

**CHEMICAL AND RADIOCHEMICAL CONSTITUENTS  
IN WATER FROM WELLS IN THE VICINITY OF THE  
NAVAL REACTORS FACILITY, IDAHO NATIONAL  
ENGINEERING AND ENVIRONMENTAL  
LABORATORY, IDAHO, 1996**

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

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## CONVERSION FACTORS, VERTICAL DATUM, AND ABBREVIATED UNITS

<u>Multiply</u>	<u>By</u>	<u>To obtain</u>
foot (ft)	0.3048	meter
inch (in.)	25.4	millimeter
mile (mi)	1.609	kilometer
square mile (mi <sup>2</sup> )	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:  
 $^{\circ}\text{F} = (1.8)(^{\circ}\text{C}) + 32.$

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); mL (milliliter); L (liter); µL (microliter).

# CHEMICAL AND RADIOCHEMICAL CONSTITUENTS IN WATER FROM WELLS IN THE VICINITY OF THE NAVAL REACTORS FACILITY, IDAHO NATIONAL ENGINEERING AND ENVIRONMENTAL LABORATORY, IDAHO, 1996

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## 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 1996 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 51 samples were collected from the 13 monitoring wells. Seven quality-assurance samples also were collected and analyzed; one was a field-blank sample, one was a spiked organic sample, one was an organic trip-blank sample, and four were replicate samples. The field-blank sample contained concentrations of two inorganic constituents, one organic constituent, total organic carbon, and six radioactive constituents that were greater than the reporting levels. Concentrations of other constituents in the field-blank sample and those in the organic trip-blank sample were less than their respective reporting levels. The 4 replicate samples and their respective primary samples generated 517 pairs of analytical results for a variety of chemical and radiochemical constituents. Of the 517 data pairs, 493 were statistically equivalent at the 95-percent confidence level; about 95 percent of the analytical results were in agreement.

## INTRODUCTION

The Idaho National Engineering and Environmental Laboratory (INEEL), encompassing about 890 mi<sup>2</sup> 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, advanced energy concepts, and environmental research. 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 the NRF environmental summary report (Bettis Atomic Power Laboratory, 1998).

This study was conducted by the U.S. Geological Survey (USGS) in cooperation with the DOE's Pittsburgh Naval Reactors (PNR) Office, Idaho Branch Office (IBO). IBO is responsible for the NRF at the INEEL. The 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, the IBO of the PNR Office, DOE, 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 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 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 (EPA) Ground-Water

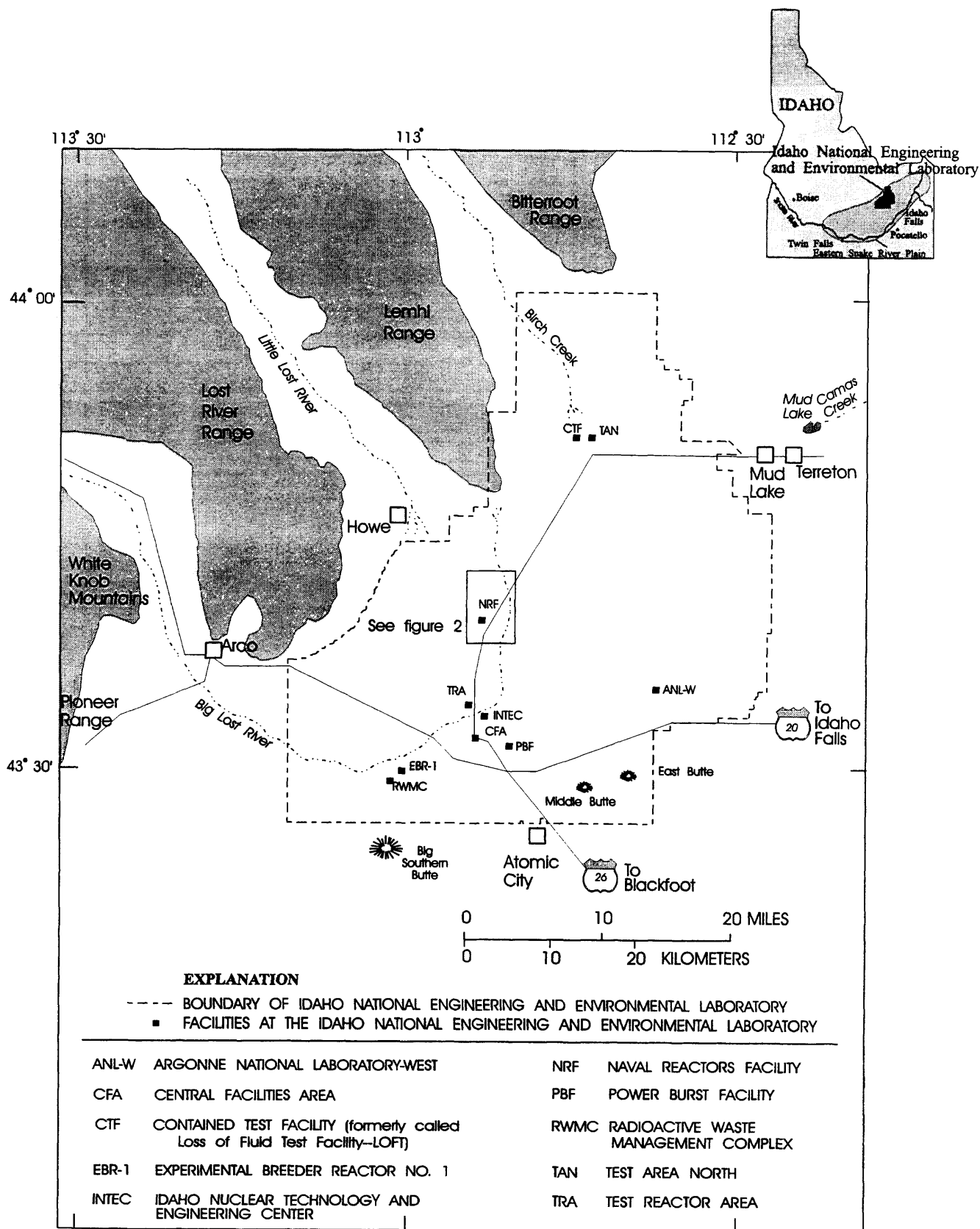


Figure 1. Location of the Idaho National Engineering and Environmental Laboratory, Naval Reactors Facility, and other selected facilities.

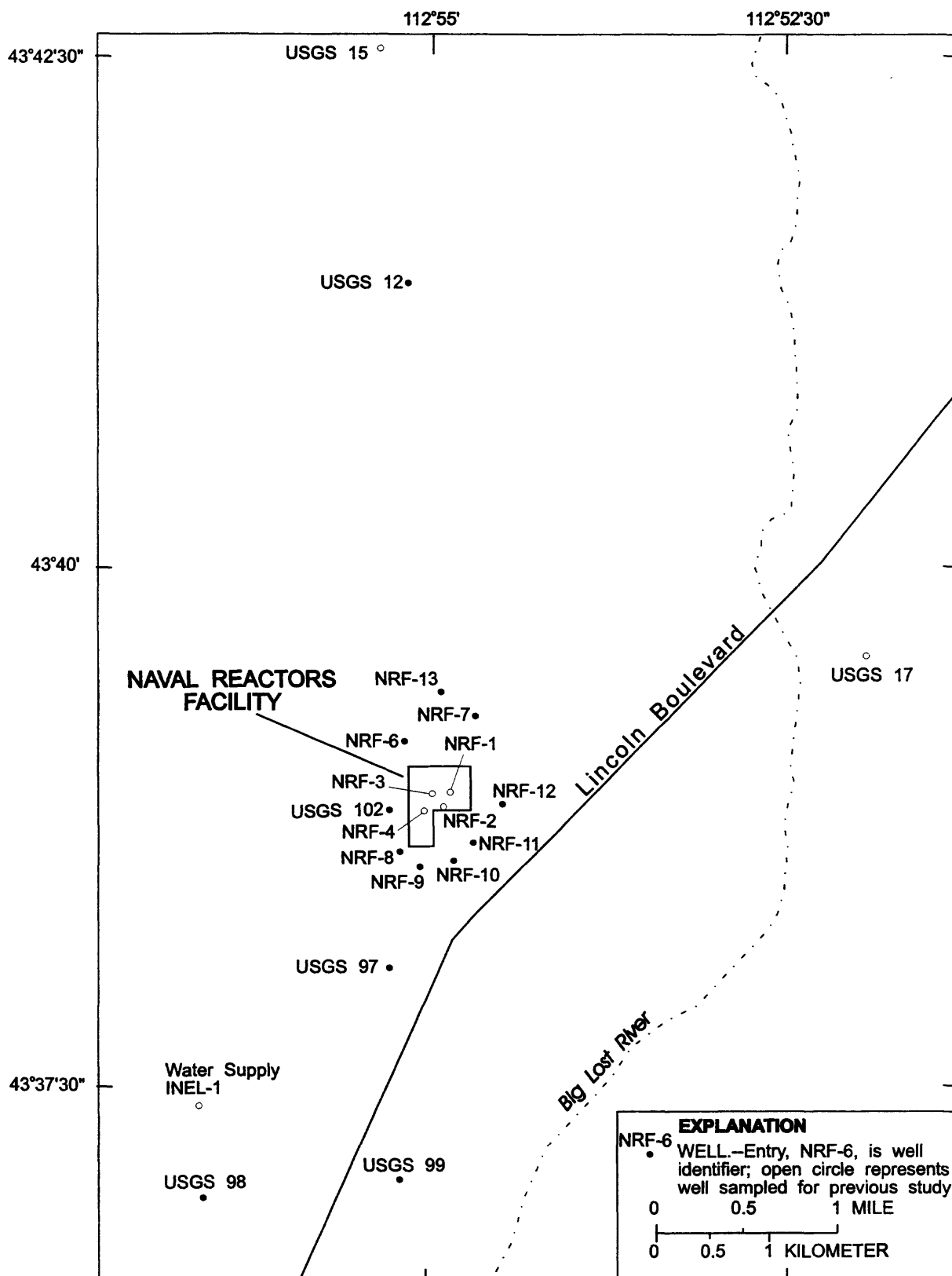


Figure 2. Location of wells, Naval Reactors Facility and vicinity, Idaho National Engineering and Environmental Laboratory.

Monitoring List—Appendix IX (U.S. Environmental Protection Agency, 1989, p. 636-642). Round two consisted of bimonthly collection of five samples from each well that were analyzed for the chemical constituents listed in Appendix III-EPA Interim Primary Drinking Water Standards, 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 in round-two samples 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 the ground water. 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. Analytical results for round-four samples are included in this report. Wells sampled in rounds one through three

that were eliminated from the program were the four water-supply production wells with line shaft turbine pumps (NRF-1, -2, -3, and -4) and three monitoring wells (USGS 15, USGS 17, and Water Supply INEL-1) with dedicated submersible pumps. The six newly constructed monitoring wells that were added to the sampling program in 1996 are NRF-8, -9, -10, -11, -12, and -13. All of these wells and the older monitoring wells that remain in the monitoring network (NRF-6, -7, USGS 12, 97-99, and 102) have dedicated submersible pumps. Locations of the sampling sites currently being sampled and the sampling sites eliminated from the sampling program are shown in figure 2.

In addition to changing the locations of sample collection, the list of constituents for analysis in round-four samples was modified. These constituents and analytical results are presented in tables 3-10 at the back of this report. Field measurements for round-four samples included alkalinity as  $\text{CaCO}_3$ , pH, specific conductance, and temperature and are presented in table 2. Round-four 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 consists 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  $\text{mi}^2$  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 and others, 1995, 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 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 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. Locally, the hydraulic gradient was from about 1 to 15 ft/mi. From March-May 1991 to March-May 1995, water-level changes in INEEL

wells ranged from a 8.5-ft decline north of the NRF to a 2.5-ft decline 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 NRF during 1992-95 because of drought (Bartholomay, Tucker, and others, 1997, p. 20-25), but have risen since mid-1995 (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 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 1.6 $s$  before the qualitative decision can be made as to whether the radionuclide was detected. At 1.6 $s$ , there is a 95-percent probability that the correct conclusion—not

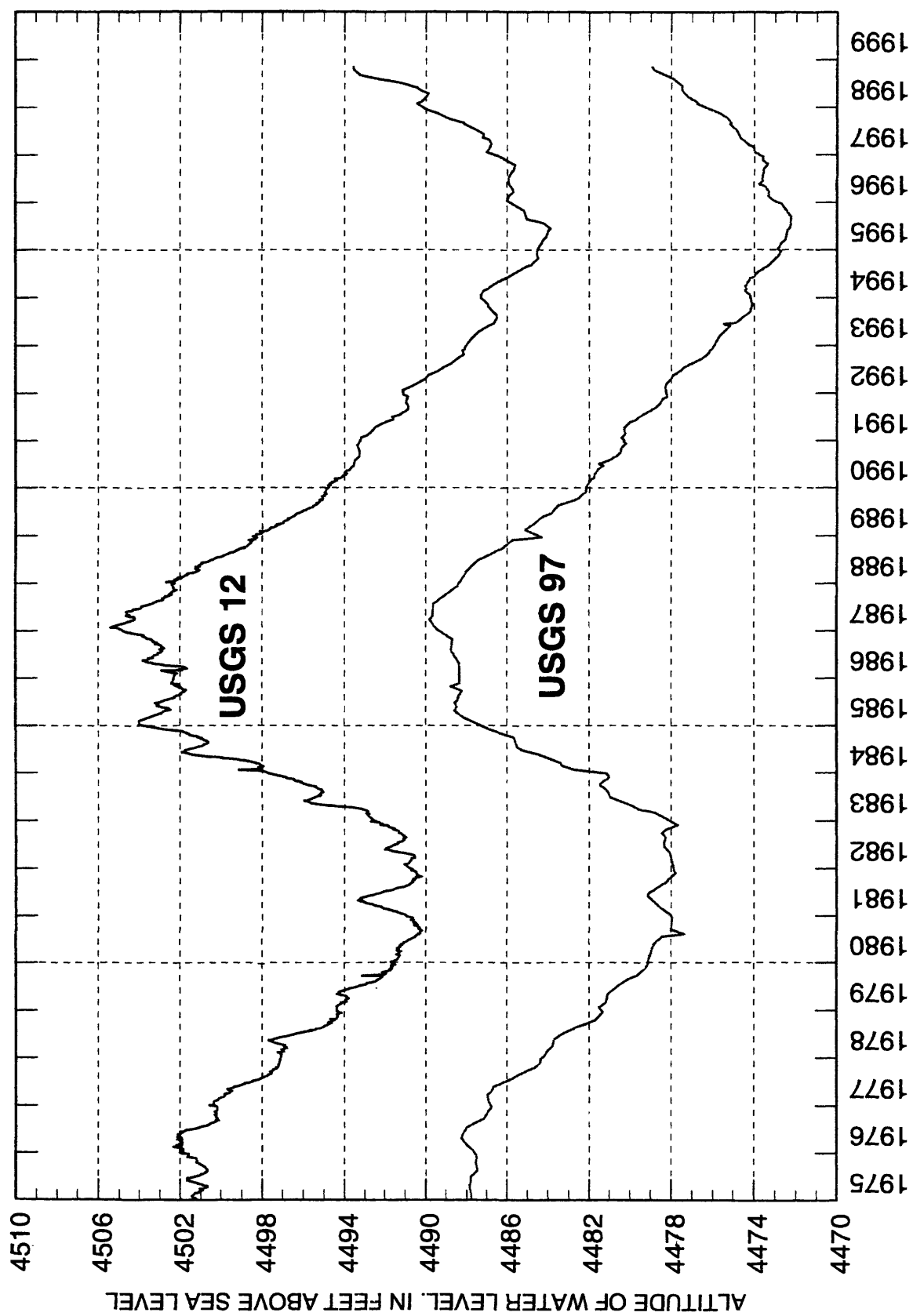


Figure 3. Water levels in two wells near the Naval Reactors Facility, 1975-98.

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 "minimum reporting level," which is used for inorganic and organic analyses. In this report, the term "minimum reporting level" is the smallest measured concentration of a nonradioactive constituent that may be reliably reported using a given analytical method (Timme, 1995, p. 92). Because of unpredictable matrix effects on detection limits, the laboratory reporting levels are set somewhat higher than the analytical method detection limits (Pritt and Jones, 1989).

## **Acknowledgments**

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## **METHODS AND QUALITY ASSURANCE**

The methods used for collecting water samples generally followed the guidelines established by the USGS (Goerlitz and Brown, 1972; Stevens and others, 1975; Wood, 1981; Claassen, 1982; W.L. Bradford, USGS, written commun., 1985; Wershaw and others, 1987; Fishman and Friedman, 1989; Hardy and others, 1989; Faires, 1992; Fishman, 1993). The methods used in the field and the quality-assurance practices are described in the following sections.

## Sample Containers and Preservatives

Sample containers and preservatives differed depending on the constituent(s) for which analyses were requested. Samples analyzed by the USGS National Water Quality Laboratory (NWQL) were placed in containers and preserved in accordance with laboratory requirements specified by Timme (1995). Containers and preservatives were supplied by the NWQL and had undergone a rigorous quality-control procedure (Pritt, 1989, p. 75) to eliminate sample contamination. 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, 97-99, 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 from dedicated submersible pumps were collected from a portable sampling apparatus which was decontaminated before sampling at each site. After collection, sample containers were sealed with laboratory film, labeled, and stored under secured conditions. Water samples were placed in ice chests, sealed, and shipped as soon as possible to the NWQL.

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 NWQL. These records are available for inspection at the USGS Project Office at the INEEL. The results of field measurements for alkalinity, pH, specific conductance, and water temperature are listed in table 2.

## Quality Assurance

Internal quality control and the overall quality-assurance practices used by the NWQL are described in reports by Friedman and Erdmann

(1982), Jones (1987), and Pritt and Raese (1992). 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; the plan was finalized in June 1989, was revised in March 1992 and again in 1996 (Mann, 1996), and is available from the USGS Project Office at the INEEL. 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 instituted for this sampling program included a field-blank sample prepared with inorganic-free and organic-free water, an organic trip-blank sample prepared by the NWQL with organic-free water; a spiked organic sample, and four replicate samples. After collection of the primary sample, a replicate sample was immediately collected. The replicate-sample analytical results were then compared with the primary-sample analytical results to evaluate the combined effects of laboratory reproducibility in analytical measurements and consistency in field-collection methods. Many organizations use the term "sequential replicate" in place of "replicate" sample.

On October 1, 1994, the USGS stopped preserving nutrient samples with mercuric chloride. As part of the INEEL Project Office's Quality-Assurance Program, a study was conducted by Bartholomay and Williams (1996) to determine if the nutrient data collected before and after that date were comparable. NRF samples collected from October 27 to November 10, 1994, were included in that study. The results indicated that nutrient data collected before and after October 1, 1994, are comparable.

Analytical results for primary and replicate water samples in this report were compared using the method described by Williams (1996, 1997). If standard deviations of primary- and replicate-sample results are known, it is possible to determine—within specified confidence limits—whether the results of a pair of samples are statistically equivalent. This determination can be made using an adaptation of the equation to determine

the standard deviate or the number of standard deviations that the variable deviates from the mean (Volk, 1969, p. 55), where Z is the ratio of the absolute value of the difference of the two results and the pooled standard deviation (Taylor, 1987, p. 29). In that way, a comparison can be made of two analytical results on the basis of the precision—or an approximation of the precision—associated with each of the results:

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

where

x = result of the primary (routine) sample,

y = result of the replicate (quality-assurance) sample,

S<sub>x</sub> = standard deviation of x, and

S<sub>y</sub> = standard deviation of y.

If the Z-value is less than or equal to 1.96, the analytical results of the primary and replicate pair are considered statistically equivalent at the 95-percent confidence limit. The analytical results for radionuclides are reported by the NWQL 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) and equation 1 can be applied directly to the results.

Equation 1 cannot be applied directly to the results for which no standard deviations or uncertainties are reported. The NWQL does not report standard deviations with analytical results for non-radiochemical constituents; however, the USGS Branch of Quality Assurance conducts a Blind Sample Program (BSP) (Maloney and others, 1993) that allows the calculation of a most probable deviation (MPD) at any concentration for most constituents. A minimum MPD has been established for a few constituents that are generally present at small concentrations (Maloney and others, 1993, p. 4). Linear-regression equations generated from BSP data can be used to determine if the analytical results of the primary and replicate samples are statistically equivalent by calculating an

MPD for each result and substituting them for the standard deviations in equation 1 (Williams, 1996, 1997).

Organic constituents and laboratory specific conductance were not included in the BSP. Therefore, for organic carbon, standard deviations were calculated from the relative standard deviations (RSD) for dissolved organic carbon (DOC) reported by Wershaw and others (1987, p. 14-15). Wershaw and others (1987, p. 16) estimated that the RSD values for TOC are larger than those for DOC; therefore, the calculated Z-values are more conservative. Concentrations of volatile organic compounds in the replicate-sample pairs (except for one compound in one pair) were less than the laboratory reporting levels. The standard deviation of this volatile organic compound was calculated from the RSD's provided by Rose and Schroeder (1995, p. 18-23). The standard deviations for the laboratory measurements of specific conductance were calculated from the RSD's provided by Fishman and Friedman (1989, p. 463). Analytical results for organic constituents are included in tables 5 and 10.

Z-values for replicate pairs of all constituents were calculated using equation 1 and are presented in the data tables. If analytical results of the pair were not statistically equivalent, an "N" in parenthesis is listed next to the Z-value. If the results of both samples of the replicate pair were less than the reporting level, the results were assumed to be equivalent and the Z-value is reported as zero. Analytical results for the quality-assurance samples will be discussed, along with similar data, in subsequent sections of this report.

## ANALYTICAL RESULTS

During the period beginning in January 1996 and ending in September 1996, quarterly water samples were collected for round four of the NRF sampling program (table 2). All wells were sampled four times except NRF-10, which was not sampled in January 1996 because the pump was inoperable. Because of a shipping delay during the September sampling round, temperature-sensitive constituents in water from wells NRF-6, -8, -9, -10, -11, -12, -13, and USGS 102 (table 2) had to be

resampled. Quality-assurance samples included a spiked organic sample (QAS-47), an organic trip-blank sample (QAS-48), a field-blank sample (QAS-52), and 4 replicate samples: NRF-8 (QAS-46), NRF-10 (QAS-50), NRF-11 (QAS-49), and NRF-13 (QAS-51). QAS-47 also included a bottle of organic-free water for determination of TOC.

### **Dissolved Anions and Total Recoverable Cations**

Water samples were analyzed for concentrations of dissolved chloride and sulfate, and concentrations of total recoverable calcium, magnesium, potassium, and sodium (table 3).

All concentrations in the field-blank sample (QAS-52) were less than the respective laboratory reporting levels, except the concentration of calcium, which was 2.9 mg/L. All 24 replicate-sample concentrations listed in table 3 were statistically equivalent to their primary-sample concentrations.

### **Total Recoverable Trace Elements and Dissolved Beryllium and Thallium**

Water samples collected in 1996 were analyzed for concentrations of total recoverable aluminum, antimony, arsenic, barium, cadmium, chromium, copper, iron, lead, manganese, mercury, nickel, selenium, silver, and zinc, and for concentrations of dissolved beryllium and thallium (table 4).

The concentrations of all constituents in the field-blank sample (QAS-52), except that of manganese, were less than the minimum reporting levels. Of 68 replicate-sample concentrations (table 4), 63 were statistically equivalent to their primary-sample concentrations. The statistical equivalence of the antimony concentrations in QAS-51 (<1 µg/L) and the primary sample NRF-13 (1 µg/L) was uncertain. The concentration of aluminum in QAS-50 (440 µg/L) was not statistically equivalent to the concentration in the primary sample, NRF-10 (520 µg/L). The iron concentrations in three replicate samples were not statistically equivalent to the iron concentrations in their respective primary samples: QAS-50

(640 µg/L) and NRF-10 (770 µg/L); QAS-49 (60 µg/L) and NRF-11 (100 µg/L); and QAS-51 (5,400 µg/L) and NRF-13 (3,100 µg/L).

### **Dissolved and Total Recoverable Nutrients**

Filtered water samples were analyzed for concentrations of nitrite as nitrogen, and nitrite plus nitrate as nitrogen (table 5). Unfiltered water samples were analyzed for total concentrations of ammonia plus organic nitrogen as nitrogen, and phosphorus as phosphorus (table 5).

Concentrations of all constituents in the field-blank sample (QAS-52) were less than the laboratory reporting levels. Fifteen of the 16 replicate-sample concentrations of nitrogen and phosphorus compounds listed in table 5 were statistically equivalent to their primary-sample concentrations. The total phosphorus as phosphorus concentration in QAS-49 (<0.01 mg/L) was not statistically equivalent to the concentration in primary sample NRF-11 (0.04 mg/L).

### **Total Organic Carbon**

Water samples were analyzed for concentrations of TOC (table 5). The concentration of TOC in the blank total organic carbon sample (QAS-47) was 0.1 mg/L and, in the field-blank sample (QAS-52), was 0.2 mg/L. The laboratory reporting level was 0.1 mg/L. The concentration of TOC in one replicate sample of the four listed in table 5 was statistically equivalent to the primary-sample concentration. The concentrations of TOC in QAS-46 (3.4 mg/L), QAS-50 (1.0 mg/L), and QAS-51 (3.9 mg/L) were not statistically equivalent to the concentrations in their respective primary water samples: NRF-8 (0.3 mg/L), NRF-10 (1.7 mg/L), and NRF-13 (0.2 mg/L).

### **Gross Alpha- and Gross Beta-Particle Radioactivity**

Water samples were analyzed for concentrations of dissolved gross alpha- and gross beta-particle radioactivity by the NWQL using a residue procedure. Concentrations of radioactive constituents greater than or equal to three times the 1s

uncertainty are considered to be above the reporting level in this report. All analytical measurements are listed in table 6. 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 two ways: as natural uranium in micrograms per liter and as thorium-230 in picocuries per liter; however, the NWQL discontinued reporting gross alpha as natural uranium before the June 1996 sample round, and these data are not available for June and September 1996. Concentrations of dissolved gross alpha-particle radioactivity are listed in table 6.

In the field-blank sample (QAS-52), the concentration of gross alpha-particle radioactivity as thorium-230 ( $-0.132 \pm 0.085$  pCi/L) was less than the reporting level. All of the six replicate-sample concentrations listed in table 6 were statistically equivalent to their primary-sample concentrations.

**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 or a chemically similar pair of radionuclides in equilibrium. In this report, concentrations are reported in two ways: as strontium-90 in equilibrium with yttrium-90 ( $\text{Sr}^{90}/\text{Y}^{90}$ ) in picocuries per liter; and as cesium-137 in picocuries per liter; however, the NWQL discontinued reporting gross beta as  $\text{Sr}^{90}/\text{Y}^{90}$  before the June 1996 sample round, and these data are not available for June and September 1996. Concentrations of dissolved gross beta-particle radioactivity are listed in table 6.

In the field-blank sample (QAS-52), the concentration of gross beta-particle radioactivity as cesium-137 ( $0.695 \pm 0.276$  pCi/L) was less than the reporting level. Five of the six replicate-sample

concentrations listed in table 6 were statistically equivalent to their primary-sample concentrations. The concentration as  $\text{Sr}^{90}/\text{Y}^{90}$  in QAS-49 ( $5.87 \pm 0.88$  pCi/L) was not statistically equivalent to the concentration in the primary sample NRF-11 ( $3.82 \pm 0.84$  pCi/L).

## Strontium-90

Water samples were analyzed for strontium-90 by chemical separation and beta counting (table 6). The concentration of strontium-90 in the field-blank sample (QAS-52) was less than the reporting level ( $0.292 \pm 0.172$  pCi/L). All of the four replicate-sample concentrations listed in table 6 were statistically equivalent to their primary-sample concentrations.

## Tritium

Water samples were analyzed for tritium by liquid scintillation (table 6). The concentration of tritium in the field-blank sample (QAS-52) was  $76.8 \pm 12.8$  pCi/L. All of the four replicate-sample concentrations listed in table 6 were statistically equivalent to their primary-sample concentrations.

## Selected Gamma-emitting Radioisotopes

Water samples were analyzed by gamma spectrometry for actinium-228, bismuth-214, cesium-134 and -137, chromium-51, cobalt-60, lead-212 and -214, potassium-40, radium-223, -224, -226, and -228, ruthenium-106, thallium-208, thorium-228, -232, and -234, uranium-234, -235, and -238, and zinc-65 (table 7). The field-blank sample (QAS-52) contained concentrations of bismuth-214 ( $0.845 \pm 0.215$  pCi/L), potassium-40 ( $14.1 \pm 1.7$  pCi/L), radium-226 ( $0.845 \pm 0.215$  pCi/L), thallium-208 ( $0.396 \pm 0.105$  pCi/L), and thorium-228 ( $1.54 \pm 0.495$  pCi/L) that were greater than their reporting levels. Concentrations of the other radioisotopes in QAS-52 were less than their respective reporting levels. Of 89 replicate-sample concentrations (table 7), 75 were statistically equivalent to their primary sample concentrations. Concentrations were not reported for either the replicate or the primary sample for 6 of these 75 sample pairs. Because gamma spectrometry records the energy

released as a result of gamma photon interactions and assigns the various energy releases to specific radionuclides by means of multi-channel analysis (American Society for Testing and Materials, 1998), the lack of a value implies that there was insufficient energy for quantification. As a result, the Z-value for the six data pairs without reported concentrations was set to zero and the pairs were assumed to be statistically equivalent. The concentration of bismuth-214 in QAS-49 ( $-0.189 \pm 0.215$  pCi/L) was not statistically equivalent to the concentration in the primary sample, NRF-11 ( $0.579 \pm 0.21$  pCi/L). Concentrations in QAS-46 of lead-212 ( $0.175 \pm 0.27$  pCi/L) and of lead-214 ( $1.02 \pm 0.195$  pCi/L) were not statistically equivalent to the concentrations in the respective primary sample (NRF-8) of lead-212 ( $0.919 \pm 0.145$  pCi/L) and lead-214 ( $0.336 \pm 0.175$  pCi/L). The potassium-40 concentrations in three replicate samples were not statistically equivalent to the potassium-40 concentrations in their respective primary samples: QAS-46 ( $19.8 \pm 1.95$  pCi/L) and NRF-8 ( $31.5 \pm 2.6$  pCi/L), QAS-50 ( $3.56 \pm 2.8$  pCi/L) and NRF-10 ( $27.8 \pm 2.25$  pCi/L), and QAS-51 ( $11.0 \pm 2.70$  pCi/L) and NRF-13 ( $58.2 \pm 3.75$  pCi/L). The concentration of radium-226 in QAS-49 ( $-0.189 \pm 0.215$  pCi/L) was not statistically equivalent to the concentration in the primary sample NRF-11 ( $0.579 \pm 0.210$  pCi/L), and the concentration of strontium-85 in QAS-51 ( $0 \pm 0$  pCi/L) was not statistically equivalent to the concentration in the primary sample NRF-13 ( $0.641 \pm 0.170$  pCi/L). The concentration of thallium-208 in QAS-51 ( $0.138 \pm 0.105$  pCi/L) was not statistically equivalent to the concentration in the primary sample NRF-13 ( $0.540 \pm 0.105$  pCi/L), and the concentration of thorium-234 in QAS-51 ( $54.9 \pm 17.5$  pCi/L) was not statistically equivalent to the concentration in the primary sample NRF-13 ( $-16.5 \pm 18.5$  pCi/L). The concentration of uranium-234 in QAS-50 ( $1.30 \pm 0.335$  pCi/L) was not statistically equivalent to the concentration in the primary sample NRF-10 ( $-0.332 \pm 0.325$  pCi/L), and the concentration of uranium-238 in QAS-46 ( $1.02 \pm 0.195$  pCi/L) was not statistically equivalent to the concentration in the primary sample NRF-8 ( $0.336 \pm 0.175$  pCi/L). The zinc-65 concentrations in two replicate samples were not statistically equivalent to the zinc-65 concentrations in their respective primary samples:

QAS-50 ( $0.0920 \pm 0.235$  pCi/L) and NRF-10 ( $-0.825 \pm 0.240$  pCi/L), and QAS-51 ( $-0.645 \pm 0.235$  pCi/L) and NRF-13 ( $0.664 \pm 0.195$  pCi/L).

## Regulatory Volatile and Base/Neutral Organic Compounds

Water samples collected in 1996 were analyzed for 30 regulatory volatile organic compounds (table 8) and 43 base/neutral organic compounds (table 9). Spiked organic samples (QAS-47) were prepared and submitted to the NWQL, along with a laboratory-prepared organic trip blank (QAS-48), for analysis of the compounds listed in tables 8 and 9.

### Regulatory Volatile Organic Compounds

The 30 regulatory volatile organic compounds that were analyzed for in the round-four water samples are listed in table 8 along with their respective laboratory reporting levels. Most samples did not contain regulatory volatile organic compounds; however, NRF-6 contained chloroform and tetrachloroethene in all four sampling events (table 10) and NRF 13 contained methylene chloride in all four sampling events (table 10). The replicate sample (QAS-51) and the primary sample (NRF-13) collected on June 13, 1998, both contained 0.5 µg/L of methylene chloride. Concentrations of all compounds in the trip-blank (QAS-47) were less than their respective reporting levels. All 120 replicate and primary sample pairs were statistically equivalent.

Table 8 contains information about the quality-assurance sample (QAS-47) spiked for the regulatory volatile organic compounds. The NWQL provided a solution with known concentrations of 13 organic compounds (table 8) for use in spiking matrix samples. Three 40-mL vials were prepared by adding 0.1 mL of the spiking solution to 39.9 mL of certified organic-free water. These vials then were submitted to the NWQL for analyses. The results of the analysis, the expected concentrations in the spiked sample, and the calculated percent recoveries are listed in table 8. The expected concentrations were calculated from the known concentrations in the spiking solution and the dilution volume. The vinyl chloride (20 per-



cent) and 1,1-dichloroethene (41 percent) recovery values were outside the range considered normal (60-140 percent) by the NWQL. The remaining percent-recovery values were within the expected range. Methylene chloride (which was not contained in the spiking solution) was measured in the spiked sample at a concentration of 1.3 µg/L.

### Base/Neutral Organic Compounds

The 43 base/neutral organic compounds that were analyzed for in the round-four water samples are listed in table 9 along with their respective laboratory reporting levels. Most samples did not contain base/neutral organic compounds; however, the field-blank sample (QAS-52) contained 6 µg/L of bis (2-ethylhexyl) phthalate; the June 1996 sample from USGS 99 contained 6 µg/L of diethyl phthalate; and the June 1996 sample from USGS 102 contained 57 µg/L of Di-n-butylphthalate (table 10). All 172 replicate and primary sample pairs were statistically equivalent.

Table 9 contains information about the quality-assurance sample (QAS-47) that was spiked for base/neutral organic compounds. The NWQL provided a solution with known concentrations of 41 base/neutral organic compounds (table 9) for use in spiking matrix samples. A 1-L sample was prepared by the addition of 100 µL of spike solution to certified organic-free water. The 1-L sample then was submitted to the NWQL for analysis. The results of the analysis, the expected concentrations in the spiked sample, and the calculated percent recoveries are listed in table 9. The expected concentrations were calculated from the known concentrations in the spiking solution and the dilution volume. Several recovery values were outside the range considered normal (60-140 percent) by the NWQL: butylbenzylphthalate (58 percent), diethyl phthalate (25 percent), dimethyl phthalate (9 percent), hexachlorocyclopentadiene (46 percent), isophorone (17 percent), n-nitrosodi-n-propylamine (47 percent), n-nitrosodiphenylamine (203 percent), n-nitrosodimethylamine (29 percent), and di-n-butyphthalate (59 percent). The remaining 32 recovery values were within the expected range. Benzo (a) pyrene and 4-bromophenylphenylether (which were not contained in the

spiking solution) were measured in the spiked sample at concentrations of 20 µg/L and 16 µg/L, respectively.

## 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 1996 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 51 samples were collected from 13 monitoring wells with dedicated submersible pumps. Seven quality-assurance samples also were collected and analyzed: one field-blank sample, one spiked-organic sample, one organic trip-blank sample, and four replicate samples. The field-blank sample contained concentrations of 10 constituents that were greater than the laboratory reporting levels: two inorganic constituents (calcium and manganese), one organic constituent (bis (2-ethylhexyl) phthalate), total organic carbon, and six radionuclides (bismuth-214, potassium-40, radium-226, thallium-208, thorium-228, and tritium). Concentrations of other constituents in the field-blank sample and the organic trip-blank sample were less than the respective reporting levels. The 4 replicate samples and their respective primary samples generated 517 pairs of analytical results for a variety of chemical and radiochemical constituents. Of the 517 pairs of analytical results, 493 were statistically equivalent at the 95-percent confidence level; about 95 percent of the analytical results were in agreement. The 23 data pairs that were not statistically equivalent included the following numbers and types of data pairs: 1 aluminum, 1 gross beta-particle radioactivity as Sr<sup>90</sup>/Y<sup>90</sup>, 3 iron, 1 total phosphorus as phosphorus, 3 TOC, and 14 gamma emitting radioisotopes. The statistical equivalence of one antimony data pair was uncertain. Percent recovery values for two of 13 regulatory volatile organic compounds and 9 of 41 base/neutral organic compounds in the spiked organic sample were outside the range considered normal (60-140 percent) by the NWQL.

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**Table 1. *Containers and preservatives used for water samples, Naval Reactors Facility and vicinity***

[Analyses by U.S. Geological Survey National Water Quality Laboratory. Abbreviations: mL, milliliter; L, liter; HNO<sub>3</sub>, nitric acid; K<sub>2</sub>Cr<sub>2</sub>O<sub>7</sub>, potassium dichromate; H<sub>2</sub>SO<sub>4</sub>, sulfuric acid; HCl, hydrochloric acid; °C, degrees Celsius. Chilled samples were shipped by overnight-delivery mail]

Type of constituent	Container		Preservative		Other treatment
	Type	Size	Type	Volume	
Anions	Polyethylene	250 mL	None	None	Filter
Cations, total recoverable	Polyethylene, acid-rinsed	250 mL	HNO <sub>3</sub>	1 mL	None
Trace elements, total recoverable	Polyethylene, acid-rinsed	250 mL	HNO <sub>3</sub>	1 mL	None
Trace elements, dissolved	Polyethylene, acid-rinsed	250 mL	HNO <sub>3</sub>	1 mL	Filter
Mercury, total recoverable	Glass, acid-rinsed	250 mL	K <sub>2</sub> Cr <sub>2</sub> O <sub>7</sub> /HNO <sub>3</sub>	10 mL	None
Nutrients, dissolved	Polyethylene, brown	125 mL	H <sub>2</sub> SO <sub>4</sub>	1 mL	Filter, chill 4°C
Nutrients, dissolved	Polyethylene, brown	125 mL	None	None	Filter, chill 4°C
Nutrients, total recoverable	Polyethylene, brown	125 mL	H <sub>2</sub> SO <sub>4</sub>	1 mL	Chill 4°C
Specific conductance	Polyethylene	125 mL	None	None	None
Total organic carbon	Glass, baked	125 mL	None	None	Chill 4°C
Volatile organic compounds	Glass, baked	40 mL	HCl	4 drops	Chill 4°C
Base/neutral organic compounds	Glass, baked	1L	None	None	Chill 4°C
Gamma-emitting radioisotopes	Polyethylene, acid-rinsed	1L	HNO <sub>3</sub>	4mL	Filter
Gross alpha- and beta-particle radioactivity	Polyethylene, acid-rinsed	1L	HNO <sub>3</sub>	4 mL	Filter
Strontium-90	Polyethylene, acid-rinsed	1L	HNO <sub>3</sub>	4 mL	Filter
Tritium	Polyethylene	125 mL	None	None	None

**Table 2. Results of field measurements for alkalinity, pH, specific conductance, and temperature of water, Naval Reactors Facility and vicinity**

[Sample identifier: see figure 2 for well locations. Measurements for QAS-47 were made prior to the addition of the spiking solution. Date sampled: (m/d/y), month/day/year. Alkalinity: CaCO<sub>3</sub>, calcium carbonate. Units: pH, negative base-10 logarithm of hydrogen ion activity in moles per liter; specific conductance, microsiemens per centimeter at 25 °C (degrees Celsius); temperature, °C. Abbreviations: lab, laboratory; NM, not measured; NC, not collected. Remarks: Field blank, indicates sample was inorganic- and organic-free water from the U.S. Geological Survey National Water Quality Laboratory. QAS indicates quality-assurance sample (values for field measurements for each pair of primary and replicate samples are the same measurement); Z-values associated with QA replicates for lab specific conductance were calculated using equation 1]

Sample identifier	Date sampled (m/d/y)	Time	Alkalinity as CaCO <sub>3</sub>	pH	Specific conductance (field)	Temperature	Specific conductance (lab)	Remarks
QAS-47	1/23/96	0900	NM	9.8	20	10.5	NC	Spiked organic sample
NRF-6	1/16/96	1615	155	7.4	1,447	11.5	1,420	
	3/19/96	1305	166	7.9	1,478	11.5	1,450	
	6/10/96	1600	171	7.9	1,454	11.5	1,420	
	9/5/96	0920	173	7.8	1,480	11.5	1,460	
NRF-7	9/10/96	1330	NM	8.0	1,472	12.0	NC	Resample
	1/16/96	1145	94	8.0	248	14.5	247	
	3/19/96	1140	103	8.2	249	14.5	246	
	6/10/96	1145	108	8.3	250	15.0	249	
	9/3/96	1120	106	8.5	236	17.0	237	
NRF-8	9/3/96	1130	NM	NM	NM	NM	2	QAS-52, field blank
	1/17/96	1505	209	7.6	585	11.0	561	
	1/17/96	1600	209	7.6	585	11.0	584	QAS-46, replicate (Z-value = 0.93)
	3/25/96	1330	217	7.9	591	11.5	573	
	6/11/96	1410	210	8.0	594	12.0	584	

Table 2. *Results of field measurements for alkalinity, pH, specific conductance, and temperature of water, Naval Reactors Facility and vicinity—Continued*

Sample identifier	Date sampled (m/d/y)	Time	Alkalinity as CaCO <sub>3</sub>	pH	Specific conductance (field)	Temperature	Specific conductance (lab)	Remarks
NRF-8 - Cont.	9/4/96	1315	214	8.0	595	11.5	586	
	9/10/96	0900	NM	8.0	596	11.5	NC	Resample
NRF-9	1/18/96	1300	201	7.4	630	11.0	632	
	3/26/96	0930	201	7.8	630	11.5	620	
	6/11/96	1530	203	8.0	648	12.0	635	
	9/4/96	1425	205	8.1	647	11.5	635	
	9/10/96	0945	NM	8.0	649	11.5	NC	Resample
NRF-10	5/8/96	1045	203	8.0	615	11.5	598	
	6/12/96	0915	201	8.0	615	12.0	607	
	6/12/96	1030	201	8.0	615	12.0	608	QAS-50, replicate (Z-value = 0.04)
	9/4/96	1540	200	8.1	608	11.5	605	
	9/10/96	1035	NM	8.0	615	11.5	NC	Resample
NRF-11	1/18/96	1540	194	7.7	615	11.0	619	
	3/25/96	1510	201	7.9	629	11.5	609	
	3/25/96	1545	201	7.9	629	11.5	613	QAS-49, replicate (Z-value = 0.16)
	6/12/96	1100	205	8.0	631	12.0	619	
	9/5/96	1200	198	8.0	631	11.5	624	
	9/10/96	1130	NM	8.0	627	11.5	NC	Resample



Table 2. Results of field measurements for alkalinity, pH, specific conductance, and temperature of water, Naval Reactors Facility and vicinity—Continued

Sample identifier	Date sampled (m/d/y)	Time	Alkalinity as CaCO <sub>3</sub>	pH	Specific conductance (field)	Temperature	Specific conductance (lab)	Remarks
NRF-12	1/22/96	1120	197	7.8	684	11.5	673	
	3/20/96	1545	196	7.9	682	11.5	657	
	6/12/96	1255	197	8.0	682	12.0	671	
	9/5/96	1045	201	8.0	684	11.5	671	
	9/10/96	1240	NM	8.0	684	12.0	NC	Resample
NRF-13	1/22/96	1520	92	8.2	496	15.0	480	
	3/20/96	1410	112	8.4	489	18.5	469	
	6/13/96	1245	88	8.4	532	18.5	530	
	6/13/96	1330	88	8.4	532	18.5	526	QAS-51, replicate (Z-value = 0.18)
	9/5/96	1550	93	8.5	540	16.5	534	
USGS 12	9/11/96	0950	NM	8.4	532	17.5	NC	Resample
	1/16/96	1430	194	7.5	606	11.5	600	
	3/21/96	1040	214	7.7	597	11.5	587	
	6/10/96	1440	215	7.9	607	11.5	594	
	9/3/96	1540	214	8.0	595	11.5	587	
USGS 97	1/17/96	1255	212	7.4	593	11.0	591	
	3/25/96	1140	222	7.8	596	11.0	580	
	6/11/96	1045	217	8.0	600	11.5	590	
	9/4/96	1035	219	8.0	602	11.5	591	

Table 2. *Results of field measurements for alkalinity, pH, specific conductance, and temperature of water, Naval Reactors Facility and vicinity—Continued*

Sample identifier	Date sampled (m/d/y)	Time	Alkalinity as CaCO <sub>3</sub>	pH	Specific conductance (field)	Temperature	Specific conductance (lab)	Remarks
USGS 98	1/17/96	0905	174	7.8	431	12.0	430	
	3/21/96	1345	161	7.9	430	12.5	425	
	6/11/96	0810	181	8.0	440	12.0	435	
	9/4/96	0800	180	7.9	440	12.0	434	
USGS 99	1/17/96	1055	207	7.5	525	11.0	525	
	3/25/96	0945	213	7.7	532	11.5	513	
	6/11/96	0930	212	8.0	532	11.5	526	
	9/4/96	0920	221	8.0	537	11.5	528	
USGS 102	1/18/96	1050	210	7.5	578	11.0	584	
	3/19/96	1435	218	7.9	592	11.5	571	
	6/11/96	1250	217	8.0	593	11.5	586	
	9/4/96	1200	218	8.0	596	11.5	586	
	9/10/96	0815	NM	7.9	598	11.5	NC	Resample

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

[Analyses were performed by the U.S. Geological Survey National Water Quality Laboratory. Analytical results in milligrams per liter. Sample identifier: see figure 2 for well locations. Date sampled: (m/d/y), month/day/year. QAS indicates quality-assurance sample; 52 is a field-blank sample; others are replicates. Z-values associated with QA replicates were calculated using equation 1. Symbol: <, concentration is less than the specified laboratory reporting level]

Sample identifier	Date sampled (m/d/y)	Calcium (total)	Chloride (dissolved)	Magnesium (total)	Potassium (total)	Sodium (total)	Sulfate (dissolved)
QAS-52	9/3/96	2.9	<0.1	<0.1	<0.1	<0.1	<0.1
NRF-6	1/16/96	130	220	37	4.4	100	220
	3/19/96	52	230	35	4.4	110	210
	6/10/96	120	230	36	4.7	100	210
	9/5/96	130	240	35	4.4	110	200
NRF-7	1/16/96	25	4.6	8.8	2.9	9.1	13
	3/19/96	25	5	8.9	2.8	8.9	14
	6/10/96	25	5.1	9.3	2.8	8.7	13
	9/3/96	24	5.2	9	2.8	9.5	14
NRF-8	1/17/97	69	34	24	2.1	15	34
QAS-46	1/17/96	69	34	24	2.1	14	34
Z-value	1/17/96	0	0	0	0	1.65	0
NRF-8	3/25/96	74	37	23	2.2	14	35
	6/11/96	67	35	24	2.4	13	34
	9/4/96	71	35	24	2.2	14	35
NRF-9	1/18/96	74	45	25	2.3	17	49
	3/26/96	79	46	23	2.4	17	50

Table 3. *Concentrations of dissolved anions and total recoverable 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-9 - Cont.	6/11/96	68	48	25	2.4	16	48
	9/4/96	73	48	24	2.4	17	49
NRF-10	5/8/96	84	42	25	2.3	15	44
	6/12/96	70	44	24	2.5	14	42
QAS-50	6/12/96	69	43	24	2.3	15	43
Z-value	6/12/96	.19	.42	0	.75	1.65	.32
NRF-10	9/4/96	72	43	25	2.4	16	44
NRF-11	1/18/96	70	43	24	2.6	19	47
	3/25/96	78	46	23	2.5	18	49
QAS-49	3/25/96	85	46	24	2.5	19	49
Z-value	3/25/96	1.12	0	.68	0	1.16	0
NRF-11	6/12/96	65	45	25	2.4	18	47
	9/5/96	72	44	23	2.8	19	50
NRF-12	1/22/96	75	58	26	2.7	22	59
	3/20/96	80	57	23	2.3	22	60
	6/12/96	69	59	26	2.5	21	58
	9/5/96	72	59	25	2.5	21	59
NRF-13	1/22/96	63	58	18	5.0	12	67
	3/20/96	71	57	18	4.8	10	69
	6/13/96	70	61	22	4.6	11	69

Table 3. *Concentrations of dissolved anions and total recoverable 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)
QAS-51	6/13/96	66	60	21	4.5	11	69
Z-value	6/13/96	.77	.30	.74	.21	0	0
NRF-13	9/5/96	64	60	19	4.2	62	73
USGS 12	1/16/96	70	38	24	2.1	17	34
	3/21/96	77	40	23	2.1	16	36
	6/10/96	66	38	24	2.0	16	34
	9/3/96	68	38	23	1.9	17	35
USGS 97	1/17/96	70	35	25	2.1	15	34
	3/25/96	72	36	22	1.9	15	35
	6/11/96	64	35	24	2.0	14	34
	9/4/96	71	35	24	2.0	15	35
USGS 98	1/17/96	92	14	37	2.0	9.9	21
	3/21/96	50	14	18	1.9	9.3	22
	6/11/96	49	14	21	2.0	9.3	21
	9/4/96	50	15	20	2.0	10	22
USGS 99	1/17/96	58	21	22	1.7	14	25
	3/25/96	64	21	22	1.5	14	27
	6/11/96	58	22	22	1.7	14	26
	9/4/96	62	22	22	1.7	14	27

Table 3. *Concentrations of dissolved anions and total recoverable 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	1/18/96	69	34	25	2.1	14	33
	3/19/96	75	35	22	2.0	14	35
	6/11/96	66	34	24	2.2	14	33
	9/4/96	74	33	24	2.1	15	35

**Table 4. Concentrations of selected total recoverable trace elements and dissolved beryllium and thallium in water, Naval Reactors Facility and vicinity**

[Analyses were performed by the U.S. Geological Survey National Water Quality Laboratory. Analytical results are in micrograms per liter. Sample identifier: see figure 2 for well locations. Date sampled: (m/d/y), month/day/year. QAS indicates quality-assurance sample; 52 is a field-blank sample; others are replicates. Z-values associated with QA replicates were calculated using equation 1; (N) indicates that Z-value is greater than 1.96 and that the two results are not equivalent at the 95-percent confidence limit; U indicates that statistical equivalence is uncertain. Symbol: <, concentration is less than the specified laboratory reporting level]

Constituent	Sample identifier and date sampled (m/d/y)									
	QAS-52 9/3/96	NRF-6 1/16/96	NRF-6 3/19/96	NRF-6 6/10/96	NRF-6 9/5/96	NRF-7 1/16/96	NRF-7 3/19/96	NRF-7 6/10/96	NRF-7 9/3/96	NRF-8 1/17/96
Aluminum	<10	20	<10	<10	<10	<1	80	60	70	20
Antimony	<1	<1	<1	1	1	<1	<1	<1	<1	<1
Arsenic	<1	3	3	3	3	2	2	2	2	2
Barium	<100	<100	<100	<100	<100	<100	<100	<100	<100	100
Beryllium (dissolved)	<.5	<.5	<.5	<.5	<.5	<.5	<.5	<.5	<.5	<.5
Cadmium	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
Chromium	<1	34	30	30	27	14	15	15	13	6.2
Copper	<1	<1	1	<1	<1	<1	<1	<1	<1	<1
Iron	<10	150	130	320	240	180	160	70	230	30
Lead	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
Manganese	10	10	<10	<10	<10	<10	<10	<10	<10	10
Mercury	<.1	<.1	<.1	<.1	<.1	<.1	<.1	<.1	<.1	<.1
Nickel	<1	6	8	11	8	5	6	6	6	<1
Selenium	<1	2	2	2	2	1	1	<1	1	2
Silver	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
Thallium (dissolved)	<.5	<.5	<.5	<.5	<.5	<.5	<.5	<.5	<.5	<.5
Zinc	<10	<10	20	<10	<10	<10	<10	<10	<10	<10

Table 4. Concentrations of selected total recoverable trace elements and dissolved beryllium and thallium in water, Naval Reactors Facility and vicinity—Continued

Constituent	Sample identifier and date sampled (m/d/y)										
	QAS-46 1/17/96	Z-value 1/17/96	NRF-8 3/25/96	NRF-8 6/11/96	NRF-8 9/4/96	NRF-9 1/18/96	NRF-9 3/26/96	NRF-9 6/11/96	NRF-9 9/4/96	NRF-10 5/8/96	NRF-10 6/12/96
Aluminum	30	0.94	<10	<10	<10	20	30	40	<10	2,000	520
Antimony	<1	0	<1	<1	<1	<1	<1	<1	<1	<1	<1
Arsenic	2	0	2	2	2	1	2	2	2	2	2
Barium	100	0	<100	<100	<100	100	<100	<100	<100	<100	<100
Beryllium (dissolved)	<.5	0	<.5	<.5	<.5	<.5	<.5	<.5	<.5	<.5	<.5
Cadmium	<1	0	<1	<1	<1	<1	<1	<1	<1	<1	<1
Chromium	6.2	0	6.5	7.1	7.1	11	12	14	12	17	17
Copper	1	0	<1	<1	<1	<1	<1	<1	<1	3	<1
Iron	50	1.69	30	40	80	20	190	60	30	2,900	770
Lead	<1	0	<1	<1	<1	<1	<1	<1	<1	<1	<1
Manganese	<10	0	<10	<10	<10	<10	<10	<10	<10	60	30
Mercury	<.1	0	<.1	<.1	<.1	<.1	<.1	<.1	<.1	<.1	<.1
Nickel	<1	0	<1	<1	2	<1	<1	<1	<1	9	3
Selenium	2	0	2	2	2	2	2	2	2	2	2
Silver	<1	0	<1	<1	<1	<1	<1	<1	<1	<1	<1
Thallium (dissolved)	<.5	0	<.5	<.5	<.5	<.5	<.5	<.5	<.5	<.5	<.5
Zinc	<10	0	<10	<10	<10	<10	<10	<10	<10	<10	<10



Table 4. Concentrations of selected total recoverable trace elements and dissolved beryllium and thallium in water, Naval Reactors Facility and vicinity—Continued

Constituent	Sample identifier and date sampled (m/d/y)										
	QAS-50 6/12/96	Z-value 6/12/96	NRF-10 9/4/96	NRF-11 1/18/96	NRF-11 3/25/96	QAS-49 3/25/96	Z-value 3/25/96	NRF-11 6/12/96	NRF-11 9/5/96	NRF-12 1/22/96	NRF-12 3/20/96
Aluminum	440	4.97 (N)	1,000	70	40	40	0	60	40	60	60
Antimony	<1	0	<1	<1	<1	<1	0	<1	<1	<1	<1
Arsenic	2	0	2	2	2	2	0	2	2	2	2
Barium	<100	0	<100	100	100	<100	.94	<100	<100	200	<100
Beryllium (dissolved)	<.5	0	<.5	<.5	<.5	<.5	0	<.5	<.5	<.5	<.5
Cadmium	<1	0	<1	<1	<1	<1	0	<1	<1	<1	<1
Chromium	17	0	14	21	23	22	.28	24	23	18	19
Copper	<1	0	1	<1	1	<1	0	<1	<1	<1	<1
Iron	640	3.09 (N)	1,700	70	100	60	2.92 (N)	320	60	40	110
Lead	<1	0	2	<1	<1	<1	0	<1	<1	<1	<1
Manganese	30	0	40	<10	<10	<10	0	<10	<10	<10	<10
Mercury	<.1	0	<.1	<.1	<.1	<.1	0	<.1	<.1	<.1	<.1
Nickel	3	0	8	3	3	3	0	6	7	<1	<1
Selenium	2	0	2	2	2	2	0	2	2	2	2
Silver	<1	0	<1	3	<1	<1	0	<1	<1	<1	<1
Thallium (dissolved)	<.5	0	<.5	<.5	<.5	<.5	0	<.5	<.5	<.5	<.5
Zinc	<10	0	<10	<10	20	<10	0	<10	<10	<10	<10

Table 4. Concentrations of selected total recoverable trace elements and dissolved beryllium and thallium in water, Naval Reactors Facility and vicinity—Continued

Constituent	Sample identifier and date sampled (m/d/y)									
	NRF-12 6/12/96	NRF-12 9/5/96	NRF-13 1/22/96	NRF-13 3/20/96	NRF-13 6/13/96	QAS-51 6/13/96	Z-value 6/13/96	NRF-13 9/5/96	USGS 12 1/16/96	USGS 12 3/21/96
Aluminum	20	10	2,800	<10	3,500	3,400	1.61	1,400	<10	<10
Antimony	<1	<1	<1	<1	1	<1	U	<1	<1	<1
Arsenic	2	2	2	2	2	2	0	1	2	2
Barium	<100	<100	100	<100	<100	<100	0	<100	100	100
Beryllium (dissolved)	<.5	<.5	<.5	<.5	<.5	<.5	0	<.5	<.5	<.5
Cadmium	<1	<1	<1	<1	<1	<1	0	<1	<1	<1
Chromium	20	17	31	30	34	35	.22	26	6.5	6.9
Copper	<1	<1	5	7	6	7	.42	2	<1	<1
Iron	20	<10	2,500	3,400	3,100	5,400	11.01 (N)	1,300	30	50
Lead	<1	<1	1	2	1	2	.67	<1	<1	<1
Manganese	<10	<10	40	60	60	60	0	<10	<10	<10
Mercury	<.1	<.1	<.1	<.1	<.1	<.1	0	<.1	<.1	<.1
Nickel	<1	<1	6	8	10	10	0	5	<1	<1
Selenium	2	2	1	1	1	1	0	1	2	2
Silver	2	<1	<1	<1	<1	<1	0	<1	<1	<1
Thallium (dissolved)	<.5	<.5	<.5	<.5	<.5	<.5	0	<.5	<.5	<.5
Zinc	<10	<10	<10	10	<10	<10	0	<10	<10	<10

Table 4. Concentrations of selected total recoverable trace elements and dissolved beryllium and thallium in water, Naval Reactors Facility and vicinity—Continued

Constituent	Sample identifier and date sampled (m/d/y)											
	USGS 12 6/10/96	USGS 12 9/3/96	USGS 12 9/3/96	USGS 97 1/17/96	USGS 97 3/25/96	USGS 97 6/11/96	USGS 97 9/4/96	USGS 98 1/17/96	USGS 98 3/21/96	USGS 98 6/11/96	USGS 98 9/4/96	
Aluminum	<10	<10	<10	20	<10	40	20	<10	<10	<10	<10	
Antimony	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	
Arsenic	2	2	2	1	2	2	2	2	2	1	2	
Barium	<100	<100	<100	100	<100	<100	<100	<100	<100	<100	<100	
Beryllium (dissolved)	<.5	<.5	<.5	<.5	<.5	<.5	<.5	<.5	<.5	<.5	<.5	
Cadmium	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	
Chromium	7.8	6.8	6.8	6.2	6.1	6.5	6.6	5.3	5.1	6.6	5.6	
Copper	<1	<1	<1	1	<1	<1	<1	<1	7	<1	<1	
Iron	30	50	50	40	30	20	50	80	120	260	60	
Lead	<1	<1	<1	1	1	<1	1	7	7	7	6	
Manganese	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	
Mercury	<.1	<.1	<.1	<.1	<.1	<.1	<.1	<.1	<.1	<.1	<.1	
Nickel	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	
Selenium	2	2	2	2	2	2	2	1	1	1	<1	
Silver	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	
Thallium (dissolved)	<.5	<.5	<.5	<.5	<.5	<.5	<.5	<.5	<.5	<.5	<.5	
Zinc	<10	<10	<10	100	90	100	80	180	170	180	160	

Table 4. Concentrations of selected total recoverable trace elements and dissolved beryllium and thallium in water, Naval Reactors Facility and vicinity—Continued

Constituent	Sample identifier and date sampled (m/d/y)									
	USGS 99 1/17/96	USGS 99 3/25/96	USGS 99 6/11/96	USGS 99 9/4/96	USGS 102 1/18/96	USGS 102 3/19/96	USGS 102 6/11/96	USGS 102 9/4/96		
Aluminum	<10	<10	<10	20	10	20	<10	10		
Antimony	<1	<1	<1	<1	<1	<1	<1	<1		
Arsenic	1	2	1	2	2	2	2	2		
Barium	100	<100	<100	<100	100	<100	<100	<100		
Beryllium (dissolved)	<.5	<.5	<.5	<.5	<.5	<.5	<.5	<.5		
Cadmium	<1	<1	<1	<1	<1	<1	<1	<1		
Chromium	5.1	5.9	5.6	5.5	6.3	6.4	7.1	6.6		
Copper	<1	2	3	<1	<1	<1	<1	<1		
Iron	50	70	90	70	160	260	110	20		
Lead	1	2	<1	1	<1	<1	<1	<1		
Manganese	<10	<10	<10	<10	<10	<10	<10	<10		
Mercury	<.1	<.1	<.1	<.1	<.1	<.1	<.1	<.1		
Nickel	<1	1	<1	<1	<1	<1	<1	<1		
Selenium	1	2	2	1	2	2	2	2		
Silver	<1	<1	<1	<1	<1	<1	<1	<1		
Thallium (dissolved)	<.5	<.5	<.5	<.5	<.5	<.5	<.5	<.5		
Zinc	80	90	90	70	<10	<10	<10	<10		

**Table 5. Concentrations of dissolved and total nutrients, and total organic carbon in water, Naval Reactors Facility and vicinity**

[Analyses were performed by the U.S. Geological Survey National Water Quality Laboratory. Analytical results are in milligrams per liter. Sample identifier: see figure 2 for well locations. Date sampled: (m/d/y), month/day/year. QAS indicates quality-assurance sample: 47 is a blank total organic carbon sample and 52 is a field-blank sample; all others are replicates; Z-values associated with QA replicates were calculated using equation 1. (N) indicates that Z-value is greater than 1.96 and that the two results are not equivalent at the 95-percent confidence limit. Symbols: <, concentration is less than the specified laboratory reporting level. Abbreviation: NR, analysis was not requested]

Sample identifier	Date sampled (m/d/y)	Ammonia plus organic nitrogen (as nitrogen) (total)	Nitrite (as nitrogen) (dissolved)	Nitrite plus nitrate (as nitrogen) (dissolved)	Phosphorus (as phosphorus) (total)	Total organic carbon
QAS-47	1/23/96	NR	NR	NR	NR	0.1
QAS-52	9/3/96	<0.2	<0.01	<0.05	<0.01	.2
NRF-6	1/16/96	<.2	<.01	1.9	.07	2.3
	3/19/96	<.2	<.01	1.9	.1	.9
	6/10/96	<.2	<.01	1.9	.05	1.1
	9/10/96	<.2	<.01	1.7	.08	1.2
NRF-7	1/16/96	<.2	<.01	.49	<.01	.8
	3/19/96	<.2	<.01	.46	.01	.3
	6/10/96	<.2	<.01	.5	.03	<.1
	9/13/96	<.2	<.01	.47	.02	.5
NRF-8	1/17/96	<.2	<.01	2.0	.02	.3
QAS-46	1/17/96	<.2	<.01	2.0	.01	3.4
Z-value	1/17/96	0	0	0	.67	15.72 (N)
NRF-8	3/25/96	<.2	<.01	1.9	<.01	4.9
	6/11/96	<.2	.01	2.0	.04	.7
	9/10/96	<.2	<.01	1.9	.03	.5
NRF-9	1/18/96	<.2	<.01	2.3	.03	.4
	3/26/96	<.2	<.01	2.2	<.01	.9
	6/11/96	<.2	.01	2.4	.03	.4
NRF-9	9/10/96	<.2	<.01	2.2	.02	.6
NRF-10	5/8/96	<.2	<.01	1.8	.09	.1
	6/12/96	<.2	.01	1.9	.06	1.7
QAS-50	6/12/96	<.2	.02	1.9	.05	1.0
Z-value	6/12/96	0	.94	0	.58	3.81 (N)

Table 5. *Concentrations of dissolved and total nutrients, and total organic carbon in water, Naval Reactors Facility and vicinity—Continued*

Sample identifier	Date sampled (m/d/y)	Ammonia plus organic nitrogen (as nitrogen) (total)	Nitrite (as nitrogen) (dissolved)	Nitrite plus nitrate (as nitrogen) (dissolved)	Phosphorus (as phosphorus) (total)	Total organic carbon
NRF-10	9/10/96	<.2	<.01	1.8	.02	.4
NRF-11	1/18/96	<.2	<.01	2.0	.01	2.5
	3/25/96	<.2	<.01	1.9	.04	.5
QAS-49	3/25/96	<.2	<.01	1.9	<.01	.3
Z-value	3/25/96	0	0	0	2.20(N)	1.09
NRF-11	6/12/96	<.2	.01	2.0	.04	3.5
	9/10/96	<.2	<.01	1.9	.02	2.9
NRF-12	1/22/96	<.2	<.01	2.1	<.01	2.5
	3/20/96	<.2	<.01	1.9	.03	1.2
	6/12/96	<.2	.01	2.1	.03	.5
	9/10/96	<.2	<.01	2.0	.01	2.1
NRF-13	1/22/96	<.2	<.01	.81	.09	1.8
	3/20/96	<.2	<.01	.74	.16	1.0
	6/13/96	<.2	.02	.8	.15	.2
QAS-51	6/13/96	<.2	.02	.81	.16	3.9
Z-value	6/13/96	0	0	.17	.44	18.77 (N)
NRF-13	9/11/96	<.2	.01	.75	.17	.9
USGS 12	1/16/96	<.2	<.01	2.2	<.01	1.7
	3/21/96	<.2	<.01	2.1	.03	.8
	6/10/96	<.2	<.01	2.2	<.01	2.0
	9/3/96	<.2	<.01	2.0	.03	1.9
USGS 97	1/17/96	<.2	<.01	2.2	<.01	1.6
	3/25/96	<.2	<.01	2.0	.05	.6
	6/11/96	<.2	.01	2.1	.04	.6
	9/4/96	4.1	<.01	2.1	.03	.4
USGS 98	1/17/96	<.2	<.01	1.2	<.01	.6
	3/21/96	<.2	<.01	1.1	.03	.7
	6/11/96	<.2	.01	1.2	.03	.4
	9/4/96	<.2	<.01	1.1	.06	.8

Table 5. *Concentrations of dissolved and total nutrients, and total organic carbon in water, Naval Reactors Facility and vicinity—Continued*

Sample identifier	Date sampled (m/d/y)	Ammonia plus organic nitrogen (as nitrogen) (total)	Nitrite (as nitrogen) (dissolved)	Nitrite plus nitrate (as nitrogen) (dissolved)	Phosphorus (as phosphorus) (total)	Total organic carbon
USGS 99	1/17/96	<.2	<.01	1.7	.01	.3
	3/25/96	<.2	<.01	1.6	.01	.2
	6/11/96	<.2	.02	1.7	.04	2.4
	9/4/96	<.2	<.01	1.6	.04	2.3
USGS 102	1/18/96	<.2	<.01	2.1	<.01	.8
	3/19/96	<.2	<.01	2.0	.02	.4
	6/11/96	<.2	.01	2.1	.05	.5
	9/10/96	<.2	<.01	2.0	<.01	2.3

**Table 6. Concentrations of gross alpha-particle radioactivity, gross beta-particle radioactivity, strontium-90, and tritium in water, Naval Reactors Facility and vicinity**

[Analyses were performed by the U.S. Geological Survey National Water Quality Laboratory using a residue procedure for gross alpha- and beta-particle radioactivity, chemical separation for strontium-90, and liquid scintillation for tritium. Analytical results and uncertainties—for example, **8.23±1.18**—in indicated units. Analytical uncertainties are reported as 1s. 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 well locations. Date sampled: (m/d/y), month/day/year. QAS indicates quality-assurance sample; 52 is a field-blank sample; others are replicates. Z-values associated with QA replicates were calculated using equation 1. (N) indicates that Z-value is greater than 1.96 and that the two results are not equivalent at the 95-percent confidence limit. Abbreviations: pCi/L, picocurie per liter; µg/L, microgram per liter; Sr-90/Y-90, strontium-90 in equilibrium with yttrium-90; NR, analysis was not requested; NC, value was not calculated]

Sample identifier	Date sampled (m/d/y)	Gross alpha-particle radioactivity		Gross beta-particle radioactivity		Strontium-90 (pCi/L)	Tritium (pCi/L)
		as Thorium-230 (pCi/L)	as Uranium (µg/L)	as Cesium-137 (pCi/L)	as Sr <sup>90</sup> /Y <sup>90</sup> (pCi/L)		
QAS-52	9/3/96	-0.132±0.085	NR	0.695±0.276	NR	0.292±0.172	<b>76.8±12.8</b>
NRF-6	1/16/96	2.22±1.42	2.88±1.84	<b>8.23±1.18</b>	<b>6.19±0.89</b>	-0.112±0.11	<b>64.0±12.8</b>
	3/19/96	.316±1.75	.734±4.06	12.0±4.68	10.1±3.87	-.134±0.136	<b>83.2±12.8</b>
	6/10/96	1.36±1.36	NR	8.12±3.98	NR	.191±0.170	<b>54.4±12.8</b>
	9/5/96	1.91±1.70	NR	<b>9.89±2.98</b>	NR	.067±0.136	<b>89.6±12.8</b>
NRF-7	1/16/96	.780±0.386	1.08±0.535	<b>4.40±0.640</b>	<b>3.41±0.403</b>	.0266±0.145	12.8±12.8
	3/19/96	1.69±0.95	3.07±1.73	<b>7.30±1.16</b>	<b>3.97±0.457</b>	.049±0.126	0.0±12.8
	6/10/96	1.54±0.80	NR	<b>6.83±1.18</b>	NR	-.0105±0.022	-12.8±12.8
	9/3/96	1.41±0.76	NR	<b>5.68±0.88</b>	NR	.070±0.118	12.8±12.8
NRF-8	1/17/96	<b>3.20±0.89</b>	<b>4.53±1.26</b>	<b>3.18±0.585</b>	<b>2.34±0.396</b>	.0652±0.13	<b>6.72±12.8</b>
QAS-46	1/17/96	<b>3.72±0.94</b>	<b>5.16±1.31</b>	<b>3.58±0.53</b>	<b>2.72±0.402</b>	.121±0.14	<b>57.6±12.8</b>
Z-value	1/17/96	.40	.35	.51	.67	.29	.53
NRF-8	3/25/96	2.85±1.26	6.82±3.04	<b>7.36±1.82</b>	<b>3.58±0.78</b>	.019±0.114	<b>38.4±12.8</b>
	6/11/96	.912±0.92	NR	<b>7.17±2.28</b>	NR	.023±0.117	<b>54.4±12.8</b>



Table 6. *Concentrations of gross alpha-particle radioactivity, gross beta-particle radioactivity, strontium-90, and tritium in water, Naval Reactors Facility and vicinity*—Continued

Sample identifier	Date sampled (m/d/y)	Gross alpha-particle radioactivity		Gross beta-particle radioactivity		Strontium-90 (pCi/L)	Tritium (pCi/L)
		as Thorium-230 (pCi/L)	as Uranium (µg/L)	as Cesium-137 (pCi/L)	as Sr <sup>90</sup> /Y <sup>90</sup> (pCi/L)		
NRF-8 - Cont.	9/4/96	1.43±1.09	NR	11.4±2.16	NR	.019±0.106	57.6±12.8
NRF-9	1/18/96	2.65±0.84	4.14±1.32	4.18±0.70	3.08±0.463	.197±0.150	147.2±16.0
	3/26/96	1.60±1.14	3.98±2.84	8.36±1.96	4.04±0.82	.182±0.138	115.2±12.8
	6/11/96	3.99±1.32	NR	6.32±1.77	NR	.311±0.124	112.0±12.8
	9/4/96	4.19±1.45	NR	9.17±2.00	NR	.329±0.126	131.2±12.8
NRF-10	5/8/96	1.70±0.89	4.11±2.18	2.57±1.85	2.12±1.52	1.31±0.195	140.8±12.8
	6/12/96	1.92±1.00	NR	7.50±1.78	NR	.093±0.119	137.6±12.8
QAS-50	6/12/96	2.86±1.18	NR	6.85±1.65	NR	.309±0.138	144.0±12.8
Z-value	6/12/96	.61	NC	.27	NC	1.19	.35
NRF-10	9/4/96	5.13±1.52	NR	8.82±1.89	NR	-.111±0.098	144.0±12.8
NRF-11	1/18/96	1.96±0.66	2.78±0.94	4.62±0.72	3.44±0.65	-.106±0.140	342.4±16
	3/25/96	3.47±1.36	8.68±3.46	6.98±1.70	3.82±0.84	.031±0.132	281.6±16
QAS-49	3/25/96	3.46±1.36	8.61±3.42	11.8±2.24	5.87±0.88	.188±0.144	320.0±16
Z-value	3/25/96	.01	.01	1.71	2.32 (N)	.80	1.70
NRF-11	6/12/96	6.58±1.64	NR	8.03±2.09	NR	.075±0.118	323.2 ±12.8
	9/5/96	2.88±1.23	NR	7.87±2.09	NR	.043±0.114	297.6±12.8
NRF-12	1/22/96	3.93±1.17	5.09±1.52	4.32±0.70	3.17±0.441	-.00438±0.14	67.2±12.8
	3/20/96	1.37±1.14	3.55±2.96	7.53±1.92	3.83±0.88	.162±0.131	41.6±12.8

Table 6. *Concentrations of gross alpha-particle radioactivity, gross beta-particle radioactivity, strontium-90, and tritium in water, Naval Reactors Facility and vicinity—Continued*

Sample identifier	Date sampled (m/d/y)	Gross alpha-particle radioactivity		Gross beta-particle radioactivity		Strontium-90 (pCi/L)	Tritium (pCi/L)
		as Thorium-230 (pCi/L)	as Uranium (µg/L)	as Cesium-137 (pCi/L)	as Sr <sup>90</sup> /Y <sup>90</sup> (pCi/L)		
NRF-12 - Cont.	6/12/96	2.00±1.05	NR	10.1±2.33	NR	.253±0.152	54.4±12.8
	9/5/96	3.32±1.34	NR	9.30±2.04	NR	.077±0.110	76.8±12.8
NRF-13	1/22/96	2.62±0.80	4.09±1.24	6.20±0.79	4.61±0.482	-.0604±0.135	48.0±12.8
	3/20/96	2.10±1.08	4.39±2.26	12.7±1.95	6.67±0.70	.201±0.112	41.6±12.8
	6/13/96	3.99±1.21	NR	9.75±1.88	NR	.008±0.086	28.8±12.8
QAS-51	6/13/96	2.29±1.00	NR	10.3±1.74	NR	.075±0.108	32.0±12.8
Z-value	6/13/96	1.08	NC	.21	NC	.49	.18
NRF-13	9/5/96	2.09±1.12	NR	13.5±2.16	NR	.026±0.098	48.0±12.8
USGS 12	1/16/96	4.18±1.06	5.63±1.44	4.29±0.70	3.16±0.468	-.00485±0.105	60.8±12.8
	3/21/96	1.69±1.06	3.71±2.34	7.45±1.80	3.18±0.66	.041±0.119	64.0±12.8
	6/10/96	.32±0.80	NR	6.71±2.24	NR	.019±0.104	60.8±12.8
	9/3/96	2.52±1.24	NR	7.02±2.12	NR	.053±0.110	48.0±12.8
USGS 97	1/17/96	3.74±1.00	5.28±1.42	3.23±0.59	2.37±0.52	-.0691±0.13	73.6±12.8
	3/25/96	2.07±1.16	4.94±2.80	6.47±1.67	3.29±0.76	.066±0.132	19.2±12.8
	6/11/96	3.81±1.32	NR	6.97±2.25	NR	.086±0.116	51.2±12.8
	9/4/96	3.29±1.32	NR	7.26±1.74	NR	.132±0.109	60.8±12.8
USGS 98	1/17/96	2.15±0.67	2.80±0.88	3.23±0.481	2.45±0.364	-.0115±0.11	16.0±12.8
	3/21/96	1.17±0.97	2.47±2.05	7.10±1.50	3.52±0.62	.171±0.117	6.4±12.8

Table 6. *Concentrations of gross alpha-particle radioactivity, gross beta-particle radioactivity, strontium-90, and tritium in water, Naval Reactors Facility and vicinity—Continued*

Sample identifier	Date sampled (m/d/y)	Gross alpha-particle radioactivity		Gross beta-particle radioactivity		Strontium-90 (pCi/L)	Tritium (pCi/L)
		as Thorium-230 (pCi/L)	as Uranium (µg/L)	as Cesium-137 (pCi/L)	as Sr <sup>90</sup> /Y <sup>90</sup> (pCi/L)		
USGS 98 - Cont.	6/11/96	1.57±0.92	NR	7.12±1.65	NR	.174±0.118	9.6±12.8
	9/4/96	3.66±1.26	NR	7.85±1.56	NR	.087±0.102	19.2±12.8
USGS 99	1/17/96	2.02±0.68	3.15±1.06	2.70±0.53	2.04±0.438	.0108±0.11	35.2±12.8
	3/25/96	2.30±1.18	5.41±2.80	6.55±1.63	3.33±0.735	.140±0.124	12.8±12.8
	6/11/96	.833±0.84	NR	7.56±1.56	NR	.199±0.130	19.2±12.8
	9/4/96	2.89±1.23	NR	7.85±1.74	NR	-.010±0.110	32.0±12.8
USGS 102	1/18/96	2.37±0.74	3.19±1.00	3.94±0.63	2.89±0.413	.159±0.130	60.8±12.8
	3/19/96	3.95±1.40	9.71±3.50	9.09±1.98	4.46±0.82	.055±0.112	48.0±12.8
	6/11/96	3.43±1.26	NR	8.14±1.78	NR	.118±0.134	48.0±12.8
	9/4/96	3.83±1.38	NR	9.78±2.00	NR	.163±0.127	54.4±12.8

**Table 7. Concentrations of selected isotopes from analysis by gamma spectrometry, Naval Reactors Facility and vicinity**

[Analyses were performed by the U.S. Geological Survey National Water Quality Laboratory using gamma spectrometry. Analytical results and uncertainties—for example, **1.39±0.39**—are in picocuries per liter (pCi/L). Analytical uncertainties are reported as 1s. 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. Date sampled: (m/d/y), month/day/year. QAS indicates quality assurance sample: 52 is a field-blank; others are replicates. Z-values associated with QA replicates were calculated using equation 1; (N) indicates that Z-value is greater than 1.96 and that the two results are not equivalent at the 95-percent confidence limit. NC, value was not calculated; NR, analysis was not reported. The sample collected from well NRF-13 on 6/13/96 contained **0.641±0.170** pCi/L of strontium-85. Strontium-85 was not reported in the replicate sample (QAS-51). The calculated Z-value for this sample pair was 3.77, which indicates that the two results were not statistically equivalent at the 95-percent confidence limit]

Isotope	Sample identifier and date sampled (m/d/y)			
	QAS-52 9/3/96	NRF-6 1/16/96	NRF-6 3/19/96	NRF-6 6/10/96
Actinium-228	NR	<b>1.39±0.39</b>	<b>1.83±0.43</b>	NR
Bismuth-214	<b>0.845±0.215</b>	<b>.841±0.215</b>	<b>.864±0.215</b>	0.0739±0.22
Cesium-134	-.0303±0.095	-.183±0.095	-.0142±0.095	-.0132±0.105
Cesium-137	-.101±0.105	.0911±0.10	.183±0.09	.077±0.10
Chromium-51	1.20±0.95	-1.14±0.135	-1.04±1.5	.830±1.3
Cobalt-60	.0705±0.095	-.00287±0.095	.182±0.095	-.146±0.10
Lead-212	.118±0.305	<b>.695±0.145</b>	.199±0.285	.397±0.15
Lead-214	.0573±0.19	.439±0.18	.360±0.20	.416±0.18
Potassium-40	<b>14.1±1.7</b>	<b>24.8±2.2</b>	<b>16.6±3.25</b>	.257±3.5
Radium-223	.554±0.45	.876±0.435	-.504±0.445	.0555±0.45
Radium-224	NR	<b>.715±0.15</b>	<b>.926±0.165</b>	NR
Radium-226	<b>.845±0.215</b>	<b>.841±0.215</b>	<b>.864±0.215</b>	.0739±0.22
Radium-228	.720±0.395	<b>1.4±0.395</b>	<b>1.85±0.435</b>	.0261±0.41
Ruthenium-106	-1.80±0.9	1.95±0.9	-1.16±0.95	.206±0.95
Thallium-208	<b>.396±0.105</b>	<b>.542±0.105</b>	<b>.510±0.105</b>	.160±0.10
Thorium-228	<b>1.54±0.495</b>	<b>1.55±0.305</b>	<b>1.47±0.295</b>	.459±0.29
Thorium-232	NR	1.19±0.55	<b>1.86±0.60</b>	NR
Thorium-234	38.2±18.5	40.6±16	51.5±18	39.9±17
Uranium-234	.454±0.33	.407±0.315	.436±0.340	-.322±0.335
Uranium-235	.911±0.425	.206±0.405	.659±0.425	.216±0.43
Uranium-238	.0573±0.19	.439±0.18	.360±0.200	.416±0.18
Zinc-65	-.159±0.22	-.0739±0.22	-.581±0.225	.130±0.225

Table 7. *Concentrations of selected isotopes from analysis by gamma spectrometry, Naval Reactors Facility and vicinity—Continued*

Isotope	Sample identifier and date sampled (m/d/y)			
	NRF-6 9/5/96	NRF-7 1/16/96	NRF-7 3/19/96	NRF-7 6/10/96
Actinium-228	NR	<b>1.90±0.425</b>	1.01±0.40	NR
Bismuth-214	<b>.808±0.215</b>	.495±0.20	<b>.624±0.205</b>	<b>1.28±0.245</b>
Cesium-134	-.101±0.095	.00633±0.095	-.074±0.10	.0232±0.11
Cesium-137	-.0354 ±0.105	-.233±0.11	.210±0.10	-.242±0.12
Chromium-51	.513±1.1	1.37±1.50	1.57±1.5	1.18±1.55
Cobalt-60	-.0997±0.115	.219±0.110	-.00993±0.105	.0516±0.125
Lead-212	<b>1.24±0.175</b>	.0142±0.275	.282±0.255	<b>.561±0.175</b>
Lead-214	<b>.836±0.21</b>	<b>.665±0.19</b>	.208±0.195	.640±0.215
Potassium-40	.774±3.6	<b>27.7±2.3</b>	1.65±2.90	<b>58.9±3.85</b>
Radium-223	1.22±0.495	-.590±0.465	.103±0.465	.0946±0.55
Radium-224	NR	<b>.746±0.165</b>	.291±0.265	NR
Radium-226	<b>.808±0.215</b>	.495±0.20	<b>.624±0.205</b>	1.28±0.245
Radium-228	<b>2.13±0.425</b>	<b>1.92±0.43</b>	1.02±0.405	<b>1.91±0.465</b>
Ruthenium-106	1.43±0.9	-.963±0.95	.966±0.95	-.428±1.05
Thallium-208	<b>.554±0.11</b>	<b>.401±0.11</b>	.239±0.105	<b>.437±0.125</b>
Thorium-228	<b>1.56±0.305</b>	<b>1.15±0.32</b>	.298±0.485	<b>1.25±0.355</b>
Thorium-232	NR	1.04±0.65	<b>1.98±0.60</b>	NR
Thorium-234	28.9±17	22.5±19	11.6±17.5	<b>57.9±19</b>
Uranium-234	.622±0.365	.292±0.355	-.0418±0.35	-.918±0.395
Uranium-235	1.09±0.5	<b>1.78±0.460</b>	.790±0.42	1.06±0.49
Uranium-238	<b>.836±0.21</b>	<b>.665±0.190</b>	.208±0.195	.640±0.215
Zinc-65	.473±0.225	-.160±0.240	.279±0.24	.0652±0.31

Table 7. *Concentrations of selected isotopes from analysis by gamma spectrometry, Naval Reactors Facility and vicinity—Continued*

Isotope	Sample identifier and date sampled (m/d/y)			
	NRF-7 9/3/96	NRF-8 1/17/96	QAS-46 1/17/96	Z-value 1/17/96
Actinium-228	NR	<b>1.46±0.385</b>	.605±0.39	1.56
Bismuth-214	<b>.944±0.21</b>	<b>.752±0.21</b>	<b>.988±0.205</b>	.80
Cesium-134	.0368±0.095	-.044±0.095	-.100±0.09	.43
Cesium-137	.0974±0.09	-.124±0.105	-.0937±0.10	.21
Chromium-51	-.729±0.85	1.42±1.2	-.507±1.25	1.11
Cobalt-60	.0762±0.105	.0922±0.10	.0043±0.11	.59
Lead-212	.544±0.285	<b>.919±0.145</b>	.175±0.27	2.43 (N)
Lead-214	.389±0.175	.336±0.175	<b>1.02±0.195</b>	2.61 (N)
Potassium-40	.196±3.25	<b>31.5±2.6</b>	<b>19.8±1.95</b>	3.60 (N)
Radium-223	-.429±0.405	-.162±0.415	-.108±0.43	.03
Radium-224	NR	<b>.946±0.145</b>	<b>.745±0.145</b>	.98
Radium-226	<b>.944±0.210</b>	<b>.752±0.21</b>	<b>.988±0.205</b>	.80
Radium-228	<b>1.87±0.425</b>	<b>1.47±0.39</b>	.611±0.395	1.55
Ruthenium-106	-1.65±0.90	-.697±0.85	.772±0.85	1.22
Thallium-208	.538±0.195	<b>.395±0.11</b>	<b>.344±0.11</b>	.33
Thorium-228	1.52±0.55	<b>1.13±0.315</b>	<b>.986±0.31</b>	.33
Thorium-232	NR	.680±0.55	.679±0.6	.00
Thorium-234	50.2±17	25.7±17	43.5±16.5	.75
Uranium-234	.579±0.295	-.124±0.31	.277±0.33	.89
Uranium-235	1.15±0.39	<b>1.53±0.38</b>	.443±0.405	1.96
Uranium-238	.389±0.175	0.336±0.175	<b>1.02±0.195</b>	2.61 (N)
Zinc-65	.185±0.22	.0697±0.215	.268±0.20	.68

Table 7. *Concentrations of selected isotopes from analysis by gamma spectrometry, Naval Reactors Facility and vicinity—Continued*

Isotope	Sample identifier and date sampled (m/d/y)			
	NRF-8 3/25/96	NRF-8 6/11/96	NRF-8 9/4/96	NRF-9 1/18/96
Actinium-228	.920±0.41	NR	NR	.518±0.405
Bismuth-214	<b>.763±0.215</b>	.353±0.20	.664±0.235	<b>1.14±0.225</b>
Cesium-134	-.136±0.105	.106±0.095	-.0723±0.11	-.0933±0.10
Cesium-137	.156±0.10	.139±0.105	.0906±0.115	.112±0.105
Chromium-51	.158±1.55	1.88±1.4	.268±1.2	-3.45±1.4
Cobalt-60	<b>.330±0.105</b>	.234±0.10	.138±0.12	.238±0.10
Lead-212	.0245±0.245	<b>.741±0.155</b>	<b>.568±0.15</b>	<b>.672±0.14</b>
Lead-214	.481±0.20	.279±0.185	.370±0.215	<b>.646±0.19</b>
Potassium-40	4.09±3.3	4.87±3.2	<b>57.0±3.75</b>	<b>38.0±2.75</b>
Radium-223	.874±0.46	.230±0.475	.0436±0.55	.815±0.415
Radium-224	.0253±0.255	NR	NR	<b>.691±0.145</b>
Radium-226	<b>.763±0.215</b>	.353±0.20	.664±0.235	<b>1.01±0.22</b>
Radium-228	.929±0.415	<b>1.24±0.395</b>	<b>1.63±0.44</b>	.523±0.41
Ruthenium-106	.817±0.95	-.743±0.85	1.12±1.05	.139±0.9
Thallium-208	.373±0.135	<b>.394±0.105</b>	.352±0.12	.129±0.10
Thorium-228	1.07±0.38	<b>1.13±0.305</b>	.996±0.345	.369±0.29
Thorium-232	<b>2.38±0.65</b>	NR	NR	-.195±0.6
Thorium-234	32.3±17.5	16.5±17	-31.8±21.5	39.2±18
Uranium-234	.466±0.34	-.0119±0.34	.0660±0.38	<b>1.17±0.33</b>
Uranium-235	.689±0.47	.456±0.425	.234±0.495	.944±0.425
Uranium-238	.481±0.20	.279±0.185	.370±0.215	<b>.646±0.19</b>
Zinc-65	-.0838±0.235	.128±0.215	-.385±0.27	.121±0.215

Table 7. *Concentrations of selected isotopes from analysis by gamma spectrometry, Naval Reactors Facility and vicinity—Continued*

Isotope	Sample identifier and date sampled (m/d/y)			
	NRF-9 3/26/96	NRF-9 6/11/96	NRF-9 9/4/96	NRF-10 5/8/96
Actinium-228	<b>1.75±0.38</b>	NR	NR	<b>2.27±0.49</b>
Bismuth-214	<b>.903±0.195</b>	<b>1.57±0.245</b>	<b>1.32±0.23</b>	<b>.906±0.24</b>
Cesium-134	.0872±0.09	-.188±0.105	-.0340±0.10	.103±0.11
Cesium-137	-.135±0.095	-.194±0.11	-.0893±0.11	-.274±0.125
Chromium-51	<b>1.28±0.125</b>	.00828±1.65	3.39±1.15	1.46±1.85
Cobalt-60	.217±0.095	-.0543±0.12	.254±0.11	.111±0.135
Lead-212	.558±0.245	.00403±0.29	<b>1.13±0.175</b>	.00892±0.25
Lead-214	.201±0.17	<b>.833±0.225</b>	<b>.740±0.22</b>	.0911±0.43
Potassium-40	<b>50.2±3.3</b>	5.15±3.75	.439±3.6	<b>60.5±3.9</b>
Radium-223	-.564±0.395	.313±0.55	-.0364±0.495	-.0509±0.5
Radium-224	<b>1.25±0.15</b>	.004±0.3	NR	<b>.727±0.16</b>
Radium-226	<b>.903±0.195</b>	<b>1.57±0.245</b>	<b>1.32±0.23</b>	<b>.906±0.24</b>
Radium-228	<b>1.76±0.38</b>	<b>2.58±0.435</b>	<b>2.16±0.44</b>	<b>2.30±0.495</b>
Ruthenium-106	1.16±0.85	-.537±1.0	-1.35±0.95	1.93±1.1
Thallium-208	.139±0.10	<b>.714±0.12</b>	<b>.737±0.115</b>	<b>.563±0.12</b>
Thorium-228	.399±0.29	<b>2.55±0.55</b>	<b>2.08±0.32</b>	<b>1.62±0.35</b>
Thorium-232	.208±0.55	NR	NR	.399±0.7
Thorium-234	9.27±17.5	<b>81.1±18</b>	-9.49±18.5	5.92±20.5
Uranium-234	.535±0.315	.705±0.385	<b>1.18±0.37</b>	<b>1.63±0.395</b>
Uranium-235	.597±0.40	1.46±0.55	1.41±0.55	.372±0.495
Uranium-238	.201±0.17	<b>.833±0.225</b>	<b>.740±0.22</b>	NR
Zinc-65	.229±0.22	-.00761±0.26	-.620±0.235	.106±0.27



Table 7. *Concentrations of selected isotopes from analysis by gamma spectrometry, Naval Reactors Facility and vicinity—Continued*

Isotope	Sample identifier and date sampled (m/d/y)			
	NRF-10 6/12/96	QAS-50 6/12/96	Z-value 6/12/96	NRF-10 9/4/96
Actinium-228	NR	NR	NC	NR
Bismuth-214	.291±0.20	.540±0.21	.86	<b>.967±0.205</b>
Cesium-134	.0801±0.09	.0602±0.10	.15	.0373±0.085
Cesium-137	-.194±0.105	.0105±0.105	1.38	.153±0.085
Chromium-51	-2.10±1.35	-.0587±1.6	.98	.422±0.9
Cobalt-60	.136±0.115	.0526±0.105	.54	.0589±0.11
Lead-212	.0565±0.245	.0418±0.245	.04	<b>.977±0.14</b>
Lead-214	.242±0.175	.448±0.195	.79	<b>.741±0.185</b>
Potassium-40	<b>27.8±2.25</b>	3.56±2.8	6.75 (N)	<b>45.6±3.2</b>
Radium-223	.0340±0.405	-.523±0.465	.90	.197±0.43
Radium-224	NR	NR	NC	NR
Radium-226	.291±0.20	.540±0.21	.86	<b>.967±0.205</b>
Radium-228	<b>1.64±0.385</b>	<b>1.69±0.36</b>	.09	<b>2.68±0.39</b>
Ruthenium-106	1.42±0.85	.339±1.0	.82	-.628±0.8
Thallium-208	.305±0.105	.288±0.105	.11	<b>.439±0.105</b>
Thorium-228	.873±0.30	.830±0.295	.10	<b>1.24±0.30</b>
Thorium-232	NR	NR	NC	NR
Thorium-234	-5.18±18.5	17.1±18.5	.85	-4.29±18
Uranium-234	-.332±0.325	<b>1.30±0.335</b>	3.50 (N)	-.104±0.325
Uranium-235	<b>1.23±0.39</b>	.560±0.5	1.06	.336±0.425
Uranium-238	.242±0.175	.448±0.195	.79	<b>.741±0.185</b>
Zinc-65	-.825±0.24	.0920±0.235	2.73 (N)	.357±0.22

Table 7. *Concentrations of selected isotopes from analysis by gamma spectrometry, Naval Reactors Facility and vicinity—Continued*

Isotope	Sample identifier and date sampled (m/d/y)			
	NRF-11 1/18/96	NRF-11 3/25/96	QAS-49 3/25/96	Z-value 3/25/96
Actinium-228	<b>1.56±0.42</b>	<b>2.01±0.405</b>	<b>1.56±0.395</b>	.80
Bismuth-214	<b>.710±0.21</b>	.579±0.21	-.189±0.215	2.56 (N)
Cesium-134	-.0104±0.09	.0397±0.10	.0528±0.10	.09
Cesium-137	.0875±0.105	.0875±0.10	-.134±0.105	1.53
Chromium-51	-.646±1.2	1.04±1.4	.212±1.5	.40
Cobalt-60	<b>.770±0.13</b>	.398±0.135	<b>.675±0.18</b>	1.23
Lead-212	.0043±0.255	.140±0.32	<b>.750±0.16</b>	1.71
Lead-214	<b>.647±0.19</b>	.0036±0.195	-.255±0.21	.90
Potassium-40	.885±3.7	8.59±3.2	3.73±3.0	1.11
Radium-223	.0103±0.405	.581±0.44	<b>-.531±0.485</b>	1.70
Radium-224	<b>1.03±0.15</b>	<b>.847±0.155</b>	<b>.773±0.165</b>	.33
Radium-226	<b>.710±0.21</b>	.579±0.21	-.189±0.215	2.56(N)
Radium-228	<b>1.57±0.42</b>	<b>2.03±0.405</b>	<b>1.58±0.40</b>	.79
Ruthenium-106	-.180±0.85	.133±0.95	-1.44±1.0	1.14
Thallium-208	<b>.410±0.11</b>	<b>.399±0.105</b>	<b>.349±0.11</b>	.33
Thorium-228	<b>1.17±0.315</b>	<b>1.14±0.305</b>	<b>1.00±0.32</b>	.32
Thorium-232	<b>2.14±0.6</b>	1.15±0.6	.177±0.65	1.10
Thorium-234	55.2±19.0	<b>66.9±18.0</b>	<b>57.5±19.0</b>	.36
Uranium-234	.0824 ±0.31	.330±0.33	.305±0.35	.05
Uranium-235	.770±0.41	.602±0.415	1.34±0.47	1.18
Uranium-238	<b>.647±0.19</b>	.0036±0.195	-.255±0.21	.90
Zinc-65	-.0849±0.21	-.508±0.235	-.403±0.265	.30

Table 7. *Concentrations of selected isotopes from analysis by gamma spectrometry, Naval Reactors Facility and vicinity—Continued*

Isotope	Sample identifier and date sampled (m/d/y)			
	NRF-11 6/12/96	NRF-11 9/5/96	NRF-12 1/22/96	NRF-12 3/20/96
Actinium-228	NR	NR	<b>2.17±0.40</b>	.369±0.375
Bismuth-214	.567±0.21	<b>1.22±0.22</b>	<b>.637±0.21</b>	.357±0.205
Cesium-134	-.057±0.105	-.0452±0.095	-.208±0.105	-.0256±0.10
Cesium-137	.0683±0.10	.0573±0.11	0±0.095	.0473±0.105
Chromium-51	-.558±1.45	.335±1.15	-.531±1.3	.987±1.45
Cobalt-60	<b>.769±0.195</b>	<b>.478±0.13</b>	-.00367±0.105	-.0638±0.11
Lead-212	<b>.643±0.145</b>	<b>1.26±0.18</b>	<b>.714±0.135</b>	.127±0.26
Lead-214	.158±0.19	<b>.708±0.22</b>	<b>.594±0.19</b>	.362±0.195
Potassium-40	.239±3.3	3.87±3.5	<b>37.0±2.75</b>	<b>14.2±1.7</b>
Radium-223	-.364±0.465	.655±0.48	.410±0.435	-.737±0.47
Radium-224	NR	NR	<b>.735±0.14</b>	<b>.550±0.16</b>
Radium-226	.567±0.21	<b>1.22±0.22</b>	<b>.637±0.21</b>	.357±0.205
Radium-228	<b>1.20±0.39</b>	<b>2.54±0.44</b>	<b>2.19±0.405</b>	.373±0.38
Ruthenium-106	1.46±0.9	-.546±0.95	.119±0.85	.727±1.0
Thallium-208	.0764±0.105	<b>.651±0.12</b>	<b>.460±0.11</b>	<b>.319±0.105</b>
Thorium-228	.219±0.30	<b>1.85±0.335</b>	<b>1.32±0.31</b>	<b>.914±0.30</b>
Thorium-232	NR	NR	.653±0.6	-.690±0.65
Thorium-234	48.4±18.0	<b>56.6±17.5</b>	15.1±18.0	45.0±18.0
Uranium-234	.388±0.335	.128±0.405	.109±0.365	.292±0.345
Uranium-235	.380±0.435	1.13±0.5	<b>1.55±0.43</b>	.259±1.1
Uranium-238	.158±0.19	<b>.708±0.22</b>	<b>.594±0.19</b>	.362±0.195
Zinc-65	-.164±0.21	.433±0.21	.141±0.25	-.200±0.23

Table 7. *Concentrations of selected isotopes from analysis by gamma spectrometry, Naval Reactors Facility and vicinity—Continued*

Isotope	Sample identifier and date sampled (m/d/y)			
	NRF-12 6/12/96	NRF-12 9/15/96	NRF-13 1/22/96	NRF-13 3/20/96
Actinium-228	NR	NR	<b>1.63±0.46</b>	<b>1.76±0.48</b>
Bismuth-214	<b>1.57±0.25</b>	<b>.787±0.22</b>	<b>.895±0.24</b>	<b>1.54±0.255</b>
Cesium-134	-.00984±0.10	-.0304±0.095	.0772±0.11	-.0677±0.115
Cesium-137	.115±0.11	.130±0.10	-.241±0.12	-.0253±0.115
Chromium-51	1.52±1.65	-2.32±1.05	-1.93±1.6	-3.11±1.6
Cobalt-60	.201±0.11	<b>.386±0.10</b>	.202±0.125	.250±0.135
Lead-212	<b>1.15±0.18</b>	.0391±0.265	.0874±0.26	.390±0.265
Lead-214	.638±0.225	.480±0.19	.546±0.21	.570±0.215
Potassium-40	4.41±3.7	.181±2.7	.189±3.65	<b>56.9±3.7</b>
Radium-223	.299±0.55	.372±0.455	.116±0.5	.473±0.55
Radium-224	NR	NR	.090±0.265	<b>.727±0.16</b>
Radium-226	<b>1.57±0.25</b>	<b>.787±0.22</b>	<b>.895±0.24</b>	<b>1.54±0.255</b>
Radium-228	<b>2.48±0.44</b>	.487±0.38	<b>1.64±0.465</b>	<b>1.78±0.485</b>
Ruthenium-106	-.411±1.0	0±0.9	1.82±1.05	-.743±1.1
Thallium-208	<b>.668±0.125</b>	.252±0.10	<b>.378±0.125</b>	.264±0.125
Thorium-228	<b>1.91±0.35</b>	<b>1.36±0.365</b>	1.11±0.40	.758±0.355
Thorium-232	NR	NR	NR	1.20±0.7
Thorium-234	29.6±20.5	<b>62.8±18.5</b>	-13.4±21.0	28.7±20.5
Uranium-234	.328±0.41	.806±0.355	.308±0.37	.682±0.39
Uranium-235	1.47±0.55	.627±0.435	.175±0.495	1.33±0.495
Uranium-238	.638±0.225	.480±0.19	.546±0.21	.570±0.215
Zinc-65	-.266±0.26	-.00752±0.21	-.387±0.285	-.257±0.28

Table 7. *Concentrations of selected isotopes from analysis by gamma spectrometry, Naval Reactors Facility and vicinity—Continued*

Isotope	Sample identifier and date sampled (m/d/y)			
	NRF-13 6/13/96	QAS-51 6/13/96	Z-value 6/13/96	NRF-13 9/5/96
Actinium-228	NR	NR	NC	NR
Bismuth-214	<b>.945±0.21</b>	.519±0.215	1.42	.640±0.215
Cesium-134	.0614±0.085	.0792±0.095	.14	-.0664±0.10
Cesium-137	.0443±0.095	.0604±0.10	.12	-.0767±0.095
Chromium-51	.841±1.3	0±1.5	.42	-.303±0.9
Cobalt-60	-.0276±0.10	-.00852±0.115	.13	.101±0.10
Lead-212	.0730±0.265	<b>.453±0.145</b>	1.26	<b>.775±0.15</b>
Lead-214	.380±0.18	.523±0.195	.54	.184±0.18
Potassium-40	<b>58.2±3.75</b>	<b>11.0±2.7</b>	10.21 (N)	<b>23.1±2.15</b>
Radium-223	-.740±0.445	-.0951±0.45	1.02	.124±0.435
Radium-224	NR	NR	NC	NR
Radium-226	<b>.945±0.21</b>	.519±0.215	1.42	.640±0.215
Radium-228	<b>1.59±0.41</b>	.612±0.375	1.76	.136±0.42
Ruthenium-106	.539±0.95	1.67±0.95	.84	.425±0.9
Thallium-208	<b>.540±0.105</b>	.138±0.105	2.71 (N)	.295±0.105
Thorium-228	.0684±0.6	.398±0.30	.49	.833±0.305
Thorium-232	NR	NR	NC	NR
Thorium-234	-16.5±18.5	<b>54.9±17.5</b>	2.80 (N)	18.3±16.5
Uranium-234	.686±0.325	.621±0.34	.14	.430±0.32
Uranium-235	1.27±0.425	.855±0.43	.69	1.02±0.41
Uranium-238	.380±0.18	.523±0.195	.54	.184±0.18
Zinc-65	<b>.664±0.195</b>	-.645±0.235	4.29 (N)	.121±0.21

Table 7. *Concentrations of selected isotopes from analysis by gamma spectrometry, Naval Reactors Facility and vicinity—Continued*

Isotope	Sample identifier and date sampled (m/d/y)			
	USGS-12 1/16/96	USGS-12 3/21/96	USGS-12 6/10/96	USGS-12 9/3/96
Actinium-228	<b>1.19±0.325</b>	<b>1.30±0.395</b>	NR	NR
Bismuth-214	.440±0.19	.527±0.215	.566±0.22	<b>.816±0.21</b>
Cesium-134	.0385±0.085	-.00299±0.10	.0277±0.095	.0210±0.095
Cesium-137	-.0435±0.095	.0803±0.10	.0839±0.085	-.0857±0.095
Chromium-51	.364±1.25	-2.10±1.4	-.594±1.4	.941±1.0
Cobalt-60	.0329±0.095	.108±0.10	.0287±0.09	-.00423±0.11
Lead-212	<b>.645±0.135</b>	<b>1.09±0.145</b>	.597±0.325	.420±0.15
Lead-214	.446±0.16	.396±0.175	.306±0.185	<b>.999±0.19</b>
Potassium-40	<b>37.5±2.8</b>	<b>35.4±2.8</b>	<b>11.8±3.3</b>	1.09±2.75
Radium-223	.0679±0.39	-.394±0.435	.651±0.435	.245±0.465
Radium-224	<b>.664±0.14</b>	<b>1.12±0.145</b>	NR	NR
Radium-226	.440±0.19	.527±0.215	.566±0.22	<b>.816±0.21</b>
Radium-228	<b>1.20±0.325</b>	<b>1.32±0.40</b>	<b>1.98±0.39</b>	1.02±0.40
Ruthenium-106	.433±0.8	-.831±0.95	.226±0.9	.514±0.9
Thallium-208	<b>.377±0.095</b>	<b>.435±0.105</b>	<b>.414±0.105</b>	.0169±0.105
Thorium-228	<b>1.08±0.27</b>	<b>1.25±0.31</b>	<b>1.19±0.305</b>	.0478±0.29
Thorium-232	.208±0.5	.803±0.55	NR	NR
Thorium-234	37.1±15.5	36.3±17.5	29.7±17.5	46.9±18.0
Uranium-234	.218±0.305	.100±0.325	.0825±0.335	.955±0.34
Uranium-235	.583±0.375	1.02±0.42	.206±0.445	.615±0.435
Uranium-238	.446±0.16	.396±0.175	.306±0.185	<b>.999±0.19</b>
Zinc-65	.179±0.195	-.0155±0.21	-.134±0.235	.320±0.195

Table 7. *Concentrations of selected isotopes from analysis by gamma spectrometry, Naval Reactors Facility and vicinity—Continued*

Isotope	USGS-97 1/17/96	USGS-97 3/25/96	USGS-97 6/11/96	USGS-97 9/4/96
Actinium-228	.318±0.36	.879±0.395	NR	NR
Bismuth-214	<b>.774±0.210</b>	.542±0.215	<b>1.09±0.21</b>	<b>.873±0.245</b>
Cesium-134	.0512±0.095	.0883±0.105	.0115±0.095	-.0792±0.10
Cesium-137	.234±0.10	-.00179±0.10	<b>.331±0.095</b>	.116±0.105
Chromium-51	2.84±1.35	-.234±1.35	2.54±1.35	2.25±1.1
Cobalt-60	.0993±0.105	-.0258±0.10	.0808±0.11	-.0249±0.11
Lead-212	.254±0.145	.290±0.27	<b>.494±0.125</b>	<b>1.21±0.18</b>
Lead-214	.376±0.185	<b>.616±0.185</b>	.488±0.18	<b>.728±0.215</b>
Potassium-40	1.72±2.6	6.17±2.95	<b>28.8±2.35</b>	<b>46.6±3.15</b>
Radium-223	-.261±0.47	.860±0.445	.656±0.41	-.436±0.5
Radium-224	.262±0.15	<b>1.04±0.15</b>	NR	NR
Radium-226	<b>.774±0.21</b>	.542±0.215	<b>1.09±0.21</b>	<b>.873±0.245</b>
Radium-228	.321±0.365	.888±0.40	<b>1.19±0.395</b>	1.27±0.43
Ruthenium-106	-.596±0.95	-1.50±1.0	-2.76±0.9	-.229±0.9
Thallium-208	<b>.369±0.105</b>	<b>.462±0.115</b>	.237±0.10	<b>.662±0.115</b>
Thorium-228	<b>1.06±0.295</b>	<b>1.32±0.325</b>	.681±0.29	<b>1.87±0.33</b>
Thorium-232	.260±0.6	.532±0.55	NR	NR
Thorium-234	33.7±16.5	<b>69.8±16.0</b>	<b>54.6±17.0</b>	38.9±18.0
Uranium-234	.501±0.34	.813±0.32	.504±0.315	.942±0.375
Uranium-235	.737±0.435	.613±0.40	<b>1.39±0.395</b>	.736±0.5
Uranium-238	.376±0.185	<b>.616±0.185</b>	.488±0.18	<b>.728±0.215</b>
Zinc-65	-.646±0.24	-.380±0.23	-.366±0.225	-.190±0.24

Table 7. *Concentrations of selected isotopes from analysis by gamma spectrometry, Naval Reactors Facility and vicinity—Continued*

Isotope	Sample identifier and date sampled (m/d/y)			
	USGS-98 1/17/96	USGS-98 3/21/96	USGS-98 6/11/96	USGS-98 9/4/96
Actinium-228	.222±0.36	<b>2.34±0.55</b>	NR	NR
Bismuth-214	.343±0.19	<b>1.08±0.29</b>	<b>.978±0.205</b>	<b>1.04±0.21</b>
Cesium-134	.0176±0.085	-.00319±0.135	.0615±0.85	-.0923±0.095
Cesium-137	.0369±0.09	-.154±0.13	-.0107±0.095	.196±0.9
Chromium-51	-.489±1.2	.791±1.95	-2.38±1.3	.119±0.95
Cobalt-60	<b>.300±0.085</b>	.102±0.155	.0474±0.095	.0146±0.11
Lead-212	.150±0.23	.500±0.285	<b>.788±0.145</b>	.360±0.135
Lead-214	.0816±0.165	.641±0.26	.207±0.18	.349±0.18
Potassium-40	<b>35.5±2.65</b>	<b>60.6±4.1</b>	<b>55.5±3.6</b>	<b>27.4±2.25</b>
Radium-223	.489±0.38	.178±0.6	.510±0.41	.448±0.42
Radium-224	<b>1.23±0.14</b>	<b>.788±0.185</b>	NR	NR
Radium-226	.343±0.19	<b>1.08±0.29</b>	<b>.979±0.205</b>	<b>1.04±0.21</b>
Radium-228	.112±0.36	<b>2.36±0.6</b>	<b>1.87±0.40</b>	<b>1.30±0.395</b>
Ruthenium-106	-.262±0.85	.0999±1.3	-1.61±0.85	-1.26±0.9
Thallium-208	<b>.309±0.095</b>	<b>.565±0.145</b>	<b>.531±0.105</b>	<b>.485±0.105</b>
Thorium-228	<b>.884±0.28</b>	<b>1.62±0.41</b>	<b>1.52±0.30</b>	<b>1.37±0.295</b>
Thorium-232	.573±0.5	.612±0.8	NR	NR
Thorium-234	26.3±15.0	39.6±23.0	<b>67.0±16.5</b>	<b>50.9±16.5</b>
Uranium-234	-.597±0.30	.173±0.465	.509±0.315	.771±0.325
Uranium-235	.0444±0.375	.370±0.6	.288±0.405	.912±0.405
Uranium-238	.0816±0.165	.641±0.26	.207±0.18	.349±0.18
Zinc-65	-.0214±0.225	-.398±0.34	-.229±0.22	-.407±0.225



**Table 7. Concentrations of selected isotopes from analysis by gamma spectrometry, Naval Reactors Facility and vicinity—Continued**

Isotope	Sample identifier and date sampled (m/d/y)			
	USGS-99 1/17/96	USGS-99 3/25/96	USGS-99 6/11/96	USGS-99 9/4/96
Actinium-228	1.02±0.405	<b>1.55±0.37</b>	NR	NR
Bismuth-214	.418±0.20	.518±0.195	<b>1.20±0.21</b>	.236±0.21
Cesium-134	.0915±0.10	-.0994±0.09	-.0829±0.095	.0189±0.095
Cesium-137	-.0394±0.10	-.226±0.10	.108±0.11	.119±0.095
Chromium-51	-.961±1.45	-.419±1.35	-.538±1.4	-.443±1.0
Cobalt-60	.143±0.105	-.0751±0.10	-.0397±0.115	.230±0.095
Lead-212	<b>.696±0.15</b>	.0695±0.23	<b>.666±0.135</b>	.0803±0.245
Lead-214	.229±0.18	.349±0.175	.378±0.185	.147±0.185
Potassium-40	1.08±2.75	<b>43.7±3.1</b>	2.14±3.65	4.62±2.95
Radium-223	-.0951±0.46	.143±0.405	.371±0.40	-.332±0.415
Radium-224	<b>.718±0.155</b>	<b>.768±0.145</b>	NR	NR
Radium-226	.418±0.20	.518±0.195	<b>1.20±0.21</b>	.236±0.21
Radium-228	1.03±0.41	<b>1.56±0.37</b>	<b>1.56±0.42</b>	<b>1.16±0.385</b>
Ruthenium-106	-1.04±0.9	-.327±0.85	.739±1.0	2.36±0.85
Thallium-208	.310±0.11	<b>.381±0.10</b>	<b>.595±0.11</b>	<b>.489±0.105</b>
Thorium-228	-.889±0.31	<b>1.09±0.29</b>	1.71±0.31	1.39±0.305
Thorium-232	1.23±0.6	1.41±0.55	NR	NR
Thorium-234	31.9±18.0	9.79±17.0	16.7±18.5	32.9±17.0
Uranium-234	.436±0.34	.436±0.30	.100±0.31	.788±0.31
Uranium-235	1.26±0.445	.311±0.39	1.05±0.375	.781±0.43
Uranium-238	.229±0.18	.349±0.175	.378±0.185	.147±0.185
Zinc-65	-.117±0.23	.0431±0.21	-.428±0.235	-.834±0.23

**Table 7. Concentrations of selected isotopes from analysis by gamma spectrometry, Naval Reactors Facility and vicinity—Continued**

Isotope	Sample identifier and date sampled (m/d/y)			
	USGS-102 1/18/96	USGS-102 3/19/96	USGS-102 6/11/96	USGS-102 9/14/96
Actinium-228	1.73±0.44	1.09±0.365	NR	NR
Bismuth-214	.762±0.24	1.29±0.21	1.58±0.235	.884±0.21
Cesium-134	-.0458±0.11	-.0439±0.09	-.106±0.095	-.136±0.095
Cesium-137	-.00327±0.115	-.0205±0.10	-.0329±0.105	.182±0.10
Chromium-51	.378±1.55	-3.81±1.4	1.71±1.7	-1.45±1.0
Cobalt-60	.119±0.11	.0697±0.105	.00836±0.115	-.0254±0.12
Lead-212	.238±0.28	.727±0.135	.389±0.36	.0347±0.295
Lead-214	.800±0.205	.526±0.185	.706±0.23	.480±0.195
Potassium-40	52.4±3.5	.102±3.15	8.12±3.65	1.14±2.5
Radium-223	-.0946±0.5	.138±0.435	.750±0.50	.404±0.475
Radium-224	.245±0.29	.749±0.14	.401±0.375	NR
Radium-226	.762±0.24	1.29±0.21	1.58±0.235	.884±0.21
Radium-228	1.75±0.445	1.10±0.37	3.16±0.43	1.00±0.375
Ruthenium-106	-.677±1.05	-.658±0.95	-2.47±1.00	1.07±0.85
Thallium-208	.319±0.115	.248±0.105	.839±0.155	.189±0.105
Thorium-228	1.56±0.5	.711±0.30	2.41±0.44	.534±0.30
Thorium-232	.818±0.65	.689±0.55	NR	NR
Thorium-234	23.7±21.0	-1.72±17.5	54.4±19.0	62.0±18.5
Uranium-234	.643±0.36	.689±0.32	1.14±0.395	-.203±0.34
Uranium-235	-.217±0.47	.746±0.40	1.33±0.55	.366±0.425
Uranium-238	.800±0.205	.526±0.185	.706±0.23	.480±0.195
Zinc-65	-.538±0.295	-.287±0.23	-.0153±0.23	.163±0.125

**Table 8. *Regulatory volatile organic compounds for which round-four water samples were analyzed, and measured concentrations, expected concentrations, and percent recoveries for QAS-47***

[Analyses were performed by the U.S. Geological Survey National Water Quality Laboratory using U.S. Environmental Protection Agency method 524.2. Analytical results and expected concentrations are in micrograms per liter (µg/L). The laboratory reporting levels in µg/L are from Timme (1995, p. 49). Concentrations of all listed compounds were less than the laboratory reporting levels, except for those listed in table 10 and those listed for QAS-47. The quality-assurance spiked organic sample (QAS-47) was prepared on January 23, 1996. Symbols: <, less than; NIS, compound was not contained in the spiking solution; NA, calculating a percent recovery value was not appropriate]

Compound	Reporting level	Measured concentration, QAS-47	Expected concentration, QAS-47	Percent recovery, QAS-47
Dichlorodifluoromethane	0.2	<0.2	NIS	NA
Vinyl chloride	.2	.3	1.75	20
Trichlorofluoromethane	.2	<.2	NIS	NA
1,1-Dichloroethene	.2	.5	1.25	41
Methylene chloride	.2	1.3	NIS	NA
Trans-1,2-dichloroethene	.2	<.2	NIS	NA
1,1-Dichloroethane	.2	<.2	NIS	NA
Cis-1,2-dichloroethene	.2	<.2	NIS	NA
Chloroform	.2	<.2	NIS	NA
1,1,1-Trichloroethane	.2	.8	1.25	65
Carbon tetrachloride	.2	.8	1.25	62
Benzene	.2	<.2	NIS	NA
1,2-Dichloroethane	.2	1.2	1.50	79
Trichloroethene	.2	1.0	1.25	76
1,2-Dichloropropane	.2	<.2	NIS	NA
Bromodichloromethane	.2	1.2	1.50	80
Toluene	.2	<.2	NIS	NA
Tetrachloroethene	.2	.9	1.25	68
Dibromochloromethane	.2	1.3	1.75	75
Chlorobenzene	.2	<.2	NIS	NA
Ethylbenzene	.2	1.3	1.50	84
Xylenes (total)	.2	<.2	NIS	NA
Styrene	.2	<.2	NIS	NA
Bromoform	.2	1.3	1.75	74
1,3-Dichlorobenzene (meta)	.2	<.2	NIS	NA
1,4-Dichlorobenzene (para)	.2	1.5	1.50	97
1,2-Dichlorobenzene (ortho)	.2	<.2	NIS	NA
Trichlorotrifluoroethane	.2	<.2	NIS	NA
MTBE	.2	1.3	1.75	75
1,1,2,2-Tetrachloroethane	.2	<.2	NIS	NA

**Table 9. *Base/neutral organic compounds for which round-four water samples were analyzed, and measured concentrations, expected concentrations, and percent recoveries for QAS-47***

[Analyses were performed by the U.S. Geological Survey National Water Quality Laboratory using gas chromatography to separate the compounds and mass spectrometry for identification and quantification. Initial extraction was with methylene chloride. Analytical results and expected concentrations are in micrograms per liter (µg/L). Laboratory reporting levels are in µg/L (Timme, 1995, p. 58). Concentrations of all listed compounds were less than the laboratory reporting levels, except those listed in table 10 and those listed for QAS-47. The quality-assurance spiked organic sample (QAS-47) was prepared on January 23, 1996. Symbols: <, less than; NIS, compound was not contained in the spiking solution; NA, calculating a percent recovery was not appropriate]

Compound	Reporting level	Measured concentration, QAS-47	Expected concentration, QAS-47	Percent recovery, QAS-47
Acenaphthylene	5	16	20	79
Acenaphthene	5	14	20	71
Anthracene	5	20	20	101
Benzo (b) fluoranthene	10	17	20	84
Benzo (k) fluoranthene	10	20	20	100
Benzo (a) pyrene	0.5	20	NIS	NA
Bis (2-chloroethyl) ether	5	14	20	71
Bis (2-chloroethoxy) methane	5	15	20	73
Bis (2-chloroisopropyl) ether	5	12	20	62
Butylbenzylphthalate	5	12	20	58
Chrysene	0.5	21	20	104
Diethyl phthalate	5	<5	20	25
Dimethyl phthalate	5	<5	20	9
Fluoranthene	5	22	20	109
Fluorene	5	18	20	91
Hexachlorocyclopentadiene	5	9	20	46
Hexachloroethane	5	13	20	67
Indeno (1,2,3-c,d) pyrene	10	20	20	98
Isophorone	5	<5	20	17
N-Nitrosodi-n-propylamine	5	9	20	47
N-Nitrosodiphenylamine	5	41	20	203
N-Nitrosodimethylamine	5	6	20	29
Nitrobenzene	5	15	20	77
Phenanthrene	5	17	20	85
Pyrene	5	23	20	114
Benzo (g, h, i) perylene	10	19	20	97
Benz (a) anthracene	0.5	20	20	98
Benzene, 1,2,-dichloro-	5	13	20	65
Benzene, 1,2,4-trichloro-	5	14	20	72
1,2,5,6-Dibenz (a,h) anthracene	10	20	20	100
Benzene, 1,3-dichloro-	5	13	20	65
Benzene, 1,4-dichloro-	5	13	20	65
Naphthalene, 2-chloro-	5	16	20	78
Di-n-octylphthalate	10	18	20	91
Toluene, 2,4-dinitro-	5	14	20	72
Toluene, 2,6-dinitro-	5	15	20	77

Table 9—*Base/neutral organic compounds for which round-four water samples were analyzed and measured concentrations, expected concentrations, and percent recoveries for QAS-47—Continued*

Compound	Reporting level	Measured concentration, QAS-47	Expected concentration, QAS-47	Percent recovery, QAS-47
Phenylphenylether, 4-bromo-	5	16	NIS	NA
Phenylphenylether, 4-chloro	5	19	20	94
Naphthalene	5	16	20	78
Bis (2-ethylhexyl) phthalate	5	19	20	93
Di-n-butylphthalate	5	12	20	59
Hexachlorobenzene	5	21	20	106
Hexachlorobutadiene	5	15	20	77

**Table 10. Concentrations of regulatory volatile organic compounds and base/neutral organic compounds in water from round-four samples**

[Analyses were performed by the U.S. Geological Survey National Water Quality Laboratory. Analytical results are in micrograms per liter. No entry for a sample listed in table 2 indicates that concentrations of compounds listed in tables 8 and 9 were less than their respective reporting levels. Sample identifier: see figure 2 for location of wells. Date sampled: m/d/y, month/day/year. QAS indicates quality-assurance sample; the Z-value associated with the replicate sample (QAS-51) was calculated using equation 1. Remarks: E, indicates concentration was estimated by laboratory analyst]

Sample identifier	Date sampled (m/d/y)	Compound	Concentration	Remarks
[Regulatory volatile organic compounds]				
NRF-6	1/16/96	Chloroform	0.4	E
		Tetrachloroethene	.5	
	3/19/96	Chloroform	.4	
		Tetrachloroethene	.6	
	6/10/96	Chloroform	.4	
		Tetrachloroethene	.5	
	6/10/96	Chloroform	.4	
		Tetrachloroethene	.5	
NRF-13	1/22/96	Methylene chloride	.7	Replicate, Z-value = 0.00
	3/20/96	Methylene chloride	.8	
	6/13/96	Methylene chloride	.5	
QAS-51	6/13/96	Methylene chloride	.5	
NRF-13	9/11/96	Methylene chloride	.3	
[Base/neutral organic compounds]				
QAS-52	9/3/96	Bis (2-ethylhexyl) phthalate	6	Field blank
USGS 99	6/11/96	Diethyl phthalate	6	
USGS 102	6/11/96	Di-n-butylphthalate	57	