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CHEMICAL CONSTITUENTS IN GROUND WATER FROM 39 SELECTED SITES WITH AN EVALUATION OF ASSOCIATED QUALITY ASSURANCE DATA, IDAHO NATIONAL ENGINEERING AND ENVIRONMENTAL LABORATORY AND VICINITY, IDAHO

U.S. GEOLOGICAL SURVEY
OPEN-FILE REPORT 99-246

Prepared in cooperation with the U.S. DEPARTMENT OF ENERGY

USGS
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Cover: Aerial view of Big Lost River Sinks looking toward Howe Point, Idaho National Engineering and Environmental Laboratory

Photograph courtesy of the National Park Service

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By LeRoy L. Knobel, Roy C. Bartholomay, Betty J. Tucker,
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Idaho Falls, Idaho
August 1999

U.S. DEPARTMENT OF THE INTERIOR
BRUCE BABBITT, Secretary

U.S. GEOLOGICAL SURVEY
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CONVERSION FACTORS, VERTICAL DATUM, AND ABBREVIATED UNITS

Multiply	By	To obtain
foot (ft)	0.3048	meter
square foot per day (ft^2/day)	.0929	square meter per day
inch (in.)	25.4	millimeter
mile (mi)	1.609	kilometer
square mile (mi^2)	2.590	square kilometer
acre-foot (acre-ft)	1,233	cubic meter
foot per mile (ft/mi)	.1894	meter per kilometer
picocurie per liter (pCi/L)	.037	becquerel per liter

For temperature, degrees Celsius (°C) may be converted to degrees Fahrenheit (°F) by using the formula: °F = (°C × 1.8) + 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: µg/L (microgram per liter), mg/L (milligram per liter).

Chemical Constituents in Ground Water from 39 Selected Sites with an Evaluation of Associated Quality Assurance Data, Idaho National Engineering and Environmental Laboratory and Vicinity, Idaho

by LeRoy L. Knobel, Roy C. Bartholomay, Betty J. Tucker, Linda M. Williams, *and* L. DeWayne Cecil

Abstract

Ground-water-quality data—collected during 1990–94 from 39 locations in the eastern Snake River Plain—are presented as part of the U.S. Geological Survey's continuing hydrogeologic investigation at the Idaho National Engineering and Environmental Laboratory. The minimum and maximum concentrations for dissolved cations, anions, and silica were: calcium, 5.4 and 88 mg/L (milligrams per liter); magnesium, 0.82 and 23 mg/L; sodium, 5.4 and 47 mg/L; potassium, 1.0 and 15 mg/L; silica, 10 and 48 mg/L; chloride, 2.6 and 120 mg/L; sulfate, 2.0 and 200 mg/L; bicarbonate, 41 and 337 mg/L; and fluoride, <0.1 and 4.8 mg/L.

Purgeable organic compounds and extractable acid and base/neutral organic compounds were detected in water from 10 and 15 sites, respectively. Concentrations of dissolved organic carbon ranged from 0.1 to 1.2 mg/L.

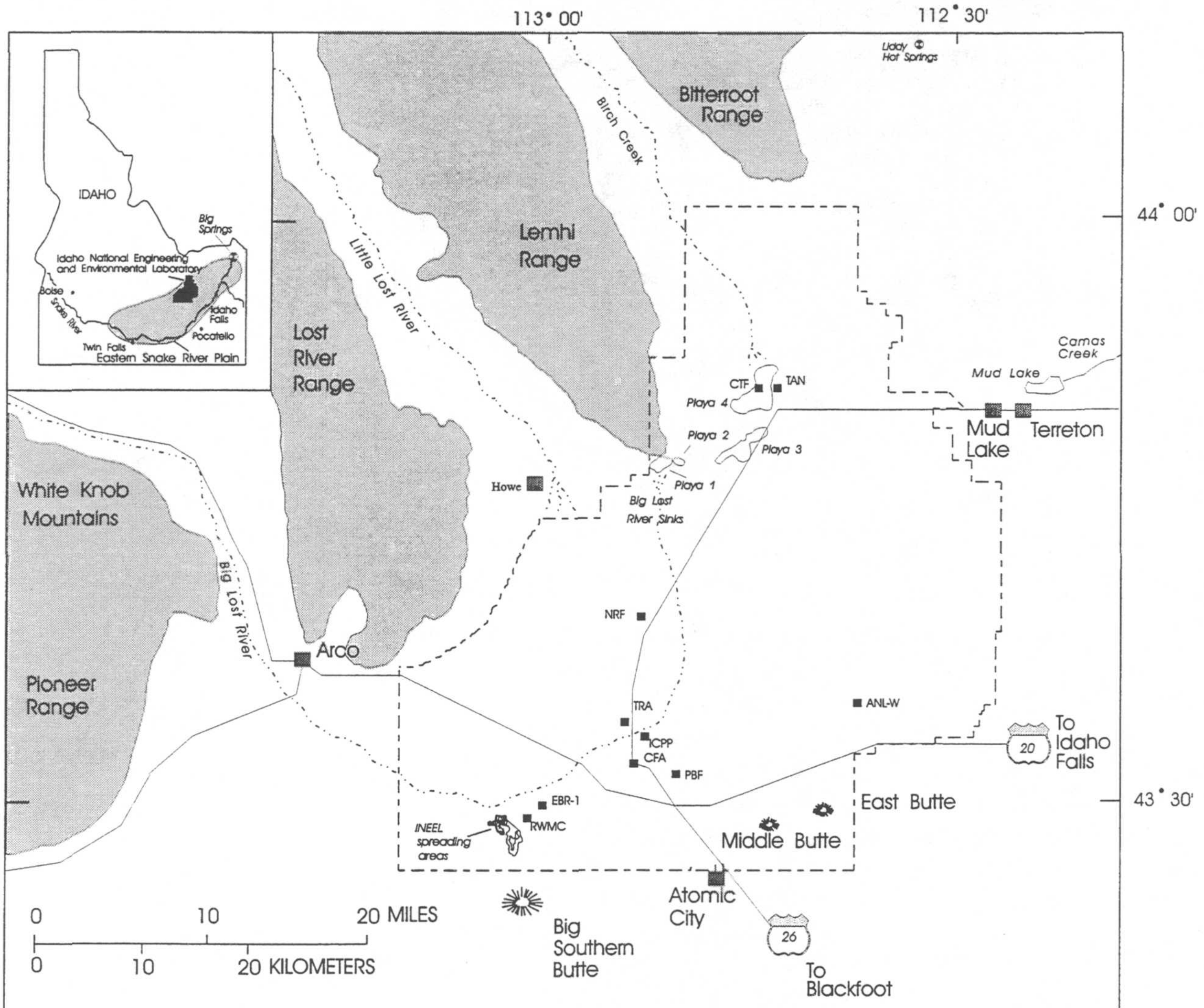
Concentrations of gross alpha-particle radioactivity as thorium-230 ranged from less than the reporting level to 14.4±1.2 pCi/L (picocuries per liter), and concentrations of gross beta-particle radioactivity as cesium-137 ranged from 1.5±0.38 to 106±6.2 pCi/L. Concentrations of selected transuranics were less than the reporting level. Concentrations of radon-222 ranged from 48±14 to 694±14 pCi/L. Tritium concentrations in 38 samples analyzed by the U.S. Department of Energy's Radiological and Environmental Sciences Laboratory ranged from less than the reporting level to 40,900±900 pCi/L.

Relative isotopic ratios ranged from -141 to -120 permil for $\delta^{2}H$, -18.55 to -14.95 permil for $\delta^{18}O$, -13.5 to -7.5 permil for $\delta^{13}C$, 3.3 to 16.0 permil for $\delta^{34}S$, and 3.7 to 9.5 permil for $\delta^{15}N$.

Of 600 quality assurance sample pairs, 592, or 99 percent, were statistically equivalent. Equivalence of two sample pairs was statistically indeterminate.

INTRODUCTION

The INEEL (Idaho National Engineering and Environmental Laboratory), encompassing about 890 mi^2 of the eastern Snake River Plain in southeastern Idaho (fig. 1), is operated by the U.S. Department of Energy (DOE). INEEL facilities are used in the development of peacetime atomic-energy applications, nuclear safety research, defense programs, and advanced energy concepts. Liquid radionuclide and chemical wastes generated at these facilities have been discharged to onsite infiltration ponds and disposal wells since 1952. Liquid-waste disposal has resulted in detectable concentrations of several waste constituents in water in the Snake River Plain aquifer underlying the INEEL.



EXPLANATION

Big Springs ⊕ SPRING SAMPLING SITE AND IDENTIFIER

■ SELECTED FACILITIES AT THE IDAHO NATIONAL ENGINEERING AND ENVIRONMENTAL LABORATORY

---- BOUNDARY OF IDAHO NATIONAL ENGINEERING AND ENVIRONMENTAL LABORATORY

ANL-W	ARGONNE NATIONAL LABORATORY-WEST	NRF	NAVAL REACTORS FACILITY
CFA	CENTRAL FACILITIES AREA	PBF	POWER BURST FACILITY
CTF	CONTAINED TEST FACILITY (formerly called Loss of Fluid Test Facility--LOFT)	RWMC	RADIOACTIVE WASTE MANAGEMENT COMPLEX
EBR-1	EXPERIMENTAL BREEDER REACTOR NO. 1	TAN	TEST AREA NORTH
ICPP	IDAHO CHEMICAL PROCESSING PLANT	TRA	TEST REACTOR AREA

Figure 1. Location of the Idaho National Engineering and Environmental Laboratory, spring sampling sites, and selected facilities.

The DOE requires information about the mobility of dilute radionuclide- and chemical-waste constituents in the Snake River Plain aquifer. Waste-constituent mobility is, in part, determined by (1) the rate and direction of ground-water flow; (2) the locations, quantities, and methods of waste disposal; (3) waste-constituent chemistry; and (4) the geochemical processes taking place in the aquifer (Orr and Cecil, 1991, p. 2). This study was conducted by the U.S. Geological Survey (USGS) in cooperation with the DOE's Idaho Operations Office.

Purpose and Scope

In 1949, the U.S. Atomic Energy Commission, later to become the DOE, requested that the USGS describe the water resources of the area now known as the INEEL. The purpose of the resulting study was to characterize these resources prior to the development of nuclear reactor testing facilities. The USGS since has maintained a monitoring network at the INEEL to determine hydrologic trends and to delineate the movement of facility-related radionuclide and chemical wastes in the Snake River Plain aquifer.

This report presents a compilation of water-quality data along with an evaluation of associated quality assurance data collected during 1990–94 from the Snake River Plain aquifer and two springs located in areas that provide recharge to the Snake River Plain aquifer. The data were collected as part of the continuing hydrogeologic investigation at the INEEL. This report is the third in a series of four reports and presents data collected to quantitatively assess the natural geochemical system at the INEEL. The results of the quantitative assessment will be published in a separate report (the fourth report of this series). The previously published reports in this series are by Knobel and others (1992, 1997). The extent and magnitude of selected radiochemical and chemical constituents in ground water at the INEEL are described in Bartholomay and others (1995).

Hydrologic Conditions

The Snake River Plain aquifer is one of the most productive aquifers in the United States (U.S. Geological Survey, 1985, p. 193). The aquifer consists of a thick sequence of basalts and sedimentary interbeds filling a large, arcuate, structural basin that underlies the eastern Snake River Plain in southeastern Idaho (fig. 1).

Surface Water.—Recharge to the Snake River Plain aquifer is principally from infiltration of applied irrigation water, infiltration of streamflow, and alluvial ground-water inflow from adjoining mountain drainage basins. Some recharge could be from direct infiltration of precipitation, although the small amount of annual precipitation on the plain (8 in. at the INEEL), evapotranspiration, and the great depth to water (in places exceeding 900 ft) probably minimize this source of recharge (Orr and Cecil, 1991, p. 22-23).

The Big Lost River drains more than 1,400 mi^2 of mountainous area that includes parts of the Lost River Range and Pioneer Range west of the INEEL (fig. 1). Flow in the Big Lost River infiltrates to the Snake River Plain aquifer along its channel and at sinks and playas. Since 1958, excess runoff has been diverted to spreading areas in the southwestern part of the INEEL, where much of the water rapidly infiltrates to the aquifer (Orr and Cecil, 1991, p. 23). Other surface drainages that provide recharge to the Snake River Plain aquifer at or near the INEEL include Birch Creek, Little Lost River, and Camas Creek (fig. 1) (Bartholomay and others, 1997, p. 18).

Ground Water.—Water in the Snake River Plain aquifer moves principally through fractures and interflow zones in the basalt. A significant proportion of ground water moves through the upper 200 to 800 ft of saturated basaltic rocks. Hydraulic conductivity of basalt in the upper 800 ft of the aquifer generally is 1 to 100 ft/day. Hydraulic conductivity of underlying rocks is several orders of magnitude smaller (Mann, 1986, p. 21). Ackerman (1991, p. 30) reported the range of transmissivity in the upper part of the aquifer to be about 760,000 ft^2/day. The effective base of the Snake River Plain aquifer at the INEEL probably ranges from about 800 to 1,700 ft below land surface (Anderson and others, 1996, p. 23).

Depth to water in wells completed in the Snake River Plain aquifer ranges from about 200 ft in the northern part of the INEEL to more than 900 ft in the southeastern part. In March-May 1995, the altitude of the water table was about 4,580 ft above sea level in the northern part of the INEEL and about 4,420 ft above sea level in the southwestern part. Water flowed southward and southwestward beneath the INEEL at an average hydraulic gradient of about 4 ft/mi. Locally, however, the hydraulic gradient ranged from about 1 to 15 ft/mi. From March-May 1991 to March-May 1995, water levels generally declined throughout the INEEL because of drought conditions that began in 1987. Water-level declines ranged from about 8.5 ft in wells in the west-central part of the INEEL to about 2.5 ft in wells in the southern part. The larger water-level decline in wells in the west-central part of the INEEL is attributed to lack of recharge from the Big Lost River (Bartholomay and others, 1997, p. 20).

Ground water moves southwestward from the INEEL and eventually discharges to springs along the Snake River downstream from Twin Falls, 100 mi southwest of the INEEL. Approximately 3.7 million acre-ft of ground water discharged to these springs in 1995 (C.E. Berenbrock, USGS, written commun., 1996).

Guidelines for Interpreting Results of Radiochemical Analyses

Concentrations of radionuclides are reported with an estimated sample standard deviation, s, that is obtained by propagating sources of analytical uncertainty in measurements. The following guidelines for interpreting analytical results are based on an extension of a method proposed by Currie (1984).

In the analysis for a particular radionuclide, laboratory measurements are made on a target sample and prepared blank. Instrument signals for the sample and the 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 larger than the signal observed for the blank before the decision can be made that the radionuclide was detected; and (2) an estimation must be made of the minimum radionuclide concentration that will yield a sufficiently large observed signal before the correct decision can be made for detection or nondetection of the radionuclide. The first aspect of the problem is a qualitative decision based on an observed signal and a definite criterion for detection. The second aspect of the problem is an estimation of the detection capabilities of a given measurement process.

In the laboratory, instrument signals must exceed a critical level before the qualitative decision can be made as to whether the radionuclide was detected. Radionuclide concentrations that equal 1.6s meet this criterion; at 1.6s, there is a 95-percent probability that the correct conclusion—not detected—will be made. Given a large number of samples, as many as 5 percent of the samples with measured concentrations larger than or equal to 1.6s, which were concluded as being detected, might not contain the radionuclide. 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 determined. Radionuclide concentrations that equal 3s represent a measurement at the minimum detectable concentration. For true concentrations of 3s or larger, there is a 95-percent or larger probability that the radionuclide was detected in a sample. In a large number of samples, the conclusion—not detected—will be made in 5 percent of the samples that contain true concentrations at the minimum detectable concentration of 3s. 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, the probability of false negative results for samples with true concentrations between 1.6s and 3s is larger than 5 percent. There was a significant instrument signal in the laboratory that gave a result between 1.6s and 3s that lead to the conclusion not detected by using the guidelines outlined here. However, between 1.6s and 3s there may be true transuranic concentrations in the sample. By equating 1.6s and 3s there may be true transuranic concentrations in the sample. By equating 1.6s and

3s without discussing the possibilities of a true concentration between 1.6s and 3s, the probability of false negatives is about 50 percent. In other words, using only the 3s minimum detectable concentration as a guide, at least 50 percent of the time, true concentrations between 1.6s and 3s will be missed.

The critical level and minimum detectable concentration 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, with the number of gross counts for individual analyses, and for different radionuclides. In this report, radionuclide concentrations less than 3s are considered to be below a "reporting level." The critical level, minimum detectable concentration, and reporting level aid the reader in the interpretation of analytical results and do not represent absolute concentrations of radioactivity which might or might not have been detected.

Guidelines for Interpreting Results of Inorganic and Organic Analyses

The term "reporting level" used for radiochemical analyses should not be confused with the term "laboratory reporting level," which is used for inorganic and organic analyses. In this report, the laboratory reporting level is the smallest measured concentration of a nonradioactive constituent that can be reliably reported using a given analytical method. Because of unpredictable matrix effects on detection limits, the laboratory reporting levels are set somewhat higher than the analytical method detection limits (Pritt and Jones, 1989).

Acknowledgments

The U.S. DOE's Radiological and Environmental Sciences Laboratory (RESL) conducted analyses of most of the water samples for concentrations of selected radionuclides. The authors are grateful to Deborah J. Parliman and Gary Barton of the USGS for technically reviewing the manuscript.

METHODS AND QUALITY ASSURANCE

The methods used for collecting water samples and conducting analyses 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; Hardy and others, 1989; Faires, 1992; and Fishman, 1993). The methods used in the field and quality-assurance practices are described in the following sections.

Sample Containers and Preservatives

Sample containers and preservatives differ depending on the constituent(s) for which analyses are requested. Samples analyzed by the USGS National Water Quality Laboratory (NWQL) were placed in containers and preserved in accordance with laboratory requirements specified by Pritt and Jones (1989). Containers and preservatives were supplied by the NWQL and had undergone a rigorous quality control procedure (Pritt, 1989, p. 75) to eliminate sample contamination. Samples analyzed by the RESL were placed in containers in accordance with laboratory requirements specified by the chief and research chemists of the Analytical Chemistry Branch of the RESL. Containers and preservatives used for this study are listed in table 1.

Sampling Locations and Sample Collection

Samples of raw, untreated water were collected from 39 locations (figs. 1 and 2): 29 ground-water monitoring wells (No Name No. 1, NPR Test, P&W 2, Site 9, Site 14, Site 17, Site 19, USGS 1, 2, 4, 7, 8, 9, 17, 19, 20, 23, 26, 27, 29, 31, 32, 57, 65, 85, 86, 101, 110, and 112); 4 production wells (CFA-1, CPP-1, EBR-I, and Fire Station 2); 3 domestic wells (McKinney, Ruby Farms, and Stoddart); 1 irrigation well (Park Bell); and 2 springs (Big Springs and Lidy Hot Springs). The production wells and irrigation well were equipped with line-shaft turbine pumps. The ground-water monitoring wells and the domestic wells were equipped with dedicated submersible pumps. The springs did not have permanent pump installations.

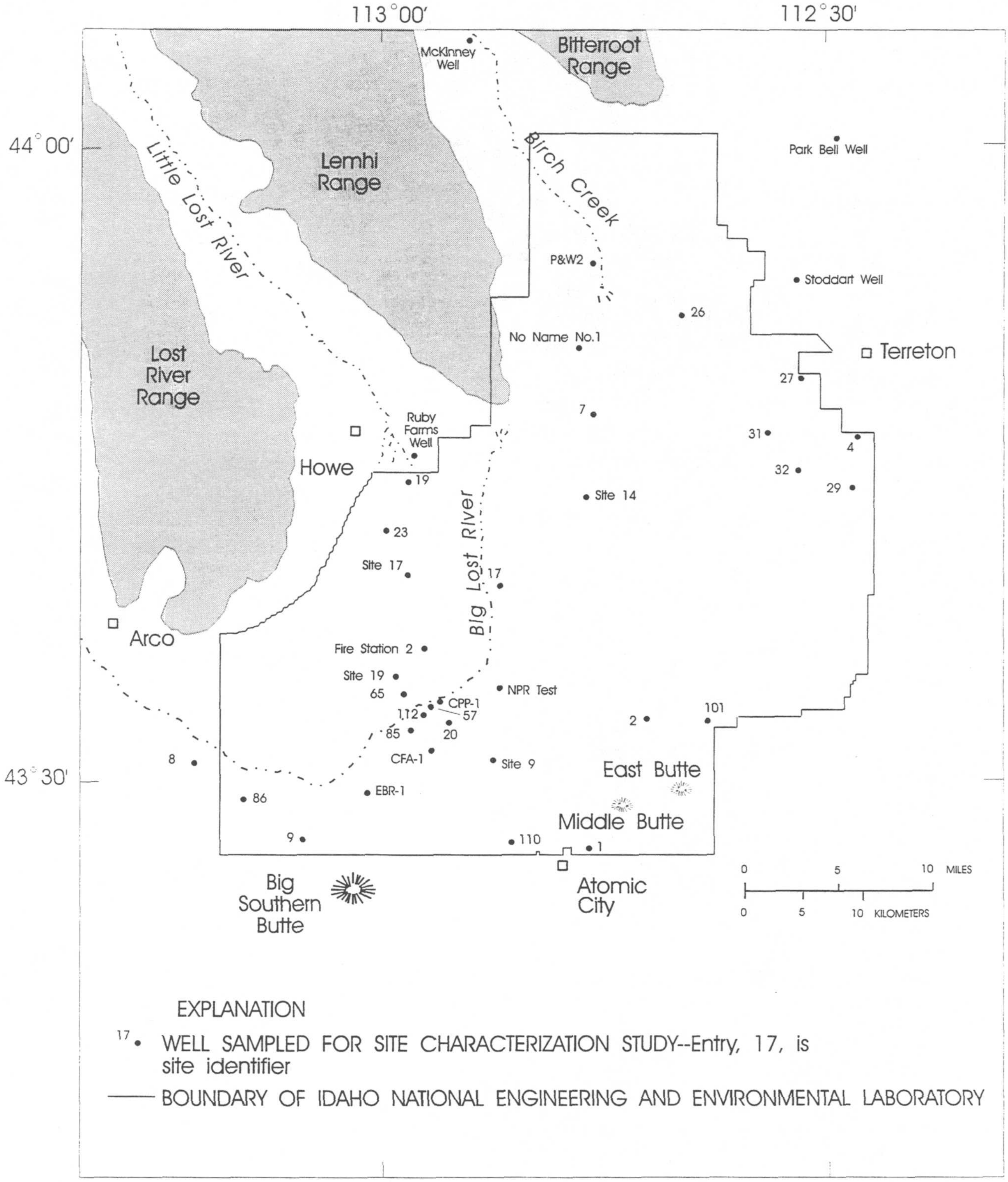


Figure 2. Location of selected wells, Idaho National Engineering and Environmental Laboratory and vicinity.

Samples were collected from a portable sampling apparatus at the wells with dedicated submersible pumps; from sampling ports on the discharge lines of the turbine pumps for the production wells; from spigots close to the pumps at the domestic wells; from an open pipe off the turbine pump for the irrigation well; from a spring orifice at Big Springs; and from a spigot on a collection pipe at Lidy Hot Springs. A minimum of three wellbore volumes were removed from the wells prior to sample collection. All portable equipment was decontaminated after each sample. After collection, sample containers were sealed with laboratory film, labeled, and stored under secured conditions. Containers with water samples to be analyzed by the NWQL were placed in ice chests and the ice chests were sealed. The ice chests were shipped by overnight-delivery mail to the NWQL. Containers with water samples to be analyzed by RESL were hand-delivered to the laboratory.

Conditions at the sampling site during sample collection were recorded in a field logbook, and a chain-of-custody record was used to track 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. The results of field measurements for pH, specific conductance, and water temperature are listed in table 2, and the results of field measurements for alkalinity and dissolved oxygen and laboratory calculations of hardness and dissolved solids are listed in table 3.

Calculation of Estimated Experimental Standard Errors

The analytical results for radionuclides are presented with calculated analytical uncertainties. There is about a 67-percent probability that the true radionuclide concentration is in a range of the reported concentration plus or minus the uncertainty. The uncertainties are expressed as one standard deviation for the sample population. The associated uncertainties presented with mean concentrations are experimental standard errors and are an estimate of the uncertainty of the mean concentration (Iman and Conover, 1983, p. 158).

Quality Assurance

Detailed descriptions of internal quality control (QC) and of the overall quality assurance (QA) practices used by the NWQL are provided in reports by Friedman and Erdmann (1982) and Jones (1987). The water samples were collected in accordance with a QA plan for quality of water activities conducted by personnel assigned to the INEEL Project Office; the plan was finalized in June 1989, updated in 1992, and is available for inspection at the USGS Project Office at the INEEL. Comparative studies to determine agreement between analytical results for individual water-sample pairs by laboratories involved in the INEEL Project Office's QA program were summarized by Wegner (1989) and Williams (1996, 1997). Additional QA instituted for this sampling program included four full-suite replicate samples from Site 17 and USGS 2, 4, and 7. The four replicate pairs of samples were collected sequentially and sent with different identifiers to the laboratory. There was no correlation between the identifier of the QA replicate and the regular water-quality sample; the field personnel assigned a QA number and recorded that number in their field logbooks along with the required information about that particular site. This type of sample is useful for determining the overall measurement reproducibility related to variability caused by laboratory equipment, materials, or analysts, and by the sample collection process. Lidy Hot Springs and USGS 26 were resampled as a result of the need for additional data and these samples should not be considered QA samples. Analytical results from the QA samples are discussed along with similar data in subsequent sections of this report. Concentrations of replicates and resamples were not included in the computation of descriptive statistical parameters.

EVALUATION OF QUALITY ASSURANCE DATA

The method of evaluating QA data in this report is adopted from Williams (1996).

Statistical Comparisons of Replicate Pairs of Samples

Test statistics were used to determine whether analytical results of replicate pairs of samples were statistically equivalent. If the standard deviations are known, it is possible to determine, within a specified confidence level, whether the results of a replicate pair of samples are statistically equivalent. When the standard deviations are unknown, approximations of the standard deviations are used for the statistical comparison. The comparison can be done using an adaptation of the equation to determine the standard deviate, Z, or the number of standard deviations the variable deviates from the mean (Volk, 1969, p. 55), where Z is the ratio of the absolute value of the difference between the two results and the square root of the sum of the squares of the standard deviations (the pooled standard deviation). In that way, a comparison can be made of two analytical results on the basis of the precision, or an approximation of the precision, associated with each of the results:

$$Z = \frac{|x-y|}{\sqrt{(s_x)^2 + (s_y)^2}} , \qquad (1)$$

where
x is the result of the routine water-quality sample,
y is the result of the QA/QC sample,
s_x is the standard deviation of x, and
s_y is the standard deviation of y.

When the population is distributed normally and the standard deviation is known, the analytical results of replicate pairs can be considered statistically equivalent at the 95-percent confidence level if the Z-value is less than or equal to 1.96. When the population is not distributed normally or an approximation of the standard deviation is used, a Z-value less than or equal to 1.96 must be considered a guide when testing for equivalence. At the 95-percent confidence level, the probability of error is 0.05. In other words, when a Z-value is less than or equal to 1.96, the results are within approximately two standard deviations of each other. Equation 1 is essentially the equation used to compare replicate data in the USGS protocol for collection and processing surface-water samples (Horowitz and others, 1995, p. 36).

Instead of setting a value that is approximately equal to two standard deviations as a test of equivalence, the level of significance, or *p*-value, which indicates the weight of the evidence to reject the null hypothesis, $x \pm s_x = y \pm s_y$, can be determined. The null hypothesis is tested using the Z-value as the test statistic. The Z-value is calculated by using equation 1, then the *p*-value is determined by referring to table 19 at the end of this report. If the distribution is assumed to be normal, the *p*-value is the area under the curve for the Z-value. The greater the Z-value, the smaller the *p*-value and the more likely that the results of the replicate pair are not equivalent and that the null hypothesis will be rejected. When Z = 1.96, the *p*-value = 0.0250 for a one-tailed test and 0.0500 for a two-tailed test (table 19). This shows that these *p*-values are equivalent to the 95-percent confidence level and $\alpha = 0.05$, where α is the probability that the null hypothesis will be rejected when true.

Inorganic Constituents.—Equation 1 cannot be applied directly to the results when no standard deviations or uncertainties are reported. The analyses for inorganic constituents, which were done at the NWQL, were not reported with standard deviations; therefore, approximations of standard deviations were used. The USGS Branch of Quality Assurance conducts a Blind Sample Program (BSP) in which reference samples disguised as environmental samples are submitted to the NWQL. A report by Maloney and others (1993) describes the program and presents evaluations of the analytical results. The BSP data are stored in the QADATA program that is available through the USGS computer network (Lucey, 1990, p. 1). The statistical analyses included in the program generate linear regression equations that allow the calculation of a Most Probable Deviation (MPD) at any concentration for most analyses. A minimum MPD has been established for a few analyses at very low concentrations (Maloney and others, 1993, p. 4). The linear regression equations can be used to determine whether the analytical results of the replicate pairs are statistically equivalent by calculating an MPD for each result and substituting for the standard deviation in equation 1. Because these are approximate standard deviations, the Z-value of 1.96 must be considered a guide when testing for equivalence.

The results of the replicate pairs of the inorganic constituent analyses and the Z-values for each replicate pair are included in tables 4 through 7. If the analytical results of the pair were not statistically equivalent, that is, if the Z-value was greater than 1.96, an "N" appears in parentheses attached to the Z-value.

For many samples, the analytical results were less than the reporting level. If the results of both samples of the replicate pair were less than the reporting level, the results were assumed to be equivalent and the Z-value was reported as a zero. If, however, only one of the results was less than the reporting level, one of two approaches was taken.

First, if one result was less than the reporting level and the other exceeded the reporting level, the numerical value and the MPD of the numerical value of the reporting level were substituted in equation 1 for the result at the reporting level. For example, the analytical results of fluoride in the replicate pair collected at USGS 97 on June 7, 1990, were <0.1 mg/L and 0.4 mg/L (Williams, 1996, p. 15-16, table 13). When the minimum MPD of 0.075 mg/L that has been set for this analysis (Maloney and others, 1993) was used, the results were 0.1±0.075 mg/L and 0.4±0.075 mg/L. The Z-value, calculated from equation 1, equaled 2.83. The Z-value was greater than 1.96 and, therefore, was outside the 95-percent confidence level. The results of the replicate pair were not equivalent.

Second, if one result was less than the reporting level and the other was at the reporting level, the MPD of the result was calculated at the reporting level by using the linear regression equation for that analysis. It is impractical to use equation 1 because the Z-value will always equal zero. Therefore, to compare the two results by using the precision associated with them, the deviation was multiplied by 1.96. If the range of the deviation had included zero, the results would have been equivalent because any result less than the reporting level was included in the 95-percent confidence level. For example, the analytical results of fluoride in the replicate pair collected at USGS 12 on June 15, 1990, were <0.1 mg/L and 0.1 mg/L (Williams, 1996, p. 16, table 13). The linear regression equation generated an MPD of 0.018 mg/L, but a minimum MPD of 0.075 mg/L has been set for this analysis (Maloney and others, 1993, p. 5). Therefore, the result of 0.1 mg/L would have an MPD of 1.96×0.075 mg/L at the 95-percent confidence level: 0.1±0.147 mg/L. The range included zero and the results were considered equivalent. If the range had not included zero, as often is the case when the MPD is very small, equivalency could not have been determined and a "U" would have appeared in parentheses attached to the Z-value.

Gross Radioactivity and Radionuclides.—The use of equation 1 is straightforward in determining whether the results of radiochemical analyses of a replicate pair of samples were equivalent. Because the NWQL reported radiochemical results and two standard deviations, it was necessary to divide the value by two to compute the one standard deviation required by equation 1. The results and reported standard deviations for the analyses of gross radioactivity and radionuclides in replicate pairs and the Z-values are listed in tables 14-17. Calculations using equation 1 were performed on each replicate pair.

Organic Constituents.—Organic constituents were not included in the BSP. Therefore, for dissolved organic carbon and total phenol results, standard deviations were calculated from the Relative Standard Deviations (RSD) reported by Wershaw and others (1987, p. 14-15) and in the NWQL Services Catalog (Pritt and Jones, 1989, p. 5-28) for these two types of analyses, respectively. The standard deviations of the volatile organic compounds were calculated from the RSD's provided by Rose and Schroeder (1995, p. 18-23). Analytical results for organic constituents are included in tables 10 and 12-13. Calculations using equation 1 were performed on each replicate pair and the Z-values were determined. If the results of both samples of the replicate pair were less than the reporting level, the results were assumed to be equivalent and the Z-value was reported as a zero.

Statistical Comparisons of Resampled Constituents

Lidy Hot Springs and USGS 26 were resampled to fill in missing parts of the data record. The resampling took place at different times and, as a result, the samples should not be statistically compared.

CATIONS, ANIONS, AND SILICA

Water samples were analyzed for dissolved concentrations of cations—calcium, magnesium, sodium, potassium; anions—chloride, sulfate, bicarbonate, and fluoride; and silica (tables 4 and 5). The ranges of concentrations, the median concentration, and the mean concentration for each constituent, excluding replicates and resamples, follow: calcium, 5.4 to 88, 43, and 46 mg/L; magnesium, 0.82 to 23, 15, and 15 mg/L; sodium, 5.4 to 47, 14, and 17 mg/L; potassium, 1.0 to 15, 3.1, and 3.5 mg/L; silica, 10 to 48, 26, and 27 mg/L; chloride, 2.6 to 120, 16, and 27 mg/L; sulfate, 2.0 to 200, 24, and 31 mg/L; bicarbonate, 41 to 337, 169, and 174 mg/L; and fluoride, <0.1 to 4.8, 0.3, and 0.5 mg/L. Cation, anion, and silica concentrations in QA replicate samples were statistically equivalent, except for chloride in samples from USGS 4 and sulfate in samples from USGS 7.

SELECTED INORGANIC CONSTITUENTS

Water samples were collected and analyzed for dissolved concentrations of aluminum, arsenic, barium, beryllium, bromide, cadmium, cobalt, copper, chromium, hexavalent chromium, iron, lead, lithium, manganese, mercury, molybdenum, nickel, selenium, silver, strontium, vanadium, and zinc (table 6). Water samples also were analyzed for total chromium.

Aluminum.—Concentrations in 29 samples were less than the reporting level of 10 µg/L. Concentrations in the remaining 10 samples ranged from 10 to 40 µg/L and were distributed about median and mean concentrations of 10 and 13 µg/L, respectively. Aluminum concentrations in QA replicate samples were statistically equivalent to those in the routine samples.

Arsenic.—Concentrations in five samples were less than the reporting level of 1 µg/L. Concentrations in the remaining 34 samples ranged from 1 to 21 µg/L and were distributed about median and mean concentrations of 2 and 3 µg/L, respectively. Arsenic concentrations in QA replicate samples were statistically equivalent to those in the routine samples.

Barium.—Concentrations in two samples were less than the respective reporting levels of 2 or 100 µg/L. Concentrations in 37 samples ranged from 17 to 180 µg/L and were distributed about median and mean concentrations of 56 and 63 µg/L, respectively. Barium concentrations in QA replicate samples were statistically equivalent to those in the routine samples.

Beryllium.—Concentrations in 36 samples were less than the reporting level of 0.5 µg/L. The sample from well 31 contained a concentration of 0.5 µg/L. Beryllium concentrations in QA replicate samples were statistically equivalent to those in the routine samples.

Bromide.—Concentrations in all 39 samples ranged from 10 to 150 µg/L and were distributed about median and mean concentrations of 40 and 47 µg/L, respectively. Bromide concentrations in QA replicate samples were statistically equivalent to those in the routine samples.

Cadmium.—Concentrations in 35 samples were less than the reporting level of 1 µg/L. Three samples each contained a concentration of 2 µg/L. Cadmium concentrations in QA replicate samples were statistically equivalent to those in the routine samples.

Cobalt.—Concentrations in 36 samples were less than the reporting level of 3 µg/L. The sample from well 86 contained a concentration of 3 µg/L. Cobalt concentrations in QA replicate samples were statistically equivalent to those in the routine samples.

Copper.—Concentrations in all 36 samples analyzed were less than the reporting level of 10 µg/L. Copper concentrations in QA replicate samples were statistically equivalent to those in the routine samples.

Chromium.—Concentrations in 17 samples were less than the reporting levels of 1 or 5 µg/L. Concentrations in the remaining 21 samples ranged from 1 to 190 µg/L and were distributed about median and mean concentrations of 5 and 15 µg/L, respectively. Chromium concentrations in QA replicate samples were statistically equivalent to those in the routine samples.

Hexavalent chromium.—Concentrations in eight samples were less than the reporting level of 1 µg/L. Concentrations in the remaining 31 samples ranged from 1 to 160 µg/L and were distributed about median and mean concentrations of 3 and 10 µg/L, respectively. Hexavalent chromium concentrations in QA replicate samples were statistically equivalent to those in the routine samples.

Total chromium.—Concentrations in eight samples were less than the reporting level of 1 µg/L. Concentrations in the remaining 31 samples ranged from 1 to 210 µg/L and were distributed about median and mean concentrations of 6 and 14 µg/L, respectively. Total chromium concentrations in QA replicate samples were statistically equivalent to those in the routine samples.

Iron.—Concentrations in 39 samples ranged from 4 to 210 µg/L and were distributed about median and mean concentrations of 16 and 25 µg/L, respectively. Iron concentrations in QA replicate samples were statistically equivalent to those in the routine samples, except for those in samples from wells Site 17 and USGS 4.

Lead.—Concentrations in 30 samples were less than the reporting levels of 1 or 10 µg/L. Concentrations in the remaining nine samples ranged from 1 to 30 µg/L and were distributed about median and mean concentrations of 20 and 13 µg/L, respectively. Lead concentrations in QA replicate samples were statistically equivalent to those in the routine samples.

Lithium.—Concentrations in seven samples were less than the reporting level of 4 µg/L. Concentrations in the remaining 29 samples ranged from 4 to 71 µg/L and were distributed about median and mean concentrations of 11 and 16 µg/L, respectively. Lithium concentrations in QA replicate samples were statistically equivalent to those in the routine samples.

Manganese.—Concentrations in 22 samples were less than the reporting level of 1 µg/L. Concentrations in the remaining 17 samples ranged from 2 to 83 µg/L and were distributed about median and mean concentrations of 3 and 9 µg/L, respectively. Manganese concentrations in QA replicate samples were statistically equivalent to those in the routine samples.

Mercury.—Concentrations in all but two samples were less than the reporting level of 0.1 µg/L. Wells 57 and 112 each contained concentrations of 0.2 µg/L. Mercury concentrations in QA replicate samples were statistically equivalent to those in the routine samples.

Molybdenum.—Concentrations in all 36 samples analyzed were less than the reporting level of 10 µg/L. Molybdenum concentrations in QA replicate samples were statistically equivalent to those in the routine samples.

Nickel.—Concentrations in all 36 samples analyzed were less than the reporting level of 10 µg/L. Nickel concentrations in QA replicate samples were statistically equivalent to those in the routine samples.

Selenium.—Concentrations in 35 samples were less than the reporting level of 1 µg/L. Concentrations in the remaining four samples ranged from 1 to 4 µg/L and were distributed about median and mean concentrations of 2.5 and 2 µg/L, respectively. Selenium concentrations in QA replicate samples were statistically equivalent to those in the routine samples.

Silver.—Concentrations in 31 samples were less than the reporting level of 1 µg/L. Concentrations in the remaining seven samples ranged from 2 to 3 µg/L and were distributed about median and mean concentrations of 2 and 2 µg/L, respectively. Silver concentrations in QA replicate samples were statistically equivalent to those in the routine samples.

Strontium.—Concentrations in all 39 samples ranged from 6 to 990 µg/L and were distributed about median and mean concentrations of 220 and 237 µg/L, respectively. Strontium concentrations in QA replicate samples were statistically equivalent to those in the routine samples.

Vanadium.—Concentrations in 28 samples were less than the reporting level of 6 µg/L. Concentrations in the remaining eight samples ranged from 6 to 14 µg/L and were distributed about median and mean concentrations of 7 and 8 µg/L, respectively. Vanadium concentrations in QA replicate samples were statistically equivalent to those in the routine samples.

Zinc.—Concentrations in two samples were less than the reporting level of 3 µg/L. Concentrations in the remaining 34 samples ranged from 3 to 420 µg/L and were distributed about median and mean concentrations of 10.5 and 54 µg/L, respectively. Zinc concentrations in QA replicate samples were statistically equivalent to those in the routine samples, except for those in samples from well USGS 4.

NUTRIENTS

Concentrations of ammonia as nitrogen, nitrite as nitrogen, nitrite plus nitrate as nitrogen, and orthophosphate as phosphorus were analyzed in 39 water samples (table 7).

Ammonia as nitrogen.—Concentrations in 23 samples were less than the reporting levels of 0.01 or 0.015 mg/L; the remaining 16 concentrations ranged from 0.01 to 0.33 mg/L and were distributed about median and mean concentrations of 0.02 and 0.05 mg/L, respectively. Ammonia as nitrogen concentrations in QA replicate samples were statistically equivalent to those in the routine samples.

Nitrite as nitrogen.—Concentrations in 34 samples were less than the reporting level of 0.01 mg/L. Concentrations in the remaining five samples ranged from 0.01 to 0.02 mg/L. Nitrite as nitrogen concentrations in QA replicate samples were statistically equivalent to those in the routine samples, except for those in samples from well USGS 7, for which the equivalence could not be determined.

Nitrite plus nitrate as nitrogen.—Concentrations in three samples were less than the reporting levels of 0.05 or 0.10 mg/L. Concentrations in the remaining 36 samples ranged from 0.06 to 4.4 mg/L and were distributed about median and mean concentrations of 1.0 and 1.4 mg/L, respectively. Nitrite plus nitrate as nitrogen concentrations in QA replicate samples were statistically equivalent to those in the routine samples.

Orthophosphate as phosphorus.—Concentrations in 30 samples were less than the reporting level of 0.01 mg/L. Concentrations in the remaining nine samples ranged from 0.01 to 0.03 mg/L and were distributed about median and mean concentrations of 0.02 and 0.02 mg/L, respectively. Orthophosphate as phosphorus concentrations in QA replicate samples were statistically equivalent to those in the routine samples.

MISCELLANEOUS CHEMICAL DATA

Total concentrations of selected inorganic constituents, organic carbon, and sodium; and concentrations of selected dissolved anions and nutrients in water from USGS 17 were determined as part of another study. The results are listed in table 8 for comparison with dissolved concentrations listed in tables 4 through 7.

PURGEABLE ORGANIC COMPOUNDS

Concentrations of 36 purgeable organic compounds (table 9) were determined by the NWQL using a method that conforms to U.S. Environmental Protection Agency method 524 (Pritt and Jones, 1989). The concentrations of selected purgeable organic compounds from several sites are listed in table 10. Compounds with concentrations less than the reporting level of 0.2 µg/L are excluded. An additional compound (1,2,4-trimethylbenzene) was detected in one QA replicate sample but not in the original sample, and the concentration is included in table 10. The only purgeable organic compounds detected in the QA replicate samples and the associated routine samples were tentatively identified organic compounds (TIOC's[1]) (table 10) for which statistical equivalence could not be determined. For the other 36 compounds (table 9), the concentrations in both the QA replicate samples and the routine samples were less than the reporting level of 0.2 µg/L and the Z-values were zero, which indicates statistical equivalence.

EXTRACTABLE ACID AND BASE/NEUTRAL ORGANIC COMPOUNDS

An extractable acid and base/neutral organic compound sample for Big Springs was not collected. The samples from the remaining sites were analyzed by the NWQL for 54 compounds (table 11). Concentrations of compounds that were larger than the reporting level (table 11) are listed in table 12. Compounds in table 12 that are not listed in table 11 are TIOC's. The only extractable acid/base neutral organic compounds detected in the QA replicate samples and the associated routine samples were TIOC's (table 12), and statistical equivalence could not be determined. For the other 54 compounds (table 11), the concentrations in both the QA replicate samples and the routine samples were less than the respective reporting levels (table 11) and the Z-values were zero, which indicates statistical equivalence.

MISCELLANEOUS ORGANIC CHEMICAL DATA

Concentrations of DOC (dissolved organic carbon) were determined for 39 samples, and concentrations of EDTA (ethylenediaminetetraacetic acid) and citrate were each determined for 35 samples (table 13). Concentrations of EDTA and citrate in all samples were less than the reporting levels of 20 and 5 µg/L, respectively. Concentrations of DOC ranged from 0.1 to 1.2 mg/L and were distributed about median and mean concentrations of 0.4 and 0.5 mg/L, respectively. Concentrations of DOC, EDTA, and citrate in the QA replicate samples and the associated routine samples were all statistically equivalent.

GROSS ALPHA- AND GROSS BETA-PARTICLE RADIOACTIVITY

Concentrations of gross alpha- and gross beta-particle radioactivity were determined for 39 samples. Concentrations in the dissolved fraction of the water samples are listed in table 14 and those in the suspended fraction are listed in table 15. Concentrations of gross alpha- and gross beta-particle radioactivity in both the dissolved and suspended fractions in QA replicate samples were statistically equivalent to those in the routine samples.

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. For convenience, laboratories report the radioactivity as if it were all given off by one radionuclide. In this report, concentrations are reported two ways: as thorium-230 in picocuries per liter, and as natural uranium in micrograms per liter. In addition to dissolved concentrations (table 14), gross alpha-particle radioactivity was measured in the suspended fractions of the water samples (table 15). Concentrations of gross alpha-particle radioactivity in the dissolved fraction of all the water samples except one were larger than the reporting level (table 14). The concentrations reported as thorium-230 ranged from less than the reporting level to 14.4±1.2 pCi/L. Concentrations of gross alpha-particle radioactivity reported as thorium-230 in the suspended fractions of the water samples ranged from less than the reporting level to 4.4±1.2 pCi/L. Concentrations in only two samples (McKinney Well and No Name No. 1) were larger than the reporting level (table 15). The concentrations in the dissolved fractions reported as uranium ranged from less than the reporting level to 20.9±1.6 µg/L. Concentrations of gross alpha-particle radioactivity reported as uranium in the suspended fractions of the water samples ranged from less than the reporting level to 5.2±1.4 µg/L. Concentrations in only two samples (McKinney Well and No Name No. 1) were larger than the reporting level (table 15).

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1. Data for TIOC's in this report are based on comparison of sample spectra with library spectra followed by visual examination by gas chromatography/mass spectrometry analysts. TIOC data have not been confirmed by direct comparison with reference standards. Therefore, TIOC identification is tentative, and reported concentrations are semiquantitative.

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. For convenience, laboratories report the radioactivity as if it were all given off by one radionuclide or a chemically similar pair of radionuclides in equilibrium. In this report, concentrations are reported two ways: as strontium-90 in equilibrium with yttrium-90 in picocuries per liter, and as cesium-137 in picocuries per liter. In addition to dissolved concentrations (table 14), gross beta-particle radioactivity was measured in the suspended fractions of the water samples (table 15). Concentrations of gross beta-particle radioactivity in the dissolved fraction of all the water samples were larger than the reporting level (table 14). The concentrations reported as strontium-90 in equilibrium with yttrium-90 ranged from 1.1±0.27 to 75.0±4.4 pCi/L. Concentrations of gross beta-particle radioactivity reported as strontium-90 in equilibrium with yttrium-90 in the suspended fractions of the water samples ranged from less than the reporting level to 4.0±0.46 pCi/L. The concentrations reported as cesium-137 in the dissolved fractions ranged from 1.5±0.38 to 106±6.2 pCi/L. Concentrations of gross beta-particle radioactivity reported as cesium-137 in the suspended fractions of the water samples ranged from less than the reporting level to 4.3±0.50 pCi/L.

TRANSURANIC ELEMENTS AND CESIUM-137

Transuranic elements.—Some transuranic elements can be produced in nature because of the availability of neutrons that can be captured by uranium isotopes (Orr and others, 1991, p. 16) and some are produced as by-products of the nuclear industry (Wampler, 1972, p. 6-7). Concentrations of plutonium-238, plutonium-239, -240 (undivided), and americium-241 were determined in 38 samples by the RESL (table 16). All concentrations were less than the reporting level (table 16). Concentrations of plutonium-238, plutonium-239, -240 (undivided), and americium-241 in QA replicate samples were statistically equivalent to those in the routine samples.

Cesium-137.—Cesium-137 is not naturally occurring; however, it can be present in ground water as a fission product from nuclear facilities and weapons tests (Orr and others, 1991, p. 28). The concentrations of cesium-137 in 38 samples were less than the reporting level (table 16). Concentrations of cesium-137 in QA replicate samples were statistically equivalent to those in the routine samples.

RADON-222

Radon-222 is a radioactive noble gas that is a naturally occurring decay product of radium-226. Concentrations in all 38 samples analyzed for radon-222 were larger than the reporting level. The concentrations ranged from 48±14 to 694±14 pCi/L (table 17). Concentrations of radon-222 in QA replicate samples were statistically equivalent to those in the routine samples.

STRONTIUM-90

Strontium-90 does not occur naturally, with the exception of natural reactors such as Oklo, where nuclear fission reactions have occurred in a uranium-enriched deposit (Kuroda, 1982, p. 48-49; Durrance, 1986, p. 90). This radionuclide is present in ground water as a fission product of nuclear-weapons tests and as a result of disposal practices in the nuclear industry (Orr and others, 1991, p. 19). Thirty-eight water samples were analyzed by the RESL and 1 sample was analyzed by the NWQL for strontium-90 concentrations (table 17). Of the 38 samples analyzed by the RESL, only wells USGS 57 and 112 had concentrations larger than the reporting level (table 17). Concentrations in these wells were 33±3 and 30±3 pCi/L, respectively. Concentrations of strontium-90 in QA replicate samples were statistically equivalent to those in the routine samples.

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 (Orr and others, 1991, p. 17). Thirty-eight and 39 water samples were collected and analyzed for tritium concentrations by the RESL and the NWQL, respectively. Although both laboratories used the liquid scintillation technique, the analytical method detection limits differed. The analytical method detection limit for the RESL was about 160 pCi/L using a 20- to 100-minute counting period, and that for the NWQL was 26 pCi/L using a 1,200-minute counting period.

The concentrations in 38 samples analyzed by RESL ranged from less than the reporting level to 40,900±900 pCi/L (table 17). The concentrations in 39 samples analyzed by the NWQL ranged from less than the reporting level to 39,600±380 pCi/L (table 17). Concentrations of tritium analyzed by the NWQL and the RESL in QA replicate samples were statistically equivalent to those in the routine samples.

STABLE ISOTOPES

Water samples were analyzed for relative concentrations of stable isotopes of hydrogen (H), oxygen (O), carbon (C), sulfur (S), and nitrogen (N). Because the absolute measurement of isotopic ratios is analytically difficult, relative isotopic ratios are measured instead (Toran, 1982). For example,

$^{18}O/^{16}O$ of a sample is compared with $^{18}O/^{16}O$ of a standard:

$$\delta^{18}O = (R_{sample}/R_{standard} - 1) \times 1{,}000,$$

where

R_{sample} = $^{18}O/^{16}O$ in the sample,

$R_{standard}$ = $^{18}O/^{16}O$ in the standard, and

$\delta^{18}O$ = relative concentration, in units of parts per thousand (permil).

Delta ^{18}O ($\delta^{18}O$) is referred to as delta notation and is the value reported by isotopic laboratories for stable isotope analysis. $^{2}H/^{1}H$, $^{13}C/^{12}C$, $^{34}S/^{32}S$, and $^{15}N/^{14}N$ are defined in a similar manner with the respective ratios replacing $^{18}O/^{16}O$ in R_{sample} and $R_{standard}$. The standard used for determining $\delta^{18}O$ and $\delta^{2}H$ in water is standard mean ocean water as defined by Craig (1961). The standard used for determining $\delta^{13}C$ in water is the PeeDee Belemnite reference standard (Timme, 1995, p. 71). The standard used for determining $\delta^{34}S$ in water is the Vienna Canyon Diablo Troilite reference standard (Carmody, USGS, written commun., 1996). The standard used for determining $\delta^{15}N$ in water is air equilibrated with water (Timme, 1995, p. 71). The respective precisions of measurement for $\delta^{2}H$, $\delta^{18}O$, $\delta^{13}C$, $\delta^{34}S$, and $\delta^{15}N$ are 1.5 permil, 0.15 permil, 0.3 permil, 0.2 permil, and 0.2 permil at the 95-percent confidence level (Timme, 1995, p. 71-72; Carmody, USGS, written commun., 1996).

Relative concentrations of stable isotopes are shown in table 18. Relative isotopic ratios reported as $\delta^{2}H$ in 39 samples ranged from -141 to -120 permil. Relative isotopic ratios reported as $\delta^{18}O$ in 39 samples ranged from -18.55 to -14.95 permil. Relative isotopic ratios reported as $\delta^{13}C$ in 37 samples ranged from -13.5 to -7.5 permil. Relative isotopic ratios reported as $\delta^{34}S$ in 39 samples ranged from 3.3 to 16.0 permil. Relative isotopic ratios reported as $\delta^{15}N$ in 38 samples ranged from 3.7 to 9.5 permil. Relative isotopic concentrations reported as $\delta^{2}H$, $\delta^{18}O$, $\delta^{13}C$, $\delta^{34}S$, and $\delta^{15}N$ in QA replicate samples were statistically equivalent to those in the routine samples, except for $\delta^{13}C$ in the samples from Site 17 (which was statistically indeterminate) and $\delta^{15}N$ in the sample from USGS 7 (which was not equivalent).

SUMMARY

This report presents ground-water-quality data collected during 1990–94 from 39 locations in the eastern Snake River Plain. The data were collected as part of the USGS's continuing hydrogeologic investigations at the INEEL. The ranges of concentrations for dissolved cations, anions, and silica follow: calcium, 5.4 to 88 mg/L; magnesium, 0.82 to 23 mg/L; sodium, 5.4 to 47 mg/L; potassium, 1.0 to 15 mg/L; silica, 10 to 48 mg/L; chloride, 2.6 to 120 mg/L; sulfate, 2.0 to 200 mg/L; bicarbonate, 41 to 337 mg/L; and fluoride, <0.1 to 4.8 mg/L.

Samples were analyzed for as many as 23 minor inorganic constituents. Concentrations of aluminum, beryllium, cadmium, cobalt, copper, lead, mercury, molybdenum, nickel, selenium, silver, and vanadium were either less than or near the laboratory reporting levels. Hexavalent chromium ranged from less than the reporting level to 160 µg/L; dissolved chromium ranged from less than the reporting level to 190 µg/L; and total chromium ranged from less than the reporting level to 210 µg/L. The respective ranges of concentrations for arsenic, barium, bromide, iron, lithium, manganese, stable strontium, and zinc were less than the reporting level to 21 µg/L, less than the reporting level to 180 µg/L, 10 to 150 µg/L, 4 to 210 µg/L, less than the reporting level to 71 µg/L, less than the reporting level to 83 µg/L, 6 to 990 µg/L, and less than the reporting level to 420 µg/L. The predominant nitrogen-bearing compound in these samples was nitrite plus nitrate, which ranged in concentration from less than the reporting level to 4.4 mg/L expressed as nitrogen.

At least one purgeable organic compound was present in water from 10 of 39 sampling sites, and one or more extractable acid and base/neutral organic compounds were present in water from 15 of 38 sampling sites. EDTA and citrate were not present in any sample at concentrations larger than the laboratory reporting levels of 20 and 5 µg/L, respectively. Concentrations of DOC ranged from 0.1 to 1.2 mg/L.

Concentrations of dissolved gross alpha-particle radioactivity reported as thorium-230 ranged from less than the reporting level to 14.4±1.2 pCi/L, and concentrations of dissolved gross beta-particle radioactivity reported as cesium-137 ranged from 1.5±0.38 to 106±6.2 pCi/L. Concentrations of plutonium-238, plutonium-239, -240 (undivided), americium-241, and cesium-137 were less than the reporting level. Concentrations of radon-222 ranged from 48±14 to 694±14 pCi/L. Strontium-90 concentrations ranged from less than the reporting level to 33±3 pCi/L; however, concentrations in samples from only wells USGS 57 and 112 were larger than the reporting level. Tritium concentrations in 38 samples analyzed by the RESL ranged from less than the reporting level to 40,900±900 pCi/L, and concentrations in 39 samples analyzed by the NWQL ranged from less than the reporting level to 39,600±380 pCi/L.

Relative isotopic ratios ranged from -141 to -120 permil for δ^2H, -18.55 to -14.95 permil for $\delta^{18}O$, -13.5 to -7.5 permil for $\delta^{13}C$, 3.3 to 16.0 permil for $\delta^{34}S$, and 3.7 to 9.5 permil for $\delta^{15}N$. Of 600 QA sample pairs, 592, or 99 percent, were statistically equivalent. Equivalence of two sample pairs was statistically indeterminate.

SELECTED REFERENCES

Ackerman, D.J., 1991, Transmissivity of the Snake River Plain aquifer at the Idaho National Engineering Laboratory, Idaho: U.S. Geological Survey Water-Resources Investigations Report 91-4058 (DOE/ID-22097), 35 p.

Anderson, S.R., Ackerman, D.J., Liszewski, M.J., and Freiburger, R.M., 1996, Stratigraphic data for wells at and near the Idaho National Engineering Laboratory, Idaho: U.S. Geological Survey Open-File Report 96-248 (DOE/ID-22127), 27 p. and 1 diskette.

Bartholomay, R.C., Orr, B.R., Liszewski, M.J., and Jensen, R.G., 1995, Hydrologic conditions and distribution of selected radiochemical and chemical constituents in water, Snake River Plain aquifer, Idaho National Engineering Laboratory, Idaho, 1989 through 1991: U.S. Geological Survey Water-Resources Investigations Report 95-4175 (DOE/ID-22123), 47 p.

Bartholomay, R.C., Tucker, B.J., Ackerman, D.J., and Liszewski, M.J., 1997, Hydrologic conditions and distribution of selected radiochemical and chemical constituents in water, Snake River Plain aquifer, Idaho National Engineering Laboratory, Idaho, 1992 through 1995: U.S. Geological Survey Water-Resources Investigations Report 97-4086 (DOE/ID-22137), 57 p.

Claassen, H.C., 1982, Guidelines and techniques for obtaining water samples that accurately represent the water chemistry of an aquifer: U.S. Geological Survey Open-File Report 82-1024, 49 p.

Craig, Harmon, 1961, Isotopic variations in meteoric waters: Science, v. 133, p. 1,702-1,703.

Currie, L.A., 1984, Lower limits of detection—definition and elaboration of a proposed position for radiological effluent and environmental measurements: U.S. Nuclear Regulatory Commission NUREG/CR-4007, 139 p.

Durrance, E.M., 1986, Radioactivity in geology: principles and applications: New York, John Wiley and Sons, Inc., 441 p.

Faires, L.M., 1992, Methods of analysis by the U.S. Geological Survey National Water Quality Laboratory—determinations of metals in water by inductively coupled plasma—mass spectrometry: U.S. Geological Survey Open-File Report 92-634, 28 p.

Fishman, M.J., ed., 1993, Methods of analysis by the U.S. Geological Survey National Water Quality Laboratory—determination of inorganic and organic constituents in water and fluvial sediments: U.S. Geological Survey Open-File Report 93-125, 217 p.

Fishman, M.J., and Friedman, L.C., eds., 1989, Methods for determination of inorganic substances in water and fluvial sediments: U.S. Geological Survey Techniques of Water-Resources Investigations, book 5, chap. A1, 545 p.

Friedman, L.C., and Erdmann, D.E., 1982, Quality assurance practices for the chemical and biological analyses of water and fluvial sediments: U.S. Geological Survey Techniques of Water-Resources Investigations, book 5, chap. A6, 181 p.

Goerlitz, D.F., and Brown, Eugene, 1972, Methods for analysis of organic substances in water: U.S. Geological Survey Techniques of Water-Resources Investigations, book 5, chap. A3, 40 p.

Hardy, M.A., Leahy, P.P., and Alley, W.M., 1989, Well installation and documentation and ground-water sampling protocols for the pilot National Water-Quality Assessment Program: U.S. Geological Survey Open-File Report 89-396, 36 p.

Hem, J.D., 1985, Study and interpretation of the chemical characteristics of natural water (3rd ed.): U.S. Geological Survey Water-Supply Paper 2254, 263 p.

Horowitz, A.J., Demas, C.R., Fitzgerald, K.K., Miller, T.L., and Rickert, D.A., 1995, U.S. Geological Survey protocol for the collection and processing of surface-water samples for the subsequent determination of inorganic constituents in filtered water: U.S. Geological Survey Open-File Report 94-539, 57 p.

Iman, R.L., and Conover, W.J., 1983, A modern approach to statistics: New York, John Wiley & Sons, Inc., 497 p.

Jones, B.E., 1987, Quality control manual of the U.S. Geological Survey's National Water Quality Laboratory: U.S. Geological Survey Open-File Report 87-457, 17 p.

Knobel, L.L., Bartholomay, R.C., Cecil, L.D., Tucker, B.J., and Wegner, S.J., 1992, Chemical constituents in the dissolved and suspended fractions of ground water from selected sites, Idaho National Engineering Laboratory and vicinity, Idaho, 1989: U.S. Geological Survey Open-File Report 92-51 (DOE/ID-22101), 56 p.

Knobel, L.L., Bartholomay, R.C., and Orr, B.R., 1997, Preliminary delineation of natural geochemical reactions, Snake River Plain aquifer system, Idaho National Engineering Laboratory and vicinity, Idaho: U.S. Geological Survey Water-Resources Investigations Report 97-4093 (DOE/ID-22139), 52 p.

Kuroda, P.K., 1982, The origin of the chemical elements and the Oklo phenomenon: New York, Springer-Verlag, 165 p.

Lucey, K.J., 1990, QADATA User's Manual: An interactive computer program for the retrieval and analysis of the results from the external blind sample quality-assurance project of the U.S. Geological Survey: U.S. Geological Survey Open-File Report 90-162, 53 p.

Maloney, T.J., Ludtke, A.S., and Krizman, T.L., 1993, Quality assurance for routine water analysis in the laboratories of the U.S. Geological Survey for water year 1990: U.S. Geological Survey Water-Resources Investigations Report 93-4082, 145 p.

Mann, L.J., 1986, Hydraulic properties of rock units and chemical quality of water for INEL-1—a 10,365-foot deep test hole drilled at the Idaho National Engineering Laboratory, Idaho: U.S. Geological Survey Water-Resources Investigations Report 86-4020 (DOE/ID-22070), 23 p.

----- 1989, Tritium concentrations in flow from selected springs that discharge to the Snake River, Twin Falls-Hagerman area, Idaho: U.S. Geological Survey Water-Resources Investigations Report 89-4156 (DOE/ID-22084), 20 p.

Orr, B.R., and Cecil, L.D., 1991, Hydrologic conditions and distribution of selected chemical constituents in water, Snake River Plain aquifer, Idaho National Engineering Laboratory, Idaho, 1986 to

1988: U.S. Geological Survey Water-Resources Investigations Report 91-4047 (DOE/ID-22096), 56 p.

Orr, B.R., Cecil, L.D., and Knobel, L.L., 1991, Background concentrations of selected radionuclides, organic compounds, and chemical constituents in ground water in the vicinity of the Idaho National Engineering Laboratory: U.S. Geological Survey Water-Resources Investigations Report 91-4015 (DOE/ID-22094), 52 p.

Ott, R.L., 1993, An introduction to statistical methods and data analysis (4th ed.): Belmont, California, Wadsworth Publishing Company, 1,183 p.

Pritt, J.W., 1989, Quality assurance of sample containers and preservatives at the U.S. Geological Survey National Water Quality Laboratory, *in* Pederson, G.L., and Smith, M.M., compilers, U.S. Geological Survey Second National Symposium on Water Quality—Abstracts of the technical sessions, Orlando, Fla., November 12-17, 1989: U.S. Geological Survey Open-File Report 89-409, 111 p.

Pritt, J.W., and Jones, B.E., eds., 1989, 1990 National Water Quality Laboratory services catalog: U.S. Geological Survey Open-File Report 89-386, [variously paged].

Pritt, J.W., and Raese, J.W., eds., 1995, Quality assurance/quality control manual—National Water Quality Laboratory: U.S. Geological Survey Open-File Report 95-443, 35 p.

Rose, D.L., and Schroeder, M.P., 1995, Methods of analysis by the U.S. Geological Survey National Water Quality Laboratory—determination of volatile organic compounds in water by purge and trap capillary gas chromatograph/mass spectrometry: U.S. Geological Survey Open-File Report 94-708, 26 p.

Skougstad, M.W., Fishman, M.J., Friedman, L.C., Erdmann, D.E., and Duncan, S.S., eds., 1979, Methods for determination of inorganic substances in water and fluvial sediments: U.S. Geological Survey Techniques of Water-Resources Investigations, book 5, chap. A1, 626 p.

Stevens, H.H., Jr., Ficke, J.F., and Smoot, G.F., 1975, Water temperature—influential factors, field measurement, and data presentation: U.S. Geological Survey Techniques of Water-Resources Investigations, book 5, chap. D1, 65 p.

Thatcher, L.L., Janzer, V.J., and Edwards, K.W., 1977, Methods for determination of radioactive substances in water and fluvial sediments: U.S. Geological Survey Techniques of Water-Resources Investigations, book 5, chap. A5, 95 p.

Timme, P.J., 1995, National Water Quality Laboratory, 1995 services catalog: U.S. Geological Survey Open-File Report 95-352, 120 p.

Toran, Laura, 1982, Isotopes in ground-water investigations: Groundwater, v. 20, no. 6, p. 740-745.

U.S. Geological Survey, 1985, National water summary, 1984—hydrologic events, selected water-quality trends, and ground-water resources: U.S. Geological Survey Water-Supply Paper 2275, 467 p.

Volk, William, 1969, Applied statistics for engineers (2d ed.): New York, McGraw-Hill Book Company, 415 p.

Wampler, J.M., 1972, Actinide series, *in* Fairbridge, R.W., ed., The encyclopedia of geochemistry and environmental sciences: Stroudsburg, Pa., Dowden, Hutchinson, and Ross, p. 5-9.

Wegner, S.J., 1989, Selected water quality assurance data for water samples collected by the U.S. Geological Survey, Idaho National Engineering Laboratory, Idaho, 1980 to 1988: U.S. Geological Survey Water-Resources Investigations Report 89-4168 (DOE/ID-22085), 91 p.

Wegner, S.J., and Campbell, L.J., 1991, Radionuclides, chemical constituents, and organic compounds in water from designated wells and springs from the southern boundary of the Idaho National Engineering Laboratory to the Hagerman area, Idaho, 1989: U.S. Geological Survey Open-File Report 91-232 (DOE/ID-22098), 49 p.

Wershaw, R.L., Fishman, M.J., Grabbe, R.R., and Lowe, L.E., 1987, Methods for the determination of organic substances in water and fluvial sediments: U.S. Geological Survey Techniques of Water-Resources Investigations, book 5, chap. A3, 80 p.

Williams, L.M., 1996, Evaluation of quality assurance/quality control data collected by the U.S. Geological Survey for water-quality activities at the Idaho National Engineering Laboratory, Idaho, 1989 through 1993: U.S. Geological Survey Water-Resources Investigations Report 96-4148 (DOE/ID-22129), 115 p.

---- 1997, Evaluation of quality assurance/quality control data collected by the U.S. Geological Survey for water-quality activities at the Idaho National Engineering Laboratory, Idaho, 1994 through 1995: U.S. Geological Survey Water-Resources Investigations Report 97-4058 (DOE/ID-22136), 87 p.

Wood, W.W., 1981, Guidelines for collection and field analysis of ground-water samples for selected unstable constituents: U.S. Geological Survey Techniques of Water-Resources Investigations, book 1, chap. D2, 24 p.

Table 1. Containers and preservatives used for water samples, Idaho National Engineering and Environmental Laboratory and vicinity

[Abbreviations: L, liter; mL, milliliter; mg, milligram; EDTA, ethylenediaminetetraacetic acid; $HgCl_2$, mercuric chloride; NaCl, sodium chloride; NaOH, sodium hydroxide; HNO_3, nitric acid; $K_2Cr_2O_7$, potassium dichromate; HCl, hydrochloric acid; $SrCl_2$, strontium chloride; C, carbon; O, oxygen; D, deuterium; H, protium; S, sulfur; N, nitrogen; Hg, mercury; °C, degrees Celsius. Samples were shipped to the laboratory by overnight-delivery mail. Analyzing laboratory: NWQL, U.S. Geological Survey's National Water Quality Laboratory; RESL, U.S. Department of Energy's Radiological and Environmental Sciences Laboratory]

Type of constituent	Container		Preservative		Other treatment	Analyzing laboratory
	Type	Size	Type	Size		
Anions and silica	Polyethylene	250 mL	None	None	Filter	NWQL
Cations, dissolved	Polyethylene, acid-rinsed	500 mL	HNO_3	2 mL	Filter	NWQL
Cations, total	Polyethylene, acid-rinsed	250 mL	HNO_3	1 mL	None	NWQL
Cyanide, dissolved	Polyethylene	250 mL	NaOH	5 mL	Filter, chill 4°C	NWQL
Metals, dissolved	Polyethylene, acid-rinsed	500 mL	HNO_3	2 mL	Filter	NWQL
Metals, total	Polyethylene, acid-rinsed	1 L	HNO_3	4 mL	None	NWQL
Mercury, dissolved	Glass, acid-rinsed	250 mL	$K_2Cr_2O_7/HNO_3$	10 mL	Filter	NWQL
Mercury, total	Glass, acid-rinsed	250 mL	$K_2Cr_2O_7/HNO_3$	10 mL	None	NWQL
Chromium, total	Polyethylene, acid-rinsed	500 mL	HNO_3	2 mL	None	NWQL
Nutrients, dissolved	Polyethylene, brown	250 mL	$HgCl_2$/ NaCl	1 mL	Filter, chill 4°C	NWQL
Purgeable organic compounds	Glass, baked	40 mL	None	None	Chill 4°C	NWQL
Semi-volatile organic compounds	Glass, baked	1 L	None	None	Chill 4°C	NWQL
Dissolved organic carbon	Glass, baked	125 mL	None	None	Filter, silver, chill 4°C	NWQL
Total organic carbon	Glass, baked	125 mL	None	None	Chill 4°C	NWQL
EDTA and citrate	Glass, baked	1 L	None	None	Chill 4°C	NWQL

Table 1. Containers and preservatives used for water samples, Idaho National Engineering and Environmental Laboratory and vicinity—Continued

Type of constituent	Container		Preservative		Other treatment	Analyzing laboratory
	Type	Size	Type	Size		
$^{13}C/^{12}C$	Glass, baked	1 L	Ammoniacal $SrCl_2$	50 mL	None	NWQL
$^{15}N/^{14}N$	Glass, baked	1 L	$HgCl_2$/NaCl	1 mL	Filter, chill 4°C	NWQL
$^{18}O/^{16}O$ and D/H	Polyethylene	125 mL	None	None	None	NWQL
	Polyethylene	125 mL	$HgCl_2$/NaCl	Tablet, 10 mg Hg	None	NWQL
$^{34}S/^{32}S$	Glass, baked	1 L	$HgCl_2$/NaCl	1 mL	Filter, chill 4°C	NWQL
	Glass, baked	1 L	None	None	Filter, chill 4°C	NWQL
Gross alpha and beta	Polyethylene, acid-rinsed	1 L	None	None	None	NWQL
Tritium	Polyethylene, acid-rinsed	250 mL	None	None	None	NWQL
	Polyethylene	500 mL	None	None	None	RESL
	Glass, baked	1 L	None	None	None	NWQL
Radon-222	Glass vials	20 mL	Scintillation cocktail	10 mL	None	NWQL
Stronium-90	Polyethylene, acid-rinsed	1 L	HCl	20 mL	None	RESL
Radium-226	Polyethylene, acid-rinsed	1 L	HCl	5 mL	Filter	NWQL
Radium-228	Polyethylene, acid-rinsed	1 L	HCl	5 mL	Filter	NWQL
Gamma spectroscopy	Polyethylene, acid-rinsed	1 L	HCl	20 mL	None	RESL
Transuranics	Polyethylene, acid-rinsed	1 L	HCl	20 mL	None	RESL

Table 2. Results of field measurements for pH, specific conductance, and temperature of water from selected sites, Idaho National Engineering and Environmental Laboratory and vicinity

[Site identifier: see figures 1 and 2 for location of sites. 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. Remarks: QA indicates quality assurance]

Site identifier	Date sampled (m/d/y)	Time	pH	Specific conductance	Temperature	Remarks
Big Springs	11/1/94	1230	6.5	98	10.5	Spring
CFA-1	6/19/91	0925	7.8	680	12.0	
CPP-1	6/6/91	0930	8.0	405	12.5	
EBR-I	6/19/91	1110	8.2	279	19.5	
Fire Station 2	6/19/91	1325	8.0	421	12.0	
Lidy Hot Springs	11/5/90	1255	7.1	550	46.0	Spring
	8/20/92	1045	7.1	690	47.0	Spring, resample
McKinney Well	6/13/91	1125	7.9	352	8.0	
No Name No. 1	5/22/91	1140	8.1	360	11.5	
NPR Test	6/20/91	1110	8.0	442	14.5	
P&W 2	5/22/91	1405	8.0	348	10.5	
Park Bell Well	6/11/91	1140	8.1	282	12.5	
Ruby Farms Well	5/10/91	1100	7.9	550	10.0	
Site 9	6/25/91	1430	8.0	350	14.5	
Site 14	6/13/91	1430	8.0	335	17.0	
Site 17	6/18/91	1420	7.8	431	13.0	
	6/18/91	1420	7.8	431	13.0	QA replicate
Site 19	5/9/91	1345	8.0	387	15.0	
Stoddart Well	6/12/91	0915	8.5	335	12.5	
USGS 1	5/30/91	1015	8.1	303	14.5	
2	5/28/91	1145	8.0	342	14.0	
	5/28/91	1145	8.0	342	14.0	QA replicate
4	6/4/91	1010	7.8	722	12.0	
	6/4/91	1010	7.8	722	12.0	QA replicate
7	5/20/91	1130	8.1	300	20.0	

Table 2. Results of field measurements for pH, specific conductance, and temperature of water from selected sites, Idaho National Engineering and Environmental Laboratory and vicinity—Continued

Site identifier	Date sampled (m/d/y)	Time	pH	Specific conductance	Temperature	Remarks
	5/20/91	1130	8.1	300	20.0	QA replicate
USGS 8	5/31/91	1405	8.1	370	12.0	
9	5/31/91	0935	8.3	390	11.5	
17	6/6/91	1305	8.2	291	14.0	
19	5/21/91	1015	7.8	401	17.5	
20	5/30/91	1250	8.0	348	13.0	
23	5/21/91	1315	8.0	358	16.0	
26	5/23/91	0950	7.9	382	15.5	
	11/17/92	1310	7.9	365	14.5	Resample
27	5/23/91	1225	8.0	550	16.0	
29	6/12/91	1515	8.0	470	13.0	
31	6/12/91	1235	8.0	398	16.0	
32	6/12/91	1800	8.0	537	15.0	
57	5/13/91	1410	7.8	690	14.5	
65	5/16/91	1020	8.0	600	14.0	
85	6/4/91	1400	8.0	518	13.0	
86	5/31/91	1145	8.2	340	11.0	
101	5/15/91	1240	8.1	273	14.0	
110	5/8/91	1400	8.1	370	14.5	
112	5/13/91	1015	7.8	760	14.0	

Table 3. Results of field measurements for alkalinity and dissolved oxygen, and laboratory calculations of total hardness and dissolved solids in water from selected sites, Idaho National Engineering and Environmental Laboratory and vicinity

[Site identifier: see figures 1 and 2 for location of sites. Units: milligrams per liter. Chemical symbols: $CaCO_3$ indicates calcium carbonate. Alkalinity: digital titration with 0.16 normal sulfuric acid. Dissolved oxygen: digital titration using the azide modification of the Winkler method. Remarks: OS indicates dissolved oxygen measurement exceeded saturation at ambient temperature and pressure. QA indicates quality assurance. Symbols: < indicates less than; NM indicates not measured]

Site identifier	Alkalinity (as $CaCO_3$)	Dissolved oxygen	Hardness, total (as $CaCO_3$)	Dissolved solids, sum (as $CaCO_3$)	Remarks
Big Springs	34	8.9	17	97	Spring
CFA-1	125	9.5	250	356	
CPP-1	159	9.2	190	237	
EBR-I	116	6.7	130	179	
Fire Station 2	170	9.1	200	243	
Lidy Hot Springs	158	1.7	290	480	Spring
	141	NM	280	467	Spring, resample
McKinney Well	149	5.4	170	199	
No Name No. 1	127	12.2	140	200	OS
NPR Test	173	9.2	210	257	
P&W 2	139	9.7	160	194	
Park Bell Well	127	<.2	74	203	
Ruby Farms Well	167	9.6	250	305	
Site 9	139	6.8	150	213	
Site 14	133	6.8	140	213	
Site 17	187	8.1	210	240	
	187	8.1	200	239	QA replicate
Site 19	163	8.1	180	230	
Stoddart Well	156	.7	120	206	
USGS 1	126	7.9	120	202	
2	136	8.0	140	213	
	136	8.0	140	217	QA replicate
4	276	7.7	260	396	
	276	7.7	260	415	QA replicate

Table 3. Results of field measurements for alkalinity and dissolved oxygen, and laboratory calculations of total hardness and dissolved solids in water from selected sites, Idaho National Engineering and Environmental Laboratory and vicinity—Continued

Site identifier	Alkalinity (as $CaCO_3$)	Dissolved oxygen	Hardness, total (as $CaCO_3$)	Dissolved solids, sum (as $CaCO_3$)	Remarks
USGS 7	122	3.9	100	219	
	122	3.9	100	212	QA replicate
8	154	8.0	180	217	
9	140	8.2	170	239	
17	124	8.8	130	175	
19	177	6.9	190	226	
20	120	8.6	150	201	
23	153	7.5	170	243	
26	150	7.6	190	263	
	146	NM	160	237	Resample
27	134	5.3	200	325	
29	170	7.4	190	275	
31	140	7.3	170	243	
32	135	8.0	220	309	
57	121	8.3	240	386	
65	123	8.6	290	388	
85	153	9.0	200	288	
86	102	11.4	140	205	OS
101	120	7.2	110	183	
110	138	7.6	150	237	
112	116	6.6	250	402	

Table 4. Concentrations of dissolved major cations and silica in water, Idaho National Engineering and Environmental Laboratory and vicinity

[Analyses were performed by the U.S. Geological Survey's National Water Quality Laboratory. Analytical results in milligrams per liter. Site identifier: see figures 1 and 2 for location of sites. Silica: concentrations are reported as SiO_2. Remarks: QA indicates quality assurance; Z-values associated with QA replicates were calculated using equation 1]

Site identifier	Calcium	Magnesium	Sodium	Potassium	Silica	Remarks
Big Springs	5.4	0.82	13	3.0	46	Spring
CFA-1	66	21	30	4.3	26	
CPP-1	54	14	7.9	2.5	23	
EBR-I	24	16	9.0	3.4	34	
Fire Station 2	53	17	8.7	2.4	24	
Lidy Hot Springs	88	16	27	15	33	Spring
	88	15	26	15	31	Spring, resample
McKinney Well	45	15	5.4	1.0	10	
No Name No. 1	33	14	11	3.4	24	
NPR Test	59	15	8.4	2.5	22	
P&W 2	40	14	7.9	1.2	14	
Park Bell Well	22	4.6	28	4.8	48	
Ruby Farms Well	62	23	14	1.6	19	
Site 9	37	14	12	2.5	27	
Site 14	35	13	16	2.9	31	
Site 17	54	17	10	1.3	18	
	53	17	10	1.3	17	QA replicate
	.76	0	0	0	1.35	Z-value
Site 19	45	17	8.7	1.8	21	
Stoddart Well	19	17	23	4.3	29	
USGS 1	30	11	14	3.1	32	
2	36	12	16	3.4	33	
	37	12	16	3.4	33	QA replicate
	1.49	0	0	0	0	Z-value
4	66	23	45	5.4	28	
	65	23	44	5.6	28	QA replicate

Table 4. Concentrations of dissolved major cations and silica in water, Idaho National Engineering and Environmental Laboratory and vicinity—Continued

Site identifier	Calcium	Magnesium	Sodium	Potassium	Silica	Remarks
	.86	0	0.39	0.53	0	Z-value
USGS 7	25	9.2	25	4.6	48	
	25	9.2	25	4.4	48	QA replicate
	0	0	0	.61	0	Z-value
8	46	15	6.7	1.8	20	
9	43	16	13	3.4	24	
17	36	9.3	7.0	2.4	23	
19	48	18	13	1.6	16	
20	41	12	8.0	2.6	23	
23	41	17	9.4	1.6	19	
26	43	15	14	6.0	33	
	39	14	14	3.3	33	Resample
27	50	17	27	6.0	38	
29	52	15	22	3.4	34	
31	43	14	15	3.6	35	
32	55	19	20	4.4	35	
57	67	18	41	3.6	23	
65	85	19	14	3.0	21	
85	57	14	22	2.9	21	
86	39	9.6	11	3.1	26	
101	29	9.1	15	2.7	35	
110	37	15	19	3.8	33	
112	70	18	47	4.5	23	

Table 5. Concentrations of dissolved major anions and alkalinity in water, Idaho National Engineering and Environmental Laboratory and vicinity

[Analyses were performed by the U.S. Geological Survey's National Water Quality Laboratory. Alkalinity data were calculated from field measurements listed in table 3; the alkalinity (as calcium carbonate) was divided by 0.8202 (Hem, 1985, p. 57). Analytical results in milligrams per liter. Site identifier: see figures 1 and 2 for location of sites. Remarks: QA indicates quality assurance; Z-values associated with QA replicates were calculated using equation 1; N indicates that Z-value is greater than 1.96 and that the two results are not equivalent. Chemical symbol: HCO_3^- indicates bicarbonate. Symbol: < indicates less than]

Site identifier	Chloride	Sulfate	Alkalinity (as HCO_3^-)	Fluoride	Remarks
Big Springs	2.6	2.0	41	3.0	Spring
CFA-1	100	33	152	.2	
CPP-1	18	22	194	.1	
EBR-I	7.4	13	141	.2	
Fire Station 2	15	21	207	.2	
Lidy Hot Springs	6.7	200	193	4.8	Spring
	8.4	190	172	4.2	Spring, resample
McKinney Well	5.4	26	182	.2	
No Name No. 1	21	17	155	.4	
NPR Test	20	26	211	.2	
P&W 2	11	21	169	.3	
Park Bell Well	6.8	8.3	155	.9	
Ruby Farms Well	50	32	204	<.1	
Site 9	16	21	169	.4	
Site 14	9.5	24	162	.5	
Site 17	11	16	228	.1	
	12	16	228	.1	QA replicate
	0.71	0	0	0	Z-value
Site 19	10	27	199	<.1	
Stoddart Well	10	9.8	190	.5	
USGS 1	14	18	154	.7	
2	16	14	166	.7	
	19	14	166	.8	QA replicate
	1.84	0	0	.79	Z-value

Table 5. Concentrations of dissolved major anions and alkalinity in water, Idaho National Engineering and Environmental Laboratory and vicinity—Continued

Site identifier	Chloride	Sulfate	Alkalinity (as HCO_3^-)	Fluoride	Remarks
USGS 4	51	39	337	.3	
	40	40	337	.3	QA replicate
	3.34(N)	.33	0	0	Z-value
7	12	20	149	1.4	
	9.9	16	149	1.6	QA replicate
	1.52	4.48(N)	0	1.21	Z-value
8	10	22	188	.3	
9	25	29	171	.2	
17	6.0	16	151	.1	
19	14	24	216	.3	
20	21	22	146	.2	
23	16	31	187	.2	
26	13	32	183	.4	
	14	31	178	.5	Resample
27	67	40	163	.6	
29	29	16	207	.4	
31	19	26	171	.4	
32	53	40	165	.4	
57	110	35	148	.3	
65	21	150	150	<.1	
85	46	31	187	.2	
86	19	28	124	.2	
101	10	9.5	146	.9	
110	22	22	168	.5	
112	120	34	141	.3	

Table 6. Concentrations of selected dissolved minor inorganic constituents and total chromium in water, Idaho National Engineering and Environmental Laboratory and vicinity

[Analyses were performed by the U.S. Geological Survey's National Water Quality Laboratory. Analytical results in micrograms per liter. See figures 1 and 2 for location of sites. Symbols: NR indicates analysis not requested; < indicates concentration is less than the indicated reporting level. Z-values associated with replicates were calculated using equation 1; N indicates that Z-value is greater than 1.96 and that the two results are not equivalent. Water samples from the Ruby Farms Well, Site 19, USGS 57, 65, 101, 110, and 112 were analyzed for cyanide; the concentrations were less than the reporting level of 0.01 milligram per liter]

Constituent	Big Springs	CFA-1	CPP-1	EBR-I	Fire Station 2	Lidy Hot Springs	Resample, Lidy Hot Sp.	McKinney Well	No Name No. 1	NPR Test	P&W 2	Park Bell Well	Ruby Farms Well
Aluminum	<10	<10	<10	<10	<10	10	<10	<10	<10	<10	<10	<10	<10
Arsenic	2	<1	1	1	<1	9	NR	2	2	1	1	21	2
Barium	<2	92	81	21	70	48	NR	64	63	84	43	62	110
Beryllium	NR	<.5	<.5	<.5	<.5	NR	NR	<.5	<.5	<.5	<.5	<.5	<.5
Bromide	20	140	40	20	40	20	30	10	40	50	20	20	100
Cadmium	NR	<1	<1	<1	<1	<1	NR	<1	<1	<1	<1	<1	<1
Cobalt	<3	<3	<3	<3	<3	NR	NR	<3	<3	<3	<3	<3	<3
Copper	NR	<10	<10	<10	<10	NR	NR	<10	<10	<10	<10	<10	<10
Chromium	NR	20	7	5	4	1	NR	<1	10	5	<5	<5	8
Chromium, hexavalent	1	12	5	3	2	<1	<1	<1	8	2	<1	<1	10
Chromium, total	<1	20	6	7	5	2	<1	<1	22	6	2	<1	12
Iron	6	11	16	13	9	11	8	7	84	8	18	85	14
Lead	<1	<1	20	<1	1	<1	<1	<1	20	1	20	<1	<1
Lithium	NR	5	11	<4	<4	NR	NR	5	5	<4	6	71	5
Manganese	<1	<1	<1	<1	<1	12	12	<1	3	4	<1	83	<1
Mercury	<.1	<.1	<.1	<.1	<.1	<.1	<.1	<.1	<.1	<.1	<.1	<.1	<.1
Molybdenum	NR	<10	<10	<10	<10	NR	NR	<10	<10	<10	<10	<10	<10
Nickel	NR	<10	<10	<10	<10	NR	NR	<10	<10	<10	<10	<10	<10
Selenium	<1	<1	<1	<1	<1	<1	NR	<1	2	<1	<1	<1	3
Silver	NR	<1	2	<1	<1	<1	NR	<1	2	<1	<1	2	3
Strontium	6	430	270	210	290	990	990	170	160	300	140	77	240
Vanadium	NR	<6	6	14	6	NR	NR	<6	<6	<6	<6	<6	<6
Zinc	NR	5	17	3	15	NR	NR	8	6	150	61	10	64

Table 6. Concentrations of selected dissolved minor inorganic constituents and total chromium in water, Idaho National Engineering and Environmental Laboratory and vicinity—Continued

Constituent	Site 9	Site 14	Site 17	Replicate, Site 17	Z-value	Site 19	Stoddart Well	USGS 1	USGS 2	Replicate, USGS 2	Z-value
Aluminum	<10	<10	<10	<10	0	<10	10	10	<10	20	0.94
Arsenic	2	4	2	2	0	1	18	3	<1	2	.92
Barium	56	63	78	78	0	45	51	23	32	31	1.18
Beryllium	<.5	<.5	<.5	<.5	0	<.5	<.5	<.5	<.5	<.5	0
Bromide	30	20	40	40	0	40	30	30	50	40	1.04
Cadmium	<1	<1	<1	<1	0	<1	<1	<1	<1	<1	0
Cobalt	<3	<3	<3	<3	0	<3	<3	<3	<3	<3	0
Copper	<10	<10	<10	<10	0	<10	<10	<10	<10	<10	0
Chromium	6	3	4	4	0	<5	<1	2	<5	<5	0
Chromium, hexavalent	3	6	1	1	0	3	3	<1	2	2	0
Chromium, total	6	3	6	5	0.27	6	<1	<1	1	3	.50
Iron	16	17	19	10	3.05(N)	8	11	18	32	16	1.91
Lead	<1	1	<1	<1	0	<1	<1	<1	2	<10	1.63
Lithium	4	13	5	5	0	<4	47	22	22	22	0
Manganese	3	<1	<1	<1	0	<1	15	4	3	2	1.11
Mercury	<.1	<.1	<.1	<.1	0	<.1	<.1	<.1	<.1	<.1	0
Molybdenum	<10	<10	<10	<10	0	<10	<10	<10	<10	<10	0
Nickel	<10	<10	<10	<10	0	<10	<10	<10	<10	<10	0
Selenium	<1	<1	<1	<1	0	<1	<1	<1	<1	<1	0
Silver	<1	<1	<1	<1	0	<1	<1	<1	<1	<1	0
Strontium	190	180	240	230	1.07	230	160	120	130	130	0
Vanadium	6	7	<6	<6	0	<6	<6	7	<6	<6	0
Zinc	5	190	7	7	0	72	7	8	10	13	1.09

Table 6. Concentrations of selected dissolved minor inorganic constituents and total chromium in water, Idaho National Engineering and Environmental Laboratory and vicinity—Continued

Constituent	USGS 4	Replicate, USGS 4	Z-value	USGS 7	Replicate, USGS 7	Z-value	USGS 8	USGS 9	USGS 17	USGS 19	USGS 20	USGS 23
Aluminum	<10	<10	0	<10	<10	0	<10	10	10	<10	<10	<10
Arsenic	5	5	0	4	4	0	<1	1	2	2	1	1
Barium	130	130	0	17	17	0	70	33	35	80	47	56
Beryllium	<.5	<.5	0	<.5	<.5	0	<.5	<.5	<.5	<.5	<.5	<.5
Bromide	80	70	1.04	30	30	0	30	60	20	40	30	40
Cadmium	<1	<1	0	<1	<1	0	<1	<1	2	<1	<1	<1
Cobalt	<3	<3	0	<3	<3	0	<3	<3	<3	<3	<3	<3
Copper	<10	<10	0	<10	<10	0	<10	<10	<10	<10	<10	<10
Chromium	10	10	0	<5	<5	0	<5	<5	<5	<5	7	<5
Chromium, hexavalent	9	10	.89	2	1	1.55	2	4	2	<1	7	<1
Chromium, total	11	12	.32	3	5	.79	2	4	2	4	8	3
Iron	41	110	6.06(N)	10	7	.40	21	27	9	11	21	17
Lead	<10	<10	0	<10	<10	0	<10	<10	<10	<10	<10	<10
Lithium	25	27	.66	27	28	.32	6	<4	<4	5	6	6
Manganese	<1	2	1.05	2	2	0	<1	2	2	<1	2	2
Mercury	<.1	<.1	0	<.1	<.1	0	<.1	<.1	<.1	<.1	<.1	<.1
Molybdenum	<10	<10	0	<10	<10	0	<10	<10	<10	<10	<10	<10
Nickel	<10	<10	0	<10	<10	0	<10	<10	<10	<10	<10	<10
Selenium	4	4	0	<1	<1	0	<1	<1	<1	<1	<1	<1
Silver	2	2	0	<1	<1	0	<1	<1	<1	<1	2	<1
Strontium	280	280	0	120	120	0	230	190	200	280	230	230
Vanadium	7	6	0.88	<6	<6	0	<6	<6	<6	<6	<6	<6
Zinc	10	22	4.10(N)	<3	<3	0	14	160	11	5	21	5

Table 6. Concentrations of selected dissolved minor inorganic constituents and total chromium in water, Idaho National Engineering and Environmental Laboratory and vicinity—Continued

Constituent	USGS 26	Resample, USGS 26	USGS 27	USGS 29	USGS 31	USGS 32	USGS 57	USGS 65	USGS 85	USGS 86	USGS 101	USGS 110	USGS 112
Aluminum	<10	<10	10	<10	<10	<10	10	<10	<10	40	10	<10	10
Arsenic	2	NR	2	2	3	2	2	<1	2	1	2	2	1
Barium	37	36	<100	60	40	59	170	56	110	19	18	39	180
Beryllium	<.5	<.5	NR	<.5	.5	<.5	<.5	<.5	<.5	<.5	<.5	<.5	<.5
Bromide	40	30	150	70	40	120	50	50	30	60	30	50	50
Cadmium	<1	<1	<1	<1	<1	2	<1	<1	<1	2	<1	<1	<1
Cobalt	<3	<3	NR	<3	<3	<3	<3	<3	<3	3	<3	<3	<3
Copper	<10	<10	NR	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10
Chromium	<5	<5	2	4	2	5	<5	190	10	19	<5	<5	<5
Chromium, hexavalent	6	<1	6	3	2	3	7	160	12	12	<1	2	6
Chromium, total	3	2	8	<1	<1	<1	8	210	12	22	3	5	8
Iron	19	10	11	26	4	40	4	210	28	59	9	5	6
Lead	<1	<1	<1	<1	<1	<1	<10	<10	<10	30	<10	20	<10
Lithium	17	19	NR	26	18	21	<4	5	6	11	28	17	5
Manganese	2	<1	<1	<1	<1	<1	<1	3	3	2	<1	<1	<1
Mercury	<.1	NR	<.1	<.1	<.1	<.1	.2	<.1	<.1	<.1	<.1	<.1	.2
Molybdenum	<10	<10	NR	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10
Nickel	<10	<10	NR	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10
Selenium	<1	NR	<1	<1	<1	<1	<1	<1	<1	1	<1	<1	<1
Silver	<1	<1	<1	<1	<1	<1	<1	<1	3	<1	<1	<1	<1
Strontium	190	190	230	170	220	270	360	390	310	140	90	170	400
Vanadium	<6	<6	NR	<6	<6	<6	<6	<6	<6	8	<6	<6	<6
Zinc	<3	7	NR	5	5	6	14	420	8	210	73	130	92

Table 7. Concentrations of nutrients dissolved in water, Idaho National Engineering and Environmental Laboratory and vicinity

[Analyses were performed by the U.S. Geological Survey's National Water Quality Laboratory. Analytical results in milligrams per liter. Site identifier: see figures 1 and 2 for location of sites. Remarks: QA indicates quality assurance; Z-values associated with QA replicates were calculated using equation 1; U indicates statistical equivalence could not be determined. Symbol: < indicates concentration is less than the indicated reporting level]

Site identifier	Ammonia (as nitrogen)	Nitrite (as nitrogen)	Nitrite plus nitrate (as nitrogen)	Ortho-phosphate (as phosphorus)	Remarks
Big Springs	<0.015	<0.01	0.06	<0.01	Spring
CFA-1	<.01	<.01	4.3	.01	
CPP-1	.01	<.01	1.0	.01	
EBR-I	<.01	<.01	.39	<.01	
Fire Station 2	<.01	<.01	1.1	.02	
Lidy Hot Springs	.05	<.01	<.10	<.01	Spring
McKinney Well	.02	<.01	.28	<.01	
No Name No. 1	.01	<.01	.66	<.01	
NPR Test	<.01	<.01	1.1	.03	
P&W 2	<.01	<.01	.38	<.01	
Park Bell Well	.20	<.01	<.05	.02	
Ruby Farms Well	<.01	<.01	2.9	<.01	
Site 9	.07	<.01	.62	<.01	
Site 14	.01	<.01	.58	<.01	
Site 17	<.01	<.01	1.0	.02	
	<.01	<.01	1.1	.02	QA replicate
	0	0	.90	0	Z-value
Site 19	<.01	<.01	1.0	<.01	
Stoddart Well	.33	.02	<.05	.02	
USGS 1	<.01	<.01	.88	<.01	
2	.02	<.01	1.1	<.01	
	<.01	<.01	1.2	.02	QA replicate
	.35	0	1.15	.67	Z-value
4	<.01	<.01	4.4	<.01	

Table 7. Concentrations of nutrients dissolved in water, Idaho National Engineering and Environmental Laboratory and vicinity—Continued

Site identifier	Ammonia (as nitrogen)	Nitrite (as nitrogen)	Nitrite plus nitrate (as nitrogen)	Ortho-phosphate (as phosphorus)	Remarks
USGS 4	<.01	<.01	4.4	<.01	QA replicate
	0	0	0	0	Z-value
7	.02	.01	.41	<.01	
	.01	<.01	.40	<.01	QA replicate
	.35	U	.21	0	Z-value
8	<.01	<.01	.86	<.01	
9	<.01	<.01	.72	<.01	
17	<.01	<.01	.32	<.01	
19	.03	.01	1.1	<.01	
20	<.01	<.01	.99	<.01	
23	.03	.01	.75	<.01	
26	<.01	<.01	.85	<.01	
27	.01	<.01	2.3	<.01	
29	<.01	<.01	2.1	<.01	
31	.02	<.01	.81	<.01	
32	.01	<.01	1.6	<.01	
57	<.01	<.01	3.7	.02	
65	<.01	.01	1.6	<.01	
85	<.01	<.01	2.5	<.01	
86	.03	<.01	1.7	<.01	
101	<.01	<.01	.80	<.01	
110	<.01	<.01	1.1	<.01	
112	<.01	<.01	3.8	.02	

Table 8. Concentrations of selected total recoverable minor inorganic constituents, organic carbon, and sodium, and concentrations of selected dissolved anions and nutrients in water from USGS 17, Idaho National Engineering and Environmental Laboratory

[Analyses were performed by the U.S. Geological Survey's National Water Quality Laboratory. Water sample was collected on June 6, 1991, at 1300, as part of another study. Abbreviations: mg/L, milligram per liter; µg/L, microgram per liter. Symbol: < indicates less than]

Constituent	Concentration
Bromide, mg/L, dissolved	0.02
Chloride, mg/L, dissolved	7.4
Chromium, µg/L, total recoverable	1
Fluoride, mg/L, dissolved	.2
Iron, µg/L, total recoverable	140
Lead, µg/L, total recoverable	2
Mercury, µg/L, total recoverable	<.1
Nickel, µg/L, total recoverable	<1
Organic carbon, mg/L, total recoverable	.1
Silver, µg/L, total recoverable	<1
Sodium, mg/L, total recoverable	6.5
Sulfate, mg/L, dissolved	12
Ammonia and organic nitrogen (as nitrogen), mg/L, dissolved	<.20
Nitrite (as nitrogen), mg/L, dissolved	<.01
Nitrite plus nitrate (as nitrogen), mg/L, dissolved	.32
Orthophosphate (as phosphorus), mg/L, dissolved	<.01

Table 9. Purgeable organic compounds for which water samples were analyzed

[Analyses were performed by the U.S. Geological Survey's National Water Quality Laboratory using an analytical method that conforms to U.S. Environmental Protection Agency method 524. Reporting level for all compounds is 0.2 microgram per liter (Pritt and Jones, 1989)]

Compound	Compound
Benzene	Cis-1,3-Dichloropropene
Bromoform	Trans-1,3-Dichloropropene
Carbon tetrachloride	1,3-Dichloropropene
Chlorobenzene	Ethylbenzene
Chloroethane	Methyl bromide
2-Cloroethyl vinyl ether	Styrene
Chloroform	Methylene chloride
Chloromethane	1,1,2,2-Tetrachloroethane
Dibromochloromethane	Tetrachloroethylene
Dichlorobromomethane	Toluene
1,2-Dichlorobenzene	Trichlorofluoromethane
1,3-Dichlorobenzene	1,1,1-Trichloroethane
1,4-Dichlorobenzene	1,1,2-Trichloroethane
Dichlorodifluoromethane	Trichloroethylene
1,2-Dibromoethane	Vinyl chloride
1,1-Dichloroethane	Xylenes, mixed
1,2-Dichloroethane	
1,1-Dichloroethylene	
1,2-trans-Dichloroethylene	
1,2-Dichloropropane	

Table 10. Concentrations of selected purgeable organic compounds in water, Idaho National Engineering and Environmental Laboratory and vicinity

[Analyses were performed by the U.S. Geological Survey's National Water Quality Laboratory. Analytical results in µg/L (microgram per liter); no entry indicates the concentration was less than the reporting level of 0.2 µg/L. Compounds not listed in table 9 are TIOC's (tentatively identified organic compounds): the reported concentration generally is accurate to one order of magnitude. Data for TIOC's in this report are based on a comparison of sample spectra with library spectra followed by visual examination by gas chromatograph/mass spectrometer analysts. TIOC data have not been confirmed by direct comparison with reference standards. Therefore, TIOC identification is tentative, and reported concentrations are semiquantitative. Site identifier: see figures 1 and 2 for location of sites. Remarks: QA indicates quality assurance. Symbol: # indicates Chemical Abstract Services (CAS) number not tabulated in Pritt and Jones (1989)]

Site identifier	Compound	Concentration	CAS number	Remarks
CFA-1	Chloroform	5.0	67-66-3	
	Dichlorobromomethane	.2	75-27-4	
	1,1,1-Trichloroethane	.4	71-55-6	
	Trichlorethylene	.5	79-01-6	
Fire Station 2	1,1-Dichloroethylene	.2	75-35-4	
	1,1,1-Trichloroethane	2.0	71-55-6	
	Trichloroethylene	.2	79-01-6	
USGS 2	1,2,4-Trimethylbenzene	.2	#	QA replicate
USGS 4	Isopropylbenzene	.7	#	
	Isopropylbenzene	.2	#	QA replicate
USGS 20	1,1,1-Trichloroethane	.2	71-55-6	
USGS 26	Isopropylbenzene	.3	#	
USGS 57	1,1,1-Trichloroethane	.4	71-55-6	
USGS 65	1,1,1-Trichlorethane	.5	71-55-6	
USGS 85	Toluene	.9	108-88-3	
	1,1,1-Trichoroethane	.3	71-55-6	
USGS 112	1,1,1-Trichloroethane	.4	71-55-6	

Table 11. Extractable acid and base/neutral organic compounds for which water samples were analyzed

[Analyses were performed by the U.S. Geological Survey's National Water Quality Laboratory using gas chromatography to separate the compounds and mass spectrometry and flame ionization for identification and quantification. Initial extraction was with methylene chloride. Reporting levels are in micrograms per liter (Pritt and Jones, 1989)]

Compound	Reporting level	Compound	Reporting level
Acenaphthene	5.0	2,4-Dinitrophenol	20.0
Acenaphthylene	5.0	2,4-Dinitrotoluene	5.0
Anthracene	5.0	2,6-Dinitrotoluene	5.0
Benzo (a) anthracene	10.0	Di-n-octylphthalate	10.0
Benzo (b) fluoranthene	10.0	bis (2-Ethylhexyl) phthalate	5.0
Benzo (k) fluoranthene	10.0	Fluoranthene	5.0
Benzo (g,h,i) perylene	10.0	Fluorene	5.0
Benzo (a) pyrene	10.0	Hexachlorobenzene	5.0
4-Bromophenyl phenyl ether	5.0	Hexachlorobutadiene	5.0
Butyl benzyl phthalate	5.0	Hexachlorocyclopentadiene	5.0
bis (2-Chloroethoxy) methane	5.0	Hexachloroethane	5.0
bis (2-Chloroethyl) ether	5.0	Indeno (1,2,3-cd) pyrene	10.0
bis (2-Chloroisopropyl) ether	5.0	Isophorone	5.0
4-Chloro-3-methylphenol	30.0	2-Methyl-4,6-dinitrophenol	30.0
2-Chloronaphthalene	5.0	Naphthalene	5.0
2-Chlorophenol	5.0	Nitrobenzene	5.0
4-Chlorophenyl phenyl ether	5.0	2-Nitrophenol	5.0
Chrysene	10.0	4-Nitrophenol	30.0
Dibenzo (a,h) anthracene	10.0	n-Nitrosodimethylamine	5.0
1,2-Dichlorobenzene	5.0	n-Nitrosodi-n-propylamine	5.0
1,3-Dichlorobenzene	5.0	n-Nitrosodiphenylamine	5.0
1,4-Dichlorobenzene	5.0	Pentachlorophenol	30.0
2,4-Dichlorophenol	5.0	Phenanthrene	5.0
Diethyl phthalate	5.0	Phenol	5.0
Dimethyl phthalate	5.0	Pyrene	5.0
2,4-Dimethylphenol	5.0	1,2,4-Trichlorobenzene	5.0
Di-n-butyl phthalate	5.0	2,4,6-Trichlorophenol	20.0

Table 12. Concentrations of selected extractable acid and base/neutral organic compounds in water, Idaho National Engineering and Environmental Laboratory and vicinity

[Analyses were performed by the U.S. Geological Survey's National Water Quality Laboratory. Analytical results in micrograms per liter; no entry indicates the concentration was less than the reporting level. Compounds not listed in table 11 are TIOC's (tentatively identified organic compounds): the reported concentration generally is accurate to one order of magnitude. Data for TIOC's in this report are based on a comparison of sample spectra with library spectra followed by visual examination by gas chromatograph/mass spectrometer analysts. TIOC data have not been confirmed by direct comparison with reference standards. Therefore, TIOC identification is tentative, and reported concentrations are semiquantitative. Site identifier: see figures 1 and 2 for location of sites. Compound: ?? following compound name indicates that compound identification is uncertain. Retention time: time required for a compound to pass through the column of a gas chromatograph. Remarks: CAS No. indicates Chemical Abstract Services number; QA indicates quality assurance. Symbol: * indicates that molecular weight was not reported by the laboratory]

Site identifier	Compound	Concentration	Molecular weight (gram/mole)	Retention time (minutes)	Remarks
No Name No. 1	Diketone??	0.2	112	8.53	
	Nitrogen-containing compound	.4	*	15.47	
	Phenol, 4-(1-methylethyl)-	.3	136	17.63	CAS No. 99898
NPR Test	Alkyl benzene	.5	195	25.33	
	Aromatic ??	.3	178	25.70	
	Alkyl benzene	.4	178	26.53	
	Alkyl phenol ??	.2	168	27.96	
	Nonyl phenol	.2	*	31.57	
	Aromatic acid	.9	314	43.99	
	Heterocyclic amine	.3	227	47.36	
	Aromatic	.5	324	55.35	
	Aromatic	.5	324	55.62	
	Aromatic	.5	324	55.92	
P&W 2	Alkyl aromatic	.1	*	25.54	
USGS 1	1H-Inden-1-one, 2,3-dihydro-3, 3-dimethyl	.1	160	22.74	CAS No. 26465816
	Benzene, 1,2,3,4-tetramethyl-5-(1-methyl)	.4	176	23.75	CAS No. 61142674
	Ethanone, 1,1'-(1,4-phenylene) bis-	4.0	162	24.57	CAS No. 1009616

Table 12. Concentrations of selected extractable acid and base/neutral organic compounds in water, Idaho National Engineering and Environmental Laboratory and vicinity—Continued

Site identifier	Compound	Concentration	Molecular weight (gram/mole)	Retention time (minutes)	Remarks
USGS 1	Ethanone, 1,1'-(1,4-phenylene) bis-	2.0	162	25.02	CAS No. 1009616
	Alkyl aromatic-contains nitrogen ??	.1	*	25.10	
	Alkyl aromatic	.3	*	25.26	
	Alkyl aromatic	20.0	*	25.38	
	Alkyl phenol ??	.8	*	25.54	
	Alkyl aromatic	20.0	*	25.76	
	Alkyl phenol ??	.3	*	26.04	
	Alkyl aromatic	6.0	*	26.38	
	Ethanone, 1-[4-(1-hydroxy-1-methylethyl)]	10.0	178	26.58	CAS No. 54549723
	Unknown compound	.6	*	30.39	
	1,1'-Biphenyl, 4-bromo-	.3	232	30.89	CAS No. 92660
	4H-1-Benzopyran-4-one, 5,7-dihydroxy-2-	.1	192	32.59	CAS No. 1013690
	Unknown compound	.5	*	34.00	
2	Benzene, 1,2,4-trimethyl-	.1	120	10.95	CAS No. 95636
	1,3-Cyclopentanedione, 2-bromo- ??	.1	176	13.32	CAS No. 14203248
	Benzene, 1,4-bis(1-methylethenyl)-	.1	158	21.01	CAS. No. 1605181
	3-Methylbenzalacetone	.1	160	22.76	
	Alkyl aromatic	.1	*	23.77	
	Ethanone, 1,1'-(1,4-phenylene) bis-	.1	162	24.57	CAS No. 1009616
	Alkyl aromatic	2.0	*	25.35	
	Alkyl aromatic	2.0	*	25.72	
	Alkyl aromatic	.6	*	26.36	
	Ethanone, 1-[4-(1-hydroxy-1-methylethyl)]	2.0	178	26.55	CAS No. 54549723
	Benzene, 1,4-bis (1-methylethenyl)-	.1	158	20.99	CAS No. 1605181, QA replicate

Table 12. Concentrations of selected extractable acid and base/neutral organic compounds in water, Idaho National Engineering and Environmental Laboratory and vicinity—Continued

Site identifier	Compound	Concen-tration	Molecular weight (gram/mole)	Retention time (minutes)	Remarks
USGS 2	Unknown compound	.2	*	21.53	QA replicate
	3-Methylbenzalacetone??	.1	160	22.74	QA replicate
	Alkyl aromatic	.1	*	23.74	QA replicate
	Ethanone, 1,1'-(1,3-phenylene) bis-	.2	162	24.56	CAS No. 6781426, QA replicate
	Alkyl aromatic	1.0	*	25.32	QA replicate
	Alkyl aromatic	2.0	*	25.70	QA replicate
	Alkyl aromatic	.5	*	26.33	QA replicate
	Ethanone, 1-[4-(1-hydroxy-1-methylethyl)]	1.0	178	26.52	CAS No. 54549723, QA replicate
4	Benzene, 1-propenyl-	.4	118	10.61	CAS No. 637503
	Unknown compound	.1	*	12.81	
	Benzenemethanol, .alpha.-methyl-	.3	122	13.17	CAS No. 98851
	Ethanone, 1-phenyl-	7.0	120	13.37	CAS No. 98862
	Benzenemethanol, .alpha.,.alpha.-dimeth	20.0	136	14.00	CAS No. 617947
	Nitrogen-containing ??	.3	*	14.20	
	Aromatic hydrocarbon	.1	*	32.59	
	Benzene, (1-methylethenyl)-	.4	118	10.61	CAS No. 98839, QA replicate
	Benzenemethanol, .alpha.-methyl-	.3	122	13.18	CAS No. 98851, QA replicate
	Ethanone, 1-phenyl-	6.0	120	13.38	CAS No. 98862, QA replicate
	Benzenemethanol, .alpha.,.alpha.-dimeth	20.0	136	14.01	CAS No. 617947, QA replicate
7	Ethanone, 1-phenyl-	.2	120	13.41	CAS No. 98862
	Benzenemethanol, .alpha.,.alpha.-dimeth	.8	136	14.01	CAS No. 617947
	Unknown compound	.1	*	7.76	QA replicate

Table 12. Concentrations of selected extractable acid and base/neutral organic compounds in water, Idaho National Engineering and Environmental Laboratory and vicinity—Continued

Site identifier	Compound	Concentration	Molecular weight (gram/mole)	Retention time (minutes)	Remarks
USGS 7	Ethanone, 1-phenyl (maybe in blank)	.1	120	13.41	CAS No. 98862, QA replicate
	Benzenemethanol, .alpha.,.alpha.-dimeth	.5	136	14.02	CAS No. 617947, QA replicate
	Organic acid ester	.1	*	25.00	QA replicate
8	Alkyl aromatic	.9	*	25.31	
	Alkyl aromatic	1.0	*	25.69	
	Alkyl aromatic	.4	*	26.32	
	Alkyl aromatic	.8	*	26.52	
9	Aromatic-contains nitrogen ?? and hydroxyl ??	.1	*	25.33	
	Alkyl aromatic	.2	*	25.55	
	Aromatic-contains nitrogen	.1	179	26.35	
	Nonyl phenol	.2	*	31.38	
	Nonyl phenol	.3	*	31.58	
	Nonyl phenol	.2	*	32.45	
23	Organic acid ester	.1	*	24.94	
	Alkyl aromatic	1.0	*	25.31	
	Alkyl aromatic	.7	*	25.68	
	Alkyl aromatic	.2	*	26.31	
	Ethanone, 1-[4-(1-hydroxy-1-methylethyl)]	.5	178	26.51	CAS No. 54549723
26	Benzene, (1-methylethenyl)-	.8	118	10.59	CAS No. 98839
	Ethanone, 1-phenyl-	3.0	120	13.35	CAS No. 98862
	Benzene methanol, .alpha.,.alpha.-dimeth	6.0	136	13.98	CAS No. 617947
	Aromatic-nitrogen containing ??	.1	*	15.46	

Table 12. Concentrations of selected extractable acid and base/neutral organic compounds in water, Idaho National Engineering and Environmental Laboratory and vicinity—Continued

Site identifier	Compound	Concen-tration	Molecular weight (gram/mole)	Retention time (minutes)	Remarks
USGS 57	Alkyl aromatic	.7	*	25.81	
	Alkyl aromatic	.3	*	26.65	
	Unknown compound	.5	*	51.88	
	Unknown compound	.2	*	52.77	
65	Unknown compound	.6	*	9.32	
	Ethanone, 1-(2-furanyl)-	.2	110	18.08	CAS No. 1192627
	2H-Indol-2-one, 1,3-dihydro-	.6	133	27.14	CAS No. 59483
	Alkane	.3	*	31.23	
85	Ethanone, 1,1'-(1,3-phenylene) bis-	.3	162	24.60	CAS No. 6781426
	Alkyl aromatic	2.0	*	25.37	
	Alkyl phenol ??	.3	*	25.55	
	Ethanone, 1-[4-(1-hydroxy-1-methylethyl)]	3.0	178	25.75	CAS No. 54549723
	Alkyl phenol ??	.1	*	26.06	
	Alkyl aromatic	.7	*	26.38	
	Ethanone, 1-[4-(1-hydroxy-1-methylethyl)]	2.0	178	26.57	CAS No. 54549723
	Aromatic hydrocarbon	.1	*	32.62	
86	Alkyl aromatic	.4	*	25.35	
	Alkyl aromatic	.1	*	25.57	
	Alkyl aromatic	.2	*	25.72	
	Alkyl aromatic	.4	*	26.37	
	Alkyl aromatic	.2	*	26.56	
	Nonyl phenol	.1	*	31.61	

Table 13. Concentrations of dissolved organic carbon, ethylenediaminetetraacetic acid, and citrate in water, Idaho National Engineering and Environmental Laboratory and vicinity

[Analyses were performed by the U.S. Geological Survey's National Water Quality Laboratory. Chemical symbols: DOC indicates dissolved organic carbon; EDTA indicates ethylenediaminetetraacetic acid; C indicates carbon. Abbreviations: mg/L, milligram per liter; µg/L, microgram per liter. Site identifier: see figures 1 and 2 for location of sites. Remarks: QA indicates quality assurance; Z-values associated with QA replicates were calculated using equation 1. Symbols: < indicates less than; LS indicates sample lost by laboratory; NS indicates not sampled]

Site identifier	DOC (mg/L as C)	EDTA (µg/L)	Citrate (µg/L)	Remarks
Big Springs	0.1	NS	NS	Spring
CFA-1	.4	<20	<5	
CPP-1	.5	<20	<5	
EBR-I	.2	<20	<5	
Fire Station 2	.4	<20	<5	
Lidy Hot Springs	.5	<20	<5	Spring
McKinney Well	.4	<20	<5	
No Name No. 1	.4	<20	<5	
NPR Test	.4	<20	<5	
P&W 2	.4	<20	<5	
Park Bell Well	.2	<20	<5	
Ruby Farms Well	.6	<20	<5	
Site 9	.4	<20	<5	
Site 14	.2	<20	<5	
Site 17	.4	<20	<5	
	.5	<20	<5	QA replicate
	.54	0	0	Z-value
Site 19	.3	<20	<5	
Stoddart Well	.4	<20	<5	
USGS 1	.6	<20	<5	
2	.4	<20	<5	
	.7	<20	<5	QA replicate
	1.63	0	0	Z-value

Table 13. Concentrations of dissolved organic carbon, ethylenediaminetetraacetic acid, and citrate in water, Idaho National Engineering and Environmental Laboratory and vicinity—Continued

Site identifier	DOC (mg/L as C)	EDTA (µg/L)	Citrate (µg/L)	Remarks
USGS 4	1.2	<20	<5	
	1.2	<20	<5	QA replicate
	0	0	0	Z-value
7	.2	<20	<5	
	.3	<20	<5	QA replicate
	.54	0	0	Z-value
8	.3	<20	<5	
9	.5	<20	<5	
17	.4	<20	<5	
19	1.2	<20	<5	
20	.2	<20	<5	
23	.4	<20	<5	
26	.3	<20	<5	
27	1.0	<20	<5	
29	.6	<20	<5	
31	.3	<20	<5	
32	.8	<20	<5	
57	.4	LS	LS	
65	.5	<20	<5	
85	.4	<20	<5	
86	.4	<20	<5	
101	.4	LS	LS	
110	.5	<20	<5	
112	.4	LS	LS	

Table 14. Concentrations of gross alpha- and gross beta-particle radioactivity in the dissolved fraction of water, Idaho National Engineering and Environmental Laboratory and vicinity

[Analyses were performed by the U.S. Geological Survey's National Water Quality Laboratory using a residue procedure. Analytical results and uncertainties—for example, **2.9±0.54**—in indicated units. Analytical uncertainties are reported as 1s. Concentrations that exceed the reporting level of 3 times the 1s value are shown in boldface type. Site identifier: see figures 1 and 2 for location of sites. Remarks: QA indicates quality assurance; Z-values associated with QA replicates were calculated using equation 1. Abbreviations: µg/L, microgram per liter; pCi/L, picocurie per liter. Raw field samples were processed in the laboratory prior to analysis]

Site identifier	Alpha		Beta		Remarks
	as uranium (µg/L)	as thorium-230 (pCi/L)	as strontium-90 in equilibrium with yttrium-90 (pCi/L)	as cesium-137 (pCi/L)	
Big Springs	**4.4±1.0**	**3.5±0.78**	**3.8±0.59**	**4.6±0.70**	Spring
CFA-1	**2.9±0.54**	**2.0±0.38**	**4.1±0.56**	**5.5±0.74**	
CPP-1	**4.5±0.64**	**3.1±0.45**	**4.3±0.49**	**5.7±0.65**	
EBR-I	**2.3±0.50**	**1.4±0.33**	**2.3±0.44**	**3.1±0.52**	
Fire Station 2	**2.5±0.52**	**1.8±0.36**	**2.0±0.34**	**2.6±0.45**	
Lidy Hot Springs	**20.9±1.6**	**14.4±1.2**	**12.9±1.0**	**17.3±1.4**	Spring
McKinney Well	**3.8±0.62**	**2.4±0.40**	**1.1±0.27**	**1.5±0.38**	
No Name No. 1	**2.0±0.41**	**1.3±0.28**	**2.7±0.37**	**3.7±0.58**	
NPR Test	**3.1±0.56**	**2.2±0.40**	**2.2±0.35**	**2.9±0.47**	
P&W 2	**4.4±0.62**	**3.0±0.43**	**1.4±0.35**	**1.9±0.42**	
Park Bell Well	**1.0±0.32**	**.71±0.23**	**4.1±0.46**	**5.3±0.60**	
Ruby Farms Well	**3.8±0.60**	**2.7±0.43**	**1.8±0.32**	**2.5±0.48**	
Site 9	**2.7±0.49**	**1.9±0.34**	**2.7±0.38**	**3.8±0.58**	
Site 14	**3.9±0.62**	**2.7±0.44**	**2.4±0.36**	**3.2±0.55**	
Site 17	**2.3±0.46**	**1.6±0.32**	**1.5±0.30**	**1.9±0.39**	
	3.5±0.57	**2.4±0.40**	**1.6±0.32**	**2.1±0.43**	QA replicate
	1.66	1.64	.25	.29	Z-value
Site 19	**3.8±0.59**	**2.6±0.42**	**1.9±0.38**	**2.7±0.56**	
Stoddart Well	.30±0.21	.20±0.15	**2.9±0.38**	**3.9±0.58**	
USGS 1	**3.9±0.60**	**2.8±0.43**	**2.5±0.50**	**3.4±0.56**	
USGS 2	**3.8±0.59**	**2.6±0.41**	**2.8±0.37**	**3.8±0.57**	

Table 14. Concentrations of gross alpha- and gross beta-particle radioactivity in the dissolved fraction of water, Idaho National Engineering and Environmental Laboratory and vicinity—Continued

Site identifier	Alpha		Beta		Remarks
	as uranium (µg/L)	as thorium-230 (pCi/L)	as strontium-90 in equilibrium with yttrium-90 (pCi/L)	as cesium-137 (pCi/L)	
USGS 2	**2.9±0.54**	**2.0±0.37**	**2.3±0.48**	**3.1±0.53**	QA replicate
	1.20	1.14	.83	.91	Z-value
4	**4.3±0.62**	**2.9±0.43**	**6.0±0.76**	**8.1±1.0**	
	5.4±0.69	**3.7±0.47**	**6.6±0.77**	**8.9±1.0**	QA replicate
	1.15	1.16	.55	.58	Z-value
7	**3.7±0.63**	**2.3±0.41**	**2.9±0.49**	**3.8±0.58**	
	5.0±1.0	**3.5±0.70**	**2.7±0.37**	**3.6±0.58**	QA replicate
	1.07	1.44	.23	.17	Z-value
8	**3.6±0.56**	**2.4±0.39**	**1.6±0.31**	**2.2±0.45**	
9	**3.7±0.56**	**2.5±0.38**	**3.1±0.41**	**4.1±0.54**	
17	**2.6±0.49**	**1.8±0.35**	**2.4±0.46**	**3.2±0.53**	
19	**4.1±0.62**	**2.9±0.45**	**1.7±0.31**	**2.3±0.46**	
20	**2.9±0.53**	**2.0±0.36**	**2.9±0.39**	**4.0±0.62**	
23	**3.7±0.58**	**2.6±0.41**	**1.2±0.28**	**1.7±0.40**	
26	**5.1±0.72**	**3.2±0.48**	**2.4±0.37**	**3.3±0.57**	
27	**4.1±0.62**	**2.9±0.44**	**4.8±0.56**	**6.6±0.90**	
29	**3.5±0.56**	**2.4±0.39**	**3.5±0.45**	**4.6±0.59**	
31	**4.6±0.68**	**3.4±0.50**	**2.9±0.60**	**4.0±0.62**	
32	**3.3±0.57**	**2.4±0.40**	**4.0±0.47**	**5.2±0.62**	
57	**4.2±0.63**	**2.9±0.44**	**75.0±4.4**	**106±6.2**	
65	**3.8±0.60**	**2.7±0.42**	**5.2±0.60**	**6.9±0.80**	
85	**4.5±0.66**	**3.1±0.46**	**10.0±0.86**	**13.0±1.1**	
86	**1.2±0.35**	**.76±0.22**	**2.6±0.35**	**3.5±0.54**	
101	**2.7±0.52**	**1.9±0.36**	**2.2±0.32**	**3.0±0.49**	
110	**3.8±0.58**	**2.6±0.402**	**3.0±0.39**	**4.1±0.63**	
112	**3.9±0.64**	**2.4±0.42**	**73.7±4.3**	**98.1±5.8**	

Table 15. Concentrations of gross alpha- and gross beta-particle radioactivity in the suspended fraction of water, Idaho National Engineering and Environmental Laboratory and vicinity

[Analyses were performed by the U.S. Geological Survey's National Water Quality Laboratory using a residue procedure. Analytical results and uncertainties—for example, 0.47±0.25—in indicated units. Analytical uncertainties are reported as 1s. Concentrations that exceed the reporting level of 3 times the 1s value are shown in boldface type. Site identifier: see figures 1 and 2 for location of sites. Remarks: QA indicates quality assurance; Z-values associated with QA replicates were calculated using equation 1. Abbreviations: µg/L, microgram per liter; pCi/L, picocurie per liter. Raw field samples were processed in the laboratory prior to analysis; NA, not analyzed]

Site identifier	Alpha		Beta		Remarks
	as uranium (µg/L)	as thorium-230 (pCi/L)	as strontium-90 in equilibrium with yttrium-90 (pCi/L)	as cesium-137 (pCi/L)	
Big Springs	NA	NA	NA	NA	Spring
CFA-1	-0.18±0.14	-0.1±0.07	0.45±0.24	0.47±0.25	
CPP-1	.02±0.16	.01±0.09	.33±0.24	.35±0.26	
EBR-I	-.07±0.13	-.04±0.08	.44±0.23	.46±0.24	
Fire Station 2	-.07±0.11	-.04±0.06	.42±0.26	.43±0.26	
Lidy Hot Springs	.32±0.28	.17±0.16	.18±0.25	.18±0.26	Spring
McKinney Well	**1.5±0.38**	**1.7±0.50**	**1.8±0.33**	**2.0±0.36**	
No Name No. 1	**5.2±1.4**	**4.4±1.2**	**4.0±0.46**	**4.3±0.50**	
NPR Test	.08±0.12	.04±0.07	.59±0.26	.61±0.27	
P&W 2	-.01±0.09	-.01±0.05	.18±0.23	.18±0.24	
Park Bell Well	.03±0.1	.02±0.07	-.02±0.19	-.02±0.2	
Ruby Farms Well	.08±0.13	.04±0.07	.003±0.23	.003±0.24	
Site 9	.20±0.23	.11±0.13	**.82±0.23**	**.86±0.24**	
Site 14	.29±0.24	.15±0.13	.19±0.24	.2±0.25	
Site 17	-.02±0.12	-.01±0.07	.47±0.23	.50±0.25	
	.08±0.12	.05±0.08	.25±0.23	.26±0.23	QA replicate
	.57	.58	.67	.71	Z-value
Site 19	-.02±0.12	-.01±0.07	.61±0.25	.63±0.26	
Stoddart Well	-.12±0.12	-.06±0.06	.62±0.24	.65±0.26	
USGS 1	.03±0.14	.02±0.08	.13±0.26	.14±0.27	
2	.10±0.21	.06±0.11	.49±0.25	.51±0.26	

Table 15. Concentrations of gross alpha- and gross beta-particle radioactivity in the suspended fraction of water, Idaho National Engineering and Environmental Laboratory and vicinity—Continued

Site identifier	Alpha		Beta		Remarks
	as uranium (µg/L)	as thorium-230 (pCi/L)	as strontium-90 in equilibrium with yttrium-90 (pCi/L)	as cesium-137 (pCi/L)	
USGS 2	-.07±0.10	-.04±0.06	.37±0.22	.39±0.23	QA replicate
	.72	.72	.37	.35	Z-value
4	-.18±0.13	-.1±0.07	.24±0.23	.25±0.24	
	.00±0.21	.00±0.12	.07±0.25	.07±0.26	QA replicate
	.73	.71	.49	.49	Z-value
7	-.2±0.18	-.10±0.1	.32±0.22	.33±0.23	
	.05±0.16	.03±0.09	.04±0.23	.04±0.24	QA replicate
	1.01	.99	.86	.85	Z-value
8	.08±0.13	.05±0.07	.12±0.24	.13±0.24	
9	.9±0.34	.47±0.18	.17±0.24	.18±0.25	
17	.22±0.19	.12±0.11	.24±0.23	.24±0.24	
19	-.12±0.12	-.06±0.06	.27±0.22	.28±0.23	
20	.2±0.18	.14±0.12	.72±0.27	.76±0.28	
23	.13±0.14	.07±0.08	.27±0.25	.28±0.26	
26	-.12±0.12	-.06±0.06	.33±0.25	.34±0.26	
27	-.06±0.1	-.04±0.06	.4±0.25	.42±0.27	
29	.42±0.22	.22±0.12	.16±0.23	.16±0.24	
31	.3±0.23	.16±0.13	-.10±0.23	-.10±0.23	
32	.07±0.18	.04±0.1	.04±0.20	.05±0.21	
57	-.07±0.10	-.04±0.06	.4±0.24	.41±0.24	
65	.13±0.17	.07±0.09	.44±0.23	.46±0.24	
85	.07±0.15	.04±0.09	.22±0.25	.23±0.26	
86	.77±0.33	1.0±0.46	**1.0±0.31**	**1.1±0.33**	
101	-.29±0.15	-.16±0.09	.16±0.2	.2±0.25	
110	-.07±0.11	-.04±0.06	.25±0.22	.27±0.24	
112	.06±0.17	.04±0.09	.19±0.22	.2±0.23	

Table 16. Concentrations of selected transuranic elements and cesium-137 in water, Idaho National Engineering and Environmental Laboratory and vicinity

[Analyses were performed by the U.S. Department of Energy's Radiological and Environmental Sciences Laboratory. Analytical results and uncertainties—for example, 0.01±0.03—in picocuries per liter. Analytical uncertainties are reported as 1s. All concentrations were less than the reporting level of 3 times the 1s value. Site identifier: see figures 1 and 2 for location of sites. Remarks: QA indicates quality assurance; Z-values associated with QA replicates were calculated using equation 1. Symbol: NS indicates not sampled]

Site identifier	Plutonium-238	Plutonium-239, -240 (undivided)	Americium-241	Cesium-137	Remarks
Big Springs	NS	NS	NS	NS	Spring
CFA-1	-0.01±.0.03	0.003±0.01	0.01±.0.03	30±30	
CPP-1	-.04±0.02	.003±0.02	-.04±.0.03	30±30	
EBR-I	.01±0.02	-.01±0.01	.01±0.03	20±20	
Fire Station 2	-.01±0.02	.004±0.01	-.03±0.03	14±32	
Lidy Hot Springs	-.02±0.03	-.03±0.02	-.08±0.06	0±30	Spring
McKinney Well	-.03±0.02	.004±0.01	0±0.03	-30±30	
No Name No. 1	.02±0.02	.03±0.02	-.02±0.03	-12±36	
NPR Test	0±0.02	.02±0.02	-.03±0.02	-40±20	
P&W 2	-.03±0.02	-.001±0.02	-.03±0.03	-20±20	
Park Bell Well	-.06±0.02	0±0.01	-.02±0.03	-14±24	
Ruby Farms Well	0±0.02	.004±0.01	-.06±0.03	10±20	
Site 9	-.04±0.02	-.01±0.01	-.04±0.03	30±40	
Site 14	0±0.02	.02±0.02	-.03±0.03	0±30	
Site 17	.02±0.02	.01±0.01	-.06±0.03	-50±30	
	0±0.02	.003±0.01	-.06±0.03	-30±20	QA replicate
	.71	.28	0	.55	Z-value
Site 19	0±0.02	-.01±0.01	0±0.02	-12±17	
Stoddart Well	-.03±0.02	-.02±0.01	.01±0.04	-70±30	
USGS 1	.02±0.022	-.001±0.02	-.03±.0.03	0±30	
2	.02±0.03	.004±0.02	.02±0.03	-30±30	
	.01±0.02	-.01±0.02	-.05±0.03	0±30	QA replicate
	.19	.62	1.65	.71	Z-value

Table 16. Concentrations of selected transuranic elements and cesium-137 in water, Idaho National Engineering and Environmental Laboratory and vicinity—Continued

Site identifier	Plutonium-238	Plutonium-239, -240 (undivided)	Americium-241	Cesium-137	Remarks
USGS 4	-.02±0.02	0±0.02	-.03±0.03	-30±30	
	-.01±0.03	-.01±0.01	-.08±0.04	30±30	QA replicate
	.93	.44	1.20	1.41	Z-value
7	.02±0.01	.004±0.01	-.02±0.02	0±30	
	.004±0.01	-.004±0.01	-.02±0.02	-15±22	QA replicate
	.71	.51	.14	.40	Z-value
8	-.01±0.02	.01±0.01	.02±0.02	0±30	
9	-.02±0.02	.003±0.01	.03±0.02	10±30	
17	-.02±0.03	-.01±0.01	-.05±0.04	-30±30	
19	-.01±0.02	0±0.01	.02±0.02	0±30	
20	-.01±0.02	-.001±0.01	.02±0.02	-10±30	
23	-.004±0.02	0±0.01	-.01±0.02	-40±30	
26	-.02±0.02	.004±0.02	.01±0.03	10±30	
27	.03±0.03	0±0.02	.01±0.03	-40±30	
29	-.02±0.02	.01±0.01	.01±0.03	-40±20	
31	-.06±0.03	-.01±0.01	-.03±0.03	-20±30	
32	-.01±0.02	-.02±0.01	-.02±0.03	0±20	
57	.02±0.02	.01±0.01	.01±0.02	20±30	
65	-.01±0.01	-.004±0.01	-.01±0.02	-30±20	
85	-.04±0.03	.01±0.02	-.08±0.03	13±29	
86	-.01±0.02	.01±0.01	0±0.02	-40±30	
101	.01±0.02	.004±0.01	-.01±0.02	-50±30	
110	.01±0.02	0±0.02	-.7±0.5	-40±30	
112	-.02±0.02	-.004±0.01	0±0.02	0±30	

Table 17. Concentrations of radon-222, strontium-90, and tritium in water, Idaho National Engineering and Environmental Laboratory and vicinity

[NWQL indicates the U.S. Geological Survey's National Water Quality Laboratory. RESL indicates the U.S. Department of Energy's Radiological and Environmental Sciences Laboratory. Analyses for radon-222 and tritium were performed by the NWQL and analyses for strontium-90 and tritium were performed by the RESL. Analytical results and uncertainties—for example, **543±16**—in picocuries per liter. Analytical uncertainties are reported as 1s. Concentrations that exceed the reporting level of 3 times the 1s value are shown in boldface type. Site identifier: see figures 1 and 2 for location of sites. Remarks: QA indicates quality assurance; Z-values associated with QA replicates were calculated using equation 1. Water samples from Lidy Hot Springs were analyzed for radium-226 and radium-228 by the NWQL. The respective concentrations were **2.9±0.20** and 0.65±0.23 picocuries per liter. NS, not sampled]

Site identifier	Radon-222	Strontium-90	Tritium, NWQL	Tritium, RESL	Remarks
Big Springs	NS	0.14±0.12	**131±4.2**	NS	Spring, Strontium-90 from NWQL
CFA-1	**543±16**	2±2	**19,500±160**	**19,300±600**	
CPP-1	**112±20**	2.1±1.6	**355±16**	300±200	
EBR-I	**167±16**	.3±1.7	-3.2±13	10±160	
Fire Station 2	**117±15**	-.5±1.6	32±13	40±160	
Lidy Hot Springs	**470±14**	.2±1.6	.42±0.29	-120±170	Spring
McKinney Well	**694±14**	1.0±1.6	-3.2±13	50±160	
No Name No. 1	**201±14**	-2±2	13±13	40±160	
NPR Test	**162±12**	0±2	**74±13**	0±160	
P&W 2	**195±14**	-2±2	16±13	-20±160	
Park Bell Well	**497±14**	1.6±1.6	3.2±13	-20±160	
Ruby Farms Well	**245±18**	2.6±1.6	9.6±13	10±160	
Site 9	**121±14**	-.2±1.6	13±13	60±160	
Site 14	**246±12**	-1.1±1.4	0±13	-20±160	
Site 17	**171±14**	-1.8±1.6	32±13	-20±160	
	168±14	-.2±1.6	16±13	50±160	QA replicate
	.15	.71	.87	.31	Z-value
Site 19	**174±20**	-1±2	22±13	-10±160	
Stoddart Well	**173±12**	3.1±1.7	-22±13	-20±160	
USGS 1	**74±12**	-.8±1.6	16±13	10±160	
2	**109±12**	-2.0±1.5	19±13	0±160	

Table 17. Concentrations of radon-222, strontium-90, and tritium in water, Idaho National Engineering and Environmental Laboratory and vicinity—Continued

Site identifier	Radon-222	Strontium-90	Tritium, NWQL	Tritium, RESL	Remarks
USGS 2	**102±12**	2±2	26±13	110±170	QA replicate
	.41	1.60	.35	.47	Z-value
4	**99±17**	-3.5±1.5	**96±13**	-90±160	
	121±16	-.8±1.7	**90±13**	130±170	QA replicate
	.94	1.19	.35	.94	Z-value
7	**106±19**	1.6±1.7	6.4±13	60±160	
	145±20	1±2	3.2±13	-60±160	QA replicate
	1.41	.25	.17	.53	Z-value
8	**143±28**	-1.1±1.6	**70±13**	170±170	
9	**143±20**	-2.2±1.6	**67±13**	100±170	
17	**278±19**	2.6±1.6	**70±13**	70±170	
19	**314±16**	2±2	6.4±13	-110±160	
20	**415±12**	-1±2	**10,500±90**	**10,700±400**	
23	**133±15**	-4±2	19±13	10±160	
26	**232±28**	-3±2	16±13	10±160	
27	**364±28**	-2.8±1.6	16±13	-100±160	
29	**71±16**	3.3±1.6	16±13	40±160	
31	**270±16**	1.4±1.7	-3.2±13	0±160	
32	**151±15**	1.4±1.5	0±13	0±160	
57	**111±12**	**33±3**	**24,500±260**	**25,600±700**	
65	**196±12**	-3±2	**39,600±380**	**40,900±900**	
85	**90±16**	2±2	**16,800±130**	**17,200±500**	
86	**147±29**	-1.5±1.7	32.0±13	40±160	
101	**77±14**	-1.6±1.9	-3.2±13	-40±160	
110	**48±14**	.5±1.6	-9.6±13	20±160	
112	**186±12**	**30±3**	**27,400±260**	**28,700±700**	

Table 18.—Relative concentrations of stable isotopes in water, Idaho National Engineering and Environmental Laboratory and vicinity

[Analyses were performed by the U.S. Geological Survey's National Water Quality Laboratory. Symbols: δ^2H, delta notation for stable hydrogen isotope ratios; δ^{18}O, delta notation for stable oxygen isotope ratios; δ^{13}C, delta notation for stable carbon isotope ratios; δ^{34}S, delta notation for stable sulfur isotope ratios; δ^{15}N, delta notation for stable nitrogen isotope ratios; ±, plus or minus; permil, parts per thousand relative to a standard. Site identifier: see figures 1 and 2 for location of sites. Remarks: QA indicates quality assurance; Z-values associated with QA replicates were calculated using equation 1; N indicates that Z-value is greater than 1.96 and that the two results are not equivalent; U indicates statistical equivalence could not be determined. Abbreviations: BL indicates bottle broke in laboratory; NS indicates not sampled]

Site identifier	δ^2H (±1.5 permil)	δ^{18}O (±1.5 permil)	δ^{13}C (±0.3 permil)	δ^{34}S (±0.2 permil)	δ^{15}N (±0.2 permil)	Remarks
Big Springs	-135.0	-18.32	-7.7	8.4	3.7	Spring
CFA-1	-137.0	-17.55	NS	6.9	8.1	
CPP-1	-137.0	-17.85	-11.0	5.4	6.6	
EBR-I	-139.0	-18.35	-8.7	6.9	6.3	
Fire Station 2	-139.0	-18.15	-9.7	7.9	6.5	
Lidy Hot Springs	-135.0	-18.1	-3.9	8.4	NS	Spring, resample
McKinney Well	-141.0	-18.55	-7.9	7.6	6.7	
No Name No. 1	-128.0	-16.10	-9.2	6.9	7.1	
NPR Test	-137.0	-17.75	-10.6	5.6	7.1	
P&W 2	-140.0	-18.55	-8.0	7.7	7.0	
Park Bell Well	-135.0	-17.90	-12.6	8.3	6.9	
Ruby Farms Well	-138.0	-18.15	-9.1	3.3	6.0	
Site 9	-137.0	-17.95	-9.5	8.6	6.2	
Site 14	-136.0	-18.00	-10.6	9.2	5.8	
Site 17	-140.0	-18.15	-9.2	7.5	6.3	
	-139.0	-18.15	NS	7.2	6.4	QA replicate
	.47	0	U	1.06	.35	Z-value
Site 19	-138.0	-18.10	-9.8	7.2	7.3	
Stoddart Well	-135.0	-17.85	-11.7	16.0	9.5	
USGS 1	-135.0	-18.00	-11.5	11.9	4.7	
2	-135.0	-17.95	-12.1	11.0	4.7	
	-134.0	-17.95	-11.7	11.2	4.6	QA replicate
	.47	0	.94	.71	.35	Z-value

Table 18.—Relative concentrations of stable isotopes in water, Idaho National Engineering and Environmental Laboratory and vicinity—Continued

Site identifier	δ^2H (±1.5 permil)	δ^{18}O (±1.5 permil)	δ^{13}C (±0.3 permil)	δ^{34}S (±0.2 permil)	δ^{15}N (±0.2 permil)	Remarks
USGS 4	-120.0	-14.95	-13.2	8.2	4.7	
	-120.0	-14.95	-13.2	7.8	5.1	QA replicate
	0	0	0	1.41	1.41	Z-value
7	-136.0	-18.10	-11.3	11.9	6.0	
	-137.0	-18.00	-10.8	12.3	5.2	QA replicate
	.47	.47	1.18	1.41	2.83(N)	Z-value
8	-137.0	-18.00	-10.6	5.2	5.4	
9	-136.0	-18.00	-10.8	5.8	6.3	
17	-137.0	-17.65	-10.7	5.7	8.3	
19	-136.0	-18.10	-7.5	8.6	7.2	
20	-139.0	-18.10	-10.8	6.0	5.1	
23	-137.0	-18.25	-8.4	6.1	5.9	
26	-136.0	-18.00	-9.4	10.5	6.3	
27	-135.0	-17.85	-10.5	10.7	7.6	
29	-134.0	-17.65	-13.5	10.2	5.3	
31	-136.0	-17.90	-10.9	11.0	6.5	
32	-135.0	-17.75	-10.6	9.0	6.5	
57	-136.0	-17.70	-11.3	5.3	5.9	
65	-133.0	-16.90	-10.4	4.8	6.6	
85	-136.0	-17.90	-11.0	5.8	5.4	
86	-139.0	-18.30	-10.1	5.7	8.1	
101	-135.5	-18.00	-13.0	11.8	5.1	
110	-133.0	-17.80	-11.9	9.8	5.4	
112	-136.5	-17.65	-11.2	4.7	6.0	

Table 19. Upper-tail areas for a normal curve

[The statistical table was compiled by J.W. Stegeman (Ott, 1993, p. A-3). The level of significance (or *p*-value) is the area and must be multiplied by two for two-tailed tests]

z	0.00	0.01	0.02	0.03	0.04	0.05	0.06	0.07	0.08	0.09
0.00	0.5000	0.4960	0.4920	0.4880	0.4840	0.4801	0.4761	0.4721	0.4681	0.4641
.10	.4602	.4562	.4522	.4483	.4443	.4404	.4364	.4325	.4286	.4247
.20	.4207	.4168	.4129	.4090	.4052	.4013	.3974	.3936	.3897	.3859
.30	.3821	.3783	.3745	.3707	.3669	.3632	.3594	.3557	.3520	.3483
.40	.3446	.3409	.3372	.3336	.3300	.3264	.3228	.3192	.3156	.3121
.50	.3085	.3050	.3015	.2981	.2946	.2912	.2877	.2843	.2810	.2776
.60	.2743	.2709	.2676	.2643	.2611	.2578	.2546	.2514	.2483	.2451
.70	.2420	.2389	.2258	.2327	.2296	.2266	.2236	.2206	.2177	.2148
.80	.2119	.2090	.2061	.2033	.2005	.1977	.1949	.1922	.1894	.1867
.90	.1841	.1814	.1788	.1762	.1736	.1711	.1685	.1660	.1635	.1611
1.00	.1587	.1562	.1539	.1515	.1492	.1469	.1446	.1423	.1401	.1379
1.10	.1357	.1335	.1314	.1292	.1271	.1251	.1230	.1210	.1190	.1170
1.20	.1151	.1131	.1112	.1093	.1075	.1056	.1038	.1020	.1003	.0985
1.30	.0968	.0951	.0934	.0918	.0901	.0885	.0869	.0853	.0838	.0823
1.40	.0808	.0793	.0778	.0764	.0749	.0735	.0721	.0708	.0694	.0681
1.50	.0668	.0655	.0643	.0630	.0618	.0606	.0594	.0582	.0571	.0559
1.60	.0548	.0537	.0526	.0516	.0505	.0495	.0485	.0475	.0465	.0455
1.70	.0446	.0436	.0427	.0418	.0409	.0401	.0392	.0384	.0375	.0367
1.80	.0359	.0351	.0344	.0336	.0329	.0322	.0314	.0307	.0301	.0294
1.90	.0287	.0281	.0274	.0268	.0262	.0256	.0250	.0244	.0239	.0233
2.00	.0228	.0222	.0217	.0212	.0207	.0202	.0197	.0192	.0188	.0183
2.10	.0179	.0174	.0170	.0166	.0162	.0158	.0154	.0150	.0146	.0143
2.20	.0139	.0136	.0132	.0129	.0125	.0122	.0119	.0116	.0113	.0110
2.30	.0107	.0104	.0102	.0099	.0096	.0094	.0091	.0089	.0087	.0084
2.40	.0082	.0080	.0078	.0075	.0073	.0071	.0069	.0068	.0066	.0064
2.50	.0062	.0060	.0059	.0057	.0055	.0054	.0052	.0051	.0049	.0048
2.60	.0047	.0045	.0044	.0043	.0041	.0040	.0039	.0038	.0037	.0036

Table 19. Upper-tail areas for a normal curve—Continued

z	0.00	0.01	0.02	0.03	0.04	0.05	0.06	0.07	0.08	0.09
2.70	.0035	.0034	.0033	.0032	.0031	.0030	.0029	.0028	.0027	.0026
2.80	.0026	.0025	.0024	.0023	.0023	.0022	.0021	.0021	.0020	.0019
2.90	.0019	.0018	.0018	.0017	.0016	.0016	.0015	.0015	.0014	.0014
3.00	.0013	.0013	.0013	.0012	.0012	.0011	.0011	.0011	.0010	.0010

z	Area
3.500	0.00023263
4.000	.00003167
4.500	.00000340
5.000	.00000029