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CHEMICAL AND RADIOCHEMICAL CONSTITUENTS IN WATER FROM WELLS IN THE VICINITY OF THE NAVAL REACTORS FACILITY, IDAHO NATIONAL ENGINEERING AND ENVIRONMENTAL LABORATORY, IDAHO, 1997-98

U.S. GEOLOGICAL SURVEY
Open-File Report 00-236

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

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Idaho Falls, Idaho
June 2000

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
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) can be converted to degrees Fahrenheit (°F) by using the equation:
°F = (1.8)(°C) + 32.

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

Abbreviated units used in report: mg/L (milligram per liter); µg/L (microgram per liter); pCi/L (picocuries per liter).

CHEMICAL AND RADIOCHEMICAL CONSTITUENTS IN WATER FROM WELLS IN THE VICINITY OF THE NAVAL REACTORS FACILITY, IDAHO NATIONAL ENGINEERING AND ENVIRONMENTAL LABORATORY, IDAHO, 1997–98

by **Roy C. Bartholomay, LeRoy L. Knobel, Betty J. Tucker, and Brian V. Twining**

Abstract

The U.S. Geological Survey, in response to a request from the U.S. Department of Energy's Pittsburgh Naval Reactors Office, Idaho Branch Office, sampled water from 13 wells during 1997–98 as part of a long-term project to monitor water quality of the Snake River Plain aquifer in the vicinity of the Naval Reactors Facility, Idaho National Engineering and Environmental Laboratory, Idaho. Water samples were analyzed for naturally occurring constituents and man-made contaminants. A total of 91 samples were collected from the 13 monitoring wells. The routine samples contained detectable concentrations of total cations and dissolved anions, and nitrite plus nitrate as nitrogen. Most of the samples also had detectable concentrations of gross alpha- and gross beta-particle radioactivity and tritium. Fourteen quality-assurance samples also were collected and analyzed; seven were field-blank samples, and seven were replicate samples. Most of the field blank samples contained less than detectable concentrations of target constituents; however, some blank samples did contain detectable concentrations of calcium, magnesium, barium, copper, manganese, nickel, zinc, nitrite plus nitrate, total organic halogens, tritium, and selected volatile organic compounds.

INTRODUCTION

The Idaho National Engineering and Environmental Laboratory (INEEL), 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. At the Naval Reactors Facility (NRF) (fig. 2), one facility at the INEEL, small amounts of some constituents have been released to the environment as described in two NRF Remedial Investigation/Feasibility Studies (Bettis Atomic Power Laboratory, 1994, 1997).

This study was conducted by the U.S. Geological Survey (USGS) in cooperation with the DOE's Pittsburgh Naval Reactors Office, Idaho Branch Office (IBO). IBO is responsible for the NRF at the INEEL. IBO requires information about the mobility of radionuclide- and chemical-waste constituents in the Snake River Plain aquifer. Waste-constituent mobility is determined principally 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).

Purpose and Scope

In 1989, IBO requested that the USGS initiate a water-quality data-collection program in the vicinity of the NRF at the INEEL (fig. 1). The purpose of the data-collection program is to provide the IBO with water-chemistry data to evaluate the effect of NRF activities on the water quality of the Snake River Plain aquifer.

Through 1995, the data-collection program has consisted of three rounds of sample collection. Round one was a one-time sampling of each well for a comprehensive suite of chemical constituents that approximates those contained in the U.S. Environmental Protection Agency's Ground-Water Monitoring List—Appendix IX (U.S. Environmental Protection Agency, 1989, p. 636–642). Round two consisted of bimonthly collection of samples five times from each well that were analyzed for the chemical constituents listed in Appendix III-EPA Interim Primary Drinking Water Standards,

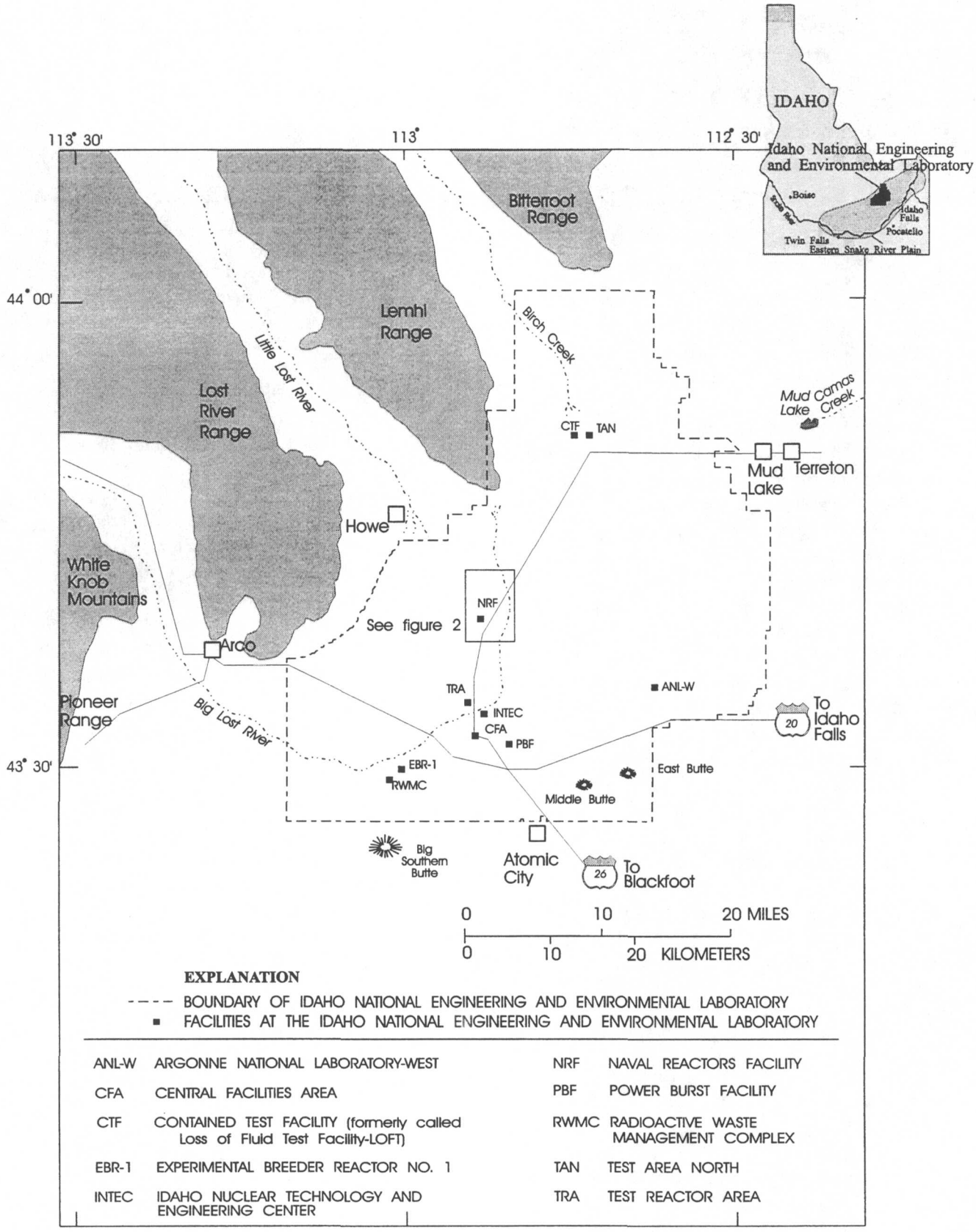

Figure 1. Location of the Idaho National Engineering and Environmental Laboratory, Naval Reactors Facility, and other selected facilities.

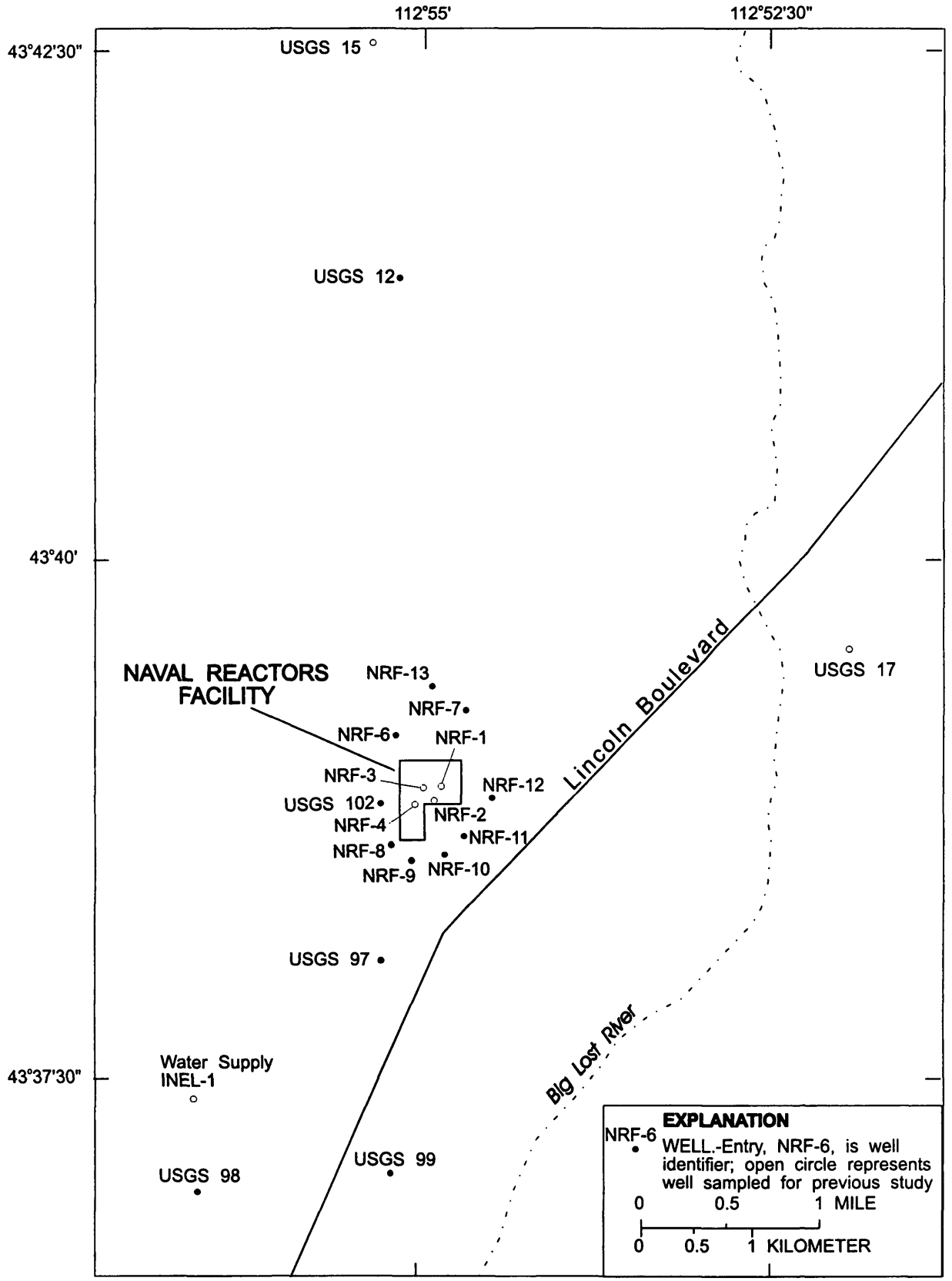

Figure 2. Location of the wells, Naval Reactors Facility and vicinity, Idaho National Engineering and Environmental Laboratory.

the constituents listed as parameters establishing ground-water quality, and selected measurements used as indicators of ground-water contamination (U.S. Environmental Protection Agency, 1989, p. 660–661, 730). Additional constituents analyzed during round two included copper, nickel, zinc, and extractable acid and base/neutral compounds. Round three samples were collected quarterly through 1995. Constituents analyzed in 1994 included chloride, chromium, iron, lead, mercury, nickel, nitrate as nitrogen, silver, sodium, and sulfate. Other round-three measurements were gross alpha- and gross beta-particle radioactivity, pH, specific conductance, and total organic carbon (TOC). The round-three sampling program was expanded in 1995 to include analyses for aluminum, antimony, arsenic, barium, beryllium, cadmium, copper, manganese, selenium, thallium, tritium, and zinc. As a result of expanded laboratory procedures, rounds one through three of the sample-collection program included analyses for constituents in addition to those listed above. Results of analyses of rounds one through three samples are presented by Knobel, Bartholomay, and others (1992), Bartholomay and others (1993), Tucker and others (1995), and Bartholomay, Knobel, and Tucker (1997).

An analysis by Westinghouse Electric Corporation of the water chemistry data collected for the NRF monitoring program during 1989–95 indicated that several changes to the program would improve the overall usefulness of the data. As a result, several older wells were eliminated from the program and replaced by monitoring wells specifically constructed to meet NRF needs and strategically placed to better intercept chemical plumes in ground water. In order to differentiate between the data generated from the NRF sampling program in rounds one through three (1989–95) and subsequent data (1996), the samples collected in 1996 were designated round-four samples (Knobel and others, 1999). Wells sampled in rounds one through three that were eliminated from the program are the four water-supply production wells with line shaft turbine pumps (NRF-1, -2, -3, and -4; fig. 2) and three monitoring wells (USGS 15, USGS 17, and Water Supply INEL-1; fig. 2) which have dedicated submersible pumps. The six newly constructed monitoring wells that were added to the sampling program in 1996 were NRF-8, -9, -10, -11, -12, and -13 (fig. 2). All of these wells and the older monitoring wells which remain in the monitoring network (NRF-6, NRF-7, USGS 12, 97, 98, 99, and 102; fig. 2) have dedicated submersible pumps.

At the end of 1996, NRF increased its validation requirement for ground-water data on the basis of documents that supported the Record of Decision for the industrial waste ditch and NRF landfills. The additional cost for the USGS National Water Quality Laboratory (NWQL) was too great to supply the required documentation. Consequently, NRF personnel sampled the wells during the first quarter of 1997. After further consideration of the program, it was determined that the sampling could be done under the USGS Department of Defense Environmental Conservation (DODEC) Program. Under this program, samples are contracted to Quanterra Environmental Laboratory Services, a laboratory that routinely handles documentation requirements of regulatory programs. Starting in June of 1997, analyses of water samples collected by the USGS were analyzed by the Quanterra laboratory. Results from the 1997–98 sampling are presented in this report. These samples are designated round-five samples. Location of wells sampled are shown in figure 2.

The constituent list for round-five samples was modified slightly from round four because availability of analyses at the laboratory. The constituents included in the round-five sampling program are presented along with analytical results in tables 3–12 at the back of this report. Field measurements and calculations for round-five samples include alkalinity as $CaCO_3$, pH, specific conductance, temperature, total dissolved solids (TDS), and turbidity. Total dissolved solids were estimated by multiplying specific conductance by .543 as determined by Olmstead (1962, figure 5). Round-five samples were collected quarterly at each well.

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 underlies the eastern Snake River Plain and con-

sists of a thick sequence of basalts and sedimentary interbeds filling a large, arcuate, structural basin in southeastern Idaho (fig. 1).

Surface Water

The Big Lost River drains more than 1,400 mi^2 of mountainous area that includes parts of the Lost River Range and the 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 in sinks and playas near the river's terminus. 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. Other surface drainages that provide recharge to the Snake River Plain aquifer at the INEEL include the Little Lost River, Birch Creek, and Camas Creek (fig. 1) (Bartholomay, Tucker, and others, 1997, p. 18).

Ground Water

Recharge to the Snake River Plain aquifer is principally from infiltration of applied irrigation water, infiltration of streamflow, and ground-water inflow from adjoining mountain drainage basins. Some recharge may 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).

Water in the Snake River Plain aquifer moves principally through fractures and interflow zones in the basalt. Most ground water moves through the upper 800 ft of saturated rocks. Hydraulic conductivities of basalt in the upper 800 ft of the aquifer, estimated from INEEL-wide transmissivity data, are from 0.0086 to 5,500 ft/day (Ackerman, 1991, p. 30). Estimated hydraulic conductivities in a 10,365-ft deep test hole near NRF are smaller; at depths exceeding 1,500 ft, hydraulic conductivities are from 0.002 to 0.03 ft/day (Mann, 1986, p. 21). The effective base of the Snake River Plain aquifer at the INEEL is from about 815 to 1,710 ft below land surface (Anderson and others, 1996, table 3, p. 23).

Depth to water in wells completed in the Snake River Plain aquifer is from about 200 ft below land surface in the northern part of the INEEL to more than 900 ft in the southeastern part; in the vicinity of NRF, depth to water is about 375 ft below land surface. In March–May 1995, the altitude of the water table was about 4,575 ft above sea level near Test Area North (fig. 1) and about 4,425 ft above sea level near the Radioactive Waste Management Complex (fig. 1); near the NRF, the water table was about 4,475 ft above sea level. Water generally flowed southward and southwestward beneath the INEEL at an average hydraulic gradient of about 4 ft/mi; however, significant local variation in flow direction is common. Beneath the NRF, water generally flowed southward. From March–May 1991 to March–May 1995, water-level changes in INEEL wells ranged from an 8.5-ft decline north of the NRF to a 2.5-ft decline in wells in the southern part of the INEEL; near the NRF, the water-level decline was about 6 to 8 ft. Water levels generally declined at the INEEL during 1992–95 because of drought (Bartholomay, Tucker, and others, 1997, p. 20–25), but since 1995, have risen (fig. 3).

Ground water moves southwestward from the INEEL and eventually discharges as springs along the Snake River downstream from Twin Falls, about 100 mi southwest of the INEEL (fig. 1). Approximately 3.7 million acre-ft of ground water was discharged 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 a 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

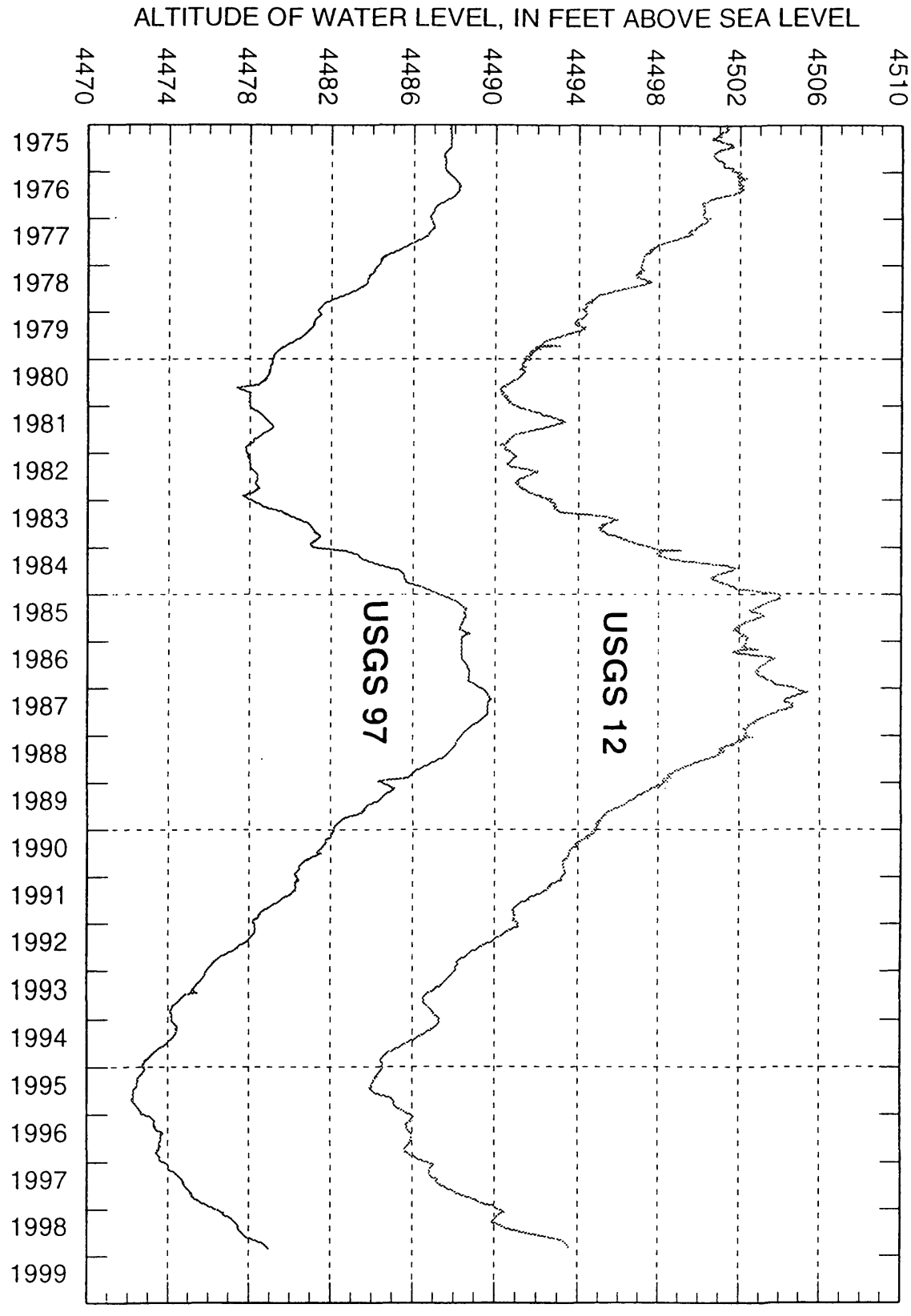

Figure 3. Water levels in two wells near the Naval Reactors Facility.

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 of 1.6s before the qualitative decision can be made as to whether the radionuclide was detected. 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 may 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, there is a larger-than-5-percent probability of false negative results for samples with true concentrations between 1.6s and 3s. Although the radionuclide might have been detected, such detection may not be considered reliable; at 1.6s, the probability of a false negative is about 50 percent.

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 may or may not have been detected.

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

Guidelines for Interpreting Results of Inorganic and Organic Analyses

The term "reporting level" used for radiochemical analyses should not be confused with the term "reporting limit," used for inorganic and organic analyses. In this report, the term "reporting limit" is the lowest level at which measurements become quantitatively meaningful (Quanterra Environmental Services, 1998). Because of unpredictable matrix effects on detection limits, the laboratory reporting limits are set somewhat higher than the analytical method detection limits. Because of this, some estimated results are given.

Acknowledgments

The authors are grateful to Robert Hermandson of the USGS for checking data in the tables and to Richard J. Wagner of the USGS and Kelly D. Willie and Adolfo Sierra of Bechtel-Bettis Corporation for technically reviewing the manuscript.

METHODS AND QUALITY ASSURANCE

The methods used for collecting water samples generally followed the guidelines established by the USGS (Stevens and others, 1975; Wood, 1981; Claassen, 1982; W.L. Bradford, USGS, written commun., 1985; Hardy and others, 1989; Wilde and others, 1998). Descriptions of methods used for analysis are found in Quanterra Environmental Services (1998) and Thatcher and others (1977). The methods used in the field and the quality-assurance practices are described in following sections.

Sample Containers and Preservatives

Sample containers and preservatives differed depending on the constituent(s) for which analyses were requested. Samples analyzed by Quanterra Environmental Services were placed in containers and preserved in accordance with bottle manufacturer requirements. Containers and preservatives were supplied by the Quanterra laboratory. The containers and preservatives used for this study are listed in table 1 (all tables located at the end of report).

Sampling Locations and Sample Collection

Samples were collected from 13 monitoring wells (NRF-6, -7, -8, -9, -10, -11, -12, -13, USGS 12, 97, 98, 99, and 102) equipped with dedicated submersible pumps. NRF-6, -7, -13, and USGS 12 are upgradient of the NRF; USGS 102 is west of NRF; NRF-11 and -12 are east of NRF; and the remaining monitoring wells are downgradient of NRF (fig. 2).

Samples were collected from a portable sampling apparatus attached to dedicated submersible pumps. The apparatus was decontaminated before sampling at each site. Samples were collected after three well-bore volumes of water were purged from each well and field measurements of water temperature, pH, and specific conductance indicated probable hydraulic and chemical stability as described by Mann (1996). After collection, sample containers were sealed with laboratory film, labeled, and stored under secured conditions. Water samples were placed in ice chests, chilled when appropriate, sealed, and shipped the same day 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 laboratory. These records are available for inspection at the USGS INEEL Project Office. The results of field measurements and calculations for alkalinity, pH, specific conductance, water temperature, TDS, and turbidity are listed in table 2.

Quality Assurance

Internal quality control and the overall quality-assurance practices used by the Quanterra laboratory are described in Quanterra Environmental Services (1998). The water samples were collected by personnel assigned to the INEEL Project Office in accordance with a quality-assurance plan for quality-of-water activities (Mann, 1996), and is available from the USGS INEEL Project Office. Comparative studies to determine agreement between analytical results for water-sample pairs by laboratories involved in the INEEL Project Office's quality-assurance program are summarized by Wegner (1989), Williams (1996), and Williams (1997). Additional quality assurance used for this sampling program included seven field-blank samples prepared with inorganic-free and organic-free water and seven replicate samples. Bottles for the field-blank samples were filled in the field camper with the respective inorganic and organic-free water. Inorganic-free water was used for the radiochemical analyses. Respective bottles were then opened at the well while sample collection occurred. After collection of the primary sample, a replicate sample was immediately collected. Many organizations use the term "sequential replicate" in place of "replicate" sample.

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 sample standard deviation (s).

The associated uncertainties presented with mean concentrations are experimental standard errors and are an estimate of the uncertainty of the mean concentration. The estimated experimental standard errors (EESE) were calculated using the following equation (Iman and Conover, 1983, p. 158):

$$EESE = \sigma/(n)^{0.5}, \quad (2)$$

where

σ = population standard deviation, and
n = sample size.

The population standard deviation, σ, is customarily estimated by s (Iman and Conover, 1983, p. 106). The s is the square root of the sample variance (Iman and Conover, 1983, p. 100–101).

ANALYTICAL RESULTS

During the period beginning in June 1997 and ending in November 1998, seven sets of quarterly water samples were collected for round five of the NRF sampling program (table 2). All wells were sampled seven times. Because original samples for purgeable organic compounds and semivolatiles were destroyed at the lab during the August 1998 sampling round, the constituents had to be resampled for wells NRF-8, -10, -11, -12, -13, and QAS-63. Because original radionuclide samples for selected radionuclides broke in shipment to the lab during November 1998 sampling, the constituents had to be resampled for NRF-6, -7, -9, -10, and USGS 102 (table 2). Quality-assurance samples included field-blank samples; NRF-8 (QAS-64), NRF-9 (QAS-62), USGS 12 (QAS-54), USGS 97 (QAS-57), USGS 98 (QAS-60), USGS 99 (QAS-55 and -66), and seven replicate samples: NRF-6 (QAS-59), NRF-7 (QAS-61), NRF-9 (QAS-56), NRF-11 (QAS-58), NRF-12 (QAS-53), USGS 12 (QAS-63), and USGS 102 (QAS-65).

Dissolved Anions and Total Cations

Water samples were analyzed for concentrations of dissolved chloride and sulfate, and concentrations of total calcium, magnesium, potassium, and sodium (table 3). Statistical parameters for these constituents are provided by well in table 4 and were calculated using the data presented in this report.

Mean concentrations of calcium in the 13 wells ranged from 28 mg/L in NRF-7 to 132 mg/L in NRF-6. Mean concentrations of chloride ranged from 4.5 to 249 mg/L. Mean concentrations of magnesium ranged from 9.5 to 34 mg/L. Estimated mean concentrations of potassium ranged from 1.8 to 5.0 mg/L. Mean concentrations of sodium ranged from 9.1 to 116 mg/L. Mean concentrations of sulfate ranged from 13.6 to 170 mg/L.

Concentrations in the seven field-blank samples were not detected except for calcium in QAS-62 which had an estimated concentration of 0.061 mg/L and calcium and magnesium in QAS-55 which had concentrations of 0.63 and 0.21 mg/L, respectively.

Total Trace Elements

Water samples collected in 1997–98 were analyzed for concentrations of total aluminum, antimony, arsenic, barium, beryllium, cadmium, chromium, copper, iron, lead, manganese, mercury, nickel, selenium, silver, thallium, and zinc (table 5). Statistical parameters for selected trace elements are provided by well in table 6 and were calculated using the data presented in this report.

Aluminum.—The mean concentration of aluminum for seven samples from NRF-13 was 4,600 µg/L; however, aluminum concentrations were not detected in samples from most wells.

Antimony.—The estimated mean concentration of antimony for five samples from NRF-6 was 0.71 µg/L; however, antimony concentrations were not detected in samples from most wells.

Arsenic.—The estimated mean concentration of arsenic for six samples from NRF-6 was 3.8 µg/L; however, arsenic concentrations were not detected in samples from most wells.

Barium.—Estimated mean concentrations ranged from 50 µg/L in USGS 98 to 158 µg/L in NRF-12.

Beryllium.—Concentrations were not detected in all but one sample. NRF-6 had one sample with an estimated concentration of 0.023 µg/L.

Cadmium.—The estimated mean concentration of cadmium in five samples from USGS 98 was 0.18 µg/L; however, cadmium concentrations were not detected in samples from most wells.

Chromium.—Estimated mean concentrations ranged from 4.7 µg/L in USGS 98 to 66.5 µg/L in NRF-12.

Copper.—The estimated mean concentration of copper in five samples from NRF-7 was 18 µg/L; however, copper concentrations were not detected in samples from most wells.

Iron.—The mean concentration of iron in seven samples from NRF-13 was 4,960 µg/L; iron concentrations were not detected in samples from several wells.

Lead.—The estimated mean concentration of lead in seven samples from USGS 98 was 5.5 µg/L; however, lead concentrations were not detected in samples from most wells.

Manganese.—Estimated mean concentrations ranged from 1.2 µg/L in USGS 97 to 33.9 µg/L in NRF-13.

Mercury.—Concentrations of mercury were not detected in most samples.

Nickel.—Estimated mean concentrations ranged from 1.9 µg/L in USGS 98 to 35 µg/L in NRF-12.

Selenium.—The estimated mean concentration of selenium in five samples from NRF-11 was 2.7 µg/L; however, selenium concentrations were not detected in samples from most wells.

Silver.—Concentrations of silver were not detected in most samples.

Thallium.—Concentrations of thallium were not detected in most of the samples.

Zinc.—The estimated mean concentration of zinc in seven samples from USGS 98 was 154 µg/L; however, zinc concentrations were not detected in samples from most wells.

Most of the trace elements in the field blanks were not detected or had estimated concentrations below the respective reporting limits. Exceptions include: QAS-54 (blank at USGS 12) has a manganese concentration of 0.21 µg/L; QAS-57 (blank at USGS 97) has a barium concentration of 1.3 µg/L; copper, 2.3 µg/L; manganese, 0.87 µg/L; nickel, 0.29 µg/L; and zinc, 11 µg/L; QAS-60 (blank at USGS 98) has a barium concentration of 1.4 µg/L; copper, 2.5 µg/L; manganese, 1.1 µg/L; nickel, 0.32 µg/L; and zinc, 13 µg/L. QAS-55 (blank at USGS 99) has a manganese concentration of 0.48 µg/L.

Dissolved and Total Nutrients

Water samples were analyzed for dissolved concentrations of nitrite as nitrogen (table 7). Water samples were analyzed for total concentrations of kjeldahl nitrogen (TKN), nitrite plus nitrate as nitrogen, and phosphorus as phosphorus (table 7); statistical parameters for selected nutrients are provided by well in table 8 and were calculated using the data presented in this report.

Kjeldahl nitrogen.—Concentrations ranged from not detected in most samples to an estimated mean concentration of 0.33 mg/L in NRF-12.

Nitrite as nitrogen.—Concentrations ranged from not detected in most samples to an estimated mean concentration of 0.007 mg/L in NRF-13.

Nitrite plus nitrate as nitrogen.—Mean concentrations ranged from 0.54 mg/L in NRF-7 to 2.3 mg/L in NRF-9 and USGS 97.

Phosphorus as phosphorus.—Mean concentrations ranged from an estimated 0.048 mg/L in USGS 99 to 0.15 mg/L in NRF-13.

Concentrations of constituents in the blank samples were less than the reporting limits except for two samples of nitrite plus nitrate, QAS-54 (blank at USGS 12) contained 0.21 mg/L and QAS-55 (blank at USGS 99) contained 0.12 mg/L. Several of the blanks contained estimated concentrations of selected nutrients (table 7).

Total Organic Carbon and Total Organic Halogens

Water samples were analyzed for concentrations of TOC and total organic halogens (TOX) (table 7). The statistical parameters are provided by well in table 8 and were calculated using data in this report.

Concentrations of TOC ranged from not detected in most samples to an estimated mean concentration of 1.1 mg/L in USGS 97. Concentrations of TOX ranged from not detected in most samples to an estimated mean concentration of 0.064 mg/L in NRF-8. The estimated concentration of TOC in blank sample QAS-54 (blank at USGS 12) was 0.36 mg/L. Blank sample QAS-66 (blank at USGS 99) contained 0.094 mg/L TOX. Concentrations in all other blank samples were not detected.

Gross Alpha- and Gross Beta-Particle Radioactivity

Water samples were analyzed for concentrations of dissolved gross alpha- and gross beta-particle radioactivity by the Quanterra laboratory in Richland, WA through a contract with the NWQL using a residue procedure. Concentrations of radioactive constituents greater than or equal to 3 times the 1s uncertainty are considered to be above the reporting level in this report. All analytical measurements are listed in table 9. For a more detailed discussion of reporting levels for radioactive constituents and measurements, see the section of this report titled "Guidelines for Interpreting Results of Radiochemical Analyses."

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 all were given off by one radionuclide. In this report, concentrations are reported as thorium-230 in picocuries per liter. Concentrations of dissolved gross alpha-particle radioactivity are listed in table 9. Statistical parameters are provided by well in table 10 and were calculated using the data presented in this report.

Mean concentrations of gross alpha-particle radioactivity as thorium-230 ranged from 1.42±0.1 pCi/L in NRF-7 to 4.23±0.82 pCi/L in NRF-6. All the field blank samples had concentrations less than the reporting level.

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 all were given off by one radionuclide as cesium-137 in picocuries per liter. Concentrations of dissolved gross beta-particle radioactivity are listed in table 9. Statistical parameters are provided by well in table 10 and were calculated using the data presented in this report.

Mean concentrations of gross beta-particle radioactivity as cesium-137 ranged from 2.53±0.26 pCi/L in USGS 99 to 7.21±0.53 pCi/L in NRF-6. All the field blank samples had concentrations less than the reporting level.

Strontium-90

Water samples were analyzed for strontium-90 by chemical separation and beta counting (table 9). Statistical parameters are provided by well in table 10 and were calculated using the data presented in this report. The concentration of strontium-90 in all the regular and in all field-blank samples were less than the reporting level.

Tritium

Water samples were analyzed for tritium by enrichment and liquid scintillation (table 9). Statistical parameters are provided by well in table 10 and were calculated using data presented in this report.

Mean concentrations of tritium ranged from 4.12±0.88 pCi/L in NRF-7 to 194±12 pCi/L in NRF-11. The concentrations of tritium in field-blank samples ranged from less than the reporting level in two samples to 52.1±4.9 pCi/L in QAS-60 (blank for USGS 98). The result for QAS-64 (blank for NRF-8) (58.0±5.5 pCi/L) is questionable because of problems with the analysis.

Selected Gamma-Emitting Radioisotopes

Gamma spectrometry involves using a series of detectors to simultaneously determine the concentrations of a variety of radionuclides by the detection of their characteristic gamma emissions. Radionuclides identified in selected samples include cesium-137, potassium-40, lead-214, uranium-234, uranium-238, thorium-228, thallium-208, lead-212, radium-224, and radium-226. Concentrations of all the radionuclides identified using gamma spectrometry are given in table 9. Cesium-137 was detected in all the samples, so a summary of the statistical parameters for that radionuclide by well is given in table 10.

All the field-blank samples had concentrations reported as cesium-137 less than the reporting level.

Regulatory Volatile and Base/Neutral Organic Compounds

Water samples collected in August 1997–98 were analyzed for 59 regulatory volatile compounds (table 11) and 40 base/neutral organic compounds (table 12). Most samples were free of regulatory volatile compounds except for QAS-56, which contained 9.6 µg/L of naphthalene on September 4, 1997, and NRF-6, which contained 0.3 µg/L chloroform, 0.5 µg/L tetrachloroethylene, and 0.1 µg/L 1,1,1-trichloroethane on August 3, 1998. Samples from NRF-8, QAS-55, and USGS 98 contained estimated concentrations of naphthalene during September 1997 at concentrations of 2.6 µg/L, 0.50 µg/L, and 0.96 µg/L, respectively. NRF-6 contained estimated concentrations of 0.27 µg/L of chloroform and 0.47 µg/L of tolulene on September 2, 1997. A field blank (QAS-64) sample of inorganic-free water collected on August 5, 1998, at NRF-8 contained concentrations of 0.5 µg/L dichloromethane, 0.3 µg/L ethylbenzene, 3.6 µg/L toluene, 0.1 µg/L 1,2,4-trimethylbenzene, and 0.6 µg/L total xylenes. An additional compound, 1,1-dichloropropanene was also detected at a concentration of 21 µg/L. Inorganic-free water was used because there was no organic-free water available at the time of collection. Samples from USGS 12, 97, 99, and 102 collected on September 3, 1997 contained 5.6 µg/L, 1.5 µg/L, 4.7 µg/L, and 0.7 µg/L of di (2-ethylhexl) phthalate, respectively. All other samples collected were free of base/neutral organic compounds; one sample, NRF-6, collected on August 3, 1998, contained an additional compound of bromacil at a concentration of 0.3 µg/L.

SUMMARY

The USGS, in response to a request from the U.S. Department of Energy's Pittsburgh Naval Reactors Office, Idaho Branch Office, sampled 13 wells during 1997–98 as part of a long-term project to monitor water quality of the Snake River Plain aquifer in the vicinity of the NRF, INEEL, Idaho. Water samples were collected and analyzed for naturally occurring constituents and man-made contaminants. A total of 91 samples were collected from 13 monitoring wells with dedicated submersible pumps. Fourteen quality-assurance samples also were collected and analyzed; seven field-blank samples and seven replicate samples.

The ranges of mean concentrations of total cations and dissolved anions follow: calcium, 28 to 132 mg/L; chloride, 4.5 to 249 mg/L; magnesium, 9.5 to 34 mg/L; potassium, 1.8 to 5.0 mg/L; sodium, 9.1 to 116 mg/L; and sulfate, 13.6 to 170 mg/L.

Samples were analyzed for 17 trace elements. Concentrations of aluminum, antimony, arsenic, beryllium, cadmium, copper, lead, mercury, selenium, silver, thallium, and zinc were not detected in most wells. Concentrations of iron ranged from not detected in several wells to a mean concentration of 4,960 µg/L. The respective ranges of estimated mean concentrations for barium, chromium, manganese, and nickel were: 50 to 158 µg/L; 4.7 to 66.5 µg/L; 1.2 to 33.9 µg/L; and 1.9 to 35 µg/L, respectively. The predominant nitrogen-bearing compound was nitrite plus nitrate, which ranged in mean concentration from 0.54 to 2.3 mg/L. Mean concentrations of phosphorus as phosphorus ranged from 0.048 to 0.15 mg/L.

Concentrations of TOC and TOX ranged from not detected in most samples to estimated mean concentrations of 1.1 and 0.064 mg/L, respectively.

Concentrations of dissolved gross alpha- and gross beta-particle radioactivity and tritium exceeded the reporting level in most samples. Concentrations of strontium-90 and gross gamma as cesium-137 were less than the reporting level in all samples.

All but two samples were free of regulatory volatile organic compounds. All the samples collected were free of base/neutral organic compounds. Most of the field blank samples contained concentrations of the constituents less than the reporting levels. Select field blank samples contained small concentrations of calcium, magnesium, barium, copper, manganese, nickel, zinc, nitrite plus nitrate, TOX, tritium, and selected volatile organic compounds.

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Table 1. Containers and preservatives used for water samples, Naval Reactors Facility and vicinity
[Analyses by Quanterra Environmental Services Laboratory. Abbreviations: L, liter; mL, milliliter; HNO_3, nitric acid; H_2SO_4, sulfuric acid; HCL, hydrochloric acid; °C, degrees Celsius. Samples were shipped by overnight-delivery mail]

Type of constituent	Container		Preservative		Other treatment
	Type	Size	Type	Volume	
Anions	Polyethylene	1 L	None	None	Filter
Cations, total recoverable	Polyethylene	500 mL	HNO_3	10 mL	None
Trace elements, total recoverable	Polyethylene	500 mL	HNO_3	10 mL	None
Nitrite	Polyethylene	1 L	None	None	Filter
Nutrients, total recoverable	Glass, baked	500 mL	H_2SO_4	2 mL	Chill 4°C
Specific conductance	Polyethylene	1 L	None	None	Filter
Total organic carbon	Glass, baked	500 mL	H_2SO_4	2 mL	Chill 4°C
Total organic halogens	Glass, baked	250 mL	H_2SO_4	1 mL	Chill 4°C
Purgeable organic compounds	Glass, baked	40 mL	HCL	4 drops	Chill 4°C
Semi-volatile organic compounds	Glass, baked	1 L	None	None	Chill 4°C
Gamma	Polyethylene, acid-rinsed	1 L	HNO_3	20 mL	Filter
Gross alpha- and beta-particle radioactivity	Polyethylene, acid-rinsed	1 L	HNO_3	20 mL	Filter
Strontium-90	Polyethylene, acid-rinsed	1 L	HNO_3	20 mL	Filter
Tritium	Polyethylene or glass, baked	500 mL	None	None	None

Table 2. Results of measurements of water for alkalinity, pH, specific conductance, temperature, and turbidity, and calculated total dissolved solids, Naval Reactors Facility and vicinity

[Sample identifier: see figure 2 for location of sites. QAS, water quality assurance sample, 59, sample number, R, replicate, B, field blank. Date sampled: (m/d/y), month/day/year. Units: alkalinity, milligrams per liter as calcium carbonate ($CaCO_3$); 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; total dissolved solids, milligrams per liter calculated from specific conductance; turbidity, FTU, Formazin turbidity units; units less than 50 FTU are considered unreliable (Wilde and others, 1998); NTU, nephlometric turbidity units. Abbreviation: NA, not analyzed; ND, not detected; J, method blank contamination. The associated method blank contains the target analyte at a reportable level]

Sample identifier	Date sampled m/d/y	Time	Alkalinity as $CaCO_3$	pH	Specific conductance (field)	Specific conductance (lab)	Temperature	Total dissolved solids	Turbidity
NRF-6	6/5/97	1250	174	7.8	1,480	1,440	12.0	804	3 FTU
	9/2/97	1225	175	7.9	1,510	1,450	12.0	818	5.04 NTU
	11/17/97	1125	157	7.8	1,500	1,420	11.5	816	2.12 NTU
	2/9/98	1235	178	7.9	1,490	1,450	11.5	810	.53 NTU
QAS-59R	2/9/98	1315	178	7.9	1,490	1,440	11.5	810	.53 NTU
NRF-6	5/11/98	1300	176	8.0	1,450	1,410	11.5	788	7.52 NTU
	8/3/98	1225	181	7.9	1,420	1,350	11.5	770	4.93 NTU
	11/2/98	1210	177	7.9	1,350	1,260	11.5	731	4.69 NTU
Resample	11/4/98	1220	NA	7.9	1,350	NA	11.5	733	NA
NRF-7	6/5/97	1200	104	8.2	242	238	16.5	131	4 FTU
	9/2/97	1105	100	8.5	240	232	15.0	130	3.85 NTU
	11/17/97	1025	93	8.4	247	236	14.5	134	2.94 NTU
	2/9/98	1130	105	8.2	255	250	14.5	138	1.36 NTU
	5/11/98	1150	111	8.2	265	265	15.0	144	7.00 NTU
QAS-61R	5/11/98	1230	111	8.2	265	264	15.0	144	7.00 NTU
NRF-7	8/3/98	1115	99	8.5	240	238	15.0	130	2.92 NTU
	11/2/98	1115	107	8.3	258	257 J	14.5	140	6.68 NTU
Resample	11/4/98	1150	NA	8.3	268	NA	12.5	146	NA
NRF-8	6/10/97	1005	219	7.8	580	595	11.5	315	0 FTU
	9/4/97	0800	215	7.9	602	546	11.5	327	.63 NTU
	11/17/97	1320	210	7.9	602	577	11.5	327	.32 NTU
	2/10/98	1135	215	7.9	604	576	11.5	328	.14 NTU
	5/13/98	0755	215	8.0	601	593	11.5	326	.34 NTU
	8/5/98	0815	226	8.0	605	574 J	11.5	329	.45 NTU
Resample	8/19/98	0955	NA	7.8	601	NA	11.5	326	NA
QAS-64B	8/5/98	0845	NA	NA	NA	2.0 J	NA	NA	NA
Resample	8/19/98	1010	NA	NA	NA	NA	NA	NA	NA
NRF-8	11/3/98	1110	215	8.0	603	580	11.5	327	.43 NTU

Table 2. Results of measurements of water for alkalinity, pH, specific conductance, temperature, and turbidity, and calculated total dissolved solids, Naval Reactors Facility and vicinity—Continued

Sample identifier	Date sampled m/d/y	Time	Alkalinity as $CaCO_3$	pH	Specific conductance (field)	Specific conductance (lab)	Temperature	Total dissolved solids	Turbidity
NRF-9	6/10/97	1050	205	7.9	634	653	11.5	344	0 FTU
	9/4/97	0855	206	8.0	656	586	11.5	356	.64 NTU
QAS-56R	9/4/97	0940	206	8.0	656	593	11.5	356	.64 NTU
NRF-9	11/18/97	1145	209	7.9	649	585	11.5	352	.98 NTU
	2/10/98	1240	206	8.0	647	620	11.5	351	.29 NTU
	5/13/98	0915	203	8.0	646	632	11.5	351	.79 NTU
QAS-62B	5/13/98	0945	NA	NA	NA	1.7	NA	NA	NA
NRF-9	8/4/98	1320	210	8.0	646	605 J	11.0	351	.56 NTU
	11/3/98	1205	207	8.0	643	619	11.0	349	.70 NTU
Resample	11/4/98	1317	NA	8.0	643	NA	11.0	349	NA
NRF-10	6/11/97	0815	201	7.6	587	630	11.5	319	1 FTU
	9/4/97	1005	197	8.0	621	572	11.5	337	1.52 NTU
	11/18/97	1250	201	8.0	620	562	11.5	337	4.02 NTU
	2/10/98	1330	199	8.0	614	589	11.5	333	9.31 NTU
	5/13/98	1025	193	8.1	610	599	11.5	331	3.98 NTU
	8/5/98	0930	199	8.0	615	582 J	11.0	334	.32 NTU
Resample	8/19/98	1030	NA	7.9	618	NA	11.5	336	NA
NRF-10	11/3/98	1255	201	8.0	613	589	11.0	333	2.28 NTU
Resample	11/5/98	0935	NA	7.8	607	NA	11.0	330	NA
NRF-11	6/11/97	0930	200	7.6	595	633	11.5	323	1 FTU
	9/4/97	1055	204	8.0	626	575	12.0	340	.7 NTU
	11/19/97	1130	205	7.9	625	456	11.5	339	.99 NTU
QAS-58R	11/19/97	1215	205	7.9	625	455	11.5	339	.99 NTU
NRF-11	2/11/98	1040	199	8.0	625	607	11.5	339	.73 NTU
	5/13/98	1130	202	8.0	625	612	11.5	339	.92 NTU
	8/5/98	1025	208	8.0	628	590 J	11.5	341	1.14 NTU
Resample	8/19/98	1056	NA	7.9	628	NA	12.0	341	NA

Table 2. Results of measurements of water for alkalinity, pH, specific conductance, temperature, and turbidity, and calculated total dissolved solids, Naval Reactors Facility and vicinity—Continued

Sample identifier	Date sampled m/d/y	Time	Alkalinity as $CaCO_3$	pH	Specific conductance (field)	Specific conductance (lab)	Temperature	Total dissolved solids	Turbidity
NRF-11	11/4/98	1025	206	7.9	637	617 J	11.0	346	2.99 NTU
NRF-12	6/5/97	1347	206	7.9	680	655	12.0	369	8 FTU
QAS-53R	6/5/97	1400	206	7.9	680	662	12.0	369	8 FTU
NRF-12	9/4/97	1205	200	7.9	698	645	12.0	379	6.52 NTU
	11/18/97	1350	199	7.9	703	634	11.5	382	5.66 NTU
	2/11/98	1135	202	7.9	708	685	11.5	384	1.68 NTU
	5/13/98	1220	194	8.0	710	696	11.5	386	9.06 NTU
	8/5/98	1120	199	8.0	712	660 J	11.5	387	4.16 NTU
Resample	8/19/98	1125	NA	7.9	713	NA	12.0	387	NA
NRF-12	11/4/98	1110	204	7.9	713	688 J	11.5	387	7.92 NTU
NRF-13	6/9/97	1350	99	8.3	546	506	19.0	296	47 FTU
	9/5/97	1230	98	8.3	562	515	17.5	305	37.8 NTU
	11/19/97	1335	91	8.2	556	406	14.5	302	202 NTU
	2/11/98	1400	89	8.3	548	535	17.5	298	35.7 NTU
	5/13/98	1315	96	8.2	587	578	16.0	319	26.3 NTU
	8/5/98	1235	96	8.2	587	556 J	18.0	319	67.8 NTU
Resample	8/19/98	1315	NA	8.0	603	NA	16.5	327	NA
NRF-13	11/4/98	1400	104	8.0	616	601 J	17.0	334	64.1 NTU
USGS 12	6/9/97	1120	212	7.8	549	526	12.0	298	3 FTU
QAS-54B	6/9/97	1200	NA	NA	NA	ND	NA	NA	NA
USGS 12	9/3/97	1140	206	7.9	567	528	11.5	308	.49 NTU
	11/19/97	1015	201	7.8	554	405	11.5	301	.79 NTU
	2/11/98	0915	211	7.7	544	527	11.5	295	.89 NTU
	5/12/98	0950	199	8.0	528	518	11.5	287	.78 NTU
	8/4/98	0905	203	7.9	518	495 J	11.0	281	.30 NTU
QAS-63R	8/4/98	0945	203	7.9	518	492 J	11.0	281	.30 NTU
USGS 12	11/4/98	0920	199	7.9	507	493 J	11.0	275	.46 NTU

Table 2. Results of measurements of water for alkalinity, pH, specific conductance, temperature, and turbidity, and calculated total dissolved solids, Naval Reactors Facility and vicinity—Continued

Sample identifier	Date sampled m/d/y	Time	Alkalinity as $CaCO_3$	pH	Specific conductance (field)	Specific conductance (lab)	Temperature	Total dissolved solids	Turbidity
USGS 97	6/10/97	0915	219	7.8	585	608	11.0	318	1 FTU
	9/3/97	1240	216	8.0	612	574	11.5	332	.48 NTU
	11/18/97	1035	221	7.9	612	445	11.5	332	.27 NTU
QAS-57B	11/18/97	1045	NA	NA	NA	2.0	NA	NA	NA
USGS 97	2/10/98	1035	223	7.9	614	594	11.5	333	.14 NTU
	5/12/98	1200	219	8.0	615	600	11.5	334	.36 NTU
	8/4/98	1225	219	8.0	614	579 J	11.0	333	.41 NTU
	11/3/98	1015	222	7.9	611	591	11.0	332	.23 NTU
USGS 98	6/10/97	0735	175	7.9	400	435	12.0	218	3 FTU
	9/3/97	0750	176	8.0	430	401	12.5	233	1.65 NTU
	11/18/97	0810	181	7.8	437	403	12.0	237	.22 NTU
	2/10/98	0820	179	7.7	440	424	12.0	239	.14 NTU
QAS-60B	2/10/98	0900	NA	NA	NA	2.4	NA	NA	NA
USGS 98	5/12/98	0750	173	8.0	434	428	12.0	236	.36 NTU
	8/4/98	1030	180	8.0	435	419 J	12.0	236	1.11 NTU
	11/3/98	0755	175	7.9	440	424	12.0	339	.47 NTU
USGS 99	6/10/97	0830	215	7.9	509	540	11.5	276	14 FTU
	9/3/97	0915	212	8.0	536	495	11.5	291	.43 NTU
QAS-55B	9/3/97	0930	NA	NA	NA	ND	NA	NA	NA
USGS 99	11/18/97	0905	216	7.9	535	408	11.5	291	.48 NTU
	2/10/98	0935	217	7.9	536	518	11.5	291	.25 NTU
	5/12/98	1105	210	8.1	534	524	11.5	290	12.0 NTU
	8/4/98	1125	213	8.0	532	508 J	11.0	289	1.20 NTU
	11/3/98	0915	221	8.0	532	512	11.0	289	.72 NTU
QAS-66B	11/3/98	0930	NA	NA	NA	1.6	NA	NA	NA
USGS 102	6/9/97	1245	224	7.9	584	539	11.5	317	3 FTU
	9/3/97	1325	218	8.0	600	566	11.5	326	2.16 NTU
	11/17/97	1225	188	7.9	604	576	11.5	328	.23 NTU
	2/9/98	1350	221	8.0	604	582	11.5	328	.11 NTU
	5/11/98	1355	211	8.0	603	593	11.5	327	1.05 NTU
	8/3/98	1320	214	8.0	603	579	11.0	327	.28 NTU
	11/2/98	1305	212	8.0	606	590 J	11.0	329	.37 NTU
Resample	11/4/98	1250	NA	8.0	606	NA	11.0	329	NA
QAS-65R	11/2/98	1400	212	8.0	606	590 J	11.0	329	.37 NTU

Table 3. Concentrations of dissolved anions and total cations in water, Naval Reactors Facility and vicinity

[Analyses were performed by Quanterra Environmental Services Laboratory. Analytical results in milligrams per liter. Sample identifier: see figure 2 for location of sites. QAS, water quality assurance sample; 59, sample number; R, replicate; B, field blank. Date sampled: (m/d/y), month/day/year. ND, analysis not detected; *, estimated result; S, sample diluted due to concentration of target compounds; Q, reporting limit is elevated due to high analyte levels]

Sample identifier	Date sampled m/d/y	Calcium (total)	Chloride (dissolved)	Magnesium (total)	Potassium (total)	Sodium (total)	Sulfate (dissolved)
NRF-6	6/5/97	134	267 S	34.4	5.0	122	194 S
	9/2/97	141	257 S	35.9	5.7	124	191 S
	11/17/97	128	251 S	33	5.0	115	182 S
	2/9/98	132	261 S	33.7	5.3	118	165 S
QAS-59R	2/9/98	132	258 S	34.0	5.3	118	166 S
NRF-6	5/11/98	137	245 Q	34.2	5.0	119	156 Q
	8/3/98	125	243 Q	33.4	4.53*	113	159 Q
	11/2/98	124	209 Q	32.1	4.5*	100	145 Q
NRF-7	6/5/97	26.9	4.7	8.9	2.9*	9.1	13.5
	9/2/97	26.6	4.6	9.1	2.9*	8.3	13.7
	11/17/97	27.2	4.0	9.5	3.3*	9.5	13.8
	2/9/98	28.7	4.5	9.6	3.3*	9.0	13.4
	5/11/98	31.5	4.3	9.5	3.1*	9.7	13.6
QAS-61R	5/11/98	31.9	4.3	9.6	3.2*	9.9	13.5
NRF-7	8/3/98	24.1	4.8	9.39	2.72*	8.27	13.9
	11/2/98	30.4	4.9	10.1	2.8*	9.4	13.1
NRF-8	6/10/97	76.0	39.3	24.5	2.4*	16.3	37.3
	9/4/97	73.0	35.1	24.6	2.2*	14.8	34.8
	11/17/97	73.0	35.5	23.5	2.5*	15.1	36.7
	2/10/98	75.5	36.1	24.1	2.6*	15.1	35.9
	5/13/98	75.2	36.2	23.3	2.3*	15.0	36.2
	8/5/98	70.3	36.6	23.4	2.29*	15.2	37.5
QAS-64B	8/5/98	ND	ND	ND	ND	ND	ND
NRF-8	11/3/98	76.3	35.7	24.4	2.2*	15.1	34.8
NRF-9	6/10/97	79.5	51.0	25.0	2.6*	19.6	48.5
	9/4/97	78.1	46.8	25.2	2.5*	18.2	46.9
QAS-56R	9/4/97	74.3	46.9	25.2	2.5*	15.0	46.7
NRF-9	11/18/97	76.6	47.5	23.9	2.8*	18.4	48.3
	2/10/98	79.7	47.1	24.5	2.8*	18.2	46.8
	5/13/98	80.2	47.9	24.5	2.6*	19.7	46.8
QAS-62B	5/13/98	.061*	ND	ND	ND	ND	ND
NRF-9	8/4/98	72.2	44.4 Q	23.3	2.59*	18.8	46.9
	11/3/98	79.8	45.7	24.6	2.2*	18.0	44.1
NRF-10	6/11/97	76.1	47.1	24.7	2.6*	16.8	45.8
	9/4/97	77.6	44.0	25.1	2.5*	18.9	43.3
	11/18/97	72.7	45.5	23.3	2.8*	15.5	45.2
	2/10/98	75.6	44.7	24.6	3.1*	15.8	43.7
	5/13/98	76.9	44.7	23.5	2.6*	15.8	43.7
	8/5/98	69.2	44.4	23.1	2.29*	15.2	44.5
	11/3/98	75.5	42.5	24.2	2.2*	16.0	40.7
NRF-11	6/11/97	75.1	48.0	24.0	2.8*	20.5	49.1
	9/4/97	73.9	42.9	24.8	2.6*	18.4	43.8
	11/19/97	74.4	43.1	23.2	2.7*	18.3	44.7
QAS-58R	11/19/97	73.6	43.3	23.2	2.6*	17.9	44.5
NRF-11	2/11/98	74.5	44.4	23.9	2.8*	17.6	43.5
	5/13/98	80.3	43.3	24.1	2.7*	18.7	43.2
	8/5/98	69.5	45.2	22.9	2.28*	17.8	44.6
	11/4/98	71.3	44.1	22.9	2.5*	17.6	41.4

Table 3. Concentrations of dissolved anions and total cations in water, Naval Reactors Facility and vicinity—Continued

Sample identifier	Date sampled m/d/y	Calcium (total)	Chloride (dissolved)	Magnesium (total)	Potassium (total)	Sodium (total)	Sulfate (dissolved)
NRF-12	6/5/97	80.1	61.6	24.5	2.6*	22.4	60.3
QAS-53R	6/5/97	81.1	61.8	25.0	2.7*	22.2	59.5
NRF-12	9/4/97	80.5	60.0	26.3	2.7*	23.2	57.5
	11/18/97	80.8	61.6	24.7	2.9*	22.9	60.5
	2/11/98	82.0	64.4	25.7	3.0*	23.5	60.3
	5/13/98	82.3	64.0	24.5	2.6*	23.9	59.8
	8/5/98	77.6	64.6	25.0	2.94*	25.7	60.9
	11/4/98	76.5	60.9 Q	24.1	2.7*	24.1	52.4 Q
NRF-13	6/9/97	75.6	66.7	21.2	4.8*	12.2	76.1
	9/5/97	103	63.3	32.6	4.9*	14.1	74.8
	11/19/97	74.1	65.3	20.2	4.7*	11.4	78.8
	2/11/98	61.8	65.2	16.9	4.2*	10.7	78.6
	5/13/98	73.3	68.0	20.0	4.0*	10.9	83.1
	8/5/98	71.2	69.4	20.7	4.0*	10.9	85.8
	11/4/98	71.9	69.1 Q	21.9	4.1*	11.2	82.0 Q
USGS 12	6/9/97	70.9	36.3	22.7	2.2*	17.7	35.4
QAS-54B	6/9/97	ND	ND	ND	ND	ND	ND
USGS 12	9/3/97	67.8	32.0	22.6	2.0*	16.7	32.1
	11/19/97	66.2	29.5	20.9	2.2*	16.5	31.5
	2/11/98	66.1	28.2	21.1	2.3*	16.4	30.1
	5/12/98	65.1	25.0	19.7	2.1*	16.1	28.4
	8/4/98	59.0	24.2	19.4	1.83*	15.2	28.2
QAS-63R	8/4/98	58.9	26.9	19.5	1.8*	15.0	28.7
USGS 12	11/4/98	57.4	19.6	18.6	1.8*	14.5	25.0
USGS 97	6/10/97	74.6	38.1	24.3	2.2*	16.4	36.2
	9/3/97	76.5	35.5	24.1	2.4*	15.9	36.6
	11/18/97	73.1	36.0	23.6	2.4*	15.6	36.2
QAS-57B	11/18/97	ND	ND	ND	ND	ND	ND
USGS 97	2/10/98	74.8	36.5	24.7	2.2*	15.6	35.9
	5/12/98	73.4	36.2	23.5	2.2*	15.9	35.8
	8/4/98	70.3	39.4	23.9	2.09*	16.2	36.7
	11/3/98	77.1	36.1	25.2	2.0*	16.0	34.8
USGS 98	6/10/97	51.3	14.6	19.7	2.2*	10.4	21.6
	9/3/97	50.4	15.1	20.1	2.0*	10.1	22.0
	11/18/97	51.4	13.9	19.4	2.3*	9.7	22.2
	2/10/98	53.0	14.7	20.1	2.2*	9.4	21.8
QAS-60B	2/10/98	ND	ND	ND	ND	ND	ND
USGS 98	5/12/98	49.8	14.2	18.3	2.0*	9.6	21.7
	8/4/98	48.0	14.6	18.8	2.03*	9.68	21.9
	11/3/98	52.8	13.9	20.1	1.8*	9.3	21.0
USGS 99	6/10/97	65.6	23.0	22.9	1.9*	15.8	26.0
	9/3/97	63.7	21.4	23.2	1.8*	15.1	25.9
QAS-55B	9/3/97	.63	ND	.21	ND	ND	ND
USGS 99	11/18/97	63.5	21.1	21.8	2.0*	15.1	26.9
	2/10/98	64.5	22.0	22.7	1.8*	14.5	26.5
	5/12/98	63.6	21.5	21.3	1.8*	15.3	26.4
	8/4/98	60.1	22.0	21.7	1.68*	14.5	26.9
	11/3/98	64.8	20.6	22.6	1.7*	14.7	25.1
QAS-66B	11/3/98	ND	ND	ND	ND	ND	ND

Table 3. Concentrations of dissolved anions and total cations in water, Naval Reactors Facility and vicinity—Continued

Sample identifier	Date sampled m/d/y	Calcium (total)	Chloride (dissolved)	Magnesium (total)	Potassium (total)	Sodium (total)	Sulfate (dissolved)
USGS 102	6/9/97	74.4	38.9	23.9	2.3*	15.2	36.5
	9/3/97	76.2	36.8	23.4	2.4*	15.2	36.4
	11/17/97	73.2	35.7	23.6	ND	15.1	36.3
	2/9/98	75.7	36.1	24.0	2.6*	15.1	35.5
	5/11/98	76.0	35.7	23.2	2.2*	15.1	35.7
	8/3/98	71.9	36.6	23.5	2.34*	16.0	36.1
	11/2/98	77.0	35.2	24.7	2.0*	15.1	34.1
QAS-65R	11/2/98	76.7	35.3	24.6	2.0*	15.4	34.1

Table 4. Statistical parameters for dissolved anions and total cations, by well

[See figure 2 for well locations. Units are milligrams per liter. Values are derived from table 3. Quality-assurance replicates are included in the calculation of statistical parameters. Mean and median sample size: includes all samples with concentrations greater than laboratory reporting limit and estimated results. *, results were estimated; ND, not detected]

	Statistical parameter					
Constituent	Minimum	Maximum	Median	Mean	Sample size	Mean and median sample size
			NRF-6			
Calcium	124	141	132	132	8	8
Chloride	209	267	254	249	8	8
Magnesium	32.1	35.9	33.85	34	8	8
Potassium	4.5*	5.7	5.0	5.0*	8	8
Sodium	100	124	118	116	8	8
Sulfate	145	194	165.5	170	8	8
			NRF-7			
Calcium	24.1	31.9	27.95	28.4	8	8
Chloride	4.0	4.9	4.55	4.5	8	8
Magnesium	8.9	10.1	9.5	9.5	8	8
Potassium	2.72*	3.3*	3.0*	3.0	8	8
Sodium	8.27	9.9	9.25	9.1	8	8
Sulfate	13.1	13.9	13.55	13.6	8	8
			NRF-8			
Calcium	70.3	76.3	75.2	74.2	7	7
Chloride	35.1	39.3	36.1	36.4	7	7
Magnesium	23.3	24.6	24.1	24.0	7	7
Potassium	2.2*	2.6*	2.3*	2.4*	7	7
Sodium	14.8	16.3	15.1	15.2	7	7
Sulfate	34.8	37.5	36.2	36.2	7	7
			NRF-9			
Calcium	72.2	80.2	78.8	77.6	8	8
Chloride	44.4	51.0	47.0	47.2	8	8
Magnesium	23.3	25.2	24.55	24.5	8	8
Potassium	2.2*	2.8*	2.595*	2.6*	8	8
Sodium	15.0	19.7	18.3	18.2	8	8
Sulfate	44.1	48.5	46.8	46.9	8	8
			NRF-10			
Calcium	69.2	77.6	75.6	74.8	7	7
Chloride	42.5	47.1	44.7	44.7	7	7
Magnesium	23.1	25.1	24.2	24.1	7	7
Potassium	2.2*	3.1*	2.6*	2.6*	7	7
Sodium	15.2	18.9	15.8	16.3	7	7
Sulfate	40.7	45.8	43.7	43.8	7	7

Table 4. Statistical parameters for dissolved anions and total cations, by well—Continued

Constituent	Statistical parameter					
	Minimum	Maximum	Median	Mean	Sample size	Mean and median sample size
			NRF-11			
Calcium	69.5	80.3	74.15	74.1	8	8
Chloride	42.9	48.0	43.7	44.3	8	8
Magnesium	22.9	24.8	23.55	23.6	8	8
Potassium	2.28*	2.8*	2.65*	2.6*	8	8
Sodium	17.6	20.5	18.1	18.4	8	8
Sulfate	41.4	49.1	44.15	44.4	8	8
			NRF-12			
Calcium	76.5	82.3	80.65	80.1	8	8
Chloride	60.0	64.6	61.7	62.4	8	8
Magnesium	24.1	26.3	24.85	25.0	8	8
Potassium	2.6*	3.0*	2.7*	2.8*	8	8
Sodium	22.2	25.7	23.35	23.5	8	8
Sulfate	52.4	60.9	60.05	58.9	8	8
			NRF-13			
Calcium	61.8	103	73.3	75.8	7	7
Chloride	63.3	69.4	66.7	66.7	7	7
Magnesium	16.9	32.6	20.7	21.9	7	7
Potassium	4.0*	4.9*	4.2*	4.4*	7	7
Sodium	10.7	14.1	11.2	11.6	7	7
Sulfate	74.8	85.8	78.8	79.9	7	7
			USGS 12			
Calcium	57.4	70.9	65.6	63.9	8	8
Chloride	19.6	36.3	27.55	27.7	8	8
Magnesium	18.6	22.7	20.3	20.6	8	8
Potassium	1.8*	2.3*	2.05*	2.0*	8	8
Sodium	14.5	17.7	16.25	16.0	8	8
Sulfate	25.0	35.4	29.4	29.9	8	8
			USGS 97			
Calcium	70.3	77.1	74.6	74.3	7	7
Chloride	35.5	39.4	36.2	36.8	7	7
Magnesium	23.5	25.2	24.1	24.2	7	7
Potassium	2.0*	2.4*	2.2*	2.2*	7	7
Sodium	15.6	16.4	15.9	15.9	7	7
Sulfate	34.8	36.7	36.2	36.0	7	7

Table 4. Statistical parameters for dissolved anions and total cations, by well—Continued

Constituent	Statistical parameter					
	Minimum	Maximum	Median	Mean	Sample size	Mean and median sample size
			USGS 98			
Calcium	48.0	53.0	51.3	51.0	7	7
Chloride	13.9	15.1	14.6	14.4	7	7
Magnesium	18.3	20.1	19.7	19.5	7	7
Potassium	1.8*	2.3*	2.03*	2.1*	7	7
Sodium	9.3	10.4	9.68	9.7	7	7
Sulfate	21.0	22.2	21.8	21.7	7	7
			USGS 99			
Calcium	60.1	65.6	63.7	63.7	7	7
Chloride	20.6	23.0	21.5	21.7	7	7
Magnesium	21.3	23.2	22.6	22.3	7	7
Potassium	1.68*	2.0*	1.8*	1.8*	7	7
Sodium	14.5	15.8	15.1	15.0	7	7
Sulfate	25.1	26.9	26.4	26.2	7	7
			USGS 102			
Calcium	71.9	77.0	75.85	75.1	8	8
Chloride	35.2	38.9	35.9	36.3	8	8
Magnesium	23.2	24.7	23.75	23.9	8	8
Potassium	ND	2.6*	2.3*	2.3*	8	7
Sodium	15.1	16.0	15.15	15.3	8	8
Sulfate	34.1	36.5	35.9	35.6	8	8

Table 5. Concentrations of selected total trace elements in water, Naval Reactors Facility and vicinity

[Analyses were performed by Quanterra Environmental Services Laboratory. Analytical results in micrograms per liter. Sample identifier: see figure 2 for location of sites. QAS, water quality-assurance sample; 59, sample number; R, replicate; B, blank. Date sampled: (m/d/y), month/day/year. ND, not detected; *, estimated concentration; B, compound detected in the blank; G, reporting limit raised due to the matrix of the sample]

Constituent	NRF-6 6/5/97	NRF-6 9/2/97	NRF-6 11/17/97	NRF-6 2/9/98	QAS-59R 2/9/98	NRF-6 5/11/98	NRF-6 8/3/98	NRF-6 11/2/98
Aluminum	ND	ND	ND	ND	ND	ND	ND	56*
Antimony	ND	.29*	.31*	.24*	.19*	ND	2.5*	ND
Arsenic	3.9*	3.8*	3.6*	3.8*	3.8*	3.9*	ND	ND
Barium	75	78	79	79 B	76 B	78	79.1	ND
Beryllium	ND	ND	.023*	ND	ND	ND	ND	ND
Cadmium	ND	ND	.025*	ND	ND	ND	ND	ND
Chromium	400	34	27	30	28	42	42.8	37
Copper	7.4	4.6	3.9	3.3	3.2	1	ND	ND
Iron	3,400	710	610	250	160	500	490	5,100
Lead	ND	.63*	ND	.62*	.45*	.36*	ND	ND
Manganese	14	7.0	7.8	3.5 B	3.3 B	7.1	5.7*	35.9
Mercury	ND	ND	.038*	.079*	.12*	ND	ND	ND
Nickel	28	21	14	24	12	27	29.9*	24.2*
Selenium	1.9*	2.8*	2.7*	2.8*	2.8*	2.0*	ND	ND
Silver	ND	.32*	.23*	ND	ND	.22*	ND	ND
Thallium	ND	ND	ND	ND	ND	ND	ND	ND
Zinc	5.3*	10	37	15 B	12 B	6.2*	ND	ND

Constituent	NRF-7 6/5/97	NRF-7 9/2/97	NRF-7 11/17/97	NRF-7 2/9/98	NRF-7 5/11/98	QAS-61R 5/11/98	NRF-7 8/3/98	NRF-7 11/2/98
Aluminum	130	44*	ND	57*	ND	ND	ND	160
Antimony	ND	.17*	.44*	1.1*	.24*	.71*	ND	ND
Arsenic	1.4*	1.9*	1.5 *	1.7*	1.8*	1.9*	ND	1.7*
Barium	52	53	56	55 B	59*	62*	54.7	60
Beryllium	ND	ND	ND	ND	ND	ND	ND	ND
Cadmium	ND	ND	.052*	ND	ND	ND	ND	ND
Chromium	9.7	10	10	9.6	11*	12*	11.4	11
Copper	67	2.5	16	3.3	ND	.88*	ND	ND
Iron	540	93*	1,800	100	80*	140	ND	130
Lead	1.3	ND	1.3	.58*	.42*	1.2*	ND	ND
Manganese	7.6	3.6	24	4.0 B	5.5*	9.8*	ND	3.6
Mercury	ND	ND	.084*	.089*B	ND	ND	ND	ND
Nickel	6.3	5.2	8.2	7.7	6.5*	7.5*	ND	5.7
Selenium	.94*	1.6*	1.2*	1.4*	1.5*	1.5*	ND	1.4*
Silver	ND	ND	.34*	ND	.2*	.34*	ND	ND
Thallium	ND	.062*	.006*	ND	ND	ND	ND	ND
Zinc	13	5.1*	120	17 B	24*	67*	ND	5.6*

Table 5. Concentrations of selected total trace elements in water, Naval Reactors Facility and vicinity—Continued

Constituent	NRF-8 6/10/97	NRF-8 9/4/97	NRF-8 11/17/97	NRF-8 2/10/98	NRF-8 5/13/98	NRF-8 8/5/98	QAS-64B 8/5/98	NRF-8 11/3/98
Aluminum	ND	ND	ND	ND	ND	ND	ND	62*
Antimony	ND	ND	ND	ND	ND	ND	ND	ND
Arsenic	1.4*	ND	1.8*	1.8*	1.9*	ND	ND	2.0*
Barium	120	120	110	120 B	130*	134	ND	130
Beryllium	ND	ND	ND	ND	ND	ND	ND	ND
Cadmium	ND	ND	.015*	ND	ND	ND	ND	ND
Chromium	5.0	5.5	5.2	5.5	6.8*	11.6	.2*	7
Copper	3.4	ND	1.7	2.5	ND	ND	ND	ND
Iron	180	ND	ND	31	ND	477	ND	ND
Lead	ND	ND	.22*	.4*	ND	3.7	ND	ND
Manganese	1.5	.73	1.5	1.4 B	.7*	5.8*	ND	.21*
Mercury	ND	ND	.063*	.15*B	ND	ND	ND	ND
Nickel	4.8	3.8	4.5	5.2	1.5*	ND	ND	1.3
Selenium	ND	ND	2.5*	2.7*	2.3*	ND	ND	2.9*
Silver	ND	ND	.12*	ND	ND	ND	ND	ND
Thallium	ND	ND	.012*	ND	ND	ND	ND	ND
Zinc	9.1*	ND	25	20 B	9.9*	ND	ND	4.6*

Constituent	NRF-9 6/10/97	NRF-9 9/4/97	QAS-56R 9/4/97	NRF-9 11/18/97	NRF-9 2/10/98	NRF-9 5/13/98	QAS-62B 5/13/98	NRF-9 8/4/98	NRF-9 11/3/98
Aluminum	43*	ND	160	ND	ND	ND	ND	ND	100
Antimony	ND	ND	ND	ND	ND	ND	ND	ND	ND
Arsenic	1.5*	ND	ND	1.7*	1.8*	1.8*	ND	ND	1.9*
Barium	130	140	130	130	120 B	140*	ND	140	140
Beryllium	ND	ND	ND	ND	ND	ND	ND	ND	ND
Cadmium	ND	ND	ND	.019*	ND	ND	ND	ND	ND
Chromium	11	11	12	9.0	10	11*	.65*	9.6	11
Copper	2.2	ND	2.1	2.7	3.0	ND	ND	ND	ND
Iron	98*	61*	290	ND	110	150	ND	ND	450
Lead	ND	ND	ND	.30*	.59*	ND	ND	ND	ND
Manganese	1.9	1.2	13	1.3	2.5 B	1.8*	.24*	ND	4.2
Mercury	ND	ND	ND	.083*	.14*B	ND	ND	ND	ND
Nickel	4.5	3.9	17	4.7	5.3	1.5*	ND	ND	1.8
Selenium	2.0*	ND	ND	2.5*	2.6*	2.3*	ND	ND	3.1*
Silver	ND	ND	ND	.10	ND	ND	ND	ND	ND
Thallium	ND	ND	ND	.021	ND	ND	ND	ND	ND
Zinc	6.9*	ND	ND	24	21 B	11*	ND	ND	4.8*

Table 5. Concentrations of selected total trace elements in water, Naval Reactors Facility and vicinity—Continued

Constituent	NRF-10 6/11/97	NRF-10 9/4/97	NRF-10 11/18/97	NRF-10 2/10/98	NRF-10 5/13/98	NRF-10 8/5/98	NRF-10 11/3/98
Aluminum	180	ND	43*	1200	61*	ND	190
Antimony	ND	ND	ND	ND	ND	ND	ND
Arsenic	1.3*	ND	1.5*	1.9*	1.6*	ND	1.8*
Barium	130	130	130	150 B	130*	137	130
Beryllium	ND	ND	ND	ND	ND	ND	ND
Cadmium	ND	.072*	.014*	ND	ND	ND	ND
Chromium	10	9.5	12	20	13*	12.6	12
Copper	ND	ND	2.7	5.8	ND	ND	ND
Iron	250	38*	340	1,200	150	113	100
Lead	ND	ND	.41*	1.3	ND	ND	ND
Manganese	10	.68	13	33	7.3*	5.2*	5.4
Mercury	ND	ND	ND	.099*B	ND	ND	ND
Nickel	11	3.5	19	30	22*	24.0*	19
Selenium	1.6*	ND	2.2*	2.6*	2.5*	ND	3.0*
Silver	ND	ND	.17*	ND	ND	ND	ND
Thallium	ND	ND	.022*	ND	ND	ND	ND
Zinc	7.2*	ND	38	29 B	8.9*	ND	4.9*

Constituent	NRF-11 6/11/97	NRF-11 9/4/97	NRF-11 11/19/97	QAS-58R 11/19/97	NRF-11 2/11/98	NRF-11 5/13/98	NRF-11 8/5/98	NRF-11 11/4/98
Aluminum	48*	ND	ND	ND	ND	ND	ND	150
Antimony	ND	ND	ND	ND	ND	ND	ND	ND
Arsenic	ND	ND	1.7*	1.6*	1.8	1.8*	ND	1.9*
Barium	130	140	130	130	130 B	140*	141	140
Beryllium	ND	ND	ND	ND	ND	ND	ND	ND
Cadmium	ND	ND	.21*	.028*	ND	ND	ND	ND
Chromium	16	17	16	14	14	16*	14.2	18
Copper	ND	2.5	2.1	2.9	3.3	ND	ND	ND
Iron	130	80	37*	27*	160	ND	ND	680
Lead	ND	ND	.29*	.34*	.56*	ND	ND	ND
Manganese	1.5	1.7	2.1	2.1	2.5 B	1.3*	ND	7.2
Mercury	ND	ND	ND	ND	.17* B	ND	ND	1.9*
Nickel	12	15	12	12	19	10*	ND	9.5
Selenium	ND	ND	2.4*	2.4*	2.7*	2.7*	ND	3.1*
Silver	ND	ND	.098*	.081*	ND	ND	ND	ND
Thallium	ND	ND	.018*	.019*	ND	ND	ND	ND
Zinc	13	12	31	31	17 B	9.6*	ND	5.5*

Table 5. Concentrations of selected total trace elements in water, Naval Reactors Facility and vicinity—Continued

Constituent	NRF-12 6/5/97	QAS-53R 6/5/97	NRF-12 9/4/97	NRF-12 11/18/97	NRF-12 2/11/98	NRF-12 5/13/98	NRF-12 8/5/98	NRF-12 11/4/98
Aluminum	120	150	ND	ND	ND	ND	ND	ND
Antimony	ND	ND	ND	ND	ND	ND	2.8*	ND
Arsenic	1.6*	1.5*	ND	1.6*	1.7*	1.8*	ND	1.9*
Barium	140	150	160	150	150 B	170*	175	170
Beryllium	ND	ND	ND	ND	ND	ND	ND	ND
Cadmium	ND	ND	ND	.022*	ND	ND	ND	ND
Chromium	360	38	23	20	18	26*	21.8	25
Copper	5.9	2.7	2.1	2.5	2.6	ND	ND	ND
Iron	1900	480	160	130	92*	120	119	130
Lead	ND	ND	ND	.34*	.38*	ND	ND	ND
Manganese	4.9	5.0	4.6	4.2	2.8 B	3.2*	ND	1.8
Mercury	ND	ND	ND	.099*	.11*B	ND	ND	1.9*
Nickel	43	37	39	33	29	34*	37.7*	26
Selenium	1.8*	1.7*	ND	2.2*	2.7*	2.2*	ND	2.6*
Silver	ND	ND	ND	.12*	ND	ND	ND	ND
Thallium	ND	ND	ND	.016*	ND	ND	ND	ND
Zinc	7.6*	7.3*	ND	23	18 B	11*	ND	6.3*

Constituent	NRF-13 6/9/97	NRF-13 9/5/97	NRF-13 11/19/97	NRF-13 2/11/98	NRF-13 5/13/98	NRF-13 8/5/98	NRF-13 11/4/98
Aluminum	4,800	19,200	2,800	1,400	350	597	3,100
Antimony	ND	ND	ND	ND	ND	ND	ND
Arsenic	1.4 *	ND	2.0*	1.7*	1.7*	ND	1.8*
Barium	84	140	92	79 B	89*	94.9	110
Beryllium	ND	ND	ND G	ND	ND	ND	ND
Cadmium	ND	.088*	.051*	.11	ND	ND	ND
Chromium	35	39	34 G	29	27*	47.2	58
Copper	5.7	12	11 G	5.0	1.4*	3.0*	3.8
Iron	4,200	20,500	3,600	1,400	820	1,710	2,500
Lead	1.1	3	1.7	1.6	.31*	6.1	.88*
Manganese	43	220	72 G	24 B	15*	41.7	41
Mercury	ND	.04*	ND	.10*B	ND	ND	1.9*
Nickel	16	34	19 G	12	4.1*	18.4*	21
Selenium	.90*	ND	2.5*	1.9*	1.4*	ND	2.0*
Silver	.72	ND	ND	ND	ND	ND	ND
Thallium	ND	ND	.036*	ND	ND	10.7	ND
Zinc	11	43	39	21 B	9.1*	ND	11*

Table 5. Concentrations of selected total trace elements in water, Naval Reactors Facility and vicinity—Continued

Constituent	USGS 12 6/9/97	QAS-54B 6/9/97	USGS 12 9/3/97	USGS 12 11/18/97	USGS 12 2/11/98	USGS 12 5/12/98	USGS 12 8/4/98	QAS-63R 8/4/98	USGS 12 11/4/98
Aluminum	ND	ND	ND	ND	ND	ND	ND	ND	ND
Antimony	ND	ND	ND	ND	ND	ND	ND	ND	ND
Arsenic	1.5*	ND	ND	1.6*	1.9*	1.9*	5.8*	ND	1.9*
Barium	130	.54*	140	130	130 B	140*	136	137	130
Beryllium	ND	ND	ND	ND	ND	ND	ND	ND	ND
Cadmium	ND	ND	ND	.016*	.081	ND	ND	ND	ND
Chromium	4.9	ND	5.3	5.8	5.7	6.2*	5.9	5.8	6.3
Copper	ND	1.2*	ND	1.9*	3.1	ND	ND	ND	1.7
Iron	59	ND	42*	30*	32*	ND	ND	ND	ND
Lead	ND	ND	ND	.33*	.50*	ND	ND	ND	ND
Manganese	1.3	.21	1.6	1.7	2.5 B	1.3*	ND	ND	.75*
Mercury	ND	ND	ND	ND	.13*B	ND	ND	ND	1.9*
Nickel	2.8	ND	2.4	3.4	4.2	.46*	ND	ND	.78*
Selenium	1.8*	ND	ND	2.0*	2.5*	2.5*	ND	ND	2.5*
Silver	ND	ND	ND	ND	ND	ND	ND	ND	ND
Thallium	ND	ND	ND	.019*	ND	ND	ND	ND	.11*
Zinc	7.2*	ND	ND	19	20 B	9.3*	ND	ND	6.0*

Constituent	USGS 97 6/10/97	USGS 97 9/3/97	USGS 97 11/18/97	QAS-57B 11/18/97	USGS 97 2/10/98	USGS 97 5/12/98	USGS 97 8/4/98	USGS 97 11/3/98
Aluminum	ND	ND	ND	ND	ND	ND	ND	64*
Antimony	ND	.42*	.39*	ND	ND	ND	ND	ND
Arsenic	1.4*	1.7*	1.6*	ND	1.8*	1.8*	ND	1.9*
Barium	120	130	120	1.3	120 B	140*	140	140
Beryllium	ND	ND	ND	ND	ND	ND	ND	ND
Cadmium	ND	ND	.041*	.016*	ND	ND	ND	ND
Chromium	4.3	5.4	4.6	ND	5.3	6.1*	5.9	6.4
Copper	2.0	2.9	2.2	2.3	3.2	ND	ND	ND
Iron	39*	32*	45*	ND	ND	ND	ND	290
Lead	1.3	2.4	2.4	.39*	1.8	1.0*	ND	2.7
Manganese	.41	.67	2.0	.87	1.1 B	.75*	ND	1.9
Mercury	ND	ND	.068*	.06*	.12*B	ND	ND	ND
Nickel	3.4	2.6	3.8	.29	4.6	.38*	ND	.73*
Selenium	1.7*	2.6*	2.2*	ND	2.8*	2.6*	ND	2.9*
Silver	ND	.13*	.099*	.095*	ND	ND	ND	ND
Thallium	ND	ND	.023*	ND	ND	ND	ND	ND
Zinc	99	130	130	11	110 B	100*	109	95*

Table 5. Concentrations of selected total trace elements in water, Naval Reactors Facility and vicinity—Continued

Constituent	USGS 98 6/10/97	USGS 98 9/3/97	USGS 98 11/18/97	USGS 98 2/10/98	QAS-60B 2/10/98	USGS-98 5/12/98	USGS 98 8/4/98	USGS 98 11/3/98
Aluminum	ND	ND	ND	ND	ND	ND	ND	55*
Antimony	ND	ND	ND	ND	ND	ND	ND	ND
Arsenic	1.3*	ND	1.5*	1.6*	ND	1.8*	ND	1.5*
Barium	46	50	49	49 B	1.4 B	53*	52.7	53*
Beryllium	ND	ND	ND	ND	ND	ND	ND	ND
Cadmium	ND	.25*	.17*	.18*	ND	.15*	ND	.16*
Chromium	3.8	4.3	4.4	4.4	ND	5.3*	4.9	5.7*
Copper	3.7	36	3.7	3.6	2.5	1.6*	ND	1.6*
Iron	150	42*	ND	30*	ND	ND	ND	350
Lead	5.9	7.3	5.0	5.2	.43*	4.6*	5.9	4.6*
Manganese	1.3	1.2	2.6	1.5 B	1.1 B	.71*	ND	3.1*
Mercury	ND	ND	.084*	.11*B	.11*B	ND	ND	ND
Nickel	2.2	2.0	2.9	3.0	.32	.37*	ND	.81*
Selenium	1.1*	ND	1.4*	1.6*	.076*	1.5*	ND	1.8*
Silver	ND	ND	.091*	ND	ND	ND	ND	ND
Thallium	ND	ND	.019*	ND	ND	ND	ND	ND
Zinc	140	190	150	150 B	13 B	140*	158	150*

Constituent	USGS 99 6/10/97	USGS 99 9/3/97	QAS-55B 9/3/97	USGS 99 11/18/97	USGS 99 2/10/98	USGS 99 5/12/98	USGS 99 8/4/98	USGS 99 11/3/98	QAS-66B 11/3/98
Aluminum	ND	ND	ND	ND	ND	170	ND	54*	48*
Antimony	ND	ND	ND	.46*	ND	ND	ND	ND	ND
Arsenic	1.2*	ND	ND	1.5*	1.6*	1.7*	ND	1.7*	ND
Barium	93	100	.98*	95	95 B	110*	105	100	ND
Beryllium	ND	ND	ND	ND	ND	ND	ND	ND	ND
Cadmium	ND	.061*	ND	.065*	.11*	.073*	ND	ND	ND
Chromium	3.6	4.3	ND	4.2	4.8	6.9*	5.0	5.6	.35*
Copper	2.6	2.7	ND	2.7	4.4	10*	ND	.91*	ND
Iron	110	57*	ND	ND	73*	800	ND	300	ND
Lead	1.2	1.4	.16*	1.2	1.7	4.4*	ND	1.2	ND
Manganese	1.3	1.7	.48	2.2	1.9 B	15*	ND	2.0	ND
Mercury	ND	ND	ND	.048*	.14*B	ND	ND	ND	ND
Nickel	3.0	2.9	.11*	3.8	4.5	3.1*	ND	1.4	ND
Selenium	1.4*	ND	ND	1.8*	1.8*	2.1*	ND	2.2*	.27*
Silver	ND	ND	ND	.092*	ND	ND	ND	ND	ND
Thallium	ND	ND	ND	.021*	ND	ND	ND	ND	ND
Zinc	93	110	2.0*	130	100 B	160*	106	97*	ND

Table 5. Concentrations of selected total trace elements in water, Naval Reactors Facility and vicinity—Continued

Constituent	USGS 102 6/9/97	USGS 102 9/3/97	USGS 102 11/17/97	USGS 102 2/9/98	USGS 102 5/11/98	USGS 102 8/3/98	USGS 102 11/2/98	QAS-65R 11/2/98
Aluminum	ND	ND	ND	ND	ND	ND	63*	64*
Antimony	ND	ND	.21*	ND	ND	ND	ND	ND
Arsenic	1.4*	1.8*	1.7*	1.7*	1.8*	ND	1.7*	1.7*
Barium	110	120	110	110 B	120	126	130	130
Beryllium	ND	ND	ND	ND	ND	ND	ND	ND
Cadmium	ND	ND	.021*	.056*	ND	ND	ND	ND
Chromium	4.7	5.7	5.3	5.3	6.1	6.0	6.7	6.2
Copper	5.3	2.9	3.3	2.5	ND	ND	ND	ND
Iron	110	ND	87*	ND	30*	ND	590	620
Lead	ND	.31*	.49*	.37*	ND	ND	ND	ND
Manganese	.80	.65	2.6	.96 B	1.2	ND	4.3*	4.4*
Mercury	ND	ND	.071*	.15*B	ND	ND	ND	ND
Nickel	3.1	2.6	4.2	4.3	.47*	ND	2.9*	2.5*
Selenium	1.8*	2.6*	2.4*	2.7*	2.2*	ND	3.0*	2.9*
Silver	ND	ND	.30*	ND	ND	ND	ND	ND
Thallium	ND	ND	.017*	ND	ND	ND	ND	ND
Zinc	7.3*	8.2*	29	18 B	8.4*	ND	9.9*	11

Table 6. Statistical parameters for selected total trace elements, by well

[See figure 2 for well locations. Units are milligrams per liter. Values are derived from table 5. Quality-assurance replicates are included in the calculation of statistical parameters. Mean and median sample size: includes all samples with concentrations greater than laboratory reporting limit and estimated results. *, results were estimated; ND, not detected]

	Statistical parameter					
Constituent	Minimum	Maximum	Median	Mean	Sample size	Mean and median sample size
			NRF-6			
Antimony	ND	2.5*	.29*	.71*	8	5
Arsenic	ND	3.9*	3.8*	3.8*	8	6
Barium	ND	79.1	78	77.7	8	7
Chromium	ND	42.8	34	34.4	8	7
Copper	ND	7.4	3.6	3.9	8	6
Iron	160	5,100	555	1,400	8	8
Lead	ND	.63*	.535*	.52*	8	4
Manganese	3.3	35.9	7.05	10.5*	8	8
Mercury	ND	.12*	.079*	.079*	8	3
Nickel	12	29.9*	24.1*	22.5*	8	8
Selenium	ND	2.8*	2.75*	2.5*	8	6
Silver	ND	.32*	.23*	.26*	8	3
Zinc	ND	37	11	14.2*	8	6
			NRF-7			
Aluminum	ND	160	93.5*	98*	8	4
Antimony	ND	1.1*	.44*	.53*	8	5
Arsenic	ND	1.9*	1.7*	1.7*	8	7
Barium	52	62*	55.5	56.5*	8	8
Chromium	9.6	12*	10.5*	10.6*	8	8
Copper	ND	67	3.3	18*	8	5
Iron	ND	1,800	130	410*	8	7
Lead	ND	1.3	1.2*	.96*	8	5
Manganese	ND	24	5.5*	8.3*	8	7
Nickel	ND	8.2	6.5*	6.7*	8	7
Selenium	ND	1.6*	1.4*	1.4*	8	7
Silver	ND	.34*	.34*	.29*	8	3
Zinc	ND	120	17	36*	8	7
			NRF-8			
Arsenic	ND	2.0*	1.8*	1.8*	7	5
Barium	110	134	120	123*	7	7
Chromium	5.0	11.6	5.5	6.7*	7	7
Copper	ND	3.4	2.5	2.5	7	3
Iron	ND	477	180	229	7	3
Lead	ND	3.7	.4*	1.44*	7	3
Manganese	.21*	5.8*	1.4	1.7*	7	7

Table 6. Statistical parameters for selected total trace elements, by well—Continued

Constituent	Statistical parameter					
	Minimum	Maximum	Median	Mean	Sample size	Mean and median sample size
			NRF-8—cont.			
Nickel	ND	5.2	4.15	3.5*	7	6
Selenium	ND	2.9*	2.6*	2.6*	7	4
Zinc	ND	25	9.9*	13.7*	7	5
			NRF-9			
Arsenic	ND	1.9*	1.8*	1.7*	7	5
Barium	120	140*	140*	130*	7	7
Chromium	9.0	11	11*	10.4*	7	7
Copper	ND	3.0	2.7	2.6	7	3
Iron	ND	450	110	174	7	5
Manganese	ND	4.2	1.85*	2.2*	7	6
Nickel	ND	5.3	4.2	3.6*	7	6
Selenium	ND	3.1*	2.5*	2.5*	7	5
Zinc	ND	24	11*	13.5*	7	5
			NRF-10			
Aluminum	ND	1,200	180	335*	7	5
Arsenic	ND	1.9*	1.6*	1.6*	7	5
Barium	130*	150	130*	134*	7	7
Chromium	9.5	20	12	12.7*	7	7
Iron	38*	1,200	150	313	7	7
Manganese	.68	33	7.3*	10.7*	7	7
Nickel	3.5	30	19	18.4*	7	7
Selenium	ND	3.0*	2.5*	2.4*	7	5
Zinc	ND	38	8.9*	17.6*	7	5
			NRF-11			
Arsenic	ND	3.8*	1.8*	2.2*	8	5
Barium	76	141	135*	128*	8	8
Chromium	14	28	16	17.4*	8	8
Copper	ND	3.2	2.7	2.7	8	4
Iron	ND	680	105	186*	8	6
Lead	ND	.45*	.34*	.36*	8	3
Manganese	ND	7.2	2.1	2.7*	8	7
Nickel	ND	15	12	11.8*	8	7
Selenium	ND	3.1*	2.7*	2.7*	8	5
Zinc	ND	31	12	16.3*	8	7
			NRF-12			
Arsenic	ND	1.9*	1.65*	1.7*	8	6
Barium	140	175	155	158*	8	8
Chromium	18	360	24	66.5*	8	8

Table 6. Statistical parameters for selected total trace elements, by well—Continued

Constituent	Statistical parameter					
	Minimum	Maximum	Median	Mean	Sample size	Mean and median sample size
			NRF-12-cont			
Copper	ND	5.9	2.6	3.2	8	5
Iron	92*	1900	130	391	8	8
Manganese	ND	5.0	4.2	3.8*	8	7
Mercury	ND	1.9*	.11*	.70*	8	3
Nickel	26	43	35.5	35*	8	8
Selenium	ND	2.7*	2.2*	2.2*	8	6
Zinc	ND	23	9.3*	12.2*	8	6
			NRF-13			
Aluminum	350	19,200	2,800	4,600	7	7
Arsenic	ND	2.0*	1.75*	1.7*	7	6
Barium	79	120	92	95.6*	7	7
Chromium	5.7	58	34	33.7*	7	7
Copper	1.4*	11	3.8	4.7*	7	7
Iron	820	20,500	2,500	4,960	7	7
Lead	.31*	6.1	1.1	1.7*	7	7
Manganese	.65	72	41	33.9*	7	7
Mercury	ND	1.9*	.10*	.68*	7	3
Nickel	2.6	21	16	13.3*	7	7
Selenium	ND	2.6*	1.95*	1.9*	7	6
Zinc	ND	39	11*	16.6	7	6
			USGS 12			
Arsenic	ND	5.8*	1.9*	2.4*	8	6
Barium	130	140*	133	134*	8	8
Chromium	4.9	6.3	5.8	5.7*	8	8
Copper	ND	3.1	1.9*	2.2*	8	3
Iron	ND	59	37*	41*	8	4
Manganese	ND	2.5	1.45*	1.5*	8	6
Nickel	ND	4.2	2.6	2.3*	8	6
Selenium	ND	2.5*	2.5*	2.3*	8	5
Zinc	ND	20	9.3*	12.3*	8	5
			USGS 97			
Arsenic	ND	1.9*	1.75*	1.7*	7	6
Barium	120	140*	130	130*	7	7
Chromium	4.3	6.4	5.4	5.4	7	7
Copper	ND	3.2	2.55	2.6	7	4
Iron	ND	290	42*	102*	7	4
Lead	ND	2.7	2.1	1.9*	7	6
Manganese	ND	2.0	.925*	1.1*	7	6

Table 6. Statistical parameters for selected total trace elements, by well—Continued

Constituent	Statistical parameter					
	Minimum	Maximum	Median	Mean	Sample size	Mean and median sample size
			USGS 97—cont.			
Nickel	ND	4.6	3.0	2.6*	7	6
Selenium	ND	2.9*	2.6*	2.5*	7	6
Zinc	95*	130	109	110*	7	7
			USGS 98			
Arsenic	ND	1.8*	1.5*	1.5*	7	5
Barium	46	53*	50	50*	7	7
Cadmium	ND	.25*	.17*	.18*	7	5
Chromium	3.8	5.7*	4.4	4.7*	7	7
Copper	ND	36	3.65	8.4*	7	6
Iron	ND	350	96*	143*	7	4
Lead	4.6*	7.3	5.2	5.5*	7	7
Manganese	ND	3.1*	1.4	1.7*	7	6
Nickel	ND	3.0	2.1	1.9*	7	6
Selenium	ND	1.8*	1.5*	1.5*	7	5
Zinc	140	190	150	154*	7	7
			USGS 99			
Arsenic	ND	1.7*	1.6*	1.5*	7	5
Barium	93	110*	100	100	7	7
Cadmium	ND	.11*	.069*	.077*	7	4
Chromium	3.6	6.9*	4.8	4.9*	7	7
Copper	ND	10*	2.7	3.9*	7	6
Iron	ND	800	110	268*	7	5
Lead	ND	4.4*	1.3	1.8*	7	6
Manganese	ND	15*	1.95	4.0*	7	6
Nickel	ND	4.5	3.05	3.1*	7	6
Selenium	ND	2.2*	1.8*	1.9*	7	5
Zinc	93	160*	106	114*	7	7
			USGS 102			
Arsenic	ND	1.8*	1.7*	1.7*	8	7
Barium	110	130	120	120	8	8
Chromium	4.7	6.7	5.85	5.8	8	8
Copper	ND	5.3	3.1	3.5	8	4
Iron	ND	620	110	287	8	5
Lead	ND	.49	.37*	.39*	8	3
Manganese	ND	4.4*	1.2	2.1*	8	7
Nickel	ND	4.3	2.9*	2.9*	8	7
Selenium	ND	3.0*	2.6*	2.5*	8	7
Zinc	ND	29	9.9*	13*	8	7

Table 7. Concentrations of dissolved and total nutrients, total organic carbon, and total organic halogens in water, Naval Reactors Facility and vicinity

[Analyses were performed by Quanterra Environmental Services Laboratory. Analytical results in milligrams per liter. Sample identifier: see figure 2 for location of sites. QAS, water quality-assurance sample; 59, sample number; R, replicate; B, field blank. Date sampled: (m/d/y), month/day/year. ND, analysis not detected; *, estimated result; B, compound is also detected in blank; Q, reporting limit elevated due to high analyte level; S, sample diluted due to the concentration of target compounds]

Sample identifier	Date sampled m/d/y	Kjeldahl nitrogen (total)	Nitrite (dissolved)	Nitrite plus nitrate (total)	Phosphorus (total)	Total organic carbon	Total organic halogens
NRF-6	6/5/97	ND	ND	2.0	.20	.67*	.020*
	9/2/97	ND	ND	1.9	.099	.26*	.024*
	11/17/97	ND	ND	1.8	.12	.85*	.019*
	2/9/98	.32*	.003*	2.0	.10	.27*	.014*B
QAS-59R	2/9/98	ND	.004*	2.0	.13	.44*	.021*B
NRF-6	5/11/98	.37*	.002*	1.7	.11	.76*	.013*
	8/3/98	ND	ND	1.6	.081	ND	.059
	11/2/98	.15*	ND	1.6	.12	.35*	ND
NRF-7	6/5/97	ND	ND	.72	.17	ND	.008*
	9/2/97	ND	ND	.68	.024*	ND	ND
	11/17/97	ND	ND	.44	.039*	.31*	ND
	2/9/98	.094*	.003*	.59	.034*	ND	ND B
	5/11/98	.18*	.002*	.47	.022*	ND	ND
QAS-61R	5/11/98	.12*	.001*	.47	.022*	.24*	ND
NRF-7	8/3/98	ND	ND	.47	.022*	ND	ND
	11/2/98	ND	ND	.46	.035*	ND	ND
NRF-8	6/10/97	ND	ND	2.3	.18	.50*	.004*
	9/4/97	ND	.005*	2.1	.026*	.22*	.008*
	11/17/97	ND	ND	2.0 S	.085*	.56*	ND
	2/10/98	ND	ND	2.2	.046*	.20*	ND B
	5/13/98	.22*	.006*	2.1	.052*	ND	ND
	8/5/98	.19*	ND	1.9	.027*	ND	.016*
QAS-64B	8/5/98	.22*	ND	.031*	ND	ND	ND
NRF-8	11/3/98	ND	ND	2.3	.023*	ND	.23
NRF-9	6/10/97	ND	ND	2.5	.20	.56*	ND
	9/4/97	ND	.005*	2.2	.089	.22*	.008*
QAS-56R	9/4/97	ND	.006*	2.2	.027*	.42*	.010*
NRF-9	11/18/97	ND	ND	2.4	.042*	.69*	ND
	2/10/98	ND	.003*B	2.4	.038*	.32*	ND B
	5/13/98	.18*	.003*	2.1	.035*	ND	ND
QAS-62B	5/13/98	ND	.004*	ND	.022*	ND	ND
NRF-9	8/4/98	ND	ND	2.1 Q	.033*	ND	.05
	11/3/98	.079*	ND	2.4	.026*	ND	.069
NRF-10	6/11/97	ND	ND	2.2	.21	.47*	.003*
	9/4/97	ND	.005*	1.9	.042*	.48*	.004*
	11/18/97	ND	ND	1.9	.047*	.54*	ND
	2/10/98	ND	.004*B	2.0	.16	ND	.009*B
	5/13/98	.37*	.004*	1.9	.04*	ND	ND
	8/5/98	.063*	ND	1.8	.027*	ND	.021*

Table 7. Concentrations of dissolved and total nutrients, total organic carbon, and total organic halogens in water, Naval Reactors Facility and vicinity—Continued

Sample identifier	Date sampled m/d/y	Kjeldahl nitrogen (total)	Nitrite (dissolved)	Nitrite plus nitrate (total)	Phosphorus (total)	Total organic carbon	Total organic halogens
NRF-10	11/3/98	ND	ND	2.1	.025*	ND	.055
NRF-11	6/11/97	ND	ND	2.3	.20	.56*	.010*
	9/4/97	ND	.005*	2.0	.026*	.33*	.006*
	11/19/97	ND	ND	2.3	.041*	.41*	.008*
QAS-58R	11/19/97	ND	.004*	2.1	.040*	.40*	ND
NRF-11	2/11/98	ND	ND	2.2	.045*	ND	ND B
	5/13/98	.22*	.004*	2.1	.046*	ND	ND
	8/5/98	.26*	ND	2.0	.034*	ND	.024*
	11/4/98	ND	ND	2.4	.039*	ND	.066
NRF-12	6/5/97	ND	ND	2.3	.24	.31*	.009*
QAS-53R	6/5/97	ND	ND	2.3	.28	.33*	.005*
NRF-12	9/4/97	ND	.005*	2.1	.028*	.42*	.011*
	11/18/97	ND	ND	2.1	.038*	.62*	.009*
	2/11/98	ND	ND	2.3	.049*	ND	.011*B
	5/13/98	.30	.005*	2.1	.037*	ND	ND
	8/5/98	.55	ND	2.0	.023*	ND	.019*
	11/4/98	.15*	ND	2.4 Q	.026*	ND	.042
NRF-13	6/9/97	ND	ND	.90	.48	.34*	.012*
	9/5/97	ND	.009*	.80	.088	ND	.014*
	11/19/97	ND	.006*	.98	.17	.35*	ND
	2/11/98	ND	ND	1.1	.079	ND	.011*B
	5/13/98	.30*	.007*	.83	.051	ND	.02*
	8/5/98	.32*	ND	.74	.11	ND	.018*
	11/4/98	ND	ND	.89	.10	ND	.015*
USGS 12	6/9/97	ND	ND	2.2	.17	.50*	ND
QAS-54B	6/9/97	ND	ND	.21	ND	.36*	ND
USGS 12	9/3/97	ND	ND	2.0	.027*	.32*	.006*
	11/19/97	ND	.004*	1.8	.035*	3.6	ND
	2/11/98	ND	ND	1.6	.049*	ND	ND B
	5/12/98	.27*	.001*	1.4	.022*	.44*	ND
	8/4/98	ND	ND	1.3	.032*	ND	.055
QAS-63R	8/4/98	ND	ND	1.3	.032*	ND	ND
USGS 12	11/4/98	ND	ND	1.5	.025*	.32*	.048
USGS 97	6/10/97	ND	ND	2.4	.21	.46*	ND
	9/3/97	ND	ND	2.3	.026*	.64*	.011*
	11/18/97	ND	ND	2.2	.038*	3.7	ND
QAS-57B	11/18/97	ND	ND	ND	.022*	ND	ND
USGS 97	2/10/98	ND	.005*B	2.3	.045*	ND	ND B
	5/12/98	.21*	.001*	2.2	.022*	.39*	.015*
	8/4/98	ND	ND	2.0 Q	.029*	ND	ND
	11/3/98	ND	ND	2.4	.03*	.35*	.073
USGS 98	6/10/97	ND	ND	1.5	.21	.30*	ND
	9/3/97	ND	ND	1.2	.019*	.25*	ND

Table 7. Concentrations of dissolved and total nutrients, total organic carbon, and total organic halogens in water, Naval Reactors Facility and vicinity—Continued

Sample identifier	Date sampled m/d/y	Kjeldahl nitrogen (total)	Nitrite (dissolved)	Nitrite plus nitrate (total)	Phosphorus (total)	Total organic carbon	Total organic halogens
USGS 98	11/18/97	ND	ND	1.3	.03*	.41*	ND
	2/10/98	ND	.003*B	1.5	.035*	ND	ND B
QAS-60B	2/10/98	ND	ND	ND	.022*	ND	ND B
USGS 98	5/12/98	.22*	.001*	1.2	.017*	.55*	ND
	8/4/98	ND	ND	1.1	.024*	ND	.014*
	11/3/98	ND	ND	1.4	.026*	ND	.09
USGS 99	6/10/97	ND	ND	2.0	.15	.50*	ND
	9/3/97	ND	ND	1.8	.022*	.20*	.005*
QAS-55B	9/3/97	ND	ND	.12	ND	ND	ND
USGS 99	11/18/97	.50	.036	1.7	.038*	.64*	ND
	2/10/98	ND	ND	1.9	.04*	ND	ND B
	5/12/98	.18	.001*	1.6	.036*	.38*	.008*
	8/4/98	ND	ND	1.5	.022*	ND	.015*
	11/3/98	ND	ND	1.9	.027*	ND	.03
QAS-66B	11/3/98	.095*	ND	ND	.016*	ND	.094
USGS 102	6/9/97	ND	ND	2.3	.19	.55*	.012*
	9/3/97	ND	ND	2.3	.027*	.30*	.006*
	11/17/97	ND	ND	2.2 S	.034*	.56*	ND
	2/9/98	ND	.004*	2.2	.047*	ND	ND B
	5/11/98	.21*	.001*	2.1	.022*	.45*	ND
	8/3/98	ND	ND	1.9	.026*	ND	.022*
	11/2/98	ND	ND	2.1 Q	.032*	.23*	ND
QAS-65R	11/2/98	ND	ND	2.1 Q	.039*	ND	70.2

Table 8. Statistical parameters for dissolved and total nutrients, total organic carbon, and total organic halogens, by well

[See figure 2 for well locations. Units are milligrams per liter. Nitrite dissolved, all other constituents total. Values are derived from table 7. Quality-assurance replicates are included in the calculation of statistical parameters. Mean and median sample size: includes all samples with concentrations greater than laboratory reporting limit and estimated concentrations. *, results were estimated; ND, not detected]

	Statistical parameter					
Constituent	Minimum	Maximum	Median	Mean	Sample size	Mean and median sample size
			NRF-6			
Kjeldahl nitrogen	ND	0.37*	0.32*	0.28*	8	3
Nitrite	ND	.004*	.003*	.003*	8	3
Nitrite plus nitrate	1.6	2.0	1.85	1.8	8	8
Phosphorous	.081	.20	.115	.12	8	8
Total organic carbon	ND	.85*	.44*	.51*	8	7
Total organic halogens	ND	.059	.020*	.024*	8	7
			NRF-7			
Kjeldahl nitrogen	ND	.18*	.12*	.13*	8	3
Nitrite	ND	.003*	.002*	.002*	8	3
Nitrite plus nitrate	.44	.72	.47	.54	8	8
Phosphorous	.022*	.17	.029	.046*	8	8
			NRF-8			
Nitrite plus nitrate	1.9	2.3	2.1	2.1	7	7
Phosphorous	.023*	.18	.046*	.063	7	7
Total organic carbon	ND	.56*	.36*	.37*	7	4
Total organic halogens	ND	.23	.012*	.064*	7	4
			NRF-9			
Nitrite	ND	.006*	.004*	.004*	8	4
Nitrite plus nitrate	2.1	2.5	2.3	2.3	8	8
Phosphorous	.026*	.20	.0365*	.061*	8	8
Total organic carbon	ND	.69*	.42*	.44*	8	5
Total organic halogens	ND	.069	.03*	.034*	8	4
			NRF-10			
Nitrite	ND	.005*	.004*	.004*	7	3
Nitrite plus nitrate	1.8	2.2	1.9	2.0	7	7
Phosphorous	.025*	.21	.042*	.079*	7	7
Total organic carbon	ND	.54*	.48*	.50*	7	3
Total organic halogens	ND	.055	.009*	.018*	7	5
			NRF-11			
Nitrite	ND	.005*	.004*	.004*	8	3
Nitrite plus nitrate	2.0	2.4	2.15	2.2	8	8
Phosphorous	.025*	.20	.0405*	.059*	8	8
Total organic carbon	ND	.56*	.405*	.42*	8	4
Total organic halogens	ND	.066	.010*	.023*	8	5

Table 8. Statistical parameters for dissolved and total nutrients, total organic carbon, and total organic halogens, by well—Continued

Constituent	Statistical parameter					
	Minimum	Maximum	Median	Mean	Sample size	Mean and median sample size
			NRF-12			
Kjeldahl nitrogen	ND	.55	.30	.33*	8	3
Nitrite plus nitrate	2.0	2.4	2.2	2.2	8	8
Phosphorous	.023*	.28	.0375*	.090*	8	8
Total organic carbon	ND	.62*	.375*	.42*	8	4
Total organic halogens	ND	.042	.011*	.015*	8	7
			NRF-13			
Nitrite	ND	.009*	.007*	.007*	7	3
Nitrite plus nitrate	.74	1.1	.89	.89	7	7
Phosphorous	.051	.48	.10	.15*	7	7
Total organic halogens	ND	.02*	.0145*	.015*	7	6
			USGS 12			
Nitrite plus nitrate	1.3	2.2	1.55	1.6	8	8
Phosphorous	.022*	.17	.032*	.049*	8	8
Total organic carbon	ND	3.6	.44*	1.0*	8	5
Total organic halogens	ND	.055	.048	.036*	8	3
			USGS 97			
Nitrite plus nitrate	2.0	2.4	2.3	2.3	7	7
Phosphorous	.022*	.21	.03*	.057*	7	7
Total organic carbon	ND	3.7	.46*	1.1*	7	5
Total organic halogens	ND	.073	.015*	.033*	7	3
			USGS 98			
Nitrite plus nitrate	1.1	1.5	1.3	1.3	7	7
Phosphorous	.017*	.21	.026*	.052*	7	7
Total organic carbon	ND	.55*	.355*	.38*	7	4
			USGS 99			
Nitrite plus nitrate	1.5	2.0	1.8	1.8	7	7
Phosphorous	.022*	.15	.036*	.048*	7	7
Total organic carbon	ND	.64*	.44*	.43*	7	4
Total organic halogens	ND	.03	.0115	.014*	7	4
			USGS 102			
Nitrite plus nitrate	1.9	2.3	2.15	2.2	8	8
Phosphorous	.022*	.19	.033*	.052*	8	8
Total organic carbon	ND	.56*	.45*	.42*	8	5
Total organic halogens	ND	.0625	.017*	.026*	8	4

Table 9. Concentrations of gross alpha-particle radioactivity, gross beta-particle radioactivity, strontium-90, tritium, and selected isotopes from gamma spectroscopy in water, Naval Reactors Facility and vicinity

[Analyses were performed using a residue procedure for gross alpha- and beta-particle radioactivity, chemical separation for strontium-90, electrolytic enrichment and liquid scintillation for tritium and gamma spectroscopy for gamma. Analytical results and uncertainties-for example, 3.35±0.85-in picocuries per liter. Analytical uncertainties are reported as 1 sample standard deviation (s). Concentrations that meet or exceed the reporting level of 3 times the 1s value are shown in boldface type. Sample identifier: see figure 2 for location of sites. QAS, water quality-assurance sample; 59, sample number; R, replicate; B, field blank. Date sampled: (m/d/y), month/day/year. Gamma spectroscopy: isotope reported in parenthesis after value. *, August 1998 tritium results are questionable because of problems with analyses; NR, results not reported, samples ruined at lab; SD, original results questionable, sample destroyed at lab]

Sample identifier	Date sampled m/d/y	Gross alpha-particle radioactivity (as thorium-230)	Gross beta-particle radioactivity (as cesium-137)	Strontium-90	Tritium	Gamma spectroscopy
NRF-6	6/5/97	**3.35±0.85**	**4.32±1.15**	.567±0.25	**83.8±6.5**	1.32±1.4 (Cs-137)
	9/2/97	**5.64±1.25**	**9.58±1.25**	.436±0.195	**84.8±6.0**	-1.36±0.70 (Cs-137)
	11/17/97	2.09±1.55	**6.93±1.1**	.243±0.245	**79.3±6.0**	.459±0.36 (Cs-137)
	2/9/98	**3.98±1.0**	**7.57±0.80**	.195±0.16	**76.0±6.0**	.278±0.375 (Cs-137)
QAS-59R	2/9/98	**4.99±1.1**	**7.77±0.85**	.188±0.165	**67.8±5.5**	.608±0.36 (Cs-137)
NRF-6	5/11/98	1.11±1.0	**6.83±0.95**	-.0511±0.115	**68.6±5.5**	**.863±0.255** (Cs-137)
	8/3/98	.864±0.85	**6.66±1.0**	.143±0.135	**124±8.0***	**1.06±0.215** (Cs-137), **22.2±6.0** (K-40)
	11/4/98	**4.04±0.95**	**8.03±0.85**	.314±0.12	**64.7±5.5**	-.266±0.18 (Cs-137)
NRF-7	6/5/97	**1.15±0.32**	**3.29±0.65**	.336±0.22	.0828±3.75	.363±1.6 (Cs-137)
	9/2/97	**1.27±0.33**	**3.97±0.70**	.087±0.155	3.98±3.4	1.67±0.70 (Cs-137)
	11/17/97	**1.83±0.475**	**4.51±0.60**	NR	3.0±3.4	.197±0.355 (Cs-137), **2.78±0.8** (Pb-214), 3.71±1.85 (U-234), **2.78±0.8** (U-238)
	2/9/98	**1.55±0.28**	**4.5±0.5**	.269±0.15	3.2±3.2	.482±0.355 (Cs-137)
	5/11/98	**1.68±0.3**	**3.97±0.345**	.0168±0.095	2.0±3.25	.318±0.26 (Cs-137)
QAS-61R	5/11/98	**1.58±0.33**	**4.76±0.385**	-.00764±0.095	.275±3.2	.0278±0.22 (Cs-137)
NRF-7	8/3/98	**1.2±0.26**	**4.64±0.55**	SD	**56.7±5.0***	.166±0.235 (Cs-137), **3.39±1.0** (Th-228)
	11/4/98	**1.96±0.55**	**4.07±0.65**	.231±0.13	7.19±3.35	.0799±0.19 (Cs-137)
NRF-8	6/10/97	**3.00±0.60**	2.64±1.0	-.116±0.265	**53.2±5.5**	2.71±1.35 (Cs-137)
	9/4/97	**1.65±0.42**	**2.68±0.60**	.264±0.215	**52.8±4.9**	-.390±0.70 (Cs-137)
	11/18/97	**2.39±0.70**	**3.75±0.5**	.117±0.115	**57.9±5.0**	.554±0.365 (Cs-137)
	2/10/98	**4.46±0.65**	**3.57±0.335**	.412±0.19	**52.3±4.85**	.35±0.385 (Cs-137)
	5/13/98	**4.61±0.75**	**.812±0.245**	.0212±0.12	**45.4±4.7**	.197±0.24 (Cs-137)

Table 9. Concentrations of gross alpha-particle radioactivity, gross beta-particle radioactivity, strontium-90, tritium, and selected isotopes from gamma spectroscopy in water, Naval Reactors Facility and vicinity—Continued

Sample identifier	Date sampled m/d/y	Gross alpha-particle radioactivity (as thorium-230)	Gross beta-particle radioactivity (as cesium-137)	Strontium-90	Tritium	Gamma spectroscopy
	8/5/98	**3.48±0.55**	**3.2±0.465**	.149±0.125	**100±7.0***	-.0273±0.235 (Cs-137)
QAS-64B	8/5/98	-.00188±0.0295	.287±0.105	-.0596±0.09	**58.0±5.5***	.601±0.24 (Cs-137)
NRF-8	11/3/98	**.901±0.145**	**3.73±0.355**	.114±0.105	**52.2±4.85**	.00241±0.335 (Cs-137)
NRF-9	6/10/97	**2.68±0.60**	4.15±1.4	.542±0.305	**125±8.5**	.818±1.35 (Cs-137)
	9/4/97	**3.65±0.55**	**3.13±0.60**	.463±0.235	**110±7.0**	1.16±0.60 (Cs-137)
QAS-56R	9/4/97	**2.77±0.60**	**2.72±0.55**	.279±0.15	**81.2±6.0**	1.04±0.70 (Cs-137)
NRF-9	11/18/97	**2.48±0.75**	**4.06±0.65**	.366±0.165	**97.8±6.5**	.475±0.8 (Cs-137)
	2/10/98	**3.87±0.65**	**5.20±0.6**	.253±0.17	**102±7.0**	-.198±0.365 (Cs-137)
	5/13/98	**4.15±0.75**	**4.36±0.44**	.181±0.115	**89.5±6.5**	.323±0.24 (Cs-137), **68.8±8** (K-40)
QAS-62B	5/13/98	.0311±0.030	-.113±0.10	.182±0.12	**32±4.25**	.172±0.245 (Cs-137)
NRF-9	8/4/98	**2.87±0.495**	**3.5±0.55**	.0598±0.105	**218±11.5***	-.21±0.22 (Cs-137)
	11/4/98	**2.93±0.60**	**4.18±0.435**	.0909±0.11	**97.2±6.5**	.115±0.21 (Cs-137)
NRF-10	6/11/97	**1.70±0.475**	**2.68±0.55**	.0252±0.26	**124±8.0**	-.221±1.55 (Cs-137)
	9/4/97	**2.32±0.65**	**2.43±0.70**	.193±0.13	**104±7.0**	.75±0.70 (Cs-137)
	11/18/97	**2.71±0.8**	**3.66±0.6**	-.032±0.13	**103±7.0**	.6±0.365 (Cs-137)
	2/10/98	**2.93±0.495**	**4.09±0.365**	.252±0.175	**116±7.5**	-.0603±0.39 (Cs-137)
	5/13/98	**3.46±0.65**	**1.64±0.33**	.104±0.105	**117±7.5**	.299±0.25 (Cs-137)
	8/5/98	**2.35±0.445**	**4.35±0.60**	SD	**251±13***	.544±0.22 (Cs-137)
	11/4/98	**3.52±0.65**	**4.89±0.445**	.00661±0.1	**123±7.5**	.304±0.205 (Cs-137), 1.94±0.65 (Th-228), .669±0.22 (Tl-208)
NRF-11	6/11/97	**1.55±0.485**	**4.83±0.60**	.0564±0.255	**244±13**	2.51±1.55 (Cs-137)
	9/4/97	**2.40±0.65**	**3.59±0.60**	.52±0.18	**183±10**	.916±0.70 (Cs-137)
	11/19/97	**4.48±1.05**	**4.63±0.6**	.136±0.12	**208±11**	-.449±0.39 (Cs-137), 6.77±2.4 (Th-228)
QAS-58R	11/19/97	**2.14±0.7**	**4.62±0.6**	.305±0.145	**212±11.5**	-.176±0.375 (Cs-137)
NRF-11	2/11/98	**3.48±0.55**	**4.13±0.365**	.366±0.215	**187±10.5**	.171±0.355 (Cs-137)
	5/13/98	**2.80±0.55**	**.815±0.27**	.175±0.125	**179±10**	-.231±0.255 (Cs-137), **63.9±8.5** (K-40)

Table 9. Concentrations of gross alpha-particle radioactivity, gross beta-particle radioactivity, strontium-90, tritium, and selected isotopes from gamma spectroscopy in water, Naval Reactors Facility and vicinity—Continued

Sample identifier	Date sampled m/d/y	Gross alpha-particle radioactivity (as thorium-230)	Gross beta-particle radioactivity (as cesium-137)	Strontium-90	Tritium	Gamma spectroscopy
	8/5/98	**2.82±0.50**	**2.78±0.45**	.0396±0.105	**280±14.5***	.179±0.19 (Cs-137), **24.1±6** (K-40)
	11/4/98	**3.36±0.65**	**4.57±0.55**	.00952±0.12	**143±8.5**	-.384±0.205 (Cs-137)
NRF-12	6/5/97	1.40±0.47	**2.58±0.65**	.547±0.26	**63.1±6.0**	2.37±1.7 (Cs-137), **77.9±2.85** (K-40)
QAS-53R	6/5/97	**2.44±0.43**	**2.35±0.65**	.420±0.235	**61.9±6.0**	-3.45±1.7 (Cs-137)
NRF-12	9/4/97	**2.16±0.65**	**4.32±0.75**	.396±0.215	**61.7±5.5**	1.25±0.65 (Cs-137)
	11/18/97	**3.24±1.0**	**3.71±0.6**	.07±0.12	**65.5±5.5**	.153±0.345 (Cs-137)
	2/11/98	**2.9±0.6**	**4.2±0.41**	.375±0.185	**54.8±5.0**	-.413±0.365 (Cs-137)
	5/13/98	**3.62±0.70**	**2.14±0.325**	-.0957±0.10	**58±5.0**	.312±0.24 (Cs-137), 20.9±7 (U-238)
	8/5/98	**3.95±0.65**	**3.61±0.6**	.0671±0.115	**106±7.0***	.205±0.255 (Cs-137)
	11/4/98	**.539±0.13**	**3.96±0.37**	.147±0.115	**54.4±4.95**	.027±0.22 (Cs-137)
NRF-13	6/9/97	**1.81±0.49**	-2.62±2.05	.495±0.26	**38.9±4.95**	3.03±1.4 (Cs-137)
	9/5/97	**1.35±0.315**	**3.71±0.60**	.213±0.17	**36.8±4.35**	-.0763±0.65 (Cs-137)
	11/19/97	1.65±0.65	**9.62±0.9**	-.07±0.095	**34.2±4.35**	.108±0.385 (Cs-137)
	2/11/98	**2.62±0.47**	**5.90±0.455**	.159±0.17	**39.7±4.4**	.629±0.375 (Cs-137)
	5/13/98	**3.53±0.70**	**4.66±0.46**	-.00315±0.105	**37.9±4.4**	.249±0.225 (Cs-137)
	8/5/98	**3.33±0.50**	**5.47±0.65**	SD	**92.6±7.0***	**.816±0.23** (Cs-137), 1.86±0.65 (Pb-212), **1.95±0.65** (Ra-224), **4.26±0.90** (Th-228), **1.46±0.305** (Tl-208)
	11/4/98	.321±0.12	**5.59±0.445**	-.0239±0.095	**40.9±4.45**	-.126±0.22 (Cs-137)
USGS 12	6/9/97	**2.38±0.55**	**3.74±1.05**	.221±0.26	**61.9±6.0**	.656±1.45 (Cs-137)
QAS-54B	6/9/97	0±0.08	1.20±0.50	.272±0.285	**14.5±4.2**	-4.59±1.85 (Cs-137)
USGS 12	9/3/97	1.21±0.50	1.79±0.60	.292±0.155	**51.3±4.9**	1.01±0.70 (Cs-137)
	11/19/97	**3.01±0.8**	**2.77±0.49**	NR	**63.2±5.5**	.515±0.55 (Cs-137)
	2/11/98	**2.77±0.55**	**3.93±0.355**	.0349±0.19	**59.4±5.0**	-.174±0.37 (Cs-137)
	5/12/98	**2.20±0.475**	**.699±0.205**	.0827±0.11	**57.3±5.0**	.205±0.24 (Cs-137)
	8/4/98	**2.3±0.32**	**3.46±0.33**	.0618±0.115	**131±8.0***	.137±0.275 (Cs-137)

Table 9. Concentrations of gross alpha-particle radioactivity, gross beta-particle radioactivity, strontium-90, tritium, and selected isotopes from gamma spectroscopy in water, Naval Reactors Facility and vicinity—Continued

Sample identifier	Date sampled m/d/y	Gross alpha-particle radioactivity (as thorium-230)	Gross beta-particle radioactivity (as cesium-137)	Strontium-90	Tritium	Gamma spectroscopy
QAS-63R	8/4/98	**2.87±0.50**	**3.27±0.50**	.109±0.12	**196±11***	.257±0.235 (Cs-137)
USGS 12	11/4/98	1.29±0.445	**2.88±0.33**	.157±0.12	**69.2±5.5**	-.00859±0.215 (Cs-137)
USGS 97	6/10/97	**2.01±0.49**	2.11±1.1	.76±0.28	**56.6±5.5**	-.479±1.55 (Cs-137)
	9/3/97	**2.25±0.65**	**3.38±0.65**	.335±0.14	**52.0±4.95**	-.485±0.65 (Cs-137)
	11/18/97	1.82±0.65	**3.45±0.55**	.044±0.12	**52±5**	.224±0.345 (Cs-137)
QAS-57B	11/18/97	.051±0.065	.296±0.18	.011±0.17	8.27±5.5	-.319±0.38 (Cs-137)
USGS 97	2/10/98	**2.18±0.49**	**3.43±0.395**	.123±0.145	**40.1±4.4**	-.201±0.365 (Cs-137)
	5/12/98	**3.25±0.65**	**.776±0.215**	.0451±0.11	**42.7±4.6**	-.184±0.265 (Cs-137), **29.7±7.5** (K-40)
	8/4/98	**2.61±0.46**	**4.58±0.6**	.00435±0.11	**43.4±4.8***	.536±0.22 (Cs-137)
	11/3/98	**1.72±0.465**	**4.05±0.5**	.203±0.125	**51.9±4.8**	.511±0.32 (Cs-137)
USGS 98	6/10/97	**1.70±0.41**	**2.84±0.90**	.389±0.265	**22.1±4.4**	2.36±1.55 (Cs-137)
	9/3/97	1.14±0.425	**3.21±0.60**	.361±0.26	**16.3±3.7**	-.51±0.75 (Cs-137)
	11/18/97	**2.22±0.6**	**2.9±0.48**	NR	**19.7±3.9**	-.0291±0.35 (Cs-137)
	2/10/98	**1.55±0.365**	**2.62±0.285**	.235±0.24	**16.2±3.6**	-.49±0.405 (Cs-137)
QAS-60B	2/10/98	.023±0.0345	-.246±0.095	.467±0.175	**52.1±4.9**	.098±0.39 (Cs-137)
USGS 98	5/12/98	**2.03±0.425**	**2.9±0.31**	.0934±0.115	**14.5±3.6**	-.0129±0.27 (Cs-137)
	8/4/98	.668±0.405	**2.43±0.32**	.0999±0.13	**159±9.5***	.145±0.225 (Cs-137)
	11/3/98	**1.91±0.425**	**3.22±0.385**	.0537±0.1	**21.3±3.8**	.0725±0.22 (Cs-137)
USGS 99	6/10/97	**2.25±0.50**	1.24±0.85	.193±0.28	**35.0±4.85**	**6.21±1.5** (Cs-137)
	9/3/97	**2.10±0.55**	**2.09±0.55**	.263±0.14	**22.0±3.8**	-.42±0.70 (Cs-137)
QAS-55B	9/3/97	-.0226±0.75	-.0211±0.405	.327±0.165	8.78±3.5	-.464±0.75 (Cs-137)
USGS 99	11/18/97	**1.81±0.6**	**2.42±0.44**	.016±0.11	**27.6±4.1**	.291±0.40 (Cs-137)
	2/10/98	**2.56±0.495**	**2.78±0.325**	.212±0.205	**26.2±4.0**	-.462±0.37 (Cs-137)
	5/12/98	**3.42±0.65**	**3.30±0.395**	-.0644±0.1	**25.9±4.0**	.155±0.265 (Cs-137)
	8/4/98	**1.45±0.37**	**3.14±0.50**	.0768±0.12	**33.3±4.4***	-.0464±0.215 (Cs-137), 1.45±0.55 (Pb-212), 1.52±0.60 (Ra-224), **3.03±1.0** (Th-228)
	11/3/98	**2.2±0.49**	**2.71±0.305**	-.0675±0.09	**34.7±4.15**	-.11±0.215 (Cs-137)
QAS-66B	11/3/98	-.0214±0.028	.0545±0.1	.00749±0.105	**18.6±3.75**	-.00004±0.36 (Cs-137)

Table 9. Concentrations of gross alpha-particle radioactivity, gross beta-particle radioactivity, strontium-90, tritium, and selected isotopes from gamma spectroscopy in water, Naval Reactors Facility and vicinity—Continued

Sample identifier	Date sampled m/d/y	Gross alpha-particle radioactivity (as thorium-230)	Gross beta-particle radioactivity (as cesium-137)	Strontium-90	Tritium	Gamma spectroscopy
USGS 102	6/9/97	**2.26±0.55**	**5.62±1.6**	.307±0.26	**95.9±7.0**	1.09±1.55 (Cs-137)
	9/3/97	1.54±0.60	**2.95±0.65**	.216±0.21	**53.0±5.0**	1.15±0.65 (Cs-137)
	11/17/97	**2.84±0.8**	**3.36±0.55**	.072±0.135	**60.4±5.5**	.372±0.395 (Cs-137), **9.47±1.8** (Ra-226), **12.0±2.0** (U-234), **9.83±1.35** (U-238)
	2/9/98	**3.1±0.6**	**4.08±0.41**	.0217±0.17	**62.6±5.0**	.572±0.365 (Cs-137)
	5/11/98	**4.22±0.7**	**.839±0.275**	.0081±0.1	**39.2±4.4**	-.107±0.26 (Cs-137)
	8/3/98	**3.28±0.50**	**3.87±0.60**	.202±0.125	**99.5±7.0***	.223±0.21 (Cs-137)
	11/4/98	**2.51±0.5**	**3.14±0.445**	.194±0.115	**49.4±4.7**	.22±0.225 (Cs-137)
QAS-65R	11/2/98	**2.21±0.5**	**4.57±0.55**	.0913±0.105	**68.8±5.5**	-.138±0.195 (Cs-137)

Table 10. Statistical parameters for gross alpha-particle radioactivity, gross beta-particle radioactivity, gamma spectroscopy, strontium-90, and tritium, by well

[See figure 2 for well locations. Gross alpha-particle radioactivity is expressed as thorium-230 in picocuries per liter. Gross beta-particle radioactivity is expressed as cesium-137. Gamma spectroscopy is expressed as cesium-137. Values are derived from table 9. Quality-assurance replicates are included in the calculation of statistical parameters. Questionable tritium results from August 1998 were not used in statistical calculations. See section on calculation of estimated experimental standard error for the estimated uncertainty of the mean concentration. Abbreviations: Th-230, thorium-230; Cs-137, cesium-137]

Constituent	Statistical parameter				
	Minimum	Maximum	Median	Mean	Sample size
		NRF-6			
Gross alpha as Th-230	.864±0.85	5.64±1.25	3.665±0.656	3.26±0.62	8
Gross beta as Cs-137	4.32±1.15	9.58±1.25	7.25±0.68	7.21±0.53	8
Gamma as Cs-137	-1.36±0.70	1.32±1.4	.534±0.25	.37±0.30	8
Strontium-90	-.0511±0.115	.567±0.25	.219±0.146	.254±0.067	8
Tritium	64.7±5.5	84.8±6.0	76.0±6.0	75±3.1	7
		NRF-7			
Gross alpha as Th-230	1.15±0.32	1.96±0.55	1.565±0.216	1.53±0.105	8
Gross beta as Cs-137	3.29±0.65	4.76±0.385	4.285±0.41	4.21±0.17	8
Gamma as Cs-137	.0278±0.22	1.67±0.70	.2575±0.22	.413±0.187	8
Strontium-90	-.00764±0.095	.336±0.22	.159±0.101	.155±0.058	6
Tritium	.0828±1.05	7.19±3.35	3.98±3.4	4.12±0.88	7
		NRF-8			
Gross alpha as Th-230	.901±0.145	4.61±0.75	3.00±0.60	2.93±0.52	7
Gross beta as Cs-137	.812±0.245	3.75±0.5	3.2±0.465	2.91±0.39	7
Gamma as Cs-137	-.39±0.70	2.71±1.35	.197±0.24	.485±0.388	7
Strontium-90	-.116±0.265	.412±0.19	.117±0.115	.137±0.064	7
Tritium	45.4±4.7	57.9±5.0	52.55±3.43	52.3±1.63	6
		NRF-9			
Gross alpha as Th-230	2.48±0.75	4.15±0.75	2.90±0.39	3.18±0.22	8
Gross beta as Cs-137	2.72±0.55	5.20±0.6	4.105±0.77	3.91±0.27	8
Gamma as Cs-137	-.21±0.22	1.16±0.6	.399±0.418	.44±0.19	8
Strontium-90	.0598±0.105	.542±0.305	.266±0.113	.279±0.06	8
Tritium	81.2±6.0	125±8.5	97.8±6.5	100±5.4	7
		NRF-10			
Gross alpha as Th-230	1.70±0.475	3.52±0.65	2.71±0.8	2.71±0.25	7
Gross beta as Cs-137	1.64±0.33	4.89±0.445	3.66±0.6	3.39±0.44	7
Gamma as Cs-137	-.221±1.55	.75±0.70	.304±0.205	.316±0.134	7
Strontium-90	-.032±0.13	.252±0.175	.0646±0.14	.091±0.046	6
Tritium	103±7.0	124±8.0	116.5±5.3	114±3.7	6
		NRF-11			
Gross alpha as Th-230	1.55±0.485	4.48±1.05	2.81±0.37	2.88±0.32	8
Gross beta as Cs-137	.815±0.27	4.83±0.60	4.35±0.33	3.75±0.48	8
Gamma as Cs-137	-.449±0.39	2.51±1.55	-.0025±0.258	.317±0.349	8
Strontium-90	.00952±0.12	.52±0.18	.1555±0.087	.20±0.064	8

Table 10. Statistical parameters for gross alpha-particle radioactivity, gross beta-particle radioactivity, gamma spectroscopy, strontium-90, and tritium, by well—Continued

Constituent	Statistical parameter				Sample size
	Minimum	Maximum	Median	Mean	
		NRF-11—continued			
Tritium	143±8.5	244±13	187±10.5	194±12	7
		NRF-12			
Gross alpha as Th-230	.539±0.13	3.95±0.65	2.67±0.37	2.53±0.41	8
Gross beta as Cs-137	2.14±0.325	4.32±0.75	3.66±0.42	3.36±0.31	8
Gamma as Cs-137	-3.45±1.7	2.37±1.7	.179±0.216	.057±0.59	8
Strontium-90	-.0957±0.1	.547±0.26	.261±0.109	.241±0.079	8
Tritium	54.4±4.95	65.5±5.5	61.7±5.5	59.9±1.6	7
		NRF-13			
Gross alpha as Th-230	.321±0.12	3.53±0.70	1.81±0.49	2.09±0.43	7
Gross beta as Cs-137	-2.62±2.05	9.62±0.9	5.47±0.65	4.62±1.39	7
Gamma as Cs-137	-.126±0.22	3.03±1.4	.249±0.225	.661±0.42	7
Strontium-90	-.07±0.095	.495±0.26	.078±0.1	.128±0.086	6
Tritium	34.2±4.35	40.9±4.45	38.4±3.31	38.1±0.97	6
		USGS 12			
Gross alpha as Th-230	1.21±0.50	3.01±0.8	2.34±0.32	2.25±0.24	8
Gross beta as Cs-137	.699±0.205	3.93±0.355	3.075±0.30	2.82±0.38	8
Gamma as Cs-137	-.174±0.37	1.01±0.70	.231±0.168	.325±0.136	8
Strontium-90	.0349±0.19	.292±0.155	.109±0.12	.137±0.035	7
Tritium	51.3±4.9	69.2±5.5	60.65±3.9	60.4±2.5	6
		USGS 97			
Gross alpha as Th-230	1.72±0.465	3.25±0.65	2.18±0.49	2.26±0.2	7
Gross beta as Cs-137	.776±0.215	4.58±0.6	3.43±0.395	3.11±0.48	7
Gamma as Cs-137	-.485±0.65	.536±0.22	-.184±0.265	-.011±0.165	7
Strontium-90	.00435±0.11	.76±0.28	.123±0.145	.216±0.104	7
Tritium	40.1±4.4	56.6±5.5	51.95±3.4	49.2±2.6	6
		USGS 98			
Gross alpha as Th-230	.668±0.405	2.22±0.6	1.70±0.41	1.60±0.20	7
Gross beta as Cs-137	2.43±0.32	3.22±0.385	2.9±0.31	2.87±0.11	7
Gamma as Cs-137	-.51±0.75	2.36±1.55	-.0129±0.27	.219±0.37	7
Strontium-90	.0537±0.1	.389±0.265	.16745±0.136	.205±0.059	6
Tritium	14.5±3.6	22.1±4.4	18±2.7	18.4±1.3	6
		USGS 99			
Gross alpha as Th-230	1.45±0.37	3.42±0.65	2.2±0.49	2.26±0.24	7
Gross beta as Cs-137	1.24±0.85	3.30±0.395	2.71±0.305	2.53±0.26	7
Gamma as Cs-137	-.462±0.37	6.21±1.5	-.0464±0.215	.80±0.91	7
Strontium-90	-.0675±0.09	.263±0.14	.0768±0.12	.09±0.051	7
Tritium	22.0±3.8	35.0±4.85	26.9±2.9	28.6±2.1	6

Table 10. Statistical parameters for gross alpha-particle radioactivity, gross beta-particle radioactivity, gamma spectroscopy, strontium-90, and tritium, by well—Continued

Constituent	Statistical parameter				
	Minimum	Maximum	Median	Mean	Sample size
		USGS 102			
Gross alpha as Th-230	1.54±0.6	4.22±0.7	2.675±0.47	2.74±0.29	8
Gross beta as Cs-137	.839±0.275	5.62±1.6	3.615±0.41	3.55±0.49	8
Gross gamma as Cs-137	-.138±0.195	1.15±0.65	.2975±0.22	.423±0.173	8
Strontium-90	.0081±0.1	.307±0.26	.14265±0.078	.139±0.038	8
Tritium	39.2±4.4	95.9±7.0	60.4±5.5	61.3±6.8	7

Table 11. Regulatory volatile organic compounds for which water samples were analyzed

[Analyses were performed by the Quanterra Environmental Services Laboratory using U.S. Environmental Protection Agency method 524.2. Reporting limits are in micrograms per liter]

Compound	Reporting limit	Compound	Reporting limit
Benzene	1.0	1,2-Dichloropropane	1.0
Bromobenzene	1.0	1,3-Dichloropropane	1.0
Bromochloromethane	1.0	2,2-Dichloropropane	1.0
Bromodichloromethane	1.0	1,1-Dichloropropylene	1.0
Bromoform	1.0	cis-1,3-Dichloropropylene	1.0
Bromomethane	1.0	trans-1,3-Dichloropropylene	1.0
n-Butylbenzene	1.0	Ethylbenzene	1.0
sec-Butylbenzene	1.0	Hexachlorobutadiene	1.0
tert-Butylbenzene	1.0	Isopropylbenzene	1.0
Carbon tetrachloride	1.0	4-Isopropyltoluene	1.0
Chlorobenzene	1.0	Methyl-t-butyl ether (MTBE)	1.0
Chloroethane	1.0	Naphthalene	1.0
Chloroform	1.0	n-Propylbenzene	1.0
Chloromethane	1.0	Styrene	1.0
2-Chlorotoluene	1.0	1,1,1,2-Tetrachloroethane	1.0
4-Chlorotoluene	1.0	1,1,2,2-Tetrachloroethane	1.0
Dibromochloromethane	1.0	Tetrachloroethylene	1.0
1,2-Dibromo-3-chloropropane (DBCP)	2.0	Toluene	1.0
1,2-Dibromoethane (EDB)	1.0	1,2,3-Trichlorobenzene	1.0
Dibromomethane	1.0	1,2,4-Trichlorobenzene	1.0
1,2-Dichlorobenzene	1.0	1,1,1-Trichloroethane	1.0
1,3-Dichlorobenzene	1.0	1,1,2-Trichloroethane	1.0
1,4-Dichlorobenzene	1.0	Trichloroethylene	1.0
Dichlorodifluoromethane	1.0	Trichlorofluoromethane	1.0
1,1-Dichloroethane	1.0	1,2,3,-Trichloropropane	1.0
1,2-Dichloroethane	1.0	1,2,4-Trimethylbenzene	1.0
1,1-Dichloroethylhene	1.0	1,3,5-Trimethylbenzene	1.0
cis-1,2-Dichloroethylene	1.0	Vinyl chloride	1.0
trans-1,2-Dichloroethylene	1.0	Xylenes (total)	1.0
Dichloromethane	1.0		

Table 12. Base/neutral organic compounds for which water samples were analyzed

[Analyses were performed by the Quanterra Environmental Services Laboratory using U.S. Environmental Protection Agency method 525.2. Method detection limits (MDL) are in micrograms per liter]

Compound	MDL	Compound	MDL
Acenaphthylene	0.1	Diethylphthalate	1
Alachlor	.1	Dimethylphthalate	1
Aldrin	.1	Endrin	.01
Anthracene	.1	Fluorene	.1
Atrazine	.1	Heptachlor	.04
Benzo [a] anthracene	.1	Heptachlor epoxide	.02
Benzo [b] fluoranthene	.1	2,2',e,e',4,4',6-Heptachlorobiphenyl	.1
Benzo [k] fluoranthene	.1	Hexachlorobenzene	.1
Benzo [g,h,i] perylene	.1	2,2',4,4',5,6'-Hexachlorobiphenyl	.1
Benzo [a]pyrene	.02	Hexachlorocyclopentadiene	.1
gamma-BHC (Lindane)	.02	Indeno(1,2,3-cd)pyrene	.1
Butylbenzylphthalate	1	Methoxychlor	.1
alpha-Chlordane	.1	2,2',3,3',4,5',6,6'-Octachlorobiphenyl	.1
2-Chlorobiphenyl	.1	2,2',3',4,6-Pentachlorobiphenyl	.1
Chrysene	.1	Pentachlorophenol	.04
Dibenzo [a,h] anthracene	.1	Phenanthrene	.1
Di-n-butylphthalate	1	Pyrene	.1
2,3-Dichlorobiphenyl	.1	Simazine	.07
Di (2-ethylhexyl) adipate	.6	2,2',4,4'-Tetrachlorobiphenyl	.1
Di(2-ethylhexyl) phthalate	.6	2,4,5-Trichlorobiphenyl	.1