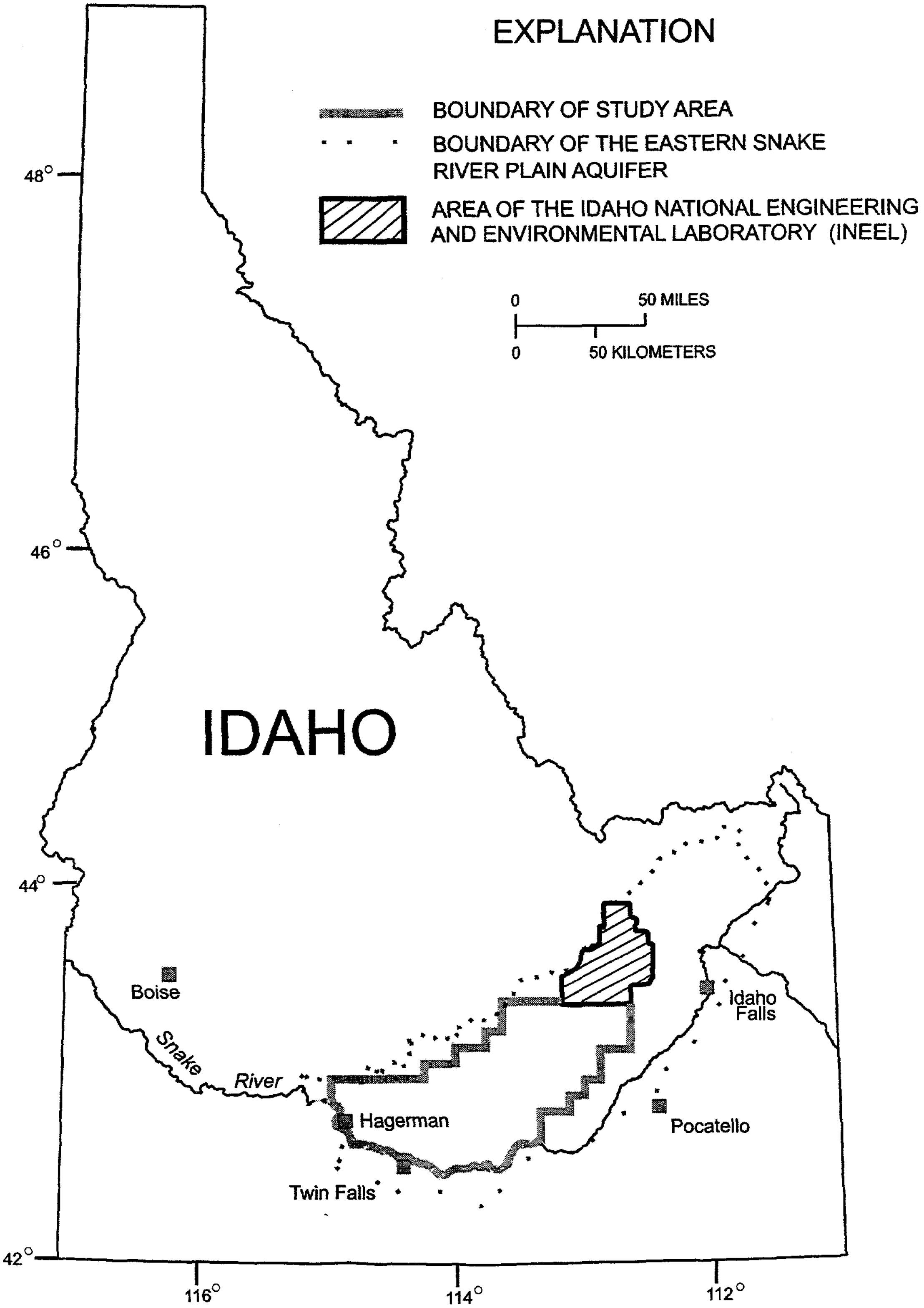

Figure 1. Location of the study area, between the Idaho National Engineering and Environmental Laboratory and Hagerman, Idaho.

(Bartholomay and others, 1998). This report summarizes the results of analyses of water samples collected from the last 18 sites during June and August 1998 as part of the fourth round.

The INEEL includes about 890 mi^2 of the northeastern part of the eastern Snake River Plain and is about 110 mi northeast of the Hagerman area (fig. 1). In the past, wastewater containing radiochemical and chemical wastes generated at the INEEL was discharged mostly to ponds and wells. Since 1983, most aqueous wastes have been discharged to infiltration ponds. Many of the constituents in the wastewater enter the aquifer indirectly by percolation through the unsaturated zone (Pittman and others, 1988).

Chemical and radioactive wastes have migrated from less than 1 to about 9 mi southwest of the disposal areas at the INEEL (Pittman and others, 1988). Tritium was detected intermittently at concentrations of 3,400±200 pCi/L or less in water from three wells along the southern boundary of the INEEL between 1983 and 1985. Since April 1985, tritium concentrations in water from wells near the southern boundary of the INEEL have been less than the reporting level (Bartholomay, Tucker, and others, 1997, p. 27).

Water samples collected from the 18 sites (fig. 2) were analyzed for selected radionuclides, trace elements, common ions, nutrients, purgeable organic compounds, carbamate insecticides, organophosphorus insecticides, gross polychlorinated biphenyls (PCBs), gross polychlorinated naphthalenes (PCNs), chlorophenoxy-acid herbicides, and other herbicides by the USGS National Water Quality Laboratory (NWQL) at Arvada, Colo. Samples also were collected at the same sites for selected radionuclide analyses by the Idaho State University Environmental Monitoring Laboratory (ISU-EML) at Pocatello, Idaho. Two replicate water samples also were collected and analyzed as a measure of quality assurance.

Geohydrologic Setting

The eastern Snake River Plain 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). Individual basalt flows average 20 to 25 ft in thickness with an aggregate thickness of 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).

Movement of water in the aquifer generally is from the northeast to the 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).

The Snake River Plain 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 primarily is by pumpage for irrigation and spring flow to the Snake River (Mann and Knobel, 1990). Discharge from all of the springs in the eastern Snake River Plain has fluctuated over the years as a result of changes in water use, irrigation practices, and precipitation (Kjelstrom, 1992, p. 2).

Acknowledgments

The authors gratefully acknowledge the well owners for granting permission to collect the water samples and extend special thanks to Dale Connell of the Shoshone District of the Bureau of Land Management for his help in locating and pumping two of the wells for sample collection. The authors are grateful for technical review of the manuscript by L. Flint Hall of the Idaho Department of Health and Welfare and Michael R. Greene of the USGS.

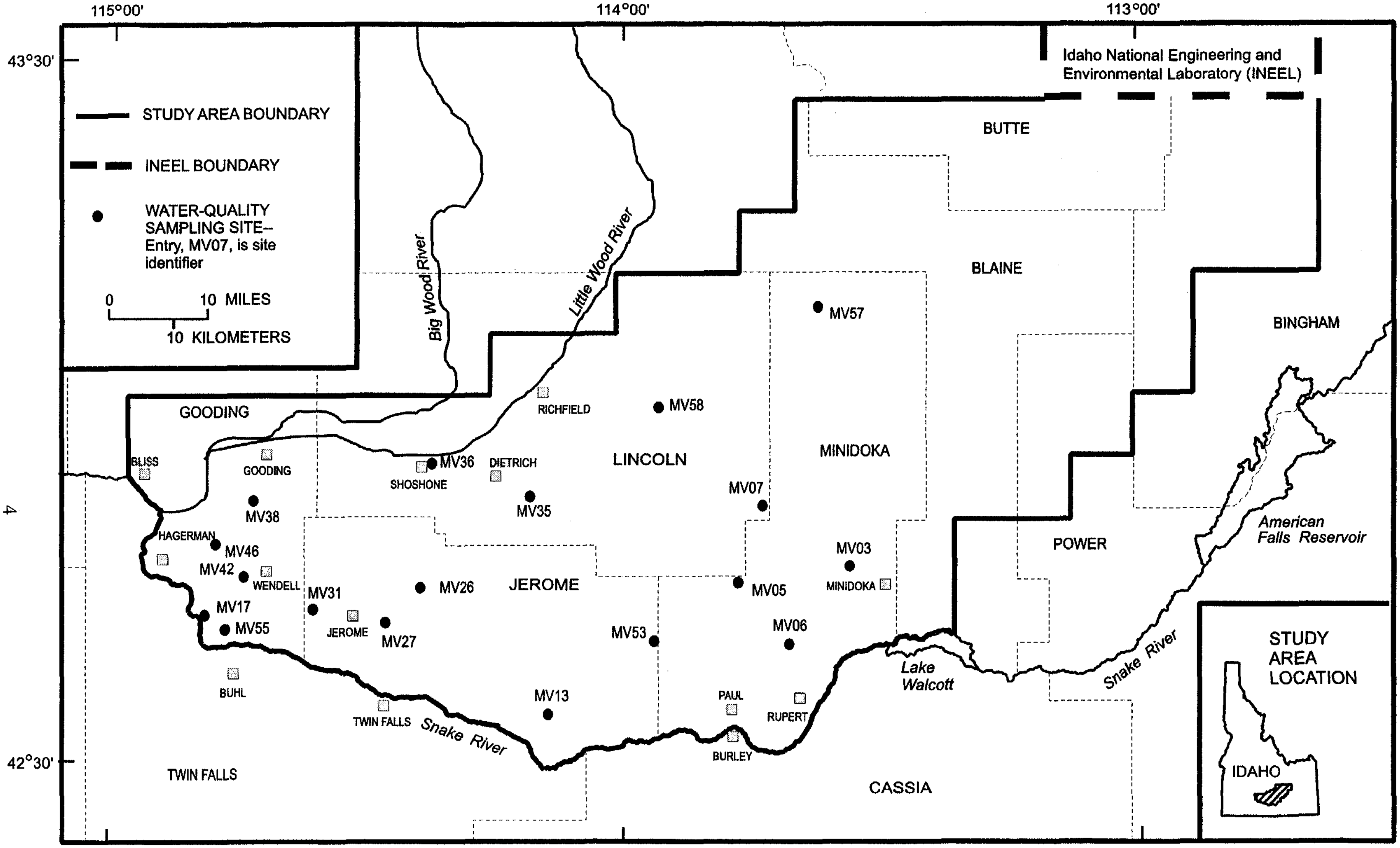

Figure 2. Location of selected water-quality sampling sites on the eastern Snake River Plain

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; and Fishman, 1993). The methods used in the field and quality-assurance practices are described in the following sections.

Site Selection

Water samples were collected at 18 sites (fig. 2), including 2 domestic wells, 12 irrigation wells, 2 stock wells, 1 spring, and 1 public supply well. Two replicate water samples also were collected for quality assurance purposes. The irrigation wells and public-supply well were equipped with turbine pumps. The domestic and stock wells were equipped with submersible pumps. 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) for which analyses are requested. 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 laboratory requirements specified by the director of the Environmental Monitoring Program at ISU. Containers and preservatives were supplied by the respective laboratories. Containers and preservatives used for this study are listed on table 1.

Sample Collection

Four of the irrigation wells discharged into stilling ponds and were sampled from the discharge pipes. The remaining irrigation wells were sampled from spigots in discharge lines or from open ports near pumps; domestic, stock, and public-supply wells were sampled from spigots closest to pumps. 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 spring was sampled near the USGS gaging station by collecting a grab sample from an area of moving water.

Chemical and physical characteristics monitored at the water-sampling 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 when measurements of these characteristics indicated probable hydrologic 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 were stored in coolers until they were hand-delivered to the laboratory.

Field measurements of pH, specific conductance, and water temperature are shown on table 2. Ranges for these measurements were from 7.6 to 8.5 for pH, which is within the U.S. Environmental Protection Agency's (1998) recommended range of 6.5 to 8.5 for community water systems; from 256 to 864 µS/cm for specific conductance; and from 10.5 to 17.5°C for water temperature.

Conditions at the sampling site during sample collection were recorded in a field logbook; 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 Project Office at the INEEL.

Quality Assurance

Detailed descriptions of internal quality control and overall quality-assurance practices used by the NWQL are provided in reports by Friedman and Erdmann (1982), Jones (1987), and Pritt and Raese (1995). Water samples analyzed by the NWQL were collected in accordance with a quality-assurance plan for quality-of-water activities conducted by personnel at the INEEL Project Office. The plan was finalized in June 1989, revised in March 1992 and in 1996 (Mann, 1996),

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

[Abbreviations: L, liter; µm, micrometer; mL, milliliter; °C, degrees Celsius. Chemical formulas: HNO_3, nitric acid; $K_2Cr_2O_7$, potassium dichromate. 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		
Strontium-90	Polyethylene, acid rinsed	1 L	HNO_3	4 mL	0.45-µm filter	NWQL
Tritium	Polyethylene	1 L	None	None	None	NWQL
	Polyethylene	1 L	None	None	None	ISU-EML
Other radionuclides	Polyethylene, acid rinsed	1 L	HNO_3	4 mL	.45-µm filter	NWQL
	Polyethylene	2 L	None	None	None	ISU-EML
Trace elements	Polyethylene, acid rinsed	250 mL	HNO_3	1 mL	.45-µm filter	NWQL
	Polyethylene	125 mL	None	None	None	NWQL
Mercury	Glass, acid rinsed	250 mL	$HNO_3/K_2Cr_2O_7$	10 mL	.45-µm filter	NWQL
Common ions	Polyethylene, acid rinsed	250 mL	HNO_3	1 mL	.45-µm filter	NWQL
Nutrients	Polyethylene, brown	125 mL	None	None	.45-µm filter, chill 4°C	NWQL
Purgeable organic compounds	Glass, baked	40 mL	None	None	Chill 4°C	NWQL
Pesticides	Glass, 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; Sp, spring; P, public supply; H, domestic; QA, quality assurance (MV-44 is a replicate of MV-13; MV-60 is a replicate of MV-42); S, stock. 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, °C]

Site identifier	Site type	Date sampled	Time	pH	Specific conductance	Temperature
MV-03	I	8/11/98	1205	7.9	532	12.5
MV-05	I	8/11/98	1055	7.8	790	12.0
MV-06	I	8/11/98	1310	7.6	622	14.0
MV-07	I	6/23/98	1540	8.1	356	13.5
MV-13	I	8/11/98	1625	7.9	599	15.0
MV-17	Sp	8/12/98	0920	8.1	400	12.0
MV-26	I	6/23/98	1810	8.1	451	13.5
MV-27	I	8/12/98	1345	7.9	655	15.0
MV-31	I	8/10/98	1715	7.9	608	14.0
MV-35	I	8/11/98	0930	8.2	290	14.0
MV-36	P	8/10/98	1525	7.9	348	13.0
MV-38	I	8/10/98	1255	8.0	372	14.0
MV-42	H	8/10/98	0955	7.8	424	15.0
MV-44	QA	8/11/98	1700	7.9	599	15.0
MV-46	I	8/10/98	1115	8.1	312	15.5
MV-53	H	8/11/98	1455	7.8	864	17.5
MV-55	I	6/24/98	0930	7.9	416	14.5
MV-57	S	6/23/98	1025	8.4	256	12.0
MV-58	S	6/23/98	1245	8.5	273	10.5
MV-60	QA	8/10/98	1015	7.8	424	15.0

and is available for inspection at the USGS Project Office at the INEEL. Water samples analyzed by ISU-EML were collected in accordance with procedures described by B. Graham (ISU, written commun., 1991). An evaluation of quality-assurance/quality-control data collected for this study from 1989 through 1995 is reported in Williams and others (1998). About 10 percent of the water samples were quality-assurance samples. Sample MV-44 is a replicate of sample MV-13. Sample MV-60 is a replicate of MV-42.

RADIOCHEMICAL CONSTITUENTS

Water samples were analyzed for strontium-90, tritium, gross alpha- and gross beta-particle radioactivity, and gamma-emitting radionuclides. The samples were analyzed using methods described by Thatcher and others (1977). Maximum contaminant levels for the types of radioactivity and for selected radionuclides are listed on table 3.

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

[The maximum contaminant levels were established pursuant to the recommendations of the U.S. Environmental Protection Agency (1998, p. 338) for community water systems and are included for comparison purposes only. Maximum contaminant levels given for strontium-90 and tritium are average annual concentrations assumed to produce a total body or organ dose of 4 millirem per year (mrem/yr) of beta-particle radiation. The maximum contaminant level given for gross alpha-particle radioactivity includes radium-226 but excludes radon and uranium. The maximum contaminant level given for gross beta-particle and gamma radioactivity excludes radioactivity from natural sources and is included for comparison purposes only. Abbreviation: pCi/L, picocurie per liter]

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

An analytical uncertainty, s, is calculated for each radionuclide concentration or radioactivity measurement. This report presents the analytical uncertainty as 2s. 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.

In the laboratory, instrument signals must exceed a critical level of 1.6s to make the qualitative decision whether the radionuclide or radioactivity was detected. At 1.6s, there is about a 95-percent probability that the correct decision—not detected—will be made. Given a large number of samples, as many as 5 percent of the samples with measured concentrations greater than or equal to 1.6s, which were concluded as being detected, might not contain the radioactive constituent. These measurements are referred to as false positives and are errors of the first kind in hypothesis testing.

Once the critical level of 1.6s has been defined, the minimum detectable concentration can be established. Concentrations that equal 3s represent a measurement at the minimum detectable concentration. For true concentrations of 3s or greater, there is a 95-percent-or-more probability of correctly concluding that the radioactive constituent was detected in a sample. Given a large number of samples, as many as 5 percent of the samples with true concentrations greater than or equal to 3s, which were concluded as being not detected, could contain the radioactive constituent at the minimum detectable concentration. These measurements are referred to as false negatives and are errors of the second kind in hypothesis testing.

True radionuclide concentrations between 1.6s and 3s have larger errors of the second kind. That is, there is a greater-than-5-percent probability of false negative results for samples with true concentrations between 1.6s and 3s, and although the radionuclide or radioactivity might have been detected, such detection may not be considered reliable; at 1.6s, 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 1.6s and 3s 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 3s, 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 of a water sample is less than the background radioactivity or the radioactivity of the prepared blank sample in the laboratory (American Society for Testing and Materials, 1992, p. 126; Knobel and others, 1992, p. 51).

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. The concentration of strontium-90 in sample MV-06 was 0.453±0.30 pCi/L. This concentration was greater than three times the sample standard deviation but was less than the minimum reporting level of 0.5 pCi/L (Timme, 1995). All other concentrations of dissolved strontium-90 were less than the reporting level for the water samples analyzed (table 4).

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 the nuclear power industry. Samples were submitted to the ISU-EML and the NWQL. The ISU-EML used two techniques: a standard liquid-scintillation technique and an enrichment and liquid-scintillation technique. The NWQL used an enrichment and gas-counting technique. The analytical method detection limit for the laboratories differed. The analytical method detection limits for the ISU-EML were 150 and less than 25 pCi/L using ten 20-minute counting periods, and that for the NWQL was 1 pCi/L using a 1,000-minute counting period.

The concentrations of tritium in the water samples are shown on table 4. Concentrations of tritium in 18 of the water samples analyzed by the NWQL were greater than the reporting level and ranged from 1.6±1.0 to 59.2±3.8 pCi/L (table 4). Concentrations of tritium in 13 of the 20 water samples analyzed by the ISU-EML using the enrichment technique were greater than the reporting level and ranged from 17±7 to 89±7 pCi/L. For the purpose of comparison, background concentrations of tritium in ground water in Idaho generally range from 0 to 40 pCi/L (Knobel and others, 1992). The maximum contaminant level for tritium in public drinking-water supplies is 20,000 pCi/L (table 3).

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 are reported as dissolved thorium-230 in picocuries per liter by the NWQL, and as total thorium-230 in picocuries per liter by the ISU-EML.

The concentrations of gross alpha-particle radioactivity reported as dissolved thorium-230 in nine of the water samples analyzed by the NWQL were greater than the reporting level (table 5) and ranged from 4.40±2.62 to 9.22±3.80 pCi/L. Total concentrations of gross alpha-particle radioactivity reported as thorium-230 in 10 water samples analyzed by ISU-EML were greater than the reporting level (table 5) and ranged from 2.0±1.3 to 9.0±2.1 pCi/L.

Table 4. Concentrations of strontium-90 and tritium 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 Idaho State University Environmental Monitoring Laboratory (ISU-EML) using the following methods: strontium-90 by chemical separation and precipitation; tritium by enrichment and gas counting at the NWQL and by liquid scintillation at ISU. Analytical results and uncertainties—for example 1.6±1.0—in picocuries per liter. Analytical uncertainties are reported as 2**s**. Concentrations that exceed the reporting level of 3 times 1**s** are shown in boldface type. Symbol: *, quality-assurance sample (MV-44 is a replicate of MV-13; MV-60 is a replicate of MV-42). ISU tritium values were determined using two different detection methods]

Site identifier	Strontium-90, NWQL	Tritium, NWQL	Tritium, ISU-EML	Tritium, ISU-EML (Enriched)
MV-03	0.142±0.24	**1.6±1.0**	0±95	6±8
MV-05	.0461±0.21	**15.7±1.3**	-80±100	13±10
MV-06	**.453±0.30**	**56.0±3.8**	60±100	**53±8**
MV-07	.116±0.23	.3±1.0	-20±100	**52±8**
MV-13	.0894±0.21	**59.2±3.8**	**150±100**	8±8
MV-17	.123±0.23	**8.6±1.0**	-45±90	**40±7**
MV-26	.163±0.25	**4.5±1.0**	100±100	**68±9**
MV-27	-.0119±0.2	**40.0±2.6**	80±100	**17±7**
MV-31	.0642±0.21	**29.4±1.9**	-30±100	**19±10**
MV-35	.218±0.24	**5.1±1.0**	-70±100	2±9
MV-36	.0556±0.20	**52.8±3.2**	-40±100	**29±10**
MV-38	.103±0.22	**37.4±2.6**	0±100	**30±10**
MV-42	.103±0.22	**15.4±1.3**	-110±100	11±10
MV-44*	.04±0.18	**40.6±2.6**	90±100	**41±8**
MV-46	-.0355±0.18	**9.6±1.0**	-30±100	-2±9
MV-53	.0329±0.22	**57.0±3.8**	60±100	**47±8**
MV-55	.0987±0.26	**8.0±1.0**	80±100	**18±8**
MV-57	.135±0.22	.3±1.0	100±100	**75±8**
MV-58	.148±0.24	**37.8±2.6**	50±100	**89±7**
MV-60*	.107±0.22	**17.0±1.3**	-30±100	-2±9

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; however, laboratories normally report the radioactivity as if it were all given off by one radionuclide. In this report, concentrations are reported as dissolved cesium-137 in picocuries per liter by the NWQL, and as total cesium-137 in picocuries per liter by the ISU-EML. The average annual concentrations of strontium-90 and cesium-137 in public drinking-water supplies that produce a 4-mrem/yr dose are 8 pCi/L and 120 pCi/L, respectively. Gross beta-particle radioactivity measurements should not be compared directly with these concentrations.

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 3.1±2.1—in picocuries per liter. Analytical uncertainties are reported as 2**s**. Concentrations that equal or exceed the reporting level of 3 times 1**s** are shown in boldface type. Symbol: *, quality-assurance sample (MV-44 is a replicate of MV-13; MV-60 is a replicate of MV-42)]

Site identifier	Gross alpha, as dissolved thorium-230, NWQL	Gross alpha, as total thorium-230, ISU-EML	Gross beta, as dissolved cesium-137, NWQL	Gross beta, as total cesium-137, ISU-EML
MV-03	**4.48±2.89**	3.1±2.1	**5.84±1.36**	**5.0±1.0**
MV-05	**5.26±3.39**	3.0±2.3	**6.99±1.89**	**4.7±1.0**
MV-06	**6.23±3.36**	2.5±2.0	**6.12±1.61**	**3.9±0.9**
MV-07	2.17±2.48	**5.7±2.0**	**4.19±1.26**	**1.4±0.8**
MV-13	4.55±3.07	**5.9±2.3**	**8.24±1.72**	**4.9±1.0**
MV-17	**5.10±2.84**	.1±1.3	**4.86±1.11**	**3.0±0.9**
MV-26	.96±2.35	**7.1±2.6**	**4.44±1.47**	**2.1±0.9**
MV-27	**4.83±3.12**	1.7±2.2	**6.06±1.54**	**4.7±1.1**
MV-31	**9.22±3.80**	2.9±2.7	**9.53±1.64**	**5.2±2.1**
MV-35	3.64±2.45	1.7±1.5	**3.84±1.00**	**2.0±0.8**
MV-36	2.64±2.34	**2.0±1.3**	**4.20±1.05**	**2.5±0.8**
MV-38	**4.58±2.73**	1.1±1.3	**3.93±1.06**	**3.5±0.9**
MV-42	2.76±2.46	**3.1±1.7**	**6.03±1.18**	**3.6±0.8**
MV-44*	3.94±2.93	**8.0±2.4**	**8.55±1.64**	**4.7±1.0**
MV-46	**4.40±2.62**	.8±1.0	**4.08±1.03**	.7±0.7
MV-53	**8.95±4.20**	2.1±2.0	**10.7±2.23**	**6.0±1.0**
MV-55	3.33±2.79	**8.7±2.0**	**6.04±1.37**	**2.4±0.9**
MV-57	-.12±1.78	**7.4±2.0**	**3.25±1.03**	**2.2±0.8**
MV-58	-.12±1.83	**9.0±2.1**	**3.48±1.05**	**2.6±0.9**
MV-60*	1.04±2.09	**6.9±2.1**	**6.14±1.18**	**2.4±0.8**

Concentrations of gross beta-particle radioactivity reported as dissolved cesium-137 in all of the water samples analyzed by the NWQL were greater than the reporting level (table 5) and ranged from 3.25±1.03 to 10.7±2.23 pCi/L. Concentrations of gross beta-particle radioactivity reported as total cesium-137 in 19 of the water samples analyzed by ISU-EML were greater than the reporting level (table 5) and ranged from 1.4±0.8 to 6.0±1.0 pCi/L.

Cesium-137 and Potassium-40

Gamma spectrometry involves using a series of detectors to simultaneously determine the concentrations of a variety of radionuclides by the identification of their characteristic gamma emissions. When no specific gamma-emitting radionuclides are identified, the concentrations are reported by ISU-EML as total cesium-137 and potassium-40. 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 about 0.0119 percent of all potassium is the naturally occurring radioactive isotope potassium-40 (Kretz, 1972). Concentrations of cesium-137 and potassium-40 in all water samples were less than the reporting level (table 6).

CHEMICAL CONSTITUENTS

Water samples were analyzed for selected chemical constituents. These constituents included trace elements, common ions, nutrients, purgeable organic compounds, insecticides, polychlorinated compounds, and herbicides. In this report, minimum reporting levels and method detection limits established for these constituents are not to be confused with reporting levels and analytical method detection limits for selected radionuclides. The minimum reporting level for inorganic and organic constituents is the smallest measured concentration of a constituent that may be reliably reported using a given analytical method (Timme, 1995, p. 92). The method detection limit is defined as the minimum concentration of a substance that can be identified, measured, and reported with 99-percent confidence that the analyte concentration is greater than zero and is determined from analysis of a sample in a given matrix containing the analyte (Timme, 1995, p. 92).

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 -0.2±2.4—are for total concentrations in picocuries per liter. Analytical uncertainties are reported as 2s. Symbol: *, quality-assurance sample (MV-44 is a replicate of MV-13; MV-60 is a replicate of MV-42)]

Site identifier	Cesium-137	Potassium-40
MV-03	-0.2±2.4	-23.3±67.1
MV-05	.5±2.4	-.5±56.7
MV-06	.1±2.4	1.6±70.2
MV-07	-.4±2.4	46±74
MV-13	-.5±2.4	12.1±73.8
MV-17	.1±2.5	-29.5±51.7
MV-26	-1.5±2.0	4±69
MV-27	.1±2.2	12.7±54.1
MV-31	.2±3.7	17.1±69.6
MV-35	-.6±2.2	26.4±56.4
MV-36	1.0±2.3	33.9±73.4
MV-38	-.7±1.7	-8.6±56.6
MV-42	1.3±2.4	23.2±54.9
MV-44*	-2.0±2.9	-4.6±55.8
MV-46	.8±2.0	-18.7±73.3
MV-53	.2±2.4	10.6±71.6
MV-55	.7±2.4	-8±57
MV-57	.4±2.3	47±63
MV-58	-.9±2.8	-33±75
MV-60*	.8±2.4	.7±70.4

Trace Elements

Water samples were analyzed for selected dissolved trace elements including arsenic, barium, beryllium, cadmium, chromium, cobalt, copper, iron, lead, lithium, manganese, mercury, molybdenum, nickel, selenium, silver, strontium, vanadium, and zinc. The maximum or secondary maximum contaminant levels and minimum reporting levels of selected trace elements are shown on table 7. The concentrations of dissolved trace elements are shown on table 8.

Arsenic.—Concentrations of arsenic in all samples were greater than the minimum reporting level and ranged from 2 to 6 µg/L. The maximum contaminant level is 50 µg/L.

Barium.—Concentrations of barium in all samples were greater than the minimum reporting level and ranged from 5 to 100 µg/L. The maximum contaminant level is 2,000 µg/L.

Beryllium.—Concentrations of beryllium in all samples were less than the minimum reporting level of 1 µg/L. The maximum contaminant level is 4 µg/L.

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

[The maximum contaminant levels are for total measurements and were established pursuant to the recommendations of the U.S. Environmental Protection Agency (1994; 1998, p. 337, 402) for community water systems and are for comparison purposes only. Secondary maximum contaminant levels—in brackets—are from U.S. Environmental Protection Agency (1998, p. 515). Minimum reporting levels are from Timme (1995). Units are in micrograms per liter (µg/L). Symbols: ••, maximum contaminant level has not been established; *, lead has an action level of 15 µg/L. Trace elements with two minimum reporting levels had samples analyzed by two methods]

Trace element	Maximum or secondary maximum contaminant level	Minimum reporting level
Arsenic	50	1
Barium	2,000	1
Beryllium	4	1
Cadmium	5	8, 1
Chromium	100	14, 1
Cobalt	••	12
Copper	[1,000]	10, 3
Iron	[300]	10
Lead	*	100, 1
Lithium	••	4
Manganese	[50]	4
Mercury	2	.1
Molybdenum	••	60
Nickel	100	40
Selenium	50	1
Silver	[100]	4
Strontium	••	.5
Vanadium	••	10
Zinc	[5,000]	20

Table 8. Concentrations of dissolved trace elements 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 micrograms per liter. Symbols: <, concentration is less than the respective minimum reporting level; *, quality-assurance sample (MV-44 is a replicate of MV-13; MV-60 is a replicate of MV-42)]

Site identifier	Arsenic	Barium	Beryllium	Cadmium	Chromium	Cobalt	Copper	Iron	Lead	Lithium
MV-03	2	28	<1	<8	<14	<12	<10	<10	<100	35
MV-05	3	64	<1	<8	<14	<12	<10	<10	<100	47
MV-06	3	84	<1	<8	<14	<12	<10	<10	<100	38
MV-07	3	21	<1	<8	<14	<12	<10	<10	<100	27
MV-13	5	79	<1	<8	<14	<12	<10	<10	<100	25
MV-17	2	22	<1	<8	<14	<12	<10	<10	<100	24
MV-26	2	26	<1	<8	<14	<12	<10	<10	<100	30
MV-27	3	53	<1	<8	<14	<12	<10	<10	<100	38
MV-31	2	51	<1	<8	<14	<12	<10	<10	<100	39
MV-35	2	13	<1	<8	<14	<12	<10	<10	<100	11
MV-36	2	33	<1	<8	<14	<12	<10	<10	<100	6
MV-38	2	29	<1	<8	<14	<12	<10	<10	<100	7
MV-42	3	23	<1	<8	<14	<12	<10	<10	<100	17
MV-44*	6	76	<1	<8	<14	<12	<10	<10	<100	22
MV-46	4	16	<1	<8	<14	<12	<10	<10	<100	12
MV-53	2	101	<1	<8	<14	<12	<10	<10	<100	54
MV-55	2	23	<1	<8	<14	<12	<10	<10	<100	26
MV-57	3	5	<1	<8	<14	<12	<10	<10	<100	<4
MV-58	3	18	<1	<1	2.7	<12	<3	<10	<1	<4
MV-60*	3	23	<1	<8	<14	<12	<10	<10	<100	17

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

Site identifier	Manganese	Mercury	Molybdenum	Nickel	Selenium	Silver	Strontium	Vanadium	Zinc
MV-03	<4	<0.1	<60	<40	<1	<4	237	<10	<20
MV-05	<4	<.1	<60	<40	1	<4	388	<10	<20
MV-06	<4	<.1	<60	<40	<1	<4	394	<10	<20
MV-07	<4	<.1	<60	<40	<1	<4	192	13	<20
MV-13	<4	<.1	<60	<40	<1	<4	259	13	<20
MV-17	<4	<.1	<60	<40	<1	<4	190	<10	<20
MV-26	<4	<.1	<60	<40	<1	<4	213	10	<20
MV-27	<4	<.1	<60	<40	<1	<4	317	<10	<20
MV-31	<4	<.1	<60	<40	<1	<4	314	<10	<20
MV-35	<4	<.1	<60	<40	<1	<4	148	<10	<20
MV-36	<4	<.1	<60	<40	<1	<4	159	<10	<20
MV-38	<4	<.1	<60	<40	<1	<4	163	<10	<20
MV-42	<4	<.1	<60	<40	<1	<4	197	<10	23
MV-44*	<4	<.1	<60	<40	<1	<4	245	12	<20
MV-46	<4	<.1	<60	<40	<1	<4	148	<10	<20
MV-53	<4	<.1	<60	<40	1	<4	443	<10	61
MV-55	<4	<.1	<60	<40	<1	<4	203	12	<20
MV-57	<4	<.1	<60	<40	<1	<4	135	<10	21
MV-58	<4	<.1	<60	<40	<1	<4	103	14	43
MV-60*	<4	<.1	<60	<40	<1	<4	198	<10	<20

Cadmium.—Concentrations of cadmium in all samples were less than the minimum reporting level of 8 µg/L. The concentration in one sample was less than 1 µg/L. The maximum contaminant level is 5 µg/L.

Chromium.—Concentrations of chromium in all but one sample were less than the minimum reporting level of 14 µg/L. One sample with a minimum reporting level of 1 had a concentration of 2.7 µg/L. The maximum contaminant level is 100 µg/L.

Cobalt.—Concentrations of cobalt in all samples were less than the minimum reporting level of 12 µg/L.

Copper.—Concentrations of copper in all samples were less than the minimum reporting level of 10 µg/L. The concentration in one sample was less than 3 µg/L. The secondary maximum contaminant level is 1,000 µg/L.

Iron.—Concentrations of iron in all samples were less than the minimum reporting level of 10 µg/L. The secondary maximum contaminant level is 300 µg/L.

Lead.—Concentrations of lead in all samples were less than the minimum reporting level of 100 µg/L. The concentration in one sample was less than 1 µg/L. Lead has an action level of 15 µg/L.

Lithium.—Concentrations of lithium in 18 samples were greater than the minimum reporting level and ranged from 6 to 54 µg/L.

Manganese.—Concentrations of manganese in all samples were less than the minimum reporting level of 4 µg/L. The secondary maximum contaminant level is 50 µg/L.

Mercury.—Concentrations of mercury in all samples were less than the minimum reporting level of 0.1 µg/L. The maximum contaminant level is 2 µg/L.

Molybdenum.—Concentrations of molybdenum in all samples were less than the minimum reporting level of 60 µg/L.

Nickel.—Concentrations of nickel in all samples were less than the minimum reporting level of 40 µg/L. The maximum contaminant level is 100 µg/L.

Selenium.—Concentrations of selenium in one sample (MV-05) was equal to the minimum reporting level of 1 µg/L; concentrations in the other samples were less than the minimum reporting level. The maximum contaminant level is 50 µg/L.

Silver.—Concentrations of silver in all samples were less than the minimum reporting level of 4 µg/L. The secondary maximum contaminant level is 100 µg/L.

Strontium.—Concentrations of strontium in all samples were greater than the minimum reporting level and ranged from 103 to 444 µg/L.

Vanadium.—Concentrations of vanadium in 6 samples were equal to or greater than the minimum reporting level and ranged from 10 to 14 µg/L.

Zinc.—Concentrations of zinc in 4 samples were greater than the minimum reporting level and ranged from 22 to 61 µg/L. The secondary maximum contaminant level is 5,000 µg/L.

Common Ions

Water samples were analyzed for dissolved common ions including calcium, magnesium, silica, and sodium. The minimum reporting levels of these ions are shown on table 9. Maximum contaminant levels have not been established for any of these common ions. The concentrations of dissolved common ions are shown on table 10.

Calcium.—Concentrations of calcium in all samples were greater than the minimum reporting level and ranged from 22 to 70 mg/L.

Magnesium.—Concentrations of magnesium in all samples were greater than the minimum reporting level and ranged from 10 to 30 mg/L.

Silica.—Concentrations of silica in all samples were greater than the minimum reporting level and ranged from 28 to 42 mg/L.

Sodium.—Concentrations of sodium in all samples were greater than the minimum reporting level and ranged from 11 to 60 mg/L. The Idaho Department of Health and Welfare (1989) recommends an optimum concentration of 20 mg/L of sodium for public drinking-water supplies.

Nutrients

Water samples were analyzed for dissolved ammonia (as nitrogen), nitrite (as nitrogen), nitrite plus nitrate (as nitrogen), and orthophosphate (as phosphorus). The maximum contaminant levels and the minimum reporting levels are shown on table 9. A maximum contaminant level has not been established or proposed for ammonia or orthophosphate. Concentrations of nutrients are shown on table 10.

Ammonia (as nitrogen).—Concentrations of ammonia (as nitrogen) in all samples were greater than the minimum reporting level and ranged from 0.036 to 0.114 mg/L.

Nitrite (as nitrogen).—Concentrations of nitrite (as nitrogen) in all samples were less than the minimum reporting level of 0.01 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 minimum reporting level and ranged from 0.38 to 5.3 mg/L. The maximum contaminant level is 10 mg/L.

Orthophosphate (as phosphorus).—Concentrations of orthophosphate (as phosphorus) in 19 of the samples were equal to or greater than the minimum reporting level and ranged from 0.01 to 0.62 mg/L.

Purgeable Organic Compounds

Water samples were analyzed for 61 purgeable organic compounds. The maximum contaminant levels and minimum reporting levels of these compounds are shown on table 11. Maximum contaminant levels for two of the compounds (1,2-Dibromo-3-chloropropane and 1,2-Dibromoethane) were less than the respective minimum reporting levels. Concentrations of purgeable organic compounds in all samples were less than the respective minimum reporting levels.

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

[The maximum contaminant levels are for total measurements and were established pursuant to the recommendations of the U.S. Environmental Protection Agency (1998, p. 402) for community water systems and are for comparison purposes only. Minimum reporting levels are from Timme (1995). Units are in milligrams per liter (mg/L). Symbol: ••, maximum contaminant level has not been established]

Constituent	Maximum contaminant level	Minimum reporting level
Calcium	••	0.02
Magnesium	••	.01
Silica	••	.01
Sodium[1]	••	.2
Ammonia (as nitrogen)	••	.015
Nitrite (as nitrogen)	1	.01
Nitrite plus nitrate (as nitrogen)	10	.05
Orthophosphate (as phosphorus)	••	.01

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

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 respective minimum reporting level; *, quality-assurance sample (MV-44 is a replicate of MV-13; MV-60 is a replicate of MV-42)]

Site identifier	Calcium	Magnesium	Silica	Sodium	Ammonia (as nitrogen)	Nitrite (as nitrogen)	Nitrite plus nitrate (as nitrogen)	Orthophosphate (as phosphorus)
MV-03	45	19	32	30	0.052	<0.01	1.9	0.01
MV-05	63	29	33	54	.040	<.01	2.9	.03
MV-06	70	21	31	25	.056	<.01	5.3	.02
MV-07	32	13	30	16	.097	<.01	.45	.01
MV-13	49	21	42	43	.051	<.01	1.8	.02
MV-17	36	16	32	20	.054	<.01	.99	.02
MV-26	40	16	30	22	.097	<.01	.89	.02
MV-27	59	22	32	33	.036	<.01	1.9	.03
MV-31	56	23	33	31	.048	<.01	1.7	.01
MV-35	25	13	31	13	.037	<.01	.58	.02
MV-36	40	13	30	13	.062	<.01	1.3	.03
MV-38	40	13	30	15	.051	<.01	1.4	.03
MV-42	37	18	33	20	.046	<.01	1.6	.02
MV-44*	48	20	41	41	.042	<.01	1.8	.03
MV-46	28	13	31	14	.045	<.01	.62	.01
MV-53	70	30	34	59	.055	<.01	4.4	.02
MV-55	36	17	32	20	.111	<.01	1.1	.62
MV-57	23	11	28	11	.114	<.01	.38	<.01
MV-58	24	11	27	14	.106	<.01	1.4	.01
MV-60*	37	18	34	20	.052	<.01	1.5	.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 using an analytical method equivalent to U.S. Environmental Protection Agency method 524.2. Maximum contaminant levels were established pursuant to the recommendations of the U.S. Environmental Protection Agency (1994; 1998, p. 400) for community water systems and are included for comparison purposes only. Minimum reporting levels are from Timme (1995). Units are in micrograms per liter (µg/L). Symbols: ••, maximum contaminant level has not been established or proposed; *, total trihalomethanes—which include bromoform, chlorodibromomethane, chloroform, and dichlorobromomethane—in community water systems serving 10,000 or more persons cannot exceed 100 µg/L (U.S. Environmental Protection Agency, 1998, p. 337). Abbreviations: MCL, maximum contaminant level; MRL, minimum reporting level]

Compound	MCL	MRL	Compound	MCL	MRL
Acrylonitrile	••	2.5	1,3-Dichloropropane	••	0.2
Benzene	5	.2	2,2-Dichloropropane	••	.2
Bromobenzene	••	.2	cis-1,3-Dichloropropene	••	.2
Bromochloromethane	••	.2	trans-1,3-Dichloropropene	••	.2
Bromoform	*	.2	1,1-Dichloropropene	••	.2
Bromomethane	••	.2	Ethylbenzene	700	.2
n-Butylbenzene	••	.2	Hexachlorobutadiene	••	.2
sec-Butylbenzene	••	.2	Isopropylbenzene	••	.2
tert-Butylbenzene	••	.2	p-Isopropyltoluene	••	.2
Carbon tetrachloride	5	.2	Methylene chloride	5	.2
Chlorobenzene	100	.2	Methyl tert-butylether	••	.2
Chlorodibromomethane	*	.2	Naphthalene	••	.2
Chloroethane	••	.2	n-Propylbenzene	••	.2
Chloroform	*	.2	Styrene	100	.2
Chloromethane	••	.2	1,1,1,2-Tetrachloroethane	••	.2
2-Chlorotoluene	••	.2	1,1,2,2-Tetrachloroethane	••	.2
4-Chlorotoluene	••	.2	Tetrachloroethylene	5	.2
1,2-Dibromo-3-chloropropane	.2	1	Toluene	1,000	.2
1,2-Dibromoethane	.05	.2	1,2,3-Trichlorobenzene	••	.2
Dibromomethane	••	.2	1,2,4-Trichlorobenzene	70	.2
1,2-Dichlorobenzene	600	.2	1,1,1-Trichloroethane	200	.2
1,3-Dichlorobenzene	600	.2	1,1,2-Trichloroethane	5	.2
1,4-Dichlorobenzene	75	.2	Trichloroethene	5	.2
Dichlorobromomethane	*	.2	Trichlorofluoromethane	••	.2
Dichlorodifluoromethane	••	.2	1,2,3-Trichloropropane	••	.2
1,1-Dichloroethane	••	.2	1,1,2-Trichloro 1,2,2-trifluoroethane	••	.2
1,2-Dichloroethane	5	.2	1,2,4-Trimethylbenzene	••	.2
cis-1,2-Dichloroethene	70	.2	1,3,5-Trimethylbenzene	••	.2
1,1-Dichloroethene	7	.2	Vinyl chloride	2	.2
trans-1,2-dichloroethene	100	.2	Xylenes, total ortho, meta, and para	10,000	.2
1,2-Dichloropropane	5	.2			

Insecticides and Gross Polychlorinated Compounds

Water samples were analyzed for concentrations of 10 carbamate insecticides, 11 organophosphate insecticides, 15 organochlorine insecticides, gross PCBs, and gross PCNs (table 12). The minimum reporting levels ranged from 0.008 to 1.0 µg/L. Water samples also were analyzed for an additional group of 23 insecticides that included 11 of the carbamate, organophosphate, and organochlorine insecticides mentioned above; therefore, 11 insecticides are listed twice and minimum reporting levels may be different. The maximum contaminant levels and minimum reporting levels for these compounds are shown on table 12. Concentrations of some of the compounds in samples from MV-13 and MV-36 were not determined because bottles broke in shipment or at the lab. One sample (MV-53) contained a concentration of chlorpyrifos of 0.007 µg/L and a concentration of lindane of 0.005 µg/L. Concentrations of insecticides or polychlorinated compounds in all other samples were less than the respective minimum reporting levels or method detection limits.

Herbicides

Water samples were analyzed for concentrations of 5 chlorophenoxy-acid herbicides and 47 other herbicides. Maximum contaminant levels and minimum reporting levels for these compounds are shown on table 13. Concentrations of some of the compounds in samples from MV-36 and MV-44 were not determined because bottles broke in shipment or at the lab. Because new laboratory schedules with lower method detection limits and minimum reporting levels than past schedules were used, concentrations of some herbicides in several samples exceeded the method detection limits or minimum reporting levels (table 14). Concentrations in some of the samples listed in table 14 exceeded the method detection limits but were less than the minimum reporting levels. The estimated concentrations in table 14 need to be evaluated carefully because of variable performance (Zaugg and others, 1995). One sample (MV-5) contained a concentration of total 2,4-D of 0.01 µg/L. Estimated and actual concentrations of atrazine in eight samples ranged from 0.003 to 0.021 µg/L. Estimated concentrations of desethyl atrazine in 13 samples ranged from 0.002 to 0.016 µg/L. The analyses for desethyl atrazine demonstrated low recovery because of poor retention on the solid-phase extraction column (Zaugg and others, 1995). The actual concentration of metribuzin in one sample (MV-5) was 0.006 µg/L. The estimated concentration of prometon in one sample (MV-6) was 0.005 µg/L. Estimated and actual concentrations of simazine in three samples ranged from 0.003 to 0.034 µg/L. Concentrations of herbicides not listed in table 14 were less than the minimum reporting levels and method detection limits in all the samples.

SUMMARY

The USGS and the IDWR, in cooperation with the DOE, sampled 18 sites as part of the fourth round of a long-term project to monitor water quality of the Snake River Plain aquifer from the southern boundary of the Idaho National Engineering and Environmental Laboratory to the Hagerman area. Water samples were collected and analyzed for selected radiochemical and chemical constituents. The samples were collected from 2 domestic wells, 12 irrigation wells, 2 stock wells, 1 spring, and 1 public-supply well. Two quality-assurance samples also were collected and analyzed.

The concentration of strontium-90 in one sample was greater than three times the sample standard deviation. Concentrations of tritium in 18 of the samples analyzed by the NWQL and 13 of the samples analyzed by ISU using an enrichment technique were greater than the reporting level, but none exceeded the maximum contaminant level for drinking water. The concentrations of gross alpha-particle radioactivity reported as dissolved thorium-230 in nine samples analyzed by the NWQL were greater than the reporting level but did not exceed the maximum contaminant level. Concentrations of gross beta-particle radioactivity reported as dissolved cesium-137 in all samples analyzed by the NWQL were greater than the reporting level. Concentrations of gross beta-particle radioactivity reported as total cesium-137 in 19 of the samples analyzed by ISU-EML were greater

Table 12. Maximum contaminant levels and minimum reporting levels of selected insecticides and gross polychlorinated compounds in drinking water

[Analyses were performed by the U.S. Geological Survey National Water Quality Laboratory. The maximum contaminant levels were established pursuant to the recommendations of the U.S. Environmental Protection Agency (1998, p. 401) for community water systems and are included for comparison purposes only. Minimum reporting levels are from Timme (1995). Method detection limits are from Zaugg and others (1995). Units are in micrograms per liter. Symbols: ••, maximum contaminant level has not been established or proposed; *, samples analyzed using two different laboratory schedules and different minimum reporting levels. **, chlorthalonil is a fungicide, DNOC is listed as an insecticide and herbicide. Abbreviations: MCL, maximum contaminant level; MRL, minimum reporting level; MDL, method detection limit]

Carbamate insecticides

Insecticide	MCL	MRL	Insecticide	MCL	MRL
Aldicarb	3	0.55	Methiocarb	••	0.026
Aldicarb sulfone	2	.10	Methomyl	••	.017
Aldicarb sulfoxide	4	.021	Oxamyl	200	.018
*Carbaryl (Sevin)	••	.008	Propham	••	.035
*Carbofuran	40	.028	Propoxur	••	.035

Organophosphate insecticides

Insecticide	MCL	MRL	Insecticide	MCL	MRL
*Chlorpyrifos; Dursban	••	0.01	*Malathion	••	0.01
DEF	••	.01	Methylparathion	••	.01
*Diazinon	••	.01	Parathion	••	.01
*Di-Syston (Disulfoton)	••	.01	*Phorate	••	.01
Ethion	••	.01	Trithion	••	.01
*Fonofos	••	.01			

Organochlorine insecticides

Insecticide	MCL	MRL	Insecticide	MCL	MRL
Aldrin	••	0.01	Heptachlor	0.4	0.01
Chlordane, technical	2	.1	Heptachlor epoxide	.2	.01
DDD, p,p'-	••	.01	*Lindane	.2	.01
*DDE, p,p'-	••	.01	Methoxychlor, p,p'-	40	.01
DDT, p,p'-	••	.01	Mirex	••	.01
*Dieldrin	••	.01	Perthane	••	.1
Endosulfan I	••	.01	Toxaphene	3	1.0
Endrin	2	.01			

Gross polychlorinated compounds

Compound	MCL	MRL
Gross polychlorinated biphenyls (PCBs)	0.5	0.1
Gross polychlorinated naphthalenes (PCNs)	••	.1

Table 12. Maximum contaminant levels and minimum reporting levels of selected insecticides and gross polychlorinated compounds in drinking water—Continued

Additional insecticides

Insecticide	MCL	MRL	MDL	Insecticide	MCL	MRL	MDL
Azinphos methyl-	••	0.038	0.001	*Fonofos	••	0 .008	0 .003
*Carbaryl (Sevin)	••	.046	.003	HCH, alpha-	••	.007	.002
*Carbofuran	40	.12	.003	*HCH, gamma- (Lindane)	.2	.011	.004
*Chlorpyrifos	••	.005	.004	Hydroxycarbofuran, 3-	••	.014	.014
**Chlorthalonil	••	.48	.035	*Malathion	••	.010	.005
*DDE, p,p'-	••	.010	.006	Parathion, ethyl-	••	.022	.004
*Diazinon	••	.008	.002	Parathion, methyl-	••	.035	.006
*Dieldrin	••	.008	.001	Permethrine, cis-	••	.019	.005
Dinoseb	••	.035	.035	*Phorate	••	.011	.002
*Disulfoton	••	.028	.017	Propargite I & II	••	.006	.013
**DNOC	••	.42	.035	Terbufos	••	.012	.013
Ethoprop	••	.012	.003				

Table 13. Maximum contaminant levels and minimum reporting levels of chlorophenoxy-acid herbicides and other herbicides in drinking water

[Analyses were performed by the U.S. Geological Survey National Water Quality Laboratory. The maximum contaminant levels were established pursuant to the recommendations of the U.S. Environmental Protection Agency (1998, p. 401) for community water systems and are included for comparison purposes only. Minimum reporting levels are from Timme (1995). Method detection limits are from Zaugg and others (1995). Units are in micrograms per liter. Symbols: ••, maximum contaminant level has not been established or proposed. *, samples analyzed using two different laboratory schedules with different minimum reporting levels. Abbreviations: MCL, maximum contaminant level; MRL, minimum reporting level; MDL, method detection limit]

Chlorophenoxy-acid herbicides

Herbicide	MCL	MRL	Herbicide	MCL	MRL
*2,4-D	70	0.01	*Silvex	50	0.01
(dissolved)	70	.15	(dissolved)	••	.021
2,4-DB	••	.24	*2,4,5-T	••	.01
2,4-DP	••	.01	(dissolved)	••	.035

Other herbicides

Herbicide	MCL	MRL	MDL	Herbicide	MCL	MRL	MDL
Acetochlor	••	0.009	0.002	*Linuron	••	0.039	0.002
Acifluorfen	••	.035	.035	(dissolved)	••	.018	.018
Alachlor	2	.009	.002	MCPA	••	.17	.050
Atrazine	3	.017	.001	MCPB	••	.14	.035
Atrazine, desethyl-	••	.007	.002	Metolachlor	••	.009	.002
Benfluralin	••	.013	.002	Metribuzin	••	.012	.004
Bentazon	••	.014	.014	Molinate	••	.007	.004
Bromacil	••	.035	.035	Napropamide	••	.010	.003
Bromoxynil	••	.035	.035	Neburon	••	.015	.015
Butylate	••	.008	.002	Norflurazon	••	.024	.024
Chloramben	••	.42	.011	Oryzalin	••	.31	.019
Clopyralid	••	.23	.050	Pebulate	••	.009	.004
Cyanazine	••	.013	.004	Pendimethalin	••	.018	.004
*DCPA (Dacthal)	••	.004	.002	Picloram	500	.050	.050
(dissolved)	••	.017	.017	Prometon	••	.008	.018
Dicamba	••	.035	.035	Pronamide	••	.009	.003
Dichlobenil	••	1.2	.020	Propachlor	••	.015	.007
Dichlorprop	••	.032	.032	Propanil	••	.016	.004
Diethylaniline	••	.006	.003	Simazine	4	.008	.005
Diuron	••	.020	.020	Tebuthiuron	••	.015	.010
EPTC (Eptam)	••	.005	.002	Terbacil	••	.030	.007
Ethalfluralin	••	.013	.004	Thiobencarb	••	.008	.002
Fenuron	••	.013	.013	Triallate	••	.008	.001
Fluometuron	••	.035	.035	Triclopyr	••	.25	.050
				Trifluralin	••	.012	.002

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. Symbols: <, concentration is less than the respective minimum reporting level; *, quality-assurance sample (MV-44 is a replicate of MV-13; MV-60 is a replicate of MV-42); E, concentration was estimated and needs to be evaluated carefully because of variable performance. Concentrations of herbicides not listed were less than the minimum reporting levels and method detection limits in all samples]

Site identifier	2,4-D (total)	Atrazine	Desethyl atrazine	Metribuzin	Prometon	Simazine
MV-03	<0.01	<0.001	<0.002	<0.004	<0.018	<0.005
MV-05	.01	.005	.004E	.006	<.018	.003E
MV-06	<.01	.021	.016E	<.004	.005E	.034
MV-07	<.01	<.001	<.002	<.004	<.018	<.005
MV-13	<.01	.004E	.005E	<.004	<.018	<.005
MV-17	<.01	.004E	.004E	<.004	<.018	<.005
MV-26	<.01	<.001	.003E	<.004	<.018	<.005
MV-27	<.01	.003E	.005E	<.004	<.018	<.005
MV-31	<.01	<.001	.005E	<.004	<.018	<.005
MV-35	<.01	<.001	<.002	<.004	<.018	<.005
MV-36	<.01	<.001	.004E	<.004	<.018	<.005
MV-38	<.01	<.001	.005E	<.004	<.018	<.005
MV-42	<.01	.008	.008E	<.004	<.018	<.005
MV-44*	<.01	.004E	.004E	<.004	<.018	<.005
MV-46	<.01	<.001	<.002	<.004	<.018	<.005
MV-53	<.01	.010	.013E	<.004	<.018	.005E
MV-55	<.01	<.001	.004E	<.004	<.018	<.005
MV-57	<.01	<.001	<.002	<.004	<.018	<.005
MV-58	<.01	<.001	<.002	<.004	<.018	<.005
MV-60*	<.01	<.008	.008E	<.004	<.018	<.005

than the reporting level. Concentrations of total cesium-137 and potassium-40 were analyzed using gamma spectrometry and concentrations in all the samples were less than the reporting level.

All the samples contained one or more dissolved trace elements and common ions in concentrations greater than the minimum reporting levels. No reported concentration exceeded an established maximum contaminant level.

Concentrations of ammonia (as nitrogen) in all of the water samples were greater than the minimum reporting level. Concentrations of nitrite (as nitrogen) in all samples were less than the minimum reporting level. Concentrations of nitrite plus nitrate (as nitrogen) in all the water samples were greater than the minimum reporting level. Concentrations of orthophosphate (as phosphorus) in 19 of the water samples were equal to or greater than the minimum reporting level. No nutrient concentration exceeded an established maximum contaminant level.

Concentrations of purgeable organic compounds, carbamate insecticides, gross PCBs, and gross PCNs in all samples were less than their respective minimum reporting levels. The concentrations of chlorpyrifos and lindane in one sample exceeded the respective minimum reporting levels or method detection limits. Concentrations of some herbicides were greater than the method detection limits or minimum reporting levels, but none exceeded established maximum contaminant levels.

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