Questa Baseline and Pre-Mining Ground-Water-Quality Investigation. 16. Quality Assurance and Quality Control for Water Analyses

By R. Blaine McCleskey, D. Kirk Nordstrom, and Cheryl A. Naus

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Contents

Contents iii
Figures iv
Tables vi
Explanation of Abbreviations and Symbols vii
Conversion Factors viii
  SI to Inch/Pound viii
Abstract 1
Introduction 2
Methods 4
  Sample Collection 4
    Blanks 6
    Sequential Duplicates 6
    Filtration Studies 6
  Analytical 7
Quality Assurance and Quality Control Results for Water Analyses 14
  Standard Reference Water Samples 14
  Charge Balance Calculations 23
  Analyses of Blanks 24
  Spike Recoveries 43
  Dissolved Organic Carbon Analyses 44
  Analyses by Different Methods 44
  Analyses by Different Laboratories 49
  Duplicate Sampling 55
  Filtration Studies 61
    Filtration Pore Size and Apparatus 61
  Filtration Timing 68
  Sequential Filtration 72
Summary 74
References Cited 74
Appendix 76

Figures

Figure 1. Location of Red River, New Mexico..3
Figure 2. (**A**) The percent difference between the measured mean concentration and the MPV for SRWSs using equation 1 plotted in relation to the measured concentration divided by the method detection limit. (**B**) The measured relative standard deviation for determinations of SRWSs plotted in relation to the measured mean concentration divided by the method detection limit..15
Figure 3. Frequency distribution of charge imbalance in percent using equation 2...23
Figure 4. (**A**) Iron concentration determined by ICP-OES and by the FerroZine colorimetric method. (**B**) Aluminum concentration determined by ICP-OES or GFAAS and ICP-MS. (**C**) Manganese concentration determined by ICP-OES and ICP-MS. (**D**) Beryllium concentration determined by ICP-OES and ICP-MS. The solid line is an equal concentration line and the dotted line is ±10 percent from the equal concentration line..45
Figure 5. (**A**) Lithium concentration determined by ICP-OES and ICP-MS. (**B**) Strontium concentration determined by ICP-OES and ICP-MS. (**C**) Barium concentration determined by ICP-OES and ICP-MS. (**D**) Zinc concentration determined by ICP-OES and ICP-MS. The solid line is an equal concentration line and the dotted line is ±10 percent from the equal concentration line..46
Figure 6. (**A**) Nickel concentration determined by ICP-OES or GFAAS and ICP-MS. (**B**) Copper concentration determined by ICP-OES or GFAAS and ICP-MS. **(C)** Cadmium concentration determined by ICP-OES or GFAAS and ICP-MS. **(D)** Cobalt concentration determined by ICP-OES or GFAAS and ICP-MS. The solid line is an equal concentration line and the dotted line is ±10 percent from the equal concentration line..47
Figure 7. (**A**) Chromium concentration determined by ICP-OES or GFAAS and ICP-MS. (**B**) Chromium concentration determined by GFAAS and ICP-OES. The solid line is an equal concentration line and the dotted line is ±10 percent from the equal concentration line..48
Figure 8. (**A**) Calcium concentration determined by a contract laboratory and the U.S. Geological Survey. (**B**) Magnesium concentration determined by a contract laboratory and the U.S. Geological Survey. (**C**) Sodium concentration determined by a contract laboratory and the U.S. Geological Survey. (**D**) Potassium concentration determined by a contract laboratory and the U.S. Geological Survey. The solid line is an equal concentration line. 50
Figure 9. (**A**) Sulfate concentration determined by a contract laboratory and the U.S. Geological Survey. (**B**) Alkalinity determined by a contract laboratory and the U.S. Geological Survey. (**C**) Fluoride concentration determined by two contract laboratories and the U.S. Geological Survey. (**D**) Chloride concentration determined by a contract laboratory and the U.S. Geological Survey. The solid line is an equal concentration line. 51
Figure 10. (**A**) Aluminum concentration determined by a contract laboratory and the U.S. Geological Survey. (**B**) Iron concentration determined by a contract laboratory and the U.S. Geological Survey. (**C**) Manganese concentration determined by a contract laboratory and the U.S. Geological Survey. (**D**) Beryllium concentration determined by a contract laboratory and the U.S. Geological Survey. The solid line is an equal concentration line and the dotted line is ±10 percent from the equal concentration line...52
Figure 11. (**A**) Barium concentration determined by a contract laboratory and the U.S. Geological Survey. (**B**) Zinc concentration determined by a contract laboratory and the U.S. Geological Survey. (**C**) Lead concentration determined by a contract laboratory and the U.S. Geological Survey. (**D**) Nickel concentration determined by a contract laboratory and the U.S. Geological Survey. The solid line is an equal concentration line and the dotted line is ±10 percent from the equal concentration line...53
Figure 12. (**A**) Copper concentration determined by a contract laboratory and the U.S. Geological Survey. (**B**) Cadmium concentration determined by a contract laboratory and the U.S. Geological Survey. (**C**) Chromium concentration determined by a contract laboratory and the U.S. Geological Survey. (**D**) Cobalt concentration determined by a contract laboratory and the U.S. Geological Survey. The solid line is an equal concentration line and the dotted line is ±10 percent from the equal concentration line...54
Figure 13. Comparison of sequential duplicates for surface- and ground-water samples collected from Straight Creek, Hottentot, and the Red River, 2002-2003, for: (**A**) calcium; (**B**) magnesium; (**C**) sodium; (**D**) potassium; (**E**) sulfate; and (**F**) alkalinity. The solid line is an equal concentration line. 56

Figure 14. Comparison of sequential duplicates for surface- and ground-water samples collected from Straight Creek, Hottentot, and the Red River, 2002-2003, for: (**A**) fluoride; (**B**) chloride; (**C**) silica; (**D**) aluminum; (**E**) aluminum less than 1 mg/L; and (F) boron. The solid line is an equal concentration line. 57

Figure 15. Comparison of sequential duplicates for surface- and ground-water samples collected from Straight Creek, Hottentot, and the Red River, 2002-2003, for: (**A**) total dissolved iron; (**B**) total dissolved iron less than 1 mg/L; (**C**) ferrous iron; (**D**) ferrous iron less than 0.1 mg/L; (**E**) lithium; and (**F**) strontium. The solid line is an equal concentration line. 58

Figure 16. Comparison of sequential duplicates for surface- and ground-water samples collected from Straight Creek, Hottentot, and the Red River, 2002-2003, for: (**A**) barium; (**B**) manganese; (**C**) zinc; (**D**) nickel; (**E**) copper; and (**F**) cadmium. The solid line is an equal concentration line. 59

Figure 17. Comparison of sequential duplicates for surface- and ground-water samples collected from Straight Creek, Hottentot, and the Red River, 2002-2003, for: (**A**) chromium; (**B**) cobalt; and (**C**) beryllium. The solid line is an equal concentration line. 60

Figure 18. Filtration apparatus and pore size comparison for Straight Creek surface water collected on April 16, 2003. (**A**) Comparison of calcium, total dissolved iron, aluminum, magnesium, and silica. (**B**) Comparison of manganese, zinc, sodium, and copper. (**C**) Comparison of nickel, ferrous iron, strontium, cobalt, and lithium. (**D**) Comparison of chromium, cadmium, beryllium, and lead. Solid line is the mean concentration and the dotted line is ± the first standard deviation. 62

Figure 19. Filtration apparatus and pore size comparison for water from the Red River below Fawn Lake collected on April 15, 2003. (**A**) Comparison of calcium, silica, magnesium, and potassium. (**B**) Comparison of strontium, aluminum, barium, and total dissolved iron. (**C**) Comparison of manganese, zinc, copper, and ferrous iron. (**D**) Comparison of nickel. Solid line is the mean concentration and the dotted line is ± the first standard deviation. 63

Figure 20. Filtration apparatus and pore size comparison for water from SC2B collected on March 25, 2002. (**A**) Comparison of total dissolved iron, ferrous iron, alkalinity, magnesium, calcium, and sulfate. (**B**) Comparison of strontium, chloride, potassium, fluoride, silica, manganese, and sodium. (**C**) Comparison of cobalt, lithium, nickel, zinc, and aluminum. (**D**) Comparison of barium, boron, and beryllium. Dashed line is the equal concentration line. 64

Figure 21. Filtration apparatus and pore size comparison for water from SC3A collected on March 27, 2002. (**A**) Comparison of magnesium, calcium, sulfate, aluminum, and silica. (**B**) Comparison of chloride, potassium, fluoride, manganese, and zinc. (**C**) Comparison of lithium, cobalt, nickel, total dissolved iron, and strontium, (**D**) Comparison of barium, boron, chromium, beryllium, ferrous iron, and cadmium. Dashed line is the equal concentration line. 65

Figure 22. Filtration apparatus and pore size comparison for water from SC3B collected on March 25, 2002. (**A**) Comparison of total dissolved iron, ferrous iron, alkalinity, magnesium, calcium, and sulfate. (**B**) Comparison of strontium, chloride, potassium, fluoride, silica, manganese, sodium, zinc, and aluminum. (**C**) Comparison of cobalt, lithium, and nickel. (**D**) Comparison of cadmium, chromium, lead, barium, molybdenum, boron, and beryllium. Solid line is the equal concentration line. 66

Figure 23. Filtration apparatus and pore size comparison for water from SC5A collected on March 27, 2002. (**A**) Comparison of magnesium, calcium, sulfate, aluminum, and silica. (**B**) Comparison of chloride, potassium, fluoride, manganese, and zinc. (**C**) Comparison of lithium, cobalt, nickel, total dissolved iron, and strontium. (**D**) Comparison of barium, boron, chromium, beryllium, ferrous iron, and cadmium. Solid line is the equal concentration line. 67

Figure 24. The effects of time on filtrate concentration for water samples collected from two sites along the Red River on April 15, 2003 for: (**A**) calcium; (**B**) magnesium; (**C**) sodium; (**D**) potassium; (**E**) strontium; and (**F**) barium...69

Figure 25. The effects of time on filtrate concentration for water samples collected from two sites along the Red River on April 15, 2003 for: (**A**) aluminum; (**B**) silica; (**C**) total dissolved iron; (**D**) ferrous iron; (**E**) copper; and (**F**) zinc. 70

Figure 26. The effects of time on filtrate concentration for water samples collected from two sites along the Red River on April 15, 2003 for: (**A**) manganese and (**B**) nickel. (**C**) The effect of time on pH for water samples collected from two sites along the Red River on April 15, 2003. 71

Figure 27. The effects of sample volume passing through filters for water samples collected from the Red River at the gage on March 20, 2002. (**A**) Calcium, magnesium, silica, sodium, and potassium concentrations after filtration through a 0.45-µm filter. (**B**) Calcium, magnesium, silica, sodium, and potassium concentrations after filtration through a 0.1-µm filter. (**C**) Manganese, strontium, zinc, total dissolved iron, and ferrous iron concentrations after

filtration through a 0.45µm filter. (**D**) Manganese, strontium, zinc, total dissolved iron, and ferrous iron concentrations after filtration through a 0.1-µm filter. (**E**) Barium, nickel, cobalt, and copper concentrations after filtration through a 0.45-µm filter. (**F**) Barium, nickel, cobalt, and copper concentrations after filtration through a 0.1-µm filter........73

Tables

Table 1. Container preparation and stabilization methods for filtered samples........5
Table 2. Filtration assemblies, membrane pore size, material, and type........7
Table 3. Analytical techniques, detection limits, typical precision, equipment used, and analytical method references.8
Table 4. Measurement of standard reference water samples........16
Table 5. Measurement of blanks........25
Table 6. Sample spike recoveries, analyses by ICP-OES........43
Table 7. Analyses by multiple methods........77
Table 8. Analyses by different laboratories........94
Table 9. Measurement of samples from Straight Creek and Red River........98
Table 10. Measurement of sequential aliquots for a sample from the Red River at U.S. Geological Survey streamflow-gaging station 082655000........102

Explanation of Abbreviations and Symbols

---	not analyzed, measured, or calculated
<	less than
°C	degrees Celsius
C.I.	charge imbalance
CVAFS	cold-vapor atomic fluorescence spectrometry
DIW	deionized water
DOC	dissolved organic carbon
F_s	pseudosigma
FA	filtered-acidified
FU	filtered-unacidified
FIAS	flow injection analysis system
GFAAS	graphite furnace atomic absorption spectrometry
GW	ground water
HCl	hydrochloric acid
HDPE	high-density polyethylene
HGAAS	hydride-generation atomic-absorption spectrometry
HNO_3	nitric acid
IC	ion chromatography
ICP-MS	inductively coupled plasma-mass spectrometry
ICP-OES	inductively coupled plasma-optical emission spectrometry
ID	identification
ISE	ion-selective electrode
km	kilometers
m	meters
mm	millimeter
meq/L	milliequivalents per liter
mM	millimoles per liter
mg/L	milligrams per liter
MPV	most probable value
N	normality
ng	nanograms
ng/L	nanograms per liter
nm	nanometer
NMED	New Mexico Environment Department
µg/L	micrograms per liter
µm	micrometer
µS/cm	microsemens per centimeter
UV	ultraviolet
n	number of analyses
NMWL	nominal molecular weight limit
PE	polyethylene
RA	raw-acidified
RSD	relative standard deviation
RU	raw-unacidified
s	standard deviation
SC	specific conductance
SRWS	standard reference water sample
SW	surface water
TOC	total organic carbon
THGA	transversely heated graphite atomizer
UFA	ultrafiltered-acidified
v/v	volume per volume

Conversion Factors

SI to Inch/Pound

Multiply	By	To obtain
Length		
micrometer (µm)	0.00003937	inch (in.)
millimeter (mm)	0.03937	inch (in.)
meter (m)	3.281	foot (ft)
kilometer (km)	0.6214	mile (mi)
Area		
square meter (m^2)	0.0002471	acre
Volume		
liter (L)	33.82	ounce, fluid (fl. oz)
liter (L)	2.113	pint (pt)
cubic meter (m^3)	264.2	gallon (gal)
liter (L)	61.02	cubic inch (in^3)
Mass		
gram (g)	0.03527	ounce, avoirdupois (oz)
kilogram (kg)	2.205	pound avoirdupois (lb)

Temperature in degrees Celsius (°C) may be converted to degrees Fahrenheit (°F) as follows:
°F=(1.8×°C)+32

Specific conductance is given in microsemens per centimeter at 25 degrees Celsius (µS/cm at 25°C).

Concentrations of chemical constituents in water are given either in milligrams per liter (mg/L), micrograms per liter (µg/L), nanograms per liter (ng/L), or mM (millimoles per liter).

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Abstract

The Questa baseline and pre-mining ground-water quality investigation has the main objective of inferring the ground-water chemistry at an active mine site. Hence, existing ground-water chemistry and its quality assurance and quality control is of crucial importance to this study and a substantial effort was spent on this activity. Analyses of seventy-two blanks demonstrated that contamination from processing, handling, and analyses were minimal. Blanks collected using water deionized with anion and cation exchange resins contained elevated concentrations of boron (0.17 milligrams per liter (mg/L)) and silica (3.90 mg/L), whereas double-distilled water did not. Boron and silica were not completely retained by the resins because they can exist as uncharged species in water. Chloride was detected in ten blanks, the highest being 3.9 mg/L, probably as the result of washing bottles, filter apparatuses, and tubing with hydrochloric acid. Sulfate was detected in seven blanks; the highest value was 3.0 mg/L, most likely because of carryover from the high sulfate waters sampled. With only a few exceptions, the remaining blank analyses were near or below method detection limits. Analyses of standard reference water samples by cold-vapor atomic fluorescence spectrometry, ion chromatography, inductively coupled plasma-optical emission spectrometry, inductively coupled plasma-mass spectrometry, FerroZine, graphite furnace atomic absorption spectrometry, hydride generation atomic spectrometry, and titration provided an accuracy check. For constituents greater than 10 times the detection limit, 95 percent of the samples had a percent error of less than 8.5. For constituents within 10 percent of the detection limit, the percent error often increased as a result of measurement imprecision. Charge imbalance was calculated using WATEQ4F and 251 out of 257 samples had a charge imbalance less than 11.8 percent. The charge imbalance for all samples ranged from -16 to 16 percent. Spike recoveries were performed by spiking ground-water samples from SC2B, SC3A, SC3B, CC2A, and Hottentot with a mixed-element standard and then analyzing them by ICP-OES. The mean recovery for all the constituents by ICP-OES was 103 percent with a standard deviation of 16 percent. Fifteen surface- and ground-water sequential duplicates were collected from Straight Creek, Hottentot, and the Red River from 2002 to 2003. Except for chloride from well SC5B and low concentrations of iron (<0.05 mg/L) and aluminum (<0.01 mg/L), constituents of sequential duplicates are generally within 10 percent of each other. Analytical results from different methods and different laboratories, with rare exceptions, were within 10 percent. Chromium analyses were in poor agreement when comparing analyses from the USGS and a contract laboratory, but USGS analyses by ICP-OES and ICP-MS were usually within 10 percent for chromium concentrations above 0.03 mg/L and analyses by ICP-OES and GFAAS were usually within 15 percent for chromium concentrations as much as 0.1 mg/L.

Filtration studies also were performed to study the effects of filtration apparatuses (Minitan, plate, capsule, and syringe), pore sizes, and timing on dissolved metal concentrations. Except for iron and aluminum, constituents with concentrations greater than about 0.05 mg/L were generally not affected by the filtration apparatus, membrane pore-size, and filtration delays. Iron, aluminum, and some dissolved metals concentrations less than about 0.05 mg/L, especially copper, were generally lowest in filtrates from the tangential flow Minitan system containing a filter membrane with a pore size of 10,000 Daltons. As part of a filtration timing study, grab samples were collected from two sites along the Red River and were processed immediately and then again 1 to 3 hours later. Aluminum and iron colloids formed during the delay in the sample collected at the USGS gaging station and, after the delay, 0.1-µm filtrate aluminum and iron concentrations approached the ultrafiltrate (Minitan) concentrations. In the upstream site below Fawn Lakes, aluminum in the 0.1-µm filtrate decreased but did not decrease in the 0.45-µm filtrate, signifying that the colloids formed during the delay are between 0.1 and 0.45 µm. Dissolved nickel and pH also decreased in both samples during the delay. Except for ferrous iron and barium, a sequential filtration study

demonstrated that water collected from the Red River at the gage did not affect dissolved metal concentrations with increasing sample volume passing through a plate filter with 0.45- or 0.1-µm membranes. Barium and ferrous iron both slightly decreased in the filtrate from the 0.45-µm filter.

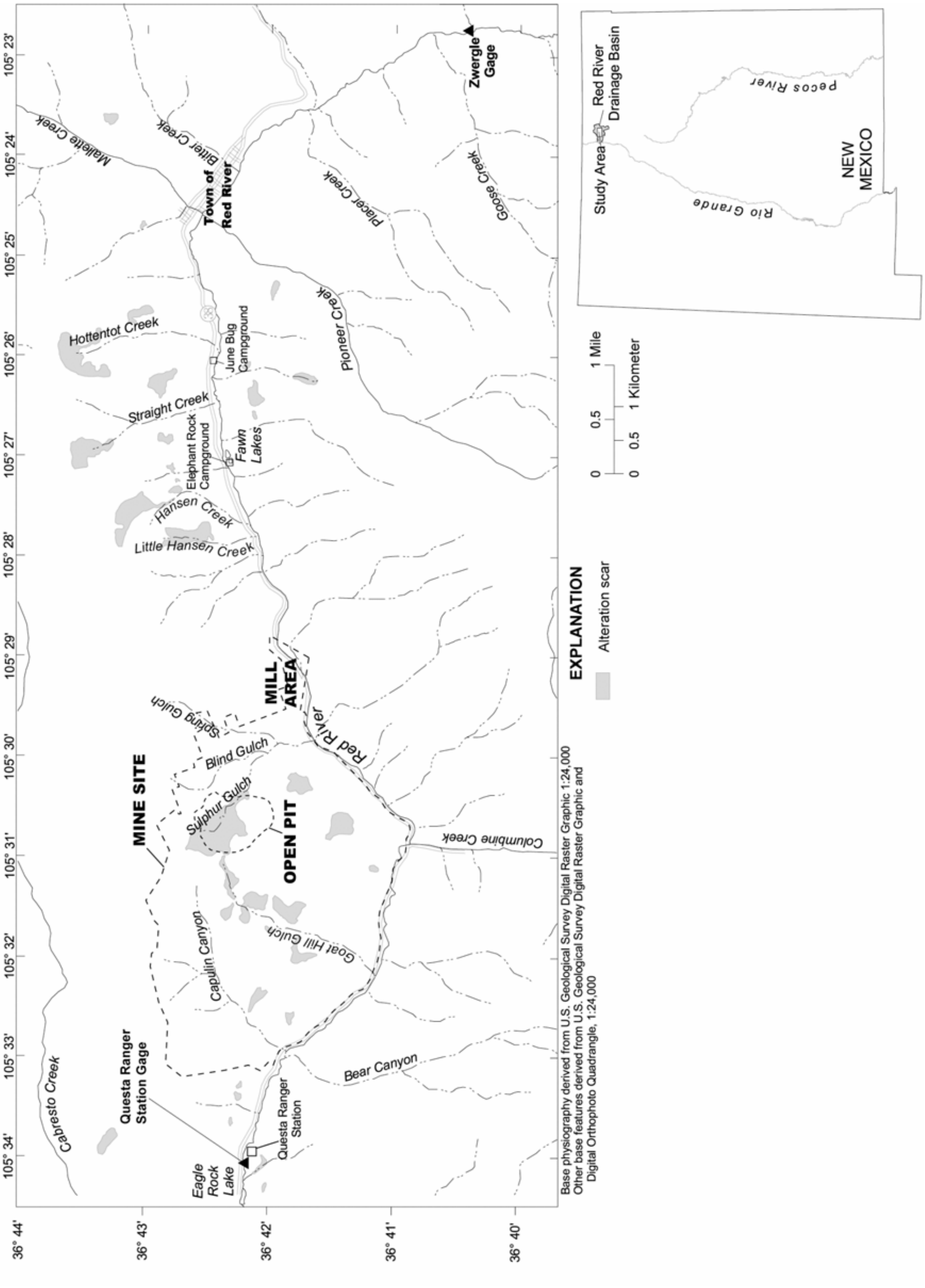
Introduction

The Red River drains 190 square miles of the Sangre de Cristo Mountains and empties into the Rio Grande River north of Taos, New Mexico (fig. 1). Waste from abandoned and operational mines, runoff from hydrothermal scars, and urban runoff and waste potentially affect the water quality in the Red River (Plazak, 1996). The U.S. Geological Survey (USGS), in cooperation with the New Mexico Environment Department (NMED), is currently investigating the baseline and pre-mining ground-water quality in the Red River Basin (Nordstrom and others, 2002).

As part of the Questa baseline and pre-mining ground-water quality investigation, analyses of surface and ground waters are reported in several reports with common QA/QC methods and data (Naus and others, 2004; D.K. Nordstrom, USGS, written commun., 2004; P.L. Verplanck, USGS, written commun., 2004). This report combines QA/QC data relevant to all three reports rather than repeating the same information in each report. These reports include ground-water analyses from Straight Creek, Hansen, Hottentot, La Bobita, and Capulin Canyon drainages, and from Questa Ranger Station, and surface-water analyses from Straight Creek and the Red River (fig. 1).

The purpose of this report is to provide QA/QC methods and results for surface-water and ground-water samples collected as part of the Questa baseline and pre-mining ground-water quality investigation. The QA/QC for water analyses include analyses of standard reference water samples, calculation of charge imbalance, collection of field and equipment blanks, analyses of spiked samples, analyses by multiple methods, analyses by different laboratories, and sequential duplicates. Filtration studies were performed to study the effects of filtration apparatuses, pore sizes, and timing on dissolved metal concentrations.

Molycorp Inc. kindly provided data for the interlaboratory comparison. Sample collection was made possible by the additional efforts of Lisa Donahoe, James Ball, Sara LoVetere, and Bob Moquino.



Base physiography derived from U.S. Geological Survey Digital Raster Graphic 1:24,000
Other base features derived from U.S. Geological Survey Digital Raster Graphic and Digital Orthophoto Quadrangle, 1:24,000

Figure 1. Location of Red River, New Mexico

Methods

Sample Collection

Phase I and phase II ground-water samples were routinely collected by filtering the water through a disposable capsule filter having a nominal pore size of 0.45 µm (Naus and others, 2004; D.K. Nordstrom, USGS, written commun., 2004). Because use of the 0.45-µm filter membrane is accepted filtration practice for dissolved metals, the data are expected to be comparable to historical samples collected with 0.45-µm filter membranes. For comparison purposes, four samples also were processed with a 142-mm diameter all-plastic filter holder (Kennedy and others, 1976) containing a 0.1-µm pore size mixed cellulose ester filter membrane. Surface waters were processed by either filtering samples through a 142-mm diameter all-plastic filter holder containing a 0.1-µm pore size mixed cellulose ester filter membrane, filtering samples though disposable capsule filters having a nominal pore size of 0.45 µm, or filtering samples through syringe filters having a pore size of either 0.2 or 0.45 µm (Naus and others, 2004; D.K. Nordstrom, USGS, written commun., 2004; P.L. Verplanck, USGS, written commun., 2004).

Several sample splits were collected for analyses of inorganic constituents, redox species, and dissolved organic carbon (DOC). Container preparation and stabilization of filtered samples are summarized in table 1. Samples for the determination of major cations and trace metals (As, Al, B, Ba, Be, Bi, Ca, Cd, Ce, Co, Cr, Cs, Cu, Dy, Er, Eu, Fe, Gd, Hf, Ho, K, La, Li, Lu, Mg, Mn, Mo, Na, Nd, Ni, Pb, Pr, Rb, Re, Sb, Se, SiO_2, Sm, Sr, Ta, Tb, Te, Th, Tl, Tm, U, V, W, Y, Yb, Zr, and Zn), major anions (Br, Cl, F, NO_3, and SO_4), alkalinity, and DOC were filtered and then stabilizing reagents, if needed, were added. Sample bottles were pre-rinsed with filtered water prior to sample collection. Samples for the determination of DOC were filtered through the same filter used to collect the inorganic constituents. At least 1 L of sample was passed through the filter assembly before a DOC sample was collected. Several techniques were used to assure the quality of the samples collected. These techniques include the collection of blanks, duplicate samples, and several filtration studies.

Table 1. Container preparation and stabilization methods for filtered samples

[HCl, hydrochloric acid; HDPE, high-density polyethylene; HNO_3, nitric acid; H_2SO_4, sulfuric acid; $K_2Cr_2O_7$, potassium dichromate; mL, milliliters; N, normal; v/v, volume per volume]

Sample type(s)	Storage container and preparation	Stabilization treatment in addition to refrigeration
Major cations and trace metals (Al, As, B, Ba, Be, Bi, Ca, Cd, Ce, Co, Cr, Cs, Cu, Dy, Er, Eu, Fe, Gd, Hf, Ho, K, La, Li, Lu, Mg, Mn, Mo, Na, Nd, Ni, Pb, Pr, Rb, Re, Sb, Se, SiO_2, Sm, Sr, Ta, Tb, Te, Th, Tl, Tm, U, V, W, Y, Yb, Zn, and Zr)	Polyethylene bottles, soaked in 5% HCl and rinsed 3 times with distilled water	1% (v/v) concentrated redistilled or Ultrex 7.7 N HNO_3 added
Major anions, alkalinity, and density (Br, Cl, F, HCO_3, NO_3, and SO_4)	Polyethylene bottles filled with distilled water and allowed to stand for 24 hours, then rinsed 3 times with distilled water	None
Mercury (Hg)	Borosilicate glass bottles, soaked with 5% HNO_3 and rinsed 3 times with deionized water	5 mL of concentrated redistilled HNO_3 (added in the field) + 0.04 % w/v $K_2Cr_2O_7$ per 125 mL of sample (added in the laboratory)
Iron and arsenic redox species (Fe(T), Fe(II), As(T), and As(III))	Opaque polyethylene bottles, soaked in 5% HCl and rinsed 3 times with distilled water	1% (v/v) redistilled 6 N or Omni 1:1 trace-metal grade HCl added
Dissolved organic carbon (DOC)	Baked glass bottle	None

Blanks

Double-distilled water was used for most blanks. Deionized water was used for one set of blanks for comparative purposes. Sample collection methods for each blank type are discussed in the following paragraphs. The types and sizes of bottles used and cleaning, filtration, and preservation methods for each analysis type are the same as those for samples (table 1).

Equipment blanks were collected to determine the extent of contamination of water samples from equipment used to pump and filter surface- and ground-water samples, from air-borne contaminants, and from handling and processing samples. The three types of equipment blanks collected for this study were portable pump, capsule filter, and plate filter. Equipment blanks were analyzed for dissolved major cations and trace metals, major anions, mercury, and dissolved organic carbon. Portable-pump blanks were collected only when the portable pump was used to collect samples from more than one well during a sampling trip. The portable-pump blanks were collected in the field following pump decontamination by pumping double-distilled or deionized water from a dedicated blank-water standpipe into sample containers. Capsule-filter and plate-filter blanks were collected in the laboratory using a peristaltic pump and dedicated blank-water tubing. Capsule-filter blanks were collected each trip for the first 3 months and at least quarterly thereafter. A plate-filter blank was collected when the plate filter was used. Because all equipment blanks were filtered, capsule-filter blanks also were collected along with other types of equipment blanks.

Field blanks were collected to determine whether the water samples were contaminated by exposure to the field environment. Field blanks were collected once per sample-collection trip and were analyzed for total major cations and trace metals. Field blanks were collected at the time of sample collection by pouring double-distilled or deionized water into a sample container at the sampling location and leaving the container open for approximately the same amount of time required to collect a sample.

Trip blanks were collected to determine if field handling and field travel caused contamination of water samples. Trip blanks were collected once per sample-collection trip and were analyzed for total major cations and trace metals. Trip blanks were prepared either in the laboratory prior to the trip or in a contaminant-free area (such as a mobile laboratory) at the field site. Trip blanks were not filtered and were not opened at a sample site, but were otherwise handled the same as water samples.

Sequential Duplicates

Sequential duplicates, samples that are collected consecutively, were used to assess variability among samples resulting from collection, processing, shipping, and laboratory procedures conducted at different sampling times (Wilde and others, 1999). For the ground-water studies, sequential duplicates were collected at a rate of one set per trip. A different well was selected for duplicate sample collection for each sampling event. Duplicate surface-water samples were collected nearly every trip. Samples were collected by first filling all bottles needed for the analyses of sample and then all bottles for the duplicate sample.

Filtration Studies

Fine colloidal material may pass through a 0.45-µm filter membrane (Kennedy and others, 1974; Kennedy and others, 1976; Laxen and Chandler, 1982). Therefore, filtration studies were performed on water samples from the Red River and Straight Creek to evaluate the effects of filtration artifacts on dissolved trace metals using different filter assemblies and pore sizes (table 2). The surface-water samples were collected by filling a 20-L carboy with water and then placing it in a black plastic bag to minimize exposure to sunlight. Samples were transported to a mobile laboratory where they were processed for analyses of inorganic constituents. The ground-water samples were processed sequentially at the well head. The samples were processed by filtering the water through a 0.1-µm, 0.45-µm, 0.2-µm, or a 10,000 nominal molecular weight limit (NMWL), or Daltons, filter. The 10,000-Dalton membranes retain particles in the range of 0.0035 µm to 0.0055 µm (Millipore Corporation, 1993). Ultrafiltrates produced by tangential-flow ultrafiltration with 10,000 NMWL membranes are the best available approximation to truly dissolved concentrations (Alpers and others, 1999).

The effects of filtration timing also were studied by filling a 20-L carboy with water and then processing the sample as quickly as possible after collection and then collecting additional filtration aliquots, using the same type and size of filters, 1 to 3 hours later. Quantifying the amount of iron and aluminum precipitation and subsequent loss of other dissolved metals by absorption or coprecipitation may be useful for interpreting results of samples that were not processed immediately after sample collection (McCleskey and others, 2003; P.L. Verplanck, USGS, written commun., 2004).

A sequential filtration study was performed at the USGS streamflow-gaging station (08265000) along the Red River. Sequential aliquots were collected by simultaneously pumping water directly from the center of the river through 142-mm plate filters with membranes having a pore size of 0.1 µm and 0.45 µm. The tubing was rinsed prior to being attached to the filter assemblies and the first drops of filtrate were collected. Ten 125-mL aliquots were collected from each assembly and subsequently analyzed for major cations, trace metals, and iron redox species.

Table 2. Filtration assemblies, membrane pore size, material, and type

[mm, millimeter; µm, micrometer]

Assembly	Pore Size	Filter Membrane	Type
142-mm plate filter	0.45 µm or 0.1 µm	mixed cellulose esters	membrane
Minitan filter	0.1 µm or 10,000 Daltons	polyvinylidene fluoride filter cassettes	tangential flow
25-mm syringe filter	0.2 µm	mixed cellulose esters	membrane
Capsule filter	0.45 µm	polyethersulfone	tortuous path capsule

Analytical

Analytical techniques, detection limits, equipment used, pertinent references, and comments are briefly described in table 3. Estimates of method detection limits are assumed equal to 3 times the standard deviation of several dozen measurements of the constituent in a blank solution treated as a sample. Typical analytical precision, or percent relative standard deviation, is based on several analytical runs and calculated using standard reference water samples. Precision for any single analytical run is better than multiple analytical runs, but using multiple analytical runs to calculate precision provides a more realistic estimate of error when comparing samples analyzed at different times. The typical relative standard deviations, or precision estimates, are for analyte concentrations greater than 10 times the detection limit and less than the high standard. Samples with analytes greater than the high standard were diluted and additional errors introduced. Techniques, general conditions, and variants of standard procedures are discussed in the following sections.

All reagents were of purity at least equal to the reagent-grade standards of the American Chemical Society. Double-distilled or deionized water and re-distilled or trace metal grade acids were used in all preparations. Samples were diluted as necessary to bring the analyte concentration within the optimal range of the method. Each sample was analyzed in at least duplicate for each dilution for all constituents. Reagent blanks also were analyzed as a means to detect contamination from reagents used to prepare standards and dilutions.

Several techniques were used to check accuracy of the analytical data. These techniques include use of standard reference water samples (SRWS), charge imbalance (C.I.), spike recoveries, determination by different methods, and determination by different laboratories. The QA/QC checks for dissolved organic carbon include analyses of laboratory reagent blanks and synthetic samples made from potassium biphthalate, sodium bicarbonate, and sodium benzoate.

Table 3. Analytical techniques, detection limits, typical precision, equipment used, and analytical method references

[CVAFS, cold-vapor atomic fluorescence spectrometry; GFAAS, graphite furnace atomic absorption spectrometry; HGAAS, hydride generation atomic absorption spectrometry; IC, ion chromatography; ICP-MS, inductively coupled plasma-mass spectrometry; ICP-OES, inductively coupled plasma-optical emission spectrometry; ISE, ion-selective electrode; mg/L, milligrams per liter; mM, millimolar; MS, mass spectrometry; ng/L, nanograms per liter; µg/L, micrograms per liter; nm, nanometer; RSD, relative standard deviation; SC, specific conductance; TOC, total organic carbon; %, percent; ---, not measured or calculated]

Constituent	Analytical Technique	Detection limit[1] / Typical precision[2]	Equipment Used	Reference(s) and comments
Calcium (Ca)	ICP-OES	0.4 mg/L / 5%	Leeman Labs Direct Reading Echelle	analytical wavelength: 315.887 nm, view: radial
Magnesium (Mg)	ICP-OES	0.04 mg/L / 5%	Leeman Labs Direct Reading Echelle	analytical wavelength: 280.270 nm, view: axial
Sodium (Na)	ICP-OES	0.05 mg/L / 5%	Leeman Labs Direct Reading Echelle	analytical wavelength: 589.592 nm, view: radial
Potassium (K)	ICP-OES	0.02 mg/L / 5%	Leeman Labs Direct Reading Echelle	analytical wavelength: 766.490 nm, view: axial
Sulfate (SO_4)	IC	0.3 mg/L / 3%	Dionex model 2010i ion chromatograph with AG4A guard and AS4A separator columns and Anion Self-Regenerating Suppressor-II	1.8 mM $NaHCO_3$ + 1.7 mM Na_2CO_3 eluent (Brinton and others, 1995)
Alkalinity (as HCO_3)	Titration	1.0 mg/L / 2%	Orion Research model 960/940 autotitrator, potentiometric detection, end-point determined by the first derivative technique	(Barringer and Johnsson, 1989)
Fluoride (F)	F-ISE	0.05 mg/L / 4%	Orion Research model 96-09 combination F-electrode	sample mixed 1:1 with TISAB (Barnard and Nordstrom, 1980)
Chloride (Cl)	IC	0.09 mg/L / 4%	Dionex model 2010i ion chromatograph with AG4A guard and AS4A separator columns	1.8 mM $NaHCO_3$ + 1.7 mM Na_2CO_3 eluent (Brinton and others, 1995)
Silica (SiO_2)	ICP-OES	0.06 mg/L / 5%	Leeman Labs Direct Reading Echelle	sample diluted 1:10 in field, analytical wavelength: 251.611 nm, view: axial
Aluminum (Al)	ICP-OES	0.07 mg/L / 5%	Leeman Labs Direct Reading Echelle	analytical wavelength: 308.215 nm, view: axial
	ICP-MS[5]	0.00003 mg/L / 5%	Perkin-Elmer SCIEX ELAN 6000	^{27}Al (Garbarino and Taylor, 1995; Taylor and Garbarino, 1991)
	GFAAS[3]	0.001 mg/L / 7%	Perkin-Elmer model 4110ZL	analytical wavelength: 309.3 nm, modifier: 15 µg $Mg(NO_3)_2$, atomization temperature: 2,300°C

Table 3. Analytical techniques, detection limits, typical precision, equipment used, and analytical method references—Continued

[CVAFS, cold-vapor atomic fluorescence spectrometry; GFAAS, graphite furnace atomic absorption spectrometry; HGAAS, hydride generation atomic absorption spectrometry; IC, ion chromatography; ICP-MS, inductively coupled plasma-mass spectrometry; ICP-OES, inductively coupled plasma-optical emission spectrometry; ISE, ion-selective electrode; mg/L, milligrams per liter; mM, millimolar; MS, mass spectrometry; ng/L, nanograms per liter; µg/L, micrograms per liter; nm, nanometer; RSD, relative standard deviation; SC, specific conductance; TOC, total organic carbon; %, percent; ---, not measured or calculated]

Constituent	Analytical Technique	Detection limit[1] / Typical precision[2]	Equipment Used	Reference(s) and comments
Total iron (Fe(T))	ICP-OES	0.007 mg/L / 5%	Leeman Labs Direct Reading Echelle	analytical wavelength: 238.204 nm, view: axial
	Colorimetry	0.001 mg/L / 3%	Hewlett-Packard model 8452A diode array spectrometer with 1 and 5 cm cells	FerroZine method (Stookey, 1970; To and others, 1999)
Ferrous iron (Fe(II))	Colorimetry	0.002 mg/L / 3%	Hewlett-Packard model 8452A diode array spectrometer with 1 and 5 cm cells	FerroZine method (Stookey, 1970; To and others, 1999)
Boron (B)	ICP-OES	0.010 mg/L / 7%	Leeman Labs Direct Reading Echelle	analytical wavelength: 249.678 nm, view: axial
	ICP-MS[5]	0.002 mg/L / 5%	Perkin-Elmer SCIEX ELAN 6000	^{11}B (Garbarino and Taylor, 1995; Taylor and Garbarino, 1991)
Lithium (Li)	ICP-OES	0.001 mg/L / 5%	Leeman Labs Direct Reading Echelle	analytical wavelength: 670.784 nm, view: axial
	ICP-MS[5]	0.00001 mg/L / 5%	Perkin-Elmer SCIEX ELAN 6000	^{7}Li (Garbarino and Taylor, 1995; Taylor and Garbarino, 1991)
Strontium (Sr)	ICP-OES	0.0003 mg/L / 4%	Leeman Labs Direct Reading Echelle	analytical wavelength: 421.552 nm, view: axial
	ICP-MS[5]	0.00001 mg/L / 5%	Perkin-Elmer SCIEX ELAN 6000	^{86}Sr (Garbarino and Taylor, 1995; Taylor and Garbarino, 1991)
Barium (Ba)	ICP-OES	0.0008 mg/L / 4%	Leeman Labs Direct Reading Echelle	analytical wavelength: 455.403 nm, view: axial
	ICP-MS[5]	0.00004 mg/L / 5%	Perkin-Elmer SCIEX ELAN 6000	^{137}Ba (Garbarino and Taylor, 1995; Taylor and Garbarino, 1991)
Manganese (Mn)	ICP-OES	0.002 mg/L / 5%	Leeman Labs Direct Reading Echelle	analytical wavelength: 257.610 nm, view: axial
	ICP-MS[5]	0.00002 mg/L / 5%	Perkin-Elmer SCIEX ELAN 6000	^{55}Mn (Garbarino and Taylor, 1995; Taylor and Garbarino, 1991)
Zinc (Zn)	ICP-OES	0.005 mg/L / 5%	Leeman Labs Direct Reading Echelle	analytical wavelength: 206.200 nm, view: radial
	ICP-MS[5]	0.00008 mg/L / 5%	Perkin-Elmer SCIEX ELAN 6000	^{64}Zn (Garbarino and Taylor, 1995; Taylor and Garbarino, 1991)

Table 3. Analytical techniques, detection limits, typical precision, equipment used, and analytical method references—Continued

[CVAFS, cold-vapor atomic fluorescence spectrometry; GFAAS, graphite furnace atomic absorption spectrometry; HGAAS, hydride generation atomic absorption spectrometry; IC, ion chromatography; ICP-MS, inductively coupled plasma-mass spectrometry; ICP-OES, inductively coupled plasma-optical emission spectrometry; ISE, ion-selective electrode; mg/L, milligrams per liter; mM, millimolar; MS, mass spectrometry; ng/L, nanograms per liter; µg/L, micrograms per liter; nm, nanometer; RSD, relative standard deviation; SC, specific conductance; TOC, total organic carbon; %, percent; ---, not measured or calculated]

Constituent	Analytical Technique	Detection limit[1] / Typical precision[2]	Equipment Used	Reference(s) and comments
Lead (Pb)	ICP-OES	0.008 mg/L / 6%	Leeman Labs Direct Reading Echelle	analytical wavelength: 220.353 nm, view: axial
	GFAAS[3]	0.0003 mg/L / 7%	Perkin-Elmer model 4110ZL	analytical wavelength: 283.3 nm, view: axial; modifier: 50 µg PO_4 + 3 µg $Mg(NO_3)_2$, atomization temperature: 1,600°C
	ICP-MS[4]	0.00001 mg/L / 2%	Perkin-Elmer SCIEX ELAN 6000	a weighted average of the ^{206}Pb, ^{207}Pb, and ^{208}Pb was used (Garbarino and Taylor, 1995; Taylor and Garbarino, 1991)
Copper (Cu)	ICP-OES	0.002 mg/L / 7%	Leeman Labs Direct Reading Echelle	analytical wavelength: 324.754 nm, view: axial
	GFAAS[3]	0.0005 mg/L / 6%	Perkin-Elmer model 4110ZL	analytical wavelength: 324.8 nm, modifier: 5 µg Pd + 3 µg $Mg(NO_3)_2$, atomization temperature: 2,000°C
	ICP-MS[4]	0.00007 mg/L / 5%	Perkin-Elmer SCIEX ELAN 6000	^{63}Cu (Garbarino and Taylor, 1995)
Cadmium (Cd)	ICP-OES	0.002 mg/L / 5%	Leeman Labs Direct Reading Echelle	analytical wavelength: 214.428 nm, view: axial
	GFAAS[3]	0.0002 mg/L / 7%	Perkin-Elmer model 4110ZL	analytical wavelength: 228.8 nm, modifier: 50 µg PO_4 + 3 µg $Mg(NO_3)_2$, atomization temperature: 1,500°C
	ICP-MS[4]	0.000002 mg/L / 5%	Perkin-Elmer SCIEX ELAN 6000	^{114}Cd (Garbarino and Taylor, 1995)
Chromium (Cr)	ICP-OES	0.002 mg/L / 5%	Leeman Labs Direct Reading Echelle	analytical wavelength: 206.149 nm, view: axial
	GFAAS[3]	0.0005 mg/L / 6%	Perkin-Elmer model 4110ZL	analytical wavelength: 357.9 nm, modifier: 15 µg $Mg(NO_3)_2$, atomization temperature: 2,300°C
	ICP-MS[4]	0.0001 mg/L / 5%	Perkin-Elmer SCIEX ELAN 6000	^{52}Cr (Garbarino and Taylor, 1995)

Table 3. Analytical techniques, detection limits, typical precision, equipment used, and analytical method references—Continued

[CVAFS, cold-vapor atomic fluorescence spectrometry; GFAAS, graphite furnace atomic absorption spectrometry; HGAAS, hydride generation atomic absorption spectrometry; IC, ion chromatography; ICP-MS, inductively coupled plasma-mass spectrometry; ICP-OES, inductively coupled plasma-optical emission spectrometry; ISE, ion-selective electrode; mg/L, milligrams per liter; mM, millimolar; MS, mass spectrometry; ng/L, nanograms per liter; µg/L, micrograms per liter; nm, nanometer; RSD, relative standard deviation; SC, specific conductance; TOC, total organic carbon; %, percent; ---, not measured or calculated]

Constituent	Analytical Technique	Detection limit[1] / Typical precision[2]	Equipment Used	Reference(s) and comments
Cobalt (Co)	ICP-OES	0.007 mg/L / 5%	Leeman Labs Direct Reading Echelle or	analytical wavelength: 228.616 nm, view: axial
	GFAAS[3]	0.0008 mg/L / 7%	Perkin-Elmer model 4110ZL	analytical wavelength: 242.5 nm, modifier: 15 µg $Mg(NO_3)_2$, atomization temperature: 2400°C
	ICP-MS[4]	0.000004 mg/L / 7%	Perkin-Elmer SCIEX ELAN 6000	^{59}Co (Garbarino and Taylor, 1995)
Beryllium (Be)	ICP-OES	0.001 mg/L / 4%	Leeman Labs Direct Reading Echelle	analytical wavelength: 313.042 nm, view: axial
	ICP-MS[4]	0.000005 mg/L / 7%	Perkin-Elmer SCIEX ELAN 6000	^{9}Be (Garbarino and Taylor, 1995)
Molybdenum (Mo)	ICP-OES	0.007 mg/L / 7%	Leeman Labs Direct Reading Echelle	analytical wavelength: 277.540 nm, view: axial
	ICP-MS[4]	0.0005 mg/L / 3%	Perkin-Elmer SCIEX ELAN 6000	^{95}Mo (Garbarino and Taylor, 1995)
Vanadium (V)	ICP-OES	0.002 mg/L / 5%	Leeman Labs Direct Reading Echelle	analytical wavelength: 292.401 nm, view: axial
	ICP-MS[4]	0.0003 mg/L / 2%	Perkin-Elmer SCIEX ELAN 6000	^{51}V (Garbarino and Taylor, 1995)
Arsenic (As)	ICP-OES	0.04 mg/L / 7%	Leeman Labs Direct Reading Echelle	analytical wavelength: 188.977 nm, view: axial
	HGAAS	0.0001mg/L / 3%	Perkin-Elmer AAnalyst 300 atomic absorption spectrometer	pre-reduction of As(V) using KI + ascorbic acid + HCl (McCleskey and others, 2003)
	ICP-MS[4]	0.00002 mg/L / 2%	Perkin-Elmer SCIEX ELAN 6000	^{75}As (Garbarino and Taylor, 1995)
Selenium (Se)	ICP-OES	0.04 mg/L / 5%	Leeman Labs Direct Reading Echelle	analytical wavelength: 196.026 nm, view: axial
	GFAAS[3]	0.001 mg/L / 7%	Perkin-Elmer model 4110ZL	analytical wavelength: 196.0 nm, modifier: 5 µg Pd + 3 µg $Mg(NO_3)_2$, atomization temperature: 1,300°C
	ICP-MS[4]	0.0002 mg/L / 3%	Perkin-Elmer SCIEX ELAN 6000	^{77}Se (Garbarino and Taylor, 1995)

Table 3. Analytical techniques, detection limits, typical precision, equipment used, and analytical method references—Continued

[CVAFS, cold-vapor atomic fluorescence spectrometry; GFAAS, graphite furnace atomic absorption spectrometry; HGAAS, hydride generation atomic absorption spectrometry; IC, ion chromatography; ICP-MS, inductively coupled plasma-mass spectrometry; ICP-OES, inductively coupled plasma-optical emission spectrometry; ISE, ion-selective electrode; mg/L, milligrams per liter; mM, millimolar; MS, mass spectrometry; ng/L, nanograms per liter; µg/L, micrograms per liter; nm, nanometer; RSD, relative standard deviation; SC, specific conductance; TOC, total organic carbon; %, percent; ---, not measured or calculated]

Constituent	Analytical Technique	Detection limit[1] / Typical precision[2]	Equipment Used	Reference(s) and comments
Dissolved organic carbon (DOC)	TOC	0.1 mg/L / 4%	Oceanography International Model 700 TOC Analyzer	wet oxidation method (Aiken, 1992)
Mercury (Hg)	CVAFS	0.4 ng/L / 4%	PS Analytical, model Galahad, direct cold-vapor atomic fluorescence spectrometry	Taylor and others (1997), Roth and others (2001)
Bismuth (Bi)	ICP-MS[4]	0.001 µg/L / ---	Perkin-Elmer SCIEX ELAN 6000	^{209}Bi
Cerium (Ce)	ICP-MS[4]	0.0004 µg/L / 3%	Perkin-Elmer SCIEX ELAN 6000	^{140}Ce (Verplanck and others, 2001)
Cesium (Cs)	ICP-MS[4]	0.002 µg/L / ---	Perkin-Elmer SCIEX ELAN 6000	^{133}Cs
Dysprosium (Dy)	ICP-MS[4]	0.0004 µg/L / 7%	Perkin-Elmer SCIEX ELAN 6000	^{163}Dy (Verplanck and others, 2001)
Erbium (Er)	ICP-MS[4]	0.0004 µg/L / 6%	Perkin-Elmer SCIEX ELAN 6000	^{167}Er (Verplanck and others, 2001)
Europium (Eu)	ICP-MS[4]	0.001 µg/L / 5%	Perkin-Elmer SCIEX ELAN 6000	^{151}Eu, problems with Ba interference (Verplanck and others, 2001)
Gadolinium (Gd)	ICP-MS[4]	0.0006 µg/L / 3%	Perkin-Elmer SCIEX ELAN 6000	^{158}Gd (Verplanck and others, 2001)
Hafnium (Hf)	ICP-MS[4]	0.0005 µg/L / ---	Perkin-Elmer SCIEX ELAN 6000	^{178}Hf
Holmium (Ho)	ICP-MS[4]	0.0002 µg/L / 3%	Perkin-Elmer SCIEX ELAN 6000	^{165}Ho (Verplanck and others, 2001)
Lanthanum (La)	ICP-MS[4]	0.0004 µg/L / 3%	Perkin-Elmer SCIEX ELAN 6000	^{139}La (Verplanck and others, 2001)
Lutetium (Lu)	ICP-MS[4]	0.0002 µg/L / 5%	Perkin-Elmer SCIEX ELAN 6000	^{175}Lu (Verplanck and others, 2001)
Neodymium (Nd)	ICP-MS[4]	0.0008 µg/L / 3%	Perkin-Elmer SCIEX ELAN 6000	^{146}Nd (Verplanck and others, 2001)
Praseodymium (Pr)	ICP-MS[4]	0.0002 µg/L / 3%	Perkin-Elmer SCIEX ELAN 6000	^{141}Pr (Verplanck and others, 2001)
Rubidium (Rb)	ICP-MS[4]	0.001 µg/L / ---	Perkin-Elmer SCIEX ELAN 6000	^{85}Rb

Table 3. Analytical techniques, detection limits, typical precision, equipment used, and analytical method references—Continued

[CVAFS, cold-vapor atomic fluorescence spectrometry; GFAAS, graphite furnace atomic absorption spectrometry; HGAAS, hydride generation atomic absorption spectrometry; IC, ion chromatography; ICP-MS, inductively coupled plasma-mass spectrometry; ICP-OES, inductively coupled plasma-optical emission spectrometry; ISE, ion-selective electrode; mg/L, milligrams per liter; mM, millimolar; MS, mass spectrometry; ng/L, nanograms per liter; µg/L, micrograms per liter; nm, nanometer; RSD, relative standard deviation; SC, specific conductance; TOC, total organic carbon; %, percent; ---, not measured or calculated]

Constituent	Analytical Technique	Detection limit[1] / Typical precision[2]	Equipment Used	Reference(s) and comments
Rhenium (Re)	ICP-MS[4]	0.0007 µg/L / ---	Perkin-Elmer SCIEX ELAN 6000	^{187}Re
Antimony (Sb)	ICP-MS[4]	0.004 µg/L / 2%	Perkin-Elmer SCIEX ELAN 6000	^{121}Sb (Garbarino and Taylor, 1995; Taylor and Garbarino, 1991)
Samarium (Sm)	ICP-MS[4]	0.0008 µg/L / 3%	Perkin-Elmer SCIEX ELAN 6000	^{147}Sm (Verplanck and others, 2001)
Tantalum (Ta)	ICP-MS[4]	0.002 µg/L / ---	Perkin-Elmer SCIEX ELAN 6000	^{181}Ta
Terbium (Tb)	ICP-MS[4]	0.0002 µg/L / 3%	Perkin-Elmer SCIEX ELAN 6000	^{159}Tb (Verplanck and others, 2001)
Tellurium (Te)	ICP-MS[4]	0.008 µg/L / ---	Perkin-Elmer SCIEX ELAN 6000	^{126}Te
Thorium (Th)	ICP-MS[4]	0.001 µg/L / ---	Perkin-Elmer SCIEX ELAN 6000	^{232}Th
Thallium (Tl)	ICP-MS[4]	0.004 µg/L / 3%	Perkin-Elmer SCIEX ELAN 6000	^{205}Tl (Garbarino and Taylor, 1995; Taylor and Garbarino, 1991)
Thulium (Tm)	ICP-MS[4]	0.0002 µg/L / 4%	Perkin-Elmer SCIEX ELAN 6000	^{169}Tm (Verplanck and others, 2001)
Uranium (U)	ICP-MS[4]	0.0005 µg/L / 3%	Perkin-Elmer SCIEX ELAN 6000	^{238}U (Garbarino and Taylor, 1995; Taylor and Garbarino, 1991)
Tungsten (W)	ICP-MS[4]	0.006 µg/L / 6%	Perkin-Elmer SCIEX ELAN 6000	^{182}W
Yttrium (Y)	ICP-MS[4]	0.0003 µg/L / 3%	Perkin-Elmer SCIEX ELAN 6000	^{89}Y
Ytterbium (Yb)	ICP-MS[4]	0.0005 µg/L / 4%	Perkin-Elmer SCIEX ELAN 6000	^{174}Yb (Verplanck and others, 2001)
Zirconium (Zr)	ICP-MS[4]	0.001 µg/L / ---	Perkin-Elmer SCIEX ELAN 6000	^{90}Zr

[1] Some samples were diluted for ICP-MS analysis; reported detection limits must be multiplied by the dilution factor for these samples (for example, the detection limit for a sample diluted to 1:10 is ten times the undiluted detection limit reported in this table.

[2] Percent relative standard deviations, or precision, are for analyte concentrations greater than 10 times the detection limit and less than the highest concentration standard. Percent relative standard deviations are based on several analytical runs. The precision would be better for any single analytical run.

[3] GFAAS was used when the concentration of the constituent was below or near the ICP-OES detection limit

[4] ICP-MS was used for a selected subset of sample

Quality Assurance and Quality Control Results for Water Analyses

Standard Reference Water Samples

Standard reference water samples were used as independent well-characterized solutions to check analytical accuracy (Farrar, 2000; Connor and others, 2001; Verplanck and others, 2001). The following USGS SRWS were used: T107, T135, T153, T157, T159, T163, T173, M134, M136, M140, M150, M156, M166, AMW4, Hg15, Hg22, and Hg26. Additional information about the USGS SRWS program can be obtained at http://bqs.usgs.gov/srs. Two SRWS for rare earth element determinations were used, PPREE and SCREE (Verplanck and others, 2001). The PPREE and SCREE samples were always analyzed at a dilution of 1 to 100. One or more SRWS was analyzed several times during each analytical run by CVAFS, FIAS, FerroZine, GFAAS, HGAAS, IC, ICP-MS, ICP-OES, and titration. The results for the SRWS have been combined and the number of analyses (n), mean concentrations, standard deviations, percent relative standard deviations, reported most probable values (MPV), F-pseudosigma (deviation), and the percent differences are reported in table 4. The percent difference was calculated using equation 1:

$$\text{Percent difference} = \frac{(\text{measured mean concentration} - \text{most probable value})}{\text{most probable value}} \times 100 \qquad (1)$$

The percent difference for 213 analyte analyses by CVAFS, FerroZine, GFAAS, HGAAS, IC, ICP-OES, ICP-MS, and titration are plotted in relation to the measured mean concentration divided by the method detection limit in figure 2A. The percent difference typically increases as the measured concentration approaches the method detection limit, or the value of 1. For measured concentrations greater than 10 times the method detection limit, 95 percent of the samples have a percent difference less than 8.5 (2 standard deviations). The percent difference ranged from –61 to 43 for samples within 10 percent of the method detection limit. The decrease in accuracy as the method detection limit is approached is the result of decreasing signal to noise ratio (fig. 2B). For samples within ten percent of the detection limit, the accuracy is expected to be better for the SWRS than for the samples reported in Naus and others (2004), D.K. Nordstrom (USGS, written commun., 2004), and P.L Verplanck (USGS, written commun., 2004), because the SRWSs were analyzed a greater number of times (up to 53 replicate analyses), whereas the samples were typically analyzed in duplicate.

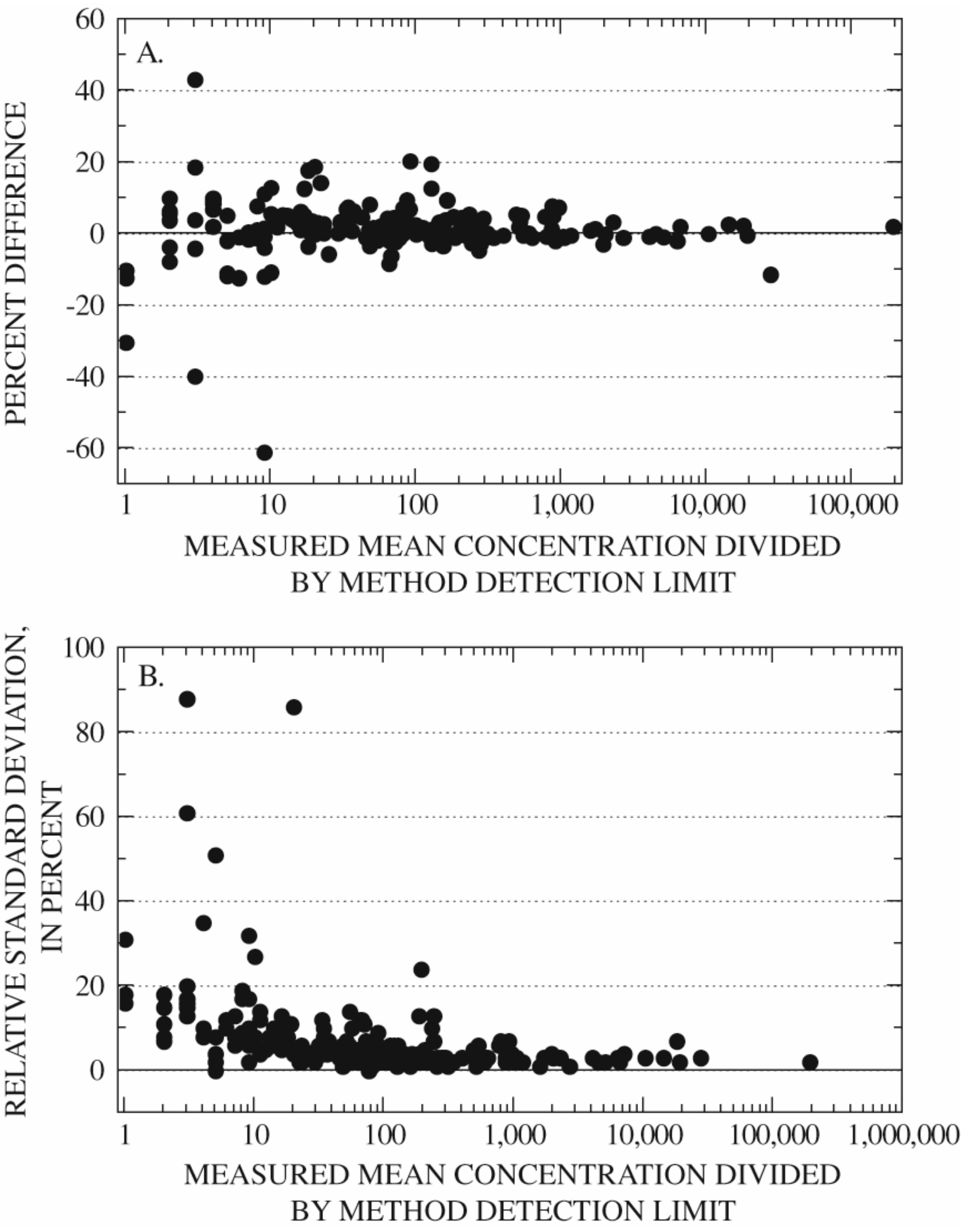


Figure 2. (**A**) The percent difference between the measured mean concentration and the MPV for SRWSs using equation 1 plotted in relation to the measured concentration divided by the method detection limit. (**B**) The measured relative standard deviation for determinations of SRWSs plotted in relation to the measured mean concentration divided by the method detection limit.

Table 4 . Measurement of standard reference water samples

[CVAFS, cold-vapor atomic fluorescence spectrometry; Fs, F-pseudosigma (deviation); GFAAS, graphite furnace atomic absorption spectrometry; HGAAS, hydride generation atomic absorption spectrometry; IC, ion chromatography; ICP-MS, inductively coupled plasma-mass spectrometry; ICP-OES, inductively coupled plasma-optical emission spectrometry; ISE, ion selective electrode; mg/L, milligrams per liter; MPV, most probable value; n, number of analyses; s, standard deviation; SRWS, standard reference water sample; %RSD, percent relative standard deviation; <, less than; ---, no data]

Constituent	Method	SRWS	n	mean, mg/L	s	%RSD	MPV	Fs	Percent error
Alkalinity (as HCO_3)	Titration	M134	14	75.7	1.0	1	76.7		-1.2
Alkalinity (as HCO_3)	Titration	M156	4	75.6	0.2	0	75.4	3.1	0.3
Aluminum (Al)	GFAAS	T107	7	0.232	0.024	10	0.22		5.4
Aluminum (Al)	GFAAS	T159	10	0.034	0.003	8	0.0319	0.0037	7.6
Aluminum (Al)	GFAAS	T173	8	0.065	0.008	12	0.071	0.005	-8.3
Aluminum (Al)	ICP-MS	PPREE	8	11.6	0.5	4	11.5	0.8	1.3
Aluminum (Al)	ICP-MS	SCREE	8	12.7	0.7	6	11.2	1.2	13.0
Aluminum (Al)	ICP-MS	T135	12	0.009	0.001	7	0.0105	0.0068	-11.9
Aluminum (Al)	ICP-MS	T153	12	0.037	0.002	7	0.035	0.0051	6.4
Aluminum (Al)	ICP-MS	T157	12	0.057	0.002	3	0.0555	0.0087	2.2
Aluminum (Al)	ICP-OES	T159	40	<0.07	---	---	0.0319	0.0037	---
Aluminum (Al)	ICP-OES	T163	49	<0.07	---	---	0.0168	0.0017	---
Aluminum (Al)	ICP-OES	T173	9	<0.07	---	---	0.071	0.005	---
Antimony (Sb)	ICP-MS	T135	12	0.076	0.001	2	0.0763	0.0087	-0.3
Antimony (Sb)	ICP-MS	T153	12	0.026	0.000	2	0.0257	0.0025	2.0
Antimony (Sb)	ICP-MS	T157	12	0.011	0.000	1	0.0108	0.0009	-1.0
Arsenic (As)	ICP-MS	T135	12	0.010	0.000	2	0.01	0.0011	-0.1
Arsenic (As)	ICP-MS	T153	12	0.0003	0.000	13	0.0005	0.00024	-39.8
Arsenic (As)	ICP-MS	T157	12	0.025	0.000	2	0.0254	0.0023	0.2
Arsenic (As)	ICP-OES	T159	40	<0.04	---	---	0.0284	0.0016	---
Arsenic (As)	ICP-OES	T163	49	<0.04	---	---	0.0253	0.0018	---
Arsenic (As)	ICP-OES	T173	9	<0.04	---	---	0.00267	0.0003	---
Barium (Ba)	ICP-MS	T135	12	0.068	0.002	3	0.0678	0.0043	0.1
Barium (Ba)	ICP-MS	T153	12	0.183	0.004	2	0.184	0.008	-0.4
Barium (Ba)	ICP-MS	T157	12	0.119	0.003	2	0.118	0.005	0.5
Barium (Ba)	ICP-OES	T159	40	0.038	0.002	4	0.0381	0.0019	0.3
Barium (Ba)	ICP-OES	T163	49	0.008	0.000	6	0.0074	0.0005	1.6
Barium (Ba)	ICP-OES	T173	9	0.043	0.002	6	0.0422	0.0020	1.3
Beryllium (Be)	ICP-MS	T135	12	0.059	0.001	2	0.059	0.0026	0.3
Beryllium (Be)	ICP-MS	T153	12	0.000004	0.000003	81	---	---	---
Beryllium (Be)	ICP-MS	T157	12	0.013	0.000	3	0.013	0.001	1.5
Beryllium (Be)	ICP-OES	T159	40	0.011	0.000	5	0.0108	0.0004	2.3
Beryllium (Be)	ICP-OES	T163	49	0.023	0.001	6	0.022	0.001	2.5
Beryllium (Be)	ICP-OES	T173	9	0.002	0.000	11	0.002	0.0001	5.7
Bismuth (Bi)	ICP-MS	T135	12	0.00000002	0.00000063	3953	---	---	---
Bismuth (Bi)	ICP-MS	T153	12	0.000003	0.000002	88	---	---	---
Bismuth (Bi)	ICP-MS	T157	12	<0.0000002	---	---	---	---	---

Table 4. Measurement of standard reference water samples—Continued

[CVAFS, cold-vapor atomic fluorescence spectrometry; Fs, F-pseudosigma (deviation); GFAAS, graphite furnace atomic absorption spectrometry; HGAAS, hydride generation atomic absorption spectrometry; IC, ion chromatography; ICP-MS, inductively coupled plasma-mass spectrometry; ICP-OES, inductively coupled plasma-optical emission spectrometry; ISE, ion selective electrode; mg/L, milligrams per liter; MPV, most probable value; n, number of analyses; s, standard deviation; SRWS, standard reference water sample; %RSD, percent relative standard deviation; <, less than; ---, no data]

Constituent	Method	SRWS	n	mean, mg/L	s	%RSD	MPV	Fs	Percent error
Boron (B)	ICP-OES	T159	40	0.025	0.004	15	0.0264	0.0030	-4.1
Boron (B)	ICP-OES	T163	49	0.010	0.003	31	0.0106	0.0024	-10.1
Boron (B)	ICP-OES	M156	10	0.088	0.002	2	0.0786	0.0051	11.3
Boron (B)	ICP-OES	T173	9	0.161	0.021	13	0.158	0.012	2.0
Boron (B)	ICP-OES	M166	9	0.155	0.010	7	0.150	0.007	3.2
Boron (B)	ICP-MS	T135	12	0.011	0.001	10	0.0131	0.0111	-12.3
Boron (B)	ICP-MS	T153	12	0.099	0.006	6	0.0994	0.0074	-0.5
Boron (B)	ICP-MS	T157	12	0.071	0.003	4	0.0704	0.0039	0.9
Calcium (Ca)	ICP-OES	M156	10	32.4	0.9	3	30.2	1.1	7.2
Calcium (Ca)	ICP-OES	T173	9	35.7	3.3	9	34.8	0.96	2.5
Calcium (Ca)	ICP-OES	M166	9	32.4	1.8	6	31.3	1.3	3.7
Cadmium (Cd)	GFAAS	T163	33	0.0068	0.0007	10	0.00659	0.0004	3.4
Cadmium (Cd)	GFAAS	T173	10	0.0013	0.0001	12	0.00126	0.0001	-0.8
Cadmium (Cd)	ICP-MS	T135	12	0.051	0.001	1	0.0505	0.0032	0.4
Cadmium (Cd)	ICP-MS	T153	12	0.016	0.000	1	0.016	0.0011	0.5
Cadmium (Cd)	ICP-MS	T157	12	0.006	0.000	2	0.0058	0.00043	0.2
Cadmium (Cd)	ICP-OES	T159	40	0.025	0.001	6	0.024	0.003	5.1
Cadmium (Cd)	ICP-OES	T163	49	0.007	0.001	8	0.00659	0.0004	8.5
Cadmium (Cd)	ICP-OES	T173	9	<0.002	---	---	0.00126	0.0001	---
Cerium (Ce)	ICP-MS	PPREE	8	0.162	0.005	3	0.163	0.01	-0.7
Cerium (Ce)	ICP-MS	SCREE	8	0.024	0.001	3	0.02460	0.00220	-0.6
Cesium (Cs)	ICP-MS	T135	12	<0.00017	---	---	---	---	---
Cesium (Cs)	ICP-MS	T153	12	<0.00017	---	---	---	---	---
Cesium (Cs)	ICP-MS	T157	12	<0.00018	---	---	---	---	---
Chloride (Cl)	IC	M136	4	93.7	4.8	5	92	2.5	1.8
Chloride (Cl)	IC	M140	3	26.7	1.4	5	25.8	1.4	3.5
Chloride (Cl)	IC	M150	16	19.4	0.4	2	17.0	1.5	14.3
Chloride (Cl)	IC	m156	6	66.3	2.7	4	64.7	1.9	2.4
Chloride (Cl)	IC	M166	23	38.1	2.0	5	36.4	1.3	4.7
Chromium (Cr)	GFAAS	T159	9	0.027	0.004	14	0.0268	0.0018	0.2
Chromium (Cr)	GFAAS	T163	49	0.040	0.003	7	0.0401	0.0022	-0.1
Chromium (Cr)	GFAAS	T173	13	0.0052	0.0004	8	0.00488	0.0003	5.6
Chromium (Cr)	ICP-MS	T135	12	0.076	0.002	2	0.079	0.0055	-3.3
Chromium (Cr)	ICP-MS	T153	12	0.015	0.000	3	0.0149	0.0011	1.1
Chromium (Cr)	ICP-MS	T157	12	0.032	0.001	2	0.0313	0.0021	1.8
Chromium (Cr)	ICP-OES	T159	40	0.028	0.002	6	0.0268	0.0018	4.4
Chromium (Cr)	ICP-OES	T163	49	0.041	0.002	5	0.0401	0.0022	3.1
Chromium (Cr)	ICP-OES	T173	9	0.007	0.001	17	0.00488	0.0003	43.2

Table 4. Measurement of standard reference water samples—Continued

[CVAFS, cold-vapor atomic fluorescence spectrometry; Fs, F-pseudosigma (deviation); GFAAS, graphite furnace atomic absorption spectrometry; HGAAS, hydride generation atomic absorption spectrometry; IC, ion chromatography; ICP-MS, inductively coupled plasma-mass spectrometry; ICP-OES, inductively coupled plasma-optical emission spectrometry; ISE, ion selective electrode; mg/L, milligrams per liter; MPV, most probable value; n, number of analyses; s, standard deviation; SRWS, standard reference water sample; %RSD, percent relative standard deviation; <, less than; ---, no data]

Constituent	Method	SRWS	n	mean, mg/L	s	%RSD	MPV	Fs	Percent error
Cobalt (Co)	GFAAS	T159	26	0.014	0.001	8	0.0133	0.0009	5.1
Cobalt (Co)	GFAAS	T163	2	0.014	0.001	8	0.012	0.0004	17.8
Cobalt (Co)	GFAAS	T173	2	0.001	0.000	18	0.00126	0.0001	-12.3
Cobalt (Co)	ICP-MS	T135	12	0.039	0.000	1	0.04	0.0026	-3.3
Cobalt (Co)	ICP-MS	T153	12	0.000053	0.000006	12	---	---	---
Cobalt (Co)	ICP-MS	T157	12	0.004	0.000	2	0.00403	0.00061	-1.9
Cobalt (Co)	ICP-OES	T159	40	0.014	0.001	7	0.0133	0.0009	3.8
Cobalt (Co)	ICP-OES	T163	49	0.013	0.001	8	0.012	0.0004	9.9
Cobalt (Co)	ICP-OES	T173	9	<0.007	---	---	0.00126	0.0001	---
Cobalt (Co)	ICP-OES	T159	40	0.014	0.001	7	0.0133	0.0009	3.8
Cobalt (Co)	ICP-OES	T163	49	0.013	0.001	8	0.012	0.0004	9.9
Cobalt (Co)	ICP-OES	T173	9	<0.007	---	---	0.00126	0.0001	---
Copper (Cu)	GFAAS	T159	20	0.035	0.004	11	0.0334	0.0025	4.6
Copper (Cu)	GFAAS	T163	11	0.034	0.004	12	0.0358	0.0017	-6.2
Copper (Cu)	GFAAS	T173	18	0.008	0.001	11	0.0075	0.0006	12.7
Copper (Cu)	ICP-MS	T135	12	0.062	0.001	2	0.062	0.0042	-0.6
Copper (Cu)	ICP-MS	T153	12	0.024	0.001	2	0.024	0.0015	0.6
Copper (Cu)	ICP-MS	T157	12	0.025	0.001	3	0.0248	0.0018	0.2
Copper (Cu)	ICP-OES	T159	40	0.034	0.002	6	0.0334	0.0025	3.2
Copper (Cu)	ICP-OES	T163	49	0.037	0.004	11	0.0358	0.0017	3.6
Copper (Cu)	ICP-OES	T173	9	0.008	0.003	35	0.0075	0.0006	9.6
Dysprosium (Dy)	ICP-MS	PPREE	8	0.022	0.001	3	0.022	0.0007	-0.5
Dysprosium (Dy)	ICP-MS	SCREE	8	0.0083	0.0003	4	0.00814	0.00034	2.1
Dysprosium (Dy)	ICP-MS	T135	12	0.0000046	0.0000006	14	---	---	---
Dysprosium (Dy)	ICP-MS	T153	12	0.0000045	0.0000005	12	---	---	---
Dysprosium (Dy)	ICP-MS	T157	12	0.0000051	0.0000004	8	---	---	---
Erbium (Er)	ICP-MS	PPREE	8	0.012	0.000	3	0.012	0.00	-0.9
Erbium (Er)	ICP-MS	SCREE	8	0.004	0.000	6	0.00437	0.00021	1.8
Erbium (Er)	ICP-MS	T135	12	0.000006	0.000001	10	---	---	---
Erbium (Er)	ICP-MS	T153	12	0.0000031	0.0000005	17	---	---	---
Erbium (Er)	ICP-MS	T157	12	0.0000032	0.0000006	19	---	---	---
Europium (Eu)	ICP-MS	PPREE	8	0.006	0.000	5	0.006	0.000	1.4
Europium (Eu)	ICP-MS	SCREE	8	0.002	0.000	6	0.00148	0.00007	3.6
Europium (Eu)	ICP-MS	T135	12	0.0000009	0.0000023	255	---	---	---
Europium (Eu)	ICP-MS	T153	12	<0.0000006	---	---	---	---	---
Europium (Eu)	ICP-MS	T157	12	0.0000012	0.0000033	271	---	---	---

Table 4. Measurement of standard reference water samples—Continued

[CVAFS, cold-vapor atomic fluorescence spectrometry; Fs, F-pseudosigma (deviation); GFAAS, graphite furnace atomic absorption spectrometry; HGAAS, hydride generation atomic absorption spectrometry; IC, ion chromatography; ICP-MS, inductively coupled plasma-mass spectrometry; ICP-OES, inductively coupled plasma-optical emission spectrometry; ISE, ion selective electrode; mg/L, milligrams per liter; MPV, most probable value; n, number of analyses; s, standard deviation; SRWS, standard reference water sample; %RSD, percent relative standard deviation; <, less than; ---, no data]

Constituent	Method	SRWS	n	mean, mg/L	s	%RSD	MPV	Fs	Percent error
Fluoride (F)	ISE	M150	16	1.00	0.04	4	1.00	0.07	-0.1
Fluoride (F)	ISE	M166	1	0.72	---	---	0.690	0.060	4.1
Gadolinium (Gd)	ICP-MS	PPREE	8	0.024	0.001	3	0.024	0.00	-0.5
Gadolinium (Gd)	ICP-MS	SCREE	8	0.009	0.000	3	0.00829	0.00065	3.3
Holmium (Ho)	ICP-MS	PPREE	8	0.004	0.000	3	0.004	0.000	-0.5
Holmium (Ho)	ICP-MS	SCREE	8	0.002	0.000	3	0.00162	0.00006	3.4
Total iron (Fe(T))	FerroZine	AMW4	9	192	3.19	2	188	12	2.1
Total iron (Fe(T))	FerroZine	T163	6	0.06	0.00	4	0.060	0.006	4.3
Total iron (Fe(T))	ICP-OES	T159	40	0.049	0.004	8	0.0489	0.0062	0.5
Total iron (Fe(T))	ICP-OES	T163	49	0.059	0.005	9	0.060	0.006	-1.2
Total iron (Fe(T))	ICP-OES	T173	7	0.022	0.003	16	0.0214	0.0034	4.0
Lanthanum (La)	ICP-MS	PPREE	8	0.080	0.002	3	0.080	0.01	-0.1
Lanthanum (La)	ICP-MS	SCREE	8	0.010	0.000	2	0.00990	0.00073	2.8
Lead (Pb)	GFAAS	T159	38	0.0168	0.0018	10	0.0166	0.0012	1.3
Lead (Pb)	GFAAS	T173	53	0.0049	0.0005	9	0.00459	0.0004	6.2
Lead (Pb)	ICP-MS	T135	12	0.102	0.002	2	0.103	0.007	-1.1
Lead (Pb)	ICP-MS	T153	12	0.047	0.001	2	0.0462	0.003	0.9
Lead (Pb)	ICP-MS	T157	12	0.007	0.000	2	0.0069	0.00071	0.3
Lead (Pb)	ICP-OES	T159	40	0.018	0.002	11	0.0166	0.0012	6.4
Lead (Pb)	ICP-OES	T163	49	0.035	0.003	8	0.032	0.0022	9.9
Lead (Pb)	ICP-OES	T173	9	<0.008	---	---	0.00459	0.0004	---
Lithium (Li)	ICP-MS	T135	12	0.072	0.002	3	0.0737	0.0052	-2.2
Lithium (Li)	ICP-MS	T153	12	0.054	0.002	4	0.0534	0.0036	1.6
Lithium (Li)	ICP-MS	T157	12	0.033	0.001	4	0.0324	0.0026	3.3
Lithium (Li)	ICP-OES	T159	40	0.010	0.001	6	0.00857	0.0019	12.9
Lithium (Li)	ICP-OES	T163	49	0.001	0.000	16	0.0016	0.0010	-30.3
Lithium (Li)	ICP-OES	T173	9	0.020	0.018	86	0.0171	0.0016	18.8
Lutetium (Lu)	ICP-MS	PPREE	8	0.001	0.000	5	0.001	0.00003	-1.8
Lutetium (Lu)	ICP-MS	SCREE	8	0.00047	0.00003	6	0.00045	0.00001	2.9
Magnesium (Mg)	ICP-OES	T159	40	5.64	0.20	4	5.60	0.21	0.6
Magnesium (Mg)	ICP-OES	T163	49	1.24	0.08	6	1.23	0.07	1.2
Magnesium (Mg)	ICP-OES	M156	10	7.25	0.21	3	6.92	0.32	4.8
Magnesium (Mg)	ICP-OES	T173	7	9.63	0.66	7	9.38	0.30	2.6
Magnesium (Mg)	ICP-OES	M166	9	19.5	0.9	5	18.5	0.67	5.5

Table 4. Measurement of standard reference water samples—Continued

[CVAFS, cold-vapor atomic fluorescence spectrometry; Fs, F-pseudosigma (deviation); GFAAS, graphite furnace atomic absorption spectrometry; HGAAS, hydride generation atomic absorption spectrometry; IC, ion chromatography; ICP-MS, inductively coupled plasma-mass spectrometry; ICP-OES, inductively coupled plasma-optical emission spectrometry; ISE, ion selective electrode; mg/L, milligrams per liter; MPV, most probable value; n, number of analyses; s, standard deviation; SRWS, standard reference water sample; %RSD, percent relative standard deviation; <, less than; ---, no data]

Constituent	Method	SRWS	n	mean, mg/L	s	%RSD	MPV	Fs	Percent error
Manganese (Mn)	ICP-MS	T135	12	0.429	0.007	2	0.423	0.02	1.5
Manganese (Mn)	ICP-MS	T153	12	0.082	0.002	3	0.0745	0.0033	9.5
Manganese (Mn)	ICP-MS	T157	12	0.139	0.004	3	0.143	0.014	-2.7
Manganese (Mn)	ICP-OES	T159	40	0.022	0.001	4	0.022	0.0016	1.9
Manganese (Mn)	ICP-OES	T163	48	0.016	0.001	9	0.0158	0.0011	1.1
Manganese (Mn)	ICP-OES	T173	8	0.482	0.061	13	0.495	0.025	-2.6
Mercury (Hg)	CVAFS	Hg15	8	410[3]	13[3]	3	410[3]	200[3]	0.0
Mercury (Hg)	CVAFS	Hg22	8	1100[3]	32[3]	3	1240[3]	130[3]	-11.3
Mercury (Hg)	CVAFS	Hg26	8	717[3]	52[3]	7	700[3]	90[3]	2.4
Molybdenum (Mo)	ICP-MS	T135	12	0.063	0.001	1	0.063	0.0051	-0.5
Molybdenum (Mo)	ICP-MS	T153	12	0.154	0.002	1	0.154	0.008	0.3
Molybdenum (Mo)	ICP-MS	T157	12	0.012	0.000	3	0.013	0.001	-5.6
Molybdenum (Mo)	ICP-OES	T159	40	0.037	0.003	8	0.0414	0.0026	-11.0
Molybdenum (Mo)	ICP-OES	T163	49	0.012	0.002	18	0.0126	0.0009	-7.7
Molybdenum (Mo)	ICP-OES	T173	9	<0.007	---	---	0.00722	0.0004	---
Neodymium (Nd)	ICP-MS	PPREE	8	0.093	0.002	2	0.093	0.0057	-0.5
Neodymium (Nd)	ICP-MS	SCREE	8	0.023	0.001	3	0.02220	0.00090	4.3
Nickel (Ni)	GFAAS	T159	10	0.024	0.002	6	0.0222	0.0016	8.3
Nickel (Ni)	GFAAS	T163	19	0.016	0.002	12	0.0154	0.0013	7.0
Nickel (Ni)	GFAAS	T173	6	0.0048	0.0013	27	0.00538	0.0004	-10.7
Nickel (Ni)	ICP-MS	T135	12	0.064	0.002	2	0.0656	0.005	-2.7
Nickel (Ni)	ICP-MS	T153	12	0.033	0.001	2	0.0322	0.0021	1.2
Nickel (Ni)	ICP-MS	T157	12	0.030	0.001	3	0.03	0.003	1.1
Nickel (Ni)	ICP-OES	T159	40	0.023	0.001	5	0.0222	0.0016	5.3
Nickel (Ni)	ICP-OES	T163	49	0.017	0.001	7	0.0154	0.0013	7.8
Nickel (Ni)	ICP-OES	T173	9	0.006	0.004	61	0.00538	0.0004	18.6
Potassium (K)	ICP-OES	T159	40	1.83	0.09	5	1.52	0.13	20.3
Potassium (K)	ICP-OES	T163	49	1.02	0.07	7	1.02	0.14	0.4
Potassium (K)	ICP-OES	M156	10	2.55	0.09	3	2.13	0.16	19.6
Potassium (K)	ICP-OES	T173	9	3.86	0.91	24	3.85	0.13	0.2
Potassium (K)	ICP-OES	M166	8	4.53	0.13	3	4.37	0.19	3.7
Praseodymium (Pr)	ICP-MS	PPREE	8	0.021	0.001	3	0.021	0.00	-1.1
Praseodymium (Pr)	ICP-MS	SCREE	8	0.004	0.000	3	0.00431	0.00028	2.6
Selenium (Se)	GFAAS	T159	2	0.0048	0.0000	0	0.00549	0.0008	-11.7
Selenium (Se)	GFAAS	T163	14	0.0085	0.0007	8	0.00888	0.0011	-3.8

Table 4. Measurement of standard reference water samples—Continued

[CVAFS, cold-vapor atomic fluorescence spectrometry; Fs, F-pseudosigma (deviation); GFAAS, graphite furnace atomic absorption spectrometry; HGAAS, hydride generation atomic absorption spectrometry; IC, ion chromatography; ICP-MS, inductively coupled plasma-mass spectrometry; ICP-OES, inductively coupled plasma-optical emission spectrometry; ISE, ion selective electrode; mg/L, milligrams per liter; MPV, most probable value; n, number of analyses; s, standard deviation; SRWS, standard reference water sample; %RSD, percent relative standard deviation; <, less than; ---, no data]

Constituent	Method	SRWS	n	mean, mg/L	s	%RSD	MPV	Fs	Percent error
Selenium (Se)	ICP-MS	T153	12	0.009	0.000	3	0.009	0.00133	-0.9
Selenium (Se)	ICP-MS	T157	12	0.002	0.003	160	0.0046	0.00066	-61.0
Selenium (Se)	ICP-OES	T159	40	<0.04	---	---	0.00549	0.0008	---
Selenium (Se)	ICP-OES	T163	49	<0.04	---	---	0.00888	0.0011	---
Selenium (Se)	ICP-OES	T173	9	<0.04	---	---	0.00247	0.0005	---
Silica (SiO_2)	ICP-OES	T159	40	11.5	0.5	4	11.5	0.7	0.3
Silica (SiO_2)	ICP-OES	T163	49	4.57	0.26	6	4.56	0.19	0.2
Silica (SiO_2)	ICP-OES	M156	10	5.18	0.16	3	4.73	0.31	9.4
Silica (SiO_2)	ICP-OES	T173	8	11.0	1.4	13	11.1	0.4	-0.7
Silica (SiO_2)	ICP-OES	M166	9	12.2	0.7	5	11.7	0.5	4.5
Samarium (Sm)	ICP-MS	PPREE	8	0.020	0.001	3	0.020	0.002	-0.2
Samarium (Sm)	ICP-MS	SCREE	8	0.007	0.000	4	0.00674	0.00031	6.9
Sodium (Na)	ICP-OES	T159	40	97.2	4.0	4	100	4	-2.8
Sodium (Na)	ICP-OES	T163	49	39.3	2.7	7	39.6	1.9	-0.7
Sodium (Na)	ICP-OES	M156	10	47.9	2.1	4	44.6	2.3	7.4
Sodium (Na)	ICP-OES	T173	8	38.3	2.2	6	36.5	1.0	4.9
Sodium (Na)	ICP-OES	M166	9	26.4	1.5	6	25.1	1.0	5.1
Sulfate (SO_4)	IC	M136	7	155	2.4	2	150	6	3.5
Sulfate (SO_4)	IC	M140	5	153	1.6	1	150	7	1.9
Sulfate (SO_4)	IC	M150	17	5.3	0.3	6	5.50	0.54	-3.4
Sulfate (SO_4)	IC	M156	28	42.0	1.8	4	43.0	1.8	-2.4
Sulfate (SO_4)	IC	M166	25	55.7	2.5	4	56.2	2.1	-0.9
Strontium (Sr)	ICP-MS	T135	12	0.048	0.001	1	0.046	0.0023	3.8
Strontium (Sr)	ICP-MS	T153	12	0.309	0.005	2	0.311	0.013	-0.7
Strontium (Sr)	ICP-MS	T157	12	0.061	0.001	2	0.0596	0.0024	1.7
Strontium (Sr)	ICP-OES	T159	40	0.188	0.005	3	0.19	0.007	-0.9
Strontium (Sr)	ICP-OES	T163	49	0.036	0.002	6	0.0355	0.0018	0.9
Strontium (Sr)	ICP-OES	M156	10	0.258	0.007	3	0.239	0.01	7.8
Strontium (Sr)	ICP-OES	T173	8	0.274	0.018	7	0.279	0.008	-1.9
Strontium (Sr)	ICP-OES	M166	9	0.261	0.010	4	0.249	0.007	5.0
Terbium (Tb)	ICP-MS	PPREE	8	0.004	0.000	2	0.004	0.000	-0.4
Terbium (Tb)	ICP-MS	SCREE	8	0.001	0.000	4	0.00134	0.00007	-0.3
Tellurium (Te)	ICP-MS	PPREE	8	0.00014	0.00027	194	<0.00001	---	---
Tellurium (Te)	ICP-MS	SCREE	8	0.00005	0.00040	857	0.000022	---	110

Table 4. Measurement of standard reference water samples—Continued

[CVAFS, cold-vapor atomic fluorescence spectrometry; Fs, F-pseudosigma (deviation); GFAAS, graphite furnace atomic absorption spectrometry; HGAAS, hydride generation atomic absorption spectrometry; IC, ion chromatography; ICP-MS, inductively coupled plasma-mass spectrometry; ICP-OES, inductively coupled plasma-optical emission spectrometry; ISE, ion selective electrode; mg/L, milligrams per liter; MPV, most probable value; n, number of analyses; s, standard deviation; SRWS, standard reference water sample; %RSD, percent relative standard deviation; <, less than; ---, no data]

Constituent	Method	SRWS	n	mean, mg/L	s	%RSD	MPV	Fs	Percent error
Thorium (Th)	ICP-MS	T135	12	0.000009	0.000001	17	---	---	---
Thorium (Th)	ICP-MS	T153	12	0.000009	0.000003	32	---	---	---
Thorium (Th)	ICP-MS	T157	12	0.0000052	0.0000027	51	---	---	---
Thallium (Tl)	ICP-MS	T153	12	0.020	0.000	2	0.0204	0.0019	-0.8
Thallium (Tl)	ICP-MS	T157	12	0.009	0.000	3	0.00875	0.0007	3.4
Thulium (Tm)	ICP-MS	PPREE	8	0.001	0.000	4	0.001	0.000	-1.4
Thulium (Tm)	ICP-MS	SCREE	8	0.001	0.000	4	0.00059	0.00002	3.3
Uranium (U)	ICP-MS	T153	12	0.007	0.000	3	0.0069	0.0004	2.7
Uranium (U)	ICP-MS	T157	12	0.003	0.000	3	0.00319	0.00019	-2.0
Vanadium (V)	ICP-OES	T159	40	0.014	0.001	6	0.0144	0.0017	-1.4
Vanadium (V)	ICP-OES	T163	49	0.035	0.002	6	0.035	0.002	0.9
Vanadium (V)	ICP-OES	M156	10	0.010	0.000	4	0.0095	0.0017	5.2
Vanadium (V)	ICP-OES	T173	9	0.004	0.001	15	0.00431	0.0002	-3.7
Vanadium (V)	ICP-OES	M166	9	0.017	0.002	10	0.0172	0.0010	-0.7
Vanadium (V)	ICP-MS	T135	12	0.053	0.001	2	0.0528	0.0036	-0.3
Vanadium (V)	ICP-MS	T153	12	0.019	0.000	2	0.019	0.001	0.3
Vanadium (V)	ICP-MS	T157	12	0.016	0.000	2	0.0157	0.001	1.5
Tungsten (W)	ICP-MS	T135	12	0.000020	0.000004	20	---	---	---
Tungsten (W)	ICP-MS	T153	12	0.000040	0.000005	13	---	---	---
Tungsten (W)	ICP-MS	T157	12	0.000087	0.000005	6	---	---	---
Yttrium (Y)	ICP-MS	PPREE	8	0.134	0.003	2	0.134	0.006	0
Yttrium (Y)	ICP-MS	SCREE	8	0.048	0.001	1	0.047	0.0041	1
Yttrium (Y)	ICP-MS	T135	12	0.000028	0.000001	3	---	---	---
Yttrium (Y)	ICP-MS	T153	12	0.000031	0.000001	3	---	---	---
Yttrium (Y)	ICP-MS	T157	12	0.000031	0.000001	4	---	---	---
Ytterbium (Yb)	ICP-MS	PPREE	8	0.008	0.000	4	0.0082	0.0001	-1
Ytterbium (Yb)	ICP-MS	SCREE	8	0.003	0.000	5	0.00340	0.00017	-2
Zinc (Zn)	ICP-MS	T135	12	0.049	0.002	4	0.0482	0.0047	2.5
Zinc (Zn)	ICP-MS	T153	12	0.072	0.002	3	0.0726	0.0051	-0.6
Zinc (Zn)	ICP-MS	T157	12	0.024	0.001	5	0.0235	0.0031	1.0
Zinc (Zn)	ICP-OES	T159	40	0.020	0.002	8	0.0192	0.0019	2.0
Zinc (Zn)	ICP-OES	T163	49	0.020	0.002	10	0.0185	0.0013	6.8
Zinc (Zn)	ICP-OES	T173	9	0.359	0.024	7	0.348	0.019	3.3

Charge Balance Calculations

Filtered sample data were checked for charge imbalance (C.I.) using the program WATEQ4F (Ball and Nordstrom, 1991). WATEQ4F uses equation 2 to calculate C.I.:

$$C.I.(\mathit{percent}) = \frac{(\text{sum cations} - \text{sum anions})}{(\text{sum cations} + \text{sum anions})/2} \times 100 \qquad (2)$$

where sum cations is the sum of the cations in milliequivalents per liter (meq/L) and sum anions is the sum of the anions in meq/L. This calculation is twice the value that is typically reported by an analytical laboratory, because equation 2 divides the difference between the sum cations and sum anions by the average of the two rather than by the sum of the ions. The calculation is performed twice by WATEQ4F, once for analytical C.I. and once after speciation for speciated C.I. More information on WATEQ4F can be found at: http://wwwbrr.cr.usgs.gov/projects/GWC_chemtherm/software.htm.

Acid waters can have a greater difference between analytical and speciated C.I. At low pH, speciated C.I. is a more accurate measure of C.I. and it is reported along with the sum cations (meq/L), sum anions (meq/L), and chemical data in each report (Naus and others, 2004; D.K. Nordstrom, USGS, written commun., 2004; P.L. Verplanck, USGS, written commun., 2004).

The distribution of the charge imbalances are shown in figure 3 along with the normal (or Gaussian) distribution fit for 257 samples and the limits for two standard deviations. Two hundred fifty-one of the values fall within ± 11.8 percent charge imbalance (two standard deviations) and are considered to be of high quality.

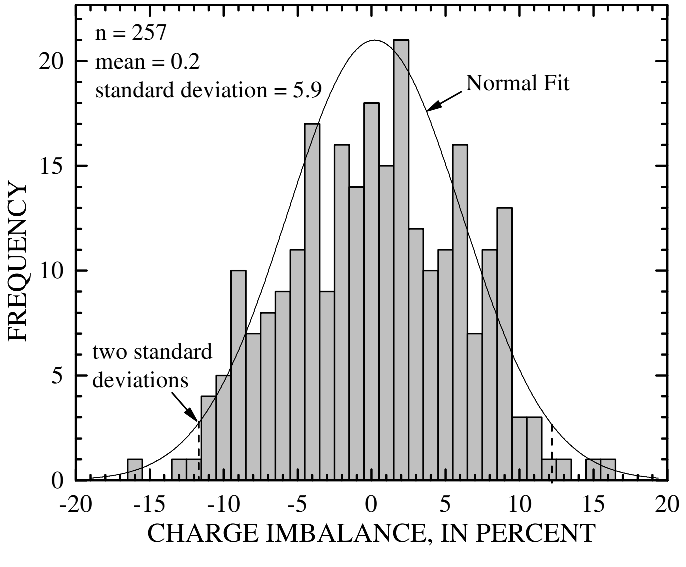


Figure 3. Frequency distribution of charge imbalance in percent using equation 2.

Analyses of Blanks

Water analyses are reported for 72 blanks in table 5. Several blanks were analyzed by multiple methods for aluminum, arsenic, cadmium, chromium, cobalt, copper, fluoride, iron, lead, nickel, and selenium. The results generated by the analytical method with the lowest detection limit are reported. Blanks collected using water deionized with anion and cation exchange resins contained elevated concentrations of boron (0.17 mg/L) and silica (3.90 mg/L). Boron and silica were not completely retained by the resins probably because they can exist as uncharged species in water. Chloride was detected in ten blanks, the highest being 3.9 mg/L, because of washing bottles, filter apparatuses, and tubing with hydrochloric acid. Sulfate was detected in seven blanks, the highest being 3.0 mg/L. Sulfate is frequently above 1,000 mg/L in several of the water samples collected for the investigation and the measured sulfate in the blanks is often less than the error of the measured concentration for the samples. With a few exceptions, the remaining analyses were near or below method detection limits.

Table 5. Measurement of blanks

[DIW, deionized water; ID, identification; GW, ground water; µm, micrometer; mg/L, milligrams per liter; RA, unfiltered-unacidified; SW, surface water; <, less than; ---, no data]

Sample ID	**Equipment Blank**	**Trip Blank**	**Equipment Blank**	**Trip Blank**
Collection Date	9/14/01	9/14/01	3/21/02	3/21/02
Filtration	0.1 µm - plate	RA	0.45 µm - capsule	RA
Constituent, mg/L				
Calcium (Ca)	<0.4	<0.4	<0.4	<0.4
Magnesium (Mg)	<0.04	<0.04	<0.04	<0.04
Sodium (Na)	<0.05	<0.05	<0.05	<0.05
Potassium (K)	<0.02	<0.02	<0.02	<0.02
Sulfate (SO_4)	1.6	---	<0.3	---
Alkalinity (as HCO_3)	---	---	<1	---
Fluoride (F)	0.3	---	<0.1	---
Chloride (Cl)	2.0	---	<0.09	---
Bromide (Br)	<0.1	---	<0.1	---
Silica (SiO_2)	<0.06	<0.06	<0.06	<0.06
Aluminum (Al)	<0.07	<0.07	<0.07	<0.07
Iron Total (Fe(T))	0.002	<0.007	0.005	<0.007
Ferrous Iron (Fe(II))	<0.002	---	---	---
Boron (B)	<0.01	<0.01	<0.01	<0.01
Lithium (Li)	<0.001	<0.001	<0.001	<0.001
Strontium (Sr)	<0.0003	<0.0003	<0.0003	<0.0003
Barium (Ba)	<0.0008	<0.0008	<0.0008	<0.0008
Manganese (Mn)	<0.002	<0.002	<0.002	<0.002
Zinc (Zn)	<0.005	<0.005	<0.005	<0.005
Lead (Pb)	<0.008	<0.008	<0.008	<0.008
Nickel (Ni)	<0.002	<0.002	<0.002	<0.002
Copper (Cu)	<0.002	<0.002	<0.002	<0.002
Cadmium (Cd)	<0.002	<0.002	<0.002	<0.002
Chromium (Cr)	<0.002	<0.002	<0.002	<0.002
Cobalt (Co)	0.0010	0.0010	<0.007	<0.007
Beryllium (Be)	<0.001	<0.001	<0.001	<0.001
Molybdenum (Mo)	<0.007	<0.007	<0.007	<0.007
Vanadium (V)	<0.002	<0.002	<0.002	<0.002
Arsenic (As)	<0.0001	<0.04	<0.0001	<0.04
Selenium (Se)	<0.04	<0.04	<0.04	<0.04
Mercury (Hg)	---	---	---	---
Dissolved Organic Carbon (DOC)	---	---	---	---

Table 5. Measurement of blanks—Continued

[DIW, deionized water; ID, identification; GW, ground water; µm, micrometer; mg/L, milligrams per liter; RA, unfiltered-unacidified; SW, surface water; <, less than; ---, no data]

Sample ID	**GW Field Blank**	**Trip Blank**	**Equipment Blank**	**Equipment Blank**
Collection Date	3/26/02	3/26/02	3/26/02	3/27/02
Filtration	RA	RA	0.1 µm - plate	0.1 µm - plate
Constituent, mg/L				
Calcium (Ca)	<0.4	<0.4	<0.4	<0.4
Magnesium (Mg)	<0.04	<0.04	<0.04	<0.04
Sodium (Na)	<0.05	<0.05	<0.05	<0.05
Potassium (K)	<0.02	<0.02	<0.02	<0.02
Sulfate (SO_4)	---	---	<0.3	<0.3
Alkalinity (as HCO_3)	---	---	---	<1
Fluoride (F)	---	---	<0.1	<0.1
Chloride (Cl)	---	---	<0.09	2.7
Bromide (Br)	---	---	<0.1	<0.1
Silica (SiO_2)	<0.06	<0.06	<0.06	<0.06
Aluminum (Al)	<0.001	<0.001	<0.07	<0.07
Iron Total (Fe(T))	<0.007	<0.007	<0.002	<0.002
Ferrous Iron (Fe(II))	---	---	<0.002	<0.002
Boron (B)	<0.01	<0.01	<0.01	<0.01
Lithium (Li)	<0.001	<0.001	<0.001	<0.001
Strontium (Sr)	<0.0003	<0.0003	<0.0003	<0.0003
Barium (Ba)	<0.0008	<0.0008	<0.0008	<0.0008
Manganese (Mn)	<0.002	<0.002	<0.002	<0.002
Zinc (Zn)	<0.005	<0.005	<0.005	<0.005
Lead (Pb)	0.0030	0.0030	<0.008	<0.008
Nickel (Ni)	<0.0005	<0.0005	<0.002	<0.002
Copper (Cu)	0.0009	0.0009	<0.002	<0.002
Cadmium (Cd)	<0.0002	<0.0002	<0.002	<0.002
Chromium (Cr)	<0.0005	<0.0005	<0.002	<0.002
Cobalt (Co)	<0.0008	<0.0008	<0.007	<0.007
Beryllium (Be)	<0.001	<0.001	<0.001	<0.001
Molybdenum (Mo)	<0.007	<0.007	<0.007	<0.007
Vanadium (V)	<0.002	<0.002	<0.002	<0.002
Arsenic (As)	<0.0001	<0.0001	<0.0001	0.0003
Selenium (Se)	<0.04	<0.04	<0.04	<0.04
Mercury (Hg)	---	---	---	---
Dissolved Organic Carbon (DOC)	---	---	---	---

Table 5. Measurement of blanks—Continued

[DIW, deionized water; ID, identification; GW, ground water; µm, micrometer; mg/L, milligrams per liter; RA, unfiltered-unacidified; SW, surface water; <, less than; ---, no data]

Sample ID	**Trip Blank**	**Trip Blank**	**GW Field Blank**	**Equipment Blank**
Collection Date	3/31/02	4/1/02	4/25/02	5/1/02
Filtration	RA	RA	RA	0.45 µm - capsule
Constituent, mg/L				
Calcium (Ca)	<0.4	<0.4	<0.4	<0.4
Magnesium (Mg)	<0.04	<0.04	<0.04	<0.04
Sodium (Na)	<0.05	<0.05	<0.05	<0.05
Potassium (K)	<0.02	<0.02	<0.02	<0.02
Sulfate (SO_4)	---	---	---	<0.3
Alkalinity (as HCO_3)	---	---	---	---
Fluoride (F)	---	---	---	<0.1
Chloride (Cl)	---	---	---	<0.09
Bromide (Br)	---	---	---	<0.1
Silica (SiO_2)	<0.06	<0.06	<0.06	<0.06
Aluminum (Al)	0.021	0.017	<0.001	<0.07
Iron Total (Fe(T))	<0.007	<0.007	<0.007	<0.002
Ferrous Iron (Fe(II))	---	---	---	<0.002
Boron (B)	<0.01	<0.01	<0.01	<0.01
Lithium (Li)	<0.001	<0.001	<0.001	<0.001
Strontium (Sr)	<0.0003	<0.0003	<0.0003	<0.0003
Barium (Ba)	<0.0008	<0.0008	<0.0008	<0.0008
Manganese (Mn)	<0.002	<0.002	<0.002	<0.002
Zinc (Zn)	<0.005	<0.005	<0.005	<0.005
Lead (Pb)	<0.0003	<0.0003	<0.0003	<0.008
Nickel (Ni)	<0.002	<0.002	<0.0005	<0.002
Copper (Cu)	<0.0005	<0.0005	<0.0005	<0.002
Cadmium (Cd)	<0.0002	<0.0002	<0.0002	<0.002
Chromium (Cr)	0.0007	<0.0005	<0.0005	<0.002
Cobalt (Co)	0.0013	<0.0008	<0.0008	<0.007
Beryllium (Be)	<0.001	<0.001	<0.001	<0.001
Molybdenum (Mo)	<0.007	<0.007	<0.007	<0.007
Vanadium (V)	<0.002	<0.002	<0.002	<0.002
Arsenic (As)	<0.04	<0.04	<0.0001	<0.04
Selenium (Se)	<0.04	<0.04	<0.04	<0.04
Mercury (Hg)	---	---	---	---
Dissolved Organic Carbon (DOC)	---	---	---	---

Table 5. Measurement of blanks—Continued

[DIW, deionized water; ID, identification; GW, ground water; µm, micrometer; mg/L, milligrams per liter; RA, unfiltered-unacidified; SW, surface water; <, less than; ---, no data]

Sample ID	**Trip Blank**	**Trip Blank**	**GW Field Blank**	**Trip Blank**
Collection Date	5/1/02	5/23/02	5/23/02	6/19/02
Filtration	RA	RA	RA	RA
Constituent, mg/L				
Calcium (Ca)	<0.4	<0.4	<0.4	<0.4
Magnesium (Mg)	<0.04	<0.04	<0.04	<0.04
Sodium (Na)	<0.05	<0.05	<0.05	<0.05
Potassium (K)	<0.02	<0.02	<0.02	<0.02
Sulfate (SO_4)	---	---	---	---
Alkalinity (as HCO_3)	---	---	---	---
Fluoride (F)	---	---	---	---
Chloride (Cl)	---	---	---	---
Bromide (Br)	---	---	---	---
Silica (SiO_2)	0.24	<0.06	<0.06	<0.06
Aluminum (Al)	<0.07	<0.001	<0.001	<0.001
Iron Total (Fe(T))	<0.007	<0.007	<0.007	<0.007
Ferrous Iron (Fe(II))	---	---	---	---
Boron (B)	<0.01	<0.01	<0.01	<0.01
Lithium (Li)	<0.001	<0.001	<0.001	<0.001
Strontium (Sr)	<0.0003	<0.0003	<0.0003	<0.0003
Barium (Ba)	<0.0008	<0.0008	<0.0008	<0.0008
Manganese (Mn)	<0.002	<0.002	<0.002	<0.002
Zinc (Zn)	<0.005	<0.005	<0.005	<0.005
Lead (Pb)	<0.008	<0.0003	<0.0003	<0.0003
Nickel (Ni)	<0.002	0.0010	<0.0005	<0.0005
Copper (Cu)	<0.002	<0.0005	0.0008	<0.0005
Cadmium (Cd)	<0.002	<0.0002	<0.0002	<0.0002
Chromium (Cr)	<0.002	<0.0005	<0.0005	<0.0005
Cobalt (Co)	<0.007	<0.0008	<0.0008	<0.0008
Beryllium (Be)	<0.001	<0.001	<0.001	<0.001
Molybdenum (Mo)	<0.007	<0.007	<0.007	<0.007
Vanadium (V)	<0.002	<0.002	<0.002	<0.002
Arsenic (As)	<0.04	<0.0001	<0.0001	<0.0001
Selenium (Se)	<0.04	<0.04	<0.04	<0.04
Mercury (Hg)	---	---	---	---
Dissolved Organic Carbon (DOC)	---	---	---	---

Table 5. Measurement of blanks—Continued

[DIW, deionized water; ID, identification; GW, ground water; µm, micrometer; mg/L, milligrams per liter; RA, unfiltered-unacidified; SW, surface water; <, less than; ---, no data]

Sample ID	**GW Field Blank**	**Trip Blank**	**GW Field Blank**	**Trip Blank**
Collection Date	6/19/02	6/26/02	6/26/02	7/24/02
Filtration	RA	RA	RA	RA
Constituent, mg/L				
Calcium (Ca)	<0.4	<0.4	<0.4	<0.4
Magnesium (Mg)	<0.04	0.07	<0.04	<0.04
Sodium (Na)	<0.05	<0.05	<0.05	0.08
Potassium (K)	<0.02	<0.02	<0.02	0.02
Sulfate (SO_4)	---	---	---	---
Alkalinity (as HCO_3)	---	---	---	---
Fluoride (F)	---	---	---	---
Chloride (Cl)	---	---	---	---
Bromide (Br)	---	---	---	---
Silica (SiO_2)	<0.06	<0.06	<0.06	<0.06
Aluminum (Al)	<0.001	<0.001	<0.001	<0.001
Iron Total (Fe(T))	<0.007	0.043	<0.007	<0.007
Ferrous Iron (Fe(II))	---	---	---	---
Boron (B)	<0.01	<0.01	<0.01	<0.01
Lithium (Li)	<0.001	<0.001	<0.001	<0.001
Strontium (Sr)	<0.0003	<0.0003	<0.0003	0.0009
Barium (Ba)	<0.0008	<0.0008	<0.0008	<0.0008
Manganese (Mn)	<0.002	0.003	<0.002	<0.002
Zinc (Zn)	<0.005	0.005	<0.005	<0.005
Lead (Pb)	<0.008	<0.0003	<0.0003	0.0010
Nickel (Ni)	<0.0005	<0.0005	<0.0005	0.0010
Copper (Cu)	<0.0005	<0.0005	<0.0005	0.0016
Cadmium (Cd)	0.0003	<0.0002	<0.0002	<0.0002
Chromium (Cr)	<0.0005	<0.0005	<0.0005	<0.0005
Cobalt (Co)	<0.0008	<0.0008	<0.0008	<0.0008
Beryllium (Be)	<0.001	<0.001	<0.001	<0.001
Molybdenum (Mo)	<0.007	<0.007	<0.007	<0.007
Vanadium (V)	<0.002	<0.002	<0.002	<0.002
Arsenic (As)	<0.0001	<0.0001	<0.0001	<0.0001
Selenium (Se)	<0.04	<0.04	<0.04	<0.04
Mercury (Hg)	---	---	---	---
Dissolved Organic Carbon (DOC)	---	---	---	---

Table 5. Measurement of blanks—Continued

[DIW, deionized water; ID, identification; GW, ground water; µm, micrometer; mg/L, milligrams per liter; RA, unfiltered-unacidified; SW, surface water; <, less than; ---, no data]

Sample ID	**GW Field Blank**	**Trip Blank**	**Equipment Blank**	**Trip Blank**
Collection Date	7/24/02	8/17/02	8/17/02	8/17/02
Filtration	RA	RA	0.45 µm - capsule	RA
Constituent, mg/L				
Calcium (Ca)	<0.4	<0.4	<0.4	<0.4
Magnesium (Mg)	<0.04	<0.04	<0.04	<0.04
Sodium (Na)	0.07	<0.05	<0.05	<0.05
Potassium (K)	<0.02	<0.02	<0.02	<0.02
Sulfate (SO_4)	---	---	<0.3	---
Alkalinity (as HCO_3)	---	---	2	---
Fluoride (F)	---	---	<0.05	---
Chloride (Cl)	---	---	0.7	---
Bromide (Br)	---	---	<0.1	---
Silica (SiO_2)	<0.06	<0.06	0.20	0.32
Aluminum (Al)	<0.001	<0.001	<0.001	<0.001
Iron Total (Fe(T))	<0.007	<0.007	<0.007	<0.007
Ferrous Iron (Fe(II))	---	---	---	---
Boron (B)	<0.01	<0.01	<0.01	<0.01
Lithium (Li)	<0.001	<0.001	<0.001	<0.001
Strontium (Sr)	0.0008	<0.0003	<0.0003	<0.0003
Barium (Ba)	<0.0008	<0.0008	<0.0008	<0.0008
Manganese (Mn)	<0.002	<0.002	<0.002	<0.002
Zinc (Zn)	<0.005	<0.005	<0.005	<0.005
Lead (Pb)	<0.0003	<0.0003	0.0070	0.0010
Nickel (Ni)	<0.0005	<0.0005	<0.0005	<0.0005
Copper (Cu)	0.0015	<0.0005	<0.0005	0.0009
Cadmium (Cd)	<0.0002	<0.0002	0.0007	0.0002
Chromium (Cr)	<0.0005	<0.0005	<0.0005	<0.0005
Cobalt (Co)	<0.0008	<0.0008	<0.0008	<0.0008
Beryllium (Be)	<0.001	<0.001	<0.001	<0.001
Molybdenum (Mo)	<0.007	<0.007	<0.007	<0.007
Vanadium (V)	<0.002	<0.002	<0.002	<0.002
Arsenic (As)	<0.0001	<0.0001	<0.04	<0.0001
Selenium (Se)	<0.04	<0.04	<0.04	<0.04
Mercury (Hg)	---	---	---	---
Dissolved Organic Carbon (DOC)	---	---	---	---

Table 5. Measurement of blanks—Continued

[DIW, deionized water; ID, identification; GW, ground water; µm, micrometer; mg/L, milligrams per liter; RA, unfiltered-unacidified; SW, surface water; <, less than; ---, no data]

Sample ID	**Equipment Blank - DIW**	**Trip Blank - DIW**	**Trip Blank - DIW**	**SW Field Blank**
Collection Date	8/17/02	8/17/02	8/17/02	8/20/02
Filtration	0.45 µm - capsule	RA	RA	RA
Constituent, mg/L				
Calcium (Ca)	<0.4	<0.4	<0.4	<0.4
Magnesium (Mg)	0.05	<0.04	<0.04	<0.04
Sodium (Na)	<0.05	<0.05	<0.05	<0.05
Potassium (K)	<0.02	<0.02	<0.02	<0.02
Sulfate (SO_4)	<0.3	---	---	<0.3
Alkalinity (as HCO_3)	2	---	---	2
Fluoride (F)	<0.05	---	---	<0.05
Chloride (Cl)	0.8	---	---	1.9
Bromide (Br)	<0.1	---	---	<0.1
Silica (SiO_2)	0.79	0.82	3.90	0.56
Aluminum (Al)	0.003	<0.001	0.008	<0.001
Iron Total (Fe(T))	<0.007	<0.007	<0.007	<0.007
Ferrous Iron (Fe(II))	---	---	---	---
Boron (B)	<0.01	<0.01	0.17	<0.01
Lithium (Li)	<0.001	<0.001	<0.001	<0.001
Strontium (Sr)	<0.0003	<0.0003	<0.0003	<0.0003
Barium (Ba)	<0.0008	<0.0008	<0.0008	<0.0008
Manganese (Mn)	<0.002	<0.002	<0.002	<0.002
Zinc (Zn)	<0.005	0.005	<0.005	<0.005
Lead (Pb)	0.0010	0.0010	0.0010	<0.0003
Nickel (Ni)	0.0010	<0.0005	<0.0005	<0.0005
Copper (Cu)	0.0011	0.0014	0.0019	<0.0005
Cadmium (Cd)	<0.0002	0.0004	0.0002	0.0006
Chromium (Cr)	<0.0005	<0.0005	<0.0005	<0.0005
Cobalt (Co)	<0.0008	<0.0008	<0.0008	<0.0008
Beryllium (Be)	<0.001	<0.001	<0.001	<0.001
Molybdenum (Mo)	<0.007	<0.007	<0.007	<0.007
Vanadium (V)	<0.002	<0.002	<0.002	<0.002
Arsenic (As)	<0.04	<0.0001	<0.0001	<0.0001
Selenium (Se)	<0.04	<0.04	<0.04	<0.04
Mercury (Hg)	---	---	---	---
Dissolved Organic Carbon (DOC)	---	---	---	---

Table 5. Measurement of blanks—Continued

[DIW, deionized water; ID, identification; GW, ground water; µm, micrometer; mg/L, milligrams per liter; RA, unfiltered-unacidified; SW, surface water; <, less than; ---, no data]

Sample ID	**GW Field Blank**	**GW Field Blank - DIW**	**Equipment Blank**	**Equipment Blank**
Collection Date	8/21/02	8/21/02	9/6/02	9/6/02
Filtration	RA	RA	0.45 µm - capsule	0.45 µm - capsule
Constituent, mg/L				
Calcium (Ca)	<0.4	<0.4	<0.4	<0.4
Magnesium (Mg)	<0.04	<0.04	<0.04	<0.04
Sodium (Na)	<0.05	<0.05	<0.05	<0.05
Potassium (K)	<0.02	<0.02	<0.02	<0.02
Sulfate (SO_4)	---	---	<0.3	<0.3
Alkalinity (as HCO_3)	---	---	---	---
Fluoride (F)	---	---	<0.1	<0.1
Chloride (Cl)	---	---	0.6	0.5
Bromide (Br)	---	---	<0.1	<0.1
Silica (SiO_2)	<0.06	3.90	<0.06	<0.06
Aluminum (Al)	0.001	<0.001	<0.07	<0.07
Iron Total (Fe(T))	<0.007	<0.007	<0.002	<0.002
Ferrous Iron (Fe(II))	---	---	<0.002	<0.002
Boron (B)	<0.01	0.17	<0.01	<0.01
Lithium (Li)	<0.001	<0.001	<0.001	<0.001
Strontium (Sr)	<0.0003	<0.0003	<0.0003	<0.0003
Barium (Ba)	<0.0008	<0.0008	<0.0008	<0.0008
Manganese (Mn)	<0.002	<0.002	<0.002	<0.002
Zinc (Zn)	<0.005	<0.005	<0.005	<0.005
Lead (Pb)	0.0004	<0.0003	<0.008	<0.008
Nickel (Ni)	<0.0005	0.0010	<0.002	<0.002
Copper (Cu)	<0.0005	0.0009	<0.002	<0.002
Cadmium (Cd)	0.0008	<0.0002	<0.002	<0.002
Chromium (Cr)	<0.0005	<0.0005	<0.002	<0.002
Cobalt (Co)	<0.0008	<0.0008	<0.007	<0.007
Beryllium (Be)	<0.001	<0.001	<0.001	<0.001
Molybdenum (Mo)	<0.007	<0.007	<0.007	<0.007
Vanadium (V)	<0.002	<0.002	<0.002	<0.002
Arsenic (As)	<0.0001	<0.0001	<0.04	<0.04
Selenium (Se)	<0.04	<0.04	<0.04	<0.04
Mercury (Hg)	---	---	---	---
Dissolved Organic Carbon (DOC)	---	---	---	---

Table 5. Measurement of blanks—Continued

[DIW, deionized water; ID, identification; GW, ground water; µm, micrometer; mg/L, milligrams per liter; RA, unfiltered-unacidified; SW, surface water; <, less than; ---, no data]

Sample ID	**Equipment Blank**	**Equipment Blank**	**Trip Blank**	**GW Field Blank**
Collection Date	9/6/02	9/6/02	9/15/02	9/17/02
Filtration	0.45 µm - capsule	0.45 µm - capsule	RA	RA
Constituent, mg/L				
Calcium (Ca)	<0.4	<0.4	<0.4	<0.4
Magnesium (Mg)	<0.04	<0.04	<0.04	<0.04
Sodium (Na)	<0.05	<0.05	<0.05	<0.05
Potassium (K)	<0.02	<0.02	<0.02	<0.02
Sulfate (SO_4)	<0.3	<0.3	---	<0.3
Alkalinity (as HCO_3)	---	---	---	---
Fluoride (F)	<0.1	<0.1	---	<0.05
Chloride (Cl)	0.6	0.6	---	3.9
Bromide (Br)	<0.1	<0.1	---	<0.1
Silica (SiO_2)	<0.06	<0.06	<0.06	<0.06
Aluminum (Al)	<0.07	<0.07	<0.001	<0.001
Iron Total (Fe(T))	<0.002	<0.002	<0.007	<0.007
Ferrous Iron (Fe(II))	<0.002	<0.002	---	---
Boron (B)	<0.01	<0.01	<0.01	<0.01
Lithium (Li)	<0.001	<0.001	<0.001	<0.001
Strontium (Sr)	<0.0003	<0.0003	<0.0003	<0.0003
Barium (Ba)	<0.0008	<0.0008	<0.0008	<0.0008
Manganese (Mn)	<0.002	<0.002	<0.002	<0.002
Zinc (Zn)	<0.005	<0.005	<0.005	<0.005
Lead (Pb)	<0.008	<0.008	0.0010	0.0003
Nickel (Ni)	<0.002	<0.002	<0.0005	<0.0005
Copper (Cu)	<0.002	<0.002	<0.0005	<0.0005
Cadmium (Cd)	<0.002	<0.002	<0.0002	<0.0002
Chromium (Cr)	<0.002	<0.002	<0.0005	<0.0005
Cobalt (Co)	<0.007	<0.007	<0.0008	<0.0008
Beryllium (Be)	<0.001	<0.001	<0.001	<0.001
Molybdenum (Mo)	<0.007	<0.007	<0.007	<0.007
Vanadium (V)	<0.002	<0.002	<0.002	<0.002
Arsenic (As)	<0.04	<0.04	<0.0001	<0.0001
Selenium (Se)	<0.04	<0.04	<0.04	<0.04
Mercury (Hg)	---	---	---	---
Dissolved Organic Carbon (DOC)	---	---	---	---

Table 5. Measurement of blanks—Continued

[DIW, deionized water; ID, identification; GW, ground water; µm, micrometer; mg/L, milligrams per liter; RA, unfiltered-unacidified; SW, surface water; <, less than; ---, no data]

Sample ID	**Trip Blank**	**GW Field Blank**	**SW Field Blank**	**Equipment Blank (Peristaltic Pump)**
Collection Date	10/8/02	10/16/02	10/15/02	10/18/02
Filtration	RA	RA	RA	RA
Constituent, mg/L				
Calcium (Ca)	<0.4	<0.4	<0.4	<0.4
Magnesium (Mg)	<0.04	<0.04	<0.04	<0.04
Sodium (Na)	<0.05	<0.05	<0.05	<0.05
Potassium (K)	<0.02	<0.02	<0.02	<0.02
Sulfate (SO_4)	---	---	<0.3	---
Alkalinity (as HCO_3)	---	---	---	---
Fluoride (F)	---	---	<0.05	---
Chloride (Cl)	---	---	0.5	---
Bromide (Br)	---	---	<0.1	---
Silica (SiO_2)	<0.06	<0.06	0.85	0.34
Aluminum (Al)	<0.001	<0.001	<0.001	<0.001
Iron Total (Fe(T))	<0.007	<0.007	<0.007	<0.007
Ferrous Iron (Fe(II))	---	---	---	---
Boron (B)	<0.01	<0.01	<0.01	<0.01
Lithium (Li)	<0.001	<0.001	<0.001	<0.001
Strontium (Sr)	<0.0003	<0.0003	<0.0003	<0.0003
Barium (Ba)	<0.0008	<0.0008	<0.0008	<0.0008
Manganese (Mn)	<0.002	<0.002	<0.002	<0.002
Zinc (Zn)	<0.005	<0.005	<0.005	<0.005
Lead (Pb)	<0.0003	<0.0003	0.0010	0.0010
Nickel (Ni)	0.0010	<0.0005	<0.002	<0.0005
Copper (Cu)	<0.0005	0.0011	<0.0005	<0.0005
Cadmium (Cd)	<0.0002	0.0021	0.0007	<0.0002
Chromium (Cr)	<0.0005	<0.0005	<0.0005	<0.0005
Cobalt (Co)	<0.0008	<0.0008	<0.0008	<0.0008
Beryllium (Be)	<0.001	<0.001	<0.001	<0.001
Molybdenum (Mo)	<0.007	<0.007	<0.007	<0.007
Vanadium (V)	<0.002	<0.002	<0.002	<0.002
Arsenic (As)	<0.0001	<0.0001	<0.0001	<0.0001
Selenium (Se)	<0.04	<0.04	<0.04	<0.04
Mercury (Hg)	---	---	---	---
Dissolved Organic Carbon (DOC)	---	---	---	---

Table 5. Measurement of blanks—Continued

[DIW, deionized water; ID, identification; GW, ground water; µm, micrometer; mg/L, milligrams per liter; RA, unfiltered-unacidified; SW, surface water; <, less than; ---, no data]

Sample ID	**Equipment Blank (Peristaltic Pump)**	**Equipment Blank**	**Trip Blank**	**SW Field Blank**
Collection Date	11/26/02	11/26/02	11/26/02	12/11/02
Filtration	RA	0.45 µm - capsule	RA	RA
Constituent, mg/L				
Calcium (Ca)	<0.4	<0.4	<0.4	<0.4
Magnesium (Mg)	<0.04	<0.04	<0.04	<0.04
Sodium (Na)	<0.05	<0.05	<0.05	<0.05
Potassium (K)	0.03	<0.02	<0.02	<0.02
Sulfate (SO_4)	---	1.3	---	1.5
Alkalinity (as HCO_3)	---	---	---	<1
Fluoride (F)	---	<0.05	---	<0.05
Chloride (Cl)	---	0.5	---	0.5
Bromide (Br)	---	<0.1	---	<0.1
Silica (SiO_2)	0.15	0.08	<0.06	0.12
Aluminum (Al)	<0.001	<0.07	<0.07	<0.07
Iron Total (Fe(T))	<0.007	<0.007	<0.007	<0.007
Ferrous Iron (Fe(II))	---	---	---	---
Boron (B)	<0.01	<0.01	<0.01	<0.01
Lithium (Li)	<0.001	<0.001	<0.001	<0.001
Strontium (Sr)	<0.0003	<0.0003	<0.0003	<0.0003
Barium (Ba)	<0.0008	<0.0008	<0.0008	<0.0008
Manganese (Mn)	<0.002	<0.002	<0.002	<0.002
Zinc (Zn)	<0.005	<0.005	<0.005	<0.005
Lead (Pb)	<0.008	<0.008	<0.008	<0.008
Nickel (Ni)	<0.0005	<0.002	<0.002	<0.002
Copper (Cu)	<0.0005	<0.0005	<0.0005	<0.002
Cadmium (Cd)	<0.0002	<0.002	<0.002	<0.002
Chromium (Cr)	<0.002	<0.0005	<0.0005	<0.0005
Cobalt (Co)	<0.0008	<0.007	<0.007	<0.007
Beryllium (Be)	<0.001	<0.001	<0.001	<0.001
Molybdenum (Mo)	<0.007	<0.007	<0.007	<0.007
Vanadium (V)	<0.002	<0.002	<0.002	<0.002
Arsenic (As)	<0.04	<0.04	<0.0001	<0.0001
Selenium (Se)	<0.04	<0.04	<0.04	<0.04
Mercury (Hg)	---	---	---	---
Dissolved Organic Carbon (DOC)	---	---	---	---

Table 5. Measurement of blanks—Continued

[DIW, deionized water; ID, identification; GW, ground water; µm, micrometer; mg/L, milligrams per liter; RA, unfiltered-unacidified; SW, surface water; <, less than; ---, no data]

Sample ID	**Equipment Blank (GW Pump Blank)**	**GW Field Blank**	**Equipment Blank (GW Pump Blank)**	**Equipment Blank (GW Pump Blank)**
Collection Date	12/11/02	12/12/02	2/4/03	2/4/03
Filtration	RA	RA	RA	RA
Constituent, mg/L				
Calcium (Ca)	<0.4	<0.4	<0.4	<0.4
Magnesium (Mg)	<0.04	<0.04	<0.04	<0.04
Sodium (Na)	<0.05	<0.05	<0.05	<0.05
Potassium (K)	<0.02	<0.02	<0.02	<0.02
Sulfate (SO_4)	1.3	---	2.0	---
Alkalinity (as HCO_3)	<1	---	2	---
Fluoride (F)	0.1	---	<0.05	---
Chloride (Cl)	0.5	---	1.4	---
Bromide (Br)	<0.1	---	<0.1	---
Silica (SiO_2)	<0.06	<0.06	<0.06	<0.06
Aluminum (Al)	<0.07	<0.07	0.002	<0.001
Iron Total (Fe(T))	<0.007	<0.007	<0.007	<0.007
Ferrous Iron (Fe(II))	---	---	---	---
Boron (B)	<0.01	<0.01	<0.01	<0.01
Lithium (Li)	<0.001	<0.001	<0.001	<0.001
Strontium (Sr)	<0.0003	<0.0003	<0.0003	<0.0003
Barium (Ba)	<0.0008	<0.0008	<0.0008	<0.0008
Manganese (Mn)	<0.002	0.004	<0.002	<0.002
Zinc (Zn)	<0.005	0.007	<0.005	<0.005
Lead (Pb)	<0.008	<0.008	<0.008	<0.0003
Nickel (Ni)	<0.002	<0.002	<0.0005	<0.0005
Copper (Cu)	0.0010	<0.0005	<0.0005	<0.0005
Cadmium (Cd)	<0.002	<0.002	<0.0002	0.0007
Chromium (Cr)	<0.0005	<0.0005	<0.0005	0.0006
Cobalt (Co)	<0.007	<0.007	<0.0008	<0.0008
Beryllium (Be)	<0.001	<0.001	<0.001	<0.001
Molybdenum (Mo)	<0.007	<0.007	<0.007	<0.007
Vanadium (V)	<0.002	<0.002	<0.002	<0.002
Arsenic (As)	<0.04	<0.0001	<0.04	<0.04
Selenium (Se)	<0.04	<0.04	<0.04	<0.04
Mercury (Hg)	---	---	---	---
Dissolved Organic Carbon (DOC)	0.5	---	1.5	---

Table 5. Measurement of blanks—Continued

[DIW, deionized water; ID, identification; GW, ground water; µm, micrometer; mg/L, milligrams per liter; RA, unfiltered-unacidified; SW, surface water; <, less than; ---, no data]

Sample ID	**Trip Blank**	**Equipment Blank**	**Trip Blank**	**Equipment Blank**
Collection Date	2/5/03	4/16/03	4/16/03	5/6/03
Filtration	RA	0.1 µm - plate	RA	0.45 µm - capsule
Constituent, mg/L				
Calcium (Ca)	<0.4	<0.4	<0.4	<0.4
Magnesium (Mg)	<0.04	<0.04	<0.04	<0.04
Sodium (Na)	<0.05	<0.05	<0.05	<0.05
Potassium (K)	<0.02	<0.02	<0.02	<0.02
Sulfate (SO_4)	---	<0.3	---	<0.3
Alkalinity (as HCO_3)	---	---	---	---
Fluoride (F)	---	<0.1	---	<0.05
Chloride (Cl)	---	0.5	---	0.8
Bromide (Br)	---	<0.1	---	<0.1
Silica (SiO_2)	<0.06	<0.06	<0.06	<0.06
Aluminum (Al)	<0.001	<0.07	<0.07	<0.001
Iron Total (Fe(T))	<0.007	0.003	<0.007	<0.007
Ferrous Iron (Fe(II))	---	---	---	---
Boron (B)	<0.01	<0.01	<0.01	<0.01
Lithium (Li)	<0.001	<0.001	<0.001	<0.001
Strontium (Sr)	<0.0003	<0.0003	<0.0003	<0.0003
Barium (Ba)	<0.0008	<0.0008	<0.0008	<0.0008
Manganese (Mn)	<0.002	<0.002	<0.002	<0.002
Zinc (Zn)	<0.005	0.006	<0.005	<0.005
Lead (Pb)	<0.0003	<0.008	<0.008	0.0024
Nickel (Ni)	<0.0005	<0.002	<0.002	<0.0005
Copper (Cu)	<0.0005	<0.002	<0.002	<0.0005
Cadmium (Cd)	<0.0002	<0.002	<0.002	<0.0002
Chromium (Cr)	<0.0005	<0.002	<0.002	<0.0005
Cobalt (Co)	<0.0008	<0.007	<0.007	<0.0008
Beryllium (Be)	<0.001	<0.001	<0.001	<0.001
Molybdenum (Mo)	<0.007	<0.007	<0.007	<0.007
Vanadium (V)	<0.002	<0.002	<0.002	<0.002
Arsenic (As)	<0.04	<0.04	<0.04	<0.04
Selenium (Se)	<0.04	<0.04	<0.04	<0.04
Mercury (Hg)	---	---	---	---
Dissolved Organic Carbon (DOC)	---	1.3	---	0.6

Table 5. Measurement of blanks—Continued

[DIW, deionized water; ID, identification; GW, ground water; µm, micrometer; mg/L, milligrams per liter; RA, unfiltered-unacidified; SW, surface water; <, less than; ---, no data]

Sample ID	**Equipment Blank (Peristaltic Pump)**	**Trip Blank**	**GW Field Blank**	**Equipment Blank (GW Pump Blank)**
Collection Date	5/6/03	5/6/03	5/12/03	5/12/03
Filtration	RA	RA	RA	RA
Constituent, mg/L				
Calcium (Ca)	<0.4	<0.4	<0.4	<0.4
Magnesium (Mg)	<0.04	<0.04	<0.04	<0.04
Sodium (Na)	<0.05	<0.05	<0.05	<0.05
Potassium (K)	<0.02	<0.02	<0.02	<0.02
Sulfate (SO_4)	---	---	---	<0.3
Alkalinity (as HCO_3)	---	---	---	---
Fluoride (F)	---	---	---	<0.05
Chloride (Cl)	---	---	---	<0.09
Bromide (Br)	---	---	---	<0.1
Silica (SiO_2)	<0.06	<0.06	<0.06	<0.06
Aluminum (Al)	<0.001	<0.001	<0.001	<0.001
Iron Total (Fe(T))	<0.007	<0.007	<0.007	<0.007
Ferrous Iron (Fe(II))	---	---	---	---
Boron (B)	<0.01	<0.01	<0.01	<0.01
Lithium (Li)	<0.001	<0.001	<0.001	<0.001
Strontium (Sr)	<0.0003	<0.0003	<0.0003	<0.0003
Barium (Ba)	<0.0008	<0.0008	<0.0008	<0.0008
Manganese (Mn)	<0.002	<0.002	<0.002	<0.002
Zinc (Zn)	<0.005	<0.005	<0.005	<0.005
Lead (Pb)	<0.0003	<0.0003	<0.0003	<0.0003
Nickel (Ni)	<0.0005	<0.0005	<0.0005	<0.0005
Copper (Cu)	<0.0005	<0.0005	<0.0005	<0.0005
Cadmium (Cd)	0.0003	0.0003	<0.0002	<0.0002
Chromium (Cr)	0.0016	<0.0005	<0.0005	<0.0005
Cobalt (Co)	<0.0008	<0.0008	<0.0008	<0.0008
Beryllium (Be)	<0.001	<0.001	<0.001	<0.001
Molybdenum (Mo)	<0.007	<0.007	<0.007	<0.007
Vanadium (V)	<0.002	<0.002	<0.002	<0.002
Arsenic (As)	<0.04	<0.04	<0.04	<0.04
Selenium (Se)	<0.04	<0.04	<0.04	<0.04
Mercury (Hg)	---	---	---	---
Dissolved Organic Carbon (DOC)	---	---	---	0.7

Table 5. Measurement of blanks—Continued

[DIW, deionized water; ID, identification; GW, ground water; µm, micrometer; mg/L, milligrams per liter; RA, unfiltered-unacidified; SW, surface water; <, less than; ---, no data]

Sample ID	**Equipment Blank (GW Pump Blank)**	**Trip Blank**	**GW Field Blank**	**SW Field Blank**
Collection Date	5/13/03	6/2/03	6/2/03	6/5/03
Filtration	RA	RA	RA	RA
Constituent, mg/L				
Calcium (Ca)	<0.4	<0.4	<0.4	<0.4
Magnesium (Mg)	<0.04	<0.04	<0.04	<0.04
Sodium (Na)	<0.05	<0.05	<0.05	<0.05
Potassium (K)	<0.02	<0.02	<0.02	<0.02
Sulfate (SO_4)	3.0	---	---	<0.3
Alkalinity (as HCO_3)	---	---	---	2
Fluoride (F)	<0.05	---	---	<0.05
Chloride (Cl)	<0.09	---	---	0.5
Bromide (Br)	<0.1	---	---	<0.1
Silica (SiO_2)	<0.06	<0.06	<0.06	<0.06
Aluminum (Al)	0.001	0.004	<0.001	<0.001
Iron Total (Fe(T))	<0.007	<0.007	<0.007	<0.007
Ferrous Iron (Fe(II))	---	---	---	---
Boron (B)	<0.01	<0.01	<0.01	<0.01
Lithium (Li)	<0.001	<0.001	<0.001	<0.001
Strontium (Sr)	<0.0003	<0.0003	<0.0003	<0.0003
Barium (Ba)	<0.0008	<0.0008	<0.0008	<0.0008
Manganese (Mn)	<0.002	<0.002	<0.002	<0.002
Zinc (Zn)	<0.005	<0.005	<0.005	<0.005
Lead (Pb)	<0.0003	<0.0003	<0.0003	<0.0003
Nickel (Ni)	<0.002	<0.0005	<0.0005	<0.0005
Copper (Cu)	<0.0005	<0.0005	<0.0005	<0.0005
Cadmium (Cd)	<0.0002	<0.0002	0.0003	0.0004
Chromium (Cr)	<0.002	<0.0005	<0.0005	<0.0005
Cobalt (Co)	0.0010	<0.0008	<0.0008	<0.0008
Beryllium (Be)	<0.001	<0.001	<0.001	<0.001
Molybdenum (Mo)	<0.007	<0.007	<0.007	<0.007
Vanadium (V)	<0.002	<0.002	<0.002	<0.002
Arsenic (As)	<0.04	<0.04	<0.04	<0.04
Selenium (Se)	<0.04	<0.04	<0.04	<0.04
Mercury (Hg)	---	---	---	---
Dissolved Organic Carbon (DOC)	0.7	---	---	---

Table 5. Measurement of blanks—Continued

[DIW, deionized water; ID, identification; GW, ground water; µm, micrometer; mg/L, milligrams per liter; RA, unfiltered-unacidified; SW, surface water; <, less than; ---, no data]

Sample ID	**Equipment Blank (Peristaltic Pump)**	**Equipment Blank**	**Equipment Blank**	**Trip Blank**
Collection Date	8/5/03	8/5/03	8/13/03	8/13/03
Filtration	RA	0.45 µm - capsule	0.45 µm - capsule	RA
Constituent, mg/L				
Calcium (Ca)	<0.4	<0.4	0.4	<0.4
Magnesium (Mg)	<0.04	<0.04	<0.04	<0.04
Sodium (Na)	<0.05	<0.05	<0.05	<0.05
Potassium (K)	<0.02	<0.02	0.02	<0.02
Sulfate (SO_4)	---	<0.3	<0.3	---
Alkalinity (as HCO_3)	---	2	---	---
Fluoride (F)	---	<0.05	<0.05	---
Chloride (Cl)	---	0.5	0.5	---
Bromide (Br)	---	<0.1	<0.1	---
Silica (SiO_2)	0.07	<0.06	<0.06	<0.06
Aluminum (Al)	<0.001	<0.001	0.034	0.001
Iron Total (Fe(T))	<0.007	<0.007	<0.007	<0.007
Ferrous Iron (Fe(II))	---	---	---	---
Boron (B)	<0.01	<0.01	<0.01	<0.01
Lithium (Li)	<0.001	<0.001	<0.001	<0.001
Strontium (Sr)	<0.0003	<0.0003	<0.0003	<0.0003
Barium (Ba)	<0.0008	<0.0008	<0.0008	<0.0008
Manganese (Mn)	<0.002	<0.002	0.008	<0.002
Zinc (Zn)	<0.005	<0.005	0.007	<0.005
Lead (Pb)	<0.0003	<0.0003	<0.0003	<0.0003
Nickel (Ni)	<0.0005	<0.0005	0.0057	<0.0005
Copper (Cu)	<0.0005	<0.0005	<0.0005	<0.0005
Cadmium (Cd)	0.0006	<0.0002	<0.0002	<0.0002
Chromium (Cr)	<0.0005	<0.0005	<0.0005	<0.0005
Cobalt (Co)	<0.0008	<0.0008	0.0014	<0.0008
Beryllium (Be)	<0.001	<0.001	<0.001	<0.001
Molybdenum (Mo)	<0.007	<0.007	<0.007	<0.007
Vanadium (V)	<0.002	<0.002	<0.002	<0.002
Arsenic (As)	<0.04	<0.04	<0.04	<0.04
Selenium (Se)	<0.04	<0.04	<0.04	<0.04
Mercury (Hg)	---	---	---	---
Dissolved Organic Carbon (DOC)	---	2.0	0.9	---

Table 5. Measurement of blanks—Continued

[DIW, deionized water; ID, identification; GW, ground water; µm, micrometer; mg/L, milligrams per liter; RA, unfiltered-unacidified; SW, surface water; <, less than; ---, no data]

Sample ID	**Equipment Blank (GW Pump Blank)**	**GW Field Blank**	**SW Field Blank**	**Trip Blank**
Collection Date	8/20/03	8/21/03	8/21/03	10/16/03
Filtration	RA	RA	RA	RA
Constituent, mg/L				
Calcium (Ca)	<0.4	<0.4	<0.4	<0.4
Magnesium (Mg)	<0.04	<0.04	<0.04	<0.04
Sodium (Na)	<0.05	<0.05	<0.05	<0.05
Potassium (K)	1.19	<0.02	<0.02	<0.02
Sulfate (SO_4)	2.5	---	<0.3	---
Alkalinity (as HCO_3)	<1	---	2	---
Fluoride (F)	<0.05	---	<0.05	---
Chloride (Cl)	0.7	---	0.6	---
Bromide (Br)	<0.1	---	<0.1	---
Silica (SiO_2)	<0.06	<0.06	0.16	0.10
Aluminum (Al)	<0.001	<0.001	<0.001	<0.001
Iron Total (Fe(T))	0.022	<0.007	<0.007	<0.007
Ferrous Iron (Fe(II))	---	---	---	---
Boron (B)	<0.01	<0.01	<0.01	<0.01
Lithium (Li)	<0.001	<0.001	<0.001	<0.001
Strontium (Sr)	<0.0003	<0.0003	<0.0003	<0.0003
Barium (Ba)	<0.0008	<0.0008	<0.0008	<0.0008
Manganese (Mn)	0.007	<0.002	<0.002	<0.002
Zinc (Zn)	0.006	<0.005	0.018	<0.005
Lead (Pb)	<0.0003	<0.0003	<0.0003	<0.0003
Nickel (Ni)	0.0104	<0.002	<0.0005	<0.0005
Copper (Cu)	0.0016	<0.0005	<0.0005	<0.0005
Cadmium (Cd)	<0.0002	0.0003	0.0002	0.0004
Chromium (Cr)	0.0039	<0.0005	<0.0005	<0.0005
Cobalt (Co)	0.0010	<0.0008	<0.0008	<0.0008
Beryllium (Be)	<0.001	<0.001	<0.001	<0.001
Molybdenum (Mo)	<0.007	<0.007	<0.007	<0.007
Vanadium (V)	<0.002	<0.002	<0.002	<0.002
Arsenic (As)	<0.04	<0.04	<0.04	<0.04
Selenium (Se)	<0.04	<0.04	<0.04	<0.04
Mercury (Hg)	---	---	---	---
Dissolved Organic Carbon (DOC)	0.8	---	---	---

Table 5. Measurement of blanks—Continued

[DIW, deionized water; ID, identification; GW, ground water; µm, micrometer; mg/L, milligrams per liter; RA, unfiltered-unacidified; SW, surface water; <, less than; ---, no data]

Sample ID	**Equipment Blank (GW Pump Blank)**	**GW Field Blank**	**Equipment Blank (GW Pump Blank)**
Collection Date	10/16/03	10/21/03	10/23/03
Filtration	RA	RA	RA
Constituent, mg/L			
Calcium (Ca)	<0.4	<0.4	<0.4
Magnesium (Mg)	<0.04	<0.04	<0.04
Sodium (Na)	<0.05	<0.05	<0.05
Potassium (K)	<0.02	<0.02	<0.02
Sulfate (SO_4)	<0.3	---	1.4
Alkalinity (as HCO_3)	2	---	<1
Fluoride (F)	<0.05	---	<0.05
Chloride (Cl)	0.9	---	0.8
Bromide (Br)	<0.1	---	<0.1
Silica (SiO_2)	<0.06	<0.06	<0.06
Aluminum (Al)	<0.001	0.015	<0.001
Iron Total (Fe(T))	<0.007	<0.007	<0.007
Ferrous Iron (Fe(II))	---	---	---
Boron (B)	<0.01	<0.01	<0.01
Lithium (Li)	<0.001	<0.001	<0.001
Strontium (Sr)	<0.0003	<0.0003	<0.0003
Barium (Ba)	<0.0008	<0.0008	<0.0008
Manganese (Mn)	<0.002	<0.002	<0.002
Zinc (Zn)	<0.005	<0.005	0.005
Lead (Pb)	<0.0003	<0.0003	<0.0003
Nickel (Ni)	0.0035	<0.0005	<0.0005
Copper (Cu)	<0.0005	<0.0005	<0.0005
Cadmium (Cd)	0.0002	<0.0002	<0.0002
Chromium (Cr)	0.0016	<0.0005	0.0007
Cobalt (Co)	0.0013	<0.0008	<0.0008
Beryllium (Be)	<0.001	<0.001	<0.001
Molybdenum (Mo)	<0.007	<0.007	<0.007
Vanadium (V)	<0.002	<0.002	<0.002
Arsenic (As)	<0.04	<0.04	<0.04
Selenium (Se)	<0.04	<0.04	<0.04
Mercury (Hg)	---	---	0.5 (ng/L)
Dissolved Organic Carbon (DOC)	1.1	---	0.3

Spike Recoveries

Spike recovery, the method of adding a known quantity of analyte to a sample and then analyzing the sample to determine the analyte concentration, is a technique used to identify analytical interferences. Spike recoveries were performed by spiking ground water samples from SC2B, SC3A, SC3B, CC2A, and Hottentot with a mixed-element standard and then analyzing them by ICP-OES along with the other samples (table 6). A mixed element standard was used to spike the samples; therefore, some constituent concentrations did not increase by an amount greater than the error of the two determinations. Only constituents with concentrations that increased by more than 12 percent were included in table 6. The spiked samples were analyzed undiluted by ICP-OES; therefore, not all of the constituents were in the calibration range and may be beyond the range of linearity. Only constituents with concentrations that were in the calibration range for the spike sample are reported. The sample matrix is simplified when the sample is diluted and interferences are minimized; therefore, spikes were not performed on diluted samples. When constituent concentrations were below the method detection limits for unspiked samples, the concentrations were set equal to zero for calculating percent recoveries. The mean recovery for all the constituents by ICP-OES was 103 percent with a standard deviation of 16 percent. The highest recoveries were for arsenic, 147 and 138 percent; however, the unspiked concentrations were below the detection limits and the spiked concentrations were about 10 times the detection limit. Lead in sample SC3A had the lowest recovery of 74 percent. Sample SC3B was spiked with a known quantity of iron and when analyzed for total iron using the FerroZine method, its recovery was 99.2 percent.

Table 6. Sample spike recoveries, analyses by ICP-OES

[see Naus and others, 2004; D.K. Nordstrom, USGS, written commun., 2004; P.L. Verplanck, USGS, written commun., 2004, for sample locations; ---, not reported because the concentration is out of range or the spike did not increase the concentration by more than 12%]

	SC2B Percent Recovery	SC3A Percent Recovery	SC3B Percent Recovery	CC2A Percent Recovery	HOTTENTOT Percent Recovery
Arsenic (As)	124	112	138	147	102
Aluminum (Al)	103	---[1, 2]	86	---[1]	---[1, 2]
Boron (B)	111	107	115	109	87
Barium (Ba)	93	90	97	98	90
Beryllium (Be)	106	89	116	111	83
Calcium (Ca)	---[2]	---[1, 2]	---[2]	---[1, 2]	115
Cadmium (Cd)	121	109	80	122	86
Cobalt (Co)	102	95	---[1]	118	109
Chromium (Cr)	116	90	82	127	86
Copper (Cu)	105	---[1, 2]	91	105	83
Total iron (Fe(T))	---[2]	94	---[1, 2]	---[1, 2]	---[1, 2]
Potassium (K)	---[2]	127	---[2]	---[1, 2]	97
Lithium (Li)	110	117	137	135	97
Magnesium (Mg)	---[2]	---[1, 2]	---[2]	---[2]	---[1, 2]
Manganese (Mn)	---[2]	---[1, 2]	---[2]	---[2]	---[1, 2]
Molybdenum (Mo)	110	83	102	105	87
Sodium (Na)	118	116	129	118	99
Nickel (Ni)	---[2]	---[2]	100	87	91
Lead (Pb)	104	74	78	104	88
Silica (SiO_2)	101	---[2]	---[2]	---[2]	---[1, 2]
Selenium (Se)	123	106	81	123	83
Strontium (Sr)	---[1, 2]	---[1]	---[2]	---[1, 2]	84
Vanadium (V)	108	94	110	103	86
Zinc (Zn)	---[2]	---[1, 2]	---[2]	---[2]	---[2]

[1] spike did not increase the concentration by more than 12%

[2] the concentration was above the calibration range

Dissolved Organic Carbon Analyses

The QA/QC checks for DOC include analyses of laboratory reagent blanks and synthetic samples made from potassium biphthalate, sodium bicarbonate, and sodium benzoate. Reagent water was used to check for interferences in the system and its reagents. A laboratory reagent blank was analyzed before every set of 10 environmental samples. A total of 145 laboratory reagent blanks were analyzed during the investigation and the mean concentration was 0.15 mg/L with a standard deviation of 0.06 mg/L. The highest value measured in the blanks was 0.3 mg/L.

Potassium biphthalate was used to calibrate the instrument, and sodium benzoate was used as a different organic carbon source to check the calibration. A total of 88 determinations of a synthetic standard, sodium benzoate, were made along side the samples. The mean recovery was 98 percent with a standard deviation of 3 percent.

Analyses of an inorganic carbon, sodium bicarbonate, provided a daily verification that the acid valve was functioning properly. A total of 18 analyses of sodium bicarbonate were performed and the mean concentration was 0.26 mg/L with a standard deviation of 0.1 mg/L. The low value indicates that inorganic carbon did not significantly contribute to or interfere with the organic carbon measurement.

Analyses by Different Methods

Several constituents were analyzed by more than one method. Although results from a single method are reported, comparing analytical results from alternate methods serves as an accuracy check. Results from different methods that are within about 10 percent of each other are considered to be within the error of the measurements. A subset of 60 samples that were analyzed for aluminum, arsenic, barium, beryllium, boron, cadmium, chromium, cobalt, copper, lead, lithium, manganese, molybdenum, nickel, strontium, vanadium, and zinc determined by ICP-OES, GFAAS, and/or ICP-MS are shown in table 7 in the appendix. Determinations of aluminum, barium, beryllium, cadmium, chromium, cobalt, copper, iron, lithium, manganese, nickel, strontium, and zinc by more than one method are shown graphically in figures 4–7. Total dissolved iron analyzed by ICP-OES and by the FerroZine colorimetric method for all of the data collected for the investigation, not just the subset of 60, reported in Naus and others (2004), D.K. Nordstrom (USGS, written commun., 2004), and P.L. Verplanck (USGS, written commun., 2004) are generally within 10 percent of each other (fig. 4A). Aluminum analyses by ICP-OES produced several results that are higher by more than 10 percent than the analyses by ICP-MS (fig. 4B). Aluminum determinations greater than about 5 mg/L by ICP-OES are expected to be more accurate than the values generated by ICP-MS because less dilution was required. With only a few exceptions, results from either ICP-OES or GFAAS were similar to ICP-MS for manganese, beryllium, lithium, strontium, barium, zinc, nickel, copper, cadmium, and cobalt (figs. 4C, 4D, 5A, 5B, 5C, 5D, 6A, 6B, 6C, and 6D, respectively). For chromium concentrations greater than 0.03 mg/L, results generated by ICP-OES are typically within 10 percent of the concentration determined by ICP-MS (fig. 7A). Low level chromium (<0.03 mg/L) determinations by the methods routinely used to report data, either ICP-OES or GFAAS depending on the sample, are elevated compared to the values generated by ICP-MS (fig. 7A). However, the chromium concentrations measured by ICP-OES and GFAAS for all of the data reported in Naus and others (2004), D.K. Nordstrom (USGS, written commun., 2004), and P.L. Verplanck (USGS, written commun., 2004, data not shown) are generally within 10 percent of each other (fig. 7B).

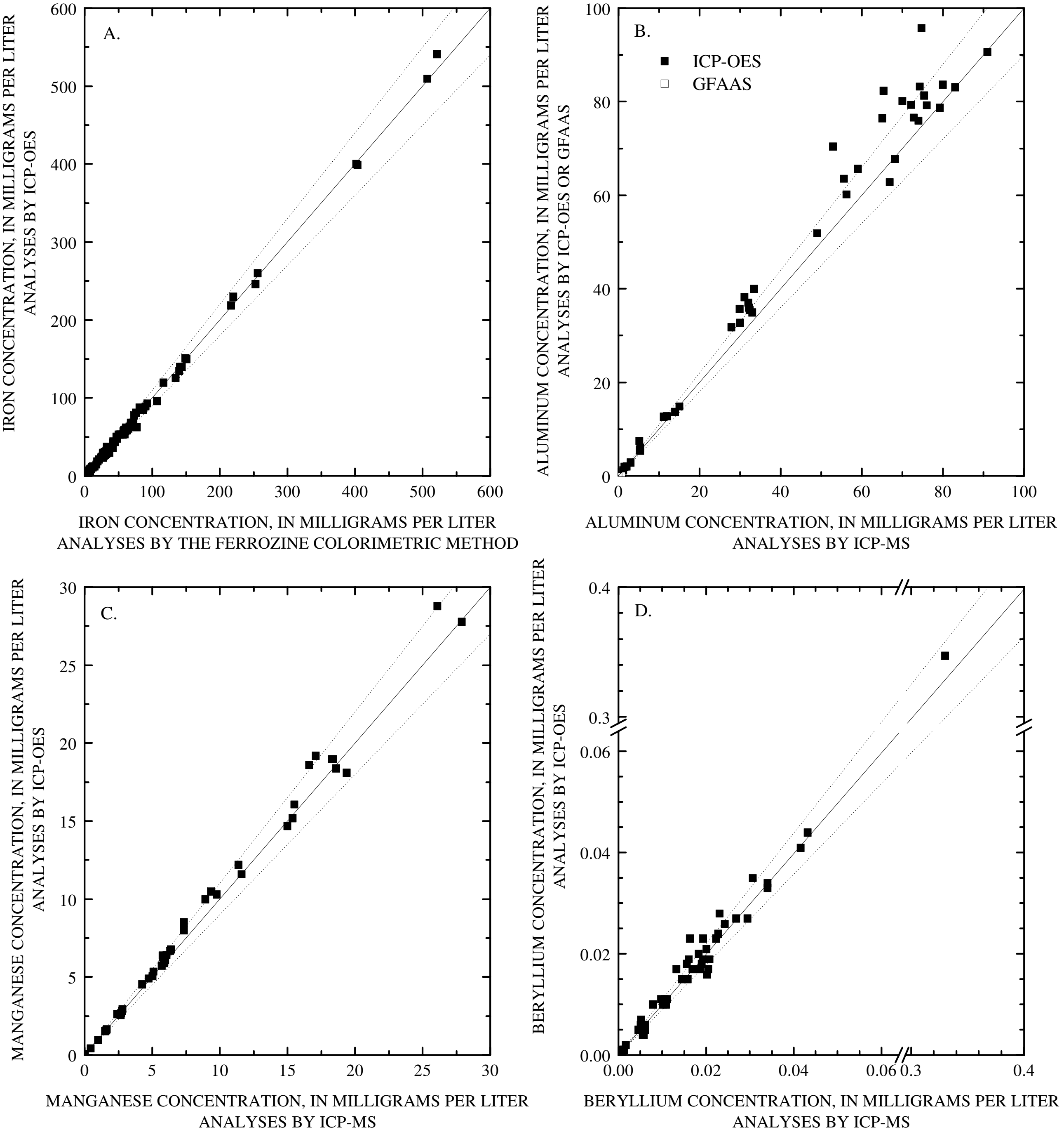


Figure 4. (**A**) Iron concentration determined by ICP-OES and by the FerroZine colorimetric method. (**B**) Aluminum concentration determined by ICP-OES or GFAAS and ICP-MS. (**C**) Manganese concentration determined by ICP-OES and ICP-MS. (**D**) Beryllium concentration determined by ICP-OES and ICP-MS. The solid line is an equal concentration line and the dotted line is ±10 percent from the equal concentration line.

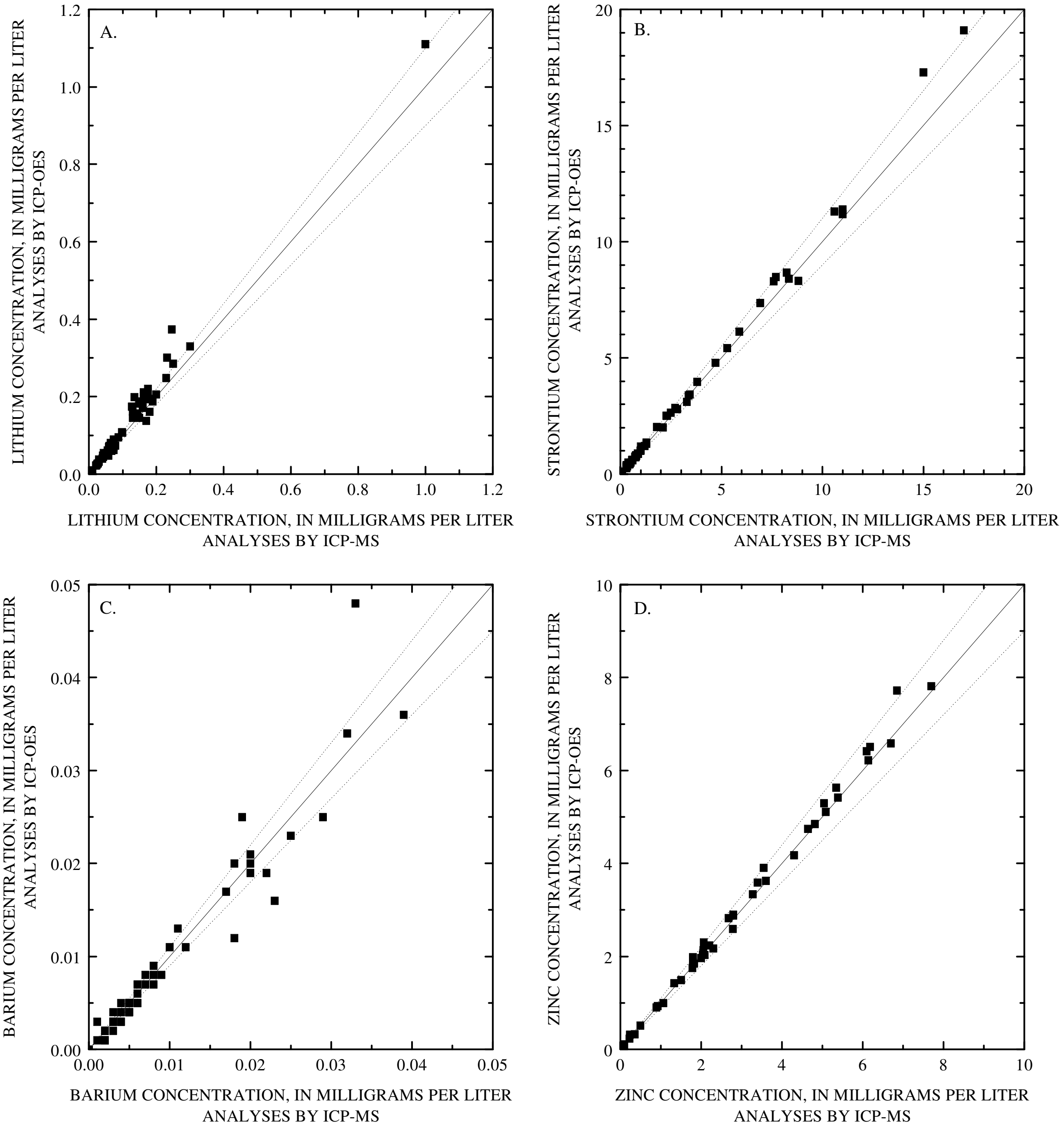


Figure 5. (**A**) Lithium concentration determined by ICP-OES and ICP-MS. (**B**) Strontium concentration determined by ICP-OES and ICP-MS. (**C**) Barium concentration determined by ICP-OES and ICP-MS. (**D**) Zinc concentration determined by ICP-OES and ICP-MS. The solid line is an equal concentration line and the dotted line is ±10 percent from the equal concentration line.

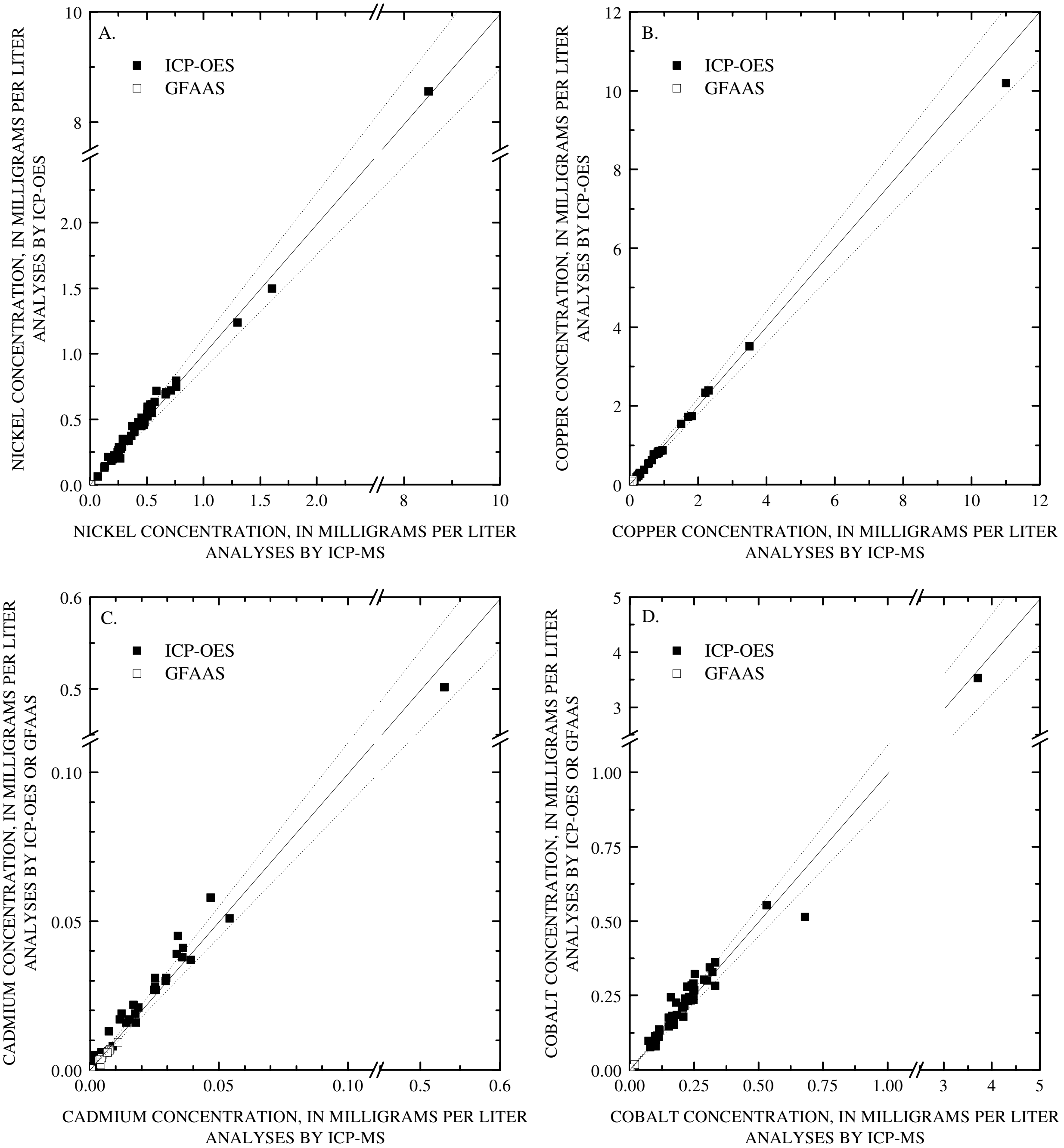


Figure 6. (**A**) Nickel concentration determined by ICP-OES or GFAAS and ICP-MS. (**B**) Copper concentration determined by ICP-OES or GFAAS and ICP-MS. (**C**) Cadmium concentration determined by ICP-OES or GFAAS and ICP-MS. (**D**) Cobalt concentration determined by ICP-OES or GFAAS and ICP-MS. The solid line is an equal concentration line and the dotted line is ±10 percent from the equal concentration line.

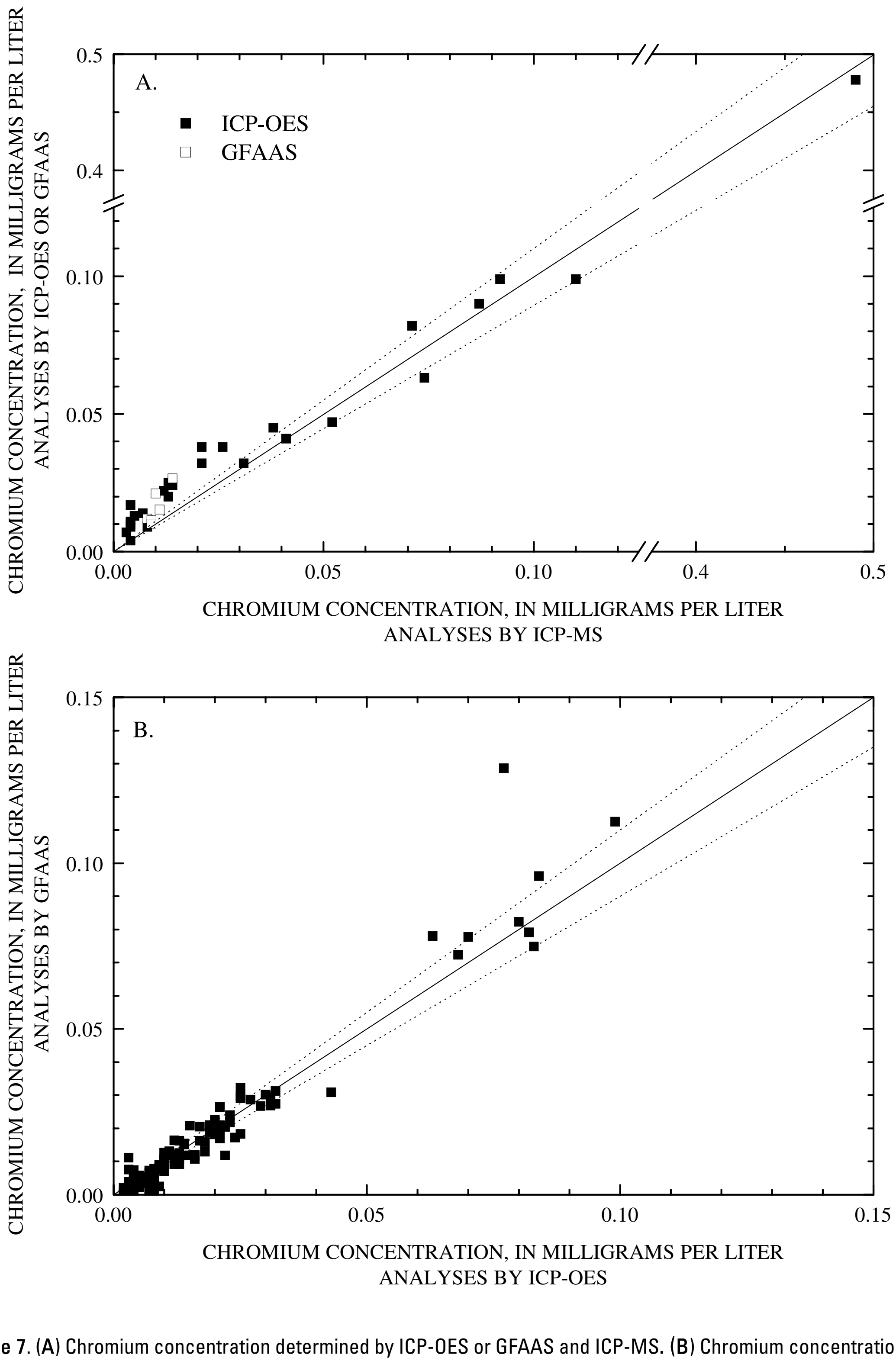


Figure 7. (**A**) Chromium concentration determined by ICP-OES or GFAAS and ICP-MS. (**B**) Chromium concentration determined by GFAAS and ICP-OES. The solid line is an equal concentration line and the dotted line is ±10 percent from the equal concentration line.

Analyses by Different Laboratories

Duplicate samples were collected from wells SC1A, SC1B, SC2A, SC3A, SC4A, SC5A, and SC5B during the March 2002 sampling trip and analyzed by both the USGS and laboratories contracted by Molycorp Inc. The analyses from both laboratories are shown in table 8 in the appendix. Determinations by contract laboratories and the USGS of alkalinity, aluminum, barium, beryllium, cadmium, calcium, chloride, chromium, cobalt, copper, fluoride, iron, lead, magnesium, manganese, nickel, potassium, sodium, sulfate, and zinc concentrations, that are above the method detection limit, are plotted in relation to each other in figures 8–12. Alkalinity, aluminum, barium, beryllium, calcium, iron, magnesium, potassium, sodium, and sulfate determinations by the two laboratories were generally within 10 percent of each other and there does not appear to be a bias between the laboratories. Determinations of manganese, zinc, and copper by the contract laboratories and the USGS are typically within 10 percent of each other, but the USGS values are consistently higher (figs. 10C, 11B, and 12A, respectively). Two contract laboratories analyzed for fluoride. Fluoride analyses by one Molycorp Inc. contracted laboratory were very scattered with the samples containing high aluminum concentrations having low levels of measured fluoride (fig. 9C). Aluminum forms a strong complex with fluoride likely causing a low fluoride determination by ion-selective electrode because free fluoride is measured. Fluoride analyses by a second Molycorp Inc. contracted laboratory were consistently higher than the USGS determinations (fig. 9C). Chloride concentrations are in agreement for the samples above contract laboratories reporting limit (fig. 9D). A few nickel determinations by the contract laboratories were low (approximately 10 percent) compared to the USGS determinations, but otherwise agree well (fig. 11D). Cadmium and cobalt determinations by the contract laboratory were consistently lower by 10 to 20 percent (fig. 12B and 12D). Only two lead determinations were detectable by both the USGS and the contract laboratory and the contract laboratory's determinations were lower in both cases (fig. 11C). Chromium determinations by the USGS are consistently higher by about 40 percent than the contract laboratories (fig. 12C).

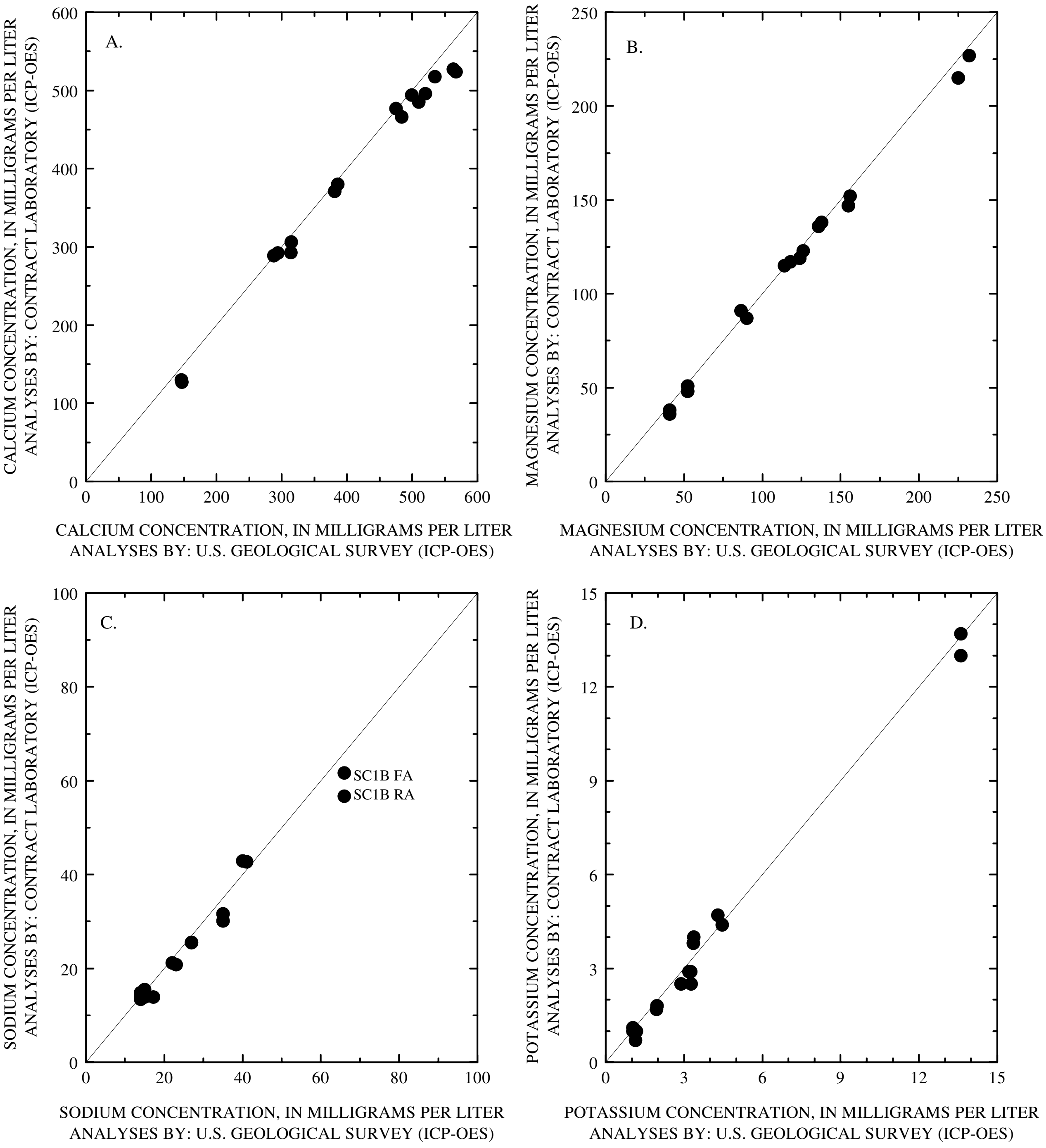


Figure 8. (A) Calcium concentration determined by a contract laboratory and the U.S. Geological Survey. **(B)** Magnesium concentration determined by a contract laboratory and the U.S. Geological Survey. **(C)** Sodium concentration determined by a contract laboratory and the U.S. Geological Survey. **(D)** Potassium concentration determined by a contract laboratory and the U.S. Geological Survey. The solid line is an equal concentration line.

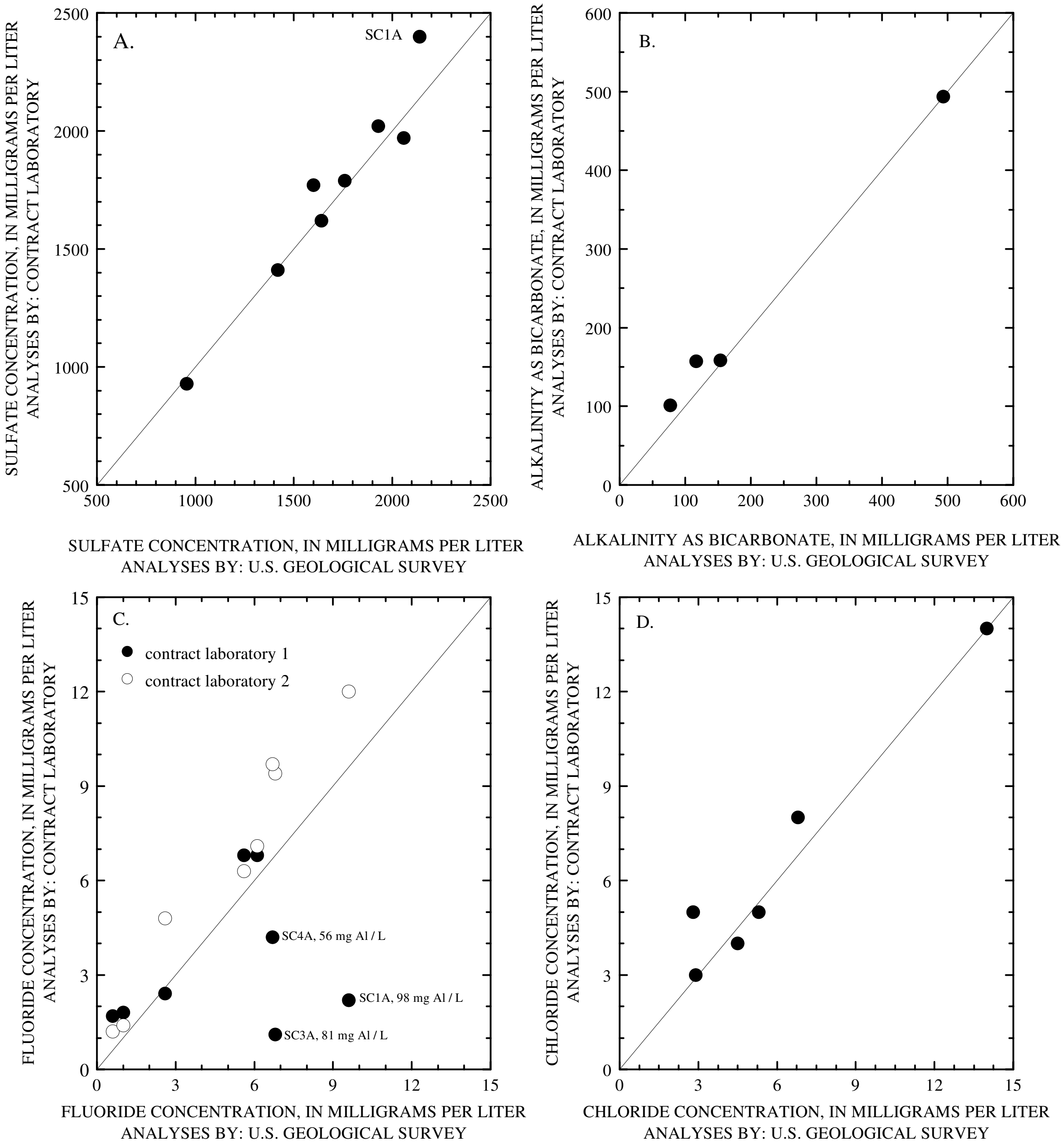


Figure 9. (**A**) Sulfate concentration determined by a contract laboratory and the U.S. Geological Survey. (**B**) Alkalinity determined by a contract laboratory and the U.S. Geological Survey. (**C**) Fluoride concentration determined by two contract laboratories and the U.S. Geological Survey. (**D**) Chloride concentration determined by a contract laboratory and the U.S. Geological Survey. The solid line is an equal concentration line.

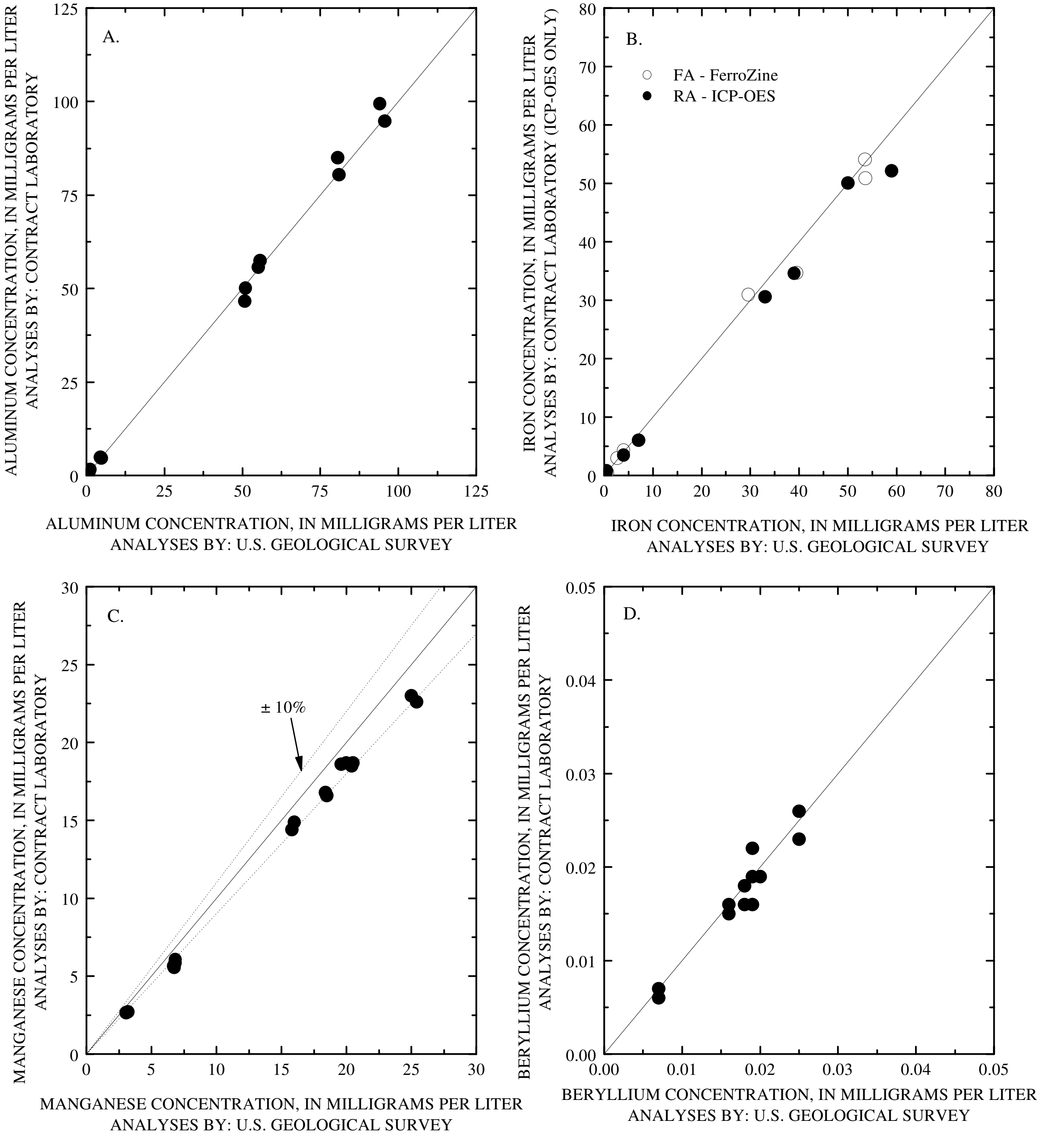


Figure 10. (**A**) Aluminum concentration determined by a contract laboratory and the U.S. Geological Survey. (**B**) Iron concentration determined by a contract laboratory and the U.S. Geological Survey. (**C**) Manganese concentration determined by a contract laboratory and the U.S. Geological Survey. (**D**) Beryllium concentration determined by a contract laboratory and the U.S. Geological Survey. The solid line is an equal concentration line and the dotted line is ±10 percent from the equal concentration line.

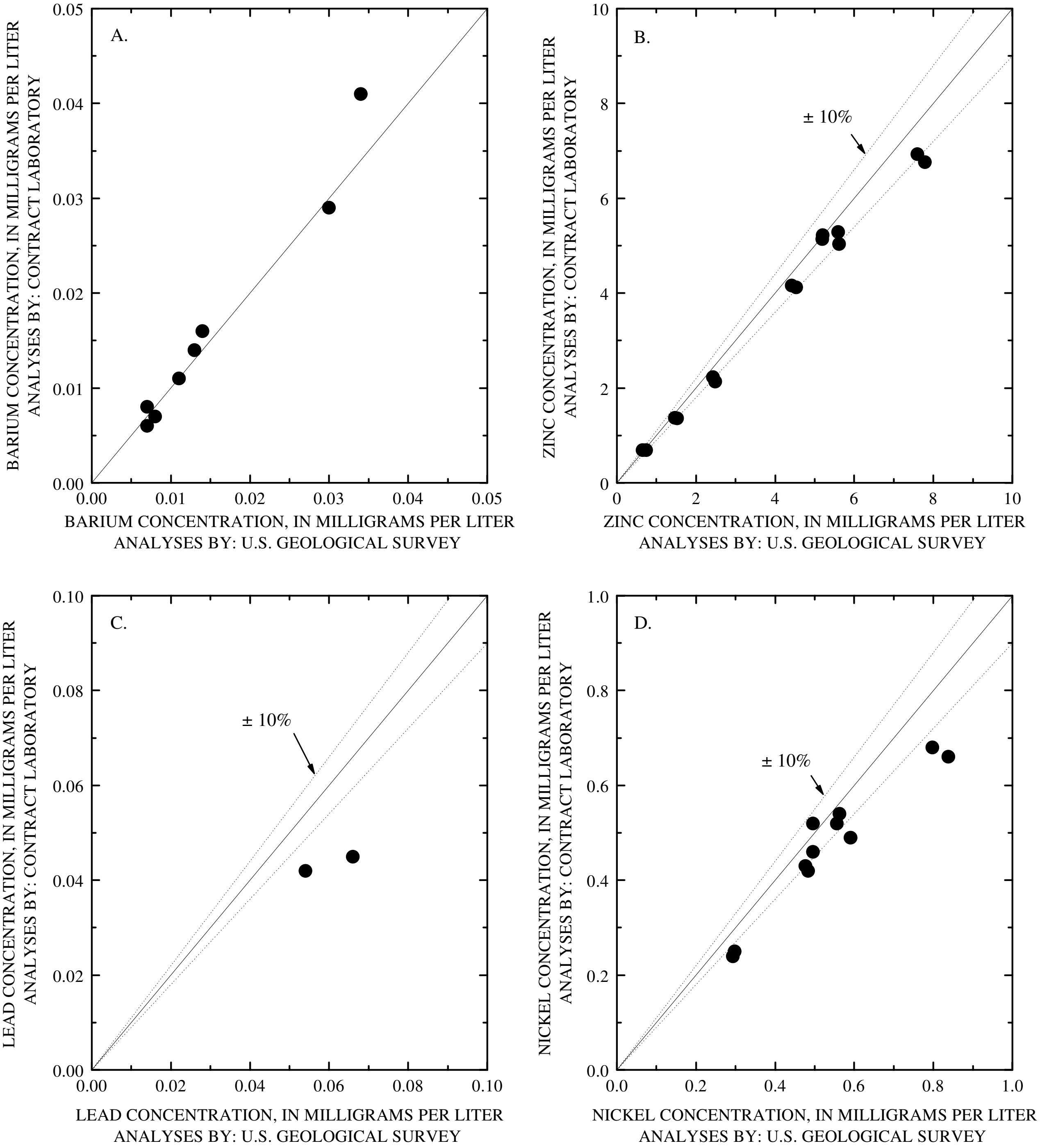


Figure 11. (**A**) Barium concentration determined by a contract laboratory and the U.S. Geological Survey. (**B**) Zinc concentration determined by a contract laboratory and the U.S. Geological Survey. (**C**) Lead concentration determined by a contract laboratory and the U.S. Geological Survey. (**D**) Nickel concentration determined by a contract laboratory and the U.S. Geological Survey. The solid line is an equal concentration line and the dotted line is ±10 percent from the equal concentration line.

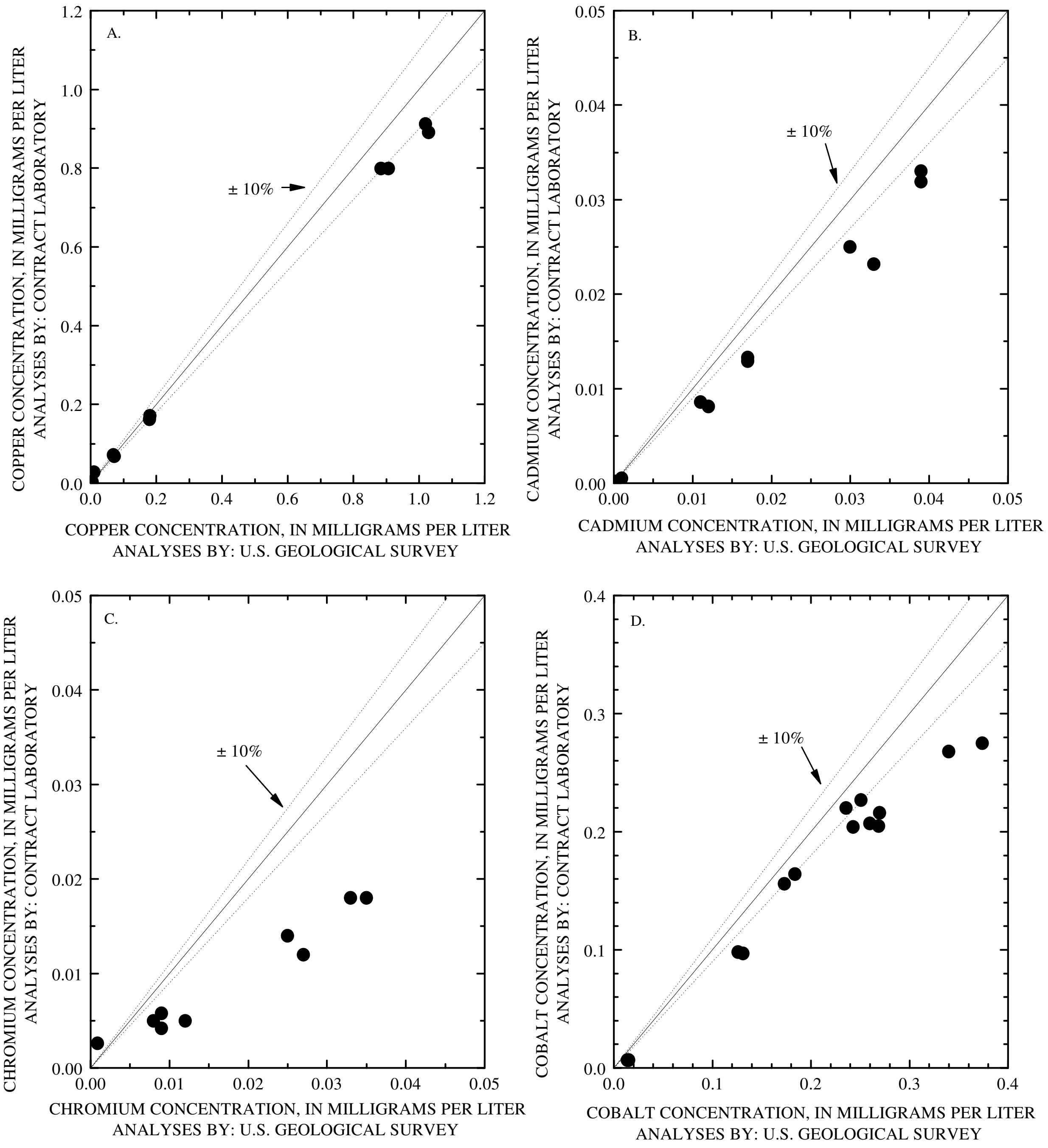


Figure 12. (**A**) Copper concentration determined by a contract laboratory and the U.S. Geological Survey. (**B**) Cadmium concentration determined by a contract laboratory and the U.S. Geological Survey. (**C**) Chromium concentration determined by a contract laboratory and the U.S. Geological Survey. (**D**) Cobalt concentration determined by a contract laboratory and the U.S. Geological Survey. The solid line is an equal concentration line and the dotted line is ±10 percent from the equal concentration line.

Duplicate Sampling

Fifteen surface- and ground-water duplicate samples, collected consecutively, were collected from Straight Creek, Hottentot, and the Red River from 2002 to 2003 (Naus and others, 2004; D.K. Nordstrom, USGS, written commun. 2004; P.L. Verplanck, written commun., 2004). Sequential duplicates were collected to assess variability among samples resulting from collection, processing, shipping, and laboratory procedures conducted at different sampling times (Wilde and others, 1999). Concentrations from the replicates are plotted in relation to each other for alkalinity, aluminum, barium, beryllium, boron, cadmium, calcium, chloride, chromium, cobalt, copper, fluoride, total dissolved iron, ferrous iron, lithium, magnesium, manganese, nickel, potassium, sodium, strontium, sulfate, and zinc (figs. 13-17). With the exception of chloride and low concentrations of iron and aluminum, results for sequential duplicates are in agreement with each other. Chloride concentrations in duplicate samples from well SC5B were 18 mg/L and 9.3 mg/L; this may be the result of contamination by hydrochloric acid used in washing procedures or analytical uncertainty resulting from a distorted chromatogram caused by the complex sample matrix (fig. 14B). Aluminum concentrations less than 0.01 mg/L in duplicate samples do not agree because of analytical uncertainty near the 0.001 mg/L detection limit or because of colloids passing through the filter (fig. 14E). Total dissolved iron concentrations in duplicate samples from the Red River at the gage (USGS streamflow-gaging station 08265000) were determined to be 0.008 mg/L and 0.040 mg/L (fig. 15B); however, ferrous iron concentrations were identical (fig. 15D). Colloidal iron may have passed through the filter causing an apparent increase in total dissolved iron concentrations.

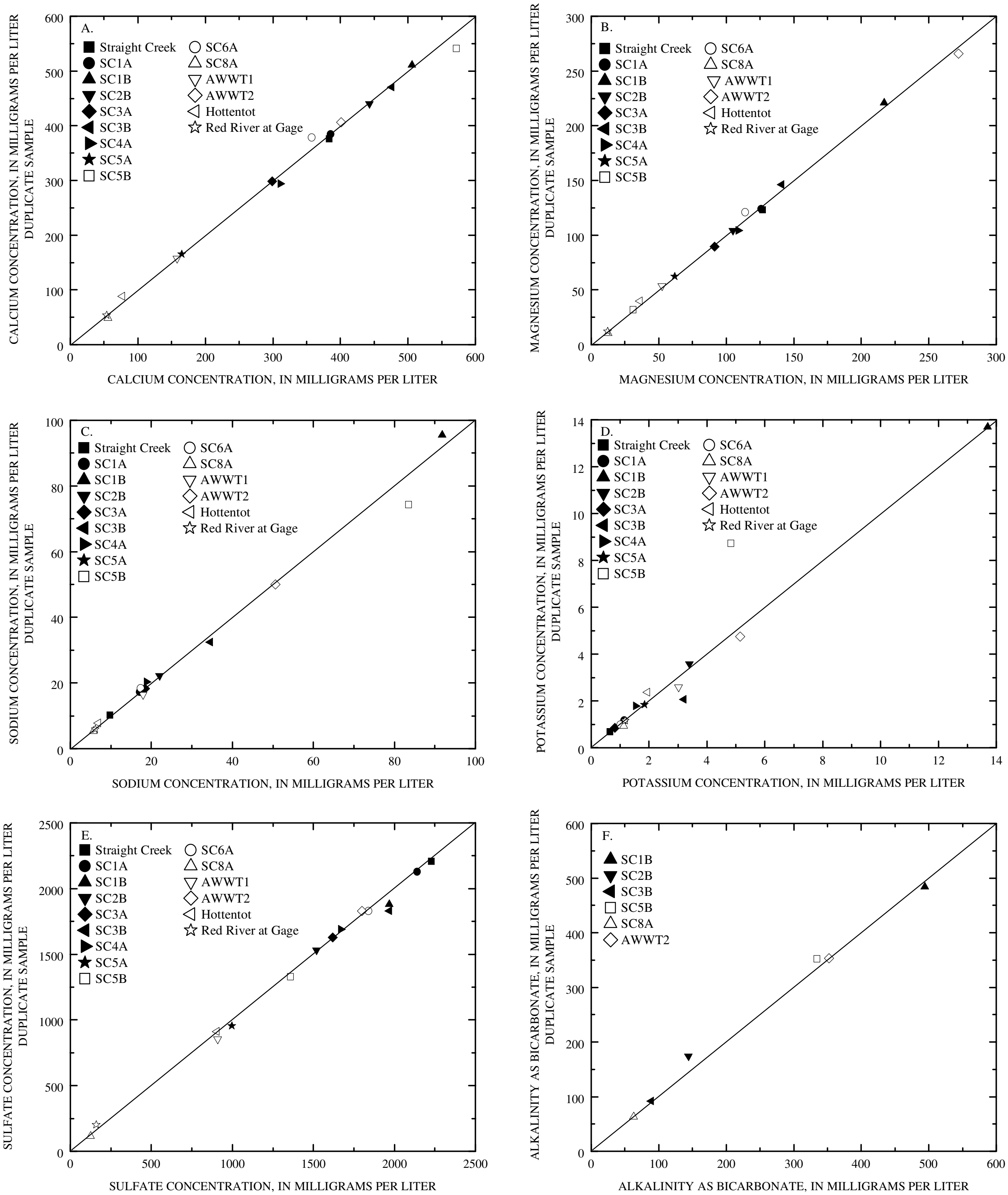


Figure 13. Comparison of sequential duplicates for surface- and ground-water samples collected from Straight Creek, Hottentot, and the Red River, 2002-2003, for: (**A**) calcium; (**B**) magnesium; (**C**) sodium; (**D**) potassium; (**E**) sulfate; and (**F**) alkalinity. The solid line is an equal concentration line.

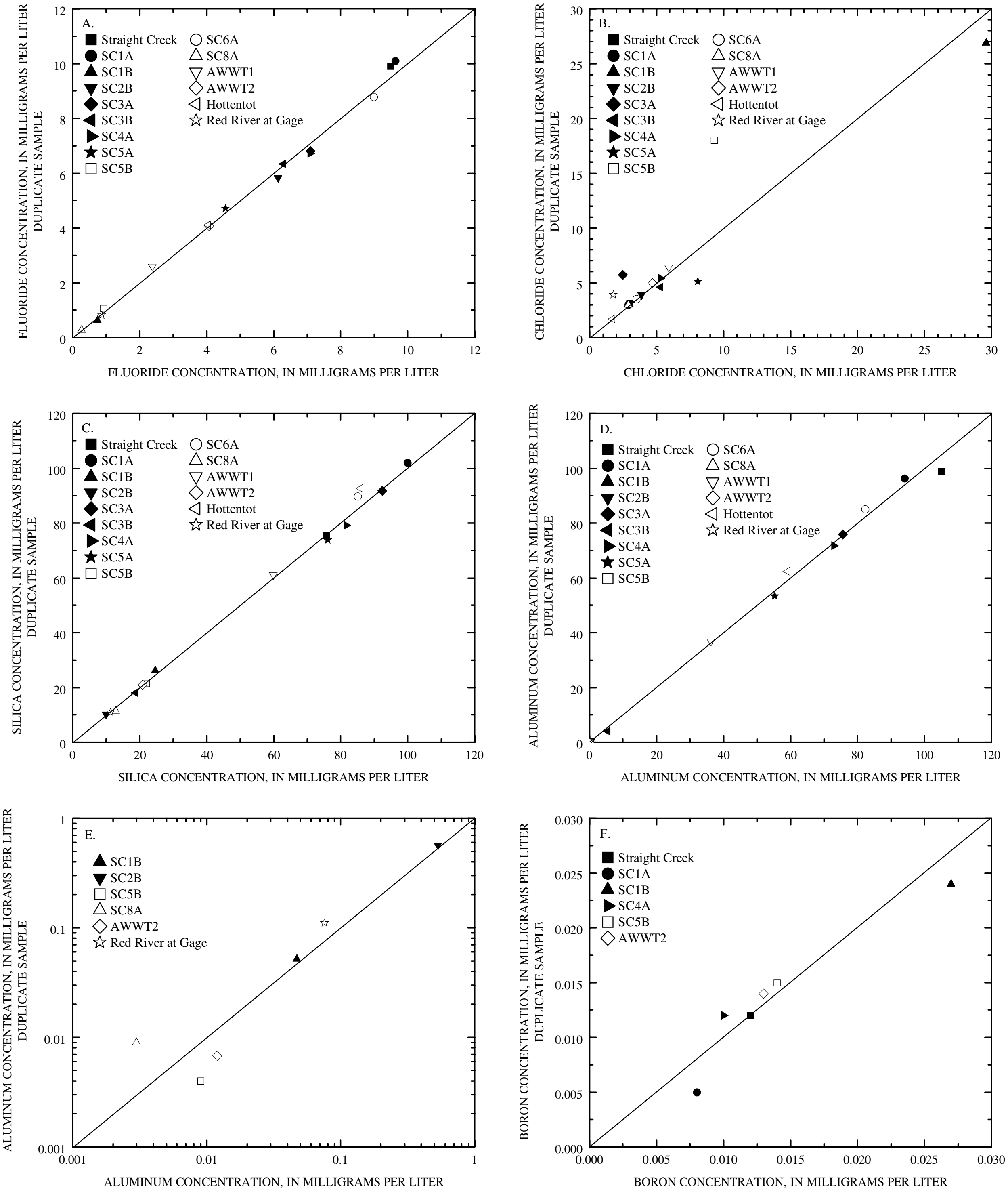


Figure 14. Comparison of sequential duplicates for surface- and ground-water samples collected from Straight Creek, Hottentot, and the Red River, 2002-2003, for: (**A**) fluoride; (**B**) chloride; (**C**) silica; (**D**) aluminum; (**E**) aluminum less than 1 mg/L; and (**F**) boron. The solid line is an equal concentration line.

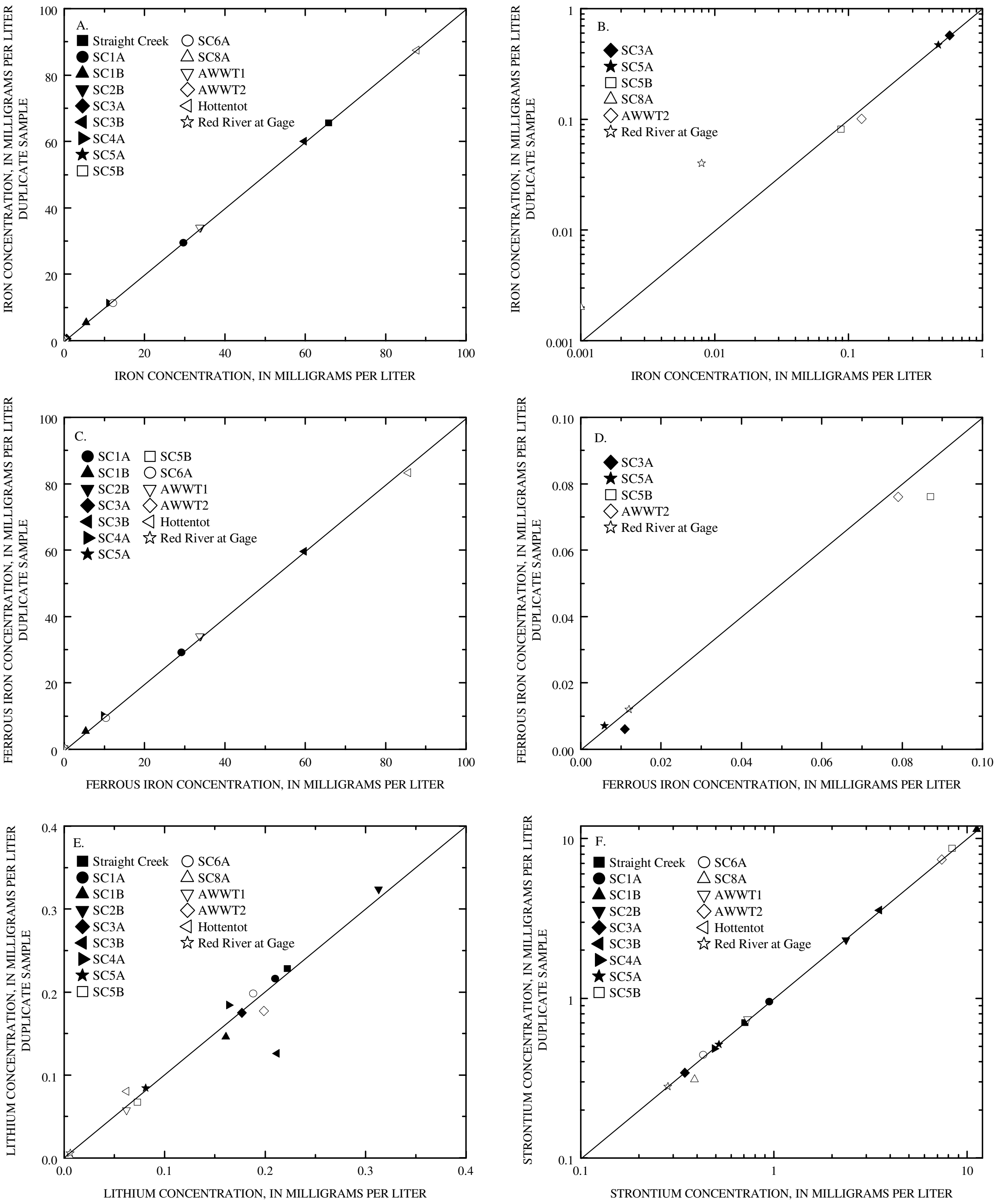


Figure 15. Comparison of sequential duplicates for surface- and ground-water samples collected from Straight Creek, Hottentot, and the Red River, 2002-2003, for: (**A**) total dissolved iron; (**B**) total dissolved iron less than 1 mg/L; (**C**) ferrous iron; (**D**) ferrous iron less than 0.1 mg/L; (**E**) lithium; and (**F**) strontium. The solid line is an equal concentration line.

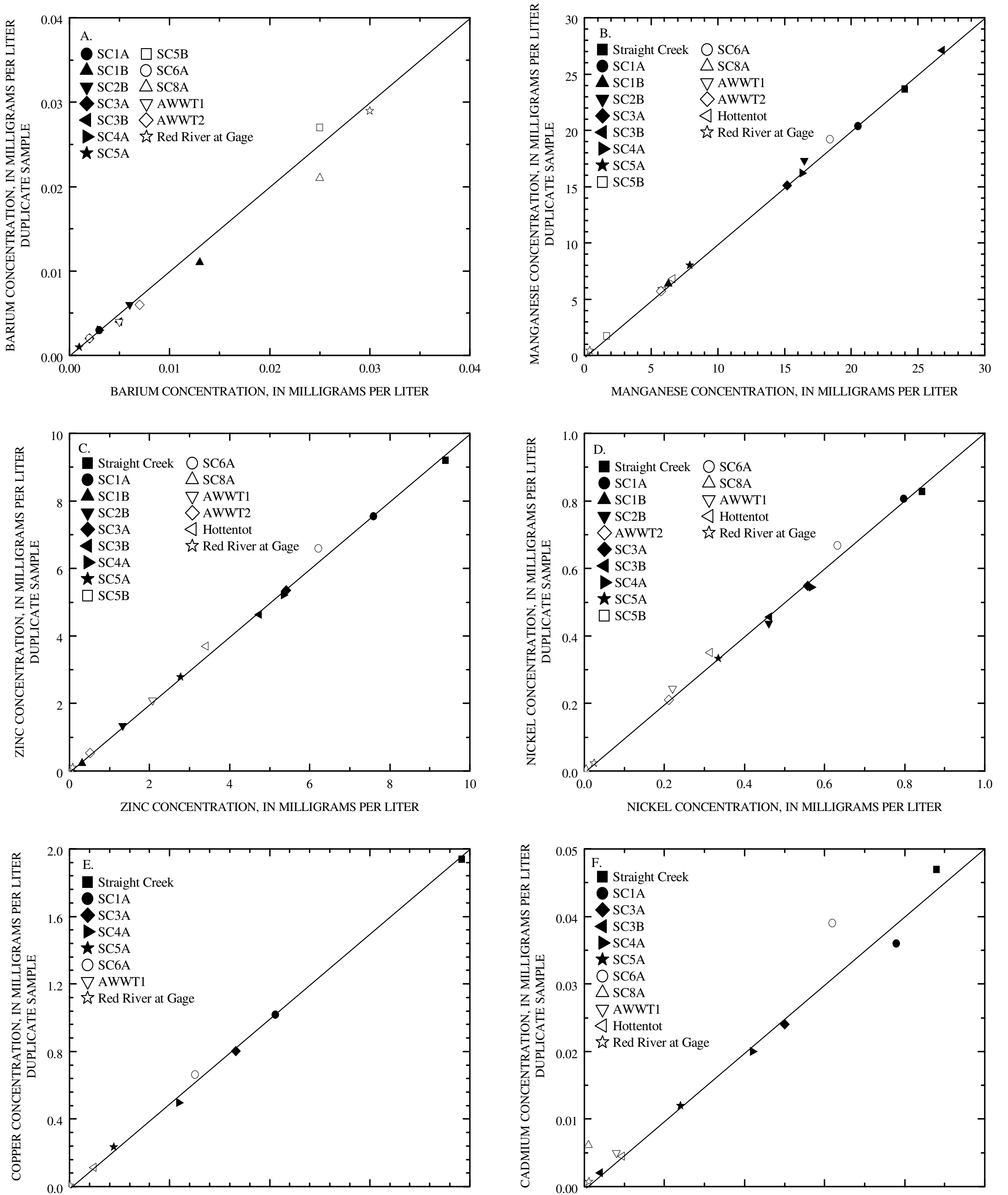


Figure 16. Comparison of sequential duplicates for surface- and ground-water samples collected from Straight Creek, Hottentot, and the Red River, 2002-2003, for: (**A**) barium; (**B**) manganese; (**C**) zinc; (**D**) nickel; (**E**) copper; and (**F**) cadmium. The solid line is an equal concentration line.

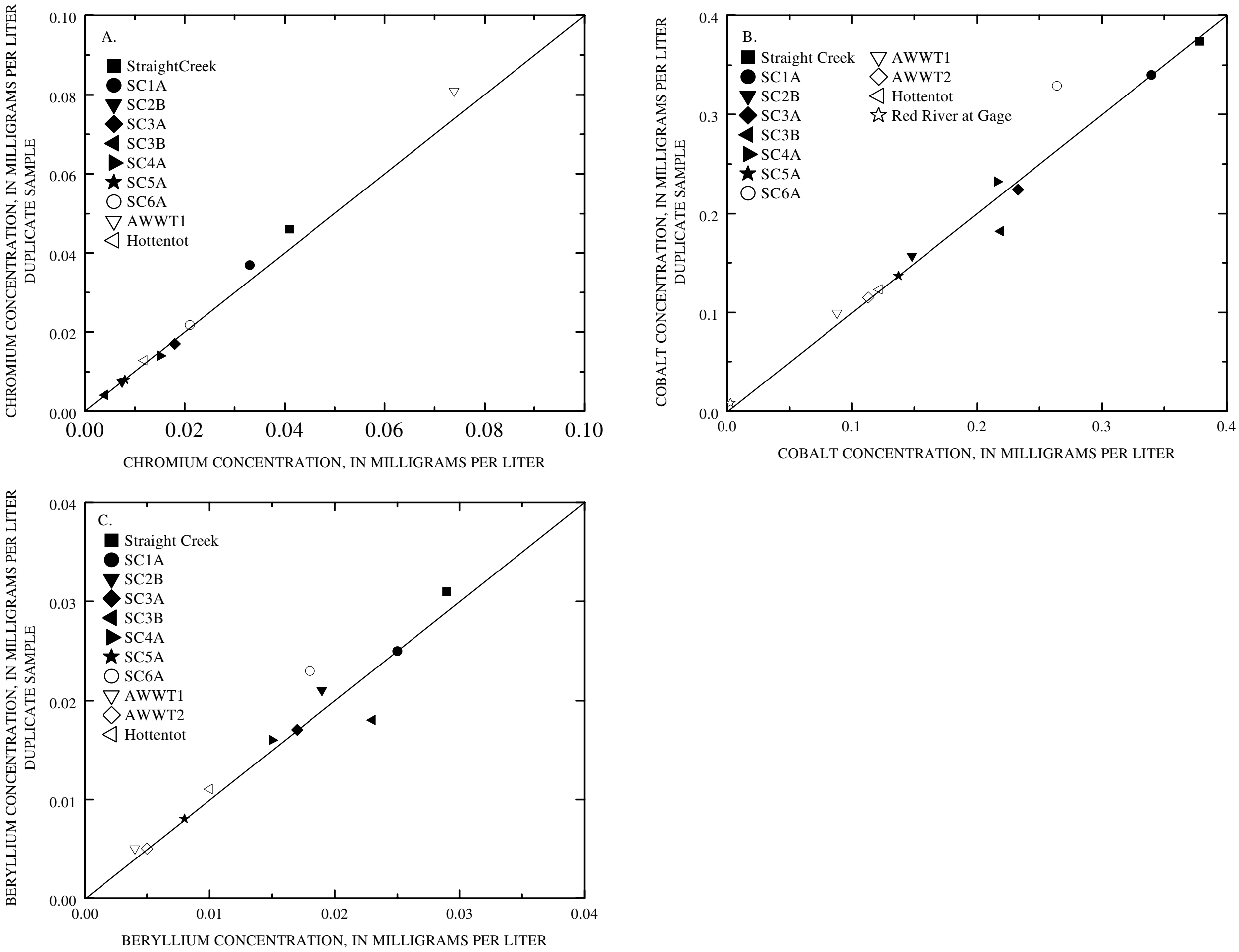


Figure 17. Comparison of sequential duplicates for surface- and ground-water samples collected from Straight Creek, Hottentot, and the Red River, 2002-2003, for: (**A**) chromium; (**B**) cobalt; and (**C**) beryllium. The solid line is an equal concentration line.

Filtration Studies

Filtration Pore Size and Apparatus

The effects of filter pore size and apparatus were studied. On April 16, 2003, a water sample from Straight Creek was filtered through a capsule filter having a nominal pore size of 0.45 µm, a plate filter containing a 0.1-µm membrane, and a Minitan filter with a 10,000-Dalton membrane (table 9 and fig. 18). Concentrations of calcium, total dissolved iron, aluminum, magnesium, silica, manganese, zinc, sodium, copper, nickel, ferrous iron, strontium, cobalt, lithium, chromium, cadmium, beryllium, and lead were measured in filtrates passing through each of the filters tested. The dashed line is the mean value for each constituent and the dotted line is the first standard deviation. Concentrations of total dissolved iron and aluminum were lowest in the filtrate from the Minitan with the 10,000-Dalton filter membrane. The concentrations for the remaining constituents were very comparable in the filtrates from the three filters.

On April 15, 2003, a water sample from the Red River below Fawn Lakes was filtered through a plate filter containing a 0.45-µm membrane, a capsule filter having a nominal pore size of 0.45 µm, a plate filter with a 0.1-µm membrane, and a Minitan filter with a 10,000-Dalton membrane (table 9, fig. 19). Concentrations of calcium, silica, magnesium, potassium, strontium, aluminum, barium, total dissolved iron, manganese, zinc, copper, ferrous iron, and nickel were determined in filtrates passing through each of the filters tested. The dashed line is the mean value for each constituent and the dotted line is the first standard deviation. Concentrations of total dissolved iron, ferrous iron, and aluminum were lowest in the filtrate from the Minitan with the 10,000-Dalton filter membrane and the capsule filter typically produced the next lowest concentration. The relative standard deviation is larger for aluminum and iron in the Red River sample than it is in the Straight Creek sample because the dissolved concentrations are much lower in the Red River sample and any colloidal material passing through the filter greatly increases, on a percentage basis, the apparent dissolved concentration. The total dissolved iron, zinc, copper, ferrous iron, and nickel filtrates from the plate filter containing a 0.45-µm filter membrane were elevated compared to the other filters. The remaining constituents were very comparable in the filtrates from the four filters.

On March 25 and 27, 2002, sequential duplicates using plate filters containing 0.1-µm membranes and capsule filters having a 0.45-µm pore size were collected from wells SC2B, SC3A, SC3B, and SC5A (Naus and others, 2004; D.K. Nordstrom, USGS, written commun., 2004). With only a couple of exceptions, the filtrate concentrations are very similar for all constituents analyzed from all four wells (figs. 20, 21, 22, and 23). Aluminum in well SC2B was about twice as high in the 0.1-µm filtered sample (fig. 20), ferrous iron in well SC5B was about twice as high in the 0.45-µm filtered sample (fig. 23), and several of trace constituents were slightly lower in the 0.1-µm filtered samples.

Except for iron and aluminum, constituents with concentrations greater than about 0.05 mg/L were generally not affected by the filtration apparatus or membrane pore-size. Iron and aluminum form colloids, which may pass through some filters. Trace metals can sorb onto iron and aluminum colloids, and because their concentrations are low their dissolved concentrations are affected by the type of apparatus and membrane pore size.

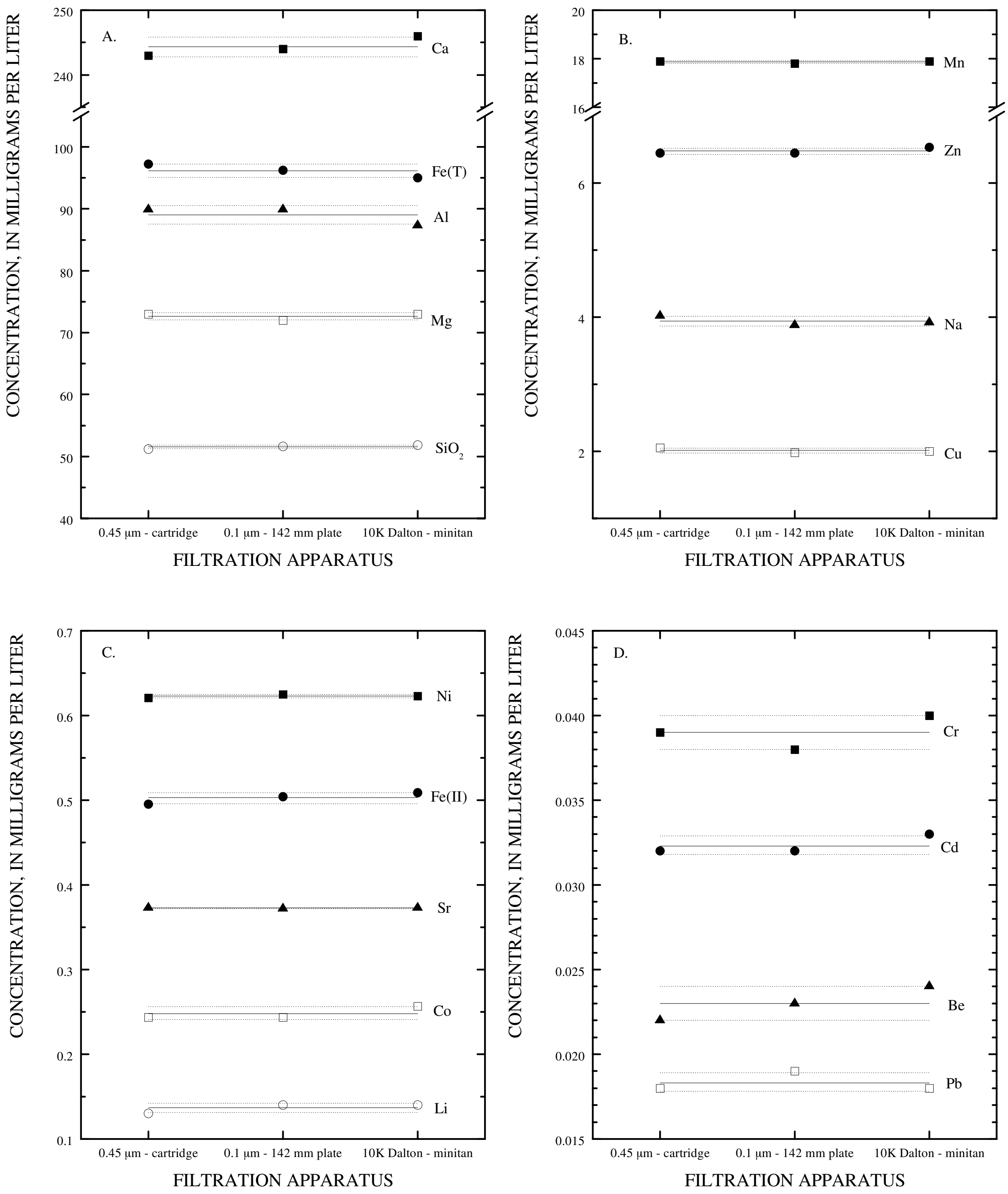


Figure 18. Filtration apparatus and pore size comparison for Straight Creek surface water collected on April 16, 2003. (**A**) Comparison of calcium, total dissolved iron, aluminum, magnesium, and silica. (**B**) Comparison of manganese, zinc, sodium, and copper. (**C**) Comparison of nickel, ferrous iron, strontium, cobalt, and lithium. (**D**) Comparison of chromium, cadmium, beryllium, and lead. Solid line is the mean concentration and the dotted line is ± the first standard deviation.

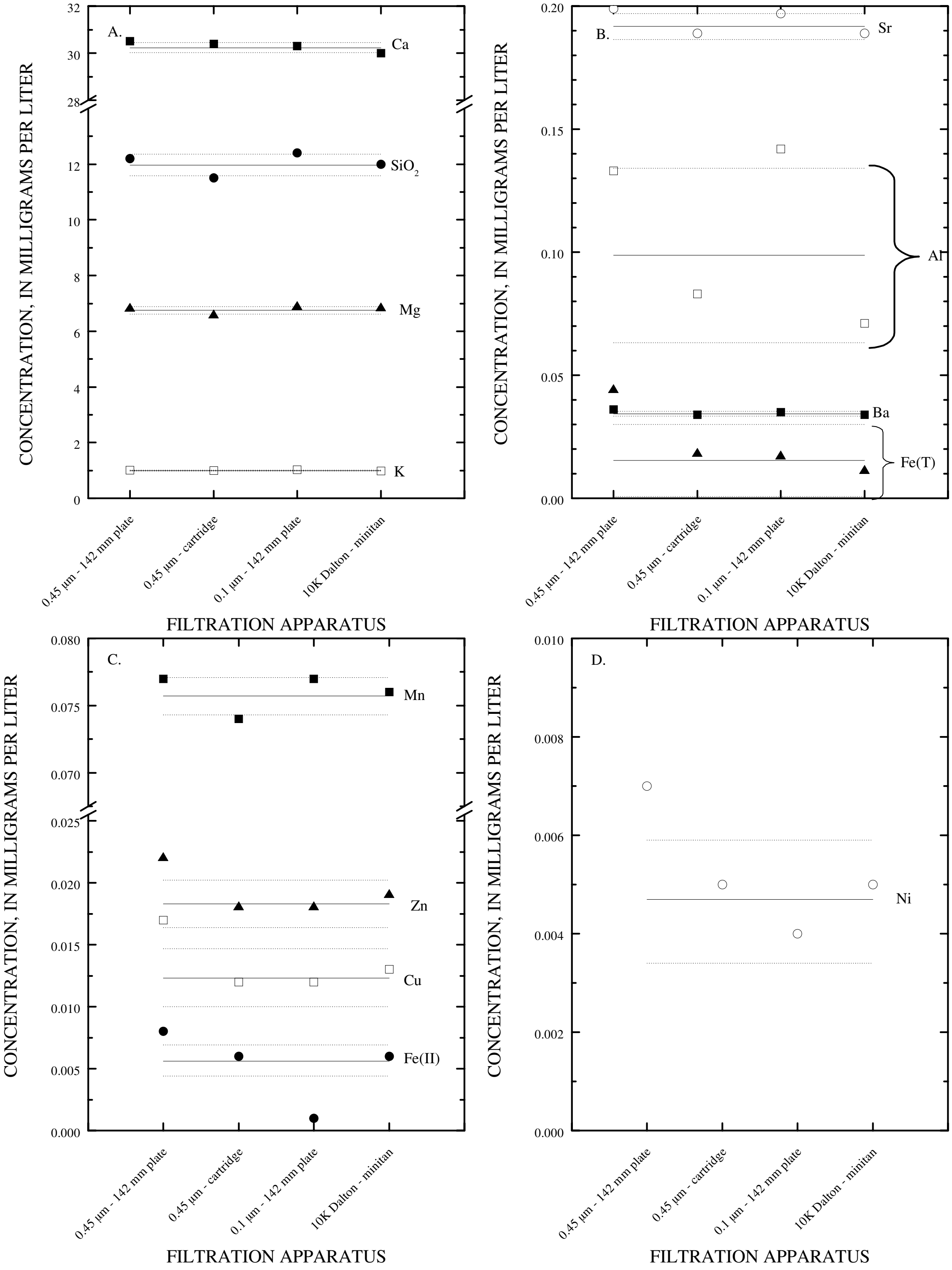


Figure 19. Filtration apparatus and pore size comparison for water from the Red River below Fawn Lake collected on April 15, 2003. (**A**) Comparison of calcium, silica, magnesium, and potassium. (**B**) Comparison of strontium, aluminum, barium, and total dissolved iron. (**C**) Comparison of manganese, zinc, copper, and ferrous iron. (**D**) Comparison of nickel. Solid line is the mean concentration and the dotted line is ± the first standard deviation.

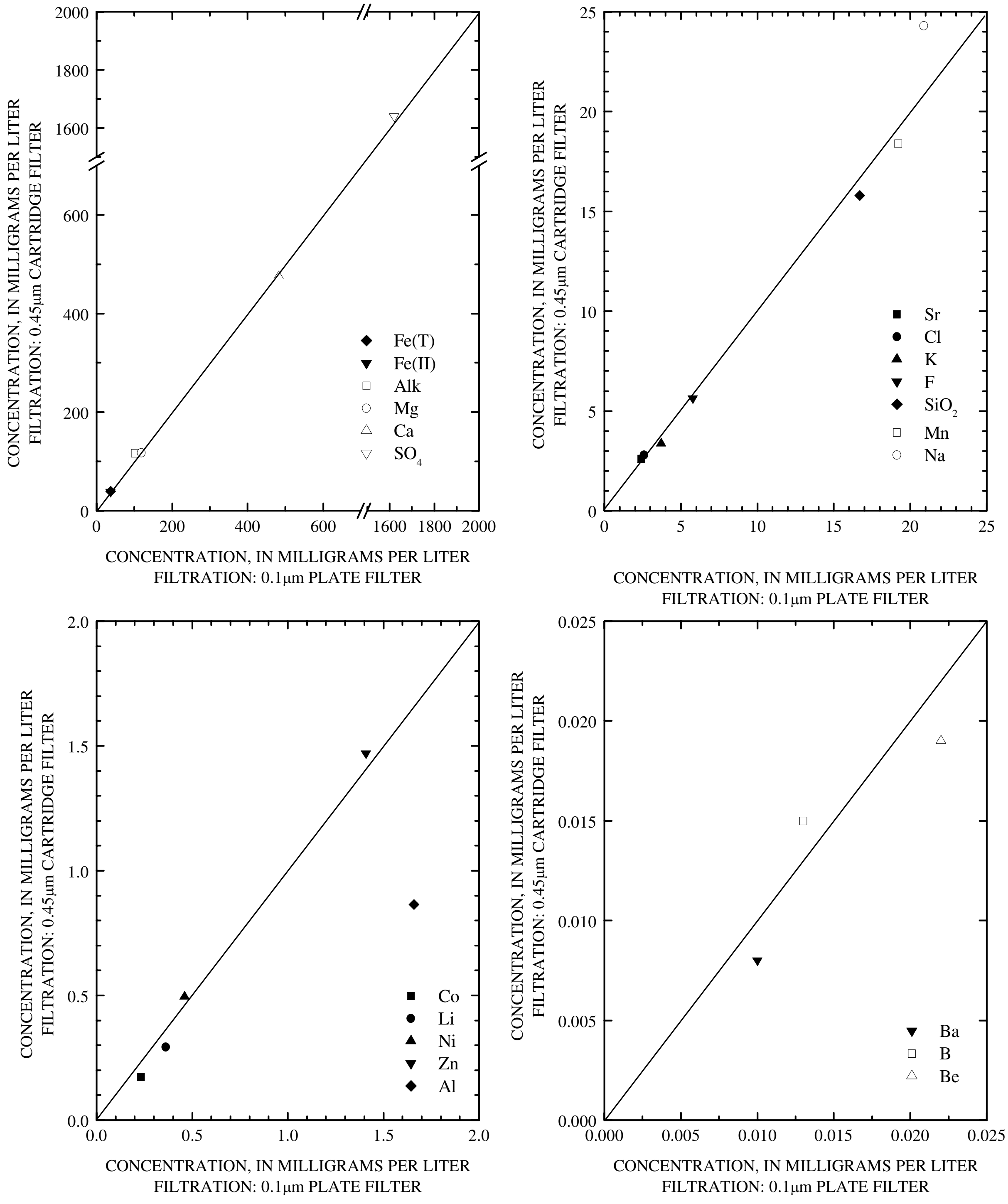


Figure 20. Filtration apparatus and pore size comparison for water from SC2B collected on March 25, 2002. (**A**) Comparison of total dissolved iron, ferrous iron, alkalinity, magnesium, calcium, and sulfate. (**B**) Comparison of strontium, chloride, potassium, fluoride, silica, manganese, and sodium. (**C**) Comparison of cobalt, lithium, nickel, zinc, and aluminum. (**D**) Comparison of barium, boron, and beryllium. Dashed line is the equal concentration line.

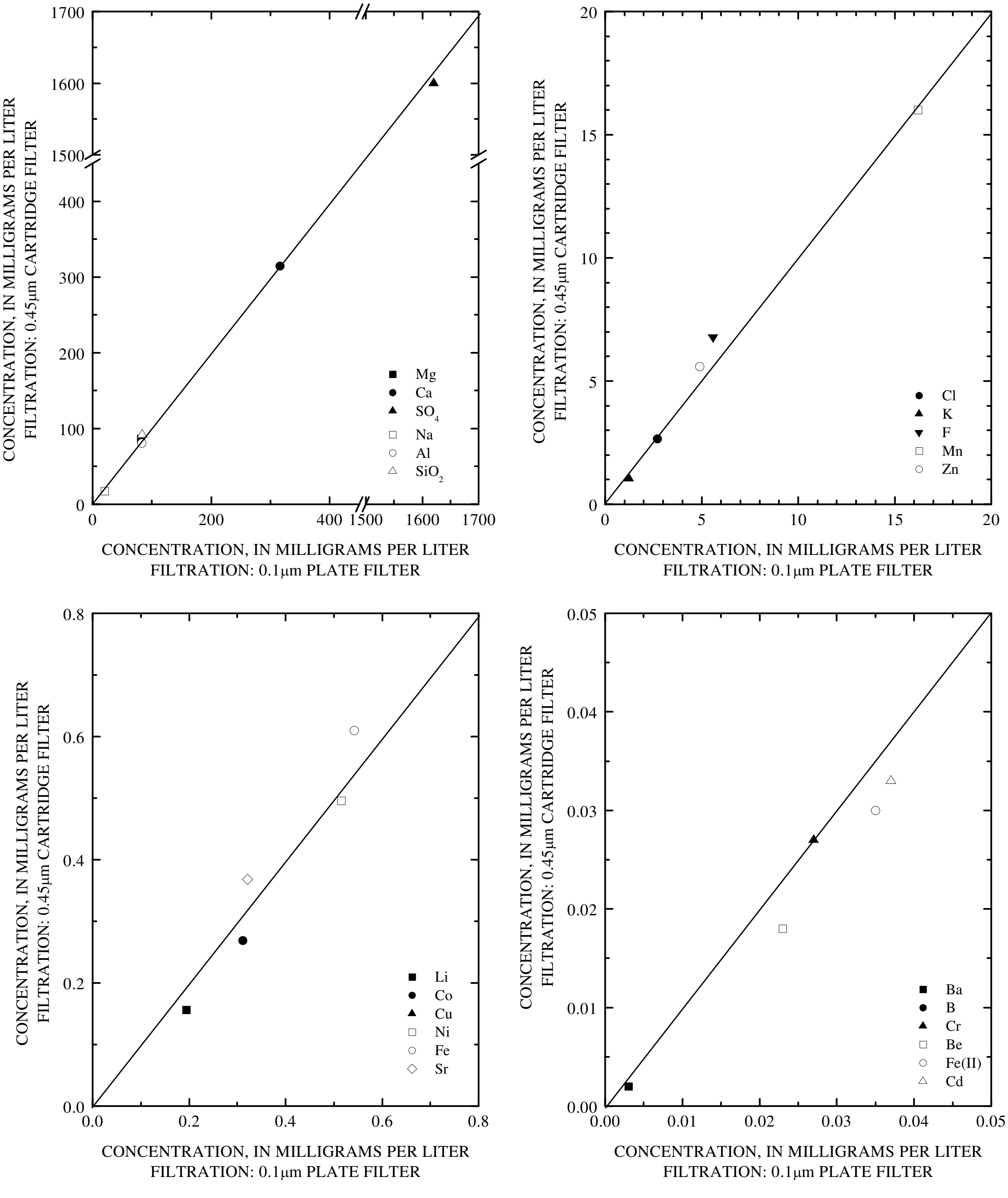


Figure 21. Filtration apparatus and pore size comparison for water from SC3A collected on March 27, 2002. (**A**) Comparison of magnesium, calcium, sulfate, aluminum, and silica. (**B**) Comparison of chloride, potassium, fluoride, manganese, and zinc. (**C**) Comparison of lithium, cobalt, nickel, total dissolved iron, and strontium, (**D**) Comparison of barium, boron, chromium, beryllium, ferrous iron, and cadmium. Dashed line is the equal concentration line.

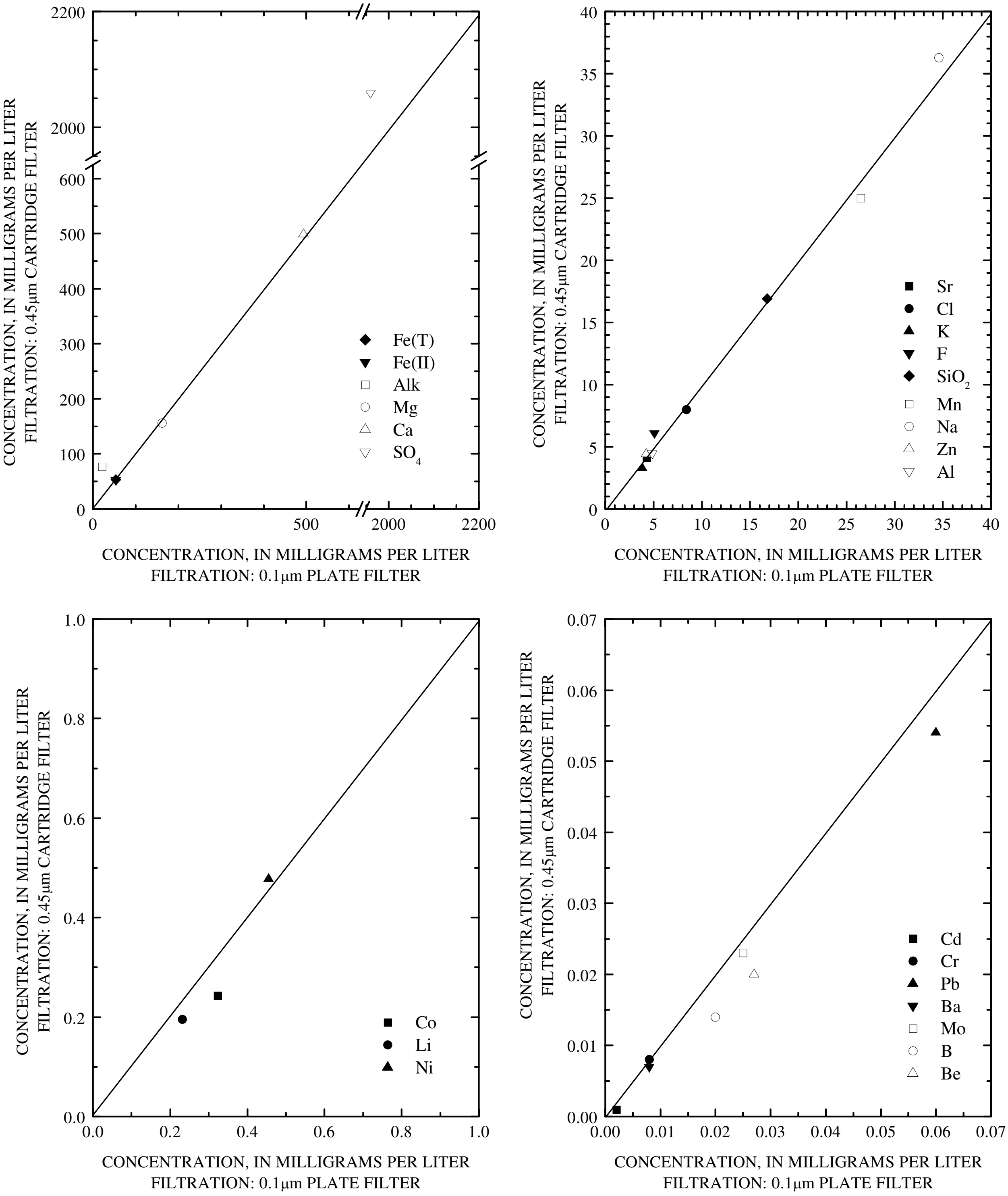


Figure 22. Filtration apparatus and pore size comparison for water from SC3B collected on March 25, 2002. (**A**) Comparison of total dissolved iron, ferrous iron, alkalinity, magnesium, calcium, and sulfate. (**B**) Comparison of strontium, chloride, potassium, fluoride, silica, manganese, sodium, zinc, and aluminum. (**C**) Comparison of cobalt, lithium, and nickel. (**D**) Comparison of cadmium, chromium, lead, barium, molybdenum, boron, and beryllium. Solid line is the equal concentration line.

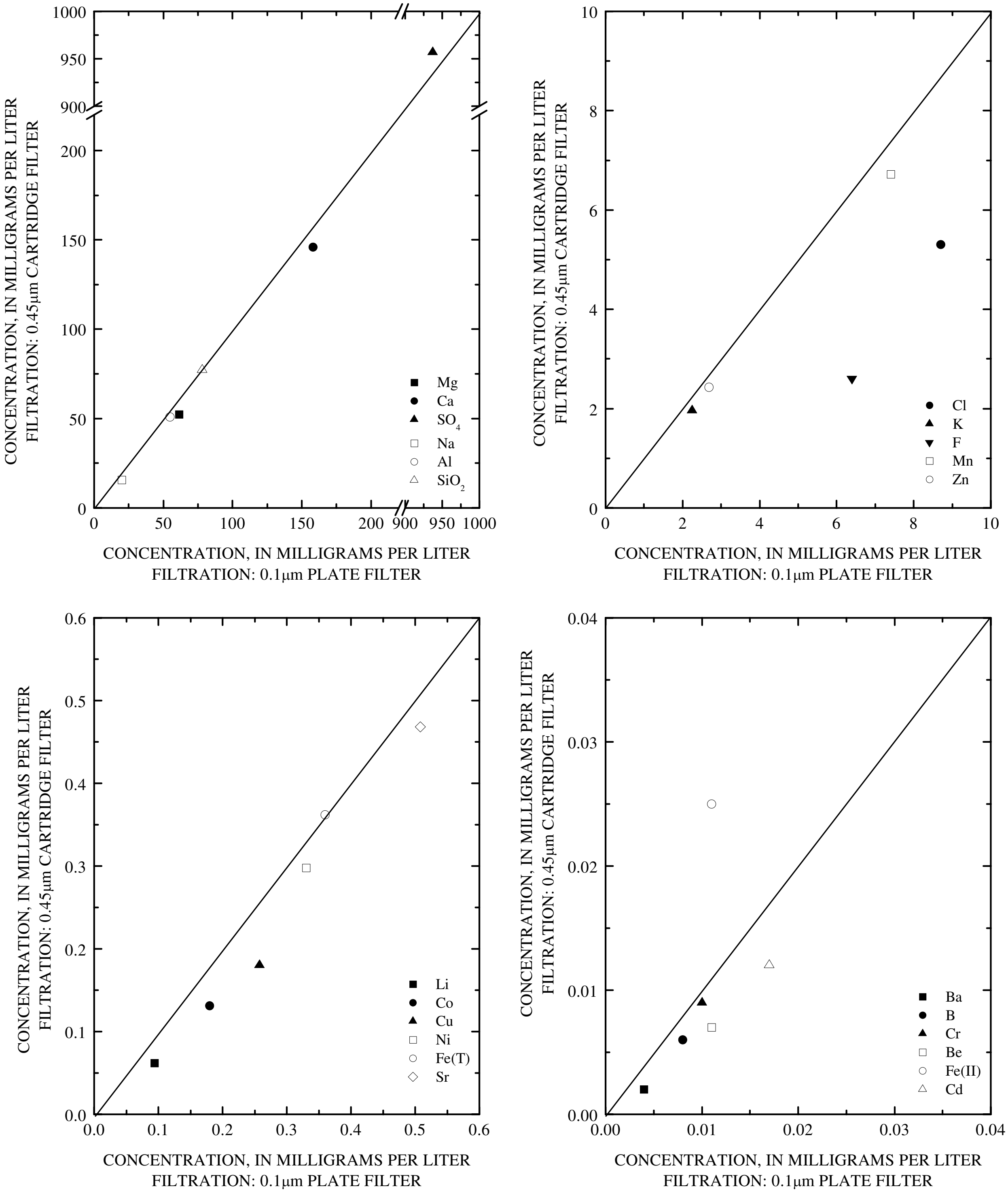


Figure 23. Filtration apparatus and pore size comparison for water from SC5A collected on March 27, 2002. (**A**) Comparison of magnesium, calcium, sulfate, aluminum, and silica. (**B**) Comparison of chloride, potassium, fluoride, manganese, and zinc. (**C**) Comparison of lithium, cobalt, nickel, total dissolved iron, and strontium. (**D**) Comparison of barium, boron, chromium, beryllium, ferrous iron, and cadmium. Solid line is the equal concentration line.

Filtration Timing

There was a time delay between collection and filtration for samples collected along the Red River during low-flow (2001) and snowmelt (2002) tracer studies and during diel studies (2003) (McCleskey and others, 2003; P.L. Verplanck, USGS, written commun., 2004). The effect of time on dissolved metal concentrations and pH was investigated from the samples collected along the Red River below the mill and just below Fawn Lakes on April 15, 2003 (table 9). For the sample collected below the mill, the sample was filtered through a plate filter containing a 0.1-µm membrane and a Minitan filter containing a 10,000-Dalton membrane. For the sample collected below Fawn Lakes, the sample was filtered through plate filters containing 0.45- and 0.1-µm membranes and a Minitan filter containing a 10,000-Dalton membrane. Both samples were processed immediately after collection and then again after 75 to 145 minutes. Calcium, magnesium, sodium, potassium, strontium, barium, silica, and manganese minimally changed during the filtration delay (figs. 24, 25, and 26). Except for total dissolved iron and aluminum, constituents having a concentration greater than about 0.05 mg/L minimally changed during the delay. Aluminum filtrates collected from the 10,000-Dalton filter remained unchanged, but after the time delay, filtrate passing through the 0.1-µm filter approached the aluminum concentration produced by the Minitan, indicating that aluminum colloids formed during the delay (fig. 25A). However, aluminum filtrates passing through the 0.45-µm membrane did not change very much, signifying that the newly formed aluminum precipitate was between 0.1 µm and 0.45 µm in size. Total dissolved iron decreased in the sample collected from below the mill during the filtration delay; however, it remained constant in the sample collected from below Fawn Lakes (fig. 25C). Both samples contained predominantly ferric iron. However, the matrices of the two samples are likely different because of inflows into the Red River, causing the sample from below the mill to precipitate iron more quickly. Ferrous iron concentrations were very low and except for the 0.45-µm filter, filtrate concentrations were either at the detection limit initially or approached it after the filtration delay (fig. 25D). Copper concentrations decreased in the samples collected from Fawn Lakes during the delay and slightly increased in the samples from below the mill, although the copper concentrations are only about 3 times the detection limit for samples, collected below the mill (fig. 25E). During the delay, copper may have sorbed onto the pre-existing iron colloids in the Fawn Lakes sample, because the dissolved iron concentration minimally changed. The increased copper sorption was likely the result of either copper not being at equilibrium with the pre-existing colloidal iron or a change in the sample temperature during the delay. Dissolved nickel concentrations decreased in both samples during the filtration delay, except in the 0.1-µm filtrate from Fawn Lakes (fig. 26B). The pH decreased in both samples during the delay, probably because of an increase in sample temperature, iron oxidation, or in-gassing (fig. 26C).

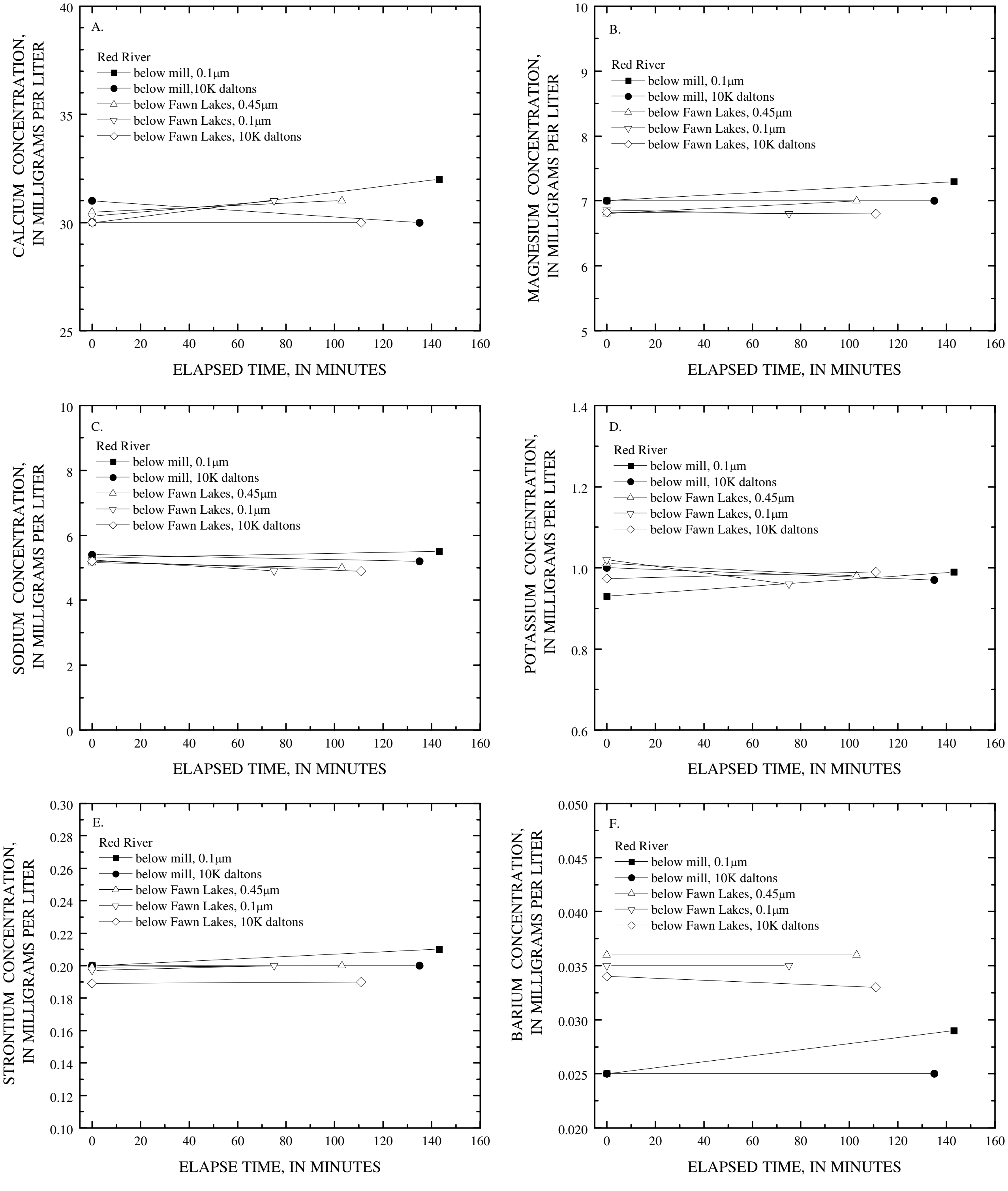


Figure 24. The effects of time on filtrate concentration for water samples collected from two sites along the Red River on April 15, 2003 for: (**A**) calcium; (**B**) magnesium; (**C**) sodium; (**D**) potassium; (**E**) strontium; and (**F**) barium.

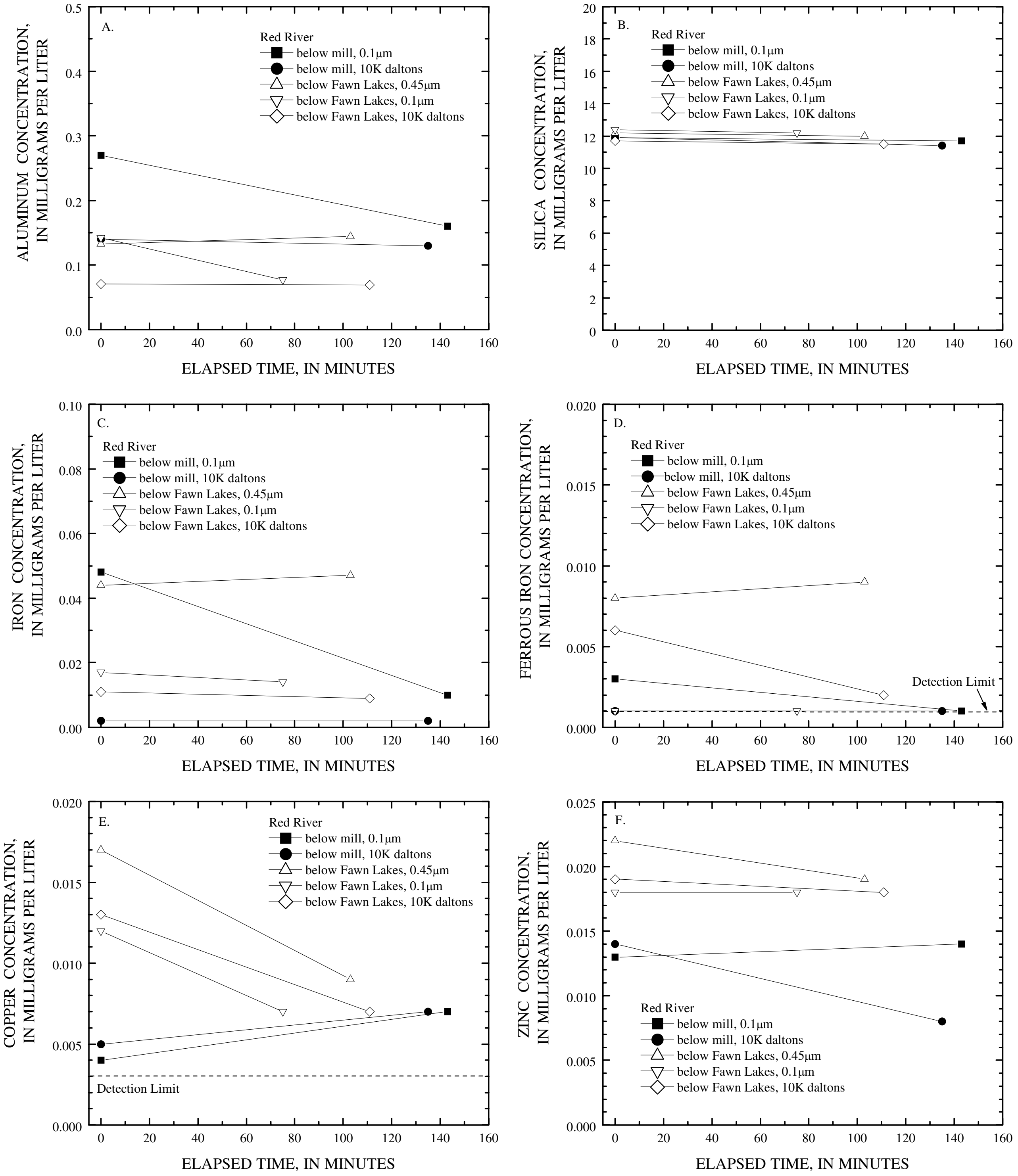


Figure 25. The effects of time on filtrate concentration for water samples collected from two sites along the Red River on April 15, 2003 for: (**A**) aluminum; (**B**) silica; (**C**) total dissolved iron; (**D**) ferrous iron; (**E**) copper; and (**F**) zinc.

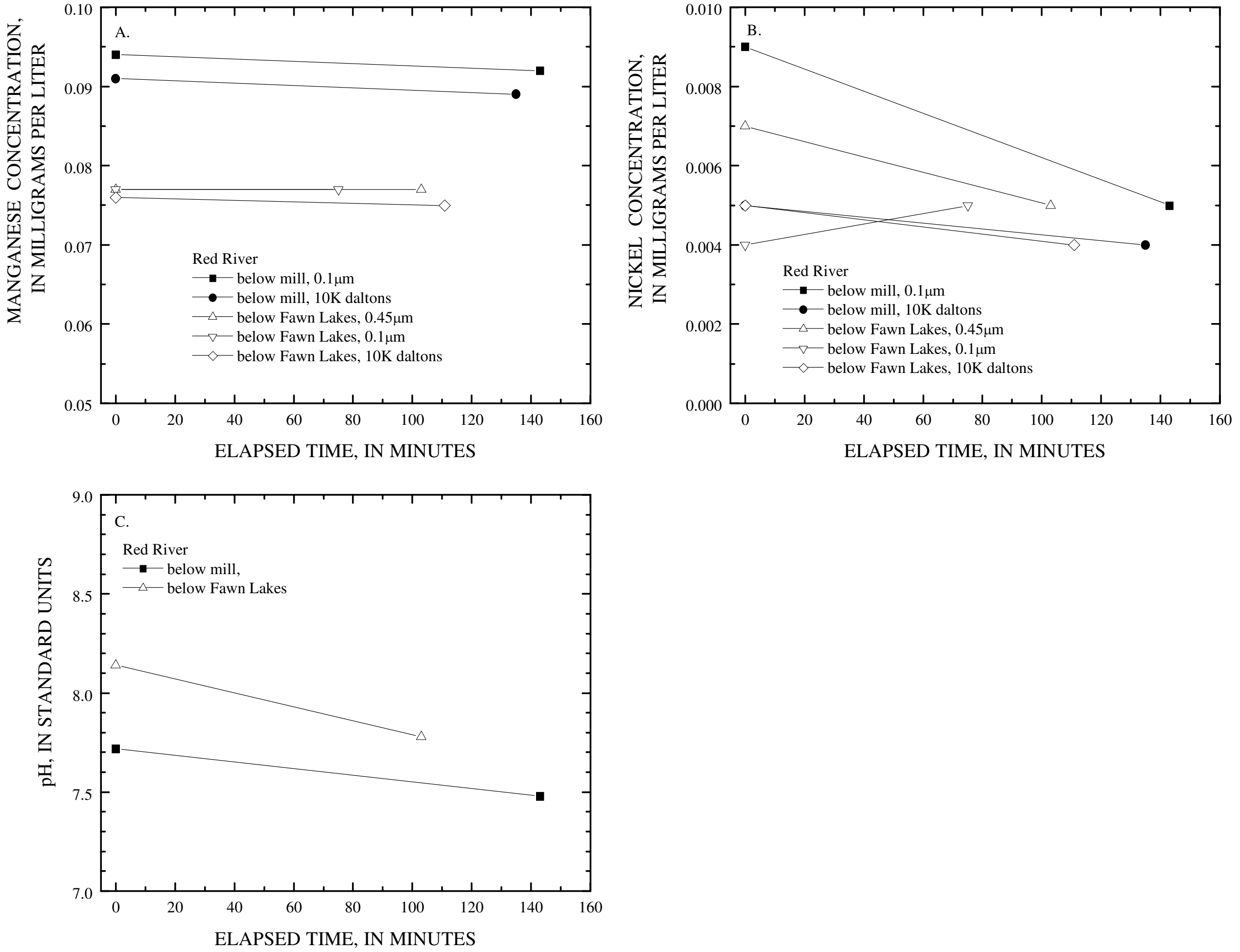


Figure 26. The effects of time on filtrate concentration for water samples collected from two sites along the Red River on April 15, 2003 for: (**A**) manganese and (**B**) nickel. (**C**) The affect of time on pH for water samples collected from two sites along the Red River on April 15, 2003.

Sequential Filtration

A sequential filtration study was performed at the Red River USGS streamflow-gaging station on March 20, 2002. Sequential aliquots were collected by simultaneously pumping water directly from the center of the river through 142-mm plate filters with membranes containing 0.1-µm and 0.45-µm pore size (table 10). Ten 125-mL aliquots were collected from each apparatus beginning with the first drops of water that passed through the filters. Concentrations of calcium, magnesium, silica, sodium, potassium, manganese, strontium, zinc, total dissolved iron, ferrous iron, barium, nickel, cobalt, and copper from each aliquot are shown in figure 27. Filtrate concentrations remained fairly constant and were within the error of the measurements for all aliquots, except for ferrous iron and barium from the 0.45-µm filter. With increasing sample volume passing through the filter, barium and ferrous iron concentrations generally decreased in the filtrate from the 0.45-µm filter and both barium and ferrous iron approached the concentrations in the 0.1-µm filtrate. The effective pore size likely decreased in the 0.45-µm filter as colloids accumulated on the filter.

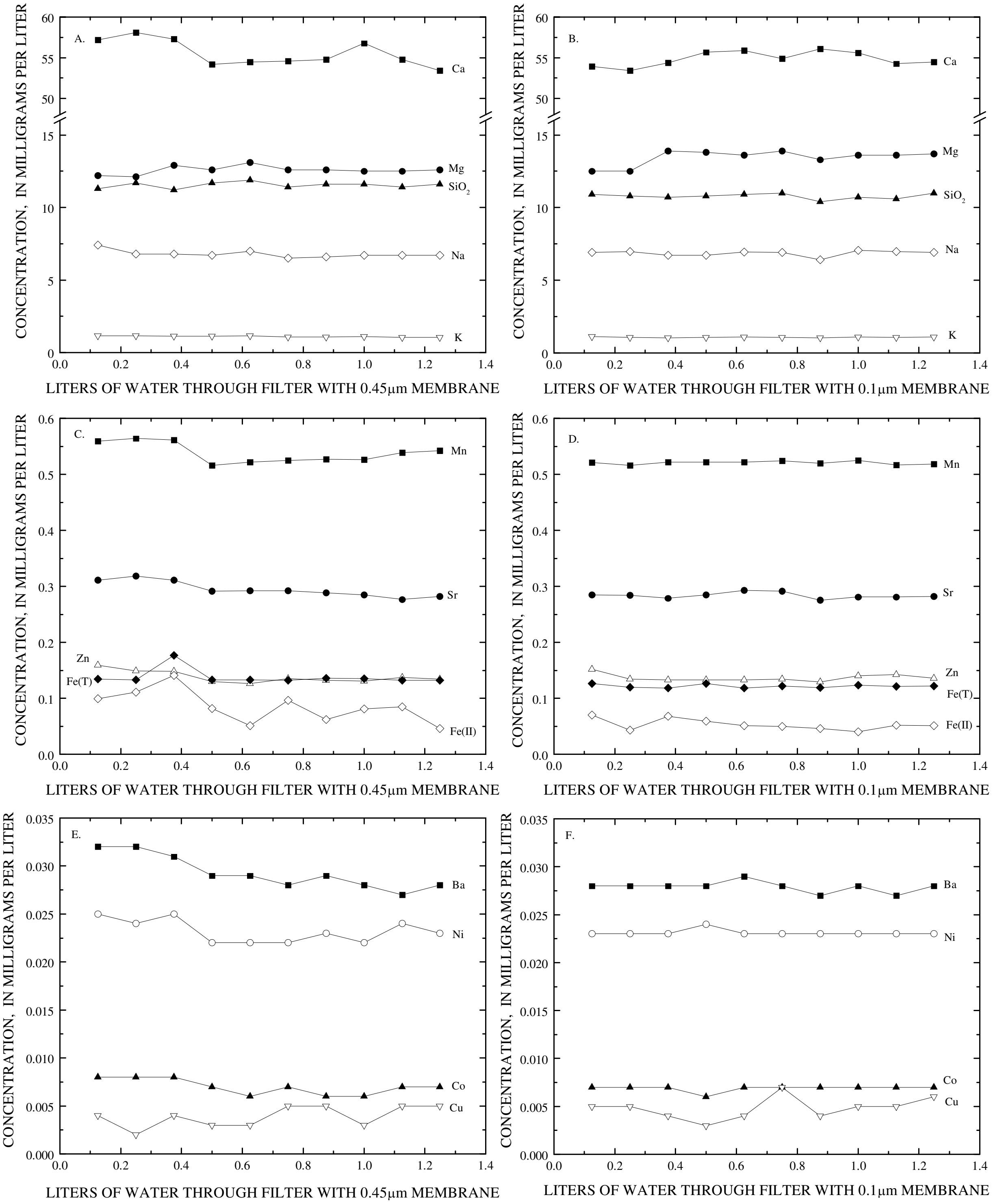


Figure 27. The effects of sample volume passing through filters for water samples collected from the Red River at the gage on March 20, 2002. (**A**) Calcium, magnesium, silica, sodium, and potassium concentrations after filtration through a 0.45-µm filter. (**B**) Calcium, magnesium, silica, sodium, and potassium concentrations after filtration through a 0.1-µm filter. (**C**) Manganese, strontium, zinc, total dissolved iron, and ferrous iron concentrations after filtration through a 0.45-µm filter. (**D**) Manganese, strontium, zinc, total dissolved iron, and ferrous iron concentrations after filtration through a 0.1-µm filter. (**E**) Barium, nickel, cobalt, and copper concentrations after filtration through a 0.45-µm filter. (**F**) Barium, nickel, cobalt, and copper concentrations after filtration through a 0.1-µm filter.

Summary

As part of the Questa baseline and pre-mining ground-water quality investigation, water analyses are tabulated in several reports for surface and ground waters collected from the Red River Basin, New Mexico. The same quality assurance and quality control (QA/QC) methods and data apply for three reports. These reports include ground-water analyses from Straight Creek, Hansen, Hottentot, La Bobita, Capulin Canyon, and Questa Ranger Station, and surface water analyses from Straight Creek and the Red River. This report combines QA/QC data relevant to all three reports rather than repeating the same information in each report. The QA/QC includes analyses of standard reference water samples, calculation of charge imbalance, collection and analyses of field and equipment blanks, analyses of spiked samples, analyses by multiple methods, analyses by different laboratories, sequential duplicates, and investigation of filtration effects.

Analyses of seventy-two blanks demonstrated that contamination from processing, handling, and analyses was minimal and had no substantial effect on results. Blanks collected using water deionized with anion and cation exchange resins contained elevated concentrations of boron (0.17 mg/L) and silica (3.90 mg/L), whereas double-distilled water did not. Boron and silica were not completely retained by the resins because they can exist as uncharged species in water. Chloride, as much as 3.9 mg/L, and sulfate, as much as 3.0 mg/L were detected in blanks. With only a few exceptions, the remaining blank analyses were near or below method detection limits. Analyses of standard reference water samples provided accuracy checks. For constituents greater than 10 times the detection limit, 95 percent of the standard reference water samples had a percent error of less than 8.5. For constituents within 10 percent of the detection limit, the percent error often increased because the signal to noise ratio decreased. Charge imbalance was calculated using WATEQ4F and 251 out of 257 samples had a charge imbalance less than 11.8 percent. Spike recoveries for metals were performed by spiking ground-water samples and then analyzing them by inductively coupled plasma-optical emission spectrometry. The mean recovery for all constituents was 103 percent with a standard deviation of 16 percent. Fifteen surface- and ground-water sequential duplicates were collected from Straight Creek, Hottentot, and the Red River from 2002 to 2003. With the exception of chloride from well SC5B and low concentrations of iron (<0.05 mg/L) and aluminum (<0.01 mg/L), constituents from sequential duplicates are usually within 10 percent of each other. Analytical results from different methods and different laboratories, with rare exceptions, were within 10 percent. Chromium analyses were in poor agreement (greater than 50 percent) when comparing laboratories, but USGS analyses by ICP-OES and ICP-MS were usually within 10 percent at concentrations above 0.03 mg/L and analyses by ICP-OES and GFAAS were usually within 15 percent for concentrations as much as 0.1 mg/L.

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Appendix

Table 7. Analyses by multiple methods

[GFAAS, graphite furnace atomic absorption spectrometry; HGAAS, hydride generation atomic absorption spectrometry; ICP-MS, inductively coupled plasma-mass spectrometry; ICP-OES, inductively coupled plasma-optical emission spectrometry; mg/L, milligrams per liter; <, less than; SW, surface water; ---, no data]

	Sample Location	**Hansen (SW-high)**	**Hansen (SW-low)**	**Little Hansen (SW)**	**Straight Creek (SW-low)**
	Collection Date	9/11/01	9/11/01	9/11/01	9/12/01
Constituent, mg/L	**Technique**				
Arsenic (As)	HGAAS	<0.0001	<0.0001	0.0020	0.0004
	ICP-MS	0.0028	0.0029	0.0071	0.0054
Aluminum (Al)	ICP-OES	76.0	103	172	107
	GFAAS	---	---	---	---
	ICP-MS	74[1]	89[1]	170[1]	99[1]
Boron (B)	ICP-OES	0.007	0.007	0.010	0.006
	ICP-MS	0.008	0.006	<0.008	<0.008
Barium (Ba)	ICP-OES	0.007	0.005	0.002	0.002
	ICP-MS	0.008	0.006	0.003	0.003
Beryllium (Be)	ICP-OES	0.015	0.015	0.033	0.027
	ICP-MS	0.016	0.015	0.034	0.027
Cadmium (Cd)	ICP-OES	0.008	0.006	0.021	0.037
	GFAAS	---	---	---	---
	ICP-MS	0.0087	0.0045	0.019	0.039
Cobalt (Co)	ICP-OES	0.215	0.147	0.515	0.283
	GFAAS	---	---	---	---
	ICP-MS	0.210	0.150	0.680	0.330
Chromium (Cr)	ICP-OES	<0.002	0.004	0.047	0.041
	GFAAS	---	---	---	---
	ICP-MS	<0.003	0.0043	0.0516	0.0409
Copper (Cu)	ICP-OES	0.190	0.087	0.554	1.75
	GFAAS	---	---	---	---
	ICP-MS	0.190	0.090	0.560	1.80
Lithium (Li)	ICP-OES	0.081	0.068	0.285	0.194
	ICP-MS	0.064	0.064	0.250	0.170
Manganese (Mn)	ICP-OES	14.3	7.69	25.1	23.6
	ICP-MS	13[1]	6.8[1]	23[1]	22[1]
Molybdenum (Mo)	ICP-OES	<0.007	<0.007	<0.007	<0.007
	ICP-MS	0.0011	<0.0006	0.0025	0.0058
Nickel (Ni)	ICP-OES	0.551	0.374	1.50	0.753
	GFAAS	---	---	---	---
	ICP-MS	0.540	0.360	1.60	0.760
Lead (Pb)	ICP-OES	<0.008	<0.008	<0.008	<0.008
	GFAAS	---	---	---	---
	ICP-MS	0.00094	0.0030	0.00066	0.0017
Strontium (Sr)	ICP-OES	2.64	1.31	3.12	0.454
	ICP-MS	2.50	1.30	3.30	0.480
Vanadium (V)	ICP-OES	<0.002	<0.002	0.002	<0.002
	ICP-MS	<0.0006	<0.0006	0.001	<0.001
Zinc (Zn)	ICP-OES	2.90	2.88	4.18	7.82
	ICP-MS	2.80	2.80	4.30	7.70

[1] sample measured at a concentration higher than the calibration range

Table 7. Analyses by multiple methods—Continued

[GFAAS, graphite furnace atomic absorption spectrometry; HGAAS, hydride generation atomic absorption spectrometry; ICP-MS, inductively coupled plasma-mass spectrometry; ICP-OES, inductively coupled plasma-optical emission spectrometry; mg/L, milligrams per liter; <, less than; SW, surface water; ---, no data]

	Sample Location	**Straight Creek (SW-high)**	**Hottentot (SW-low)**	**Hottentot (SW-high)**	**Goat Hill (SW)**
	Collection Date	**9/12/01**	**9/13/01**	**9/13/01**	**9/14/01**
Constituent, mg/L	**Technique**				
Arsenic (As)	HGAAS	0.0050	0.0040	0.0470	0.0350
	ICP-MS	0.0140	0.0058	0.0508	0.110
Aluminum (Al)	ICP-OES	139	80.2	141	1,290
	GFAAS	---	---	---	---
	ICP-MS	130[1]	70[1]	130[1]	1,300[1]
Boron (B)	ICP-OES	0.008	0.005	0.006	0.016
	ICP-MS	<0.008	<0.005	<0.008	<0.02
Barium (Ba)	ICP-OES	0.001	0.003	0.001	<0.0008
	ICP-MS	0.002	0.004	0.002	0.004
Beryllium (Be)	ICP-OES	0.044	0.011	0.023	0.347
	ICP-MS	0.043	0.010	0.022	0.330
Cadmium (Cd)	ICP-OES	0.041	0.019	0.058	0.502
	GFAAS	---	---	---	---
	ICP-MS	0.036	0.012	0.047	0.530
Cobalt (Co)	ICP-OES	0.329	0.175	0.362	3.53
	GFAAS	---	---	---	---
	ICP-MS	0.320	0.170	0.330	3.70
Chromium (Cr)	ICP-OES	0.045	0.032	0.090	0.478
	GFAAS	---	---	---	---
	ICP-MS	0.0379	0.0312	0.0875	0.490
Copper (Cu)	ICP-OES	1.72	0.541	2.34	10.2
	GFAAS	---	---	---	---
	ICP-MS	1.70	0.530	2.20	11.0
Lithium (Li)	ICP-OES	0.206	0.074	0.095	1.11
	ICP-MS	0.200	0.071	0.088	1.00
Manganese (Mn)	ICP-OES	31.9	5.85	16.0	500
	ICP-MS	29[1]	5.6[1]	14[1]	510[1]
Molybdenum (Mo)	ICP-OES	---	---	---	---
	ICP-MS	0.0093	0.0022	0.0275	0.0191
Nickel (Ni)	ICP-OES	0.784	0.403	0.796	8.56
	GFAAS	---	---	---	---
	ICP-MS	0.760	0.390	0.760	8.50
Lead (Pb)	ICP-OES	0.037	<0.008	0.018	0.063
	GFAAS	---	---	---	---
	ICP-MS	0.0273	0.00080	0.00069	0.0020
Strontium (Sr)	ICP-OES	0.340	0.081	0.093	1.21
	ICP-MS	0.300	0.082	0.092	1.20
Vanadium (V)	ICP-OES	0.004	0.004	0.014	0.010
	ICP-MS	0.002	0.002	0.011	0.022
Zinc (Zn)	ICP-OES	12.8	3.7	6.42	113
	ICP-MS	12[1]	3.5[1]	6.10	110[1]

[1] sample measured at a concentration higher than the calibration range

Table 7. Analyses by multiple methods—Continued

[GFAAS, graphite furnace atomic absorption spectrometry; HGAAS, hydride generation atomic absorption spectrometry; ICP-MS, inductively coupled plasma-mass spectrometry; ICP-OES, inductively coupled plasma-optical emission spectrometry; mg/L, milligrams per liter; <, less than; SW, surface water; ---, no data]

	Sample Location	**Junebug (SW-west)**	**Junebug (SW-east)**	**West of Little Hansen (SW)**	**Waldo (SW)**
	Collection Date	**9/14/01**	**9/14/01**	**9/15/01**	**9/15/01**
Constituent, mg/L	**Technique**				
Arsenic (As)	HGAAS	<0.0001	<0.0001	0.0002	<0.0001
	ICP-MS	0.0014	0.0058	0.0002	0.0003
Aluminum (Al)	ICP-OES	13.7	83.7	<0.07	2.90
	GFAAS	---	---	---	---
	ICP-MS	14.0	80[1]	---	3.00
Boron (B)	ICP-OES	0.003	0.004	0.007	0.005
	ICP-MS	<0.008	<0.008	0.011	0.007
Barium (Ba)	ICP-OES	0.004	0.002	0.019	0.011
	ICP-MS	0.005	0.002	0.020	0.010
Beryllium (Be)	ICP-OES	0.005	0.034	<0.001	0.001
	ICP-MS	0.006	0.034	<0.00008	0.0011
Cadmium (Cd)	ICP-OES	0.016	0.051	<0.002	0.001
	GFAAS	---	---	---	---
	ICP-MS	0.018	0.054	<0.00004	0.0012
Cobalt (Co)	ICP-OES	0.152	0.554	<0.007	0.018
	GFAAS	---	---	---	---
	ICP-MS	0.170	0.530	0.00008	0.0156
Chromium (Cr)	ICP-OES	<0.002	0.009	<0.002	<0.002
	GFAAS	---	---	---	---
	ICP-MS	<0.006	0.0077	<0.002	<0.002
Copper (Cu)	ICP-OES	2.39	3.51	<0.002	0.007
	GFAAS	---	---	---	---
	ICP-MS	2.30	3.50	0.006	0.013
Lithium (Li)	ICP-OES	0.188	0.330	0.024	0.010
	ICP-MS	0.190	0.300	0.023	0.010
Manganese (Mn)	ICP-OES	6.76	19.9	<0.002	0.99
	ICP-MS	6.41	18[1]	0.0065	1.00
Molybdenum (Mo)	ICP-OES	<0.007	<0.007	<0.007	<0.007
	ICP-MS	<0.001	<0.001	0.0012	<0.0005
Nickel (Ni)	ICP-OES	0.449	1.24	<0.002	0.063
	GFAAS	---	---	---	---
	ICP-MS	0.450	1.30	0.001	0.066
Lead (Pb)	ICP-OES	<0.008	<0.008	<0.008	<0.008
	GFAAS	---	---	---	---
	ICP-MS	0.0037	0.0025	0.00010	0.00019
Strontium (Sr)	ICP-OES	8.31	5.42	2.03	1.20
	ICP-MS	7.60	5.30	1.80	1.00
Vanadium (V)	ICP-OES	<0.002	<0.002	<0.002	<0.002
	ICP-MS	<0.001	<0.001	<0.0009	<0.0009
Zinc (Zn)	ICP-OES	2.24	6.59	<0.005	0.330
	ICP-MS	2.20	6.70	0.019	0.350

[1] sample measured at a concentration higher than the calibration range

Table 7. Analyses by multiple methods—Continued

[GFAAS, graphite furnace atomic absorption spectrometry; HGAAS, hydride generation atomic absorption spectrometry; ICP-MS, inductively coupled plasma-mass spectrometry; ICP-OES, inductively coupled plasma-optical emission spectrometry; mg/L, milligrams per liter; <, less than; SW, surface water; ---, no data]

	Sample Location	**Underground-S. Haulage (GW)**	**Underground-Rainforest East (SW)**	**Underground-Rainforest West (SW)**	**Straight Creek (SW)**
	Collection Date	**2/25/02**	**2/25/02**	**2/25/02**	**3/20/02**
Constituent, mg/L	**Technique**				
Arsenic (As)	HGAAS	0.0004	0.0007	0.0005	<0.0001
	ICP-MS	0.0005	0.0007	0.0005	0.0005
Aluminum (Al)	ICP-OES	<0.07	<0.07	<0.07	14.9
	GFAAS	---	---	---	---
	ICP-MS	---	---	---	15[1]
Boron (B)	ICP-OES	0.018	0.015	0.014	<0.01
	ICP-MS	0.010	0.014	0.009	<0.005
Barium (Ba)	ICP-OES	0.017	0.020	0.008	0.003
	ICP-MS	0.017	0.018	0.007	0.001
Beryllium (Be)	ICP-OES	<0.001	0.002	0.001	0.007
	ICP-MS	<0.00008	0.0017	0.00098	0.0052
Cadmium (Cd)	ICP-OES	0.001	<0.002	<0.002	0.013
	GFAAS	---	---	---	---
	ICP-MS	<0.00004	0.0010	0.0017	0.0072
Cobalt (Co)	ICP-OES	<0.007	<0.007	<0.007	0.098
	GFAAS	---	---	---	---
	ICP-MS	0.00004	0.00035	0.00043	0.0722
Chromium (Cr)	ICP-OES	0.003	0.004	0.005	0.014
	GFAAS	---	---	---	---
	ICP-MS	<0.002	<0.006	<0.006	0.0074
Copper (Cu)	ICP-OES	0.012	0.004	0.008	0.386
	GFAAS	---	---	---	---
	ICP-MS	0.006	0.007	0.006	0.410
Lithium (Li)	ICP-OES	0.063	0.161	0.138	0.028
	ICP-MS	0.074	0.180	0.170	0.027
Manganese (Mn)	ICP-OES	0.008	1.55	1.59	4.17
	ICP-MS	0.0053	1.50	1.60	4.4[1]
Molybdenum (Mo)	ICP-OES	0.047	8.88	8.92	<0.007
	ICP-MS	0.0410	8.30	8.50	0.0006
Nickel (Ni)	ICP-OES	<0.002	<0.002	<0.002	0.213
	GFAAS	---	---	---	---
	ICP-MS	0.001	0.014	0.015	0.160
Lead (Pb)	ICP-OES	<0.008	<0.008	<0.008	<0.008
	GFAAS	---	---	---	---
	ICP-MS	0.00008	0.00035	0.00014	0.00027
Strontium (Sr)	ICP-OES	6.13	17.3	19.1	0.107
	ICP-MS	5.90	15.0	17.0	0.096
Vanadium (V)	ICP-OES	<0.002	<0.002	<0.002	<0.002
	ICP-MS	<0.0009	<0.001	<0.001	<0.0009
Zinc (Zn)	ICP-OES	0.113	0.008	0.014	1.49
	ICP-MS	0.073	0.013	0.014	1.50

[1] sample measured at a concentration higher than the calibration range

Table 7. Analyses by multiple methods—Continued

[GFAAS, graphite furnace atomic absorption spectrometry; HGAAS, hydride generation atomic absorption spectrometry; ICP-MS, inductively coupled plasma-mass spectrometry; ICP-OES, inductively coupled plasma-optical emission spectrometry; mg/L, milligrams per liter; <, less than; SW, surface water; ---, no data]

	Sample Location	**Straight Creek (SW)**	**AWWT1**	**AWWT1**	**AWWT1**
	Collection Date	**4/24/02**	**4/25/02**	**2/4/03**	**5/12/03**
Constituent, mg/L	**Technique**				
Arsenic (As)	HGAAS	0.0002	<0.0001	<0.0001	0.0003
	ICP-MS	0.0039	0.0006	0.0004	0.0004
Aluminum (Al)	ICP-OES	83.1	35.0	36.0	35.5
	GFAAS	---	---	---	---
	ICP-MS	83[1]	33[1]	32.2	32.4
Boron (B)	ICP-OES	0.011	0.011	<0.01	<0.01
	ICP-MS	0.005	<0.005	<0.007	<0.007
Barium (Ba)	ICP-OES	<0.0008	0.005	0.004	0.005
	ICP-MS	0.002	0.005	0.005	0.005
Beryllium (Be)	ICP-OES	0.024	0.006	0.004	0.006
	ICP-MS	0.023	0.0051	0.006	0.006
Cadmium (Cd)	ICP-OES	0.038	0.006	0.005	0.006
	GFAAS	---	---	---	---
	ICP-MS	0.036	0.0045	0.0047	0.0043
Cobalt (Co)	ICP-OES	0.301	0.114	0.080	0.112
	GFAAS	---	---	---	---
	ICP-MS	0.300	0.100	0.0991	0.0970
Chromium (Cr)	ICP-OES	0.038	0.099	0.063	0.082
	GFAAS	---	---	---	---
	ICP-MS	0.0257	0.0923	0.0742	0.0709
Copper (Cu)	ICP-OES	1.55	<0.002	---	---
	GFAAS	---	---	<0.0005	<0.0005
	ICP-MS	1.50	0.006	<0.001	<0.001
Lithium (Li)	ICP-OES	0.145	0.052	0.048	0.059
	ICP-MS	0.150	0.054	0.058	0.055
Manganese (Mn)	ICP-OES	20.0	5.73	5.90	5.95
	ICP-MS	19[1]	6.1[1]	5.87	5.89
Molybdenum (Mo)	ICP-OES	<0.007	<0.007	<0.007	<0.007
	ICP-MS	0.0015	<0.0005	<0.0006	<0.0006
Nickel (Ni)	ICP-OES	0.706	0.289	0.202	0.288
	GFAAS	---	---	---	---
	ICP-MS	0.670	0.280	0.264	0.253
Lead (Pb)	ICP-OES	<0.008	<0.008	---	---
	GFAAS	---	---	0.0003	0.0002
	ICP-MS	0.0015	0.00011	<0.00008	<0.00008
Strontium (Sr)	ICP-OES	0.612	0.739	0.744	0.758
	ICP-MS	0.600	0.730	0.746	0.767
Vanadium (V)	ICP-OES	<0.002	<0.002	<0.002	<0.002
	ICP-MS	<0.0006	<0.0009	<0.001	<0.001
Zinc (Zn)	ICP-OES	7.3	1.97	2.03	2.14
	ICP-MS	6.6[1]	1.80	2.09	2.05

[1] sample measured at a concentration higher than the calibration range

Table 7. Analyses by multiple methods—Continued

[GFAAS, graphite furnace atomic absorption spectrometry; HGAAS, hydride generation atomic absorption spectrometry; ICP-MS, inductively coupled plasma-mass spectrometry; ICP-OES, inductively coupled plasma-optical emission spectrometry; mg/L, milligrams per liter; <, less than; SW, surface water; ---, no data]

	Sample Location	**AWWT1**	**AWWT2**	**CC2A**	**CC1B**
	Collection Date	**8/21/03**	**12/13/02**	**5/14/03**	**2/5/03**
Constituent, mg/L	**Technique**				
Arsenic (As)	HGAAS	<0.0001	<0.0001	<0.0001	<0.0001
	ICP-MS	0.0005	<0.0002	<0.0002	<0.0002
Aluminum (Al)	ICP-OES	38.2	<0.07	2.07	<0.07
	GFAAS	---	0.012	---	0.008
	ICP-MS	31.1	0.023	2.01	<0.005
Boron (B)	ICP-OES	<0.01	0.013	0.018	0.013
	ICP-MS	<0.007	0.009	0.024	0.013
Barium (Ba)	ICP-OES	0.004	0.007	0.004	0.036
	ICP-MS	0.005	0.006	0.004	0.039
Beryllium (Be)	ICP-OES	0.004	0.005	0.021	<0.001
	ICP-MS	0.006	0.0046	0.020	0.00019
Cadmium (Cd)	ICP-OES	0.005	<0.002	---	---
	GFAAS	---	---	0.0032	<0.0002
	ICP-MS	0.0047	0.0001	0.0032	0.0002
Cobalt (Co)	ICP-OES	0.101	0.113	---	---
	GFAAS	---	---	0.0018	<0.0008
	ICP-MS	0.0980	0.111	0.0042	0.00036
Chromium (Cr)	ICP-OES	0.099	---	---	---
	GFAAS	---	<0.0005	0.002	<0.0005
	ICP-MS	0.110	<0.002	<0.002	<0.002
Copper (Cu)	ICP-OES	---	---	---	---
	GFAAS	0.0036	<0.0005	0.0011	0.0013
	ICP-MS	<0.001	<0.001	0.002	0.002
Lithium (Li)	ICP-OES	0.062	0.199	0.038	0.022
	ICP-MS	0.056	0.136	0.030	0.020
Manganese (Mn)	ICP-OES	6.41	5.74	10.0	0.441
	ICP-MS	5.76	5.71	8.93	0.437
Molybdenum (Mo)	ICP-OES	<0.007	<0.007	0.012	<0.007
	ICP-MS	<0.0006	<0.0006	0.0009	0.0099
Nickel (Ni)	ICP-OES	0.273	0.211	---	---
	GFAAS	---	---	0.002	0.005
	ICP-MS	0.271	0.216	0.008	0.005
Lead (Pb)	ICP-OES	---	<0.008	---	---
	GFAAS	0.0001	---	<0.0003	<0.0003
	ICP-MS	<0.00008	<0.00008	<0.00008	<0.00008
Strontium (Sr)	ICP-OES	0.815	7.37	0.625	1.37
	ICP-MS	0.766	6.92	0.591	1.30
Vanadium (V)	ICP-OES	<0.002	<0.002	<0.002	<0.002
	ICP-MS	<0.001	<0.001	0.001	<0.001
Zinc (Zn)	ICP-OES	2.30	0.517	0.907	0.026
	ICP-MS	2.06	0.496	0.891	0.017

[1] sample measured at a concentration higher than the calibration range

Table 7. Analyses by multiple methods—Continued

[GFAAS, graphite furnace atomic absorption spectrometry; HGAAS, hydride generation atomic absorption spectrometry; ICP-MS, inductively coupled plasma-mass spectrometry; ICP-OES, inductively coupled plasma-optical emission spectrometry; mg/L, milligrams per liter; <, less than; SW, surface water; ---, no data]

	Sample Location	**CC2B**	**HANSEN**	**HANSEN**	**HOTTENTOT**
	Collection Date	**2/5/03**	**2/7/03**	**5/13/03**	**2/5/03**
Constituent, mg/L	**Technique**				
Arsenic (As)	HGAAS	<0.0001	<0.0001	<0.0001	0.0001
	ICP-MS	<0.0002	0.0024	0.0021	0.0007
Aluminum (Al)	ICP-OES	<0.07	81.3	76.7	60.3
	GFAAS	0.009	---	---	---
	ICP-MS	---	75.4	72.8	56.2
Boron (B)	ICP-OES	<0.01	0.011	<0.01	0.011
	ICP-MS	0.013	<0.007	<0.007	<0.007
Barium (Ba)	ICP-OES	0.012	0.003	0.003	0.001
	ICP-MS	0.018	0.004	0.003	0.002
Beryllium (Be)	ICP-OES	<0.001	0.016	0.019	0.011
	ICP-MS	0.00016	0.020	0.019	0.011
Cadmium (Cd)	ICP-OES	---	---	---	---
	GFAAS	<0.0002	0.0059	0.0062	0.0019
	ICP-MS	0.0001	0.0068	0.0068	0.0041
Cobalt (Co)	ICP-OES	---	0.179	0.211	0.136
	GFAAS	<0.0008	---	---	---
	ICP-MS	0.00088	0.207	0.203	0.113
Chromium (Cr)	ICP-OES	---	---	---	---
	GFAAS	<0.0005	0.003	0.015	0.012
	ICP-MS	<0.002	<0.002	0.0108	0.0083
Copper (Cu)	ICP-OES	---	0.117	0.121	0.118
	GFAAS	<0.0005	---	---	---
	ICP-MS	<0.001	0.133	0.129	0.114
Lithium (Li)	ICP-OES	0.061	0.071	0.090	0.074
	ICP-MS	0.067	0.074	0.074	0.066
Manganese (Mn)	ICP-OES	4.92	11.6	12.2	8.51
	ICP-MS	4.74	11.6	11.4	7.35
Molybdenum (Mo)	ICP-OES	<0.007	<0.007	<0.007	<0.007
	ICP-MS	0.0026	<0.0006	<0.0006	<0.0006
Nickel (Ni)	ICP-OES	---	0.562	0.613	0.352
	GFAAS	0.003	---	---	---
	ICP-MS	0.004	0.533	0.543	0.288
Lead (Pb)	ICP-OES	---	---	---	---
	GFAAS	0.0009	<0.0003	0.0009	<0.0003
	ICP-MS	<0.00008	0.00011	<0.00008	<0.00008
Strontium (Sr)	ICP-OES	4.79	2.79	2.85	<0.0003
	ICP-MS	4.70	2.81	2.72	0.007
Vanadium (V)	ICP-OES	<0.002	<0.002	<0.002	0.011
	ICP-MS	<0.001	<0.001	<0.001	0.009
Zinc (Zn)	ICP-OES	0.082	2.59	2.83	3.63
	ICP-MS	0.101	2.78	2.68	3.60

[1] sample measured at a concentration higher than the calibration range

Table 7. Analyses by multiple methods—Continued

[GFAAS, graphite furnace atomic absorption spectrometry; HGAAS, hydride generation atomic absorption spectrometry; ICP-MS, inductively coupled plasma-mass spectrometry; ICP-OES, inductively coupled plasma-optical emission spectrometry; mg/L, milligrams per liter; <, less than; SW, surface water; ---, no data]

	Sample Location	**HOTTENTOT**	**LA BOBITA**	**LA BOBITA**	**RANGER STATION WELL**
	Collection Date	**5/12/03**	**2/5/03**	**5/15/03**	**2/7/03**
Constituent, mg/L	**Technique**				
Arsenic (As)	HGAAS	0.0004	<0.0001	<0.0001	<0.0001
	ICP-MS	0.0008	0.0006	0.0005	0.0001
Aluminum (Al)	ICP-OES	70.4	12.8	12.7	0.087
	GFAAS	---	---	---	---
	ICP-MS	52.9	11.9	11.2	---
Boron (B)	ICP-OES	0.012	<0.01	<0.01	<0.01
	ICP-MS	<0.007	<0.007	<0.007	0.006
Barium (Ba)	ICP-OES	0.001	0.023	0.021	0.048
	ICP-MS	0.001	0.025	0.020	0.033
Beryllium (Be)	ICP-OES	0.011	0.006	0.005	<0.001
	ICP-MS	0.011	0.006	0.0054	0.00010
Cadmium (Cd)	ICP-OES	---	---	---	---
	GFAAS	0.0040	0.0041	0.0036	0.0002
	ICP-MS	0.0044	0.0044	0.0038	0.0001
Cobalt (Co)	ICP-OES	0.134	---	---	---
	GFAAS	---	0.0177	0.0194	<0.0008
	ICP-MS	0.115	0.0185	0.0187	0.00007
Chromium (Cr)	ICP-OES	---	---	---	---
	GFAAS	0.011	0.001	0.010	<0.0005
	ICP-MS	0.0091	<0.002	0.0088	<0.002
Copper (Cu)	ICP-OES	0.118	---	---	---
	GFAAS	---	0.033	0.025	0.0010
	ICP-MS	0.121	0.027	0.021	0.001
Lithium (Li)	ICP-OES	0.063	0.033	0.027	0.004
	ICP-MS	0.066	0.030	0.024	0.004
Manganese (Mn)	ICP-OES	7.99	2.62	2.71	0.014
	ICP-MS	7.34	2.42	2.72	0.018
Molybdenum (Mo)	ICP-OES	<0.007	<0.007	<0.007	0.008
	ICP-MS	<0.0006	<0.0006	0.0006	0.0128
Nickel (Ni)	ICP-OES	0.345	0.143	0.131	---
	GFAAS	---	---	---	0.005
	ICP-MS	0.296	0.129	0.125	0.004
Lead (Pb)	ICP-OES	---	---	---	---
	GFAAS	<0.0003	0.0009	0.0009	<0.0003
	ICP-MS	0.00028	0.00058	0.00035	0.00004
Strontium (Sr)	ICP-OES	0.015	0.806	0.821	0.376
	ICP-MS	0.012	0.776	0.771	0.383
Vanadium (V)	ICP-OES	0.010	<0.002	<0.002	<0.002
	ICP-MS	0.010	<0.001	<0.001	<0.0001
Zinc (Zn)	ICP-OES	3.91	1.00	0.929	0.035
	ICP-MS	3.55	1.06	0.923	0.025

[1] sample measured at a concentration higher than the calibration range

Table 7. Analyses by multiple methods—Continued

[GFAAS, graphite furnace atomic absorption spectrometry; HGAAS, hydride generation atomic absorption spectrometry; ICP-MS, inductively coupled plasma-mass spectrometry; ICP-OES, inductively coupled plasma-optical emission spectrometry; mg/L, milligrams per liter; <, less than; SW, surface water; ---, no data]

	Sample Location	**SC1A**	**SC1A**	**SC1B**	**SC1B**
	Collection Date	**4/25/02**	**5/13/03**	**4/25/02**	**5/13/03**
Constituent, mg/L	**Technique**				
Arsenic (As)	HGAAS	<0.0001	<0.0001	0.0004	<0.0001
	ICP-MS	0.0031	0.0039	0.0003	0.0004
Aluminum (Al)	ICP-OES	90.7	95.8	<0.07	<0.07
	GFAAS	---	---	0.047	0.011
	ICP-MS	91[1]	74.7	---	0.019
Boron (B)	ICP-OES	0.009	0.010	0.027	0.025
	ICP-MS	0.007	<0.007	0.016	0.022
Barium (Ba)	ICP-OES	0.003	0.002	0.013	0.008
	ICP-MS	0.003	0.002	0.011	0.009
Beryllium (Be)	ICP-OES	0.028	0.026	0.001	0.001
	ICP-MS	0.023	0.024	0.00062	0.0012
Cadmium (Cd)	ICP-OES	0.045	0.039	<0.002	---
	GFAAS	---	---	---	<0.0002
	ICP-MS	0.034	0.034	<0.00005	0.0002
Cobalt (Co)	ICP-OES	0.345	0.304	<0.007	---
	GFAAS	---	---	---	<0.0008
	ICP-MS	0.310	0.287	0.0048	0.00083
Chromium (Cr)	ICP-OES	0.038	0.032	<0.002	---
	GFAAS	---	---	---	<0.0005
	ICP-MS	0.0209	0.0210	<0.006	<0.002
Copper (Cu)	ICP-OES	0.871	0.867	<0.002	---
	GFAAS	---	---	---	<0.0005
	ICP-MS	0.950	0.896	0.006	<0.001
Lithium (Li)	ICP-OES	0.195	0.220	0.161	0.175
	ICP-MS	0.180	0.175	0.130	0.128
Manganese (Mn)	ICP-OES	19.6	18.1	6.29	6.10
	ICP-MS	19[1]	19.4	5.80	5.96
Molybdenum (Mo)	ICP-OES	<0.007	0.017	<0.007	<0.007
	ICP-MS	0.0018	<0.0006	0.0114	<0.0006
Nickel (Ni)	ICP-OES	0.720	0.692	<0.002	---
	GFAAS	---	---	---	0.003
	ICP-MS	0.710	0.665	0.012	0.001
Lead (Pb)	ICP-OES	<0.008	---	<0.008	---
	GFAAS	---	<0.0003	---	0.0014
	ICP-MS	0.0013	0.0013	0.00034	<0.00008
Strontium (Sr)	ICP-OES	0.890	0.882	11.2	11.3
	ICP-MS	0.860	0.881	11.0	10.6
Vanadium (V)	ICP-OES	<0.002	<0.002	<0.002	<0.002
	ICP-MS	0.002	0.002	<0.001	<0.001
Zinc (Zn)	ICP-OES	7.39	7.72	0.313	0.02
	ICP-MS	6.7[1]	6.85	0.240	<0.005

[1] sample measured at a concentration higher than the calibration range

Table 7. Analyses by multiple methods—Continued

[GFAAS, graphite furnace atomic absorption spectrometry; HGAAS, hydride generation atomic absorption spectrometry; ICP-MS, inductively coupled plasma-mass spectrometry; ICP-OES, inductively coupled plasma-optical emission spectrometry; mg/L, milligrams per liter; <, less than; SW, surface water; ---, no data]

	Sample Location	**SC1B_R**	**SC2B**	**SC2B**	**SC2B**
	Collection Date	**4/25/02**	**4/25/02**	**5/23/02**	**2/8/03**
Constituent, mg/L	**Technique**				
Arsenic (As)	HGAAS	0.0004	0.0001	<0.0001	0.0001
	ICP-MS	0.0003	<0.0002	0.0004	0.0005
Aluminum (Al)	ICP-OES	<0.07	6.05	1.94	1.23
	GFAAS	0.052	---	---	---
	ICP-MS	---	5.40	1.50	1.14
Boron (B)	ICP-OES	0.024	0.012	0.015	<0.01
	ICP-MS	0.018	0.012	<0.007	<0.007
Barium (Ba)	ICP-OES	0.011	0.008	0.009	0.005
	ICP-MS	0.012	0.008	0.008	0.005
Beryllium (Be)	ICP-OES	<0.001	0.017	0.023	0.041
	ICP-MS	0.00056	0.013	0.016	0.042
Cadmium (Cd)	ICP-OES	<0.002	0.005	0.003	---
	GFAAS	---	---	---	<0.0002
	ICP-MS	0.0002	0.0017	0.0003	<0.00004
Cobalt (Co)	ICP-OES	<0.007	0.227	0.245	0.186
	GFAAS	---	---	---	---
	ICP-MS	0.0049	0.180	0.159	0.182
Chromium (Cr)	ICP-OES	<0.002	---	---	---
	GFAAS	---	0.008	0.008	<0.0005
	ICP-MS	<0.006	<0.003	<0.002	<0.002
Copper (Cu)	ICP-OES	<0.002	<0.002	---	---
	GFAAS	---	---	0.0020	0.0042
	ICP-MS	0.006	0.004	0.003	<0.001
Lithium (Li)	ICP-OES	0.146	0.248	0.374	0.301
	ICP-MS	0.130	0.230	0.247	0.232
Manganese (Mn)	ICP-OES	6.35	17.1	18.6	19.0
	ICP-MS	5.80	16[1]	16.6	18.4
Molybdenum (Mo)	ICP-OES	<0.007	<0.007	<0.007	0.010
	ICP-MS	0.0102	0.0014	0.0010	<0.0006
Nickel (Ni)	ICP-OES	<0.002	0.480	0.478	0.580
	GFAAS	---	---	---	---
	ICP-MS	0.016	0.480	0.424	0.507
Lead (Pb)	ICP-OES	<0.008	<0.008	---	---
	GFAAS	---	---	<0.0003	0.0010
	ICP-MS	0.00026	0.00019	<0.00008	<0.00008
Strontium (Sr)	ICP-OES	11.4	2.01	2.51	2.51
	ICP-MS	11.0	2.10	2.27	2.33
Vanadium (V)	ICP-OES	<0.002	<0.002	<0.002	<0.002
	ICP-MS	<0.001	0.001	<0.001	<0.001
Zinc (Zn)	ICP-OES	0.235	1.99	1.43	1.97
	ICP-MS	0.230	1.80	1.33	2.00

[1] sample measured at a concentration higher than the calibration range

Table 7 . Analyses by multiple methods—Continued

[GFAAS, graphite furnace atomic absorption spectrometry; HGAAS, hydride generation atomic absorption spectrometry; ICP-MS, inductively coupled plasma-mass spectrometry; ICP-OES, inductively coupled plasma-optical emission spectrometry; mg/L, milligrams per liter; <, less than; SW, surface water; ---, no data]

	Sample Location	**SC3A**	**SC3A**	**SC3A**	**SC3B**
	Collection Date	**4/24/02**	**2/8/03**	**5/14/03**	**4/25/02**
Constituent, mg/L	**Technique**				
Arsenic (As)	HGAAS	<0.0001	<0.0001	<0.0001	0.0007
	ICP-MS	0.0028	0.0020	0.0030	0.0025
Aluminum (Al)	ICP-OES	79.3	78.7	76.5	5.39
	GFAAS	---	---	---	---
	ICP-MS	76[1]	79.2	65.1	5.40
Boron (B)	ICP-OES	0.021	<0.01	<0.01	0.015
	ICP-MS	0.009	<0.007	<0.007	0.005
Barium (Ba)	ICP-OES	0.004	0.001	0.002	0.007
	ICP-MS	0.003	0.002	0.002	0.007
Beryllium (Be)	ICP-OES	0.019	0.017	0.020	0.023
	ICP-MS	0.016	0.020	0.018	0.019
Cadmium (Cd)	ICP-OES	0.028	0.027	0.031	<0.002
	GFAAS	---	---	---	---
	ICP-MS	0.025	0.025	0.025	<0.00002
Cobalt (Co)	ICP-OES	0.246	0.233	0.280	0.269
	GFAAS	---	---	---	---
	ICP-MS	0.230	0.226	0.222	0.250
Chromium (Cr)	ICP-OES	0.024	0.020	0.025	0.008
	GFAAS	---	---	---	---
	ICP-MS	0.0138	0.0131	0.0129	<0.003
Copper (Cu)	ICP-OES	0.848	0.815	0.818	<0.002
	GFAAS	---	---	---	---
	ICP-MS	0.840	0.819	0.840	0.004
Lithium (Li)	ICP-OES	0.148	0.182	0.157	0.181
	ICP-MS	0.140	0.148	0.145	0.160
Manganese (Mn)	ICP-OES	15.1	16.1	15.2	26.3
	ICP-MS	14[1]	15.5	15.4	24[1]
Molybdenum (Mo)	ICP-OES	<0.007	<0.007	<0.007	<0.007
	ICP-MS	0.0016	<0.0006	<0.0006	0.0033
Nickel (Ni)	ICP-OES	0.584	0.597	0.541	0.459
	GFAAS	---	---	---	---
	ICP-MS	0.520	0.506	0.501	0.470
Lead (Pb)	ICP-OES	<0.008	---	---	0.030
	GFAAS	---	<0.0003	<0.0003	---
	ICP-MS	0.0022	0.00012	<0.00008	0.0191
Strontium (Sr)	ICP-OES	0.339	0.328	0.313	3.98
	ICP-MS	0.340	0.322	0.307	3.80
Vanadium (V)	ICP-OES	<0.002	<0.002	<0.002	<0.002
	ICP-MS	<0.0006	<0.001	<0.001	<0.0006
Zinc (Zn)	ICP-OES	5.93	5.63	5.42	4.43
	ICP-MS	5.1[1]	5.34	5.39	4.2[1]

[1] sample measured at a concentration higher than the calibration range

Table 7. Analyses by multiple methods—Continued

[GFAAS, graphite furnace atomic absorption spectrometry; HGAAS, hydride generation atomic absorption spectrometry; ICP-MS, inductively coupled plasma-mass spectrometry; ICP-OES, inductively coupled plasma-optical emission spectrometry; mg/L, milligrams per liter; <, less than; SW, surface water; ---, no data]

	Sample Location	**SC3B**	**SC3B**	**SC4A**	**SC4A**
	Collection Date	**2/8/03**	**5/14/03**	**4/24/02**	**2/8/03**
Constituent, mg/L	**Technique**				
Arsenic (As)	HGAAS	0.0002	<0.0001	<0.0001	<0.0001
	ICP-MS	0.0026	0.0030	0.0017	0.0022
Aluminum (Al)	ICP-OES	5.56	7.59	65.7	63.6
	GFAAS	---	---	---	---
	ICP-MS	5.26	5.18	59[1]	55.6
Boron (B)	ICP-OES	0.010	0.020	0.015	0.013
	ICP-MS	0.008	<0.007	0.007	<0.007
Barium (Ba)	ICP-OES	0.005	0.005	0.004	0.003
	ICP-MS	0.005	0.005	0.004	0.003
Beryllium (Be)	ICP-OES	0.027	0.035	0.018	0.017
	ICP-MS	0.029	0.031	0.016	0.017
Cadmium (Cd)	ICP-OES	0.002	0.001	0.022	0.019
	GFAAS	---	---	---	---
	ICP-MS	0.0001	0.0001	0.017	0.017
Cobalt (Co)	ICP-OES	0.235	0.291	0.284	0.234
	GFAAS	---	---	---	---
	ICP-MS	0.246	0.247	0.240	0.235
Chromium (Cr)	ICP-OES	0.008	0.007	0.017	0.010
	GFAAS	---	---	---	---
	ICP-MS	<0.002	<0.002	0.0041	0.0035
Copper (Cu)	ICP-OES	---	---	0.300	0.219
	GFAAS	<0.0005	0.0022	---	---
	ICP-MS	<0.001	<0.001	0.280	0.215
Lithium (Li)	ICP-OES	0.212	0.201	0.171	0.210
	ICP-MS	0.162	0.162	0.160	0.166
Manganese (Mn)	ICP-OES	27.8	28.8	18.6	19.2
	ICP-MS	27.9	26.1	17[1]	17.1
Molybdenum (Mo)	ICP-OES	0.020	0.024	<0.007	0.008
	ICP-MS	<0.0006	<0.0006	0.0010	<0.0006
Nickel (Ni)	ICP-OES	0.511	0.466	0.549	0.613
	GFAAS	---	---	---	---
	ICP-MS	0.452	0.453	0.540	0.529
Lead (Pb)	ICP-OES	---	---	<0.008	---
	GFAAS	<0.0003	0.0003	---	<0.0003
	ICP-MS	0.0018	0.00049	0.00014	<0.00008
Strontium (Sr)	ICP-OES	3.43	3.39	0.722	0.724
	ICP-MS	3.45	3.37	0.740	0.744
Vanadium (V)	ICP-OES	<0.002	<0.002	<0.002	<0.002
	ICP-MS	<0.001	<0.001	0.001	<0.001
Zinc (Zn)	ICP-OES	4.85	4.75	5.28	5.30
	ICP-MS	4.82	4.64	5.0[1]	5.04

[1] sample measured at a concentration higher than the calibration range

Table 7. Analyses by multiple methods—Continued

[GFAAS, graphite furnace atomic absorption spectrometry; HGAAS, hydride generation atomic absorption spectrometry; ICP-MS, inductively coupled plasma-mass spectrometry; ICP-OES, inductively coupled plasma-optical emission spectrometry; mg/L, milligrams per liter; <, less than; SW, surface water; ---, no data]

	Sample Location	**SC4A**	**SC5A**	**SC5A**	**SC5A**
	Collection Date	**5/14/03**	**4/25/02**	**2/8/03**	**5/13/03**
Constituent, mg/L	**Technique**				
Arsenic (As)	HGAAS	<0.0001	<0.0001	<0.0001	<0.0001
	ICP-MS	0.0022	0.0011	0.0009	0.0003
Aluminum (Al)	ICP-OES	79.4	52.0	62.9	67.8
	GFAAS	---	---	---	---
	ICP-MS	72.1	49[1]	66.9	68.2
Boron (B)	ICP-OES	<0.01	<0.01	<0.01	<0.01
	ICP-MS	<0.007	<0.005	<0.007	<0.007
Barium (Ba)	ICP-OES	0.002	<0.0008	<0.0008	<0.0008
	ICP-MS	0.002	0.001	0.0004	0.0004
Beryllium (Be)	ICP-OES	0.017	0.010	0.010	0.010
	ICP-MS	0.019	0.008	0.011	0.010
Cadmium (Cd)	ICP-OES	0.027	0.017	0.016	0.017
	GFAAS	---	---	---	---
	ICP-MS	0.025	0.012	0.014	0.015
Cobalt (Co)	ICP-OES	0.240	0.176	0.171	0.183
	GFAAS	---	---	---	---
	ICP-MS	0.214	0.150	0.156	0.165
Chromium (Cr)	ICP-OES	0.022	0.011	0.009	0.013
	GFAAS	---	---	---	---
	ICP-MS	0.0124	0.0041	0.0040	0.0049
Copper (Cu)	ICP-OES	0.788	0.238	0.264	0.277
	GFAAS	---	---	---	---
	ICP-MS	0.797	0.240	0.269	0.292
Lithium (Li)	ICP-OES	0.145	0.074	0.109	0.108
	ICP-MS	0.146	0.079	0.098	0.099
Manganese (Mn)	ICP-OES	14.7	7.86	10.5	10.3
	ICP-MS	15.0	8.3[1]	9.3	9.8
Molybdenum (Mo)	ICP-OES	0.013	<0.007	<0.007	<0.007
	ICP-MS	<0.0006	<0.0005	<0.0006	<0.0006
Nickel (Ni)	ICP-OES	0.523	0.337	0.447	0.422
	GFAAS	---	---	---	---
	ICP-MS	0.507	0.340	0.368	0.390
Lead (Pb)	ICP-OES	---	<0.008	---	---
	GFAAS	<0.0003	---	<0.0003	<0.0003
	ICP-MS	<0.00008	0.00009	<0.00008	<0.00008
Strontium (Sr)	ICP-OES	0.302	0.497	0.625	0.594
	ICP-MS	0.303	0.520	0.588	0.608
Vanadium (V)	ICP-OES	<0.002	<0.002	<0.002	<0.002
	ICP-MS	<0.001	<0.0009	<0.001	<0.001
Zinc (Zn)	ICP-OES	5.11	2.88	3.34	3.59
	ICP-MS	5.09	2.9[1]	3.28	3.40

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[1] sample measured at a concentration higher than the calibration range

Table 7. Analyses by multiple methods—Continued

[GFAAS, graphite furnace atomic absorption spectrometry; HGAAS, hydride generation atomic absorption spectrometry; ICP-MS, inductively coupled plasma-mass spectrometry; ICP-OES, inductively coupled plasma-optical emission spectrometry; mg/L, milligrams per liter; <, less than; SW, surface water; ---, no data]

	Sample Location	**SC5A**	**SC5B**	**SC5B**	**SC5B**
	Collection Date	**8/20/03**	**4/25/02**	**2/8/03**	**5/13/03**
Constituent, mg/L	**Technique**				
Arsenic (As)	HGAAS	<0.0001	0.0001	0.0017	0.0003
	ICP-MS	0.0009	0.0030	0.0006	0.0004
Aluminum (Al)	ICP-OES	40.0	<0.07	<0.07	<0.07
	GFAAS	---	0.066	0.009	0.004
	ICP-MS	33.4	---	0.020	0.006
Boron (B)	ICP-OES	<0.01	<0.01	0.014	0.011
	ICP-MS	<0.007	0.010	0.010	0.008
Barium (Ba)	ICP-OES	<0.0008	0.034	0.025	0.019
	ICP-MS	0.0004	0.032	0.029	0.022
Beryllium (Be)	ICP-OES	0.004	<0.001	<0.001	<0.001
	ICP-MS	0.006	0.00007	0.00003	0.00021
Cadmium (Cd)	ICP-OES	0.006	<0.002	---	---
	GFAAS	---	---	<0.0002	<0.0002
	ICP-MS	0.0056	<0.00002	<0.00004	<0.00004
Cobalt (Co)	ICP-OES	0.077	<0.007	---	---
	GFAAS	---	---	<0.0008	<0.0008
	ICP-MS	0.0781	0.0035	0.00014	0.00011
Chromium (Cr)	ICP-OES	0.007	<0.002	---	---
	GFAAS	---	---	<0.0005	<0.0005
	ICP-MS	0.0035	<0.003	<0.002	<0.002
Copper (Cu)	ICP-OES	0.108	<0.002	---	---
	GFAAS	---	---	<0.0005	<0.0005
	ICP-MS	0.128	0.004	<0.001	<0.001
Lithium (Li)	ICP-OES	0.055	0.045	0.073	0.040
	ICP-MS	0.044	0.042	0.060	0.040
Manganese (Mn)	ICP-OES	4.53	2.96	1.68	2.58
	ICP-MS	4.27	2.80	1.64	2.69
Molybdenum (Mo)	ICP-OES	<0.007	<0.007	<0.007	<0.007
	ICP-MS	<0.0006	0.0058	<0.0006	<0.0006
Nickel (Ni)	ICP-OES	0.186	<0.002	---	---
	GFAAS	---	---	<0.0005	<0.0005
	ICP-MS	0.188	0.011	0.006	0.006
Lead (Pb)	ICP-OES	---	<0.008	---	---
	GFAAS	<0.0003	---	<0.0003	<0.0003
	ICP-MS	<0.00008	0.00015	<0.00008	<0.00008
Strontium (Sr)	ICP-OES	0.334	8.49	8.33	8.68
	ICP-MS	0.311	7.70	8.81	8.24
Vanadium (V)	ICP-OES	<0.002	<0.002	<0.002	<0.002
	ICP-MS	<0.001	<0.0006	<0.001	<0.001
Zinc (Zn)	ICP-OES	1.75	<0.005	<0.005	<0.005
	ICP-MS	1.78	0.002	<0.005	<0.005

[1] sample measured at a concentration higher than the calibration range

Table 7. Analyses by multiple methods—Continued

[GFAAS, graphite furnace atomic absorption spectrometry; HGAAS, hydride generation atomic absorption spectrometry; ICP-MS, inductively coupled plasma-mass spectrometry; ICP-OES, inductively coupled plasma-optical emission spectrometry; mg/L, milligrams per liter; <, less than; SW, surface water; ---, no data]

	Sample Location **Collection Date**	**SC5B** **8/20/03**	**SC6A** **2/7/03**	**SC6A** **5/14/03**	**SC7A_1** **2/4/03**
Constituent, mg/L	**Technique**				
Arsenic (As)	HGAAS	0.0003	<0.0001	<0.0001	<0.0001
	ICP-MS	0.0003	0.0027	0.0026	0.0005
Aluminum (Al)	ICP-OES	<0.07	83.3	82.4	35.7
	GFAAS	0.006	---	---	---
	ICP-MS	0.006	74.3	65.4	29.9
Boron (B)	ICP-OES	<0.01	<0.01	0.012	<0.01
	ICP-MS	<0.007	<0.007	<0.007	<0.007
Barium (Ba)	ICP-OES	0.016	0.002	0.002	0.004
	ICP-MS	0.023	0.002	0.002	0.005
Beryllium (Be)	ICP-OES	<0.001	0.019	0.018	0.005
	ICP-MS	0.00018	0.021	0.019	0.006
Cadmium (Cd)	ICP-OES	---	0.030	0.031	---
	GFAAS	<0.0002	---	---	0.0070
	ICP-MS	<0.00004	0.029	0.029	0.0077
Cobalt (Co)	ICP-OES	---	0.323	0.264	0.103
	GFAAS	<0.0008	---	---	---
	ICP-MS	0.00014	0.252	0.247	0.100
Chromium (Cr)	ICP-OES	---	---	---	---
	GFAAS	<0.0005	0.027	0.021	0.005
	ICP-MS	<0.002	0.0141	0.0103	<0.002
Copper (Cu)	ICP-OES	---	0.767	0.627	---
	GFAAS	<0.0005	---	---	0.068
	ICP-MS	<0.001	0.698	0.643	0.056
Lithium (Li)	ICP-OES	0.048	0.212	0.188	0.070
	ICP-MS	0.041	0.175	0.157	0.059
Manganese (Mn)	ICP-OES	2.84	19.0	18.4	6.45
	ICP-MS	2.77	18.3	18.6	6.06
Molybdenum (Mo)	ICP-OES	<0.007	<0.007	0.016	<0.007
	ICP-MS	<0.0006	<0.0006	<0.0006	<0.0006
Nickel (Ni)	ICP-OES	---	0.716	0.632	0.249
	GFAAS	<0.0005	---	---	---
	ICP-MS	0.004	0.583	0.569	0.240
Lead (Pb)	ICP-OES	---	---	---	---
	GFAAS	<0.0003	<0.0003	0.0013	<0.0003
	ICP-MS	<0.00008	0.00013	<0.00008	<0.00008
Strontium (Sr)	ICP-OES	8.42	0.429	0.430	1.01
	ICP-MS	8.35	0.425	0.454	0.98
Vanadium (V)	ICP-OES	<0.002	<0.002	<0.002	<0.002
	ICP-MS	<0.001	<0.001	<0.001	<0.001
Zinc (Zn)	ICP-OES	<0.005	6.51	6.22	2.04
	ICP-MS	<0.005	6.18	6.14	2.04

[1]sample measured at a concentration higher than the calibration range

Table 7. Analyses by multiple methods—Continued

[GFAAS, graphite furnace atomic absorption spectrometry; HGAAS, hydride generation atomic absorption spectrometry; ICP-MS, inductively coupled plasma-mass spectrometry; ICP-OES, inductively coupled plasma-optical emission spectrometry; mg/L, milligrams per liter; <, less than; SW, surface water; ---, no data]

	Sample Location	**SC7A_1**	**SC7A_4**	**SC7A_4**	**SC8A**
	Collection Date	**5/12/03**	**2/4/03**	**5/12/03**	**2/5/03**
Constituent, mg/L	**Technique**				
Arsenic (As)	HGAAS	<0.0001	<0.0001	<0.0001	<0.0001
	ICP-MS	0.0006	0.0003	0.0004	0.0001
Aluminum (Al)	ICP-OES	37.1	31.8	32.7	<0.07
	GFAAS	---	---	---	0.010
	ICP-MS	32.0	27.9	30.0	0.001
Boron (B)	ICP-OES	<0.01	0.010	<0.01	<0.01
	ICP-MS	<0.007	<0.007	<0.007	0.005
Barium (Ba)	ICP-OES	0.005	0.005	0.006	0.020
	ICP-MS	0.004	0.006	0.006	0.020
Beryllium (Be)	ICP-OES	0.006	0.005	0.005	<0.001
	ICP-MS	0.006	0.0054	0.0055	0.00001
Cadmium (Cd)	ICP-OES	---	---	---	---
	GFAAS	0.0067	0.0094	0.0059	<0.0002
	ICP-MS	0.0076	0.011	0.0067	0.0003
Cobalt (Co)	ICP-OES	0.115	0.086	0.095	---
	GFAAS	---	---	---	<0.0008
	ICP-MS	0.104	0.0836	0.0873	0.00004
Chromium (Cr)	ICP-OES	---	---	---	---
	GFAAS	0.005	0.004	0.004	<0.0005
	ICP-MS	<0.002	<0.002	<0.002	<0.002
Copper (Cu)	ICP-OES	---	---	---	---
	GFAAS	0.062	0.122	0.075	<0.0005
	ICP-MS	0.056	0.105	0.061	0.0004
Lithium (Li)	ICP-OES	0.067	0.053	0.055	0.004
	ICP-MS	0.062	0.050	0.053	0.003
Manganese (Mn)	ICP-OES	6.68	5.07	5.36	0.002
	ICP-MS	6.31	5.02	5.11	0.0034
Molybdenum (Mo)	ICP-OES	<0.007	<0.007	<0.007	<0.007
	ICP-MS	<0.0006	<0.0006	<0.0006	0.0015
Nickel (Ni)	ICP-OES	0.263	0.196	0.226	---
	GFAAS	---	---	---	0.004
	ICP-MS	0.250	0.199	0.211	0.005
Lead (Pb)	ICP-OES	---	---	---	---
	GFAAS	<0.0003	<0.0003	0.0008	<0.0003
	ICP-MS	<0.00008	0.00011	<0.00008	0.00002
Strontium (Sr)	ICP-OES	1.02	0.791	0.793	0.263
	ICP-MS	1.00	0.752	0.792	0.294
Vanadium (V)	ICP-OES	<0.002	<0.002	<0.002	<0.002
	ICP-MS	<0.001	<0.001	<0.001	<0.0001
Zinc (Zn)	ICP-OES	2.17	1.85	1.88	0.019
	ICP-MS	2.30	1.83	1.80	0.031

[1] sample measured at a concentration higher than the calibration range

Table 7. Analyses by multiple methods—Continued

[GFAAS, graphite furnace atomic absorption spectrometry; HGAAS, hydride generation atomic absorption spectrometry; ICP-MS, inductively coupled plasma-mass spectrometry; ICP-OES, inductively coupled plasma-optical emission spectrometry; mg/L, milligrams per liter; <, less than; SW, surface water; ---, no data]

	Sample Location	**SC8A**	**SC8A**
	Collection Date	**5/12/03**	**8/18/03**
Constituent, mg/L	**Technique**		
Arsenic (As)	HGAAS	<0.0001	<0.0001
	ICP-MS	0.0001	0.0001
Aluminum (Al)	ICP-OES	<0.07	<0.07
	GFAAS	0.007	0.003
	ICP-MS	0.001	0.001
Boron (B)	ICP-OES	<0.01	<0.01
	ICP-MS	0.005	0.004
Barium (Ba)	ICP-OES	0.025	0.025
	ICP-MS	0.019	0.019
Beryllium (Be)	ICP-OES	<0.001	<0.001
	ICP-MS	0.00001	0.00001
Cadmium (Cd)	ICP-OES	---	---
	GFAAS	<0.0002	0.0005
	ICP-MS	0.0003	0.0003
Cobalt (Co)	ICP-OES	---	---
	GFAAS	<0.0008	0.0072
	ICP-MS	0.00001	0.00002
Chromium (Cr)	ICP-OES	---	---
	GFAAS	0.001	<0.0005
	ICP-MS	<0.002	<0.002
Copper (Cu)	ICP-OES	---	---
	GFAAS	<0.0005	0.0008
	ICP-MS	0.0004	0.0004
Lithium (Li)	ICP-OES	0.004	0.005
	ICP-MS	0.004	0.003
Manganese (Mn)	ICP-OES	<0.002	0.002
	ICP-MS	0.0007	0.0003
Molybdenum (Mo)	ICP-OES	<0.007	<0.007
	ICP-MS	0.0014	0.0013
Nickel (Ni)	ICP-OES	---	---
	GFAAS	0.004	0.005
	ICP-MS	0.005	0.005
Lead (Pb)	ICP-OES	---	---
	GFAAS	<0.0003	<0.0003
	ICP-MS	0.00002	<0.000008
Strontium (Sr)	ICP-OES	0.340	0.388
	ICP-MS	0.310	0.302
Vanadium (V)	ICP-OES	<0.002	<0.002
	ICP-MS	<0.0001	<0.0001
Zinc (Zn)	ICP-OES	0.035	0.039
	ICP-MS	0.033	0.031

[1] sample measured at a concentration higher than the calibration range

Table 8. Analyses by different laboratories

[USGS, U.S. Geological Survey; µm, micrometer; mg/L, milligrams per liter; <, less than; ---, no data]

Sample ID		**SC1A**	**SC1A**	**SC1B**	**SC1B**
Collection Date		**3/26/02**	**3/26/02**	**3/26/02**	**3/26/02**
Treatment		**0.45 µm**	**Unfiltered**	**0.45 µm**	**Unfiltered**
Constituent, mg/L	**Laboratory**				
Calcium (Ca)	USGS	386	381	535	520
	URS	380	371	518	496
Magnesium (Mg)	USGS	126	124	232	225
	URS	123	119	227	215
Sodium (Na)	USGS	17.2	17.2	73.0	70.6
	URS	13.9	13.9	61.7	56.7
Potassium (K)	USGS	1.14	1.18	13.6	13.6
	URS	0.70	1.00	13.7	13.0
Sulfate (SO_4)	USGS	2140	---	1930	---
	URS	---	2400	---	2020
Alkalinity (as HCO_3)	USGS	---	---	493	---
	URS	---	12	---	494
Fluoride (F)	USGS	9.64	---	0.575	---
	URS (ACZ laboratory)	---	2.20	---	1.70
	URS (PAR laboratory)	---	12.00	---	1.20
Chloride (Cl)	USGS	2.9	---	14	---
	URS	---	3	---	14
Aluminum (Al)	USGS	94.1	95.7	0.033	0.116
	URS	99.5	94.8	---	0.07
Iron Total (Fe(T))	USGS	29.6	32.5	2.66	3.85
	URS	31.0	30.6	3.00	3.48
Boron (B)	USGS	0.010	<0.01	0.021	0.033
	URS	0.10	0.05	0.02	0.02
Barium (Ba)	USGS	0.003	0.004	0.012	0.012
	URS	---	---	0.014	0.016
Manganese (Mn)	USGS	20.5	20.4	6.84	6.82
	URS	18.7	18.5	6.08	5.85
Zinc (Zn)	USGS	7.60	7.79	0.653	0.740
	URS	6.93	6.76	0.690	0.690
Lead (Pb)	USGS	<0.008	<0.008	<0.008	<0.008
	URS	0.001	---	0.001	0.001
Nickel (Ni)	USGS	0.798	0.838	0.013	0.016
	URS	0.680	0.660	---	---
Copper (Cu)	USGS	1.03	1.02	<0.0005	<0.0005
	URS	0.891	0.912	0.004	0.009
Cadmium (Cd)	USGS	0.039	0.039	0.0002	0.0003
	URS	0.0319	0.0330	0.0002	---
Chromium (Cr)	USGS	0.033	0.035	<0.0005	0.0009
	URS	0.0180	0.0180	0.0015	0.0026
Cobalt (Co)	USGS	0.340	0.374	0.015	0.014
	URS	0.268	0.275	0.0069	0.0068
Beryllium (Be)	USGS	0.025	0.025	<0.001	<0.001
	URS	0.023	0.026	---	0.003
Molybdenum (Mo)	USGS	<0.007	<0.007	<0.007	<0.007
	URS	0.0005	0.0010	0.0040	0.0043
Dissolved Organic Carbon (DOC)	USGS	1.1	---	19	---
Total Organic Carbon (DOC)	URS	---	2	---	28

Table 8. Analyses by different laboratories—Continued

[USGS, U.S. Geological Survey; µm, micrometer; mg/L, milligrams per liter; <, less than; ---, no data]

Sample ID		**SC2B**	**SC2B**	**SC3A**	**SC3A**
Collection Date		**3/25/02**	**3/25/02**	**3/25/02**	**3/25/02**
Treatment		**0.45 µm**	**Unfiltered**	**0.45 µm**	**Unfiltered**
Constituent, mg/L	**Laboratory**				
Calcium (Ca)	USGS	475	484	315	314
	URS	477	466	306	293
Magnesium (Mg)	USGS	118	114	86.3	90.0
	URS	117	115	90.9	86.9
Sodium (Na)	USGS	24.3	24.9	17.3	17.0
	URS	21.2	20.8	15.5	14.8
Potassium (K)	USGS	3.36	3.38	1.04	1.04
	URS	3.80	4.00	1.10	1.00
Sulfate (SO_4)	USGS	1640	---	1600	---
	URS	---	1620	---	1770
Alkalinity (as HCO_3)	USGS	117	---	---	---
	URS	---	157	---	12
Fluoride (F)	USGS	5.64	---	6.78	---
	URS (ACZ laboratory)	---	6.80	---	1.10
	URS (PAR laboratory)	---	6.30	---	9.40
Chloride (Cl)	USGS	2.8	---	2.7	---
	URS	---	5	---	10
Aluminum (Al)	USGS	0.864	1.08	80.6	81.0
	URS	1.02	1.68	85.00	80.50
Iron Total (Fe(T))	USGS	39.5	39.9	0.610	0.109
	URS	34.7	34.6	0.53	0.81
Boron (B)	USGS	0.015	0.011	<0.01	<0.01
	URS	0.10	0.05	0.10	0.05
Barium (Ba)	USGS	0.008	0.011	0.002	0.003
	URS	0.007	0.011	---	---
Manganese (Mn)	USGS	18.4	18.5	16.0	15.8
	URS	16.8	16.6	14.9	14.4
Zinc (Zn)	USGS	1.47	1.52	5.59	5.61
	URS	1.37	1.36	5.29	5.04
Lead (Pb)	USGS	<0.008	<0.008	<0.008	<0.008
	URS	0.000	0.005	0.001	0.001
Nickel (Ni)	USGS	0.495	0..497	0.496	0.591
	URS	0.460	0.440	0.520	0.490
Copper (Cu)	USGS	<0.0005	0.011	0.884	0.907
	URS	0.007	0.028	0.799	0.799
Cadmium (Cd)	USGS	<0.001	<0.001	0.033	0.030
	URS	0.0002	---	0.023	0.025
Chromium (Cr)	USGS	<0.0005	<0.0005	0.027	0.025
	URS	0.0006	---	0.0120	0.0140
Cobalt (Co)	USGS	0.173	0.184	0.269	0.260
	URS	0.156	0.164	0.205	0.207
Beryllium (Be)	USGS	0.019	0.019	0.018	0.018
	URS	0.016	0.019	0.016	0.018
Molybdenum (Mo)	USGS	<0.007	<0.007	<0.007	<0.007
	URS	0.0006	0.0009	0.0004	0.001
Dissolved Organic Carbon (DOC)	USGS	1.4	---	1.9	---
Total Organic Carbon (DOC)	URS	---	3	---	3

Table 8. Analyses by different laboratories—Continued

[USGS, U.S. Geological Survey; µm, micrometer; mg/L, milligrams per liter; <, less than; ---, no data]

Sample ID		**SC3B**	**SC3B**	**SC4A**	**SC4A**
Collection Date		**3/26/02**	**3/26/02**	**3/25/02**	**3/25/02**
Treatment		**0.45 µm**	**Unfiltered**	**0.45 µm**	**Unfiltered**
Constituent, mg/L	**Laboratory**				
Calcium (Ca)	USGS	499	510	294	288
	URS	494	485	292	289
Magnesium (Mg)	USGS	156	155	138	136
	URS	152	147	138	136
Sodium (Na)	USGS	36.3	37.1	27.8	27.6
	URS	31.6	30.1	25.6	25.5
Potassium (K)	USGS	3.27	2.88	3.18	3.25
	URS	2.50	2.50	2.90	2.90
Sulfate (SO_4)	USGS	2060	---	1760	---
	URS	---	1970	---	1790
Alkalinity (as HCO_3)	USGS	77.0	---	---	---
	URS	---	101	---	12
Fluoride (F)	USGS	6.12	---	6.72	---
	URS (ACZ laboratory)	---	6.80	---	4.20
	URS (PAR laboratory)	---	7.10	---	9.70
Chloride (Cl)	USGS	8.0	---	4.5	---
	URS	---	5	---	4
Aluminum (Al)	USGS	4.48	4.78	55.6	55.1
	URS	4.85	4.64	57.5	55.7
Iron Total (Fe(T))	USGS	53.5	59.9	53.6	49.8
	URS	54.1	52.2	50.9	50.1
Boron (B)	USGS	0.014	0.010	0.013	0.012
	URS	0.10	0.01	0.10	0.05
Barium (Ba)	USGS	0.007	0.006	0.004	0.004
	URS	0.006	0.008	---	---
Manganese (Mn)	USGS	25.0	25.4	20.0	19.6
	URS	23.0	22.6	18.7	18.6
Zinc (Zn)	USGS	4.42	4.53	5.20	5.19
	URS	4.16	4.12	5.22	5.14
Lead (Pb)	USGS	0.054	0.066	<0.008	0.010
	URS	0.042	0.045	---	---
Nickel (Ni)	USGS	0.477	0.483	0.563	0.556
	URS	0.430	0.420	0.540	0.520
Copper (Cu)	USGS	<0.0005	<0.0005	0.070	0.072
	URS	0.002	0.007	0.072	0.068
Cadmium (Cd)	USGS	0.001	0.001	0.017	0.017
	URS	0.0005	---	0.0129	0.0133
Chromium (Cr)	USGS	0.008	0.008	0.012	0.012
	URS	---	0.005	---	0.005
Cobalt (Co)	USGS	0.243	0.236	0.270	0.251
	URS	0.204	0.220	0.216	0.227
Beryllium (Be)	USGS	0.020	0.019	0.016	0.016
	URS	0.019	0.022	0.015	0.016
Molybdenum (Mo)	USGS	0.023	0.024	0.013	0.007
	URS	0.0001	0.001	0.0005	0.001
Dissolved Organic Carbon (DOC)	USGS	2.7	---	2.0	---
Total Organic Carbon (DOC)	URS	---	6	---	2

Table 8. Analyses by different laboratories—Continued

[USGS, U.S. Geological Survey; µm, micrometer; mg/L, milligrams per liter; <, less than; ---, no data]

Sample ID		**SC5A**	**SC5A**	**SC5B**	**SC5B**
Collection Date		**3/27/02**	**3/27/02**	**3/27/02**	**3/27/02**
Treatment		**0.45 µm**	**Unfiltered**	**0.45 µm**	**Unfiltered**
Constituent, mg/L	**Laboratory**				
Calcium (Ca)	USGS	146	147	567	563
	URS	130	127	524	527
Magnesium (Mg)	USGS	52.3	52.3	40.7	40.9
	URS	50.8	48.1	38.0	35.9
Sodium (Na)	USGS	15.8	15.5	45.1	45.4
	URS	14.0	13.4	42.7	42.9
Potassium (K)	USGS	1.96	1.95	4.30	4.47
	URS	1.80	1.70	4.70	4.40
Sulfate (SO_4)	USGS	957	---	1420	---
	URS	---	930	---	1410
Alkalinity (as HCO_3)	USGS	---	---	154	---
	URS	---	12	---	159
Fluoride (F)	USGS	2.60	---	1.04	---
	URS (ACZ laboratory)	---	2.40	---	1.80
	URS (PAR laboratory)	---	4.80	---	1.40
Chloride (Cl)	USGS	5.3	---	6.8	---
	URS	---	5	---	8
Aluminum (Al)	USGS	51.0	50.8	0.004	0.166
	URS	50.10	46.60	---	0.26
Iron Total (Fe(T))	USGS	0.362	0.40	3.99	7.10
	URS	0.41	0.44	4.30	6.08
Boron (B)	USGS	<0.01	<0.01	0.025	0.020
	URS	0.05	0.05	0.10	0.05
Barium (Ba)	USGS	0.002	0.002	0.028	0.037
	URS	---	---	0.029	0.041
Manganese (Mn)	USGS	6.72	6.74	3.07	3.18
	URS	5.66	5.58	2.66	2.71
Zinc (Zn)	USGS	2.43	2.48	<0.005	<0.005
	URS	2.23	2.14	---	0.030
Lead (Pb)	USGS	<0.008	<0.008	<0.008	<0.008
	URS	---	---	---	---
Nickel (Ni)	USGS	0.298	0.293	0.011	0.013
	URS	0.250	0.240	---	---
Copper (Cu)	USGS	0.180	0.181	0.0048	0.0007
	URS	0.162	0.171	0.003	0.007
Cadmium (Cd)	USGS	0.012	0.011	<0.0002	<0.0002
	URS	0.0081	0.0086	---	---
Chromium (Cr)	USGS	0.009	0.009	<0.0005	0.0011
	URS	0.0042	0.0058	---	---
Cobalt (Co)	USGS	0.131	0.126	<0.002	0.004
	URS	0.0971	0.0982	0.0072	0.0072
Beryllium (Be)	USGS	0.007	0.007	<0.001	<0.001
	URS	0.006	0.007	---	---
Molybdenum (Mo)	USGS	<0.007	<0.007	<0.007	<0.007
	URS	0.0005	0.0030	0.0050	0.0060
Dissolved Organic Carbon (DOC)	USGS	0.7	---	10	---
Total Organic Carbon (DOC)	URS	---	2	---	39

Table 9. Measurement of samples from Straight Creek and Red River

[mm, millimeter; µm, micrometer; µS/cm, microsemens per centimeter; mg/L, milligrams per liter; RA, unfiltered-unacidified; SC, specific conductance; <, less than; ---, no data]

Description	**Straight Cr. at pipe**	**Straight Cr. at pipe**	**Straight Cr. at pipe**	**Straight Cr. at pipe**
Date	4/16/03	4/16/03	4/16/03	4/16/03
Collection Time	12:40	12:40	12:40	12:40
Filtration Time	13:40	13:40	13:40	---
pH	2.89	2.89	2.89	2.89
Temperature (°C)	7.9	7.9	7.9	7.9
SC (µS/cm)	2220	2220	2220	2220
pore size	0.45µm	0.1µm	10,000 Dalton	RA
apparatus	capsule	142-mm plate	Minitan	---
Constituent, mg/L				
Calcium (Ca)	243	244	246	240
Magnesium (Mg)	73.0	72.0	73.0	74
Sodium (Na)	4.02	3.88	3.92	3.86
Potassium (K)	0.81	0.81	0.85	0.97
Silica (SiO_2)	51.2	51.6	51.8	54
Aluminum (Al)	89.9	89.9	87.3	87.3
Iron Total (Fe(T))	97.2	96.2	95.1	110
Ferrous Iron (Fe(II))	0.495	0.504	0.509	---
Boron (B)	0.011	0.013	<0.01	<0.01
Lithium (Li)	0.13	0.14	0.14	0.14
Strontium (Sr)	0.373	0.372	0.373	0.37
Barium (Ba)	0.001	0.002	0.002	0.01
Manganese (Mn)	17.9	17.8	17.9	18.0
Zinc (Zn)	6.45	6.45	6.53	6.60
Lead (Pb)	0.018	0.019	0.018	0.024
Nickel (Ni)	0.621	0.625	0.623	0.61
Copper (Cu)	2.05	1.98	2.00	2.09
Cadmium (Cd)	0.032	0.032	0.033	0.032
Chromium (Cr)	0.039	0.038	0.04	0.04
Cobalt (Co)	0.244	0.244	0.257	0.250
Beryllium (Be)	0.022	0.023	0.024	0.024
Molybdenum (Mo)	0.010	0.014	0.021	0.020
Vanadium (V)	<0.005	<0.005	<0.005	<0.005
Arsenic (As)	0.090	0.080	0.088	0.094
Selenium (Se)	<0.04	<0.04	<0.04	<0.04

Table 9. Measurement of samples from Straight Creek and Red River—Continued

[mm, millimeter; µm, micrometer; µS/cm, microsemens per centimeter; mg/L, milligrams per liter; RA, unfiltered-unacidified; SC, specific conductance; <, less than; ---, no data]

Description	**Red River below Fawn Lake**	**Red River below Fawn Lake**	**Red River below Fawn Lake**	**Red River below Fawn Lake**
Date	4/15/03	4/15/03	4/15/03	4/15/03
Collection Time	10:22	10:22	10:22	10:22
Filtration Time	10:40	10:45	11:08	10:51
pH	8.14	8.14	8.14	8.14
Temperature (°C)	7.1	7.1	7.1	7.1
SC (µS/cm)	223	223	223	223
pore size	0.45µm	0.45µm	0.1µm	0.1µm
apparatus	142-mm plate	capsule	142-mm plate	Minitan
Constituent, mg/L				
Calcium (Ca)	30.5	30.4	30.3	30.0
Magnesium (Mg)	6.80	6.57	6.86	6.82
Sodium (Na)	5.16	5.2	5.24	5.2
Potassium (K)	1.01	0.998	1.02	0.973
Silica (SiO_2)	12.2	11.5	12.4	12.0
Aluminum (Al)	0.133	0.083	0.142	0.071
Iron Total (Fe(T))	0.044	0.018	0.017	0.011
Ferrous Iron (Fe(II))	0.008	0.006	<0.001	0.006
Boron (B)	<0.01	<0.01	<0.01	<0.01
Lithium (Li)	0.003	0.003	0.003	0.003
Strontium (Sr)	0.199	0.189	0.197	0.189
Barium (Ba)	0.036	0.034	0.035	0.034
Manganese (Mn)	0.077	0.074	0.077	0.076
Zinc (Zn)	0.022	0.018	0.018	0.019
Lead (Pb)	<0.008	<0.008	<0.008	<0.008
Nickel (Ni)	0.007	0.005	0.004	0.005
Copper (Cu)	0.017	0.012	0.012	0.013
Cadmium (Cd)	<0.001	<0.001	<0.001	<0.001
Chromium (Cr)	<0.002	<0.002	<0.002	<0.002
Cobalt (Co)	<0.002	<0.002	<0.002	<0.002
Beryllium (Be)	<0.001	<0.001	<0.001	<0.001
Molybdenum (Mo)	<0.007	<0.007	<0.007	<0.007
Vanadium (V)	<0.005	<0.005	<0.005	<0.005
Arsenic (As)	<0.04	<0.04	<0.04	<0.04
Selenium (Se)	<0.04	<0.04	<0.04	<0.04

Table 9. Measurement of samples from Straight Creek and Red River—Continued

[mm, millimeter; µm, micrometer; µS/cm, microsemens per centimeter; mg/L, milligrams per liter; RA, unfiltered-unacidified; SC, specific conductance; <, less than; ---, no data]

Description	Red River below Fawn Lake	Red River below Fawn Lake	Red River below Fawn Lake	Red River below Fawn Lake
Date	4/15/03	4/15/03	4/15/03	4/15/03
Collection Time	10:22	10:22	10:22	10:22
Filtration Time	12:23	12:23	12:42	---
pH	8.14	8.14	8.14	8.14
Temperature (°C)	7.1	7.1	7.1	7.1
SC (µS/cm)	223	223	223	223
pore size	0.45µm	0.1µm	0.1µm	RA
apparatus	142-mm plate	142-mm plate	Minitan	---
Constituent, mg/L				
Calcium (Ca)	31	31	30	30
Magnesium (Mg)	7.0	6.8	6.8	6.8
Sodium (Na)	5.0	4.9	4.9	5.0
Potassium (K)	0.98	0.96	0.99	1.0
Silica (SiO_2)	12	12	11	13
Aluminum (Al)	0.18	0.077	0.069	0.54
Iron Total (Fe(T))	0.056	0.014	0.009	0.62
Ferrous Iron (Fe(II))	0.010	0.001	0.002	---
Boron (B)	<0.01	<0.01	<0.01	<0.01
Lithium (Li)	0.003	0.003	0.003	0.003
Strontium (Sr)	0.20	0.20	0.19	0.19
Barium (Ba)	0.036	0.035	0.033	0.043
Manganese (Mn)	0.077	0.077	0.075	0.10
Zinc (Zn)	0.019	0.018	0.018	0.037
Lead (Pb)	<0.008	<0.008	<0.008	<0.008
Nickel (Ni)	0.005	0.005	0.004	0.006
Copper (Cu)	0.009	0.007	0.007	0.032
Cadmium (Cd)	<0.001	<0.001	<0.001	<0.001
Chromium (Cr)	<0.002	<0.002	<0.002	<0.002
Cobalt (Co)	<0.002	<0.002	<0.002	<0.002
Beryllium (Be)	<0.001	<0.001	<0.001	<0.001
Molybdenum (Mo)	<0.007	<0.007	<0.007	<0.007
Vanadium (V)	<0.005	<0.005	<0.005	<0.005
Arsenic (As)	<0.04	<0.04	<0.04	<0.04
Selenium (Se)	<0.04	<0.04	<0.04	<0.04

Table 9. Measurement of samples from Straight Creek and Red River—Continued

[mm, millimeter; µm, micrometer; µS/cm, microsemens per centimeter; mg/L, milligrams per liter; RA, unfiltered-unacidified; SC, specific conductance; <, less than; ---, no data]

Description	Red River below Mill	Red River below Mill	Red River below Mill	Red River below Mill
Date	4/15/03	4/15/03	4/15/03	4/15/03
Collection Time	14:58	14:58	14:58	14:58
Filtration Time	15:27	17:50	15:40	17:55
pH	7.72	7.72	7.72	7.72
Temperature (°C)	6.8	6.8	6.8	6.8
SC (µS/cm)	242	242	242	242
pore size	0.1µm	0.1µm	10,000 Dalton	10,000 Dalton
apparatus	142-mm plate	142-mm plate	Minitan	Minitan
Constituent, mg/L				
Calcium (Ca)	30	32	31	30
Magnesium (Mg)	7	7.3	7	7
Sodium (Na)	5.3	5.2	5.4	5.2
Potassium (K)	0.93	0.99	1	0.97
Silica (SiO_2)	12	12	12	11
Aluminum (Al)	0.27	0.16	0.14	0.13
Iron Total (Fe(T))	0.048	0.010	0.002	0.002
Ferrous Iron (Fe(II))	0.003	<0.001	<0.001	<0.001
Boron (B)	<0.01	<0.01	<0.01	<0.01
Lithium (Li)	0.003	0.003	0.003	0.003
Strontium (Sr)	0.2	0.21	0.2	0.2
Barium (Ba)	0.025	0.029	0.025	0.025
Manganese (Mn)	0.094	0.092	0.091	0.089
Zinc (Zn)	0.013	0.014	0.014	0.008
Lead (Pb)	<0.008	<0.008	<0.008	<0.008
Nickel (Ni)	0.009	0.005	0.005	0.004
Copper (Cu)	0.004	0.007	0.005	0.007
Cadmium (Cd)	<0.001	<0.001	<0.001	<0.001
Chromium (Cr)	<0.002	<0.002	<0.002	<0.002
Cobalt (Co)	<0.002	<0.002	<0.002	<0.002
Beryllium (Be)	<0.001	<0.001	<0.001	<0.001
Molybdenum (Mo)	<0.007	<0.007	<0.007	<0.007
Vanadium (V)	<0.005	<0.005	<0.005	<0.005
Arsenic (As)	<0.04	<0.04	<0.04	<0.04
Selenium (Se)	<0.04	<0.04	<0.04	<0.04

Table 10. Measurement of sequential aliquots for a sample from the Red River at U.S. Geological Survey streamflow-gaging station 082655000

[mm, millimeter; µm, micrometer; µS/cm, microsemens per centimeter; mg/L, milligrams per liter; RA, unfiltered-unacidified; SC, specific conductance; <, less than; ---, no data]

Date	**3/20/02**	**3/20/02**	**3/20/02**	**3/20/02**	**3/20/02**
pH	7.54	7.54	7.54	7.54	7.54
SC (µS/cm)	419	419	419	419	419
Temperature (°C)	2.5	2.5	2.5	2.5	2.5
Filter pore size	0.45µm	0.45µm	0.45µm	0.45µm	0.45µm
Filtrate volume (Liters)	0.13	0.25	0.38	0.50	0.63
Constituent, mg/L					
Calcium (Ca)	57.2	58.1	57.3	54.2	54.5
Magnesium (Mg)	12.2	12.1	12.9	12.6	13.1
Sodium (Na)	7.4	6.8	6.8	6.7	7.0
Potassium (K)	1.15	1.17	1.13	1.12	1.15
Silica (SiO_2)	11.3	11.7	11.2	11.7	11.9
Aluminum (Al)	0.154	0.122	0.111	<0.08	<0.08
Iron Total (Fe(T))	0.134	0.133	0.177	0.133	0.133
Ferrous Iron (Fe(II))	0.099	0.111	0.141	0.082	0.051
Boron (B)	0.002	0.000	0.001	0.015	0.011
Lithium (Li)	0.007	0.007	0.006	0.006	0.006
Strontium (Sr)	0.311	0.318	0.311	0.291	0.292
Barium (Ba)	0.032	0.032	0.031	0.029	0.029
Manganese (Mn)	0.559	0.564	0.561	0.516	0.522
Zinc (Zn)	0.159	0.149	0.148	0.130	0.126
Lead (Pb)	<0.008	<0.008	<0.008	<0.008	<0.008
Nickel (Ni)	0.025	0.024	0.025	0.022	0.022
Copper (Cu)	0.004	0.002	0.004	0.003	0.003
Cadmium (Cd)	<0.002	<0.002	<0.002	<0.002	<0.002
Chromium (Cr)	<0.002	<0.002	<0.002	<0.002	<0.002
Cobalt (Co)	0.008	0.008	0.008	0.007	0.006
Beryllium (Be)	<0.001	<0.001	<0.001	<0.001	<0.001
Molybdenum (Mo)	<0.007	<0.007	<0.007	<0.007	<0.007
Vanadium (V)	<0.002	<0.002	<0.002	<0.002	<0.002
Arsenic (As)	<0.04	<0.04	<0.04	<0.04	<0.04
Selenium (Se)	<0.04	<0.04	<0.04	<0.04	<0.04

Table 10. Measurement of sequential aliquots for a sample from the Red River at U.S. Geological Survey streamflow-gaging station 082655000—Continued

[mm, millimeter; µm, micrometer; µS/cm, microsemens per centimeter; mg/L, milligrams per liter; RA, unfiltered-unacidified; SC, specific conductance; <, less than; ---, no data]

Date	**3/20/02**	**3/20/02**	**3/20/02**	**3/20/02**	**3/20/02**
pH	7.54	7.54	7.54	7.54	7.54
SC (µS/cm)	419	419	419	419	419
Temperature	2.5	2.5	2.5	2.5	2.5
Filter pore size	0.45µm	0.45µm	0.45µm	0.45µm	0.45µm
Filtrate volume (Liters)	0.75	0.88	1.00	1.13	1.25
Constituent, mg/L					
Calcium (Ca)	54.6	54.8	56.8	54.8	53.4
Magnesium (Mg)	12.6	12.6	12.5	12.5	12.6
Sodium (Na)	6.5	6.6	6.7	6.7	6.7
Potassium (K)	1.06	1.08	1.09	1.03	1.04
Silica (SiO_2)	11.4	11.6	11.6	11.4	11.6
Aluminum (Al)	<0.08	<0.08	<0.08	<0.08	<0.08
Iron Total (Fe(T))	0.132	0.136	0.135	0.132	0.132
Ferrous Iron (Fe(II))	0.096	0.062	0.081	0.085	0.046
Boron (B)	0.012	0.011	0.011	0.010	0.011
Lithium (Li)	0.006	0.006	0.006	0.005	0.006
Strontium (Sr)	0.292	0.288	0.285	0.277	0.282
Barium (Ba)	0.028	0.029	0.028	0.027	0.028
Manganese (Mn)	0.525	0.527	0.526	0.539	0.542
Zinc (Zn)	0.135	0.132	0.131	0.137	0.134
Lead (Pb)	<0.008	<0.008	<0.008	<0.008	<0.008
Nickel (Ni)	0.022	0.023	0.022	0.024	0.023
Copper (Cu)	0.005	0.005	0.003	0.005	0.005
Cadmium (Cd)	<0.002	<0.002	<0.002	<0.002	<0.002
Chromium (Cr)	<0.002	<0.002	<0.002	<0.002	<0.002
Cobalt (Co)	0.007	0.006	0.006	0.007	0.007
Beryllium (Be)	<0.001	<0.001	<0.001	<0.001	<0.001
Molybdenum (Mo)	<0.007	<0.007	<0.007	<0.007	<0.007
Vanadium (V)	<0.002	<0.002	<0.002	<0.002	<0.002
Arsenic (As)	<0.04	<0.04	<0.04	<0.04	<0.04
Selenium (Se)	<0.04	<0.04	<0.04	<0.04	<0.04

Table 10. Measurement of sequential aliquots for a sample from the Red River at U.S. Geological Survey streamflow-gaging station 082655000—Continued

[mm, millimeter; µm, micrometer; µS/cm, microsemens per centimeter; mg/L, milligrams per liter; RA, unfiltered-unacidified; SC, specific conductance; <, less than; ---, no data]

Date	**3/20/02**	**3/20/02**	**3/20/02**	**3/20/02**	**3/20/02**
pH	7.54	7.54	7.54	7.54	7.54
SC (µS/cm)	419	419	419	419	419
Temperature	2.5	2.5	2.5	2.5	2.5
Filter pore size	0.1µm	0.1µm	0.1µm	0.1µm	0.1µm
Filtrate volume (Liters)	0.13	0.25	0.38	0.50	0.63
Constituent, mg/L					
Calcium (Ca)	53.9	53.4	54.4	55.7	55.9
Magnesium (Mg)	12.5	12.5	13.9	13.8	13.6
Sodium (Na)	6.9	7.0	6.7	6.7	7.0
Potassium (K)	1.12	1.06	1.05	1.08	1.08
Silica (SiO_2)	10.9	10.8	10.7	10.8	10.9
Aluminum (Al)	<0.08	<0.08	<0.08	<0.08	<0.08
Iron Total (Fe(T))	0.126	0.120	0.118	0.126	0.118
Ferrous Iron (Fe(II))	0.070	0.043	0.068	0.059	0.051
Boron (B)	0.013	0.012	0.011	0.010	0.012
Lithium (Li)	0.006	0.006	0.006	0.006	0.006
Strontium (Sr)	0.285	0.284	0.279	0.285	0.293
Barium (Ba)	0.028	0.028	0.028	0.028	0.029
Manganese (Mn)	0.521	0.516	0.522	0.522	0.522
Zinc (Zn)	0.152	0.134	0.133	0.133	0.133
Lead (Pb)	<0.008	<0.008	<0.008	<0.008	<0.008
Nickel (Ni)	0.023	0.023	0.023	0.024	0.023
Copper (Cu)	0.005	0.005	0.004	0.003	0.004
Cadmium (Cd)	<0.002	<0.002	<0.002	<0.002	<0.002
Chromium (Cr)	<0.002	<0.002	<0.002	<0.002	<0.002
Cobalt (Co)	0.007	0.007	0.007	0.006	0.007
Beryllium (Be)	<0.001	<0.001	<0.001	<0.001	<0.001
Molybdenum (Mo)	<0.007	<0.007	<0.007	<0.007	<0.007
Vanadium (V)	<0.002	<0.002	<0.002	<0.002	<0.002
Arsenic (As)	<0.04	<0.04	<0.04	<0.04	<0.04
Selenium (Se)	<0.04	<0.04	<0.04	<0.04	<0.04

Table 10. Measurement of sequential aliquots for a sample from the Red River at U.S. Geological Survey streamflow-gaging station 082655000—Continued

[mm, millimeter; µm, micrometer; µS/cm, microsemens per centimeter; mg/L, milligrams per liter; RA, unfiltered-unacidified; SC, specific conductance; <, less than; ---, no data]

Date	**3/20/02**	**3/20/02**	**3/20/02**	**3/20/02**	**3/20/02**
pH	7.54	7.54	7.54	7.54	7.54
SC (µS/cm)	419	419	419	419	419
Temperature	2.5	2.5	2.5	2.5	2.5
Filter pore size	0.1µm	0.1µm	0.1µm	0.1µm	0.1µm
Filtrate volume (Liters)	0.75	0.88	1.00	1.13	1.25
Constituent, mg/L					
Calcium (Ca)	54.9	56.1	55.6	54.3	54.5
Magnesium (Mg)	13.9	13.3	13.6	13.6	13.7
Sodium (Na)	6.9	6.4	7.1	7.0	6.9
Potassium (K)	1.07	1.03	1.11	1.06	1.10
Silica (SiO_2)	11.0	10.4	10.7	10.6	11.0
Aluminum (Al)	<0.08	<0.08	<0.08	<0.08	<0.08
Iron Total (Fe(T))	0.122	0.119	0.123	0.121	0.122
Ferrous Iron (Fe(II))	0.050	0.046	0.040	0.052	0.051
Boron (B)	0.014	0.014	0.013	0.011	0.012
Lithium (Li)	0.006	0.006	0.006	0.006	0.006
Strontium (Sr)	0.291	0.275	0.281	0.281	0.282
Barium (Ba)	0.028	0.027	0.028	0.027	0.028
Manganese (Mn)	0.524	0.520	0.525	0.517	0.518
Zinc (Zn)	0.134	0.129	0.140	0.142	0.136
Lead (Pb)	<0.008	<0.008	<0.008	<0.008	<0.008
Nickel (Ni)	0.023	0.023	0.023	0.023	0.023
Copper (Cu)	0.007	0.004	0.005	0.005	0.006
Cadmium (Cd)	<0.002	<0.002	<0.002	<0.002	<0.002
Chromium (Cr)	<0.002	<0.002	<0.002	<0.002	<0.002
Cobalt (Co)	0.007	0.007	0.007	0.007	0.007
Beryllium (Be)	<0.001	<0.001	<0.001	<0.001	<0.001
Molybdenum (Mo)	<0.007	<0.007	<0.007	<0.007	<0.007
Vanadium (V)	<0.002	<0.002	<0.002	<0.002	<0.002
Arsenic (As)	<0.04	<0.04	<0.04	<0.04	<0.04
Selenium (Se)	<0.04	<0.04	<0.04	<0.04	<0.04

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