Prepared in cooperation with the
U.S. ENVIRONMENTAL PROTECTION AGENCY and the
BUREAU OF RECLAMATION

Effects of Fluvial Tailings Deposits on Soils and Surface- and Ground-Water Quality, and Implications for Remediation—Upper Arkansas River, Colorado, 1992–96

Water-Resources Investigations Report 99–4273

U.S. DEPARTMENT OF THE INTERIOR
U.S. GEOLOGICAL SURVEY

Cover Photograph: *View in the foreground of fluvial tailings deposits in the flood plain of the upper Arkansas River. Mount Massive in the far right background. Mount Elbert in the far left background. Photograph by Craig Walker.*

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Denver, Colorado
2000

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Abstract

Geochemical and hydrologic studies were conducted on parts of the Arkansas River and its flood plain downstream from Leadville, Colorado, to assess the effects of fluvial tailings deposits on soil and water quality, to identify processes causing water-quality degradation, and to identify implications of these results for remediation strategies. Soil samples indicated that the tailings deposits in a 3-mile reach of the flood plain contain as much as 6,500 and 12,000 milligrams per kilogram of lead and zinc, respectively. These concentrations are as much as 380 times the reported average concentrations for soils in the Western United States. Pyrite and some of its weathering products were identified in the soils, indicating that acid-rock drainage can occur.

Estimates of instantaneous mass loads for calcium, iron, lead, manganese, and zinc in unfiltered Arkansas River samples for 18 different sampling dates in 1996 showed some evidence for increases in trace-element loads in some stream reaches during a few sampling dates during snowmelt runoff. These data indicate erosion of sediments or addition of trace elements to the water column in these stream reaches. Conversely, on some dates, during low flow, downstream loads decreased, indicating deposition of sediments or formation and settling of iron and manganese oxyhydroxide minerals, or both. For most of the sampling dates, the variability in the mass-load estimate is greater than differences between loads at adjacent stream sites, making comparisons impossible. Estimated trace-element loads increased along a distributary channel that runs through the fluvial tailings deposits during some sampling periods. The estimated load increases, however, were orders of magnitude less than loads in the river, indicating that the tailings deposits do not contribute measurable trace-element loads to the river through the distributary channel. As remediation activities proceed upstream at the Leadville Superfund site, zinc concentrations and loads in the river may decrease. Because loads from the tailings might be detectable when trace-element concentrations in the river are lower, future mass-loading studies might be able to better detect zinc entering the river from the fluvial tailings deposits.

Samples of ground water from a 12-acre area revealed that shallow ground water has been affected by acid-rock drainage. Samples from as many as 10 wells have pH values less than 3 or elevated concentrations of cadmium (greater than 0.05 milligram per liter), copper (greater than 0.05 milligram per liter), lead (greater than 0.05 milligram per liter), manganese (greater than 1 milligram per liter), or zinc (greater than 5 milligrams per liter). Low pH (less than 6) and elevated concentrations of cadmium (greater than 0.05 milligram per liter) and zinc (greater than

5 milligrams per liter) in one of the most upgradient wells indicate contamination of ground water from upgradient tailings sources. During spring, a flush occurs that increases the areal extent of degraded ground water. The spring flush is from increased infiltration of springtime snowmelt through the tailings, or from seasonal fluctuation of the ground-water table and capillary fringe up into tailings material, or both.

An understanding of the mechanism causing ground-water contamination is important for remedial activities. If infiltration is the contamination mechanism, then shallow amendments of acid-neutralizing material and efforts to limit infiltration might be sufficient to remediate adverse effects of the tailings deposits. However, if water-table fluctuation is the mechanism, then deeper amendments of acid-neutralizing material would be required. In this case, a remedial effort would require detailed information about the depth, distribution, and acid-generating capacity of the tailings material.

INTRODUCTION

Fluvial tailings deposits consist of mine waste and tailing materials that have been transported and deposited by natural fluvial processes some distance from their origin in a mining district. In some areas, the deposits resemble pure tailings; in other areas, the tailings are mixed with natural fluvial sediments. Flood plains downstream from mining districts can contain abundant amounts of this material, particularly in older mining districts where mining activity occurred before environmental regulations required containment of mine-waste materials. Fluvial tailings deposits that contain pyrite and metal sulfide minerals represent potential nonpoint sources of metals and acidity to adjacent surface and ground water.

Fluvial tailings deposits are present in the flood plain of the upper Arkansas River from approximately 3 to 14 miles downstream from Leadville, Colo. (fig. 1). Preliminary characterization of these materials from this study and other studies indicates the presence of pyrite and other metal sulfide minerals (Church, 1993; Walton-Day and others, 1994, 1996; URS Operating Services, 1997). Therefore, a potential exists to contribute metals and acidity to receiving waters. Mechanisms that might introduce these contaminants to surface water include erosion of tailings deposits into the river, surface runoff of water contaminated by chemical weathering of the deposits into the stream, and discharge of ground water contaminated by the deposits into the stream. Two mechanisms that might introduce these contaminants into the ground water are infiltration of water through the tailings deposits into underlying aquifers and seasonal fluctuation of the ground-water table and capillary fringe up into contaminated sediments. Fluvial tailings deposits in other geographical areas have degraded surface-water quality through episodic dissolution of efflorescent salts and runoff to surface water (Nimick and Moore, 1991) and have degraded ground-water quality through the seasonal fluctuations of the water table up into contaminated sediments (Shay, 1997).

From 1992 through 1996, the U.S. Geological Survey (USGS), in cooperation with the U.S. Environmental Protection Agency (USEPA) and the Bureau of Land Management, studied the geochemistry and hydrology of the fluvial tailings deposits located downstream from Leadville, Colo., in three studies described herein. The purpose of these studies was to (1) characterize the effect of the deposits on soil and water quality, (2) make a preliminary determination of processes causing water-quality degradation, and (3) identify implications of these results for possible remediation strategies. These studies were done in several stages:

1. During the first stage, in 1992, a limited set of soil and water samples was collected from a 3-mile-long reach of the east side of the flood plain between sites AR65 and AR70 (figs. 1 and 2) to assess metal concentrations in soils, the presence of pyrite in the soils, and general water quality in the area.
2. During the second stage, in 1995 and 1996, surface-water samples were collected from the Arkansas River along a 6-mile river reach, which includes sites AR40, AR65, and AR70 (fig. 1), to characterize spatial and temporal trends in metal loading.

3. During the third stage, in 1995 and 1996, surface- and ground-water samples were collected from a 12-acre area (the detailed study area on figs. 1, 2, and 3) within the original 3-mile river reach to assess any effects of tailings deposits in this area on ground-water quality, to note any increased metal loads in a distributary channel that flows through the area, and to determine mechanisms causing any observed water-quality degradation. A large part of this area contains fluvial tailings deposits and is devoid of vegetation (fig. 3). Concurrent studies identified six distinct deposits of tailings material with a volume of about 158,000 cubic feet within this study site (URS Operating Services, 1997).

The scope of the work included collection and analysis of soil samples, surface-water samples, and ground-water samples; measurements of streamflow discharge and stream stage; measurement of water-table elevations; construction of instantaneous mass-flow profiles for the stream for selected constituents; construction of water-table maps and maps showing the distribution of constituents in ground water; and limited interpretation of these data as to geochemical processes causing the observed data patterns.

Description of the Study Area

The study area is in the upper Arkansas River Basin between Leadville and Granite, Colo. (fig. 1). The drainage area upstream from Granite is about 427 square miles. Elevations in the basin range from about 8,800 feet at Granite to 14,400 feet above sea level in the mountain peaks west of Leadville.[1] However, elevations between sampling sites range from about 9,250 feet at site AR70 to 9,500 feet at site AR40 (fig. 1). Climate in the study area is montane, and mean annual precipitation ranges from less than 10 inches at the lowest elevations to more than 40 inches at the highest elevations (Doeskin and others, 1984). In the study reach (from site AR40 to site AR70), the Arkansas River is a relatively high-gradient stream with a cobble and gravel streambed. Streamflow is sustained during summer by melting of the winter snowpack at higher elevations. Transmountain water is imported in several areas upstream, as described by Abbott (1985). In spite of the imported water, the stream hydrograph appears relatively natural and is characterized by a sustained peak caused by snowmelt from April to July, followed by a period of low flow punctuated by storms. In the study area, the flood plain is as much as about 0.5 mile wide. It is an area of low relief, containing grass, scrub, and wetland vegetation. Wetlands are present in areas of abandoned oxbows and where ground water discharges to the surface or where surface water forms ponds or stagnates. Many areas within the flood plain that contain fluvial tailings deposits are devoid of most vegetation. Some new gravel bars and active point-bar deposits also are devoid of vegetation, probably because they lack sufficient fine soil material to support vegetation and are periodically inundated by high-velocity flow.

Acknowledgments

The authors are grateful to landowners for providing access to their properties. Special thanks go to students who assisted with data collection, including Eric Sampson and Janelle Stefanic from Colorado Mountain College and Jeanette Jerz and Craig Walker from the Colorado School of Mines. Thanks also to the well installation and rescue unit. We are grateful to Randy Hergenreder of the Perkin Elmer Corporation who provided access to and assistance with analytical equipment. Thanks to Paul Briggs, James Crock, David Fey, and Steve Sutley who conducted soil analysis. Special thanks go to Janece Koleis and George Aiken for doing the dissolved organic carbon analyses. Thanks also for the graphical and editorial support of Alan Duran, John Evans, Mary Kidd, Joy Monson, and Loretta Ulibarri. Technical reviews by Laurie Balistrieri and Winfield Wright greatly improved the text. Additional support was provided by the USGS Toxic Substances Hydrology Program.

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

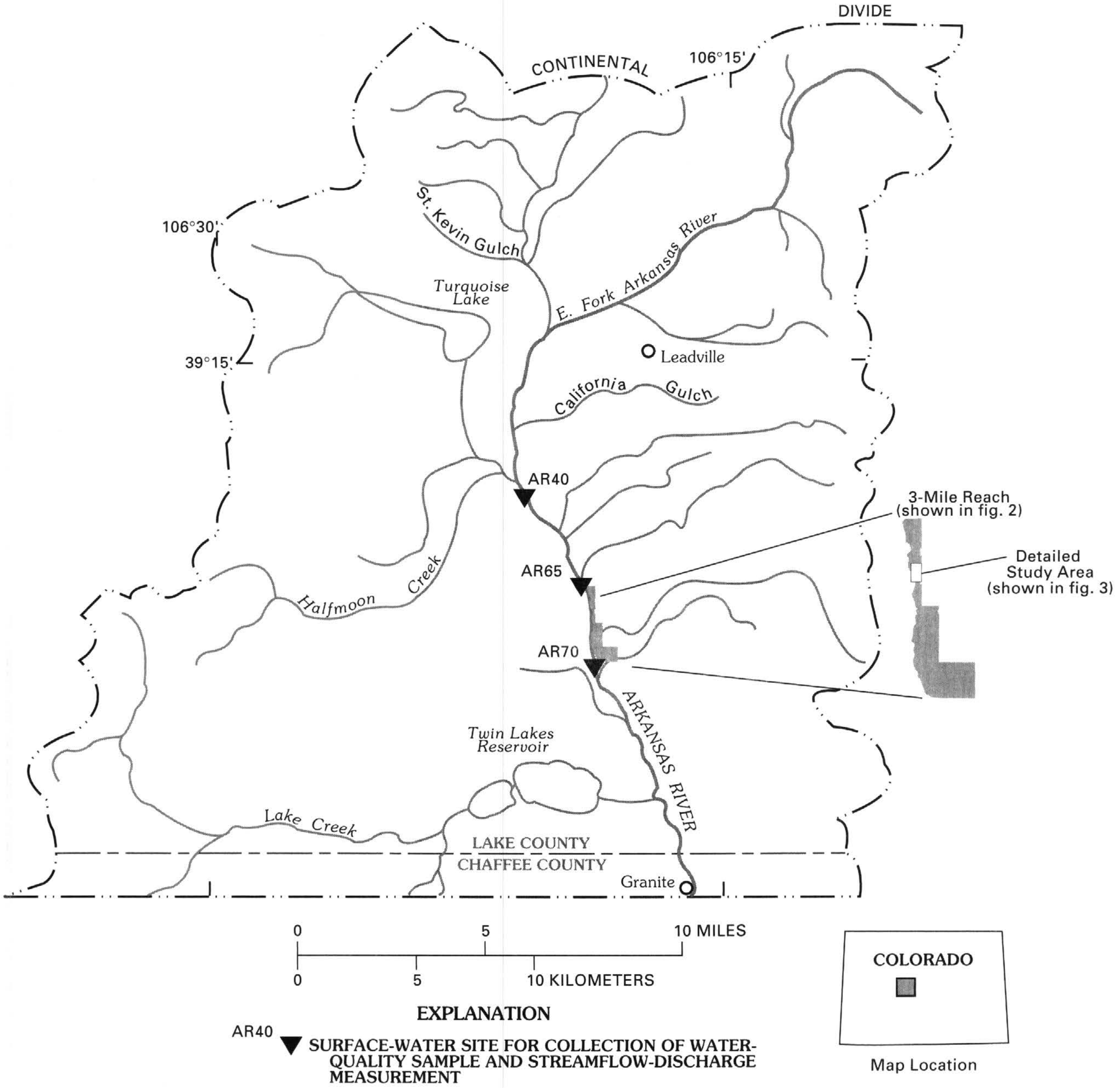

Figure 1. Location of the upper Arkansas River Basin, surface-water sampling sites, and ground-water study area.

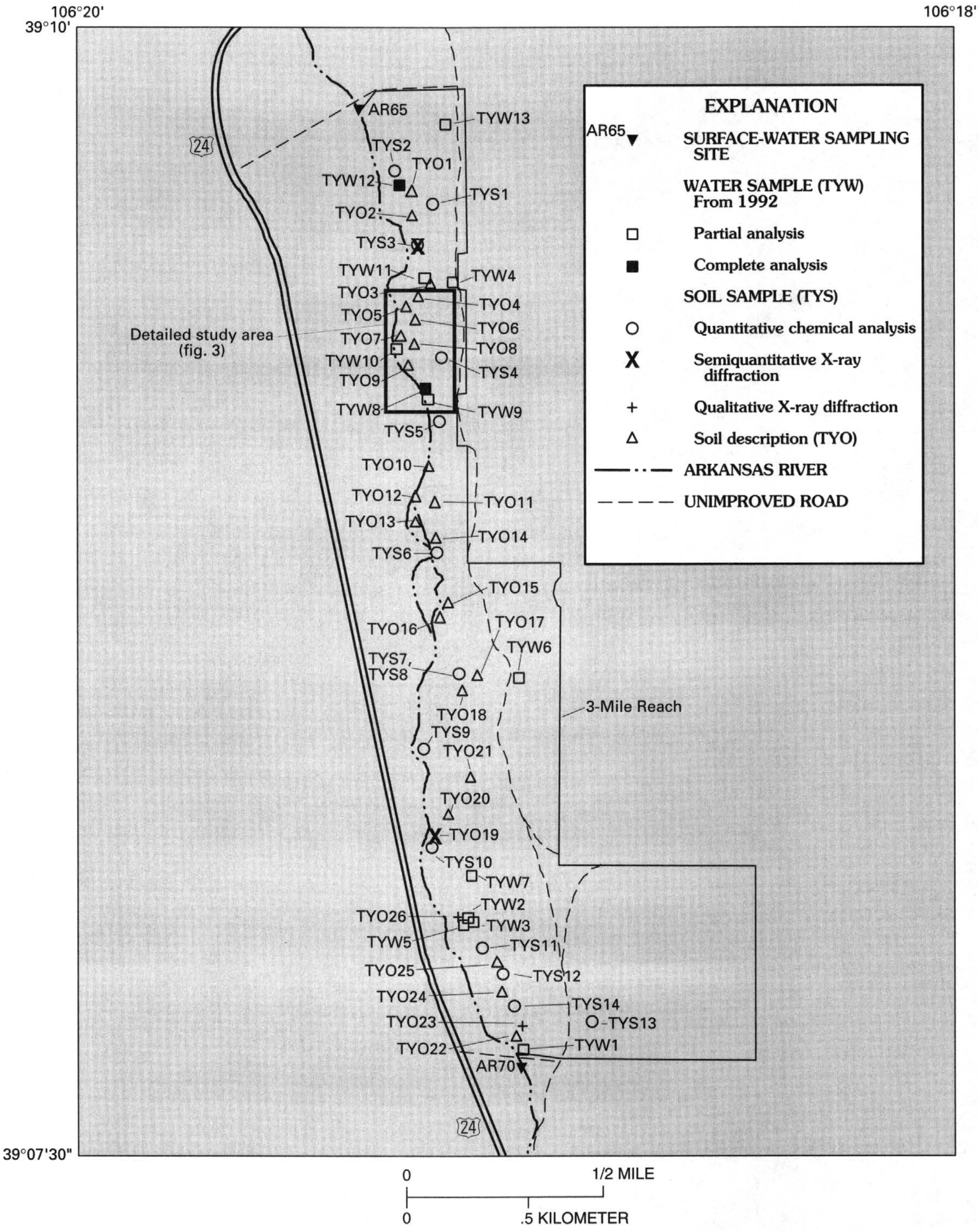

Figure 2. Location of 3-mile reach. Sites AR65 and AR70 are located at the north and south ends of the 3-mile reach, respectively.

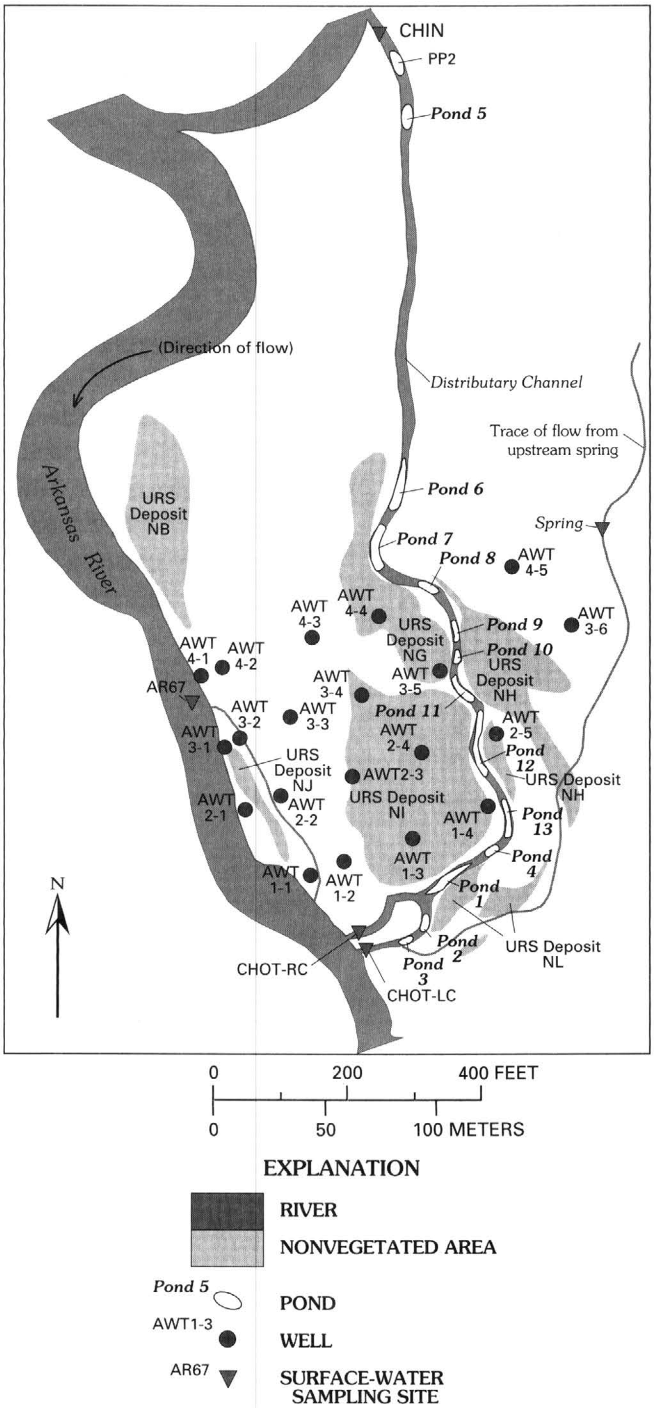

Figure 3. Location of ground-water monitoring wells, surface-water sampling sites, distributary channel (small subchannel of the main channel), ponds, and nonvegetated areas in the detailed study area. For reference, some of the nonvegetated areas are identified by the designations assigned them by URS Operating Services (1997). Ponds in the distributary channel formed during the September 1996 sampling when active inflow and outflow from the channel had ceased.

DATA COLLECTION

The chronology, location, and different types of data and samples collected are discussed in this section. Sample preparation and analysis are presented in Appendix 1. In September 1992, three types of soil data were collected from the 3-mile reach of the flood plain (fig. 2). Samples were collected for chemical analysis, descriptions of soils were compiled throughout the 3-mile reach, and samples were collected for analysis of mineralogic content by X-ray diffraction (XRD). Surface-water samples and data were collected from the 3-mile reach in September 1992 and from three sites in the Arkansas River and five sites in the detailed study area during 1995–96. Ground-water samples were collected from the detailed study area (figs. 1, 2, and 3) in 1995–96.

Soil Samples for Chemical Analysis

Thirteen soil samples were collected and submitted for total digestion and chemical analysis to enable characterization of trace-element concentrations in contaminated (compared to background) areas in the 3-mile reach. General visual and textural characteristics of the soil samples also were described. These samples and sites are designated TYSX (where X is a number from 1 to 14) in figure 2. Sample TYS12 was not submitted for chemical analysis. Of the 13 soil samples collected for chemical analysis, 11 were collected from areas where elevated trace-element concentrations were anticipated, based on the lack of vegetation and the presence of iron-oxide staining or other constituents (such as pyrite and sulfur odor) characteristic of mine waste. This sampling scheme was designed to identify potential maximum trace-element concentrations and was not intended to indicate average trace-element concentrations representative of the entire 3-mile reach. The two remaining samples were collected on or topographically above the flood plain in apparently uncontaminated areas to provide a first approximation of background trace-element concentrations in the area.

Bulk soil samples for chemical analysis were collected by digging three holes about 3 feet apart in a triangular configuration. Soil from the zone of accumulation (B horizon, usually 6 to 12 inches below the land surface) from each hole was composited equally into a new, clean plastic bag by using plastic scoops. In many locations, the soil profiles were not well developed, so the 6- to 12-inch depth was used to maintain continuity of sample-collection techniques between sites. Two to four pounds of soil were collected. Soil descriptions (including depth of sample collection, color, texture, and any odor detected at the site) were prepared onsite as part of data collection. Analytical procedures are described in Appendix 1, and field notes are included in Appendix 2.

Description of Soil Characteristics

Descriptions of soil characteristics were recorded at 26 additional sites along the 3-mile reach. These sites are designated by the prefix TYO in figure 2. Data recorded included depth of observation point below ground surface (where relevant), soil color based on comparison with Munsell color charts (Macbeth Division of Kollmorgen Instruments Corporation, 1992), general texture of the soil (grain size and sorting), descriptions of any organic material, and general comments. Of the 26 sites, 5 were augered soil core holes, 4 were cutbanks, and 17 were descriptions of general soil conditions. One additional cutbank was described at site TYS4. These field descriptions, which are included in Appendix 2, were compiled to provide information on the extent of tailing-affected areas within the 3-mile reach.

X-Ray Diffraction Analyses

Four bulk soil samples were submitted to the laboratories of the USGS Geologic Division in Lakewood, Colo., for mineral identification using XRD. Two samples (from sites TYO23 and TYO26) received qualitative analysis to identify minerals present in the samples, and two other samples (from sites TYS3 and TYO19) received semiquantitative XRD to determine the relative abundance of minerals in the samples.

Surface Water

Surface-water samples collected during the 1992 phase of the study are designated with the prefix TYW in figure 2. Eleven water samples were collected for analysis of pH and specific conductance and are designated by open squares in figure 2. Two water samples were collected for complete analysis of inorganic constituents and are designated with solid squares in figure 2. All samples were grab samples and were collected from small streams, distributary channels (small braided subchannels of the main channel), and springs located within the 3-mile reach. Samples for pH and specific-conductance analysis were collected into 250-milliliter (mL) polyethylene bottles. Samples for complete analysis were collected in clean, acid-rinsed, 2-liter polyethylene bottles; these samples were split into three aliquots. Two hundred and fifty milliliters of raw sample were retained for analysis of pH, specific conductance, and alkalinity at the laboratory; two separate 250-mL aliquots were collected after filtration through a 0.45-micrometer (µm) cellulose nitrate filter—one aliquot was retained untreated for analysis of anions by ion chromatography, and the other aliquot was acidified to pH less than 2 for analysis of major and trace cations by inductively coupled plasma atomic-emission spectroscopy (ICP-AES). Samples for analysis by ICP-AES and ion chromatography were sent to the USGS National Water Quality Laboratory in Colorado. See Appendix 1 for additional details.

Water-quality samples and streamflow-discharge measurements were collected at two sites on the Arkansas River during 1995 and three sites during 1996 to allow development of loading profiles for the stream. Site AR65 was sampled 7 times from mid-July through October in 1995 and 18 times from April through September in 1996. Site AR70 was sampled 5 times from mid-July through October in 1995 and 18 times from April through September in 1996. From April 11 to September 27, 1996, samples were collected weekly during high flow and biweekly otherwise. An additional upstream site (AR40) was sampled four times in 1996 (once in May, June, July, and September) to extend the loading profiles over a longer stream reach. Bridges span the river at each of the three sites, allowing collection of integrated samples across the entire river width at all stages of flow. Five additional surface-water sites were sampled to aid in characterization of the detailed study area (AR67, CHIN, CHOT–RC, CHOT–LC, and Spring in fig. 3). These sites were sampled once in October 1995 and once in May, June, and July 1996. Only site AR67 and Spring were sampled in September 1996 because the distributary channel was not flowing. At that time, the channel had resolved into a series of ponds that were each sampled and analyzed. Sampling sites, purposes of data collection, sampling frequency, and water-quality constituents measured are summarized in table 1.

During each visit to the surface-water sampling sites, streamflow-discharge measurements were made and water-quality samples were collected using standard USGS techniques (Rantz and others, 1982a, b; Shelton, 1994). Streamflow-discharge measurements were made either from a bridge or by wading and using a standard Price AA current meter or pygmy meter, depending on stream depth. Streamflow-discharge calculations were made according to standard USGS procedures (Rantz and others 1982a, b). Streamflow discharge was not measured at the site labeled Spring (fig. 3) and was measured only one time at site AR67. At the site labeled Spring, flow was too diffuse to measure streamflow discharge; site AR67 was not part of the loading study; samples were collected at the site to allow comparison with ground-water quality in the detailed study area. During high flow on May 21 and June 19, 1996, streamflow discharge was not measured at the downstream site (AR70) because excessive turbulence in the stream under the bridge introduced large errors into the measurement and threatened equipment integrity. For these trips, the error in the discharge measurement was judged to be greater than the difference in streamflow discharge between the two sites (AR65 and AR70). Therefore, streamflow discharge at site AR70 was estimated based on the streamflow measured at the upstream site on May 21 and June 19. Streamflow-discharge measurements are included in Appendix 1.

Table 1. Sampling sites, purpose of data collection, sampling frequency, and water-quality constituents and properties measured in 1995–96

[O = October 1995; M = May 1996; Jn = June 1996; Jl = July 1996; S = September 1996; --, no data; archive is a raw, untreated sample not analyzed but retained to be used to replace other sample aliquots if they are lost or contaminated]

Site identification (figs. 1 and 3)	Data used for river loading or characterization of detailed study area	Sampling frequency	Field parameters	Total recoverable metals, archive, filtered metals, filtered anions, filtered ferrous and total iron, and alkalinity	Ultrafiltered metals and ferrous and total iron	Total sulfide	Delta deuterium and delta 18-oxygen
AR40	Loading	M, Jn, Jl, S	All	All	M, Jn, Jl, S	--	--
AR65	Loading	25 visits	All (except dissolved oxygen)	All; no filtered samples, 08/16/95	Collected four times in 1996 during ground-water sampling in detailed study area.	--	--
AR67	Detailed study area	O, M, Jn, Jl, S	All	All	M, Jn, Jl, S	--	Jn, S
AR70	Loading	23 visits	All (except dissolved oxygen)	All; no filtered samples, 08/16/95	Collected four times in 1996 during ground-water sampling in detailed study area.	--	--
All wells with prefix AWT	Detailed study area	O, M, Jn, Jl, S	All	All	M, Jn, Jl, S	Some wells	Jn, S, selected wells
Spring	Detailed study area	O, M, Jn, Jl, S	All	All	M, Jn, Jl, S	--	--
CHIN	Detailed study area	O, M, Jn, Jl	All	All	M, Jn, Jl, S	--	--
CHOT–RC	Detailed study area	O, M, Jn, Jl	All	All	M, Jn, Jl, S	--	--
CHOT–LC	Detailed study area	O, M, Jn, Jl	All	All	M, Jn, Jl, S	--	--
Ponds	Detailed study area	S	All	No archive collected	--	--	--

Water-quality samples at sites AR40, AR65, and AR70 were composited from across the entire stream width into a churn splitter. Samples were collected using the equal-width-increment sampling technique (Shelton, 1994). Depending on flow regime, samples were collected either by using a bridge boom equipped with a D–77 sampler or by wading and using a DH–81 sampler (Shelton, 1994). At site AR67, samples were composited by wading across the river when possible; at high flow, grab samples were collected from the east bank. For each sample, three 125-mL aliquots of sample were collected from the churn splitter for analysis of pH, specific conductance, and unfiltered trace-constituent concentrations. An additional 125-mL aliquot was retained as a sample archive. Some of the water from the churn then was delivered into a stainless steel filtering vessel equipped with a 0.45-µm glass filter, and 125-mL of filtered sample was collected for analysis of dissolved organic carbon. Then, water from the churn splitter was filtered through a 0.1-µm cellulose nitrate filter, and three 125-mL aliquots were collected for analysis of anions and alkalinity, filtered metal concentrations, and field determination of total and ferrous iron. Finally, on the four sampling trips that included the ground-water sampling in 1996, ultrafiltered samples were collected using a Millipore Minitan ultrafiltration system. Membrane size was 10,000 daltons, which is a nominal pore size of 0.001 µm. Samples for analysis of unfiltered, filtered, and ultrafiltered cations were acidified to pH less than 2 by using ultrapure nitric acid. Methods of chemical analysis for surface-water samples are described in Appendix 1.

Ground Water

In August and September 1995, 20 wells were installed in the detailed study area (fig. 3). Wells were constructed of 1.25-inch-outside-diameter flush-threaded polyvinyl chloride (PVC) pipe with 0.01-inch slotted screen ranging from 1.0 to 2.5 feet long at the bottom of the pipe. The wells were designed to contain a screened interval within the zone of water-table fluctuation at the bottom of the well. The screened interval was surrounded by sand in the well annulus to a depth of approximately 6 inches above the screened interval. A bentonite seal topped by concrete completed the annular fill. A 3-inch-outside-diameter protective PVC collar was installed into the concrete at the top of the well. Total depths of wells ranged from approximately 1.5 to 6 feet. Wells were mostly excavated by hand and hand-held power auger. This method of excavation imposed several constraints on well installation:

1. Materials in the saturated zone were primarily poorly sorted sand- to cobble-sized material. Excavation of more than about 6 inches into the saturated zone was almost impossible without caving in the hole at depth. Because of this difficulty, one well (AWT3–3) was dry for all sampling periods except one (June 1996), and several wells had very small saturated intervals during some parts of the year.

2. Because the holes were excavated by hand, the holes were much larger in diameter than the desired annulus around the wells. Therefore, when the wells were installed in the excavated holes, a 4-inch-outside-diameter PVC pipe was placed vertically in the hole as a temporary protective casing for the well. Native material from the excavation then was backfilled around the outside of this pipe, maintaining the original stratigraphy as much as possible. Strict attention was paid to prevent incorporation of surficial tailings material in the backfill in the saturated zones of the holes. The well pipe was installed in the center of the 4-inch pipe, and the annular fill materials (sand, bentonite, cement) were poured in the annular space between the 4-inch PVC pipe and the well pipe. The 4-inch pipe was gradually withdrawn from the ground as the annulus filled with material. Thus, the well was essentially finished with a 4-inch-wide "drill" annulus, but there was a larger area (in some wells as much as 1 foot in diameter) of disturbance around the saturated zone of the hole.

Wells were developed by repeatedly surging and pumping until the water was visually clear [turbidity approximately less than 10 nephelometric turbidity units (NTU)]. More than 10 casing volumes of water were removed from each well. In one well (AWT4–5), the water was never clear because of residual turbidity (turbidity less than 50 NTU).

Ground-water samples were collected from 20 wells during late October 1995 and in early May, June, July, and September 1996 (fig. 3). Ground-water samples were collected after purging at least three well volumes of water using a peristaltic pump and after temperature, pH, specific conductance, and dissolved-oxygen values had stabilized. Each well was equipped with a dedicated 0.125-inch polyethylene tube that extended to the bottom of the well. At each well and during each sampling trip, clean tubing was used to connect the 0.125-inch well tube to the peristaltic pump. Values of temperature, pH, specific conductance, and dissolved oxygen were determined using a multiparameter probe that was installed in a flow-through cell at the well head, downstream from the peristaltic pump. Following initial well purging, the flow-through cell and probe were removed, the pump tubing was attached directly to the 0.125-inch polyethylene tubing in the well, and water was collected at the outflow from the peristaltic pump. Two 125-mL aliquots of unfiltered water were collected directly from the pump-outflow tube for analysis of unfiltered trace metals and for sample archive. Some sample water then was collected into a stainless steel filtering vessel equipped with a 0.45-μm glass filter, and 125-mL of filtered sample was collected for analysis of dissolved organic carbon. Two to four additional liters of water were collected and immediately transported to the field laboratory where aliquots were collected and filtered as described in the "Surface Water" section. Samples for metal analysis were acidified to pH less than 2 by using ultrapure nitric acid. Methods of analysis of ground-water samples are described in Appendix 1.

The water level in the wells was measured weekly from late April through September 1996. Measurements were made using a tape and chalk or an electric tape. The vertical distance measured was that between a surveyed reference elevation on the well casing and the water level in the well. Measurements were repeated until two identical readings were obtained. This reading was recorded and subtracted from the reference elevation to yield water-table elevation in feet above sea level. Data are in Appendix 3.

Quality-Assurance/Quality-Control Procedures

Quality-assurance/quality-control (QA/QC) procedures included adequate cleaning and rinsing of all equipment that contacted sample water; collection and analysis of field-equipment blank samples to assess the effectiveness of the cleaning procedures and to identify any sources of contamination during sampling; collection of sequential replicates to assess short-term variability of water quality and variability introduced by sampling procedures in surface- and ground-water samples; and analysis of standards, standard reference samples, and replicates to assess analytical quality for all analyses completed during the project. Details of QA/QC procedures and results are presented in Appendix 4. In addition, Appendix 4 contains a detailed discussion of how QA/QC samples were used to determine reporting limits for the constituents analyzed using ICP-AES.

EFFECTS OF FLUVIAL TAILINGS

The effects of fluvial tailings were determined by examining (1) soil composition and water quality in the 3-mile reach, (2) instantaneous mass loads in surface water, and (3) ground-water quality in a detailed study area within the 3-mile reach. The results indicate varying effects of fluvial tailings deposits in soils, surface water, and shallow ground water.

Soils

Results from elemental analyses of soil samples are listed in table 2. Mean concentrations are compared to background samples for the 3-mile reach and to published mean concentrations for soils in the Western United States in table 3. The results indicate that potentially large amounts of metal are stored in the flood-plain sediments within the 3-mile reach. For instance, the maximum concentrations of lead (sample TYS10) and zinc (sample TYS14) are 6,500 and 12,000 milligrams per kilogram (mg/kg), respectively (table 2). These concentrations are 380 times (lead) and 220 times (zinc) the mean concentrations reported for soils in the Western United States (table 3). In addition, these maximum concentrations are 34 times (lead) and 67 times (zinc) the mean concentrations from background samples collected within the 3-mile reach. Similar results were obtained for arsenic, cadmium, copper, mercury, and silver. Enriched concentrations of these elements generally are associated with metal-rich geologic areas, or mining operations, or both. These data indicate potentially significant trace-element enrichment in some of the sediments contained in the flood plain within the 3-mile reach. The samples were collected from areas that, on the basis of color and surface characteristics, appeared to contain elevated concentrations of trace elements. Therefore, the mean concentrations for any element reported in table 3 probably are greater than the mean concentration for the entire 3-mile reach.

The results of the XRD analyses indicate the presence of pyrite (table 4) and its weathering products (coquimbite and copiapite, table 4) in some samples in the 3-mile reach. These findings indicate that acid-rock drainage probably is present within the 3-mile reach.

Surface-Water Quality in the 3-Mile Reach, 1992

Results of two complete water analyses (sites TYW8 and TYW12) for samples collected from the 3-mile reach in 1992 indicate that both samples exceeded USEPA drinking-water standards only for manganese, and one sample exceeded some aquatic-life criteria for cadmium and zinc (U.S. Environmental Protection Agency, 1990a, b, 1986) (table 5). For the samples analyzed for field properties only, one sample had an acidic pH (TYW5, pH = 4.74, table 6). This sample was collected from an orange-colored seep emanating from the bank of one of the distributary channels within the 3-mile reach. The discharge of water from the seep was very small compared to the discharge of the receiving channel, so the acidity did not cause a significant decrease in pH downstream.

The results from soil samples collected from the 3-mile reach in 1992 (tables 2 and 3) indicate that high concentrations of several metals exist in the soils, and results from only two water samples indicate that only small amounts of metal exit the 3-mile reach during low-flow conditions (September). Potential implications of these results are that, during low flow, metals in soils are relatively stable, and the river is minimally affected as it flows through the 3-mile reach. However, during floods (high discharge) and possibly during storms, dissolved metals and metal-rich sediment could be transferred from the 3-mile reach to the river. The presence of pyrite and its weathering products coquimbite and copiapite (table 4) indicate that acid-rock drainage probably is present on the 3-mile reach. In addition, comparison of the topographic map (completed in 1969) with 1981 aerial photographs and with conditions during sampling (1992) indicates that the position of the Arkansas River channel has shifted through time throughout the length of the study area. When the river channel changes position, it erodes sediments from the flood plain. Through this process, sediments in the flood plain are transported into the river. These sediments are redeposited in the flood plain within the 3-mile reach or farther downstream. The magnitude of the effect of this process on water quality is not known.

Instantaneous Mass Loads of Selected Constituents in Streamflow, 1995–96

Instantaneous mass loads (*M*) are the product of streamflow discharge (*Q*), element concentration (*C*), and a conversion factor (*f*) such that:

$$Q \times C \times f = M$$

Table 2. Concentrations of selected elements for soil samples collected from the 3-mile reach

[Concentration values in bold are the maximum for that element; mg/kg, milligrams per kilogram; <, less than]

Element (concentration units)	Samples						
	TYS1[a]	TYS2	TYS3	TYS4	TYS5	TYS6	TYS7
Iron (percent)	1.9	4.7	13	5.7	7.1	5.8	9.8
Arsenic (mg/kg)	10	140	280	120	120	120	200
Cadmium (mg/kg)	5	27	38	7	32	9	60
Chromium (mg/kg)	23	27	19	21	48	40	36
Cobalt (mg/kg)	7	4	4	3	8	6	6
Copper (mg/kg)	31	95	110	37	240	130	380
Lead (mg/kg)	180	3,800	6,300	1,500	2,200	2,500	3,000
Manganese (mg/kg)	610	250	190	120	550	370	640
Mercury (mg/kg)	0.07	1.5	**2.5**	0.2	1.6	1.7	2.0
Nickel (mg/kg)	9	4	3	3	11	9	6
Selenium (mg/kg)	0.5	1.0	0.8	0.4	**2.0**	1.6	1.3
Silver (mg/kg)	<2	26	51	11	11	12	18
Zinc (mg/kg)	230	3,800	5,200	1,100	2,700	1,900	7,300

Element (concentration units)	Samples					
	TYS8	TYS9	TYS10	TYS11	TYS13[a]	TYS14
Iron (percent)	10	5.3	11	6	2.6	**30**
Arsenic (mg/kg)	210	85	160	140	10	**440**
Cadmium (mg/kg)	80	9	44	22	<2	**91**
Chromium (mg/kg)	36	41	15	31	**50**	6
Cobalt (mg/kg)	6	7	3	4	**11**	8
Copper (mg/kg)	**390**	75	89	150	34	200
Lead (mg/kg)	3,400	1,300	**6,500**	3,500	200	5,100
Manganese (mg/kg)	**720**	480	140	180	450	210
Mercury (mg/kg)	2.0	1.0	1.2	2.2	0.6	0.5
Nickel (mg/kg)	6	8	2	6	**18**	4
Selenium (mg/kg)	1.0	0.7	0.7	0.5	0.1	0.7
Silver (mg/kg)	19	8	**50**	17	<2	47
Zinc (mg/kg)	8,300	1,600	5,600	3,200	130	**12,000**

[a] Background sample. Sites identified in figure 2.

Table 3. Mean concentrations of selected elements for soil samples collected from the 3-mile reach and mean concentrations of these elements for soils in the Western United States

[mg/kg, milligrams per kilogram; <, less than]

Element (concentration units)	Arkansas River 3-mile reach samples	Arkansas River 3-mile reach, background samples	Western United States[a]
Iron (percent)	9.9	2.3	2.1
Arsenic (mg/kg)	183	10	5.5
Cadmium (mg/kg)	38	3	--
Chromium (mg/kg)	29	37	41
Cobalt (mg/kg)	5	9	7.1
Copper (mg/kg)	172	33	21
Lead (mg/kg)	3,555	190	17
Manganese (mg/kg)	350	530	380
Mercury (mg/kg)	1.49	0.33	0.05
Nickel (mg/kg)	6	13	15
Selenium (mg/kg)	1.0	0.3	0.23
Silver (mg/kg)	25	<2	--
Zinc (mg/kg)	4,791	180	55

[a] Table 2 in Shacklette and Boerngen (1984).

Table 4. Results of X-ray diffraction analyses of soil samples from the 3-mile reach, 1992

[%, percent]

Sample	Type of analysis	Mineralogy
TYO23	Qualitative	Coquimbite ($Fe_2(SO_4)_3 \cdot H_2O$), copiapite ($Fe_{14}O_3(SO_4)_{18} \cdot 63H_2O$), quartz, trace pyrite, and probably sphalerite.
TYO26	Qualitative	Pyrite and possibly sphalerite, quartz, potassium feldspar, plagioclase feldspar, muscovite, kaolinite, amphibole, pyroxene, and possible trace chalcopyrite.
TYO19	Semiquantitative	Quartz (27%), pyrite (15%), potassium feldspar (5%), plagioclase feldspar (6%), kaolinite (5%), plumbojarosite (12%), mica (4%), amorphous material (20–25%).
TYS3	Semiquantitative	Pyrite (80%), quartz (9%), plumbojarosite (3–4%), potassium feldspar (2%), plagioclase feldspar (2%), mica (1–2%), possibly pyrrhotite (1–2%), and possibly some sphalerite in the pyrite value.

Table 5. Water-quality characteristics for two surface-water samples collected from the 3-mile reach in 1992 and drinking-water standards and aquatic-life criteria

[ft^3/s, cubic feet per second; µS/cm, microsiemens per centimeter at 25 degrees Celsius; mg/L, milligrams per liter; µg/L, micrograms per liter; <, less than; --, no data]

Water-quality characteristics (units)	Samples		Drinking-water standards[a]	Aquatic-life criteria[c]
	TYW8	TYW12		
Discharge (ft^3/s)	0.19	0.05	--	--
pH (standard units)	8.1	7.5	6.5–8.5[b]	6.5–9.0
Specific conductance (µS/cm)	225	289	--	--
Hardness (mg/L as $CaCO_3$)	98	140	--	--
Alkalinity (mg/L as $CaCO_3$)	68	131	--	--
Arsenic (µg/L)	<1	<1	50	4[d]
Cadmium (µg/L)	<1	5	5	1[e]
Calcium (mg/L)	25	36	--	--
Chloride (mg/L)	2.5	0.6	250[b]	--
Chromium (µg/L)	<5	<5	100	11[f]
Cobalt (µg/L)	<3	<3	--	--
Copper (µg/L)	<10	<10	1,300 (1,000[b])	4[g]
Fluoride (mg/L)	0.2	0.2	4.0 (2[b])	--
Iron (µg/L)	170	69	300[b]	1,000[h]
Lead (µg/L)	<10	<10	15	12
Magnesium (mg/L)	8.7	12	--	--
Manganese (µg/L)	53	850	50[b]	--
Nickel (µg/L)	<10	<10	--	96
Silica (mg/L)	7.7	10	--	--
Silver (µg/L)	<1	<1	100[b]	0.12
Sodium (mg/L)	4.6	3.1	--	--
Sulfate (mg/L)	43	25	250[b]	--
Zinc (µg/L)	38	1,300	5,000[b]	47

[a] U.S. Environmental Protection Agency (1990a, b) and David Schmidt (U.S. Environmental Protection Agency, written commun., 1992).

[b] Secondary maximum contaminant level. Values without footnote in this column are maximum contaminant or action levels.

[c] Included for comparison. Values are most conservative values reported by U.S. Environmental Protection Agency for various types of freshwater aquatic life unless otherwise noted (U.S. Environmental Protection Agency, 1986).

[d] Value is for arsenic(III).

[e] Value for rainbow trout.

[f] Freshwater 4-day average not to exceed value for chromium(VI). Chronic toxicity for rainbow trout and brook trout = 265 µg/L.

[g] Chronic toxicity for brook trout.

[h] Criterion for freshwater aquatic life.

Table 6. Selected water-quality characteristics for 11 surface-water samples collected from the 3-mile reach, 1992

[µS/cm, microsiemens per centimeter at 25 degrees Celsius]

Water-quality characteristics (units)	Samples										
	TYW1	TYW2	TYW3	TYW4	TYW5	TYW6	TYW7	TYW9	TYW10	TYW11	TYW13
pH (standard units)	8.25	7.46	8.78	7.36	4.74	8.77	7.37	8.40	7.05	8.19	8.11
Specific conductance (µS/cm)	242	245	231	559	272	228	228	231	229	301	292

where Q is in cubic feet per second (ft^3/s); C is concentration of the analyte in an unfiltered sample in milligrams per liter (mg/L); and f is 28.316 liters per cubic foot. Mass load (M) is in units of mass per time and herein is reported as milligrams per second (mg/s) and grams per second (g/s). Comparison of instantaneous mass loads calculated at upstream and downstream sites can show whether addition or loss of a constituent has occurred between the sites. Effects of errors on mass-load comparisons are discussed in the following section. An increase in instantaneous mass load between two sites indicates that there is a source for the element between the two sites. The source may be eroding sediments, tributary inflows, ground-water inflows, or transfer of the element from the streambed to the water column. If there is a decrease in the mass load between two sites, then the element has been removed from the water column between the sites by diversion of surface water from the stream, by a loss of some of the streamflow to ground water, or by transfer of the element to the streambed. Because mass is conserved, a downstream decrease in concentration of an element that is due simply to dilution does not change the mass load. In addition, for the stream reach described in this report, the river is gaining flow so that mass loss to ground water is unlikely.

Zinc is the primary metal of concern because it is present in the stream and the ground water in greater concentrations than other toxic metals (such as copper, lead, and cadmium) and because it is more mobile and, therefore, more persistent in the environment than these other metals. Mass-load results for calcium, iron, lead, and manganese also are presented in the next section. Concentrations of cadmium and copper in the river generally are in the range where there is either high bias or high variability, or both (see Appendix 4). Therefore, instantaneous mass-load calculations made using these concentrations would contain unacceptable amounts of error and are not included in this report.

Arkansas River Sites

Instantaneous mass-load calculations contain at least two sources of variability or error. The first source is variability in sampling and analytical procedures that is approximately quantified in the sequential-replicate sample. The second source is variability in the streamflow-discharge measurement, which is estimated to be as much as 10 percent or more during high flow in the mountainous reaches of the Arkansas River where turbulent flow occurs. These two sources of variability are represented in figures 4–8 in two ways: (1) mass loads calculated using the chemical analysis from sequential-replicate samples and the streamflow discharge are plotted to illustrate variability from sampling and analytical procedures (for example, AR40 replicate, AR65 replicate, AR70 replicate in figs. 4–8), and (2) 10 percent error bars are included on the data for AR40, AR65, and AR70 to indicate variability introduced from the streamflow-discharge measurement. When these two sources of variability are included, the variability in mass-load calculations at a site is greater than the variability between adjacent sites for most sampling dates. On specific dates there are significant load increases that might indicate possible effects from the fluvial tailings deposits, and decreases in loads that are probably caused by instream processes.

The calcium data indicate that instantaneous load increased between sites AR40 and AR65 on May 6, June 3, and September 3, 1996. On April 25 and July 21, the calcium loads increased between sites AR65 and AR70 (fig. 4). The increase in calcium loads moving downstream probably represents addition of the solute to the water column from ground water as the stream gains flow. The only downstream decrease in load occurred on June 12 between sites AR65 and AR70 (fig. 4).

The iron data indicate increases in load moving downstream between sites AR40 and AR65 on May 6 and June 3, and between sites AR65 and AR70 on April 25 and May 6 (fig. 5). Therefore, there is addition of iron to the stream on April 25, May 6, and June 3 that might be caused by the fluvial tailings deposits. On September 3, iron loads decreased between sites AR40 and AR70. This decrease in load may indicate a loss of iron to the streambed due to the formation and settling of iron oxyhydroxide precipitates.

The lead data indicate downstream increases in load between sites AR40 and AR65 on May 6 and between sites AR65 and AR70 on May 6 and May 16 (fig. 6). These load increases probably were caused by addition of lead to the stream from the fluvial tailings deposits.

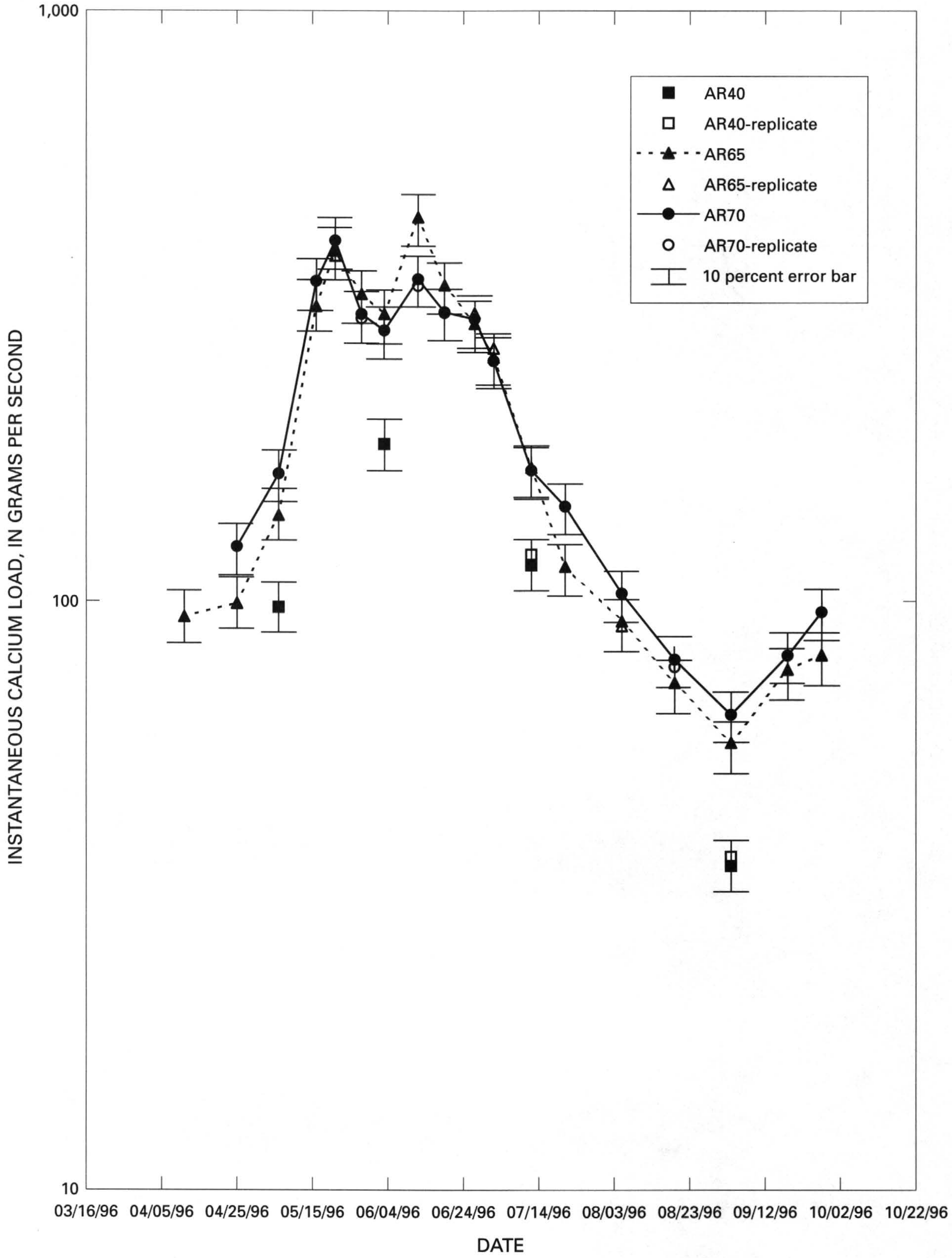

Figure 4. Instantaneous mass-loading results for unfiltered calcium at sites AR40, AR65, and AR70 during 1996. Suffix replicate indicates sequential-replicate sample.

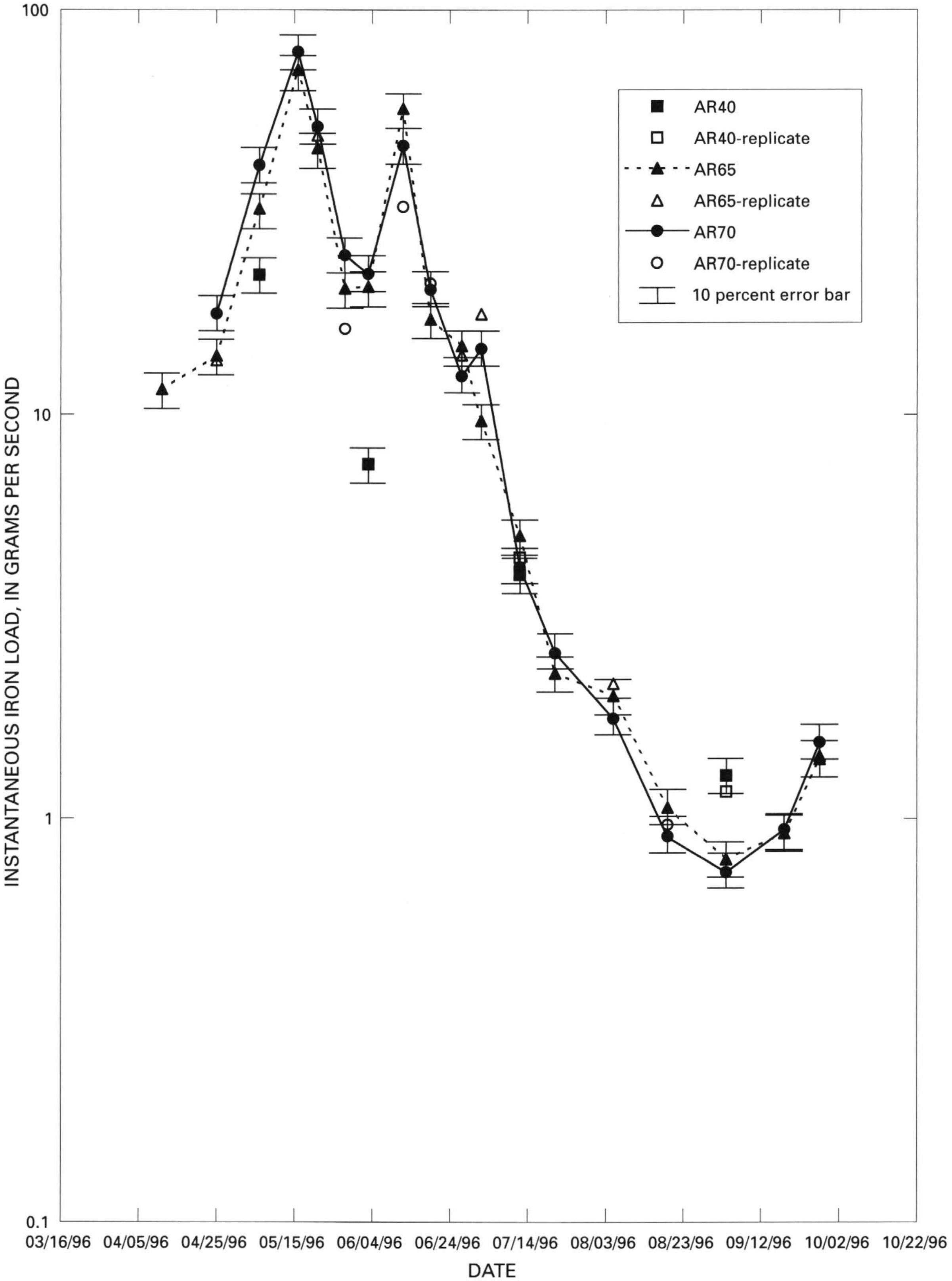

Figure 5. Instantaneous mass-loading results for unfiltered iron at sites AR40, AR65, and AR70 during 1996. Suffix replicate indicates sequential-replicate sample.

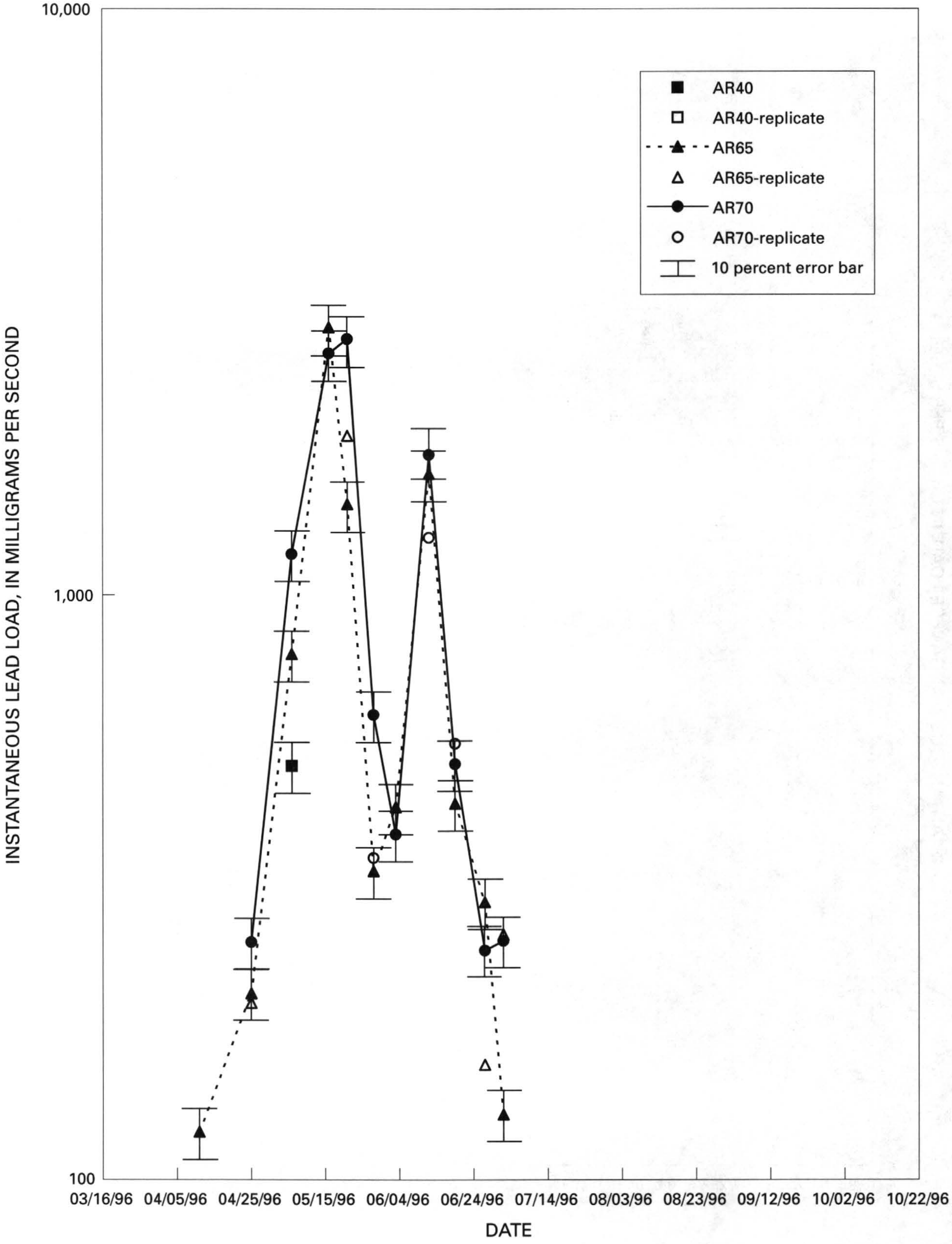

Figure 6. Instantaneous mass-loading results for unfiltered lead at sites AR40, AR65, and AR70 during 1996. Suffix replicate indicates sequential-replicate sample.

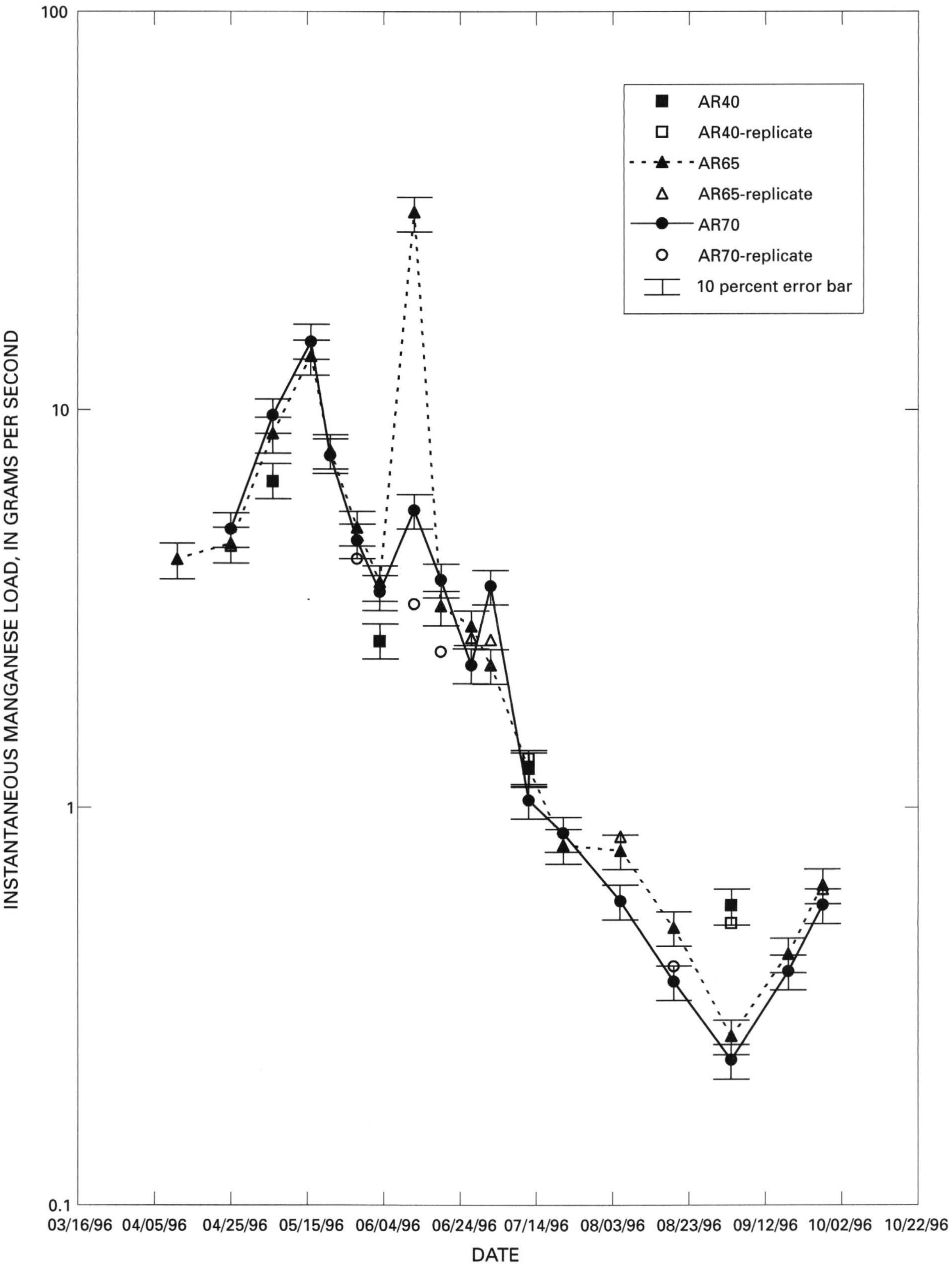

Figure 7. Instantaneous mass-loading results for unfiltered manganese at sites AR40, AR65, and AR70 during 1996. Suffix replicate indicates sequential-replicate sample.

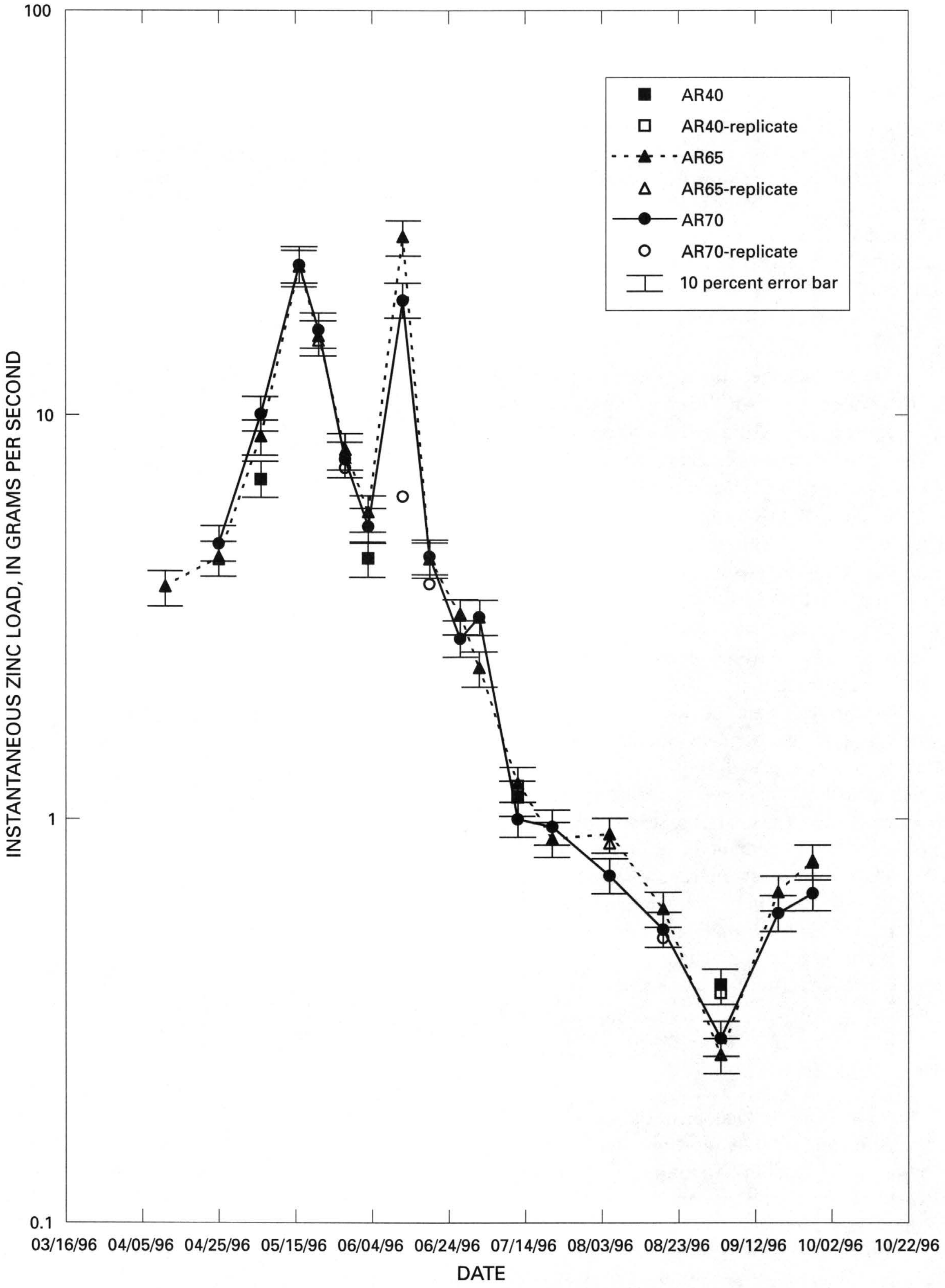

Figure 8. Instantaneous mass-loading results for unfiltered zinc at sites AR40, AR65, and AR70 during 1996. Suffix replicate indicates sequential-replicate sample.

The manganese data indicate downstream increases in load between sites AR40 and AR65 on May 6 and June 3, and between sites AR65 and AR70 on July 2 (fig. 7). Manganese loads decreased moving downstream between sites AR40 and AR65 on September 3 and between sites AR65 and AR70 on June 12, August 5, and August 19 (fig. 7). The increases in manganese load probably were from the fluvial tailings deposits. The decreases in manganese load during lower flow conditions probably were from the formation and settling of manganese oxides.

The zinc data indicate a downstream increase in zinc loads between sites AR40 and AR65 on May 6 and between sites AR65 and AR70 on July 2 (fig. 8). There were decreases in zinc loads between sites AR40 and AR65 on September 3, and between AR65 and AR70 on August 5 (fig. 8). The increase in zinc loads was due to additions of zinc to the stream from the fluvial tailings deposits. The downstream loss of zinc may be due to sorption or coprecipitation of zinc with iron or manganese precipitates.

In summary, for a few specific dates and stream reaches, there is evidence that, during snowmelt runoff, mass loads increase in the downstream direction for iron, lead, manganese, and zinc. In addition, on at least one sampling date during low flow, there is evidence that mass loads decrease downstream for all of these elements except lead. These seasonal trends could be explained by erosion and entrainment of particulate matter in these stream reaches during high flow compared to deposition of sediment and formation of iron and manganese mineral precipitates during low flow. However, most of the data contain too much variability to ascertain differences in stream loads between sites.

Distributary Sites

Comparison of instantaneous mass loads of unfiltered trace metals for the inflow and outflow of the distributary that flows through the study site should indicate whether the tailings are contributing these metals to the stream by way of surface water. Iron, manganese, and zinc loads increased at the distributary outflow relative to the inflow on October 26, 1995, and iron, lead, manganese, and zinc loads increased on May 10, 1996 (table 7). However, these load increases are orders of magnitude less than loads in the river at comparable times and, therefore, would not contribute measurably to the load in the river.

Implications for Remedial Activities

The results of the instantaneous mass-loading calculations indicate that, for some metals during some periods of snowmelt, loads increase in the downstream direction. For samples on most dates, however, variability in the load calculations was too great to make quantitative conclusions about downstream loading patterns. In addition, results of instantaneous mass-loading calculations for the distributary channel of the Arkansas River that flows through an area containing tailings deposits indicate that these deposits contribute very small amounts of iron, lead, manganese, and zinc to the river during certain times of the year. Moreover, the amounts added are orders of magnitude smaller than the amounts in the river and, thus, would not be measurable in the river by conventional mass-loading techniques. If hundreds of similar distributary channels existed, then detectable quantities of metals might be added to the river by these channels.

On the basis of the available data and the mass-loading calculations, the tailings deposits have only a minimal effect on the metal loads in the river in the study area. However, this study did not address the effect that events such as rainfall and runoff might have on water quality in the river. Studies of rainfall and runoff events in other river systems that contain fluvial tailings deposits have indicated that surface runoff during rainfall events is an important mechanism that transfers metals to the river because of dissolution of soluble efflorescent salts (Nimick and Moore, 1991). In addition, as remediation proceeds at the upstream Superfund site in Leadville, zinc concentrations in the river may decrease. If zinc is being added to the river in surface- or ground-water flow from the fluvial tailings deposits, instantaneous mass-loading studies done in the future might indicate more accurately any effects on the river. In addition, the effect of the fluvial tailings deposits on surface water is only one of several possible environmental effects of the deposits, which could include effects on ground-water quality, sediment quality, vegetation quality and quantity, and biota.

Table 7. Instantaneous loads of iron, lead, manganese, and zinc for distributary channel

[Loads in milligrams per second; inflow load measured at CHIN shown in figure 3; outflow load measured at CHOT–RC and CHOT–LC shown in figure 3; --, no data]

Sampling location (figs. 1 and 3)	October 26, 1995	May 10, 1996[a]	June 7, 1996[b]	July 11, 1996[c]
	Iron			
Instantaneous load at inflow	1	220	566	28
Instantaneous load at outflow	5	249	480	27
Instantaneous load in river at AR70	1,100	41,000	22,000	4,200
	Lead			
Instantaneous load at inflow	0.016	6.4	18.7	--
Instantaneous load at outflow	--	7.6	15.4	--
Instantaneous load in river at AR70	--	1,200	390	--
	Manganese			
Instantaneous load at inflow	0.9	96	70	7
Instantaneous load at outflow	1.6	101	66	8
Instantaneous load in river at AR70	430	9,700	3,500	1,000
	Zinc			
Instantaneous load at inflow	0.4	156	120	6
Instantaneous load at outflow	1.4	158	109	6
Instantaneous load in river at AR70	470	10,000	5,300	1,000

[a] AR70 sampled on May 6, 1996.
[b] AR70 sampled on June 3, 1996.
[c] AR70 sampled on July 12, 1996.

Shallow Ground-Water Quality, 1995–96

The effects of the fluvial tailings deposits on ground-water quality were investigated by installing and monitoring water quality in 20 shallow wells in a 12-acre area that contains abundant tailings deposits (fig. 3). Water-quality samples were collected in October 1995 and early in May, June, July, and September of 1996 (hereinafter referred to as the five sampling periods). The results presented herein are for shallow ground water; the study did not examine the depth to which ground-water contamination might be present in the study area.

Seasonal and Spatial Distribution (Variation) of Selected Water-Quality Characteristics

Contour maps of pH and specific-conductance values, and unfiltered cadmium, copper, iron, lead, manganese, and zinc concentrations for all five sampling periods (figs. 9–16) indicate that ground-water quality is locally degraded. As shown in figures 9–16, shallow ground water in the study area in some wells (particularly wells AWT1–3, AWT2–4, AWT2–5, AWT3–4, and AWT3–5; fig. 3) has low pH, high specific conductance, and high concentrations of trace metals in unfiltered samples compared to other wells at the study site. These results indicate that ground-water quality has been degraded from chemical weathering (acid-rock drainage) of the tailings deposits. In addition, concentrations of cadmium (fig. 11) and zinc (fig. 16) in well AWT4–3 indicate contamination from upgradient tailings sources. Figure 17 depicts the water-table map for June 9, 1996, which indicates that ground water generally flows from north to south. Maps constructed for other ground-water sampling periods indicated different positions of the water-level contours but showed the same general configuration of the water table.

Seasonal variations in values of pH and specific conductance and in concentrations of unfiltered cadmium, copper, lead, and zinc indicate that the number of wells affected by, and the areal extent of degraded water quality generally increases from fall to spring (from October 1995 to May and June of 1996) and generally decreases from summer to fall (from June and July to September 1996). These trends are indicated by observing the positions of the contours in bold in figures 11, 12, 14, and 16 and by the data summarized in table 8. This seasonal behavior indicates that a spring flush increases the areal extent of ground water affected by acid-rock drainage. The spring flush is either from increased infiltration through the tailings deposits during the melting of the seasonal snowpack or from upward fluctuation of the ground-water table and capillary fringe into the tailings deposits during spring runoff, or both. Dilution by, and reaction with, cleaner, upgradient water and cessation of the addition of degraded water probably cause the water-quality improvements that occur later in the year.

The water quality in wells located near the river shows different seasonal patterns than water quality in wells located farther from the river. Concentrations of elements actually decrease during spring runoff (June) and increase as flow in the river decreases in July and September. This effect probably is due to an increased size of the hyporheic zone (the area near the river

Table 8. Number of wells with specified contour intervals in figures 9–16

[µS/cm, microsiemens per centimeter at 25 degrees Celsius; mg/L, milligrams per liter; >, greater than]

Sampling date	Number of wells with pH less than or equal to 3 (fig. 9)	Number of wells with specific conductance >1,000 µS/cm (fig. 10)	Number of wells with cadmium >0.050 mg/L (fig. 11)	Number of wells with copper >0.050 mg/L (fig. 12)	Number of wells with iron >10 mg/L (fig. 13)	Number of wells with lead >0.050 mg/L (fig. 14)	Number of wells with manganese >1.0 mg/L (fig. 15)	Number of wells with zinc >5 mg/L (fig. 16)
October 1995	3	1	3	3	5	3	10	3
May 1996	3	3	5	3	4	3	9	5
June 1996	4	3	4	4	4	4	9	5
July 1996	4	3	2	4	4	3	8	3
September 1996	1	1	2	1	5	3	10	2

where ground water mixes with river water) during spring runoff and greater proportions of surface water mixing with shallow ground water at that time. Surface water is more dilute in the spring than ground water, and concentrations of iron and zinc in most wells near the river decreased. Later in the year, there is not as much mixing between surface water and ground water in these wells; that is, the wells contain a higher proportion of ground water in the summer and fall than during spring runoff. Consequently, metal concentrations in these wells are higher in summer (September 1996) and fall (October 1995) than at peak runoff (May, June, and July 1996). These trends are evident in the iron and zinc data for all or some of wells AWT1–1, AWT2–1, AWT2–2, AWT3–1, AWT3–2, and AWT4–1 (figs. 13 and 16, table 10).

Arsenic was present in unfiltered water samples from three wells (AWT1–3, AWT2–4, and AWT2–5) in October 1995, two wells (AWT1–3 and AWT2–5) in May 1996, three wells (AWT1–3, AWT2–5, and AWT4–3) in June 1996, two wells (AWT1–3 and AWT2–5) in July 1996, and three wells (AWT1–3, AWT1–4, and AWT2–5) in September 1996 (Appendix 1, table 10). Concentrations were within the estimated range (see Appendix 4 for discussion of data estimates) for all samples, except well AWT1–3 in October 1995 (arsenic = 0.512 mg/L) and September 1996 (arsenic = 0.111 mg/L). Arsenic concentrations decreased during the spring flush and increased during periods when water levels were low and pH values were at their highest in these wells. Well AWT1–3 had measurable arsenic concentrations during all five sampling trips. During the spring flush, this well showed decreased arsenic and dissolved-oxygen concentrations but no appreciable change in iron speciation (Appendix 1). Data are insufficient to evaluate what processes, such as variations in pH or redox conditions, might be controlling arsenic concentrations.

Comparisons between distributions of element concentrations in unfiltered and filtered (0.1-µm) samples for all five sampling trips, and in ultrafiltered (pore size approximately 0.001 µm) samples for the June 1996 sampling trip (Appendix 1, table 10), indicate that the most striking changes in concentration with filtration occur for iron and lead. In many wells, filtration caused sizeable decreases in concentration, indicating that the metals were resident on large and colloidal particles rather than in the dissolved phase. However, in all but three samples, lead concentrations in wells AWT1–3 and AWT 2–4 remained greater than 0.1 mg/L after ultrafiltration, indicating that lead in these locations is probably dissolved. This observation is consistent with the low pH values measured in these wells.

Relations Between Water Table and Various Chemical Characteristics

Two possible mechanisms that could introduce the products of acid-rock drainage to ground water are infiltration and water-table fluctuation. To assess the relative importance of these processes, well hydrographs and chemographs (time-series plots of various chemical characteristics) were examined (figs. 18–22). The results are mixed for the five wells in the area most definitely affected by acid-rock drainage. In well AWT1–3 (fig. 18), the period of the most degraded water quality precedes the peak in the hydrograph, and in well AWT2–5 (fig. 19), pH and specific conductance are most degraded before the peak in the hydrograph. These trends provide evidence that infiltration causes water-quality degradation in these wells. This interpretation assumes that infiltration would occur before the peak of the hydrograph was reached; snowmelt was complete at the site sometime between April 1 and May 1. This interpretation also assumes that the tailings deposits are at the highest levels in the sediment column. In wells AWT2–4, AWT3–4, and AWT3–5 (figs. 20–22), degraded water quality coincides with the highest levels of the water table (except for some October 1995 data), which supports the hypothesis that ground-water fluctuations up into the tailings deposits cause seasonal degradation in water quality. However, this interpretation is not valid if infiltration is slow at these sites. Well AWT2–5 (fig. 19) shows dilution of iron and zinc during the peak in the hydrograph, which is not consistent with either infiltration or water-table fluctuation as a contamination mechanism. The results of the hydrograph and chemograph analysis shown for the five wells in figures 18–22 generally are inconclusive. More detailed time-series data and more data on the rates of infiltration through the tailings deposits are needed to assess the relative importance of infiltration and water-table fluctuation as mechanisms that introduce low pH, metal-rich water into the ground water. Both mechanisms may occur.

(Text continued on page 45.)

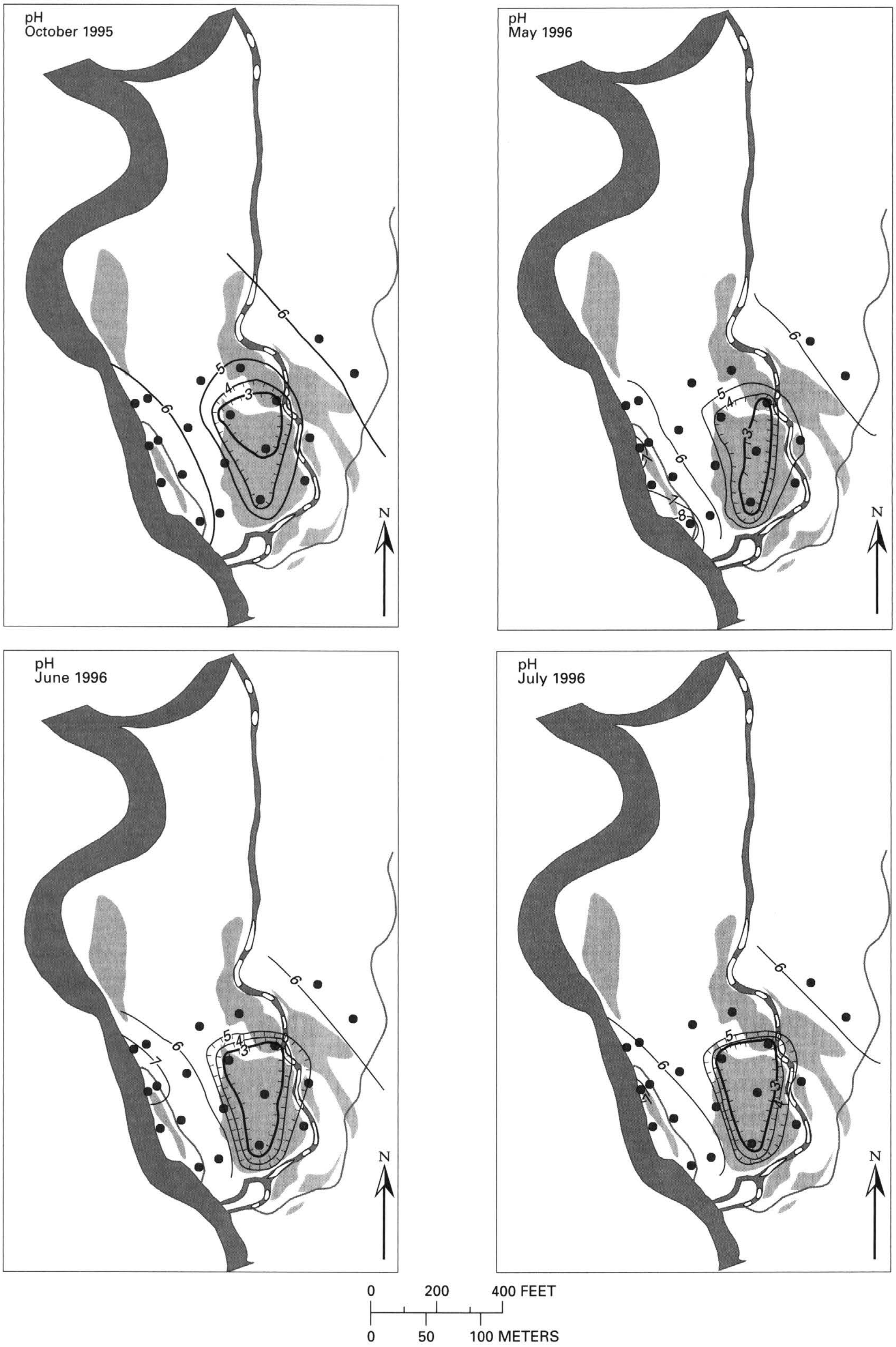

Figure 9. Values of pH of ground water. September contours based on data from wells and ponds. Others based on data from wells.

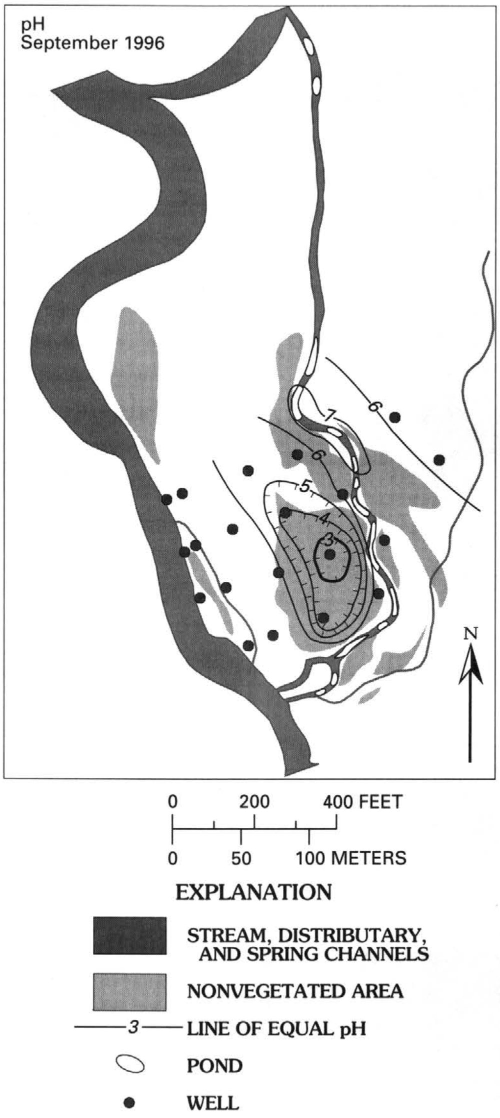

Figure 9. Values of pH of ground water. September contours based on data from wells and ponds. Others based on data from wells—Continued.

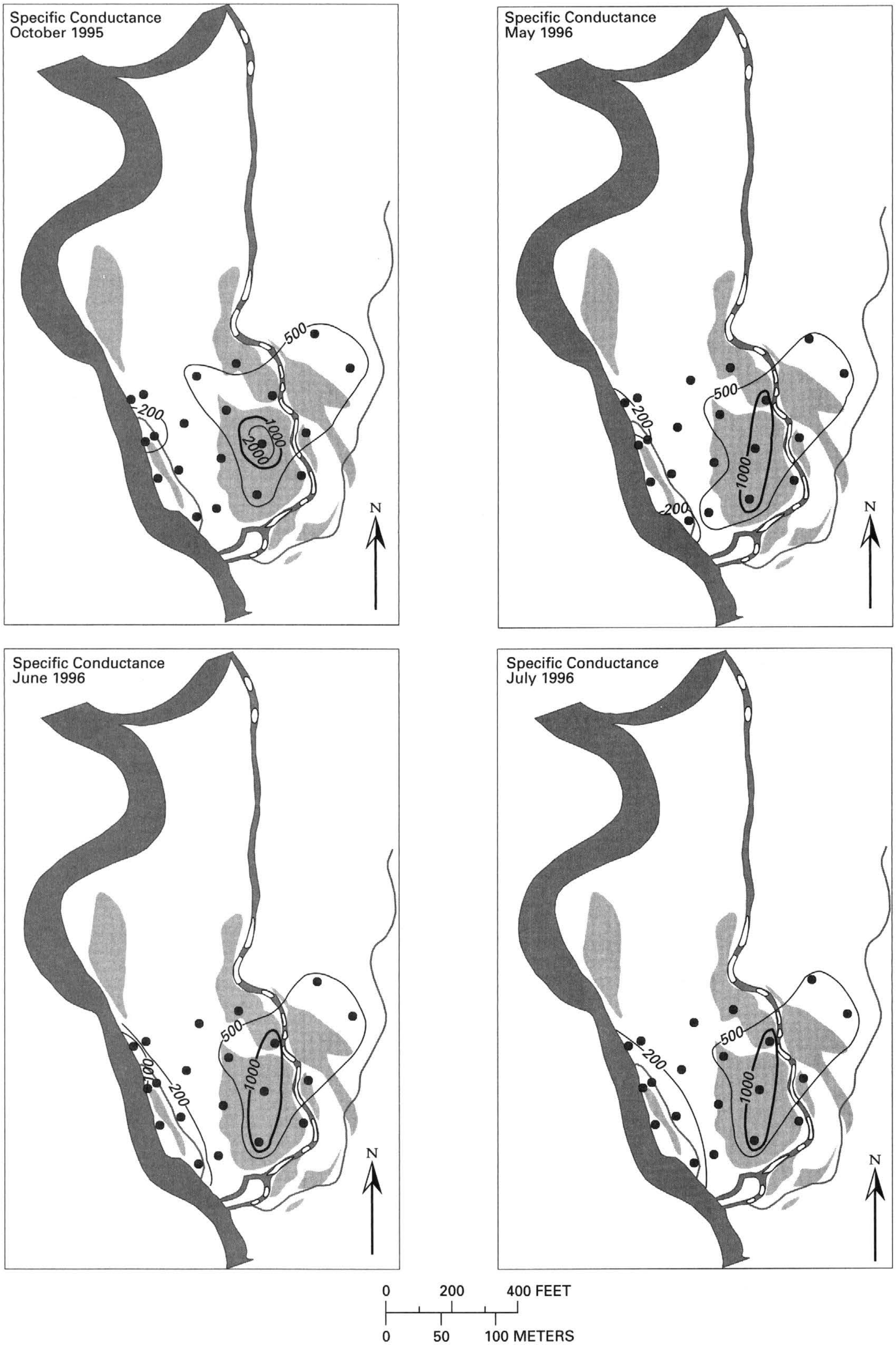

Figure 10. Specific conductance of ground water. September contours based on data from wells and ponds. Others based on data from wells.

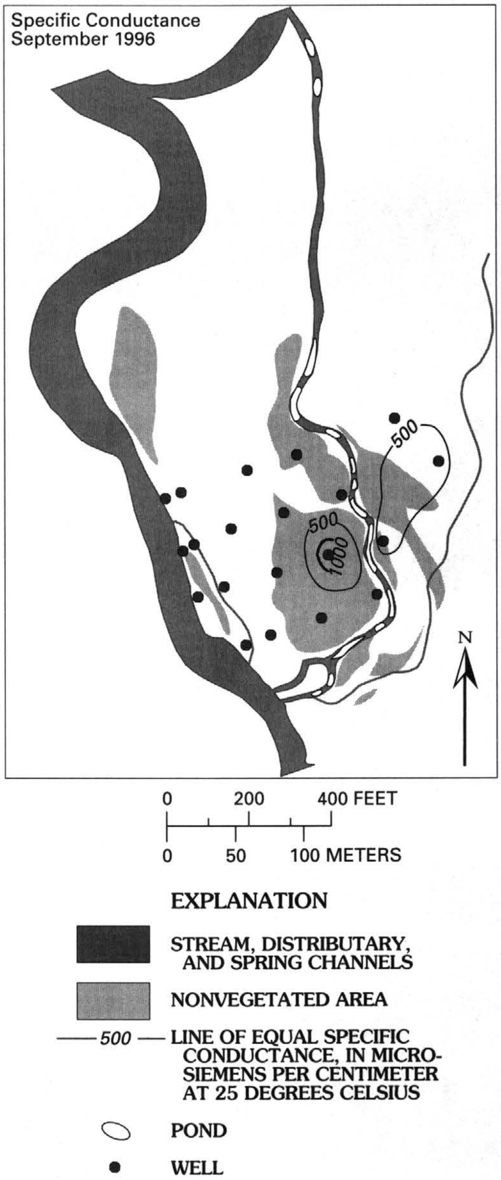

Figure 10. Specific conductance of ground water. September contours based on data from wells and ponds. Others based on data from wells—Continued.

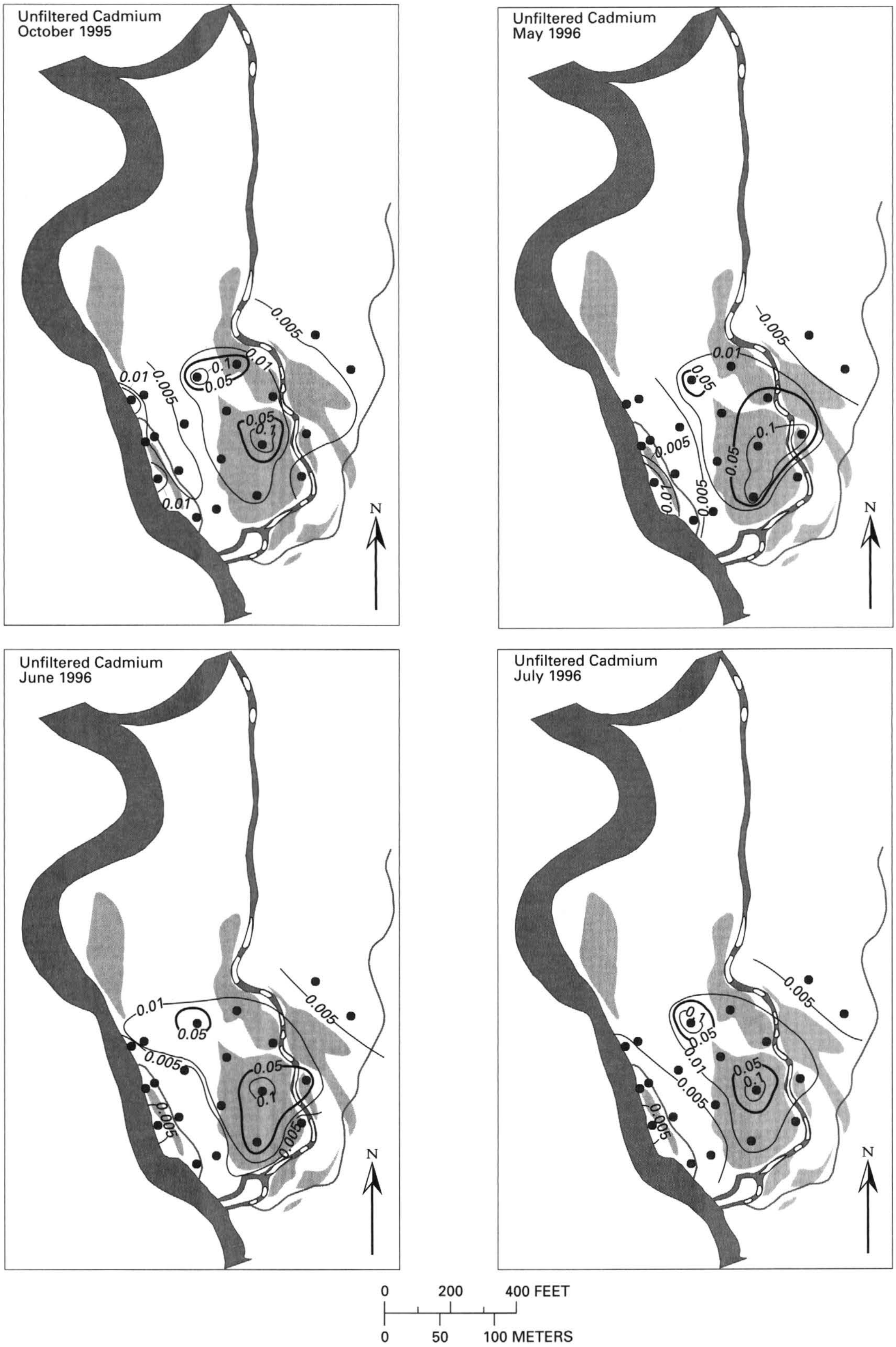

Figure 11. Unfiltered cadmium concentrations of ground water. September contours based on data from wells and ponds. Others based on data from wells.

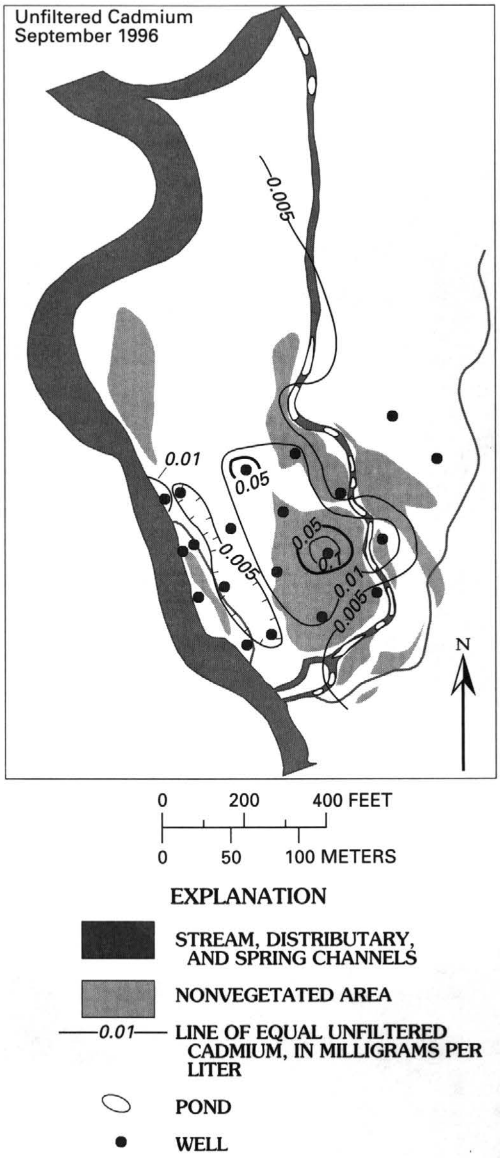

Figure 11. Unfiltered cadmium concentrations of ground water. September contours based on data from wells and ponds. Others based on data from wells—Continued.

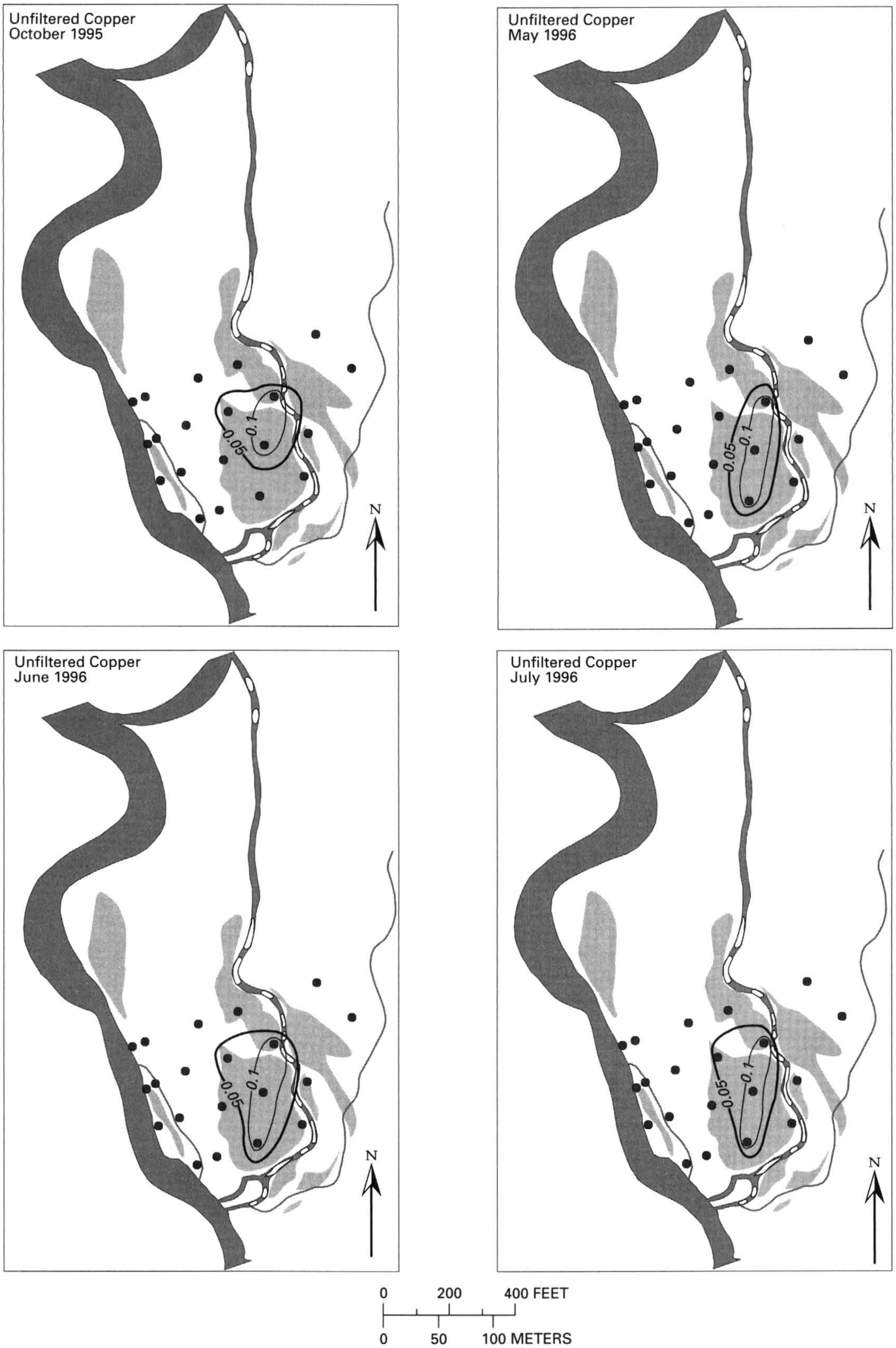

Figure 12. Unfiltered copper concentrations of ground water. September contours based on data from wells and ponds. Others based on data from wells.

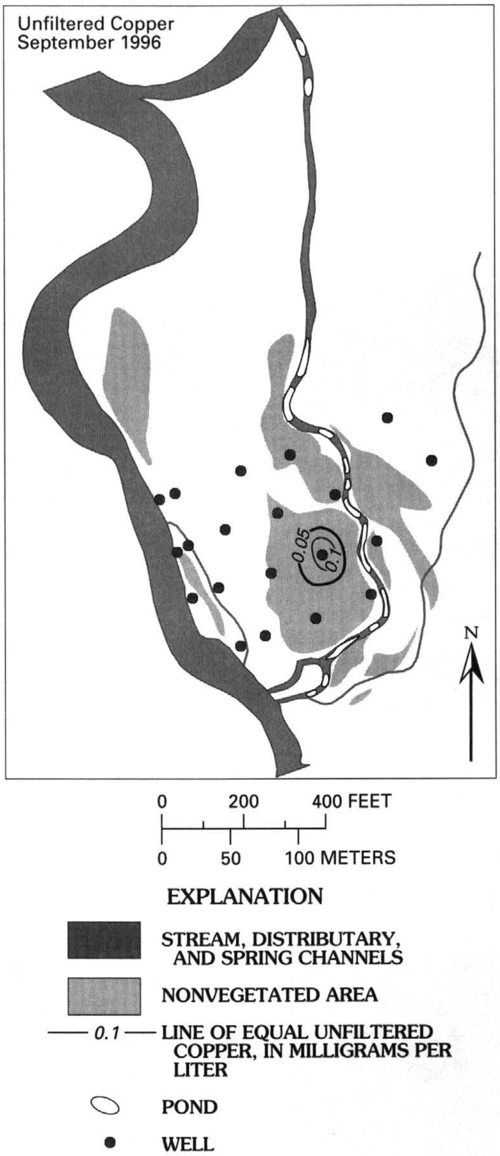

Figure 12. Unfiltered copper concentrations of ground water. September contours based on data from wells and ponds. Others based on data from wells—Continued.

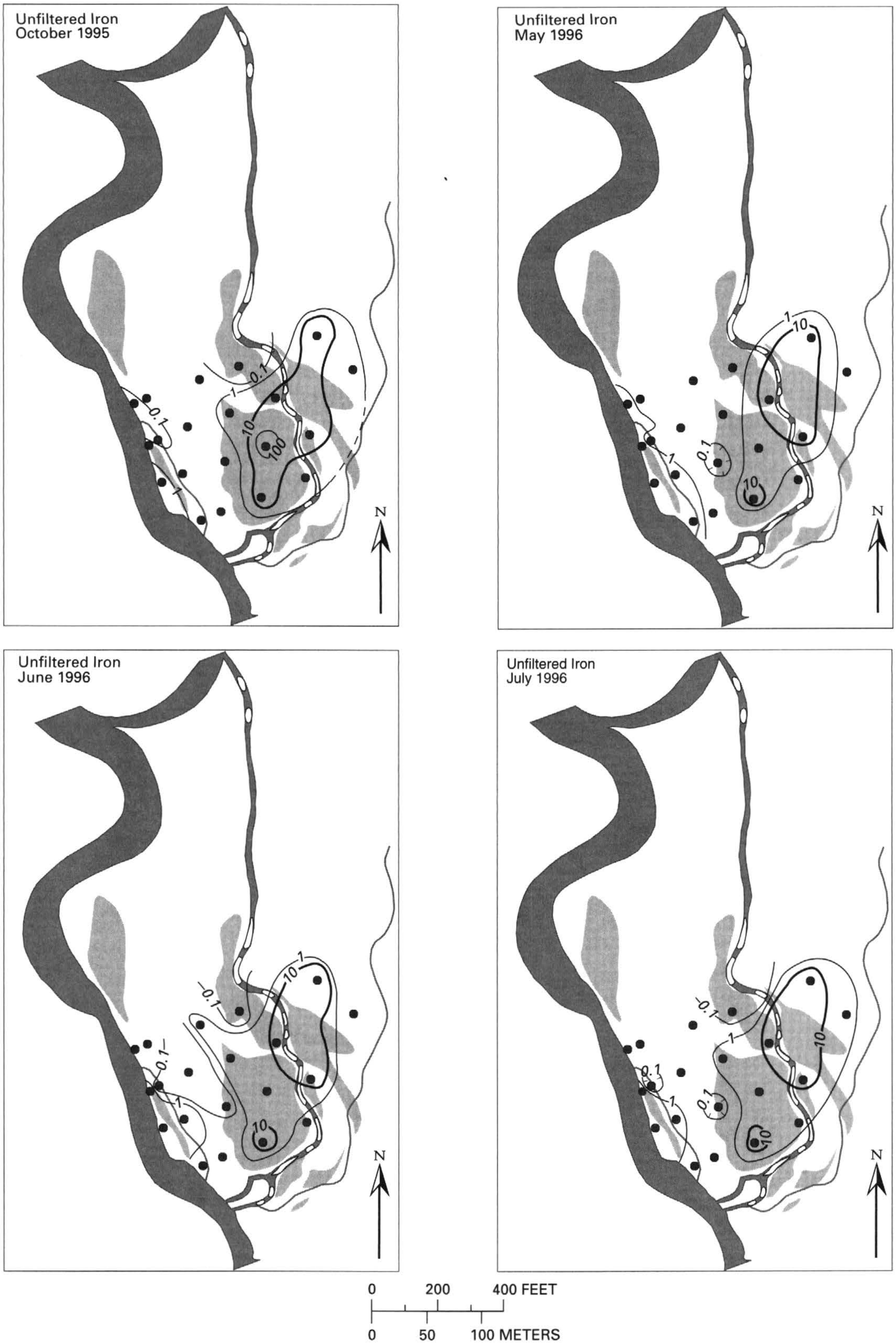

Figure 13. Unfiltered iron concentrations of ground water. September contours based on data from wells and ponds. Others based on data from wells.

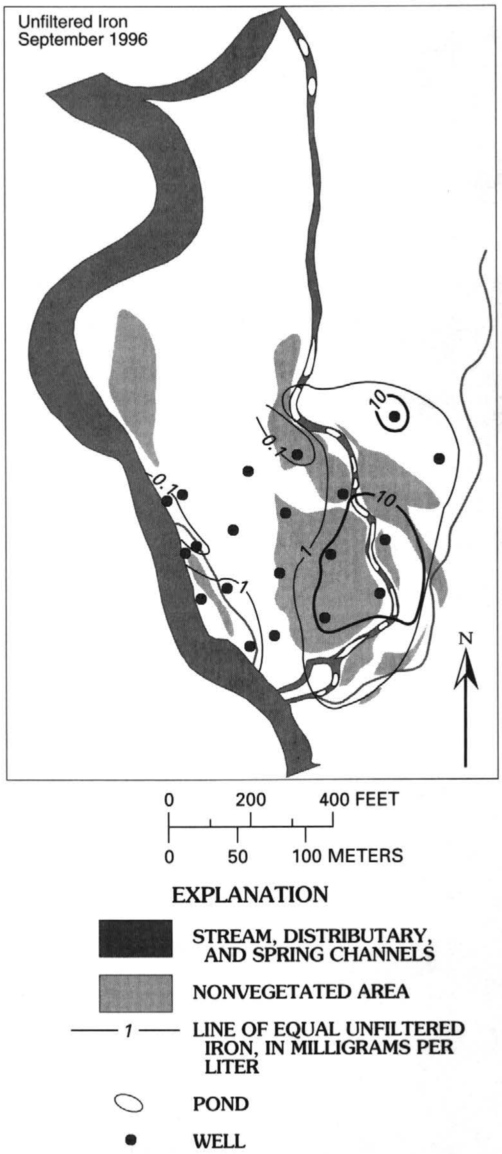

Figure 13. Unfiltered iron concentrations of ground water. September contours based on data from wells and ponds. Others based on data from wells—Continued.

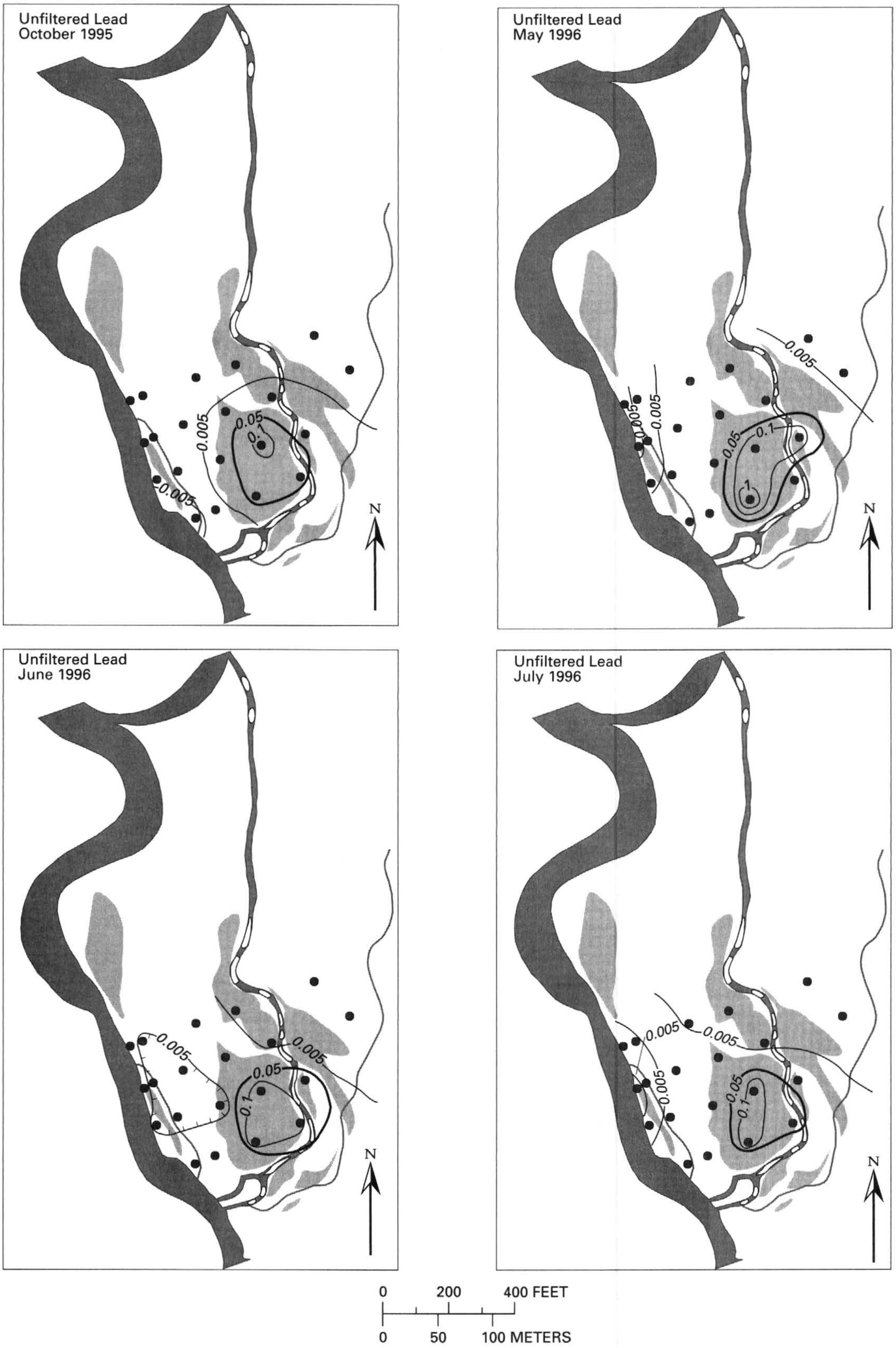

Figure 14. Unfiltered lead concentrations of ground water. September contours based on data from wells and ponds. Others based on data from wells.

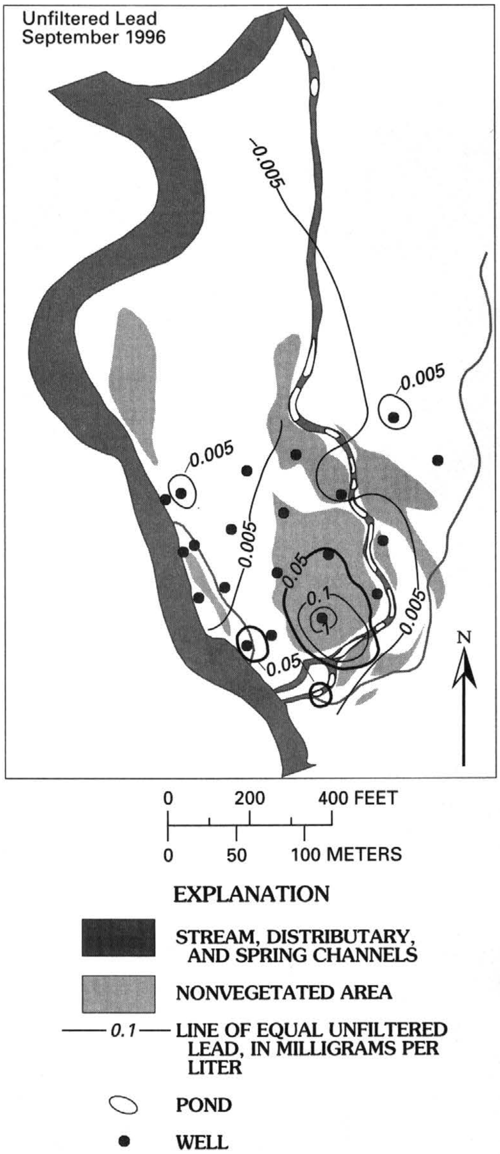

Figure 14. Unfiltered lead concentrations of ground water. September contours based on data from wells and ponds. Others based on data from wells—Continued.

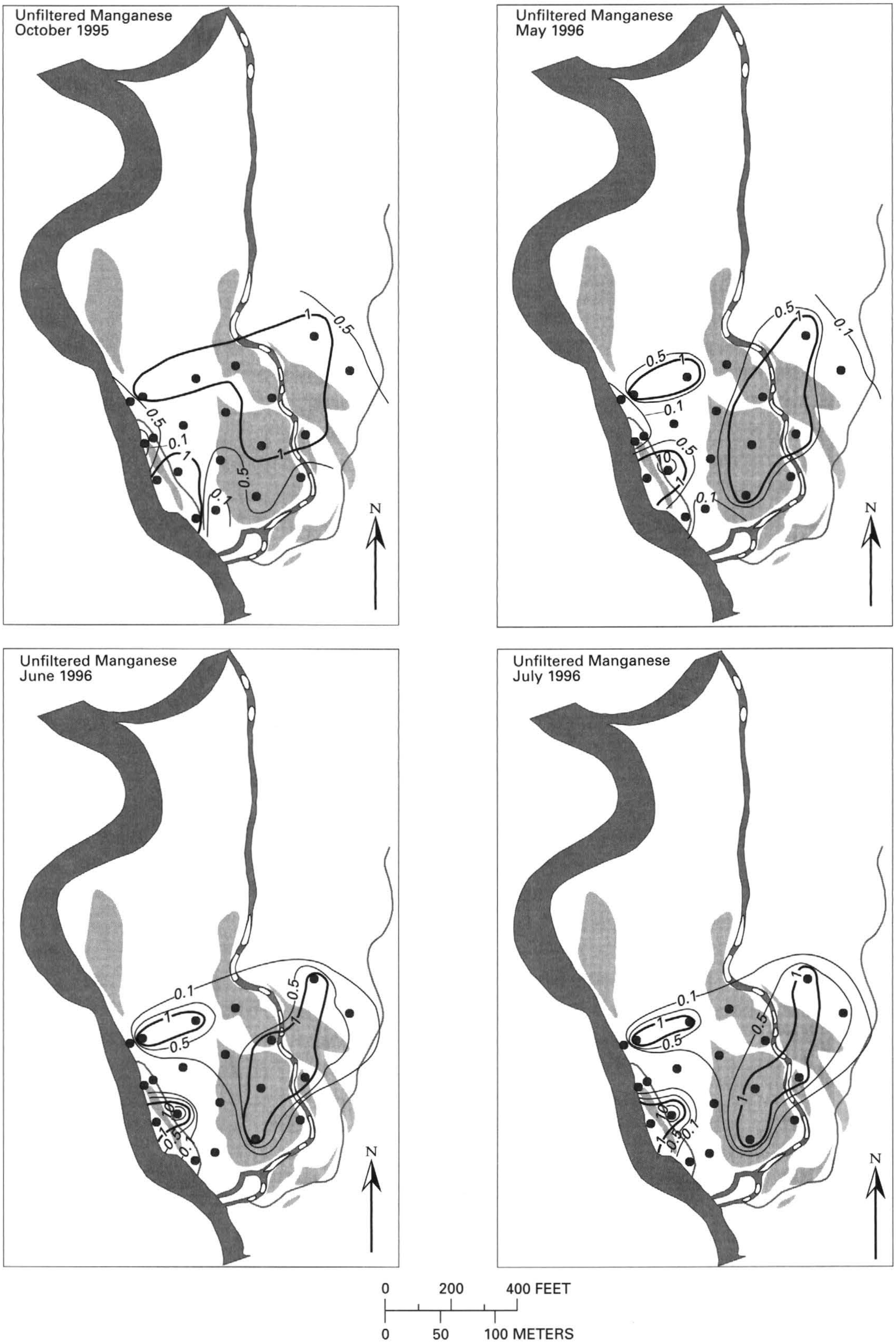

Figure 15. Unfiltered manganese concentrations of ground water. September contours based on data from wells and ponds. Others based on data from wells.

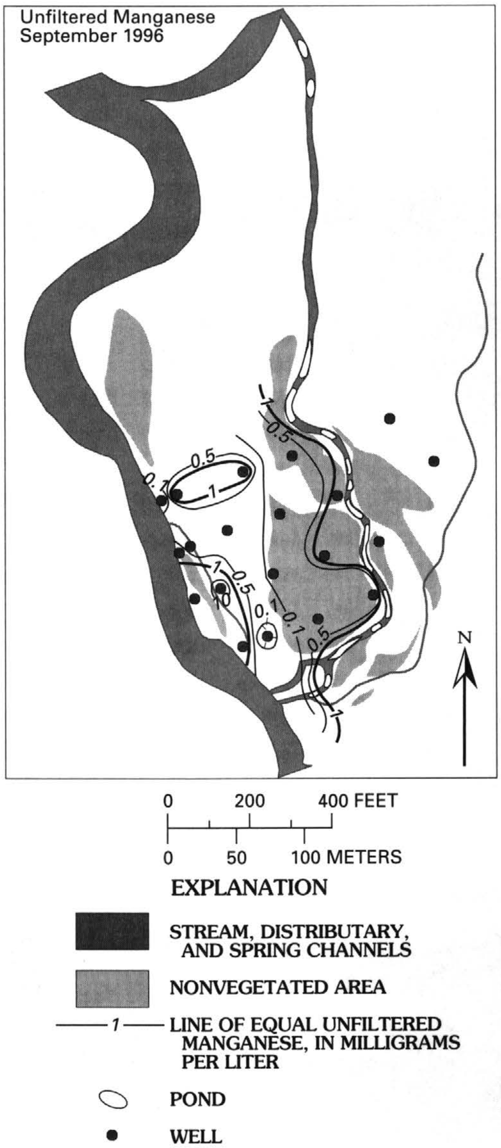

Figure 15. Unfiltered manganese concentrations of ground water. September contours based on data from wells and ponds. Others based on data from wells—Continued.

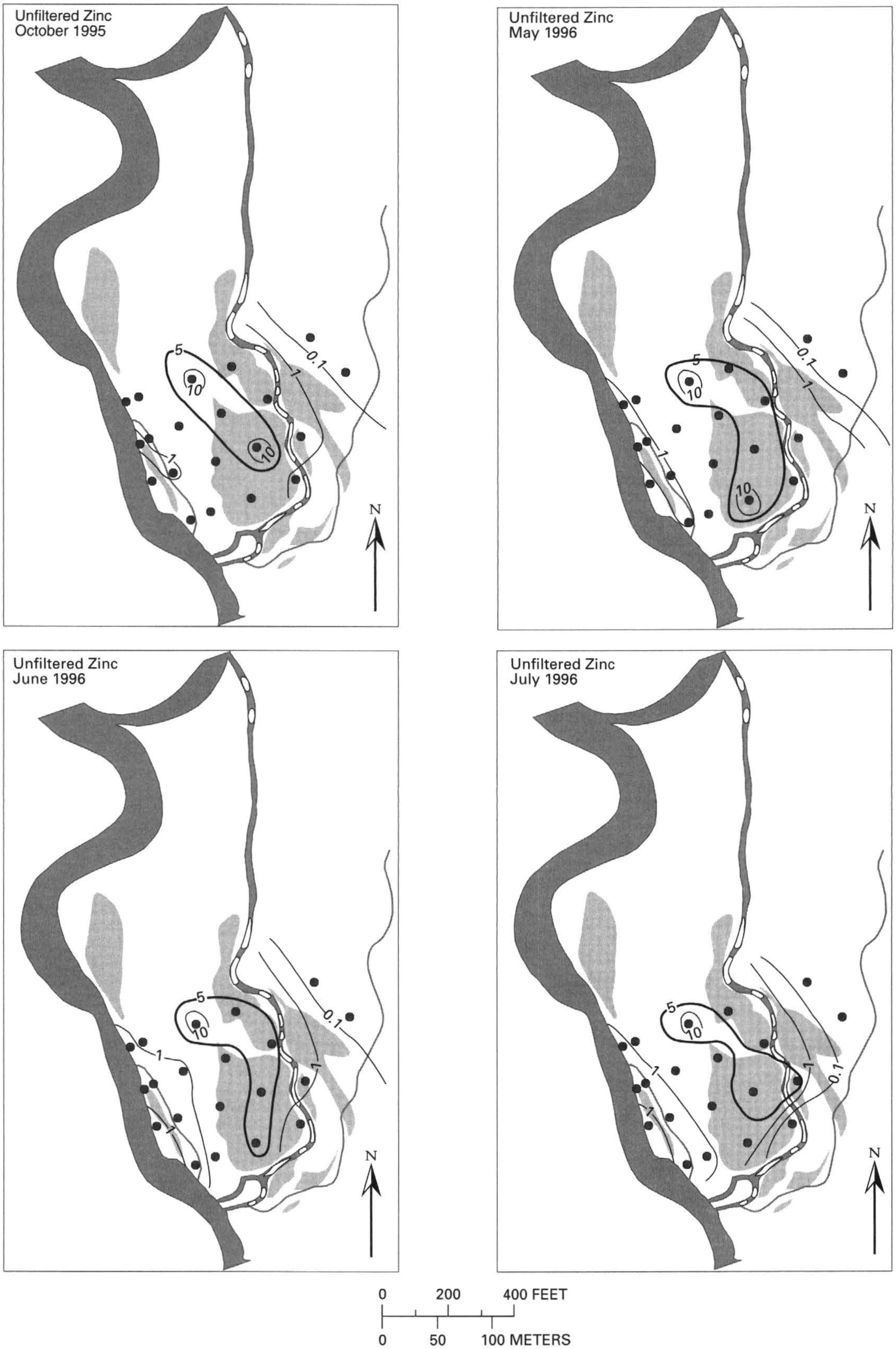

Figure 16. Unfiltered zinc concentrations of ground water. September contours based on data from wells and ponds. Others based on data from wells.

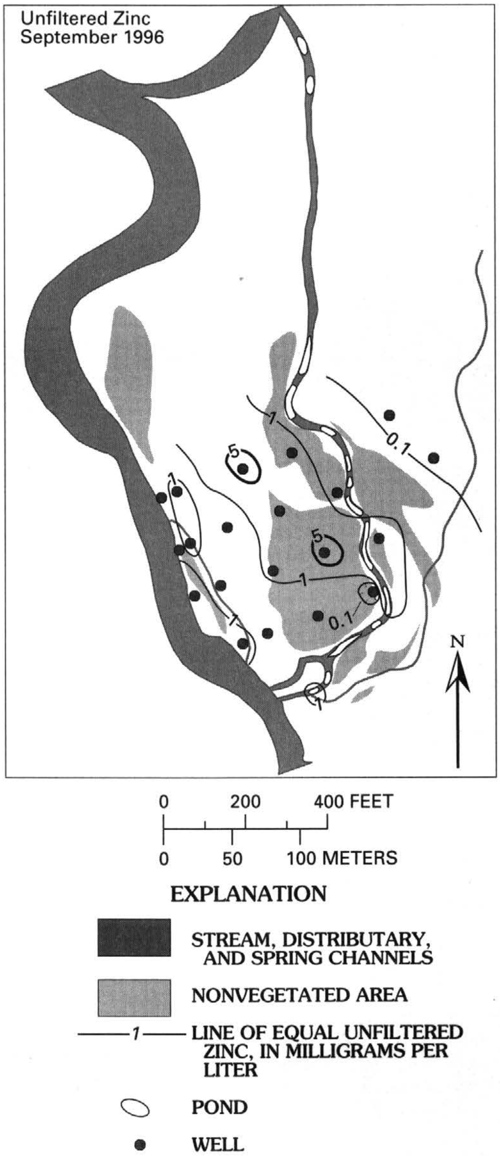

Figure 16. Unfiltered zinc concentrations of ground water. September contours based on data from wells and ponds. Others based on data from wells—Continued.

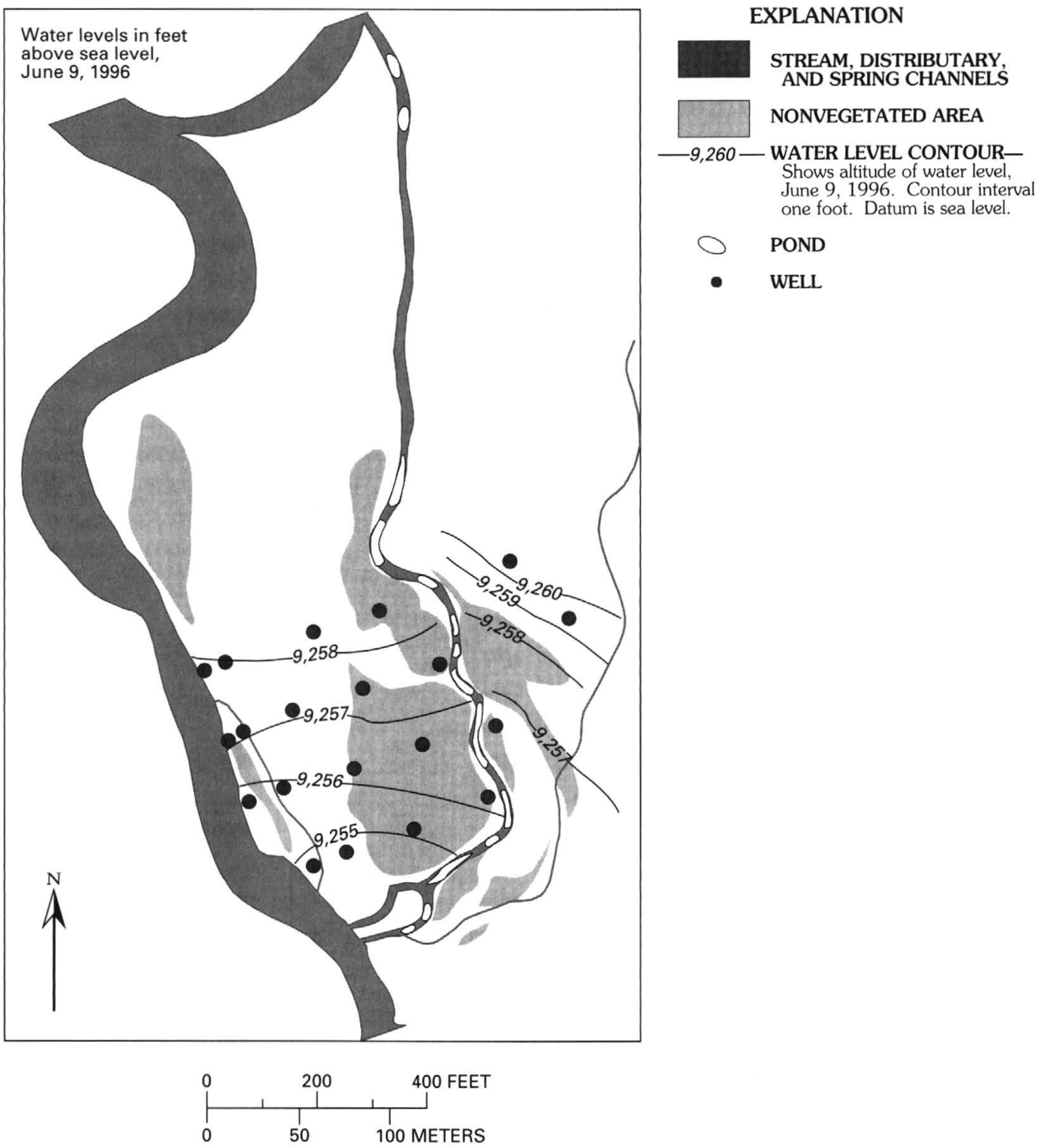

Figure 17. Configuration of the water table on June 9, 1996.

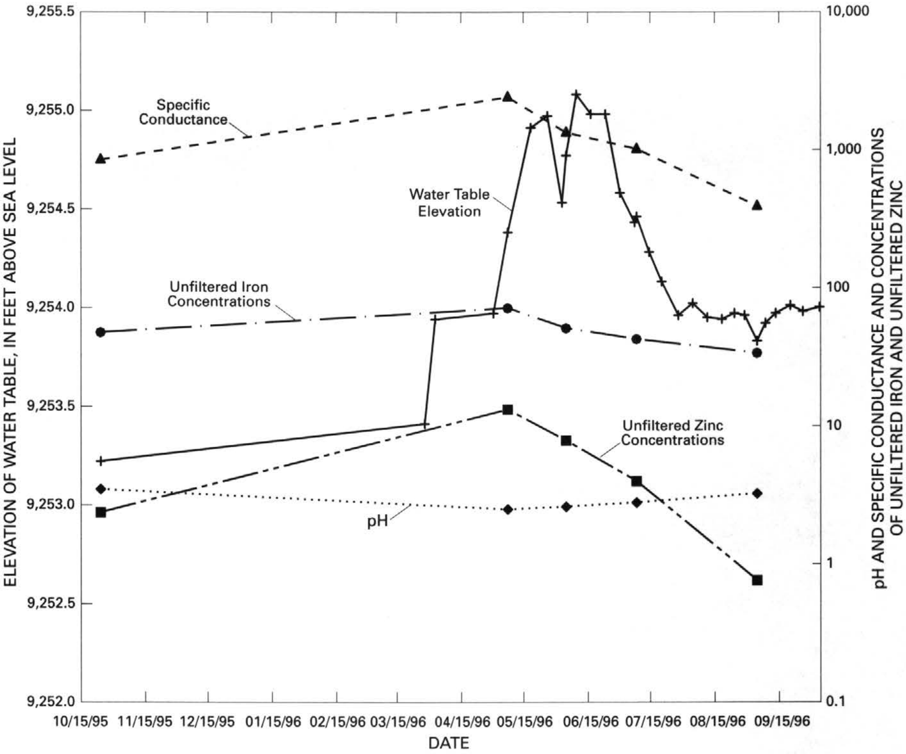

Figure 18. Hydrograph and chemograph for well AWT1–3. Specific conductance in microsiemens per centimeter at 25 degrees Celsius; unfiltered iron and unfiltered zinc concentrations in milligrams per liter.

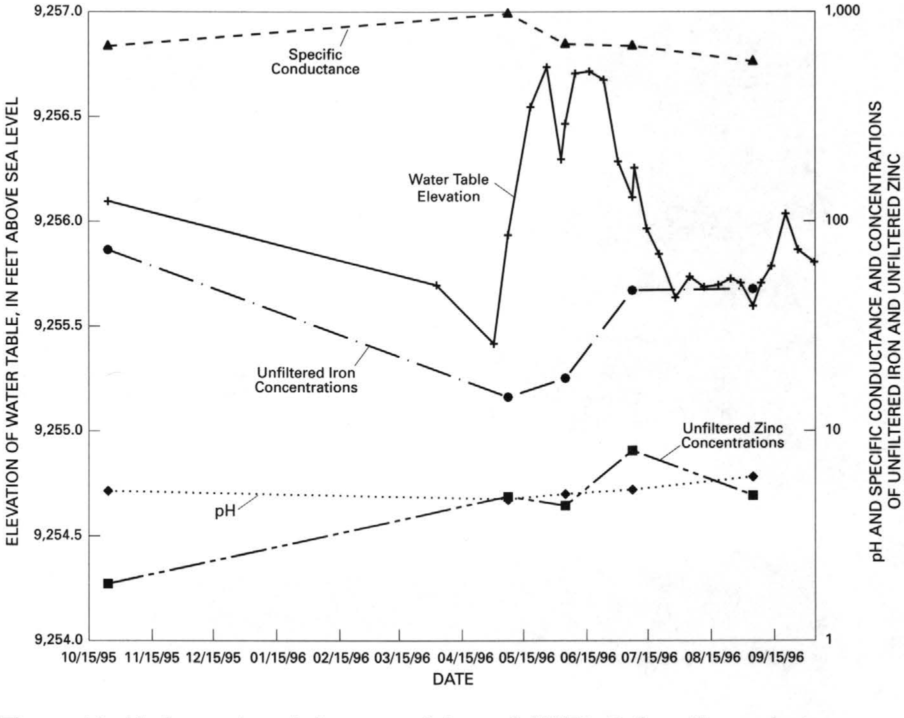

Figure 19. Hydrograph and chemograph for well AWT2–5. Specific conductance in microsiemens per centimeter at 25 degrees Celsius; unfiltered iron and unfiltered zinc concentrations in milligrams per liter.

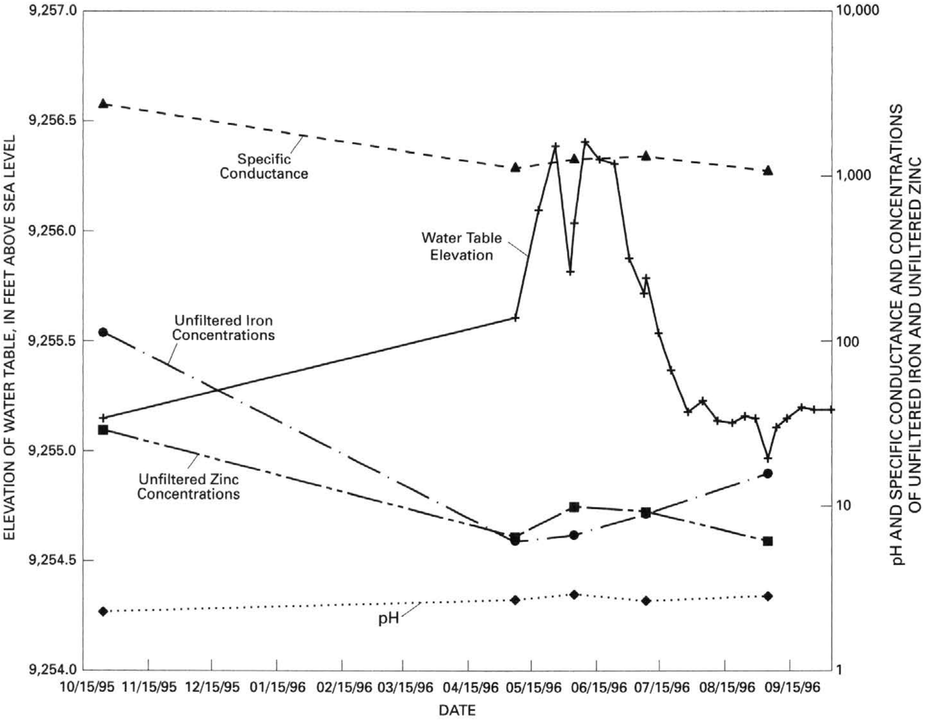

Figure 20. Hydrograph and chemograph for well AWT2–4. Specific conductance in microsiemens per centimeter at 25 degrees Celsius; unfiltered iron and unfiltered zinc concentrations in milligrams per liter.

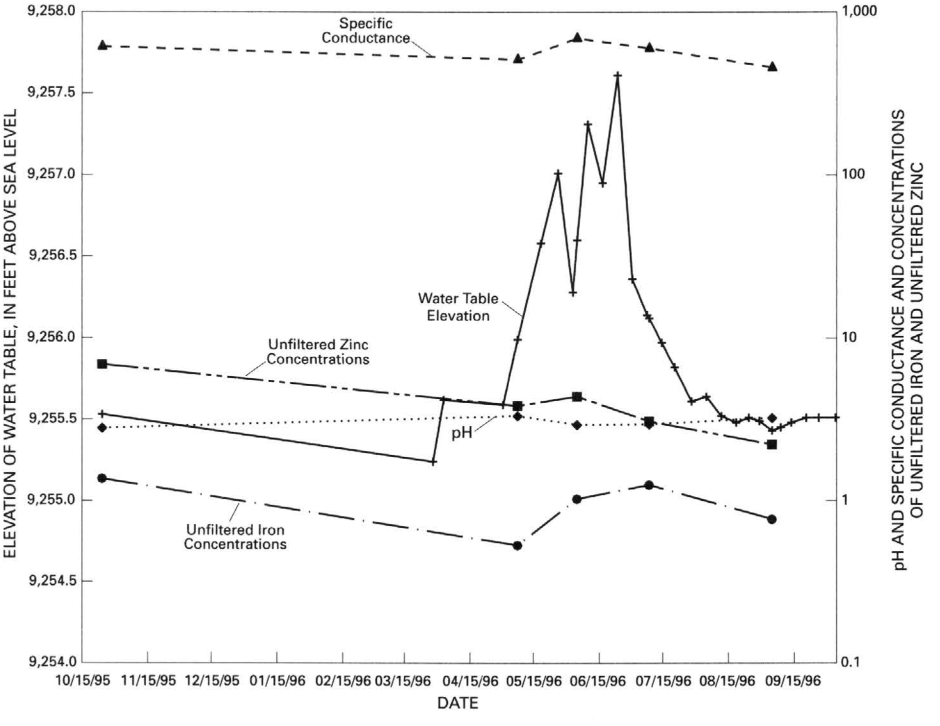

Figure 21. Hydrograph and chemograph for well AWT3–4. Specific conductance in microsiemens per centimeter at 25 degrees Celsius; unfiltered iron and unfiltered zinc concentrations in milligrams per liter.

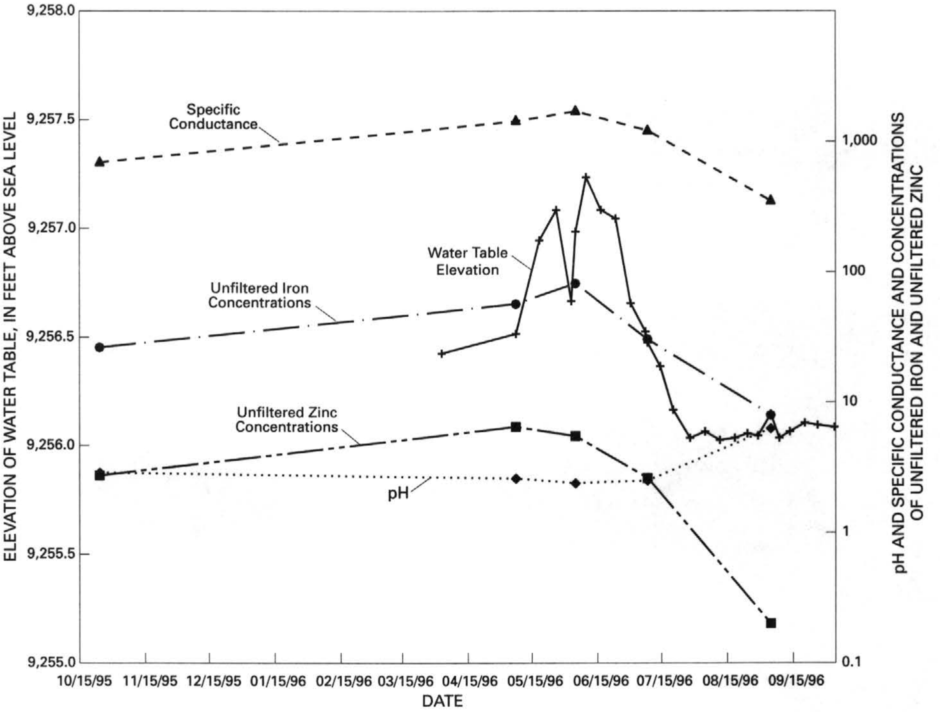

Figure 22. Hydrograph and chemograph for well AWT3–5. Specific conductance in microsiemens per centimeter at 25 degrees Celsius; unfiltered iron and unfiltered zinc concentrations in milligrams per liter.

Delta Deuterium and Delta 18-Oxygen Results and Implications for Source of Water to Wells in Areas Affected by Acid-Rock Drainage

Results for delta deuterium and delta 18-oxygen analyses can be used to distinguish different sources for water in the ground-water system. The ground water in the zone near the river that mixes with river water (the hyporheic zone) should have an isotopic composition similar to the composition of the river, whereas ground water in the most upgradient part of the flood plain should have an isotopically distinct composition similar to the composition of ground water entering the flood plain from the adjacent upland. Mixing of these two water types forms a line on a plot of delta 18-oxygen relative to delta deuterium data that defines the local meteoric water line for the area.

Figure 23 depicts the delta deuterium and delta 18-oxygen data for June and September 1996 for one river site (AR67), five sites almost immediately adjacent to the river (AWT1–1, AWT2–1, AWT3–1, AWT4–1, and AWT2–2), three sites where the ground water has been affected by acid-rock drainage (AWT2–4, AWT1–3, and AWT3–5), one site showing lesser effects from acid-rock drainage (AWT4–3), and one site at the most upgradient part of the flood plain adjacent to the upland (AWT4–5). The data indicate several trends (this analysis assumes that infiltrating snowmelt would have isotopic values within the range of values measured for the river samples):

1. Values of delta deuterium and delta 18-oxygen are distinctly lighter (depleted) for the water in the river (site AR67) and immediately adjacent to the river (sites AWT1–1, AWT2–1, AWT3–1, AWT4–1, and AWT2–2) than in the well that represents local ground water (AWT4–5). This result most likely indicates a lower temperature of the precipitation that feeds the river compared to the temperature of precipitation that recharges ground water; that is, snowmelt supports flow in the river.
2. Wells close to the river show a distinct seasonal shift where values in June are isotopically depleted compared to values in September. This trend indicates that high-elevation snowmelt supplies more water to the river in the spring than later in the year.

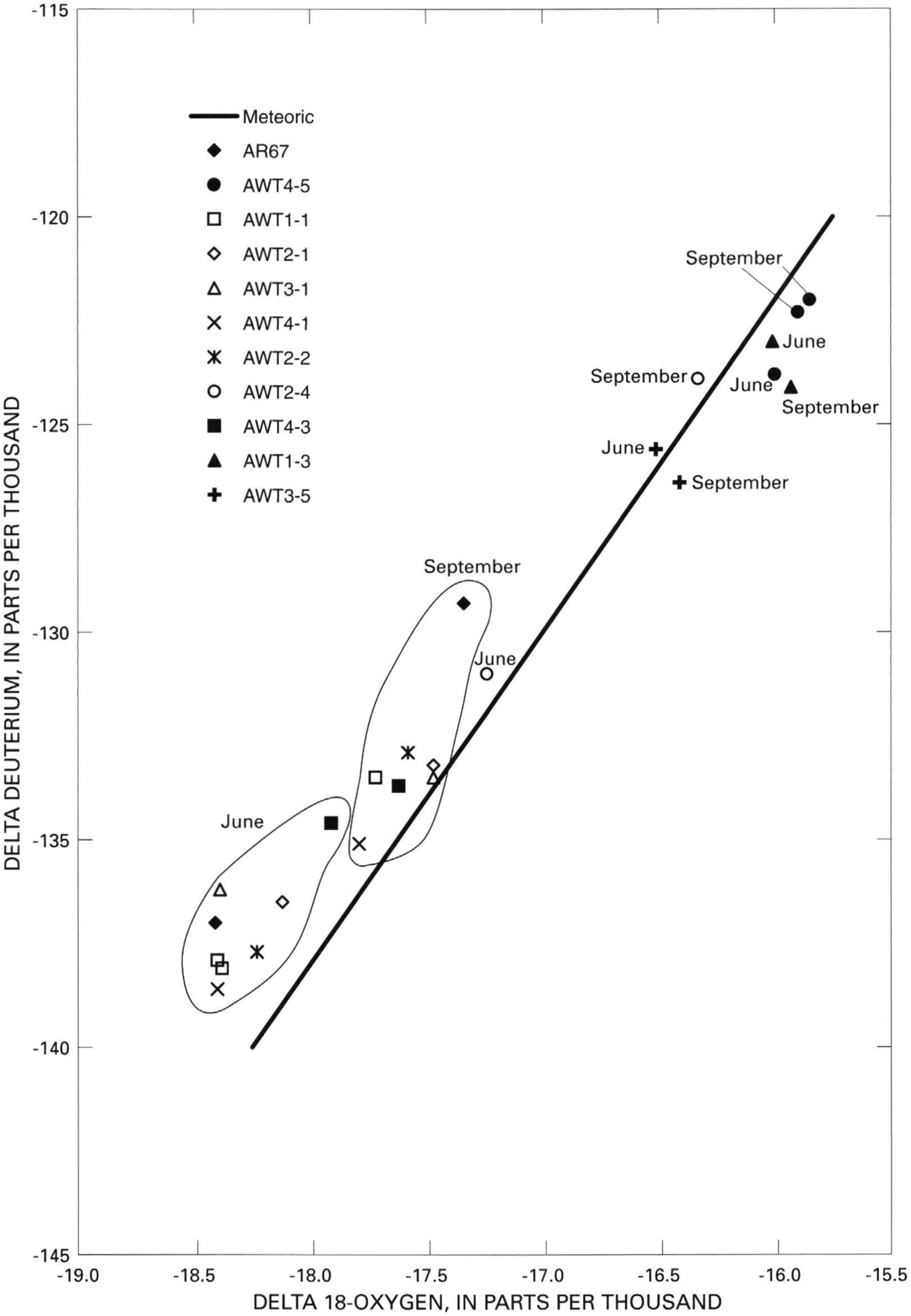

Figure 23. Relation between delta deuterium and delta 18-oxygen values for selected water samples collected during June and September 1996. Replicate analyses are shown for site AWT4–5 for September and for site AWT1–1 for June. "Meteoric" represents the meteoric water line.

3. Values for sites AWT1–3 and AWT3–5 show that the water source for these sites is distinctly different from water source for the river. These wells may receive an insignificant portion of their water from snowmelt because they show no seasonal shift toward lighter values for both isotopes in the spring and are in the region of the graph where ground water is the predominant water source.
4. Values for site AWT2–4 show more of an effect from snowmelt water in the spring than the other two wells that contained acid-rock drainage (AWT1–3 and AWT3–5). This effect may be because water from the distributary channel migrates into the local ground-water system during the spring or because snowmelt percolates down to the water table at this site during the spring.

These isotopic data conflict somewhat with the hydrographic and chemical analyses presented in the "Relations Between Water Table and Various Chemical Characteristics" section, which indicate that, at well AWT1–3, infiltration of snowmelt is likely the cause of the springtime degradation of water quality, whereas at site AWT2–4, the rise in the water table, rather than infiltrating snowmelt, is the cause of the springtime degradation of water quality. However, the isotopic data confirm the analysis that at well AWT3–5, the rise in the water table causes springtime degradation of water quality. The isotopic analyses are a more robust indicator of water source than the hydrograph analyses; thus, the isotope data override the hydrograph data for wells AWT1–3 and AWT2–4. In addition, these conflicting results underscore the difficulty of assessing the mechanism responsible for the spring flush but reaffirm that both infiltration and ground-water table fluctuation are probably occurring.

Implications for Selected Remedial Actions

Understanding the relative importance of infiltration and water-table fluctuations as the mechanisms causing the transfer of contaminants to ground water is important because each mechanism requires a different remedial treatment. If infiltration alone is causing ground-water contamination, then surface or shallow additions of acid-neutralizing material and revegetation of the land surface to decrease or stop infiltration might mitigate the contamination. Such treatments probably would not cause improvement in ground-water quality where water-table fluctuations are causing the water-quality degradation. In these areas, deeper application of sufficient amounts of acid-neutralizing material down through the entire thickness of tailings deposits that are seasonally saturated or within the capillary fringe is necessary. In the latter remediation, detailed information about the thickness and acid-producing potential of the sediments and about the extent of seasonal ground-water and capillary-zone fluctuation is needed to plan an effective remediation strategy.

SUMMARY

Studies of soil and water chemistry in the Arkansas River and in its flood plain downstream from Leadville, Colo., indicate that, in certain locations, soils contain metal concentrations and mineralogy consistent with acid-rock drainage generation and that ground water has been affected by acid-rock drainage from the fluvial tailings deposits. Assessments of instantaneous mass loads of trace elements in the river indicate that downstream increases in load can be discerned for some reaches of the river for some sampling dates during snowmelt runoff in 1996. However, for most of the sampling dates, variability in the mass-load estimates is greater than the differences between sampling sites, so no significant conclusions can be drawn. Shallow ground water sampled in some parts of a 12-acre section of the flood plain had low pH and concentrations of trace metals that are typical of acid-rock drainage. In addition, the effects on ground water are intensified by the spring flush. The spring flush of degraded water is caused either by infiltration of snowmelt or by a seasonal rise of the ground-water table and capillary fringe up into the tailings deposits, or both. If water-table fluctuation is the mechanism that degrades ground water, onsite remediation would require deeper application of acid-neutralizing material, and more information would be needed about the depth and acid-generating capacity of the tailings material than if infiltration is the mechanism of contamination. If infiltration is the mechanism, remediation might include surface or shallow amendments of acid-neutralizing material and revegetation of the land surface to decrease or stop infiltration.

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APPENDIXES

APPENDIX 1. SAMPLE PREPARATION, CHEMICAL ANALYSIS, AND WATER-QUALITY DATA

Soil Samples

Prior to chemical analysis, soil samples were dried, ground to −100 mesh, mixed, and split. The samples were acid digested by using a combination of hydrochloric, nitric, perchloric, and hydrofluoric acids, and the digests were analyzed using ICP-AES (inductively coupled plasma atomic-emission spectroscopy) for arsenic, cadmium, chromium, cobalt, copper, iron, lead, manganese, nickel, silver, and zinc. Selenium analyses were done using hydride generation atomic absorption spectrometry, and mercury analyses were done using cold vapor atomic absorption spectrometry. These analyses were completed by the U.S. Geological Survey (USGS) Geologic Division laboratories in Lakewood, Colo., and all laboratory procedures are described in Arbogast (1990). Analytical methods for XRD also are described in Arbogast (1990).

Surface- and Ground-Water-Quality Samples

Surface-water-quality samples collected in 1992 were analyzed at the USGS National Water Quality Laboratory in Colorado. Analytical techniques for ICP-AES and ion chromatography are described in Fishman and Friedman (1989).

Water-quality parameters measured in the field and included in this report are temperature, pH, specific conductance, dissolved oxygen, ferrous and total iron concentrations, and sulfide concentration. Temperature, pH, specific conductance, and dissolved oxygen were measured using a Hydrolab multiparameter sampling probe on some sampling trips. When the Hydrolab was not available, temperature was measured using mercury or alcohol in a glass thermometer, pH was measured using an Orion Ross electrode or Sensorex model S101CD electrode coupled to a Beckman phi-12 pH meter, and specific conductance was measured using a VWR conductivity meter and probe. The pH electrodes were calibrated with buffers having pH values of 4 and 7. During ground-water sampling, a buffer of pH 2 or less was used to monitor the accuracy of the electrode in water samples having pH less than 4. All electrodes responded with acceptable accuracy (±0.10 pH unit). The conductivity probe in the Hydrolab was calibrated with two specific-conductance standards that bracketed the expected values of samples for that day. The VWR conductivity probe was calibrated according to manufacturer instructions using a standard of 718 microsiemens per centimeter at 25 degrees Celsius (µS/cm). The specific conductance of a standard that had values similar to those of samples being collected that day was checked, and if not within acceptable limits (±5 percent), the conductivity probe was recalibrated and the sample measurements repeated. Results for 1995–96 samples are in table 9.

Filtered and ultrafiltered untreated samples were analyzed in the field for ferrous and total iron concentrations using a spectrophotometer (Hach Company, 1992). The linear range of the method was 0.01 to 3.3 mg/L iron. If initial analysis of a sample was greater than this range, the sample was diluted until an analysis in the linear range was obtained. Standards that bracketed the concentrations of the samples were analyzed concurrently with the samples. If these standards were not within 5 percent of the expected concentration, the samples and standards were rerun using new reagents. If a rerun was not possible, then the deviation of the standard from accepted values was used to adjust the value of the sample. This adjustment was only necessary during the first ground-water sampling trip in October 1995. Because of time-consuming sample-collection and filtration procedures, sometimes up to 3 hours elapsed prior to analysis of iron species. Therefore, some reoxidation of ferrous to ferric iron possibly occurred. If sulfide odor was detected during sample collection, an aliquot of raw, untreated sample was tested for sulfide concentration using a spectrophotometer and Hach reagents (Hach Company, 1992). Sulfide analyses are considered semiquantitative because no standards were analyzed concurrently. Filtered, untreated ground-water samples were analyzed in the field for bicarbonate alkalinity by using a gran titration (Stumm and Morgan, 1980). Alkalinity was measured in filtered, untreated surface-water samples in the laboratory by using a gran titration. Dissolved organic carbon analyses were conducted as described in Aiken (1992). Compiled results are in table 9.

Samples for total recoverable, filtered, and ultrafiltered cations and trace elements were analyzed on a Perkin-Elmer Optima 3000 ICP-AES that had an adjustable mirror allowing the detector to view along the axis of the argon plasma. The axial view of the plasma allows for lower instrument detection limits than on a conventional ICP-AES where the detector is oriented at a constant radius from the plasma. Elements analyzed include aluminum, arsenic, cadmium, calcium, copper, iron, lead, magnesium, manganese, potassium, silica (SiO_2), sodium, and zinc. A three-point calibration was used, and scandium was used as an internal standard. Analyses were performed by USGS personnel on the campus of the Colorado School of Mines, Golden, Colo. Compiled results are in table 10.

Table 9. Field parameters, streamflow discharge, alkalinity, and dissolved organic carbon for surface- and ground-water samples collected during 1995–96

[Site locations shown in figures 1, 2, and 3. NM = not measured; NA = not applicable; ND = not detected; est. = estimated value; °C, degrees Celsius; µS/cm, microsiemens per centimeter at 25 degrees Celsius; mg/L, milligrams per liter; ft^3/s, cubic feet per second; <, less than]

Sample and site identification	Date	Time	Temperature (°C)	pH (standard units)	Specific conductance (µS/cm)	Dissolved oxygen (mg/L)	Streamflow discharge (ft^3/s)	Ferrous iron in filtered sample (mg/L)	Ferrous iron in ultrafiltered sample (mg/L)	Total iron in filtered sample (mg/L)	Total iron in ultrafiltered sample (mg/L)	Sulfide (mg/L)	Alkalinity as bicarbonate (mg/L)	Dissolved organic carbon (mg/L)
AR40	05/06/96	1345	8	7.20	140	8.50	281	0.02	NM	0.17	NM	NM	32.88	4.37
AR40	06/03/96	1030	9	7.20	82	7.37	754	0.01	NM	0.10	0.01	NM	27.43	3.52
AR40	07/12/96	0820	9	7.10	99	6.40	389	0.01	0.01	0.08	0.01	NM	36.05	1.80
AR40	07/12/96	0830	NM	NM	NM	NM	NM	<0.01	<0.01	0.07	0.01	NM	34.73	1.60
AR40	09/03/96	1240	12	7.62	149	7.10	84	<0.01	<0.01	0.06	0.01	NM	50.13	1.90
AR40	09/03/96	1250	NM	NM	NM	NM	NM	<0.01	<0.01	0.03	0.01	NM	49.91	1.70
AR65	07/12/95	1450	12	7.75	NM	NM	1,660	NM	NM	NM	NM	NM	26.19	NM
AR65	07/19/95	0950	8	7.70	90.2	NM	1,160	NM	NM	NM	NM	NM	29.01	NM
AR65	07/26/95	1030	8	7.68	84.6	NM	671	NM	NM	NM	NM	NM	36.68	NM
AR65	08/02/95	1140	9	7.50	109	NM	555	NM	NM	NM	NM	NM	38.85	NM
AR65	08/16/95	1515	13	7.92	138	NM	NM	NM	NM	NM	NM	NM	NM	NM
AR65	08/23/95	1520	15	7.22	201	NM	243	NM	NM	NM	NM	NM	29.97	NM
AR65	10/26/95	1510	5	7.82	193	7.10	123	0.01	NM	0.03	NM	NM	63.70	1.68
AR65	10/26/95	1515	NM	NM	NM	NM	NM	NA	NM	0.03	NM	NM	67.73	1.77
AR65	04/11/96	1300	NM	7.35	221	NM	154	0.02	NM	0.14	NM	NM	47.81	3.81
AR65	04/25/96	1200	4	7.79	202	NM	177	0.01	NM	0.28	NM	NM	45.33	3.04
AR65	04/25/96	1205	4	7.90	206	NM	NM	0.02	NM	0.02	NM	NM	45.70	3.25
AR65	05/06/96	1620	10	7.44	152	8.30	335	0.02	NM	0.24	NM	NM	32.17	4.13
AR65	05/16/96	0840	6	7.68	135	9.20	833	0.02	NM	0.06	NM	NM	27.31	4.79
AR65	05/21/96	0955	7	7.58	98	8.70	1,330	0.01	NM	0.06	NM	NM	30.16	3.79
AR65	05/21/96	1010	NM	7.58	99	NM	NM	0.01	NM	0.07	NM	NM	27.10	3.89
AR65	05/28/96	0930	5	7.77	129	8.30	848	0.01	NM	0.10	NM	NM	40.16	3.27
AR65	06/03/96	1400	12	7.40	102	6.80	923	0.01	NM	0.09	0.01	NM	35.23	3.45
AR65	06/12/96	0945	9	7.41	87	NM	1,510	<0.01	NM	0.04	NM	NM	26.81	5.45
AR65	06/19/96	1025	8	7.42	79	NM	1,242	<0.01	NM	0.05	NM	NM	28.44	3.04
AR65	06/27/96	0840	8	7.61	96	NM	973	<0.01	NM	NM	NM	NM	26.76	2.72
AR65	06/27/96	0905	8	7.57	96	NM	NM	<0.01	NM	NM	NM	NM	27.79	3.19
AR65	07/02/96	0850	9	7.57	108	NM	779	<0.01	NM	0.07	NM	NM	36.14	2.10
AR65	07/02/96	0900	9	7.73	108	NM	NM	<0.01	NM	0.07	NM	NM	37.01	2.00
AR65	07/12/96	1230	13	7.60	120	7.70	428	0.01	NM	0.06	0.01	NM	42.14	2.60
AR65	07/21/96	0930	11	7.96	162	NM	210	NM	NM	NM	NM	NM	51.02	1.70
AR65	08/05/96	0920	9	7.78	175	NM	167	0.01	NM	0.08	NM	NM	57.94	1.90
AR65	08/05/96	0925	9	7.97	175	NM	NM	NM	NM	0.08	NM	NM	57.85	1.60
AR65	08/19/96	1045	11	8.03	228	NM	102	<0.01	NM	0.05	NM	NM	67.62	1.60
AR65	09/03/96	1540	15	8.03	202	6.50	89	0.01	<0.01	0.02	0.01	NM	62.03	1.60

Table 9. Field parameters, streamflow discharge, alkalinity, and dissolved organic carbon for surface- and ground-water samples collected during 1995–96—Continued

[Site locations shown in figures 1, 2, and 3. NM = not measured; NA = not applicable; ND = not detected; est. = estimated value; °C, degrees Celsius; µS/cm, microsiemens per centimeter at 25 degrees Celsius; mg/L, milligrams per liter; ft³/s, cubic feet per second; <, less than]

Sample and site identification	Date	Time	Temperature (°C)	pH (standard units)	Specific conductance (µS/cm)	Dissolved oxygen (mg/L)	Streamflow discharge (ft³/s)	Ferrous iron in filtered sample (mg/L)	Ferrous iron in ultrafiltered sample (mg/L)	Total iron in filtered sample (mg/L)	Total iron in ultrafiltered sample (mg/L)	Sulfide (mg/L)	Alkalinity as bicarbonate (mg/L)	Dissolved organic carbon (mg/L)
AR65	09/18/96	1015	5	7.81	224	NM	102	<0.01	NM	0.03	NM	NM	64.27	NM
AR65	09/27/96	1115	3	7.79	225	NM	115	0.01	NM	0.04	NM	NM	66.83	NM
AR65	09/27/96	1120	3	7.87	224	NM	NM	NM	NM	0.05	NM	NM	66.34	NM
AR67	10/26/95	1645	6	7.63	190	6.90	NM	0.01	NM	0.02	NM	NM	71.63	2.19
AR67	05/10/96	0915	2	7.05	160	10.20	NM	0.04	NM	0.04	0.01	NM	30.77	4.16
AR67	06/05/96	1740	11	7.41	89	6.76	NM	<0.01	NM	0.05	0.01	NM	34.78	4.37
AR67	07/11/96	1305	13	7.69	123	7.50	NM	<0.01	NM	0.00	0.01	NM	42.43	1.70
AR67	09/07/96	1517	14	8.01	213	7.48	101	ND	NM	0.01	0.00	NM	68.34	2.10
AR70	07/19/95	1345	12	7.80	93.6	NM	1,170	NM	NM	NM	NM	NM	27.13	NM
AR70	07/26/95	1340	12	7.97	86.6	NM	623	NM	NM	NM	NM	NM	39.71	NM
AR70	08/02/95	1445	14	7.73	115	NM	512	NM	NM	NM	NM	NM	40.34	NM
AR70	08/16/95	1640	14	8.15	151	NM	NM	NM	NM	NM	NM	NM	NM	NM
AR70	10/26/95	1725	5	7.74	195	6.95	112	0.01	NM	0.03	NM	NM	72.73	0.31
AR70	04/11/96	1600	6	7.39	221	NM	NM	0.03	NM	0.13	NM	NM	54.30	3.79
AR70	04/11/96	1605	NM	NM	NM	NM	NM	0.02	NM	0.17	NM	NM	55.47	3.82
AR70	04/25/96	1510	8	7.82	201	NM	219	0.01	NM	0.07	NM	NM	48.03	3.17
AR70	05/06/96	1815	10	7.20	153	8.10	361	0.01	NM	0.12	NM	NM	29.50	4.05
AR70	05/16/96	1230	8	7.89	133	8.80	899	<0.01	NM	0.05	NM	NM	29.39	4.83
AR70	05/21/96	1400	9	7.74	102	8.04	1,350 (est.)	0.01	NM	0.06	NM	NM	29.26	3.60
AR70	05/28/96	1245	7	7.89	127	7.90	770	0.01	NM	0.11	NM	NM	37.83	3.37
AR70	05/28/96	1315	NM	7.89	126	NM	NM	<0.01	NM	0.09	NM	NM	38.03	3.21
AR70	06/03/96	1610	12	7.50	112	6.84	845	0.02	NM	0.08	0.01	NM	32.07	3.54
AR70	06/12/96	1410	11	7.60	88	NM	NM	0.01	NM	0.03	NM	NM	30.39	8.99
AR70	06/12/96	1420	11	7.68	86	NM	NM	<0.01	NM	0.03	NM	NM	30.34	3.02
AR70	06/19/96	1405	13	7.71	85	NM	1,150	0.01	NM	0.04	NM	NM	30.08	2.85
AR70	06/19/96	1430	NM	7.75	84	NM	NM	0.01	NM	0.05	NM	NM	30.33	2.79
AR70	06/27/96	1215	10	7.82	107	NM	919	<0.01	NM	NM	NM	NM	32.82	2.52
AR70	07/02/96	1245	13	7.66	109	NM	742	<0.01	NM	0.07	NM	NM	38.43	2.00
AR70	07/12/96	1505	15	7.80	128	7.40	415	<0.01	NM	0.07	0.00	NM	44.44	3.00
AR70	07/21/96	1220	15	8.07	170	NM	262	NM	NM	NM	NM	NM	54.98	1.80
AR70	08/05/96	1250	13	7.9	176	NM	182	<0.01	NM	0.05	NM	NM	64.39	1.90
AR70	08/19/96	1300	13	8.06	217	NM	112	0.01	NM	0.02	NM	NM	72.97	1.60
AR70	08/19/96	1305	13	8.05	213	NM	NM	<0.01	NM	0.03	NM	NM	66.55	1.70
AR70	09/03/96	1655	16	8.10	203	6.92	96	<0.01	<0.01	0.01	0.01	NM	68.22	1.80

Table 9. Field parameters, streamflow discharge, alkalinity, and dissolved organic carbon for surface- and ground-water samples collected during 1995–96—Continued

[Site locations shown in figures 1, 2, and 3. NM = not measured; NA = not applicable; ND = not detected; est. = estimated value; °C, degrees Celsius; μS/cm, microsiemens per centimeter at 25 degrees Celsius; mg/L, milligrams per liter; ft^3/s, cubic feet per second; <, less than]

Sample and site identification	Date	Time	Temperature (°C)	pH (standard units)	Specific conductance (μS/cm)	Dissolved oxygen (mg/L)	Streamflow discharge (ft^3/s)	Ferrous iron in filtered sample (mg/L)	Ferrous iron in ultrafiltered sample (mg/L)	Total iron in filtered sample (mg/L)	Total iron in ultrafiltered sample (mg/L)	Sulfide (mg/L)	Alkalinity as bicarbonate (mg/L)	Dissolved organic carbon (mg/L)
AR70	09/18/96	1220	8	8.05	215	NM	110	<0.01	NM	0.02	NM	NM	71.76	NM
AR70	09/27/96	1440	8	8.04	229	NM	130	0.01	NM	0.02	NM	NM	73.32	NM
AWT1–1	10/23/95	1725	3	6.35	352	1.50	NA	0.21	NM	0.25	NM	0.004	107.77	6.75
AWT1–1	05/07/96	1200	5	8.10	169	9.34	NA	0.02	NM	0.04	NM	ND	57.21	3.52
AWT1–1	06/04/96	1100	9	6.90	114	4.20	NA	<0.01	NM	0.03	0.01	ND	41.40	3.20
AWT1–1	06/04/96	1130	NM	NM	NM	NM	NA	0.01	NM	0.02	0.01	ND	44.52	3.11
AWT1–1	07/08/96	1304	11	6.91	112	5.39	NA	<0.01	<0.01	0.04	0.00	ND	38.37	4.00
AWT1–1	09/04/96	0950	10	6.55	303	5.11	NA	0.02	0.01	0.04	0.02	ND	104.43	2.20
AWT1–2	10/24/95	0945	5	5.75	489	3.43	NA	<0.01	NM	0.00	NM	ND	38.45	2.10
AWT1–2	05/07/96	1305	3	6.62	587	10.00	NA	0.01	NM	0.01	0.00	ND	58.59	3.23
AWT1–2	06/04/96	1215	7	6.06	346	2.10	NA	0.01	NM	0.01	0.00	ND	64.94	1.83
AWT1–2	07/08/96	1410	9	6.14	310	0.70	NA	<0.01	NM	0.01	0.00	ND	71.73	2.30
AWT1–2	07/08/96	1440	9	NM	NM	0.70	NA	<0.01	NM	0.00	0.01	ND	71.25	NM
AWT1–2	09/04/96	1040	11	6.23	329	6.20	NA	0.01	<0.01	0.02	0.01	ND	66.39	2.30
AWT1–3	10/24/95	1040	7	3.49	864	9.47	NA	34.00	NM	50.50	NM	ND	ND	7.80
AWT1–3	05/07/96	1500	6	2.50	2,460	10.70	NA	63.50	NM	72.00	69.00	ND	ND	7.83
AWT1–3	06/04/96	1320	7	2.60	1,360	1.10	NA	46.00	47.00	51.00	51.50	ND	ND	3.80
AWT1–3	07/08/96	1546	11	2.79	1,033	0.42	NA	38.50	39.00	40.50	40.00	ND	ND	3.00
AWT1–3	09/04/96	1150	15	3.24	399	6.40	NA	16.50	16.00	18.00	18.00	ND	ND	2.40
AWT1–4	10/24/95	1225	5	5.25	280	6.04	NA	6.54	NM	6.70	NM	ND	46.11	2.76
AWT1–4	05/10/96	0810	No sample	Well frozen	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
AWT1–4	06/04/96	1430	9	5.77	288	1.40	NA	0.43	0.38	0.45	0.37	ND	34.14	2.63
AWT1–4	07/08/96	1651	12	5.81	206	0.88	NA	2.85	2.70	3.35	2.85	ND	51.78	3.50
AWT1–4	09/04/96	1325	17	6.40	409	6.29	NA	14.00	4.00	16.50	11.50	ND	124.02	3.60
AWT2–1	10/25/95	1035	4	6.58	232	1.17	NA	1.18	NM	2.72	NM	ND	71.31	1.56
AWT2–1	05/08/96	1220	4	6.95	265	0.38	NA	1.78	NM	1.85	NM	ND	64.84	1.21
AWT2–1	06/05/96	1300	8	6.74	200	0.62	NA	1.09	0.76	1.17	0.90	ND	61.08	2.51
AWT2–1	07/09/96	1440	12	6.57	193	0.53	NA	1.31	0.70	1.60	0.92	ND	66.14	1.80
AWT2–1	09/05/96	1430	14	6.58	261	1.50	NA	2.78	2.04	3.25	2.82	ND	73.52	2.10
AWT2–2	10/25/95	0940	3	6.40	240	0.17	NA	0.31	NM	0.30	NM	ND	97.30	2.04
AWT2–2	05/08/96	1105	8	6.74	359	0.70	NA	0.03	NM	0.01	NM	ND	166.38	5.48
AWT2–2	06/05/96	1135	9	6.93	171	0.77	NA	0.01	NM	0.19	0.01	<0.032	80.99	5.08
AWT2–2	07/09/96	1335	10	6.92	187	0.35	NA	1.82	0.48	2.88	0.80	0.026	93.72	8.70
AWT2–2	09/05/96	1325	11	6.57	253	1.30	NA	1.04	0.99	1.19	1.07	ND	79.71	1.90
AWT2–3	10/24/95	1605	6	5.73	379	0.71	NA	<0.01	NM	0.01	NM	ND	61.74	1.78

Table 9. Field parameters, streamflow discharge, alkalinity, and dissolved organic carbon for surface- and ground-water samples collected during 1995–96—Continued

[Site locations shown in figures 1, 2, and 3. NM = not measured; NA = not applicable; ND = not detected; est. = estimated value; °C, degrees Celsius; µS/cm, microsiemens per centimeter at 25 degrees Celsius; mg/L, milligrams per liter; ft^3/s, cubic feet per second; <, less than]

Sample and site identification	Date	Time	Temperature (°C)	pH (standard units)	Specific conductance (µS/cm)	Dissolved oxygen (mg/L)	Streamflow discharge (ft^3/s)	Ferrous iron in filtered sample (mg/L)	Ferrous iron in ultrafiltered sample (mg/L)	Total iron in filtered sample (mg/L)	Total iron in ultrafiltered sample (mg/L)	Sulfide (mg/L)	Alkalinity as bicarbonate (mg/L)	Dissolved organic carbon (mg/L)
AWT2–3	05/08/96	1020	3	5.92	369	5.40	NA	0.03	NM	0.01	NM	ND	53.61	1.34
AWT2–3	06/05/96	1030	7	5.91	437	2.70	NA	<0.01	NM	0.00	0.00	ND	20.99	1.74
AWT2–3	07/09/96	1225	9	5.85	324	1.38	NA	<0.01	<0.01	0.00	0.00	ND	39.15	1.50
AWT2–3	09/05/96	1140	11	5.96	317	1.90	NA	<0.01	<0.01	0.01	0.01	ND	72.81	1.50
AWT2–3	09/05/96	1230	NM	NM	NM	NM	NA	0.01	0.01	0.01	0.01	ND	77.17	2.00
AWT2–4	10/24/95	1500	6	2.28	2,760	5.78	NA	10.12	NM	37.37	NM	ND	ND	11.26
AWT2–4	05/08/96	0930	4	2.71	1,143	5.86	NA	0.26	NM	6.15	NM	ND	ND	1.32
AWT2–4	06/05/96	0910	9	2.91	1,292	2.80	NA	0.68	0.62	6.65	6.60	ND	ND	2.09
AWT2–4	07/09/96	1120	13	2.67	1,344	1.19	NA	1.84	NM	8.35	8.50	ND	ND	2.20
AWT2–4	09/05/96	1000	17	2.84	1,087	6.20	NA	8.60	8.60	14.00	13.80	ND	ND	2.20
AWT2–5	10/24/95	1315	7	5.19	693	8.00	NA	55.77	NM	64.00	NM	0.003	98.16	5.24
AWT2–5	10/24/95	1320	NM	NM	NM	NM	NA	56.41	NM	57.50	NM	ND	93.83	4.77
AWT2–5	05/07/96	1630	5	4.70	990	10.40	NA	15.50	NM	15.50	NM	ND	NM	3.05
AWT2–5	06/04/96	1550	4	5.01	708	2.00	NA	16.10	19.10	19.90	20.00	ND	35.91	2.40
AWT2–5	07/09/96	1005	9	5.25	695	1.21	NA	41.00	40.50	43.00	43.00	ND	38.19	2.20
AWT2–5	09/04/96	1530	16	6.05	585	6.50	NA	38.50	36.00	41.50	40.00	ND	77.03	3.40
AWT3–1	10/25/95	1135	3	6.56	179	4.87	NA	0.01	NM	0.00	NM	ND	40.14	1.80
AWT3–1	05/08/96	1340	7	7.34	210	2.99	NA	0.02	NM	0.01	NM	ND	34.48	2.31
AWT3–1	06/05/96	1415	11	7.38	99	6.00	NA	0.01	NM	0.03	0.01	ND	27.42	3.39
AWT3–1	07/09/96	1600	11	7.47	112	4.72	NA	<0.01	<0.01	0.00	0.00	ND	29.90	4.20
AWT3–1	09/05/96	1600	11	6.64	228	2.06	NA	<0.01	<0.01	0.01	0.00	ND	31.14	1.50
AWT3–2	10/25/95	1230	3	6.36	189	0.76	NA	<0.01	NM	0.01	NM	ND	56.91	1.12
AWT3–2	05/08/96	1515	8	6.75	199	0.70	NA	0.03	NM	0.01	NM	ND	53.20	1.91
AWT3–2	06/05/96	1518	9	7.33	119	1.60	NA	<0.01	NM	0.00	0.00	ND	29.55	2.89
AWT3–2	07/09/96	1715	13	6.51	128	0.38	NA	<0.01	<0.01	0.01	NM	ND	35.00	1.70
AWT3–2	09/06/96	0955	12	6.55	221	1.00	NA	<0.01	<0.01	0.01	0.01	ND	70.38	1.40
AWT3–3	06/05/96	1620	8	6.80	284	6.60	NA	<0.01	NM	0.00	0.00	ND	50.12	3.34
AWT3–4	10/25/95	1330	8	2.79	623	6.15	NA	0.01	NM	1.24	NM	ND	ND	1.36
AWT3–4	05/08/96	1635	3	3.32	520	6.71	NA	0.08	NM	0.51	NM	ND	ND	0.95
AWT3–4	05/08/96	1640	NM	NM	NM	NM	NA	0.04	NM	0.52	NM	ND	ND	0.87
AWT3–4	06/06/96	0930	6	2.93	703	3.70	NA	0.07	0.07	0.94	0.93	ND	ND	1.32
AWT3–4	07/10/96	1000	10	2.95	609	1.50	NA	0.45	0.46	1.16	1.15	ND	ND	1.80
AWT3–4	09/06/96	1110	12	3.22	463	3.90	NA	0.43	0.46	0.74	0.77	ND	ND	1.00
AWT3–5	10/25/95	1430	9	2.87	703	6.41	NA	9.33	NM	23.54	NM	ND	ND	2.78
AWT3–5	05/09/96	0950	5	2.60	1,460	4.10	NA	3.70	3.80	60.80	60.40	ND	ND	2.28

Table 9. Field parameters, streamflow discharge, alkalinity, and dissolved organic carbon for surface- and ground-water samples collected during 1995–96—Continued

[Site locations shown in figures 1, 2, and 3. NM = not measured; NA = not applicable; ND = not detected; est. = estimated value; °C, degrees Celsius; µS/cm, microsiemens per centimeter at 25 degrees Celsius; mg/L, milligrams per liter; ft^3/s, cubic feet per second; <, less than]

Sample and site identification	Date	Time	Temperature (°C)	pH (standard units)	Specific conductance (µS/cm)	Dissolved oxygen (mg/L)	Streamflow discharge (ft^3/s)	Ferrous iron in filtered sample (mg/L)	Ferrous iron in ultrafiltered sample (mg/L)	Total iron in filtered sample (mg/L)	Total iron in ultrafiltered sample (mg/L)	Sulfide (mg/L)	Alkalinity as bicarbonate (mg/L)	Dissolved organic carbon (mg/L)
AWT3–5	06/06/96	1035	8	2.39	1,740	3.60	NA	1.45	1.50	77.50	78.00	ND	ND	1.94
AWT3–5	07/10/96	1105	11	2.50	1,229	1.90	NA	1.20	1.30	28.00	28.00	ND	ND	1.20
AWT3–5	09/06/96	1230	12	6.26	356	6.00	NA	5.55	4.30	6.00	5.50	ND	50.65	1.80
AWT3–6	10/25/95	1550	6	6.54	638	2.47	NA	1.02	NM	0.93	NM	ND	473.42	5.08
AWT3–6	05/09/96	1115	3	6.68	690	3.00	NA	0.17	NM	0.17	NM	ND	388.97	3.49
AWT3–6	06/06/96	1135	7	6.42	649	0.80	NA	0.21	0.06	0.26	0.15	ND	419.69	4.21
AWT3–6	07/10/96	1205	12	6.67	740	0.40	NA	0.79	0.05	1.23	0.87	0.002	496.88	6.50
AWT3–6	09/06/96	1435	12	6.75	627	1.90	NA	1.38	1.02	1.84	1.69	0.001	420.44	4.60
AWT4–1	10/26/95	1305	5	6.23	338	0.90	NA	NA	NM	0.01	NM	ND	58.84	1.81
AWT4–1	05/09/96	1732	5	6.80	172	6.70	NA	0.01	0.01	0.02	NM	ND	20.01	3.58
AWT4–1	06/07/96	1030	7	7.34	90	7.30	NA	<0.01	NM	0.02	0.01	ND	31.19	3.34
AWT4–1	07/11/96	1050	12	6.68	112	4.80	NA	<0.01	NM	0.01	0.00	ND	40.53	2.20
AWT4–1	09/07/96	1410	11	6.33	239	0.80	NA	<0.01	NM	0.00	0.01	ND	61.90	1.70
AWT4–2	10/26/95	1220	6	6.15	278	0.36	NA	0.58	NM	0.60	NM	ND	67.30	3.25
AWT4–2	05/09/96	1645	2	6.35	420	1.70	NA	0.43	0.42	0.45	0.42	ND	60.55	2.31
AWT4–2	06/07/96	0935	4	6.12	351	0.40	NA	0.20	0.15	0.25	0.24	ND	38.68	2.55
AWT4–2	07/11/96	0940	9	6.03	312	0.50	NA	0.45	0.39	0.51	0.48	0.002	40.10	2.90
AWT4–2	09/07/96	1250	10	6.18	271	1.10	NA	0.57	0.55	0.60	0.58	ND	42.10	2.30
AWT4–3	10/26/95	1025	6	5.66	549	9.04	NA	0.10	NM	0.26	NM	ND	18.02	3.61
AWT4–3	05/09/96	1520	3	5.30	410	1.80	NA	0.04	NM	0.05	0.05	ND	NM	2.62
AWT4–3	06/06/96	1515	4	5.34	434	1.90	NA	0.01	NM	0.00	0.01	ND	13.61	3.41
AWT4–3	07/10/96	1630	9	5.11	411	4.20	NA	<0.01	NM	0.02	0.02	ND	14.88	3.20
AWT4–3	09/07/96	1140	12	5.21	303	5.90	NA	0.04	0.04	0.13	0.13	ND	9.14	2.40
AWT4–4	10/26/95	0910	7	4.83	183	0.97	NA	0.01	NM	0.01	NM	ND	25.74	1.26
AWT4–4	05/09/96	1427	3	5.29	289	4.30	NA	0.01	NM	0.01	NM	ND	23.43	1.26
AWT4–4	06/06/96	1405	5	5.14	448	3.00	NA	0.01	NM	0.00	0.00	ND	30.47	1.71
AWT4–4	07/10/96	1435	9	5.31	310	0.90	NA	<0.01	NM	0.00	0.00	ND	24.48	5.50
AWT4–4	09/07/96	0945	11	5.34	183	1.90	NA	NM	NM	0.01	0.01	ND	46.66	1.40
AWT4–5	10/25/95	1710	6	6.54	580	1.45	NA	29.17	NM	14.75	NM	0.128	374.17	5.51
AWT4–5	05/09/96	1245	2	6.65	760	1.20	NA	21.75	12.75	22.75	15.50	0.03	493.44	3.72
AWT4–5	06/06/96	1305	6	6.61	596	0.90	NA	10.20	4.20	12.20	8.60	0.02	390.59	5.87
AWT4–5	07/10/96	1330	9	6.85	513	0.30	NA	4.80	0.80	10.00	8.00	0.020	343.31	4.20
AWT4–5	09/06/96	1615	9	6.60	495	0.90	NA	9.60	5.40	11.40	9.00	0.018	333.26	4.70
CHIN	10/26/95	1050	4	6.53	232	3.42	0.02 (est.)	0.50	NM	0.55	NM	NM	91.41	1.66

Table 9. Field parameters, streamflow discharge, alkalinity, and dissolved organic carbon for surface- and ground-water samples collected during 1995–96—Continued

[Site locations shown in figures 1, 2, and 3. NM = not measured; NA = not applicable; ND = not detected; est. = estimated value; °C, degrees Celsius; µS/cm, microsiemens per centimeter at 25 degrees Celsius; mg/L, milligrams per liter; ft^3/s, cubic feet per second; <, less than]

Sample and site identification	Date	Time	Temperature (°C)	pH (standard units)	Specific conductance (µS/cm)	Dissolved oxygen (mg/L)	Streamflow discharge (ft^3/s)	Ferrous iron in filtered sample (mg/L)	Ferrous iron in ultrafiltered sample (mg/L)	Total iron in filtered sample (mg/L)	Total iron in ultrafiltered sample (mg/L)	Sulfide (mg/L)	Alkalinity as bicarbonate (mg/L)	Dissolved organic carbon (mg/L)
CHIN	05/10/96	1025	3	7.15	170	9.50	4.77	0.01	NM	0.03	0.01	NM	44.69	3.71
CHIN	05/10/96	1030	NM	NM	NM	NM	NM	0.02	NM	0.02	0.01	NM	40.39	4.05
CHIN	06/07/96	1155	9	7.40	91	7.65	22.10	<0.01	NM	0.07	0.01	NM	32.68	3.21
CHIN	07/11/96	1430	15	7.93	131	7.35	2.70	<0.01	NM	0.03	0.00	NM	51.78	4.20
CHOT–LC	10/26/95	1450	10	7.44	274	6.36	0.06 (est.)	0.02	NM	0.08	NM	NM	153.42	2.87
CHOT–LC	05/10/96	1340	8	7.38	168	8.60	3.63	0.01	NM	0.02	0.01	NM	39.09	3.88
CHOT–LC	06/07/96	1415	12	7.50	91	7.30	13.40	<0.01	NM	0.07	0.01	NM	39.23	3.27
CHOT–LC	07/11/96	1650	17	7.88	136	7.26	1.78	<0.01	NM	0.03	0.00	NM	58.06	2.00
CHOT–RC	10/26/95	1445	9	7.09	372	6.00	0.02 (est.)	1.00	NM	1.24	NM	NM	165.21	2.91
CHOT–RC	05/10/96	1255	8	7.41	170	8.70	1.76	0.03	NM	0.05	0.01	NM	43.03	4.03
CHOT–RC	06/07/96	1315	11	7.45	91	7.50	7.84	0.01	NM	0.05	0.01	NM	34.62	3.12
CHOT–RC	07/11/96	1600	17	7.95	134	7.41	NM	<0.01	NM	0.03	0.00	NM	52.45	2.40
Pond 1	09/04/96	1220	18	6.26	389	4.44	NA	2.24	NM	2.48	NM	NM	147.32	NM
Pond 2	09/04/96	1435	17	6.11	333	3.40	NA	0.14	NM	0.16	NM	NM	116.42	NM
Pond 3	09/04/96	1605	18	6.61	294	7.30	NA	0.01	NM	0.01	NM	NM	117.69	NM
Pond 4	09/04/96	1725	16	6.42	313	4.20	NA	1.00	NM	1.16	NM	NM	164.90	NM
Pond 5	09/07/96	1000	8	6.70	276	8.70	NA	0.84	NM	0.88	NM	NM	134.39	NM
Pond 6	09/07/96	0900	9	6.57	402	3.99	NA	0.34	NM	0.38	NM	NM	243.59	NM
Pond 7	09/06/96	1630	14	7.16	418	5.82	NA	<0.01	NM	0.01	NM	NM	270.58	NM
Pond 8	09/06/96	1500	15	7.39	429	7.49	NA	<0.01	NM	0.01	NM	NM	270.18	NM
Pond 9	09/06/96	1325	14	7.24	455	5.50	NA	0.44	NM	0.56	NM	NM	286.53	NM
Pond 10	09/06/96	0930	11	6.93	463	4.70	NA	0.65	NM	0.99	NM	NM	285.66	NM
Pond 11	09/05/96	1200	15	6.16	406	4.25	NA	7.40	NM	8.00	NM	NM	94.96	NM
Pond 12	09/05/96	1100	17	6.20	465	3.67	NA	18.00	NM	20.50	NM	NM	144.89	NM
Pond 13	09/05/96	1030	16	6.39	418	2.52	NA	3.40	NM	4.45	NM	NM	222.20	NM
PP2	09/07/96	0945	11	6.90	254	5.25	NA	0.13	NM	0.15	NM	NM	105.79	NM
Spring	10/25/95	1600	7	7.83	193	7.60	NM	<0.01	NM	0.00	NM	0.002	98.32	2.80
Spring	05/09/96	1315	NM	NM	NM	NM	NM	0.01	NM	0.01	NM	NM	161.32	3.37
Spring	06/07/96	0825	10	7.49	230	8.12	NM	<0.01	NM	0.01	0.01	NM	144.67	3.61
Spring	06/07/96	0830	10	7.56	231	8.11	NM	0.01	NM	0.01	0.00	NM	135.68	3.39
Spring	07/11/96	0855	12	7.39	199	5.60	NM	<0.01	NM	0.00	0.00	NM	121.95	2.80
Spring	09/06/96	1030	12	7.32	206	5.59	NM	<0.01	0.01	0.01	0.01	NM	125.15	2.40

Table 10. Results from inductively coupled plasma atomic-emission spectroscopy for unfiltered, filtered, and ultrafiltered surface- and ground-water samples collected during 1995–96

[Site locations shown in figures 1, 2, and 3. Quality code "e" indicates value is estimated as described in Appendix 4; sequential replicates are indicated by two samples collected the same day at different times; filter size 1 = unfiltered; filter size 0.1 = 0.1 µm; filter size 0.001 = ultrafiltered; mg/L, milligrams per liter; <, less than; >, detector saturated, no value obtained; sample AR65 collected on September 18, 1996, at 10:15 a.m., filter size 0.1 is the laboratory precision sample]

Sample and site identification	Date	Time	Filter size	Aluminum (mg/L)	Aluminum quality code	Arsenic (mg/L)	Arsenic quality code	Cadmium (mg/L)	Calcium (mg/L)	Copper (mg/L)	Iron (mg/L)	Lead (mg/L)	Lead quality code	Magnesium (mg/L)	Manganese (mg/L)	Potassium (mg/L)	Silica (mg/L)	Sodium (mg/L)	Zinc (mg/L)
AR40	05/06/96	1345	1	0.876	e	<0.01	--	0.005	12.3	<0.050	2.781	0.064	--	5.3	0.830	1.4	10.9	2.8	0.871
AR40	05/06/96	1345	0.1	<0.05	--	<0.01	--	<0.005	12.3	<0.050	0.142	<0.005	--	5.1	0.698	1.2	7.2	2.6	0.608
AR40	05/06/96	1345	0.001	0.269	e	<0.01	--	0.005	12.5	<0.050	1.319	0.023	e	5.2	0.748	1.3	7.9	2.7	0.696
AR40	06/03/96	1030	1	0.159	e	<0.01	--	<0.005	8.6	<0.050	0.352	<0.005	--	3.1	0.123	0.6	5.9	1.4	0.207
AR40	06/03/96	1030	0.1	<0.05	--	<0.01	--	<0.005	9.4	<0.050	0.103	<0.005	--	3.2	0.112	0.5	5.5	1.5	0.200
AR40	06/03/96	1030	0.001	<0.05	--	<0.01	--	<0.005	9.0	<0.050	<0.020	<0.005	--	3.1	0.101	0.6	7.1	1.5	0.186
AR40	07/12/96	0820	1	0.066	e	<0.01	--	<0.005	10.4	<0.050	0.365	<0.005	--	3.6	0.115	0.5	4.9	1.6	0.103
AR40	07/12/96	0820	0.1	<0.05	--	<0.01	--	<0.005	11.1	<0.050	0.088	<0.005	--	3.7	0.105	0.5	5.2	1.6	0.091
AR40	07/12/96	0820	0.001	<0.05	--	<0.01	--	<0.005	10.3	<0.050	<0.020	<0.005	--	3.6	0.101	0.5	5.7	1.7	0.072
AR40	07/12/96	0830	1	0.090	e	<0.01	--	<0.005	10.9	<0.050	0.402	<0.005	--	3.7	0.121	0.5	5.2	1.7	0.110
AR40	07/12/96	0830	0.1	<0.05	--	<0.01	--	<0.005	11.1	<0.050	0.091	<0.005	--	3.7	0.105	0.5	5.2	1.6	0.101
AR40	07/12/96	0830	0.001	<0.05	--	<0.01	--	<0.005	10.2	<0.050	<0.020	<0.005	--	3.5	0.105	0.5	4.7	1.6	0.079
AR40	09/03/96	1240	1	<0.05	--	<0.01	--	<0.005	14.9	<0.050	0.541	<0.005	--	6.1	0.238	0.9	6.7	4.1	0.163
AR40	09/03/96	1240	0.1	<0.05	--	<0.01	--	<0.005	15.3	<0.050	0.039	<0.005	--	5.9	0.175	0.9	7.8	3.7	0.093
AR40	09/03/96	1240	0.001	<0.05	--	<0.01	--	<0.005	14.8	<0.050	<0.020	<0.005	--	5.9	0.183	0.9	7.9	4.0	0.090
AR40	09/03/96	1250	1	<0.05	--	<0.01	--	<0.005	15.4	<0.050	0.489	<0.005	--	6.1	0.215	0.9	7.3	3.9	0.155
AR40	09/03/96	1250	0.1	<0.05	--	<0.01	--	<0.005	15.2	<0.050	0.022	<0.005	--	5.8	0.172	0.9	7.6	3.7	0.093
AR40	09/03/96	1250	0.001	<0.05	--	<0.01	--	<0.005	15.1	<0.050	<0.020	<0.005	--	5.8	0.178	0.9	8.9	4.3	0.091
AR65	07/12/95	1450	1	1.740	--	<0.01	--	<0.005	9.5	<0.050	2.652	0.096	--	3.4	0.302	1.1	13.8	1.8	0.279
AR65	07/12/95	1450	0.1	<0.05	--	<0.01	--	<0.005	9.7	<0.050	0.113	<0.005	--	3.1	0.078	0.6	5.0	1.3	0.116
AR65	07/12/95	1450	0.1	<0.05	--	<0.01	--	<0.005	9.3	<0.050	0.121	<0.005	--	3.1	0.082	0.6	4.9	1.4	0.109
AR65	07/19/95	0950	1	0.633	e	<0.01	--	<0.005	10.0	<0.050	0.798	0.031	e	3.3	0.110	0.7	7.8	1.6	0.118
AR65	07/19/95	0950	0.1	<0.05	--	<0.01	--	<0.005	10.3	<0.050	0.105	0.010	e	3.2	0.070	0.4	5.0	1.4	0.085
AR65	07/19/95	0950	0.1	<0.05	--	<0.01	--	<0.005	9.8	<0.050	0.113	0.010	e	3.2	0.074	0.5	4.8	1.5	0.080
AR65	07/26/95	1030	1	0.233	e	<0.01	--	<0.005	13.5	<0.050	0.632	0.013	e	4.4	0.144	0.6	6.6	1.9	0.135
AR65	07/26/95	1030	0.1	<0.05	--	<0.01	--	<0.005	13.8	<0.050	0.125	<0.005	--	4.2	0.105	0.5	5.6	1.7	0.102
AR65	07/26/95	1030	0.1	<0.05	--	<0.01	--	<0.005	13.0	<0.050	0.130	<0.005	--	4.2	0.110	0.5	5.3	1.8	0.094
AR65	08/02/95	1140	1	0.178	e	<0.01	--	<0.005	12.2	<0.050	0.596	0.021	e	4.0	0.132	0.6	6.0	1.9	0.107
AR65	08/02/95	1140	0.1	<0.05	--	<0.01	--	<0.005	12.9	<0.050	0.215	0.010	e	4.0	0.109	0.3	5.4	1.6	0.084
AR65	08/02/95	1140	0.1	<0.05	--	<0.01	--	<0.005	12.8	<0.050	0.238	0.010	e	4.1	0.119	0.3	5.5	1.9	0.081
AR65	08/16/95	1515	1	0.083	e	<0.01	--	<0.005	13.4	<0.050	0.463	<0.005	--	4.1	0.119	0.6	5.4	2.1	0.095
AR65	08/23/95	1520	1	0.093	e	<0.01	--	<0.005	20.6	<0.050	0.580	0.108	--	6.4	0.141	0.9	7.2	2.9	0.148

Table 10. Results from inductively coupled plasma atomic-emission spectroscopy for unfiltered, filtered, and ultrafiltered surface- and ground-water samples collected during 1995–96—Continued

[Site locations shown in figures 1, 2, and 3. Quality code "e" indicates value is estimated as described in Appendix 4; sequential replicates are indicated by two samples collected the same day at different times; filter size 1 = unfiltered; filter size 0.1 = 0.1 µm; filter size 0.001 = ultrafiltered; mg/L, milligrams per liter; <, less than; >, detector saturated, no value obtained; sample AR65 collected on September 18, 1996, at 10:15 a.m., filter size 0.1 is the laboratory precision sample]

Sample and site identification	Date	Time	Filter size	Aluminum (mg/L)	Aluminum quality code	Arsenic (mg/L)	Arsenic quality code	Cadmium (mg/L)	Calcium (mg/L)	Copper (mg/L)	Iron (mg/L)	Lead (mg/L)	Lead quality code	Magnesium (mg/L)	Manganese (mg/L)	Potassium (mg/L)	Silica (mg/L)	Sodium (mg/L)	Zinc (mg/L)
AR65	08/23/95	1520	0.1	<0.05	--	<0.01	--	<0.005	19.2	<0.050	0.114	0.045	e	5.8	0.106	0.3	6.1	2.5	0.115
AR65	08/23/95	1520	0.1	<0.05	--	<0.01	--	<0.005	18.4	<0.050	0.118	0.043	e	5.6	0.110	0.3	5.8	2.6	0.107
AR65	10/26/95	1510	1	<0.05	--	<0.01	--	<0.005	23.3	<0.050	0.405	<0.005	--	8.1	0.169	1.0	8.4	4.7	0.160
AR65	10/26/95	1510	0.1	<0.05	--	<0.01	--	<0.005	23.6	<0.050	0.032	<0.005	--	8.1	0.139	1.0	8.5	4.7	0.115
AR65	10/26/95	1515	1	<0.05	--	<0.01	--	<0.005	23.6	<0.050	0.411	<0.005	--	8.3	0.172	1.0	8.3	4.9	0.165
AR65	10/26/95	1515	0.1	<0.05	--	<0.01	--	<0.005	23.3	<0.050	0.031	<0.005	--	7.8	0.133	1.0	8.2	4.8	0.106
AR65	04/11/96	1300	1	0.307	e	<0.01	--	<0.005	21.6	<0.050	2.644	0.028	e	8.4	0.965	2.5	9.4	4.7	0.865
AR65	04/11/96	1300	0.1	<0.05	--	<0.01	--	<0.005	22.0	<0.050	0.309	<0.005	--	8.5	0.930	2.4	8.2	4.3	0.633
AR65	04/11/96	1300	0.1	<0.05	--	<0.01	--	<0.005	21.2	<0.050	0.300	<0.005	--	8.4	0.899	2.7	8.2	4.5	0.566
AR65	04/25/96	1200	1	0.408	e	<0.01	--	<0.005	19.8	<0.050	2.786	0.042	e	7.6	0.920	1.7	9.3	4.0	0.891
AR65	04/25/96	1200	0.1	<0.05	--	<0.01	--	<0.005	20.7	<0.050	0.212	<0.005	--	8.0	0.903	1.7	7.9	4.0	0.637
AR65	04/25/96	1200	0.1	<0.05	--	<0.01	--	<0.005	19.3	<0.050	0.201	<0.005	--	7.6	0.844	1.7	7.8	3.9	0.568
AR65	04/25/96	1200	1	0.408	e	<0.01	--	<0.005	19.8	<0.050	2.713	0.040	e	7.6	0.907	1.7	9.4	4.0	0.879
AR65	04/25/96	1200	0.1	<0.05	--	<0.01	--	<0.005	20.0	<0.050	0.133	<0.005	--	8.0	0.873	1.7	8.0	3.9	0.592
AR65	05/06/96	1620	1	1.148	--	<0.01	--	0.005	14.7	<0.050	3.403	0.084	--	6.1	0.920	1.6	12.4	3.2	0.935
AR65	05/06/96	1620	0.1	<0.05	--	<0.01	--	<0.005	14.8	<0.050	0.407	0.012	e	5.6	0.660	1.2	7.3	2.7	0.620
AR65	05/06/96	1620	0.001	0.404	e	<0.01	--	<0.005	14.2	<0.050	1.339	0.031	e	5.7	0.683	1.3	9.1	3.0	0.685
AR65	05/06/96	1620	0.001	0.381	e	<0.01	--	<0.005	14.3	<0.050	1.509	0.032	e	6.0	0.758	1.3	8.5	3.1	0.671
AR65	05/16/96	0840	1	1.702	--	<0.01	--	0.005	13.4	<0.050	3.019	0.121	--	4.8	0.578	1.4	14.0	2.2	0.988
AR65	05/16/96	0840	0.1	<0.05	--	<0.01	--	<0.005	12.9	<0.050	0.056	<0.005	--	4.6	0.293	1.0	6.8	2.0	0.617
AR65	05/21/96	0955	1	0.792	e	<0.01	--	<0.005	10.4	<0.050	1.209	0.038	e	3.6	0.210	0.9	9.1	1.6	0.417
AR65	05/21/96	1010	1	0.806	e	<0.01	--	<0.005	10.2	<0.050	1.301	0.050	e	3.6	0.210	0.9	9.2	1.5	0.406
AR65	05/21/96	1010	0.1	0.055	e	<0.01	--	<0.005	10.2	<0.050	0.082	<0.005	--	3.5	0.121	0.7	6.0	1.5	0.289
AR65	05/21/96	1010	0.1	0.061	e	<0.01	--	<0.005	10.5	<0.050	0.086	<0.005	--	3.5	0.122	0.6	5.7	1.4	0.318
AR65	05/28/96	0930	1	0.395	e	<0.01	--	<0.005	13.8	<0.050	0.853	0.014	e	4.9	0.211	0.8	8.3	2.0	0.342
AR65	06/03/96	1400	1	0.425	e	<0.01	--	<0.005	11.7	<0.050	0.793	0.017	e	4.0	0.141	0.7	7.5	1.6	0.221
AR65	06/03/96	1400	0.1	<0.05	--	<0.01	--	<0.005	12.1	<0.050	0.094	<0.005	--	3.9	0.092	0.6	5.6	1.5	0.159
AR65	06/03/96	1400	0.1	<0.05	--	<0.01	--	<0.005	11.7	<0.050	0.090	<0.005	--	3.9	0.089	0.6	5.6	1.5	0.143
AR65	06/03/96	1400	0.001	<0.05	--	<0.01	--	<0.005	12.0	<0.050	<0.020	<0.005	--	3.9	0.086	0.6	7.0	1.7	0.148
AR65	06/12/96	0945	1	0.754	e	<0.01	--	<0.005	10.5	<0.050	1.333	0.038	e	3.4	0.733	0.7	9.0	1.4	0.646
AR65	06/12/96	0945	0.1	<0.05	--	<0.01	--	<0.005	9.2	<0.050	0.041	<0.005	--	3.0	0.044	0.5	4.9	0.8	0.093
AR65	06/19/96	1025	1	0.297	e	<0.01	--	<0.005	9.7	<0.050	0.489	0.013	e	3.1	0.091	0.6	6.0	1.3	0.125

Table 10. Results from inductively coupled plasma atomic-emission spectroscopy for unfiltered, filtered, and ultrafiltered surface- and ground-water samples collected during 1995–96—Continued

[Site locations shown in figures 1, 2, and 3. Quality code "e" indicates value is estimated as described in Appendix 4; sequential replicates are indicated by two samples collected the same day at different times; filter size 1 = unfiltered; filter size 0.1 = 0.1 µm; filter size 0.001 = ultrafiltered; mg/L, milligrams per liter; <, less than; >, detector saturated, no value obtained; sample AR65 collected on September 18, 1996, at 10:15 a.m., filter size 0.1 is the laboratory precision sample]

Sample and site identification	Date	Time	Filter size	Aluminum (mg/L)	Aluminum quality code	Arsenic (mg/L)	Arsenic quality code	Cadmium (mg/L)	Calcium (mg/L)	Copper (mg/L)	Iron (mg/L)	Lead (mg/L)	Lead quality code	Magnesium (mg/L)	Manganese (mg/L)	Potassium (mg/L)	Silica (mg/L)	Sodium (mg/L)	Zinc (mg/L)
AR65	06/19/96	1025	0.1	<0.05	--	<0.01	--	<0.005	9.4	<0.050	0.056	<0.005	--	3.0	0.052	0.5	4.7	1.2	0.082
AR65	06/27/96	0840	1	0.310	e	<0.01	--	<0.005	10.7	<0.050	0.537	0.011	e	3.4	0.104	0.6	6.2	1.4	0.116
AR65	06/27/96	0840	0.1	<0.05	--	<0.01	--	<0.005	10.7	<0.050	0.077	<0.005	--	3.4	0.075	0.5	4.9	1.3	0.081
AR65	06/27/96	0905	1	0.251	e	<0.01	--	<0.005	11.2	<0.050	0.509	0.006	e	3.6	0.097	0.6	5.9	1.5	0.117
AR65	06/27/96	0905	0.1	<0.05	--	<0.01	--	<0.005	10.7	<0.050	0.075	<0.005	--	3.4	0.074	0.5	4.8	1.3	0.080
AR65	07/02/96	0850	1	0.095	e	<0.01	--	<0.005	11.7	<0.050	0.438	0.006	e	3.9	0.104	0.6	5.5	1.6	0.108
AR65	07/02/96	0850	0.1	<0.05	--	<0.01	--	<0.005	11.9	<0.050	0.068	<0.005	--	3.8	0.075	0.5	4.9	1.5	0.080
AR65	07/02/96	0900	1	0.451	e	<0.01	--	<0.005	12.2	<0.050	0.804	0.012	e	4.0	0.120	0.7	7.1	1.6	0.144
AR65	07/02/96	0900	0.1	<0.05	--	<0.01	--	<0.005	11.9	<0.050	0.067	<0.005	--	3.9	0.074	0.6	5.1	1.5	0.074
AR65	07/12/96	1230	1	0.124	e	<0.01	--	<0.005	13.9	<0.050	0.414	<0.005	--	4.5	0.103	0.6	5.6	1.9	0.101
AR65	07/12/96	1230	0.1	<0.05	--	<0.01	--	<0.005	13.9	<0.050	0.053	<0.005	--	4.3	0.085	0.5	5.4	1.8	0.082
AR65	07/12/96	1230	0.001	<0.05	--	<0.01	--	<0.005	13.5	<0.050	<0.020	<0.005	--	4.4	0.086	0.6	5.5	2.0	0.065
AR65	07/21/96	0930	1	<0.05	--	<0.01	--	<0.005	19.3	<0.050	0.385	<0.005	--	6.2	0.135	0.7	6.6	2.8	0.150
AR65	07/21/96	0930	0.1	<0.05	--	<0.01	--	<0.005	19.4	<0.050	0.080	<0.005	--	6.0	0.114	0.8	6.5	2.8	0.104
AR65	08/05/96	0920	1	<0.05	--	<0.01	--	<0.005	19.6	<0.050	0.425	<0.005	--	6.4	0.165	0.9	7.1	3.4	0.194
AR65	08/05/96	0920	0.1	<0.05	--	<0.01	--	<0.005	21.3	<0.050	0.081	<0.005	--	7.1	0.174	1.0	7.7	3.5	0.162
AR65	08/05/96	0925	1	<0.05	--	<0.01	--	<0.005	19.2	<0.050	0.457	<0.005	--	6.5	0.179	0.9	7.1	3.4	0.184
AR65	08/05/96	0925	0.1	<0.05	--	<0.01	--	<0.005	19.4	<0.050	0.074	<0.005	--	6.5	0.155	0.9	7.1	3.3	0.134
AR65	08/19/96	1045	1	<0.05	--	<0.01	--	<0.005	25.2	<0.050	0.369	<0.005	--	8.3	0.173	1.1	8.2	4.3	0.208
AR65	08/19/96	1045	0.1	<0.05	--	<0.01	--	<0.005	26.1	<0.050	0.044	<0.005	--	8.5	0.170	1.0	8.4	4.5	0.162
AR65	08/19/96	1045	0.1	<0.05	--	<0.01	--	<0.005	24.7	<0.050	0.040	<0.005	--	8.4	0.162	1.2	8.4	4.3	0.144
AR65	09/03/96	1540	1	<0.05	--	<0.01	--	<0.005	22.9	<0.050	0.317	<0.005	--	8.0	0.106	1.1	7.8	4.5	0.104
AR65	09/03/96	1540	0.1	<0.05	--	<0.01	--	<0.005	22.5	<0.050	<0.020	<0.005	--	7.5	0.067	1.0	8.1	4.5	0.055
AR65	09/03/96	1540	0.001	<0.05	--	<0.01	--	<0.005	22.1	<0.050	<0.020	<0.005	--	7.5	0.069	1.0	9.1	4.6	0.054
AR65	09/18/96	1015	1	<0.05	--	<0.01	--	<0.005	26.5	<0.050	0.319	<0.005	--	8.1	0.149	1.1	8.0	4.4	0.228
AR65	09/18/96	1015	0.1	<0.05	--	<0.01	--	<0.005	26.4	<0.050	<0.020	<0.005	--	8.4	0.121	1.2	8.3	4.7	0.166
AR65	09/18/96	1015	0.1	<0.05	--	<0.01	--	<0.005	29.4	<0.050	<0.020	<0.005	--	9.2	0.134	1.1	8.9	4.2	0.193
AR65	09/18/96	1015	0.1	<0.05	--	<0.01	--	<0.005	27.8	<0.050	0.032	<0.005	--	8.7	0.127	1.1	8.5	4.5	0.178
AR65	09/18/96	1015	0.1	<0.05	--	<0.01	--	<0.005	26.2	<0.050	<0.020	<0.005	--	8.4	0.121	1.2	8.6	4.5	0.164
AR65	09/18/96	1015	0.1	<0.05	--	<0.01	--	<0.005	26.8	<0.050	<0.020	<0.005	--	8.4	0.122	1.1	8.2	4.1	0.168
AR65	09/18/96	1015	0.1	<0.05	--	<0.01	--	<0.005	26.6	<0.050	<0.020	<0.005	--	8.5	0.125	1.1	8.5	4.3	0.177
AR65	09/18/96	1015	0.1	<0.05	--	0.022	e	<0.005	28.7	<0.050	<0.020	<0.005	--	8.8	0.130	1.0	8.3	4.1	0.196

Table 10. Results from inductively coupled plasma atomic-emission spectroscopy for unfiltered, filtered, and ultrafiltered surface- and ground-water samples collected during 1995–96—Continued

[Site locations shown in figures 1, 2, and 3. Quality code "e" indicates value is estimated as described in Appendix 4; sequential replicates are indicated by two samples collected the same day at different times; filter size 1 = unfiltered; filter size 0.1 = 0.1 µm; filter size 0.001 = ultrafiltered; mg/L, milligrams per liter; <, less than; >, detector saturated, no value obtained; sample AR65 collected on September 18, 1996, at 10:15 a.m., filter size 0.1 is the laboratory precision sample]

Sample and site identification	Date	Time	Filter size	Aluminum (mg/L)	Aluminum quality code	Arsenic (mg/L)	Arsenic quality code	Cadmium (mg/L)	Calcium (mg/L)	Copper (mg/L)	Iron (mg/L)	Lead (mg/L)	Lead quality code	Magnesium (mg/L)	Manganese (mg/L)	Potassium (mg/L)	Silica (mg/L)	Sodium (mg/L)	Zinc (mg/L)
AR65	09/18/96	1015	0.1	<0.05	--	<0.01	--	<0.005	26.6	<0.050	<0.020	<0.005	--	8.3	0.122	1.1	8.1	4.6	0.174
AR65	09/18/96	1015	0.1	<0.05	--	<0.01	--	<0.005	26.5	<0.050	<0.020	<0.005	--	8.4	0.124	1.1	8.3	4.4	0.176
AR65	09/18/96	1015	0.1	<0.05	--	<0.01	--	<0.005	27.5	<0.050	<0.020	<0.005	--	8.6	0.125	1.0	8.2	4.3	0.186
AR65	09/18/96	1015	0.1	<0.05	--	<0.01	--	<0.005	26.3	<0.050	<0.020	<0.005	--	8.3	0.120	1.0	8.1	4.3	0.173
AR65	09/18/96	1015	0.1	<0.05	--	<0.01	--	<0.005	27.5	<0.050	<0.020	<0.005	--	8.4	0.125	1.0	8.2	4.3	0.186
AR65	09/18/96	1015	0.1	<0.05	--	<0.01	--	<0.005	27.2	<0.050	<0.020	<0.005	--	8.3	0.124	1.0	8.2	4.3	0.182
AR65	09/18/96	1015	0.1	<0.05	--	<0.01	--	<0.005	26.9	<0.050	<0.020	<0.005	--	8.9	0.136	1.0	7.6	4.4	0.175
AR65	09/18/96	1015	0.1	<0.05	--	<0.01	--	<0.005	27.1	<0.050	0.021	<0.005	--	8.7	0.128	1.0	7.8	4.4	0.172
AR65	09/18/96	1015	0.1	<0.05	--	<0.01	--	<0.005	26.6	<0.050	0.021	<0.005	--	8.2	0.114	1.1	8.0	4.5	0.176
AR65	09/18/96	1015	0.1	<0.05	--	<0.01	--	<0.005	26.0	<0.050	0.022	<0.005	--	8.3	0.124	1.0	8.0	4.2	0.172
AR65	09/18/96	1015	0.1	<0.05	--	<0.01	--	<0.005	26.3	<0.050	0.025	<0.005	--	8.5	0.126	1.1	8.2	4.7	0.175
AR65	09/18/96	1015	0.1	<0.05	--	<0.01	--	<0.005	25.7	<0.050	0.020	<0.005	--	8.3	0.124	1.0	8.0	4.6	0.169
AR65	09/18/96	1015	0.1	<0.05	--	<0.01	--	<0.005	25.5	<0.050	0.052	<0.005	--	8.4	0.131	1.0	7.7	4.4	0.172
AR65	09/27/96	1115	1	<0.05	--	<0.01	--	<0.005	24.9	<0.050	0.431	<0.005	--	9.0	0.196	1.0	7.1	4.8	0.242
AR65	09/27/96	1115	0.1	<0.05	--	<0.01	--	<0.005	24.8	<0.050	0.048	<0.005	--	8.9	0.156	1.0	7.0	4.8	0.199
AR65	09/27/96	1120	1	<0.05	--	<0.01	--	<0.005	24.8	<0.050	0.439	<0.005	--	8.9	0.192	1.0	7.0	4.8	0.240
AR65	09/27/96	1120	0.1	<0.05	--	<0.01	--	<0.005	25.1	<0.050	0.047	<0.005	--	8.3	0.137	1.0	8.1	4.8	0.184
AR67	10/26/95	1645	1	<0.05	--	<0.01	--	<0.005	22.4	<0.050	0.396	<0.005	--	7.8	0.146	1.0	8.4	4.5	0.150
AR67	10/26/95	1645	0.1	<0.05	--	<0.01	--	<0.005	23.8	<0.050	0.031	<0.005	--	7.9	0.116	1.0	8.6	4.1	0.111
AR67	10/26/95	1645	0.1	<0.05	--	<0.01	--	<0.005	22.7	<0.050	0.034	<0.005	--	7.7	0.119	1.0	8.3	4.6	0.106
AR67	05/10/96	0915	1	0.821	e	<0.01	--	0.008	16.5	<0.050	1.960	0.055	--	6.2	0.802	1.3	10.5	3.1	1.273
AR67	05/10/96	0915	0.1	<0.05	--	<0.01	--	0.006	16.0	<0.050	0.040	<0.005	--	5.9	0.631	1.1	7.6	2.9	0.983
AR67	05/10/96	0915	0.001	<0.05	--	<0.01	--	0.007	15.5	<0.050	<0.020	<0.005	--	5.9	0.662	1.0	7.4	2.7	0.906
AR67	06/05/96	1740	1	0.406	e	<0.01	--	<0.005	9.8	<0.050	0.699	0.019	e	3.2	0.113	0.7	7.0	1.3	0.184
AR67	06/05/96	1740	0.001	<0.05	--	<0.01	--	<0.005	9.6	<0.050	<0.020	<0.005	--	3.1	0.047	0.6	6.3	1.4	0.115
AR67	07/11/96	1305	1	0.124	e	<0.01	--	<0.005	14.1	<0.050	0.454	0.005	e	4.6	0.101	0.6	5.6	1.9	0.100
AR67	07/11/96	1305	0.1	<0.05	--	<0.01	--	<0.005	14.4	<0.050	0.022	<0.005	--	4.5	0.081	0.5	5.6	1.8	0.071
AR67	07/11/96	1305	0.1	<0.05	--	<0.01	--	<0.005	14.9	<0.050	0.022	<0.005	--	4.6	0.084	0.5	5.7	1.9	0.074
AR67	07/11/96	1305	0.001	<0.05	--	<0.01	--	<0.005	13.8	<0.050	<0.020	<0.005	--	4.5	0.080	0.6	5.8	1.9	0.055
AR67	09/07/96	1517	1	<0.05	--	<0.01	--	<0.005	24.5	<0.050	0.389	<0.005	--	8.0	0.134	1.1	7.7	4.4	0.144
AR67	09/07/96	1517	0.1	<0.05	--	<0.01	--	<0.005	24.6	<0.050	<0.020	<0.005	--	7.9	0.088	1.1	8.5	4.5	0.085
AR67	09/07/96	1517	0.001	<0.05	--	<0.01	--	<0.005	24.3	<0.050	<0.020	<0.005	--	7.8	0.091	1.1	9.3	4.7	0.071

Table 10. Results from inductively coupled plasma atomic-emission spectroscopy for unfiltered, filtered, and ultrafiltered surface- and ground-water samples collected during 1995–96—Continued

[Site locations shown in figures 1, 2, and 3. Quality code "e" indicates value is estimated as described in Appendix 4; sequential replicates are indicated by two samples collected the same day at different times; filter size 1 = unfiltered; filter size 0.1 = 0.1 µm; filter size 0.001 = ultrafiltered; mg/L, milligrams per liter; <, less than; >, detector saturated, no value obtained; sample AR65 collected on September 18, 1996, at 10:15 a.m., filter size 0.1 is the laboratory precision sample]

Sample and site identification	Date	Time	Filter size	Aluminum (mg/L)	Aluminum quality code	Arsenic (mg/L)	Arsenic quality code	Cadmium (mg/L)	Calcium (mg/L)	Copper (mg/L)	Iron (mg/L)	Lead (mg/L)	Lead quality code	Magnesium (mg/L)	Manganese (mg/L)	Potassium (mg/L)	Silica (mg/L)	Sodium (mg/L)	Zinc (mg/L)
AR70	07/19/95	1345	1	0.630	e	<0.01	--	<0.005	10.2	<0.050	0.851	0.068	--	3.4	0.126	0.7	8.0	1.6	0.123
AR70	07/19/95	1345	0.1	<0.05	--	<0.01	--	<0.005	10.6	<0.050	0.090	0.027	e	3.3	0.067	0.4	5.2	1.5	0.078
AR70	07/19/95	1345	0.1	<0.05	--	<0.01	--	<0.005	10.0	<0.050	0.095	0.026	e	3.3	0.069	0.5	5.0	1.6	0.072
AR70	07/26/95	1340	1	0.286	e	<0.01	--	<0.005	13.5	<0.050	0.605	0.013	e	4.4	0.127	0.6	6.8	2.0	0.126
AR70	07/26/95	1340	0.1	<0.05	--	<0.01	--	<0.005	13.5	<0.050	0.109	<0.005	--	4.2	0.091	0.5	5.5	1.6	0.083
AR70	07/26/95	1340	0.1	<0.05	--	<0.01	--	<0.005	12.9	<0.050	0.115	<0.005	--	4.2	0.093	0.5	5.3	1.9	0.076
AR70	08/02/95	1445	1	0.181	e	<0.01	--	<0.005	12.6	<0.050	0.591	0.018	e	4.2	0.122	0.6	6.3	2.1	0.101
AR70	08/02/95	1445	0.1	<0.05	--	<0.01	--	<0.005	12.9	<0.050	0.185	0.008	e	4.1	0.092	0.2	5.5	1.7	0.070
AR70	08/02/95	1445	0.1	<0.05	--	<0.01	--	<0.005	12.3	<0.050	0.194	0.006	e	4.0	0.096	0.2	5.2	1.9	0.063
AR70	08/16/95	1640	1	0.081	e	<0.01	--	<0.005	17.2	<0.050	0.440	<0.005	--	5.6	0.111	0.7	6.4	2.6	0.095
AR70	10/26/95	1725	1	<0.05	--	<0.01	--	<0.005	23.4	<0.050	0.357	<0.005	--	8.1	0.136	1.0	8.1	4.7	0.147
AR70	10/26/95	1725	0.1	<0.05	--	<0.01	--	<0.005	24.0	<0.050	0.031	<0.005	--	7.9	0.105	1.0	7.9	5.0	0.104
AR70	04/11/96	1600	1	0.355	e	<0.01	--	<0.005	22.3	<0.050	2.495	0.029	e	8.4	0.823	2.5	9.7	4.8	0.731
AR70	04/11/96	1600	0.1	<0.05	--	<0.01	--	<0.005	21.9	<0.050	0.273	<0.005	--	8.4	0.725	2.6	8.4	4.6	0.464
AR70	04/11/96	1600	1	0.345	e	<0.01	--	<0.005	21.7	<0.050	2.433	0.029	e	8.3	0.805	2.5	9.6	4.8	0.714
AR70	04/11/96	1600	0.1	<0.05	--	<0.01	--	<0.005	22.4	<0.050	0.317	<0.005	--	8.6	0.739	2.8	8.4	4.7	0.469
AR70	04/23/96	1510	1	0.511	e	<0.01	--	<0.005	19.9	<0.050	2.861	0.041	e	7.6	0.808	1.7	10.1	4.1	0.775
AR70	04/23/96	1510	0.1	<0.05	--	<0.01	--	<0.005	20.6	<0.050	<0.020	<0.005	--	7.9	0.715	1.7	8.0	4.1	0.395
AR70	05/06/96	1815	1	1.615	--	<0.01	--	0.006	16.1	<0.050	4.037	0.115	--	6.5	0.947	1.8	15.5	3.4	0.983
AR70	05/06/96	1815	0.1	<0.05	--	<0.01	--	<0.005	15.6	<0.050	0.109	<0.005	--	5.9	0.605	1.2	7.5	2.9	0.585
AR70	05/06/96	1815	0.1	<0.05	--	<0.01	--	<0.005	15.7	<0.050	0.111	<0.005	--	6.0	0.620	1.3	7.8	2.9	0.597
AR70	05/06/96	1815	0.001	0.247	e	<0.01	--	<0.005	14.8	<0.050	1.109	0.025	e	6.1	0.693	1.3	8.4	3.2	0.612
AR70	05/16/96	1230	1	1.613	--	<0.01	--	0.006	13.7	<0.050	3.094	0.101	--	5.0	0.582	1.4	14.1	2.4	0.923
AR70	05/16/96	1230	0.1	<0.05	--	<0.01	--	<0.005	13.5	<0.050	0.050	<0.005	--	4.7	0.260	1.0	7.1	2.1	0.539
AR70	05/21/96	1400	1	0.788	e	<0.01	--	<0.005	10.7	<0.050	1.347	0.071	--	3.6	0.201	0.9	9.3	1.6	0.425
AR70	05/21/96	1400	0.1	<0.05	--	<0.01	--	<0.005	10.7	<0.050	0.053	<0.005	--	3.7	0.105	0.8	6.2	1.6	0.267
AR70	05/28/96	1245	1	0.535	e	<0.01	--	<0.005	14.0	<0.050	1.134	0.029	e	4.8	0.215	0.9	9.2	2.1	0.356
AR70	05/28/96	1245	0.1	<0.05	--	<0.01	--	<0.005	14.2	<0.050	0.102	<0.005	--	4.7	0.132	0.7	6.6	1.9	0.260
AR70	05/28/96	1315	1	0.326	e	<0.01	--	<0.005	13.8	<0.050	0.746	0.016	e	4.8	0.193	0.8	8.1	2.1	0.339
AR70	05/28/96	1315	0.1	<0.05	--	<0.01	--	<0.005	14.9	<0.050	0.098	<0.005	--	4.9	0.138	0.8	6.8	2.0	0.268
AR70	06/03/96	1610	1	0.354	e	<0.01	--	<0.005	12.0	<0.050	0.930	0.016	e	4.1	0.146	0.8	8.1	1.9	0.222
AR70	06/03/96	1610	0.1	<0.05	--	<0.01	--	<0.005	12.0	<0.050	0.076	<0.005	--	4.0	0.076	0.7	5.8	1.7	0.133

Table 10. Results from inductively coupled plasma atomic-emission spectroscopy for unfiltered, filtered, and ultrafiltered surface- and ground-water samples collected during 1995–96—Continued

[Site locations shown in figures 1, 2, and 3. Quality code "e" indicates value is estimated as described in Appendix 4; sequential replicates are indicated by two samples collected the same day at different times; filter size 1 = unfiltered; filter size 0.1 = 0.1 µm; filter size 0.001 = ultrafiltered; mg/L, milligrams per liter; <, less than; >, detector saturated, no value obtained; sample AR65 collected on September 18, 1996, at 10:15 a.m., filter size 0.1 is the laboratory precision sample]

Sample and site identification	Date	Time	Filter size	Aluminum (mg/L)	Aluminum quality code	Arsenic (mg/L)	Arsenic quality code	Cadmium (mg/L)	Calcium (mg/L)	Copper (mg/L)	Iron (mg/L)	Lead (mg/L)	Lead quality code	Magnesium (mg/L)	Manganese (mg/L)	Potassium (mg/L)	Silica (mg/L)	Sodium (mg/L)	Zinc (mg/L)
AR70	06/03/96	1610	0.001	<0.05	--	<0.01	--	<0.005	11.5	<0.050	<0.020	<0.005	--	3.8	0.076	0.6	6.8	1.7	0.130
AR70	06/12/96	1410	1	0.558	e	<0.01	--	<0.005	9.9	<0.050	1.304	0.049	e	3.2	0.158	0.7	8.1	1.6	0.542
AR70	06/12/96	1410	0.1	<0.05	--	<0.01	--	<0.005	9.6	<0.050	0.029	<0.005	--	3.1	0.037	0.5	4.9	1.3	0.085
AR70	06/12/96	1420	1	0.467	e	<0.01	--	<0.005	9.7	<0.050	0.921	0.035	e	3.2	0.092	0.7	7.0	1.4	0.178
AR70	06/12/96	1420	0.1	<0.05	--	<0.01	--	<0.005	10.6	<0.050	0.038	<0.005	--	3.4	0.042	0.5	5.4	1.2	0.101
AR70	06/12/96	1420	0.1	<0.05	--	<0.01	--	<0.005	9.3	<0.050	0.032	<0.005	--	3.0	0.036	0.5	4.9	1.3	0.082
AR70	06/19/96	1405	1	0.353	e	<0.01	--	<0.005	9.5	<0.050	0.625	0.016	e	3.0	0.115	0.6	6.3	1.4	0.137
AR70	06/19/96	1405	0.1	<0.05	--	<0.01	--	<0.005	9.5	<0.050	0.030	<0.005	--	3.0	0.042	0.5	4.7	1.2	0.076
AR70	06/19/96	1430	1	0.402	e	<0.01	--	<0.005	9.5	<0.050	0.648	0.017	e	3.0	0.076	0.6	6.5	1.3	0.117
AR70	06/19/96	1430	0.1	<0.05	--	<0.01	--	<0.005	10.2	<0.050	0.047	<0.005	--	3.2	0.045	0.5	5.0	1.2	0.068
AR70	06/19/96	1430	0.1	<0.05	--	<0.01	--	<0.005	9.1	<0.050	0.042	<0.005	--	2.9	0.040	0.5	4.8	1.3	0.058
AR70	06/27/96	1215	1	0.235	e	<0.01	--	<0.005	11.6	<0.050	0.478	0.009	e	3.7	0.088	0.6	6.1	1.5	0.108
AR70	06/27/96	1215	0.1	<0.05	--	<0.01	--	<0.005	11.7	<0.050	0.073	<0.005	--	3.8	0.069	0.6	5.1	1.5	0.070
AR70	07/02/96	1245	1	0.297	e	<0.01	--	<0.005	12.2	<0.050	0.692	0.012	e	4.1	0.171	0.6	6.7	1.7	0.151
AR70	07/02/96	1245	0.1	<0.05	--	<0.01	--	<0.005	12.2	<0.050	0.066	<0.005	--	4.1	0.066	0.6	5.2	1.7	0.064
AR70	07/12/96	1505	1	0.065	e	<0.01	--	<0.005	14.2	<0.050	0.357	<0.005	--	4.7	0.089	0.6	5.5	2.0	0.085
AR70	07/12/96	1505	0.1	<0.05	--	<0.01	--	<0.005	14.9	<0.050	0.069	<0.005	--	4.7	0.073	0.6	5.6	1.9	0.069
AR70	07/12/96	1505	0.001	<0.05	--	<0.01	--	<0.005	14.2	<0.050	<0.020	<0.005	--	4.8	0.074	0.6	5.7	2.0	0.052
AR70	07/21/96	1220	1	<0.05	--	<0.01	--	<0.005	19.5	<0.050	0.346	<0.005	--	6.3	0.116	0.8	6.5	2.8	0.129
AR70	07/21/96	1220	0.1	<0.05	--	<0.01	--	<0.005	19.5	<0.050	0.055	<0.005	--	6.1	0.095	0.8	6.7	2.9	0.081
AR70	08/05/96	1250	1	<0.05	--	<0.01	--	<0.005	20.0	<0.050	0.343	<0.005	--	6.7	0.113	0.9	7.3	3.5	0.140
AR70	08/05/96	1250	0.1	<0.05	--	<0.01	--	<0.005	20.0	<0.050	0.039	<0.005	--	6.7	0.103	1.0	7.4	>	0.088
AR70	08/19/96	1300	1	<0.05	--	<0.01	--	<0.005	25.1	<0.050	0.284	<0.005	--	8.3	0.115	1.1	8.0	4.6	0.168
AR70	08/19/96	1300	0.1	<0.05	--	<0.01	--	<0.005	25.4	<0.050	0.021	<0.005	--	8.6	0.112	1.1	8.2	4.5	0.110
AR70	08/19/96	1305	1	<0.05	--	<0.01	--	<0.005	24.4	<0.050	0.305	<0.005	--	8.4	0.126	1.0	7.9	4.5	0.160
AR70	08/19/96	1305	0.1	<0.05	--	<0.01	--	<0.005	25.6	<0.050	0.022	<0.005	--	8.7	0.110	1.2	8.4	4.3	0.107
AR70	09/03/96	1655	1	<0.05	--	<0.01	--	<0.005	23.5	<0.050	0.270	<0.005	--	8.2	0.085	1.1	7.6	4.7	0.105
AR70	09/03/96	1655	0.1	<0.05	--	0.010	e	<0.005	23.1	<0.050	<0.020	<0.005	--	7.8	0.054	1.0	7.9	4.4	0.065
AR70	09/03/96	1655	0.001	<0.05	--	<0.01	--	<0.005	22.4	<0.050	<0.020	<0.005	--	7.6	0.057	1.0	8.2	4.7	0.059
AR70	09/18/96	1220	1	<0.05	--	<0.01	--	<0.005	26.0	<0.050	0.302	<0.005	--	8.5	0.124	1.1	8.0	4.5	0.188
AR70	09/18/96	1220	0.1	<0.05	--	<0.01	--	<0.005	27.2	<0.050	<0.020	<0.005	--	8.5	0.095	1.0	8.0	4.3	0.146
AR70	09/18/96	1220	0.1	<0.05	--	<0.01	--	<0.005	26.1	<0.050	<0.020	<0.005	--	8.3	0.091	1.1	7.8	4.5	0.125

Table 10. Results from inductively coupled plasma atomic-emission spectroscopy for unfiltered, filtered, and ultrafiltered surface- and ground-water samples collected during 1995–96—Continued

[Site locations shown in figures 1, 2, and 3. Quality code "e" indicates value is estimated as described in Appendix 4; sequential replicates are indicated by two samples collected the same day at different times; filter size 1 = unfiltered; filter size 0.1 = 0.1 µm; filter size 0.001 = ultrafiltered; mg/L, milligrams per liter; <, less than; >, detector saturated, no value obtained; sample AR65 collected on September 18, 1996, at 10:15 a.m., filter size 0.1 is the laboratory precision sample]

Sample and site identification	Date	Time	Filter size	Aluminum (mg/L)	Aluminum quality code	Arsenic (mg/L)	Arsenic quality code	Cadmium (mg/L)	Calcium (mg/L)	Copper (mg/L)	Iron (mg/L)	Lead (mg/L)	Lead quality code	Magnesium (mg/L)	Manganese (mg/L)	Potassium (mg/L)	Silica (mg/L)	Sodium (mg/L)	Zinc (mg/L)
AR70	09/27/96	1440	1	<0.05	--	<0.01	--	<0.005	26.0	<0.050	0.420	<0.005	--	9.3	0.155	1.0	6.7	4.8	0.178
AR70	09/27/96	1440	0.1	<0.05	--	<0.01	--	<0.005	26.0	<0.050	<0.020	<0.005	--	9.3	0.107	1.0	6.6	4.8	0.114
AWT1–1	10/23/95	1725	1	0.129	e	<0.01	--	0.006	40.5	<0.050	0.628	0.006	e	14.3	2.619	2.8	10.7	12.2	1.473
AWT1–1	10/23/95	1725	0.1	<0.05	--	<0.01	--	0.005	41.1	<0.050	0.312	<0.005	--	13.8	2.413	2.3	9.7	11.2	1.565
AWT1–1	05/07/96	1200	1	3.471	--	<0.01	--	<0.005	16.8	<0.050	1.809	0.027	e	6.8	0.335	2.1	23.3	5.6	0.491
AWT1–1	05/07/96	1200	0.1	<0.05	--	<0.01	--	<0.005	16.5	<0.050	0.028	<0.005	--	5.9	0.259	2.0	7.8	5.8	0.385
AWT1–1	05/07/96	1200	0.001	3.033	--	<0.01	--	<0.005	16.4	<0.050	1.300	0.015	e	6.6	0.297	2.1	23.9	5.4	0.428
AWT1–1	06/04/96	1100	1	0.168	e	<0.01	--	<0.005	12.4	<0.050	0.336	0.010	e	4.0	0.038	0.7	7.0	1.7	0.195
AWT1–1	06/04/96	1100	0.1	<0.05	--	<0.01	--	<0.005	12.4	<0.050	0.032	<0.005	--	4.0	0.009	0.8	6.2	1.6	0.151
AWT1–1	06/04/96	1100	0.001	<0.05	--	<0.01	--	<0.005	12.3	<0.050	<0.020	<0.005	--	3.8	0.010	0.7	6.6	1.7	0.153
AWT1–1	06/04/96	1130	1	0.234	e	<0.01	--	<0.005	12.6	<0.050	0.403	0.012	e	4.0	0.047	0.8	7.6	1.7	0.209
AWT1–1	06/04/96	1130	1	0.269	e	<0.01	--	<0.005	12.6	<0.050	0.432	0.011	e	4.1	0.049	0.8	7.8	1.8	0.208
AWT1–1	06/04/96	1130	0.1	<0.05	--	<0.01	--	<0.005	12.2	<0.050	0.027	<0.005	--	3.9	0.008	0.8	6.3	1.6	0.164
AWT1–1	06/04/96	1130	0.001	<0.05	--	<0.01	--	<0.005	12.1	<0.050	<0.020	<0.005	--	3.8	0.009	0.7	8.1	1.6	0.166
AWT1–1	07/08/96	1304	1	0.085	e	<0.01	--	<0.005	13.0	<0.050	0.371	0.015	e	4.2	0.065	0.6	5.6	1.8	0.148
AWT1–1	07/08/96	1304	0.1	<0.05	--	<0.01	--	<0.005	12.3	<0.050	0.037	<0.005	--	3.8	0.033	0.5	5.4	1.6	0.125
AWT1–1	07/08/96	1304	0.001	<0.05	--	<0.01	--	<0.005	11.9	<0.050	<0.020	<0.005	--	3.9	0.030	0.5	6.0	1.7	0.112
AWT1–1	09/04/96	0950	1	1.443	--	<0.01	--	0.009	36.3	<0.050	3.166	0.092	--	12.3	1.028	1.8	16.5	6.0	1.011
AWT1–1	09/04/96	0950	0.1	<0.05	--	<0.01	--	0.006	34.8	<0.050	0.036	<0.005	--	11.4	0.755	1.3	10.4	6.2	0.860
AWT1–1	09/04/96	0950	0.001	<0.05	--	<0.01	--	0.006	34.3	<0.050	<0.020	<0.005	--	11.6	0.800	1.4	10.8	6.0	0.852
AWT1–1	09/04/96	0950	0.001	<0.05	--	<0.01	--	0.006	33.6	<0.050	<0.020	<0.005	--	11.3	0.791	1.4	10.4	6.8	0.832
AWT1–2	10/24/95	0945	1	0.063	e	<0.01	--	0.008	51.7	<0.050	0.186	<0.005	--	23.5	0.029	2.5	13.1	10.6	2.384
AWT1–2	10/24/95	0945	0.1	<0.05	--	<0.01	--	0.009	55.0	<0.050	<0.020	<0.005	--	25.2	0.023	2.6	13.6	11.2	2.791
AWT1–2	10/24/95	0945	0.1	<0.05	--	<0.01	--	0.007	51.7	<0.050	<0.020	<0.005	--	23.3	0.019	2.9	13.5	10.4	2.386
AWT1–2	05/07/96	1305	1	<0.05	--	<0.01	--	0.007	60.5	<0.050	0.137	<0.005	--	28.1	0.023	2.3	12.4	15.6	2.832
AWT1–2	05/07/96	1305	0.1	<0.05	--	<0.01	--	0.007	62.5	<0.050	<0.020	<0.005	--	28.3	0.022	2.4	12.0	16.5	2.928
AWT1–2	05/07/96	1305	0.001	<0.05	--	<0.01	--	0.007	60.6	<0.050	<0.020	<0.005	--	27.6	0.023	2.3	12.5	16.3	2.839
AWT1–2	05/07/96	1305	0.001	<0.05	--	<0.01	--	0.008	61.2	<0.050	<0.020	<0.005	--	28.9	0.026	2.2	12.0	17.3	2.802
AWT1–2	06/04/96	1215	1	1.328	--	<0.01	--	<0.005	33.9	<0.050	0.857	0.010	e	15.6	0.042	2.0	19.9	10.3	1.035
AWT1–2	06/04/96	1215	0.1	<0.05	--	<0.01	--	<0.005	35.2	<0.050	<0.020	<0.005	--	15.3	0.028	1.9	11.2	9.5	1.087
AWT1–2	06/04/96	1215	0.1	<0.05	--	<0.01	--	<0.005	34.0	<0.050	<0.020	<0.005	--	15.5	0.025	2.1	11.4	10.0	0.985
AWT1–2	06/04/96	1215	0.001	<0.05	--	<0.01	--	<0.005	32.9	<0.050	<0.020	<0.005	--	15.3	0.028	1.8	12.1	9.9	0.984

Table 10. Results from inductively coupled plasma atomic-emission spectroscopy for unfiltered, filtered, and ultrafiltered surface- and ground-water samples collected during 1995–96—Continued

[Site locations shown in figures 1, 2, and 3. Quality code "e" indicates value is estimated as described in Appendix 4; sequential replicates are indicated by two samples collected the same day at different times; filter size 1 = unfiltered; filter size 0.1 = 0.1 µm; filter size 0.001 = ultrafiltered; mg/L, milligrams per liter; <, less than; >, detector saturated, no value obtained; sample AR65 collected on September 18, 1996, at 10:15 a.m., filter size 0.1 is the laboratory precision sample]

Sample and site identification	Date	Time	Filter size	Aluminum (mg/L)	Aluminum quality code	Arsenic (mg/L)	Arsenic quality code	Cadmium (mg/L)	Calcium (mg/L)	Copper (mg/L)	Iron (mg/L)	Lead (mg/L)	Lead quality code	Magnesium (mg/L)	Manganese (mg/L)	Potassium (mg/L)	Silica (mg/L)	Sodium (mg/L)	Zinc (mg/L)
AWT1–2	07/08/96	1410	1	0.341	e	<0.01	--	<0.005	30.3	<0.050	0.365	0.007	e	13.5	0.039	1.9	13.2	7.9	0.651
AWT1–2	07/08/96	1410	0.1	<0.05	--	<0.01	--	<0.005	31.8	<0.050	<0.020	<0.005	--	13.3	0.037	1.8	11.7	7.7	0.729
AWT1–2	07/08/96	1410	0.001	<0.05	--	<0.01	--	<0.005	30.3	<0.050	<0.020	<0.005	--	13.6	0.037	1.9	11.7	8.2	0.661
AWT1–2	07/08/96	1440	1	<0.05	--	<0.01	--	<0.005	30.5	<0.050	0.049	<0.005	--	13.7	0.039	1.9	11.6	8.3	0.663
AWT1–2	07/08/96	1440	0.1	<0.05	--	<0.01	--	<0.005	32.0	<0.050	<0.020	<0.005	--	13.4	0.038	1.8	11.7	8.0	0.758
AWT1–2	07/08/96	1440	0.001	<0.05	--	<0.01	--	<0.005	29.8	<0.050	<0.020	<0.005	--	13.6	0.037	1.9	12.8	8.3	0.647
AWT1–2	09/04/96	1040	1	<0.05	--	<0.01	--	<0.005	33.5	<0.050	0.168	0.006	e	13.9	0.031	1.9	12.0	7.6	0.784
AWT1–2	09/04/96	1040	0.1	<0.05	--	<0.01	--	<0.005	32.6	<0.050	<0.020	<0.005	--	13.3	0.037	1.9	11.8	7.2	0.805
AWT1–2	09/04/96	1040	0.001	<0.05	--	<0.01	--	<0.005	32.1	<0.050	<0.020	<0.005	--	13.1	0.037	1.8	12.3	7.3	0.788
AWT1–3	10/24/95	1040	1	1.968	--	0.512	--	0.029	72.7	<0.050	47.674	0.091	--	6.5	0.860	2.7	35.1	6.7	2.367
AWT1–3	10/24/95	1040	0.1	1.908	--	0.536	--	0.027	68.3	<0.050	50.681	0.053	--	5.8	0.784	2.5	33.0	6.1	2.348
AWT1–3	05/07/96	1500	1	25.476	--	0.078	e	0.121	103.7	0.359	71.395	1.168	--	31.5	2.297	4.6	34.1	37.9	13.176
AWT1–3	05/07/96	1500	0.1	26.565	--	0.066	e	0.120	101.7	0.349	61.245	0.476	--	30.9	2.187	4.5	31.3	>	12.780
AWT1–3	05/07/96	1500	0.001	25.564	--	0.070	e	0.126	103.2	0.372	76.632	0.700	--	31.8	2.537	4.0	32.6	>	12.640
AWT1–3	06/04/96	1320	1	17.019	--	0.019	e	0.081	76.4	0.221	51.044	0.413	--	23.7	1.478	4.6	38.7	>	7.832
AWT1–3	06/04/96	1320	0.1	16.989	--	0.021	e	0.079	78.1	0.222	46.800	0.154	--	23.5	1.411	4.8	37.0	>	7.663
AWT1–3	06/04/96	1320	0.001	16.390	--	<0.01	--	0.078	78.8	0.206	46.413	0.159	--	23.3	1.365	4.5	38.8	23.7	7.890
AWT1–3	07/08/96	1546	1	7.705	--	0.026	e	0.045	49.9	0.151	42.516	0.368	--	17.2	1.342	3.3	43.2	17.7	3.978
AWT1–3	07/08/96	1546	0.1	7.416	--	0.024	e	0.043	53.3	0.153	40.214	0.052	--	17.6	1.298	2.9	42.7	18.7	4.709
AWT1–3	07/08/96	1546	0.001	7.462	--	0.020	e	0.045	50.4	0.134	41.076	0.048	e	17.0	1.329	3.1	43.2	18.7	4.026
AWT1–3	09/04/96	1150	1	2.416	--	0.111	--	0.010	11.9	<0.050	33.695	2.074	--	5.0	0.226	2.3	40.9	6.6	0.761
AWT1–3	09/04/96	1150	0.1	0.800	e	0.086	e	0.008	12.6	<0.050	16.995	0.040	e	4.8	0.196	1.2	27.5	6.9	0.693
AWT1–3	09/04/96	1150	0.001	0.701	e	0.083	e	0.008	12.1	<0.050	17.779	0.034	e	4.6	0.200	1.2	27.4	6.1	0.655
AWT1–4	10/24/95	1225	1	0.095	e	<0.01	--	<0.005	33.9	<0.050	8.902	0.099	--	9.0	0.204	2.2	12.5	11.1	0.119
AWT1–4	10/24/95	1225	0.1	<0.05	--	<0.01	--	<0.005	30.9	<0.050	6.318	<0.005	--	8.0	0.167	1.8	10.0	10.1	0.101
AWT1–4	06/04/96	1430	1	0.118	e	<0.01	--	<0.005	36.9	<0.050	0.832	0.206	--	7.4	0.054	1.2	11.8	4.2	0.144
AWT1–4	06/04/96	1430	0.1	0.070	e	<0.01	--	<0.005	38.9	<0.050	0.450	0.107	--	7.4	0.054	1.1	11.8	3.8	0.149
AWT1–4	06/04/96	1430	0.1	0.057	e	<0.01	--	<0.005	36.9	<0.050	0.431	0.100	--	7.3	0.050	1.2	11.7	3.7	0.130
AWT1–4	06/04/96	1430	0.001	<0.05	--	<0.01	--	<0.005	36.4	<0.050	0.314	0.074	--	6.9	0.046	1.1	11.9	3.9	0.136
AWT1–4	07/08/96	1651	1	<0.05	--	<0.01	--	<0.005	22.0	<0.050	4.224	0.094	--	6.2	0.046	1.4	15.1	2.0	0.058
AWT1–4	07/08/96	1651	0.1	<0.05	--	<0.01	--	<0.005	23.2	<0.050	3.500	0.014	e	6.3	0.047	1.3	15.0	1.9	0.068
AWT1–4	07/08/96	1651	0.001	<0.05	--	<0.01	--	<0.005	21.7	<0.050	2.986	<0.005	--	6.2	0.045	1.4	15.8	2.0	0.054

Table 10. Results from inductively coupled plasma atomic-emission spectroscopy for unfiltered, filtered, and ultrafiltered surface- and ground-water samples collected during 1995–96—Continued

[Site locations shown in figures 1, 2, and 3. Quality code "e" indicates value is estimated as described in Appendix 4; sequential replicates are indicated by two samples collected the same day at different times; filter size 1 = unfiltered; filter size 0.1 = 0.1 µm; filter size 0.001 = ultrafiltered; mg/L, milligrams per liter; <, less than; >, detector saturated, no value obtained; sample AR65 collected on September 18, 1996, at 10:15 a.m., filter size 0.1 is the laboratory precision sample]

Sample and site identification	Date	Time	Filter size	Aluminum (mg/L)	Aluminum quality code	Arsenic (mg/L)	Arsenic quality code	Cadmium (mg/L)	Calcium (mg/L)	Copper (mg/L)	Iron (mg/L)	Lead (mg/L)	Lead quality code	Magnesium (mg/L)	Manganese (mg/L)	Potassium (mg/L)	Silica (mg/L)	Sodium (mg/L)	Zinc (mg/L)
AWT1–4	09/04/96	1325	1	<0.05	--	0.028	e	<0.005	41.9	<0.050	18.540	0.047	e	13.4	0.195	2.7	18.8	10.8	0.016
AWT1–4	09/04/96	1325	0.1	<0.05	--	0.029	e	<0.005	41.7	<0.050	15.827	<0.005	--	13.2	0.250	3.0	18.9	10.0	0.022
AWT1–4	09/04/96	1325	0.001	<0.05	--	0.019	e	<0.005	40.2	<0.050	12.420	<0.005	--	12.8	0.242	2.7	18.5	10.4	0.019
AWT1–4	09/04/96	1325	0.001	<0.05	--	0.020	e	<0.005	39.2	<0.050	12.662	<0.005	--	12.7	0.247	2.8	17.8	10.6	0.017
AWT2–1	10/25/95	1035	1	<0.05	--	<0.01	--	0.011	27.8	<0.050	3.086	<0.005	--	9.7	2.591	1.1	14.7	5.0	3.253
AWT2–1	10/25/95	1035	0.1	<0.05	--	<0.01	--	0.012	29.4	<0.050	2.824	<0.005	--	9.9	2.416	1.1	14.8	6.4	3.648
AWT2–1	05/08/96	1220	1	<0.05	--	<0.01	--	0.013	26.1	<0.050	2.016	<0.005	--	8.9	2.635	1.1	13.6	5.7	2.947
AWT2–1	05/08/96	1220	0.1	<0.05	--	<0.01	--	0.011	26.5	<0.050	1.767	<0.005	--	8.5	2.558	1.1	13.0	5.4	2.858
AWT2–1	05/08/96	1220	0.001	<0.05	--	<0.01	--	0.014	26.8	<0.050	2.158	<0.005	--	9.2	2.755	1.1	13.3	5.5	2.924
AWT2–1	06/05/96	1300	1	0.073	e	<0.01	--	0.008	22.5	<0.050	1.797	<0.005	--	7.3	1.948	1.1	17.2	3.6	2.665
AWT2–1	06/05/96	1300	0.1	<0.05	--	<0.01	--	0.007	21.2	<0.050	1.129	<0.005	--	6.8	1.799	1.1	15.4	3.1	2.297
AWT2–1	06/05/96	1300	0.001	<0.05	--	<0.01	--	0.006	21.8	<0.050	0.786	<0.005	--	6.8	1.737	1.1	16.6	3.4	2.428
AWT2–1	07/09/96	1440	1	<0.05	--	<0.01	--	0.006	20.6	<0.050	2.318	<0.005	--	6.6	2.731	1.2	16.7	2.5	2.916
AWT2–1	07/09/96	1440	0.1	<0.05	--	<0.01	--	<0.005	20.8	<0.050	1.632	<0.005	--	6.2	2.533	1.1	17.4	2.3	3.076
AWT2–1	07/09/96	1440	0.1	<0.05	--	<0.01	--	<0.005	21.3	<0.050	1.674	<0.005	--	6.4	2.578	1.1	17.3	2.4	3.168
AWT2–1	07/09/96	1440	0.001	<0.05	--	<0.01	--	0.006	19.9	<0.050	0.783	<0.005	--	6.3	2.625	1.1	17.6	2.4	2.733
AWT2–1	09/05/96	1430	1	<0.05	--	<0.01	--	0.006	26.9	<0.050	4.169	<0.005	--	8.5	2.972	1.4	17.7	4.8	3.239
AWT2–1	09/05/96	1430	0.1	<0.05	--	<0.01	--	0.006	27.3	<0.050	3.240	<0.005	--	8.2	2.524	1.4	19.5	4.3	3.276
AWT2–1	09/05/96	1430	0.001	<0.05	--	<0.01	--	0.006	27.1	<0.050	3.027	<0.005	--	8.1	2.627	1.4	20.9	4.7	3.277
AWT2–2	10/25/95	0940	1	<0.05	--	<0.01	--	<0.005	29.7	<0.050	0.332	<0.005	--	10.3	9.060	1.3	11.1	5.8	0.702
AWT2–2	10/25/95	0940	0.1	<0.05	--	<0.01	--	<0.005	30.6	<0.050	0.304	<0.005	--	10.4	9.182	1.3	10.9	6.0	0.769
AWT2–2	05/08/96	1105	1	5.938	--	<0.01	--	<0.005	35.4	<0.050	2.342	0.006	e	12.2	12.442	2.0	48.6	9.6	0.966
AWT2–2	05/08/96	1105	0.1	<0.05	--	<0.01	--	<0.005	33.6	<0.050	<0.020	<0.005	--	11.2	11.550	1.8	11.6	8.1	0.916
AWT2–2	05/08/96	1105	0.1	<0.05	--	<0.01	--	<0.005	34.6	<0.050	<0.020	<0.005	--	11.3	11.800	1.7	11.8	8.1	0.960
AWT2–2	05/08/96	1105	0.001	<0.05	--	<0.01	--	<0.005	34.1	<0.050	<0.020	<0.005	--	11.9	12.604	1.7	13.6	8.5	0.823
AWT2–2	06/05/96	1135	1	1.519	--	<0.01	--	<0.005	16.5	<0.050	1.717	<0.005	--	4.9	12.258	1.8	21.6	4.6	0.426
AWT2–2	06/05/96	1135	0.1	<0.05	--	<0.01	--	<0.005	15.8	<0.050	0.124	<0.005	--	4.5	11.041	1.8	9.9	3.9	0.355
AWT2–2	06/05/96	1135	0.001	<0.05	--	<0.01	--	<0.005	16.1	<0.050	<0.020	<0.005	--	4.6	12.232	1.6	10.4	3.8	0.371
AWT2–2	07/09/96	1335	1	2.324	--	<0.01	--	<0.005	17.5	<0.050	5.901	0.028	e	5.4	11.751	1.8	24.6	4.2	0.297
AWT2–2	07/09/96	1335	0.1	<0.05	--	<0.01	--	<0.005	17.6	<0.050	2.888	<0.005	--	4.9	11.195	1.6	10.1	3.7	0.239
AWT2–2	07/09/96	1335	0.001	<0.05	--	<0.01	--	<0.005	16.4	<0.050	0.389	<0.005	--	4.8	11.095	1.7	9.8	3.8	0.162
AWT2–2	09/05/96	1325	1	<0.05	--	<0.01	--	<0.005	23.7	<0.050	1.447	<0.005	--	8.2	10.971	1.1	10.3	5.1	0.482

Table 10. Results from inductively coupled plasma atomic-emission spectroscopy for unfiltered, filtered, and ultrafiltered surface- and ground-water samples collected during 1995–96—Continued

[Site locations shown in figures 1, 2, and 3. Quality code "e" indicates value is estimated as described in Appendix 4; sequential replicates are indicated by two samples collected the same day at different times; filter size 1 = unfiltered; filter size 0.1 = 0.1 µm; filter size 0.001 = ultrafiltered; mg/L, milligrams per liter; <, less than; >, detector saturated, no value obtained; sample AR65 collected on September 18, 1996, at 10:15 a.m., filter size 0.1 is the laboratory precision sample]

Sample and site identification	Date	Time	Filter size	Aluminum (mg/L)	Aluminum quality code	Arsenic (mg/L)	Arsenic quality code	Cadmium (mg/L)	Calcium (mg/L)	Copper (mg/L)	Iron (mg/L)	Lead (mg/L)	Lead quality code	Magnesium (mg/L)	Manganese (mg/L)	Potassium (mg/L)	Silica (mg/L)	Sodium (mg/L)	Zinc (mg/L)
AWT2–2	09/05/96	1325	0.1	<0.05	--	<0.01	--	<0.005	23.9	<0.050	1.246	<0.005	--	7.7	9.406	1.1	11.1	5.1	0.485
AWT2–2	09/05/96	1325	0.001	<0.05	--	<0.01	--	<0.005	23.6	<0.050	1.060	<0.005	--	7.7	10.039	1.1	11.7	4.9	0.476
AWT2–3	10/24/95	1605	1	<0.05	--	<0.01	--	0.019	38.9	<0.050	0.138	0.010	e	17.6	0.422	2.0	14.5	8.0	2.583
AWT2–3	10/24/95	1605	0.1	<0.05	--	<0.01	--	0.019	38.5	<0.050	<0.020	<0.005	--	17.5	0.409	2.0	14.4	8.0	2.775
AWT2–3	05/08/96	1020	1	0.105	e	<0.01	--	0.017	28.7	<0.050	0.068	0.006	e	12.9	0.142	1.8	11.6	9.5	2.872
AWT2–3	05/08/96	1020	0.1	0.105	e	<0.01	--	0.016	29.6	<0.050	<0.020	<0.005	--	13.0	0.137	1.8	11.3	9.0	2.908
AWT2–3	06/05/96	1030	1	0.083	e	<0.01	--	0.017	40.9	<0.050	0.050	<0.005	--	19.4	0.047	1.9	11.5	11.6	3.275
AWT2–3	06/05/96	1030	0.1	0.075	e	<0.01	--	0.016	40.8	<0.050	<0.020	<0.005	--	19.4	0.044	2.2	11.2	11.8	3.089
AWT2–3	06/05/96	1030	0.001	<0.05	--	<0.01	--	0.017	40.4	<0.050	<0.020	<0.005	--	19.7	0.047	1.9	11.8	11.5	3.227
AWT2–3	07/09/96	1225	1	<0.05	--	<0.01	--	0.009	29.1	<0.050	0.056	0.007	e	14.2	0.011	1.7	10.9	8.6	1.489
AWT2–3	07/09/96	1225	0.1	<0.05	--	<0.01	--	0.008	30.7	<0.050	<0.020	<0.005	--	14.1	0.011	1.7	11.5	8.6	1.696
AWT2–3	07/09/96	1225	0.001	<0.05	--	<0.01	--	0.009	29.4	<0.050	<0.020	<0.005	--	14.2	0.011	1.7	12.1	8.5	1.512
AWT2–3	09/05/96	1140	1	<0.05	--	<0.01	--	0.012	30.4	<0.050	0.155	0.023	e	14.5	0.122	1.8	12.6	8.0	1.891
AWT2–3	09/05/96	1140	0.1	0.054	e	<0.01	--	0.012	31.1	<0.050	<0.020	<0.005	--	14.2	0.143	1.9	13.8	7.5	1.992
AWT2–3	09/05/96	1140	0.1	<0.05	--	<0.01	--	0.012	32.5	<0.050	<0.020	<0.005	--	14.2	0.148	1.9	13.9	7.3	2.082
AWT2–3	09/05/96	1140	0.001	<0.05	--	<0.01	--	0.012	30.3	<0.050	<0.020	<0.005	--	13.9	0.143	1.8	14.1	7.8	1.960
AWT2–3	09/05/96	1140	0.001	<0.05	--	<0.01	--	0.012	30.5	<0.050	<0.020	<0.005	--	13.7	0.146	1.9	13.4	7.9	1.896
AWT2–3	09/05/96	1230	1	0.289	e	<0.01	--	0.016	33.6	<0.050	0.817	0.108	--	16.1	0.234	2.1	14.7	9.4	2.269
AWT2–3	09/05/96	1230	0.1	0.093	e	<0.01	--	0.017	33.6	<0.050	<0.020	<0.005	--	15.6	0.279	2.1	13.8	9.1	2.564
AWT2–3	09/05/96	1230	0.001	<0.05	--	<0.01	--	0.017	32.5	<0.050	<0.020	<0.005	--	15.5	0.286	2.0	14.1	9.3	2.538
AWT2–4	10/24/95	1500	1	112.879	--	0.039	e	0.413	165.4	1.152	112.154	0.583	--	59.3	7.000	13.4	84.4	>	28.749
AWT2–4	10/24/95	1500	0.1	37.639	--	<0.01	--	0.249	69.8	0.442	41.133	0.202	--	24.2	2.869	2.8	80.8	26.9	12.670
AWT2–4	10/24/95	1500	0.1	37.305	--	0.017	e	0.243	71.7	0.447	38.380	0.213	--	24.7	2.687	3.0	81.1	>	12.592
AWT2–4	05/08/96	0930	1	15.492	--	<0.01	--	0.108	42.9	0.166	6.161	0.224	--	15.9	2.292	0.6	47.9	12.8	6.506
AWT2–4	05/08/96	0930	0.1	16.341	--	<0.01	--	0.111	43.5	0.171	5.971	0.230	--	15.8	2.222	0.6	49.0	13.2	6.492
AWT2–4	06/05/96	0910	1	32.668	--	<0.01	--	0.142	54.4	0.271	6.733	0.265	--	23.9	3.585	1.0	67.3	14.5	10.232
AWT2–4	06/05/96	0910	1	31.703	--	<0.01	--	0.136	53.4	0.269	6.690	0.254	--	23.4	3.638	1.0	67.0	14.6	9.717
AWT2–4	06/05/96	0910	0.1	31.743	--	<0.01	--	0.130	53.9	0.296	6.345	0.252	--	23.6	3.420	1.1	65.2	14.9	9.555
AWT2–4	06/05/96	0910	0.001	31.034	--	<0.01	--	0.135	54.8	0.256	6.397	0.264	--	23.4	3.427	1.0	69.5	14.7	9.896
AWT2–4	07/09/96	1120	1	28.888	--	<0.01	--	0.116	54.1	0.346	9.019	0.117	--	24.2	4.020	1.3	73.5	14.4	9.182
AWT2–4	07/09/96	1120	0.1	28.010	--	<0.01	--	0.112	54.6	0.303	8.241	0.117	--	23.9	3.899	1.3	76.1	13.7	9.875
AWT2–4	07/09/96	1120	0.001	29.622	--	<0.01	--	0.115	53.9	0.331	8.882	0.119	--	24.8	3.988	1.3	74.5	14.4	9.031

Table 10. Results from inductively coupled plasma atomic-emission spectroscopy for unfiltered, filtered, and ultrafiltered surface- and ground-water samples collected during 1995–96—Continued

[Site locations shown in figures 1, 2, and 3. Quality code "e" indicates value is estimated as described in Appendix 4; sequential replicates are indicated by two samples collected the same day at different times; filter size 1 = unfiltered; filter size 0.1 = 0.1 µm; filter size 0.001 = ultrafiltered; mg/L, milligrams per liter; <, less than; >, detector saturated, no value obtained; sample AR65 collected on September 18, 1996, at 10:15 a.m., filter size 0.1 is the laboratory precision sample]

Sample and site identification	Date	Time	Filter size	Aluminum (mg/L)	Aluminum quality code	Arsenic (mg/L)	Arsenic quality code	Cadmium (mg/L)	Calcium (mg/L)	Copper (mg/L)	Iron (mg/L)	Lead (mg/L)	Lead quality code	Magnesium (mg/L)	Manganese (mg/L)	Potassium (mg/L)	Silica (mg/L)	Sodium (mg/L)	Zinc (mg/L)
AWT2–4	09/05/96	1000	1	20.914	--	<0.01	--	0.114	40.7	0.311	15.732	0.053	--	17.9	2.679	1.1	79.0	15.0	6.116
AWT2–4	09/05/96	1000	0.1	19.976	--	0.011	e	0.104	39.1	0.279	13.081	0.057	--	16.7	2.198	1.2	80.0	13.9	6.041
AWT2–4	09/05/96	1000	0.001	19.779	--	<0.01	--	0.105	38.4	0.276	14.049	0.049	e	16.7	2.317	1.2	82.6	15.9	5.879
AWT2–5	10/24/95	1315	1	0.225	e	0.076	e	0.007	72.3	<0.050	74.065	0.027	e	19.7	3.370	3.6	36.2	12.1	1.859
AWT2–5	10/24/95	1315	0.1	<0.05	--	0.065	e	0.006	66.0	<0.050	62.369	<0.005	--	17.8	3.024	3.1	34.9	11.8	1.814
AWT2–5	10/24/95	1320	1	0.103	e	0.075	e	0.007	73.0	<0.050	72.425	0.018	e	19.8	3.353	3.5	37.5	12.3	1.880
AWT2–5	10/24/95	1320	0.1	<0.05	--	0.059	e	0.007	65.1	<0.050	60.400	<0.005	--	18.0	3.012	3.1	36.0	12.7	1.846
AWT2–5	05/07/96	1630	1	1.489	--	0.013	e	0.212	78.5	<0.050	14.487	0.183	--	11.7	1.903	9.8	26.6	>	4.877
AWT2–5	05/07/96	1630	0.1	0.941	e	0.017	e	0.207	89.6	<0.050	14.621	0.082	--	12.8	2.037	10.7	26.5	>	5.575
AWT2–5	05/07/96	1630	0.1	0.955	e	0.012	e	0.211	90.7	<0.050	15.102	0.083	--	13.1	2.107	10.9	27.7	>	5.694
AWT2–5	06/04/96	1550	1	0.482	e	0.014	e	0.089	66.7	<0.050	17.638	0.053	--	14.8	2.349	8.9	27.3	31.2	4.491
AWT2–5	06/04/96	1550	1	0.500	e	0.015	e	0.088	64.7	<0.050	18.024	0.052	--	14.7	2.449	9.2	26.6	>	4.340
AWT2–5	06/04/96	1550	0.1	0.180	e	0.022	e	0.071	64.1	<0.050	19.648	0.009	e	14.8	2.388	9.7	24.9	>	4.545
AWT2–5	06/04/96	1550	0.001	<0.05	--	0.023	e	0.071	63.8	<0.050	20.233	0.006	e	14.5	2.421	8.1	25.7	29.5	4.665
AWT2–5	07/09/96	1005	1	<0.05	--	0.039	e	0.037	58.5	<0.050	46.677	0.015	e	17.5	3.511	5.3	31.1	20.2	8.062
AWT2–5	07/09/96	1005	0.1	0.091	e	0.048	e	0.038	60.9	<0.050	43.031	0.013	e	16.9	3.305	5.1	32.4	19.5	8.834
AWT2–5	07/09/96	1005	0.001	0.082	e	0.033	e	0.038	58.1	<0.050	43.301	0.010	e	16.6	3.250	5.1	32.1	19.9	7.789
AWT2–5	09/04/96	1530	1	<0.05	--	0.061	e	0.010	44.7	<0.050	47.453	0.022	e	13.4	2.679	4.4	30.6	16.6	4.935
AWT2–5	09/04/96	1530	0.1	<0.05	--	0.056	e	0.007	41.5	<0.050	38.389	<0.005	--	12.9	2.432	4.4	29.6	16.2	5.005
AWT2–5	09/04/96	1530	0.1	<0.05	--	0.044	e	0.007	42.4	<0.050	39.395	<0.005	--	12.5	2.462	4.1	29.9	14.8	5.156
AWT2–5	09/04/96	1530	0.001	<0.05	--	0.041	e	0.005	42.4	<0.050	39.850	<0.005	--	12.5	2.518	4.1	30.4	16.3	4.945
AWT2–5	09/04/96	1530	0.001	<0.05	--	0.042	e	0.006	41.5	<0.050	40.283	<0.005	--	12.9	2.572	4.3	29.9	16.8	4.953
AWT3–1	10/25/95	1135	1	<0.05	--	<0.01	--	0.005	22.6	<0.050	0.195	<0.005	--	8.0	<0.005	0.8	6.6	4.9	0.807
AWT3–1	10/25/95	1135	0.1	<0.05	--	<0.01	--	<0.005	22.6	<0.050	<0.020	<0.005	--	8.0	<0.005	0.8	6.7	4.9	0.867
AWT3–1	05/08/96	1340	1	21.770	--	<0.01	--	<0.005	19.6	<0.050	6.433	0.015	e	9.3	0.030	2.4	152.7	14.9	0.600
AWT3–1	05/08/96	1340	0.1	<0.05	--	<0.01	--	<0.005	14.8	<0.050	<0.020	<0.005	--	5.0	0.007	1.5	7.6	11.3	0.434
AWT3–1	06/05/96	1415	1	3.082	--	<0.01	--	<0.005	11.0	<0.050	1.469	0.017	e	3.5	0.079	1.5	25.0	2.6	0.180
AWT3–1	06/05/96	1415	1	3.273	--	<0.01	--	<0.005	11.0	<0.050	1.522	0.016	e	3.6	0.079	1.6	27.0	2.7	0.166
AWT3–1	06/05/96	1415	0.1	<0.05	--	<0.01	--	<0.005	10.5	<0.050	0.029	<0.005	--	3.0	0.031	1.4	5.6	2.1	0.077
AWT3–1	06/05/96	1415	0.001	<0.05	--	<0.01	--	<0.005	10.0	<0.050	<0.020	<0.005	--	2.9	0.031	1.3	5.7	2.3	0.085
AWT3–1	07/09/96	1600	1	1.266	--	<0.01	--	<0.005	13.1	<0.050	1.216	0.028	e	3.9	0.073	0.8	12.5	1.9	0.102
AWT3–1	07/09/96	1600	0.1	<0.05	--	<0.01	--	<0.005	13.4	<0.050	0.024	<0.005	--	3.8	0.009	0.7	5.6	1.8	0.057

Table 10. Results from inductively coupled plasma atomic-emission spectroscopy for unfiltered, filtered, and ultrafiltered surface- and ground-water samples collected during 1995–96—Continued

[Site locations shown in figures 1, 2, and 3. Quality code "e" indicates value is estimated as described in Appendix 4; sequential replicates are indicated by two samples collected the same day at different times; filter size 1 = unfiltered; filter size 0.1 = 0.1 μm; filter size 0.001 = ultrafiltered; mg/L, milligrams per liter; <, less than; >, detector saturated, no value obtained; sample AR65 collected on September 18, 1996, at 10:15 a.m., filter size 0.1 is the laboratory precision sample]

Sample and site identification	Date	Time	Filter size	Aluminum (mg/L)	Aluminum quality code	Arsenic (mg/L)	Arsenic quality code	Cadmium (mg/L)	Calcium (mg/L)	Copper (mg/L)	Iron (mg/L)	Lead (mg/L)	Lead quality code	Magnesium (mg/L)	Manganese (mg/L)	Potassium (mg/L)	Silica (mg/L)	Sodium (mg/L)	Zinc (mg/L)
AWT3–1	07/09/96	1600	0.001	<0.05	--	<0.01	--	<0.005	12.8	<0.050	<0.020	<0.005	--	3.7	0.009	0.7	5.6	1.9	0.041
AWT3–1	09/05/96	1600	1	0.153	e	<0.01	--	0.007	23.6	<0.050	0.134	<0.005	--	8.3	0.662	1.0	8.2	4.9	0.717
AWT3–1	09/05/96	1600	0.1	<0.05	--	<0.01	--	0.006	24.5	<0.050	<0.020	<0.005	--	7.9	0.534	1.0	7.5	4.4	0.720
AWT3–1	09/05/96	1600	0.001	<0.05	--	<0.01	--	0.006	23.2	<0.050	<0.020	<0.005	--	7.7	0.539	1.0	7.8	4.7	0.692
AWT3–2	10/25/95	1230	1	<0.05	--	<0.01	--	<0.005	24.1	<0.050	0.037	<0.005	--	8.4	0.280	0.6	7.3	4.6	1.260
AWT3–2	10/25/95	1230	0.1	<0.05	--	<0.01	--	<0.005	24.4	<0.050	<0.020	<0.005	--	8.4	0.286	0.6	7.6	4.6	1.381
AWT3–2	05/08/96	1515	1	0.300	e	<0.01	--	<0.005	20.0	<0.050	0.114	<0.005	--	6.9	0.074	0.9	10.5	4.6	0.937
AWT3–2	05/08/96	1515	0.1	<0.05	--	<0.01	--	<0.005	20.8	<0.050	<0.020	<0.005	--	6.9	0.069	1.0	8.5	4.5	0.956
AWT3–2	06/05/96	1518	1	<0.05	--	<0.01	--	<0.005	12.8	<0.050	0.031	<0.005	--	4.2	<0.005	0.9	7.8	1.8	0.331
AWT3–2	06/05/96	1518	0.1	<0.05	--	<0.01	--	<0.005	13.5	<0.050	<0.020	<0.005	--	4.5	<0.005	1.0	8.3	2.0	0.363
AWT3–2	06/05/96	1518	0.001	<0.05	--	<0.01	--	<0.005	12.6	<0.050	<0.020	<0.005	--	4.2	<0.005	0.9	8.7	1.8	0.371
AWT3–2	07/09/96	1715	1	<0.05	--	<0.01	--	<0.005	14.4	<0.050	<0.020	<0.005	--	4.6	0.055	0.8	7.8	1.8	0.659
AWT3–2	07/09/96	1715	0.1	<0.05	--	<0.01	--	<0.005	15.0	<0.050	<0.020	<0.005	--	4.7	0.051	0.8	8.1	1.7	0.717
AWT3–2	07/09/96	1715	0.001	<0.05	--	<0.01	--	<0.005	13.9	<0.050	<0.020	<0.005	--	4.6	0.043	0.8	7.9	1.8	0.624
AWT3–2	09/06/96	0955	1	<0.05	--	<0.01	--	0.006	24.2	<0.050	<0.020	<0.005	--	8.7	0.309	0.8	7.9	4.8	1.413
AWT3–2	09/06/96	0955	0.1	<0.05	--	0.013	e	0.006	25.3	<0.050	<0.020	<0.005	--	8.3	0.385	0.9	9.6	4.8	1.512
AWT3–2	09/06/96	0955	0.001	<0.05	--	<0.01	--	0.006	23.9	<0.050	<0.020	<0.005	--	8.0	0.394	0.8	9.3	4.5	1.460
AWT3–3	06/05/96	1620	1	<0.05	--	<0.01	--	<0.005	30.1	<0.050	0.036	<0.005	--	11.6	<0.005	1.8	10.8	6.2	0.435
AWT3–3	06/05/96	1620	0.1	<0.05	--	<0.01	--	<0.005	30.6	<0.050	<0.020	<0.005	--	11.7	<0.005	2.1	10.7	6.0	0.417
AWT3–3	06/05/96	1620	0.001	<0.05	--	<0.01	--	<0.005	29.9	<0.050	<0.020	<0.005	--	11.7	<0.005	1.8	11.4	6.5	0.437
AWT3–4	10/25/95	1330	1	3.145	--	<0.01	--	0.045	26.8	0.078	1.364	0.017	e	11.4	0.889	1.5	27.8	7.5	6.854
AWT3–4	10/25/95	0330	0.1	3.247	--	<0.01	--	0.042	26.2	0.061	1.132	0.010	e	10.8	0.770	1.7	29.0	7.4	6.532
AWT3–4	05/08/96	1635	1	1.921	--	<0.01	--	0.019	22.3	<0.050	0.528	<0.005	--	9.7	0.331	1.1	16.0	8.2	3.855
AWT3–4	05/08/96	1635	0.1	2.004	--	<0.01	--	0.019	23.0	<0.050	0.477	<0.005	--	9.4	0.311	1.1	15.3	8.3	3.794
AWT3–4	05/08/96	1635	0.1	1.982	--	<0.01	--	0.019	23.5	<0.050	0.489	0.005	e	9.6	0.320	1.0	15.6	8.2	3.989
AWT3–4	05/08/96	1640	1	1.905	--	<0.01	--	0.019	23.0	<0.050	0.546	0.005	e	9.4	0.319	1.1	15.8	8.5	3.819
AWT3–4	05/08/96	1640	0.1	1.988	--	<0.01	--	0.019	23.4	<0.050	0.486	0.006	e	9.6	0.317	1.0	15.3	8.0	3.946
AWT3–4	06/06/96	0930	1	4.518	--	<0.01	--	0.028	41.7	0.067	1.025	0.022	e	17.9	0.413	1.3	21.5	8.6	4.369
AWT3–4	06/06/96	0930	0.001	4.450	--	<0.01	--	0.027	40.8	0.068	0.922	0.013	e	17.7	0.408	1.3	22.0	8.5	4.230
AWT3–4	07/10/96	1000	1	2.763	--	<0.01	--	0.021	31.6	0.070	1.250	0.009	e	15.2	0.344	1.8	24.6	8.3	3.074
AWT3–4	07/10/96	1000	0.1	2.675	--	0.015	e	0.021	33.4	0.069	1.190	0.012	e	15.0	0.343	1.7	26.3	8.6	3.512
AWT3–4	07/10/96	1000	0.001	2.636	--	<0.01	--	0.021	31.2	0.056	1.209	0.008	e	14.7	0.344	1.7	24.9	8.4	3.059

Table 10. Results from inductively coupled plasma atomic-emission spectroscopy for unfiltered, filtered, and ultrafiltered surface- and ground-water samples collected during 1995–96—Continued

[Site locations shown in figures 1, 2, and 3. Quality code "e" indicates value is estimated as described in Appendix 4; sequential replicates are indicated by two samples collected the same day at different times; filter size 1 = unfiltered; filter size 0.1 = 0.1 µm; filter size 0.001 = ultrafiltered; mg/L, milligrams per liter; <, less than; >, detector saturated, no value obtained; sample AR65 collected on September 18, 1996, at 10:15 a.m., filter size 0.1 is the laboratory precision sample]

Sample and site identification	Date	Time	Filter size	Aluminum (mg/L)	Aluminum quality code	Arsenic (mg/L)	Arsenic quality code	Cadmium (mg/L)	Calcium (mg/L)	Copper (mg/L)	Iron (mg/L)	Lead (mg/L)	Lead quality code	Magnesium (mg/L)	Manganese (mg/L)	Potassium (mg/L)	Silica (mg/L)	Sodium (mg/L)	Zinc (mg/L)
AWT3–4	09/06/96	1110	1	1.379	--	<0.01	--	0.016	22.9	<0.050	0.771	0.021	e	10.9	0.261	2.0	22.5	7.4	2.214
AWT3–4	09/06/96	1110	0.1	1.473	--	0.012	e	0.014	22.9	<0.050	0.729	0.017	e	10.6	0.244	2.0	23.4	7.2	2.268
AWT3–4	09/06/96	1110	0.001	1.481	--	<0.01	--	0.015	23.6	<0.050	0.806	0.018	e	11.3	0.269	2.1	25.2	7.9	2.388
AWT3–5	10/25/95	1430	1	3.993	--	<0.01	--	0.017	42.9	0.125	26.235	0.016	e	13.7	1.973	1.3	25.3	8.1	2.731
AWT3–5	10/25/95	1430	0.1	3.501	--	<0.01	--	0.015	39.8	0.106	23.626	0.013	e	13.2	1.890	1.3	22.0	8.2	2.417
AWT3–5	05/09/96	0950	1	21.796	--	<0.01	--	0.051	57.6	0.242	56.559	0.009	e	25.7	2.174	1.0	32.5	10.7	6.485
AWT3–5	05/09/96	0950	0.1	23.911	--	<0.01	--	0.054	56.9	0.253	54.367	0.006	e	25.1	2.088	1.0	32.9	11.0	6.695
AWT3–5	05/09/96	0950	0.001	23.452	--	<0.01	--	0.058	58.9	0.280	61.915	0.012	e	26.4	2.214	1.0	32.6	10.7	6.560
AWT3–5	06/06/96	1035	1	13.747	--	<0.01	--	0.045	36.4	0.306	81.109	<0.005	--	15.7	1.549	0.3	31.7	10.1	5.496
AWT3–5	06/06/96	1035	0.001	13.290	--	<0.01	--	0.044	38.0	0.283	75.377	0.005	e	16.2	1.427	0.4	33.8	10.4	5.442
AWT3–5	07/10/96	1105	1	6.009	--	<0.01	--	0.020	27.1	0.131	30.371	<0.005	--	12.2	0.804	0.7	24.7	9.2	2.611
AWT3–5	07/10/96	1105	0.1	5.581	--	<0.01	--	0.020	27.6	0.132	27.760	<0.005	--	12.3	0.794	0.7	22.9	9.0	2.443
AWT3–5	07/10/96	1105	0.001	5.565	--	<0.01	--	0.021	26.1	0.137	27.975	<0.005	--	12.3	0.767	0.7	21.5	9.3	2.131
AWT3–5	09/06/96	1230	1	<0.05	--	<0.01	--	<0.005	34.4	<0.050	7.914	<0.005	--	14.1	1.725	2.3	19.1	8.4	0.201
AWT3–5	09/06/96	1230	0.1	<0.05	--	<0.01	--	<0.005	32.7	<0.050	5.907	<0.005	--	13.1	1.520	2.2	17.8	8.1	0.285
AWT3–5	09/06/96	1230	0.001	<0.05	--	<0.01	--	<0.005	32.1	<0.050	5.594	<0.005	--	13.1	1.549	2.1	18.0	8.0	0.289
AWT3–6	10/25/95	1550	1	<0.05	--	<0.01	--	<0.005	92.5	<0.050	1.269	<0.005	--	29.6	0.864	4.0	18.1	31.1	<0.01
AWT3–6	10/25/95	1550	0.1	<0.05	--	<0.01	--	<0.005	96.8	<0.050	0.919	<0.005	--	29.3	0.822	4.0	18.2	27.0	<0.01
AWT3–6	05/09/96	1115	1	0.304	e	<0.01	--	<0.005	86.7	<0.050	0.564	<0.005	--	25.5	0.333	3.1	16.7	16.6	<0.01
AWT3–6	05/09/96	1115	0.1	<0.05	--	<0.01	--	<0.005	88.9	<0.050	0.157	<0.005	--	25.2	0.326	3.1	15.0	16.9	<0.01
AWT3–6	05/09/96	1115	0.001	<0.05	--	<0.01	--	<0.005	89.2	<0.050	0.076	<0.005	--	26.7	0.341	3.1	14.8	18.1	<0.01
AWT3–6	06/06/96	1135	1	0.072	e	<0.01	--	<0.005	94.3	<0.050	0.494	<0.005	--	27.4	0.453	3.7	17.7	19.1	<0.01
AWT3–6	06/06/96	1135	1	<0.05	--	<0.01	--	<0.005	89.0	<0.050	0.474	<0.005	--	26.7	0.447	3.8	17.0	19.0	<0.01
AWT3–6	06/06/96	1135	0.1	<0.05	--	<0.01	--	<0.005	85.9	<0.050	0.227	<0.005	--	25.3	0.423	4.2	16.7	>	<0.01
AWT3–6	06/06/96	1135	0.001	<0.05	--	<0.01	--	<0.005	93.2	<0.050	0.164	<0.005	--	27.0	0.437	3.9	17.9	19.2	<0.01
AWT3–6	07/10/96	1205	1	<0.05	--	<0.01	--	<0.005	105.6	<0.050	1.723	<0.005	--	32.6	0.740	4.7	21.2	22.4	<0.01
AWT3–6	07/10/96	1205	0.1	<0.05	--	<0.01	--	<0.005	109.3	<0.050	1.312	<0.005	--	32.2	0.721	4.7	21.6	20.6	<0.01
AWT3–6	07/10/96	1205	0.001	<0.05	--	<0.01	--	<0.005	99.3	<0.050	0.764	<0.005	--	30.9	0.668	4.7	22.3	21.7	<0.01
AWT3–6	09/06/96	1435	1	<0.05	--	<0.01	--	<0.005	91.1	<0.050	2.742	<0.005	--	28.9	1.105	3.9	22.8	9.6	<0.01
AWT3–6	09/06/96	1435	0.1	<0.05	--	0.011	e	<0.005	86.4	<0.050	1.883	<0.005	--	26.3	0.964	4.1	22.2	9.2	<0.01
AWT3–6	09/06/96	1435	0.001	<0.05	--	<0.01	--	<0.005	87.5	<0.050	1.477	<0.005	--	27.1	1.023	3.8	22.8	9.6	<0.01
AWT4–1	10/26/95	1305	1	<0.05	--	<0.01	--	0.012	37.3	<0.050	0.029	<0.005	--	14.6	0.204	1.6	9.9	7.7	1.095

Table 10. Results from inductively coupled plasma atomic-emission spectroscopy for unfiltered, filtered, and ultrafiltered surface- and ground-water samples collected during 1995–96—Continued

[Site locations shown in figures 1, 2, and 3. Quality code "e" indicates value is estimated as described in Appendix 4; sequential replicates are indicated by two samples collected the same day at different times; filter size 1 = unfiltered; filter size 0.1 = 0.1 µm; filter size 0.001 = ultrafiltered; mg/L, milligrams per liter; <, less than; >, detector saturated, no value obtained; sample AR65 collected on September 18, 1996, at 10:15 a.m., filter size 0.1 is the laboratory precision sample]

Sample and site identification	Date	Time	Filter size	Aluminum (mg/L)	Aluminum quality code	Arsenic (mg/L)	Arsenic quality code	Cadmium (mg/L)	Calcium (mg/L)	Copper (mg/L)	Iron (mg/L)	Lead (mg/L)	Lead quality code	Magnesium (mg/L)	Manganese (mg/L)	Potassium (mg/L)	Silica (mg/L)	Sodium (mg/L)	Zinc (mg/L)
AWT4–1	10/26/95	1305	0.1	<0.05	--	<0.01	--	0.012	38.3	<0.050	<0.020	<0.005	--	14.3	0.193	1.6	9.9	7.8	1.157
AWT4–1	05/09/96	1732	1	8.071	--	<0.01	--	<0.005	14.9	<0.050	3.625	0.005	e	6.7	0.014	1.4	66.2	11.0	0.422
AWT4–1	05/09/96	1732	0.1	<0.05	--	<0.01	--	<0.005	12.1	<0.050	<0.020	<0.005	--	4.5	<0.005	1.2	7.5	9.9	0.275
AWT4–1	05/09/96	1732	0.001	<0.05	--	<0.01	--	<0.005	11.6	<0.050	<0.020	<0.005	--	4.4	<0.005	1.2	8.3	9.7	0.269
AWT4–1	05/09/96	1732	0.001	<0.05	--	<0.01	--	<0.005	13.0	<0.050	<0.020	<0.005	--	5.0	<0.005	1.3	8.5	12.0	0.287
AWT4–1	06/07/96	1030	1	0.496	e	<0.01	--	<0.005	9.8	<0.050	0.488	0.006	e	3.3	0.027	0.8	7.7	1.7	0.136
AWT4–1	06/07/96	1030	1	0.492	e	<0.01	--	<0.005	9.8	<0.050	0.490	0.005	e	3.2	0.027	0.9	7.5	1.7	0.133
AWT4–1	06/07/96	1030	0.1	<0.05	--	<0.01	--	<0.005	9.6	<0.050	0.028	<0.005	--	3.1	0.016	0.8	5.1	1.6	0.101
AWT4–1	06/07/96	1030	0.001	<0.05	--	<0.01	--	<0.005	9.6	<0.050	<0.020	<0.005	--	3.1	0.016	0.8	5.6	1.6	0.101
AWT4–1	07/11/96	1050	1	0.471	e	<0.01	--	<0.005	11.8	<0.050	0.418	<0.005	--	4.1	<0.005	1.1	8.1	2.3	0.196
AWT4–1	07/11/96	1050	0.1	<0.05	--	<0.01	--	<0.005	12.4	<0.050	<0.020	<0.005	--	4.2	<0.005	1.0	6.1	2.2	0.215
AWT4–1	07/11/96	1050	0.001	<0.05	--	<0.01	--	<0.005	11.1	<0.050	<0.020	<0.005	--	3.9	<0.005	0.9	5.5	2.2	0.175
AWT4–1	09/07/96	1410	1	<0.05	--	<0.01	--	0.011	25.5	<0.050	<0.020	<0.005	--	9.4	0.037	1.5	9.5	5.6	0.694
AWT4–1	09/07/96	1410	0.1	<0.05	--	<0.01	--	0.010	24.9	<0.050	<0.020	<0.005	--	9.0	0.032	1.5	9.7	5.2	0.710
AWT4–1	09/07/96	1410	0.001	<0.05	--	<0.01	--	0.010	24.0	<0.050	<0.020	<0.005	--	8.7	0.031	1.4	9.7	5.5	0.675
AWT4–2	10/26/95	1220	1	<0.05	--	<0.01	--	<0.005	30.2	<0.050	0.676	<0.005	--	11.7	1.592	1.7	11.1	7.5	1.299
AWT4–2	10/26/95	1220	0.1	<0.05	--	<0.01	--	<0.005	29.6	<0.050	0.602	<0.005	--	11.5	1.553	1.7	10.9	7.5	1.371
AWT4–2	05/09/96	1645	1	1.160	--	<0.01	--	<0.005	37.0	<0.050	0.785	<0.005	--	14.7	1.306	1.8	18.3	11.0	2.532
AWT4–2	05/09/96	1645	0.1	<0.05	--	0.014	e	<0.005	36.7	<0.050	0.406	<0.005	--	13.8	1.266	1.8	11.0	10.2	2.407
AWT4–2	05/09/96	1645	0.001	<0.05	--	<0.01	--	<0.005	36.3	<0.050	0.464	<0.005	--	14.9	1.472	1.7	10.7	10.6	2.439
AWT4–2	06/07/96	0935	1	0.143	e	<0.01	--	0.022	33.8	<0.050	0.334	<0.005	--	13.3	1.066	2.4	12.8	9.0	4.602
AWT4–2	06/07/96	0935	1	0.284	e	<0.01	--	0.022	34.3	<0.050	0.328	<0.005	--	13.0	1.051	2.3	12.4	8.5	4.512
AWT4–2	06/07/96	0935	0.1	<0.05	--	<0.01	--	0.020	33.4	<0.050	0.233	<0.005	--	13.1	1.013	2.6	11.0	8.5	4.213
AWT4–2	06/07/96	0935	0.001	<0.05	--	<0.01	--	0.020	35.8	<0.050	0.223	<0.005	--	13.7	1.021	2.4	12.7	8.9	4.792
AWT4–2	07/11/96	0940	1	0.098	e	<0.01	--	0.006	32.2	<0.050	0.578	<0.005	--	12.0	1.197	1.8	11.7	7.0	2.097
AWT4–2	07/11/96	0940	0.1	<0.05	--	<0.01	--	0.005	33.1	<0.050	0.550	0.005	e	12.1	1.179	1.7	11.5	7.2	2.327
AWT4–2	07/11/96	0940	0.001	<0.05	--	<0.01	--	0.006	30.9	<0.050	0.521	<0.005	--	11.9	1.163	1.8	11.6	6.8	1.985
AWT4–2	09/07/96	1250	1	0.059	e	<0.01	--	<0.005	27.8	<0.050	0.776	0.006	e	11.0	1.314	1.8	11.9	5.8	1.516
AWT4–2	09/07/96	1250	0.1	<0.05	--	<0.01	--	<0.005	26.5	<0.050	0.604	<0.005	--	10.0	1.067	1.7	12.1	6.0	1.491
AWT4–2	09/07/96	1250	0.001	<0.05	--	<0.01	--	<0.005	25.8	<0.050	0.589	<0.005	--	9.6	1.091	1.6	12.1	6.2	1.448
AWT4–3	10/26/95	1025	1	0.126	e	<0.01	--	0.103	55.5	<0.050	0.325	<0.005	--	21.8	4.414	3.2	18.0	14.5	14.829
AWT4–3	10/26/95	1025	0.1	0.067	e	<0.01	--	0.110	56.8	<0.050	0.247	<0.005	--	21.6	4.051	3.1	17.1	14.5	16.203

Table 10. Results from inductively coupled plasma atomic-emission spectroscopy for unfiltered, filtered, and ultrafiltered surface- and ground-water samples collected during 1995–96—Continued

[Site locations shown in figures 1, 2, and 3. Quality code "e" indicates value is estimated as described in Appendix 4; sequential replicates are indicated by two samples collected the same day at different times; filter size 1 = unfiltered; filter size 0.1 = 0.1 µm; filter size 0.001 = ultrafiltered; mg/L, milligrams per liter; <, less than; >, detector saturated, no value obtained; sample AR65 collected on September 18, 1996, at 10:15 a.m., filter size 0.1 is the laboratory precision sample]

Sample and site identification	Date	Time	Filter size	Aluminum (mg/L)	Aluminum quality code	Arsenic (mg/L)	Arsenic quality code	Cadmium (mg/L)	Calcium (mg/L)	Copper (mg/L)	Iron (mg/L)	Lead (mg/L)	Lead quality code	Magnesium (mg/L)	Manganese (mg/L)	Potassium (mg/L)	Silica (mg/L)	Sodium (mg/L)	Zinc (mg/L)
AWT4–3	05/09/96	1520	1	0.639	e	<0.01	--	0.086	31.3	<0.050	0.572	0.006	e	12.4	2.022	2.0	17.6	12.2	11.128
AWT4–3	05/09/96	1520	0.1	0.157	e	<0.01	--	0.082	30.4	<0.050	0.047	<0.005	--	11.6	1.745	1.8	14.2	11.2	11.168
AWT4–3	05/09/96	1520	0.001	0.062	e	<0.01	--	0.086	30.6	<0.050	0.026	<0.005	--	12.1	1.837	1.8	14.5	11.4	11.001
AWT4–3	06/06/96	1515	1	5.250	--	0.012	e	0.081	30.5	<0.050	1.808	0.009	e	12.4	1.105	2.4	43.4	>	10.568
AWT4–3	06/06/96	1515	1	5.225	--	<0.01	--	0.085	31.3	<0.050	1.799	<0.005	--	12.6	1.162	2.2	43.6	35.7	11.256
AWT4–3	06/06/96	1515	0.1	0.135	e	0.010	e	0.096	34.2	<0.050	<0.020	<0.005	--	13.5	1.183	2.2	16.1	>	11.583
AWT4–3	06/06/96	1515	0.001	0.092	e	<0.01	--	0.094	34.6	<0.050	<0.020	<0.005	--	12.9	1.104	2.0	16.0	22.7	11.809
AWT4–3	07/10/96	1630	1	0.437	e	<0.01	--	0.116	34.0	<0.050	0.167	<0.005	--	14.3	1.952	2.2	17.6	10.2	12.308
AWT4–3	07/10/96	1630	0.1	0.193	e	<0.01	--	0.112	36.9	<0.050	0.045	0.005	e	14.4	2.007	2.1	16.8	10.6	13.635
AWT4–3	07/10/96	1630	0.001	0.125	e	<0.01	--	0.109	34.5	<0.050	0.042	<0.005	--	14.3	1.948	2.1	17.2	10.8	12.107
AWT4–3	09/07/96	1140	1	0.103	e	<0.01	--	0.053	25.7	<0.050	0.294	<0.005	--	11.1	1.950	2.2	13.8	7.8	7.771
AWT4–3	09/07/96	1140	0.1	0.108	e	0.010	e	0.053	25.4	<0.050	0.135	<0.005	--	10.6	1.778	2.1	13.6	7.4	7.696
AWT4–3	09/07/96	1140	0.001	<0.05	--	<0.01	--	0.052	23.9	<0.050	0.130	<0.005	--	10.0	1.795	1.9	13.0	7.5	7.552
AWT4–4	10/26/95	0910	1	0.442	e	<0.01	--	0.050	15.2	<0.050	0.083	<0.005	--	6.1	1.004	0.9	9.7	3.6	4.678
AWT4–4	10/26/95	0910	0.1	0.337	e	<0.01	--	0.046	14.6	<0.050	<0.020	<0.005	--	5.6	0.922	0.8	9.1	3.7	4.550
AWT4–4	05/09/96	1427	1	0.544	e	<0.01	--	0.032	22.6	<0.050	0.431	0.016	e	12.5	0.233	0.9	8.3	6.8	5.237
AWT4–4	05/09/96	1427	0.1	0.469	e	<0.01	--	0.036	26.4	<0.050	<0.020	<0.005	--	13.5	0.320	0.9	7.8	7.0	5.878
AWT4–4	05/09/96	1427	0.001	0.385	e	<0.01	--	0.036	25.7	<0.050	<0.020	<0.005	--	13.6	0.330	0.9	7.9	7.2	5.608
AWT4–4	05/09/96	1427	0.001	0.423	e	<0.01	--	0.040	27.1	<0.050	<0.020	<0.005	--	14.6	0.373	0.9	7.9	8.2	5.976
AWT4–4	06/06/96	1405	1	0.587	e	<0.01	--	0.045	39.9	<0.050	0.059	<0.005	--	21.0	0.230	1.1	11.1	9.3	7.354
AWT4–4	06/06/96	1405	0.1	0.677	e	<0.01	--	0.049	41.1	<0.050	<0.020	<0.005	--	21.5	0.300	1.2	11.6	9.1	7.645
AWT4–4	06/06/96	1405	0.001	0.193	e	<0.01	--	0.047	40.0	<0.050	<0.020	<0.005	--	21.4	0.310	1.2	11.5	8.9	7.527
AWT4–4	07/10/96	1435	1	0.404	e	<0.01	--	0.034	26.9	<0.050	0.039	<0.005	--	14.0	0.103	1.1	10.5	6.7	4.644
AWT4–4	07/10/96	1435	0.1	0.381	e	<0.01	--	0.034	29.5	<0.050	<0.020	<0.005	--	14.2	0.140	1.1	11.1	6.7	5.254
AWT4–4	07/10/96	1435	0.001	0.296	e	<0.01	--	0.034	27.6	<0.050	<0.020	<0.005	--	14.1	0.138	1.2	11.1	6.9	4.669
AWT4–4	09/07/96	0945	1	0.200	e	<0.01	--	0.019	15.5	<0.050	0.038	0.008	e	8.3	0.127	1.0	7.6	6.3	2.086
AWT4–4	09/07/96	0945	0.1	0.155	e	<0.01	--	0.017	15.2	<0.050	<0.020	<0.005	--	7.8	0.145	0.9	7.7	6.9	2.023
AWT4–4	09/07/96	0945	0.001	0.098	e	<0.01	--	0.018	15.1	<0.050	<0.020	<0.005	--	7.9	0.159	0.9	8.0	6.2	2.085
AWT4–5	10/25/95	1710	1	3.846	--	<0.01	--	<0.005	66.5	<0.050	17.077	<0.005	--	22.8	1.727	3.5	42.1	21.6	<0.01
AWT4–5	10/25/95	1710	0.1	<0.05	--	<0.01	--	<0.005	67.6	<0.050	14.160	<0.005	--	22.1	1.750	3.2	20.1	21.1	<0.01
AWT4–5	05/09/96	1245	1	3.915	--	<0.01	--	<0.005	82.4	<0.050	24.073	<0.005	--	28.5	2.017	3.5	42.4	37.8	<0.01
AWT4–5	05/09/96	1245	0.1	<0.05	--	<0.01	--	<0.005	83.5	<0.050	20.687	<0.005	--	27.3	1.890	3.7	19.4	>	<0.01

Table 10. Results from inductively coupled plasma atomic-emission spectroscopy for unfiltered, filtered, and ultrafiltered surface- and ground-water samples collected during 1995–96—Continued

[Site locations shown in figures 1, 2, and 3. Quality code "e" indicates value is estimated as described in Appendix 4; sequential replicates are indicated by two samples collected the same day at different times; filter size 1 = unfiltered; filter size 0.1 = 0.1 µm; filter size 0.001 = ultrafiltered; mg/L, milligrams per liter; <, less than; >, detector saturated, no value obtained; sample AR65 collected on September 18, 1996, at 10:15 a.m., filter size 0.1 is the laboratory precision sample]

Sample and site identification	Date	Time	Filter size	Aluminum (mg/L)	Aluminum quality code	Arsenic (mg/L)	Arsenic quality code	Cadmium (mg/L)	Calcium (mg/L)	Copper (mg/L)	Iron (mg/L)	Lead (mg/L)	Lead quality code	Magnesium (mg/L)	Manganese (mg/L)	Potassium (mg/L)	Silica (mg/L)	Sodium (mg/L)	Zinc (mg/L)
AWT4–5	05/09/96	1245	0.001	<0.05	--	<0.01	--	<0.005	84.7	<0.050	20.780	<0.005	--	29.9	2.235	3.3	18.2	25.4	<0.01
AWT4–5	06/06/96	1305	1	0.125	e	<0.01	--	<0.005	75.1	<0.050	16.215	<0.005	--	24.9	1.579	3.1	19.1	15.2	<0.01
AWT4–5	06/06/96	1305	0.1	<0.05	--	<0.01	--	<0.005	76.4	<0.050	14.072	<0.005	--	24.6	1.528	3.2	18.1	14.0	<0.01
AWT4–5	06/06/96	1305	0.001	<0.05	--	<0.01	--	<0.005	74.5	<0.050	4.377	<0.005	--	24.6	1.428	3.2	17.7	14.9	<0.01
AWT4–5	07/10/96	1330	1	0.076	e	<0.01	--	<0.005	65.8	<0.050	12.350	<0.005	--	22.0	1.294	3.0	19.5	12.4	<0.01
AWT4–5	07/10/96	1330	0.1	<0.05	--	<0.01	--	<0.005	68.4	<0.050	10.994	<0.005	--	21.9	1.270	3.0	20.0	11.9	<0.01
AWT4–5	07/10/96	1330	0.001	0.077	e	<0.01	--	<0.005	71.1	<0.050	6.780	<0.005	--	24.2	1.411	3.3	21.5	13.5	<0.01
AWT4–5	09/06/96	1615	1	0.149	e	<0.01	--	<0.005	66.3	<0.050	14.294	0.007	e	22.8	1.311	3.4	24.4	11.2	<0.01
AWT4–5	09/06/96	1615	0.1	<0.05	--	<0.01	--	<0.005	58.4	<0.050	11.197	<0.005	--	19.8	1.137	3.2	22.2	10.7	<0.01
AWT4–5	09/06/96	1615	0.001	<0.05	--	<0.01	--	<0.005	59.1	<0.050	9.565	<0.005	--	20.3	1.142	3.3	22.6	11.1	<0.01
CHIN	10/26/95	1050	1	0.219	e	<0.01	--	<0.005	28.9	<0.050	1.770	0.029	e	9.8	1.663	1.1	10.2	4.3	0.620
CHIN	10/26/95	1050	0.1	<0.05	--	<0.01	--	<0.005	28.3	<0.050	0.531	<0.005	--	9.5	1.538	1.0	8.9	4.2	0.537
CHIN	05/10/96	1025	1	0.518	e	<0.01	--	0.007	17.5	<0.050	1.502	0.044	e	6.4	0.696	1.2	9.1	2.9	1.099
CHIN	05/10/96	1025	0.1	<0.05	--	<0.01	--	0.005	18.6	<0.050	0.028	<0.005	--	6.5	0.607	1.0	7.6	2.9	0.930
CHIN	05/10/96	1025	0.001	<0.05	--	<0.01	--	0.006	17.8	<0.050	<0.020	<0.005	--	6.5	0.639	1.1	7.7	3.0	0.820
CHIN	05/10/96	1030	1	0.768	e	<0.01	--	0.007	19.1	<0.050	1.767	0.051	--	6.9	0.730	1.3	10.8	3.5	1.214
CHIN	05/10/96	1030	0.1	<0.05	--	<0.01	--	0.006	18.2	<0.050	0.034	<0.005	--	6.4	0.600	1.1	7.7	3.0	0.997
CHIN	05/10/96	1030	0.001	<0.05	--	<0.01	--	0.006	18.4	<0.050	<0.020	<0.005	--	6.8	0.658	1.1	8.6	3.1	0.833
CHIN	06/07/96	1155	1	0.548	e	<0.01	--	<0.005	10.3	<0.050	0.904	0.030	e	3.5	0.112	0.7	7.8	1.4	0.191
CHIN	06/07/96	1155	0.1	<0.05	--	<0.01	--	<0.005	10.1	<0.050	0.053	<0.005	--	3.3	0.050	0.6	5.1	1.3	0.116
CHIN	06/07/96	1155	0.001	<0.05	--	<0.01	--	<0.005	10.2	<0.050	<0.020	<0.005	--	3.3	0.048	0.6	6.3	1.4	0.108
CHIN	07/11/96	1430	1	0.073	e	<0.01	--	<0.005	15.1	<0.050	0.366	<0.005	--	5.0	0.087	0.6	5.5	2.0	0.077
CHIN	07/11/96	1430	0.1	<0.05	--	<0.01	--	<0.005	15.5	<0.050	0.051	<0.005	--	4.9	0.068	0.6	5.6	1.8	0.055
CHIN	07/11/96	1430	0.001	<0.05	--	<0.01	--	<0.005	14.8	<0.050	<0.020	<0.005	--	4.7	0.062	0.6	6.2	2.0	0.046
CHOT–LC	10/26/95	1450	1	<0.05	--	<0.01	--	<0.005	35.1	<0.050	0.588	<0.005	--	13.0	0.360	1.3	8.5	5.2	0.322
CHOT–LC	10/26/95	1450	0.1	<0.05	--	<0.01	--	<0.005	37.9	<0.050	0.132	<0.005	--	14.2	0.300	1.4	9.5	5.5	0.301
CHOT–LC	05/10/96	1340	1	0.507	e	<0.01	--	0.006	17.9	<0.050	1.568	0.046	e	6.5	0.662	1.2	9.5	3.2	1.030
CHOT–LC	05/10/96	1340	0.1	<0.05	--	<0.01	--	<0.005	18.2	<0.050	<0.020	<0.005	--	6.4	0.563	1.1	7.7	3.0	0.798
CHOT–LC	05/10/96	1340	0.001	<0.05	--	<0.01	--	0.006	18.1	<0.050	<0.020	<0.005	--	6.6	0.612	1.1	8.7	3.1	0.744
CHOT–LC	06/07/96	1415	1	0.413	e	<0.01	--	<0.005	10.4	<0.050	0.759	0.025	e	3.5	0.111	0.7	7.1	1.4	0.181
CHOT–LC	06/07/96	1415	0.1	<0.05	--	<0.01	--	<0.005	10.7	<0.050	0.076	<0.005	--	3.4	0.052	0.5	5.2	1.3	0.111
CHOT–LC	06/07/96	1415	0.1	<0.05	--	<0.01	--	<0.005	10.3	<0.050	0.073	<0.005	--	3.5	0.049	0.6	5.2	1.4	0.101

Table 10. Results from inductively coupled plasma atomic-emission spectroscopy for unfiltered, filtered, and ultrafiltered surface- and ground-water samples collected during 1995–96—Continued

[Site locations shown in figures 1, 2, and 3. Quality code "e" indicates value is estimated as described in Appendix 4; sequential replicates are indicated by two samples collected the same day at different times; filter size 1 = unfiltered; filter size 0.1 = 0.1 µm; filter size 0.001 = ultrafiltered; mg/L, milligrams per liter; <, less than; >, detector saturated, no value obtained; sample AR65 collected on September 18, 1996, at 10:15 a.m., filter size 0.1 is the laboratory precision sample]

Sample and site identification	Date	Time	Filter size	Aluminum (mg/L)	Aluminum quality code	Arsenic (mg/L)	Arsenic quality code	Cadmium (mg/L)	Calcium (mg/L)	Copper (mg/L)	Iron (mg/L)	Lead (mg/L)	Lead quality code	Magnesium (mg/L)	Manganese (mg/L)	Potassium (mg/L)	Silica (mg/L)	Sodium (mg/L)	Zinc (mg/L)
CHOT–LC	06/07/96	1415	0.001	<0.05	--	<0.01	--	<0.005	10.4	<0.050	<0.020	<0.005	--	3.4	0.047	0.6	6.4	1.4	0.095
CHOT–LC	07/11/96	1650	1	<0.05	--	<0.01	--	<0.005	16.3	<0.050	0.337	<0.005	--	5.4	0.099	0.7	5.6	2.2	0.075
CHOT–LC	07/11/96	1650	0.1	<0.05	--	<0.01	--	<0.005	16.4	<0.050	0.051	<0.005	--	5.2	0.090	0.6	5.9	2.0	0.060
CHOT–LC	07/11/96	1650	0.001	<0.05	--	<0.01	--	<0.005	15.7	<0.050	<0.020	<0.005	--	5.3	0.089	0.6	6.2	2.1	0.042
CHOT–RC	10/26/95	1445	1	0.430	e	<0.01	--	0.008	44.3	<0.050	7.672	0.078	--	16.0	1.783	2.0	15.0	11.0	1.638
CHOT–RC	10/26/95	1445	0.1	<0.05	--	<0.01	--	0.005	43.9	<0.050	1.246	<0.005	--	15.6	1.552	1.9	12.3	11.1	1.351
CHOT–RC	05/10/96	1255	1	0.503	e	<0.01	--	0.006	18.0	<0.050	1.570	0.052	--	6.5	0.664	1.2	9.5	3.0	1.037
CHOT–RC	05/10/96	1255	0.1	<0.05	--	<0.01	--	0.005	19.4	<0.050	0.022	<0.005	--	7.0	0.624	1.2	8.3	3.2	0.857
CHOT–RC	05/10/96	1255	0.001	<0.05	--	<0.01	--	0.006	18.5	<0.050	<0.020	<0.005	--	6.7	0.629	1.1	8.8	3.2	0.752
CHOT–RC	06/07/96	1315	1	0.496	e	<0.01	--	<0.005	10.3	<0.050	0.854	0.026	e	3.5	0.109	0.7	7.6	1.4	0.190
CHOT–RC	06/07/96	1315	1	0.518	e	<0.01	--	<0.005	10.5	<0.050	0.876	0.026	e	3.5	0.112	0.8	7.7	1.5	0.177
CHOT–RC	06/07/96	1315	0.001	<0.05	--	<0.01	--	<0.005	10.0	<0.050	<0.020	<0.005	--	3.4	0.054	0.6	6.9	1.4	0.099
CHOT–RC	07/11/96	1600	1	0.122	e	<0.01	--	<0.005	16.8	<0.050	0.367	0.007	e	5.6	0.103	0.7	5.9	2.3	0.078
CHOT–RC	07/11/96	1600	0.1	<0.05	--	<0.01	--	<0.005	16.7	<0.050	0.046	<0.005	--	5.3	0.091	0.7	6.0	2.1	0.058
CHOT–RC	07/11/96	1600	0.001	<0.05	--	<0.01	--	<0.005	15.5	<0.050	<0.020	<0.005	--	5.2	0.093	0.6	5.7	2.1	0.040
Pond 1	09/04/96	1220	1	0.166	e	0.022	e	<0.005	43.9	<0.050	7.014	0.112	--	15.5	1.653	2.0	13.1	10.9	0.576
Pond 1	09/04/96	1220	0.1	<0.05	--	0.014	e	<0.005	43.3	<0.050	2.440	<0.005	--	14.8	1.531	2.0	12.5	10.3	0.497
Pond 2	09/04/96	1435	1	<0.05	--	<0.01	--	<0.005	38.7	<0.050	1.830	0.008	e	12.9	2.247	2.2	12.8	11.0	0.809
Pond 2	09/04/96	1435	1	<0.05	--	<0.01	--	<0.005	37.2	<0.050	1.994	0.008	e	13.0	2.318	2.1	11.8	10.9	0.758
Pond 2	09/04/96	1435	0.1	<0.05	--	<0.01	--	<0.005	37.2	<0.050	0.148	<0.005	--	12.3	1.712	2.0	12.2	9.8	0.717
Pond 3	09/04/96	1605	1	0.328	e	<0.01	--	0.005	33.6	<0.050	4.168	0.061	--	11.6	1.261	1.7	15.2	7.9	1.394
Pond 3	09/04/96	1605	0.1	<0.05	--	<0.01	--	<0.005	33.0	<0.050	<0.020	<0.005	--	11.0	1.012	1.6	13.9	7.6	1.066
Pond 4	09/04/96	1725	1	<0.05	--	<0.01	--	<0.005	34.7	<0.050	4.459	0.013	e	12.7	1.376	1.9	14.0	9.2	0.754
Pond 4	09/04/96	1725	0.1	<0.05	--	<0.01	--	<0.005	33.9	<0.050	1.165	<0.005	--	12.1	1.271	1.9	14.2	8.8	0.683
Pond 5	09/07/96	1000	1	<0.05	--	<0.01	--	<0.005	32.6	<0.050	1.242	<0.005	--	10.5	2.055	1.4	13.0	5.5	0.559
Pond 5	09/07/96	1000	1	<0.05	--	<0.01	--	<0.005	31.8	<0.050	1.280	<0.005	--	10.6	2.039	1.3	12.6	5.3	0.531
Pond 5	09/07/96	1000	0.1	<0.05	--	<0.01	--	<0.005	32.5	<0.050	0.912	<0.005	--	10.7	1.959	1.4	13.4	4.9	0.565
Pond 6	09/07/96	0900	1	<0.05	--	<0.01	--	0.005	50.4	<0.050	0.869	0.011	e	18.3	1.876	2.3	15.4	10.2	0.685
Pond 6	09/07/96	0900	0.1	<0.05	--	<0.01	--	<0.005	49.8	<0.050	0.385	<0.005	--	17.1	1.732	2.2	15.5	9.5	0.707
Pond 7	09/06/96	1630	1	<0.05	--	<0.01	--	<0.005	55.0	<0.050	1.034	0.013	e	20.7	1.068	2.8	17.9	8.9	0.397
Pond 7	09/06/96	1630	0.1	<0.05	--	0.011	e	<0.005	53.6	<0.050	<0.020	<0.005	--	19.8	0.994	2.8	17.8	8.4	0.360
Pond 8	09/06/96	1500	1	<0.05	--	<0.01	--	<0.005	55.7	<0.050	1.675	0.006	e	20.7	1.480	2.9	16.6	9.4	0.462
Pond 8	09/06/96	1500	0.1	<0.05	--	<0.01	--	<0.005	55.1	<0.050	<0.020	<0.005	--	20.3	1.359	3.0	16.9	8.4	0.391

Table 10. Results from inductively coupled plasma atomic-emission spectroscopy for unfiltered, filtered, and ultrafiltered surface- and ground-water samples collected during 1995–96—Continued

[Site locations shown in figures 1, 2, and 3. Quality code "e" indicates value is estimated as described in Appendix 4; sequential replicates are indicated by two samples collected the same day at different times; filter size 1 = unfiltered; filter size 0.1 = 0.1 µm; filter size 0.001 = ultrafiltered; mg/L, milligrams per liter; <, less than; >, detector saturated, no value obtained; sample AR65 collected on September 18, 1996, at 10:15 a.m., filter size 0.1 is the laboratory precision sample]

Sample and site identification	Date	Time	Filter size	Aluminum (mg/L)	Aluminum quality code	Arsenic (mg/L)	Arsenic quality code	Cadmium (mg/L)	Calcium (mg/L)	Copper (mg/L)	Iron (mg/L)	Lead (mg/L)	Lead quality code	Magnesium (mg/L)	Manganese (mg/L)	Potassium (mg/L)	Silica (mg/L)	Sodium (mg/L)	Zinc (mg/L)
Pond 9	09/06/96	1325	1	<0.05	--	<0.01	--	<0.005	56.7	<0.050	2.580	<0.005	--	21.4	1.390	2.9	15.4	9.7	0.509
Pond 9	09/06/96	1325	1	<0.05	--	<0.01	--	<0.005	56.4	<0.050	2.696	0.005	e	21.6	1.437	2.9	14.7	10.0	0.485
Pond 9	09/06/96	1325	0.1	<0.05	--	<0.01	--	<0.005	57.6	<0.050	0.553	<0.005	--	21.8	1.349	3.0	15.5	9.4	0.453
Pond 10	09/06/96	0930	1	<0.05	--	<0.01	--	<0.005	60.7	<0.050	3.363	<0.005	--	23.7	1.602	2.9	14.2	10.4	0.728
Pond 10	09/06/96	0930	0.1	<0.05	--	<0.01	--	<0.005	59.5	<0.050	1.031	<0.005	--	22.7	1.515	3.0	14.5	9.9	0.694
Pond 11	09/05/96	1200	1	0.588	e	<0.01	--	0.008	41.3	<0.050	14.139	0.021	e	17.6	1.534	2.2	10.9	9.2	0.656
Pond 11	09/05/96	1200	0.1	<0.05	--	0.011	e	0.006	41.4	<0.050	7.947	<0.005	--	16.8	1.441	2.2	11.2	8.9	0.634
Pond 12	09/05/96	1100	1	0.104	e	<0.01	--	0.007	46.6	<0.050	26.632	0.016	e	19.1	1.906	2.6	17.3	13.0	2.197
Pond 12	09/05/96	1100	0.1	<0.05	--	0.012	e	<0.005	43.0	<0.050	19.787	<0.005	--	17.2	1.679	2.5	15.9	11.0	2.052
Pond 13	09/05/96	1030	1	0.085	e	<0.01	--	<0.005	44.0	<0.050	14.742	0.014	e	16.7	1.641	2.2	13.6	14.1	1.045
Pond 13	09/05/96	1030	1	0.059	e	<0.01	--	<0.005	43.4	<0.050	15.596	0.014	e	17.3	1.709	2.1	13.2	14.7	1.009
Pond 13	09/05/96	1030	0.1	<0.05	--	<0.01	--	<0.005	43.4	<0.050	4.629	<0.005	--	16.1	1.517	2.1	12.2	13.0	0.714
Pond 13	09/05/96	1030	0.1	<0.05	--	<0.01	--	<0.005	44.9	<0.050	4.806	<0.005	--	16.6	1.569	2.2	12.6	12.4	0.755
PP2	09/07/96	0945	1	<0.05	--	<0.01	--	<0.005	31.1	<0.050	0.849	<0.005	--	10.4	2.068	1.3	11.7	4.0	0.596
PP2	09/07/96	0945	0.1	<0.05	--	<0.01	--	<0.005	30.6	<0.050	0.162	<0.005	--	9.9	1.921	1.3	12.1	4.0	0.568
PP2	09/07/96	0945	0.1	<0.05	--	<0.01	--	<0.005	31.5	<0.050	0.166	<0.005	--	9.9	1.979	1.2	12.2	4.0	0.590
Spring	10/25/95	1600	1	<0.05	--	<0.01	--	<0.005	28.3	<0.050	0.028	<0.005	--	10.0	0.037	1.0	6.3	2.8	<0.01
Spring	10/25/95	1600	0.1	<0.05	--	<0.01	--	<0.005	27.8	<0.050	<0.020	<0.005	--	9.7	<0.005	1.0	6.3	2.8	<0.01
Spring	05/09/96	1315	1	<0.05	--	<0.01	--	<0.005	35.5	<0.050	0.028	<0.005	--	10.3	0.025	1.6	9.9	3.3	<0.01
Spring	05/09/96	1315	0.1	<0.05	--	<0.01	--	<0.005	37.4	<0.050	<0.020	<0.005	--	10.7	<0.005	1.6	10.4	3.3	<0.01
Spring	05/09/96	1315	0.001	<0.05	--	<0.01	--	<0.005	36.0	<0.050	<0.020	<0.005	--	11.2	<0.005	1.6	9.7	3.6	<0.01
Spring	06/07/96	0825	1	<0.05	--	<0.01	--	<0.005	30.2	<0.050	0.024	<0.005	--	10.1	0.010	0.7	7.3	2.6	<0.01
Spring	06/07/96	0825	0.001	<0.05	--	<0.01	--	<0.005	30.4	<0.050	<0.020	<0.005	--	10.4	<0.005	0.8	7.8	2.7	<0.01
Spring	06/07/96	0830	1	<0.05	--	<0.01	--	<0.005	30.8	<0.050	0.031	<0.005	--	10.3	0.024	0.8	7.4	2.6	<0.01
Spring	06/07/96	0830	0.1	<0.05	--	<0.01	--	<0.005	30.9	<0.050	<0.020	<0.005	--	10.2	<0.005	0.8	7.4	2.6	<0.01
Spring	06/07/96	0830	0.001	<0.05	--	<0.01	--	<0.005	30.7	<0.050	<0.020	<0.005	--	10.0	<0.005	0.8	8.1	2.7	<0.01
Spring	07/11/96	0855	1	<0.05	--	<0.01	--	<0.005	25.2	<0.050	0.039	<0.005	--	10.2	0.006	0.5	5.9	2.4	<0.01
Spring	07/11/96	0855	0.1	<0.05	--	<0.01	--	<0.005	25.2	<0.050	<0.020	<0.005	--	9.7	<0.005	0.5	6.4	2.3	<0.01
Spring	07/11/96	0855	0.001	<0.05	--	<0.01	--	<0.005	24.1	<0.050	<0.020	<0.005	--	9.9	<0.005	0.5	6.0	2.4	<0.01
Spring	09/06/96	1030	1	0.630	e	0.013	e	<0.005	25.8	<0.050	1.225	0.023	e	11.4	0.395	1.8	7.8	2.8	0.090
Spring	09/06/96	1030	0.1	<0.05	--	<0.01	--	<0.005	25.4	<0.050	<0.020	<0.005	--	10.5	0.030	1.5	4.3	2.5	<0.01
Spring	09/06/96	1030	0.001	<0.05	--	<0.01	--	<0.005	24.8	<0.050	<0.020	<0.005	--	10.5	0.028	1.5	5.5	2.6	<0.01

Anion analyses (chloride, fluoride, nitrate, and sulfate) were obtained by ion chromatography using the method of Brinton and others (1996). Analyses were done by USGS personnel in laboratories at the USGS office in Salt Lake City, Utah. The instrument was calibrated using a six-point calibration, and except for nitrate, analyses that were greater than the calibration range were diluted and reanalyzed, or reanalyzed in a different calibration range. Nitrate results are considered semiquantitative because samples were not refrigerated between sample collection and analysis. Compiled results are in table 11.

Aliquots of some ultrafiltered samples were analyzed for delta deuterium and delta 18-oxygen using mass spectrometry and techniques reported by Epstein and Mayeda (1953) and Coplen and others (1991). Analyses were performed in USGS laboratories in Reston, Va. Values are reported in parts per thousand (per mil) relative to Vienna Standard Mean Ocean Water (VSMOW):

$$\delta D = \frac{(D/H)_{\mathrm{sample}} - (D/H)_{\mathrm{VSMOW}}}{(D/H)_{\mathrm{VSMOW}}} \times 1{,}000$$

$$\delta^{18}O = \frac{(^{18}O/^{16}O)_{\mathrm{sample}} - (^{18}O/^{16}O)_{\mathrm{VSMOW}}}{(^{18}O/^{16}O)_{\mathrm{VSMOW}}} \times 1{,}000$$

where

δ = delta,
D = deuterium,
H = hydrogen,
^{18}O = 18-oxygen, and
^{16}O = 16-oxygen.

Values are normalized on scales such that the oxygen and hydrogen isotopic values of Standard Light Antarctic Precipitation are –55.5 per mil and –428 per mil, respectively. The two-sigma uncertainty of oxygen and hydrogen isotopic results is 0.2 per mil and 2 per mil, respectively. Samples analyzed for delta deuterium and delta 18-oxygen were collected during the June 1996 and September 1996 sampling trips at sites AR67, AWT1–1, AWT1–3, AWT2–1, AWT2–2, AWT2–4, AWT3–1, AWT3–5, AWT4–1, AWT4–3, and AWT4–5.

Table 11. Ion chromatography results for filtered surface- and ground-water samples collected during 1995–96

[mg/L, milligrams per liter; <, less than]

Sample identification	Date	Time	Chloride (mg/L)	Fluoride (mg/L)	Nitrate (mg/L)	Sulfate (mg/L)
AR40	05/06/96	1345	1.26	<0.12	1.6	25.8
AR40	06/03/96	1030	0.54	0.12	2.7	11.6
AR40	07/12/96	0820	0.57	<0.12	29.2	13.7
AR40	07/12/96	0830	0.59	<0.12	0.7	12.8
AR40	09/03/96	1240	1.42	0.24	2.0	22.5
AR40	09/03/96	1250	1.43	0.25	2.1	22.1
AR65	05/28/95	0930	0.74	0.13	2.7	19.3
AR65	07/12/95	1450	0.49	0.12	0.6	13.9
AR65	07/19/95	0950	0.51	0.24	2.0	11.9
AR65	07/26/95	1030	0.64	0.15	3.1	16.2
AR65	08/02/95	1140	0.64	0.13	39.1	14.8
AR65	08/23/95	1520	7.21	0.15	21.3	29.8
AR65	10/26/95	1510	1.64	0.16	2.2	40.3
AR65	10/26/95	1515	1.58	0.30	2.7	41.9
AR65	04/11/96	1300	2.20	0.15	45.3	47.2
AR65	04/25/96	1200	1.85	0.13	8.2	43.3
AR65	04/25/96	1205	1.83	0.14	6.0	42.7
AR65	05/06/96	1620	1.35	0.23	2.3	32.3
AR65	05/06/96	1620	1.42	0.12	2.3	32.7
AR65	05/16/96	0840	0.84	0.24	2.6	27.0
AR65	05/21/96	0955	0.58	<0.12	0.4	15.3

Table 11. Ion chromatography results for filtered surface- and ground-water samples collected during 1995–96—Continued

[mg/L, milligrams per liter; <, less than]

Sample identification	Date	Time	Chloride (mg/L)	Fluoride (mg/L)	Nitrate (mg/L)	Sulfate (mg/L)
AR65	05/21/96	1010	0.57	0.12	2.9	15.6
AR65	06/03/96	1400	0.63	0.14	9.5	15.6
AR65	06/12/96	0945	0.46	0.13	2.4	11.3
AR65	06/19/96	1025	0.47	<0.12	<0.23	11.0
AR65	06/27/96	0840	0.60	0.13	5.7	12.9
AR65	06/27/96	0905	0.54	<0.12	5.5	13.0
AR65	07/02/96	0850	0.57	<0.12	40.2	14.8
AR65	07/02/96	0900	0.58	0.24	17.1	16.4
AR65	07/12/96	1230	0.67	<0.12	11.7	18.5
AR65	07/21/96	0930	0.98	0.24	4.2	31.3
AR65	08/05/96	0920	1.30	0.25	13.3	29.1
AR65	08/05/96	0925	1.26	0.24	5.2	29.0
AR65	08/19/96	1045	1.60	0.25	1.3	44.0
AR65	09/03/96	1540	1.66	0.26	2.1	37.9
AR65	09/18/96	1015	1.64	0.25	3.1	49.6
AR65	09/27/96	1115	1.63	0.25	0.9	45.0
AR65	09/27/96	1120	1.62	0.25	10.8	44.9
AR67	10/26/95	1645	1.59	0.25	1.3	39.5
AR67	05/10/96	0915	1.33	0.15	16.6	36.3
AR67	06/05/96	1740	0.55	<0.12	4.0	12.5
AR67	07/11/96	1305	0.72	0.24	10.2	19.0
AR67	09/07/96	1517	1.64	0.25	0.6	43.3
AR70	07/19/95	1345	0.54	0.13	5.7	11.5
AR70	07/26/95	1340	0.68	0.15	3.2	16.4
AR70	08/02/95	1445	0.83	0.13	0.4	14.5
AR70	10/26/95	1725	1.59	0.17	24.6	36.7
AR70	04/11/96	1600	2.19	0.17	3.5	43.3
AR70	04/11/96	1605	2.19	0.18	2.4	43.9
AR70	04/25/96	1510	1.80	0.14	3.5	39.1
AR70	05/06/96	1815	1.38	0.14	27.7	30.6
AR70	05/16/96	1230	0.85	0.24	2.3	26.5
AR70	05/21/96	1400	0.62	0.13	7.0	15.9
AR70	05/28/96	1245	0.75	0.14	3.4	20.1
AR70	05/28/96	1315	0.76	0.14	2.3	20.1
AR70	06/03/96	1610	0.62	0.13	4.2	15.9
AR70	06/12/96	1410	0.45	<0.12	19.9	11.8
AR70	06/12/96	1420	0.46	<0.12	19.6	11.6
AR70	06/19/96	1405	0.48	0.12	12.9	10.9
AR70	06/19/96	1430	0.49	0.13	13.2	10.8
AR70	06/27/96	1215	0.59	<0.12	4.1	13.3
AR70	07/02/96	1245	0.57	0.24	55.7	15.5
AR70	07/12/96	1505	0.70	0.23	3.7	18.4
AR70	07/21/96	1220	0.97	0.24	0.4	31.0
AR70	08/05/96	1250	1.27	0.25	23.2	28.0
AR70	08/19/96	1300	1.56	0.25	28.2	39.9
AR70	08/19/96	1305	1.55	0.26	5.9	39.8

Table 11. Ion chromatography results for filtered surface- and ground-water samples collected during 1995–96—Continued

[mg/L, milligrams per liter; <, less than]

Sample identification	Date	Time	Chloride (mg/L)	Fluoride (mg/L)	Nitrate (mg/L)	Sulfate (mg/L)
AR70	09/03/96	1655	1.61	0.25	21.1	36.6
AR70	09/18/96	1220	1.56	0.25	8.0	45.0
AR70	09/27/96	1440	1.57	0.25	36.9	43.7
AWT1–1	10/23/95	1725	2.91	0.16	1.1	86.5
AWT1–1	05/07/96	1200	1.42	0.15	0.6	37.5
AWT1–1	06/04/96	1100	0.53	0.14	1.0	15.9
AWT1–1	06/04/96	1130	0.52	0.14	1.7	16.2
AWT1–1	07/08/96	1304	0.55	<0.12	5.8	15.8
AWT1–1	09/04/96	0950	1.64	0.13	5.4	52.0
AWT1–2	10/24/95	0945	3.39	0.30	25.2	191.3
AWT1–2	05/07/96	1305	3.75	0.28	10.5	256.4
AWT1–2	06/04/96	1215	2.21	0.30	9.2	103.1
AWT1–2	07/08/96	1410	1.86	0.41	0.6	82.0
AWT1–2	07/08/96	1440	1.89	0.45	2.0	89.2
AWT1–2	09/04/96	1040	2.10	0.51	3.9	98.4
AWT1–3	10/24/95	1040	1.89	0.12	2.4	330.1
AWT1–3	05/07/96	1500	3.66	1.32	0.5	923.4
AWT1–3	06/04/96	1320	2.75	1.06	2.4	655.4
AWT1–3	07/08/96	1546	2.45	0.63	7.3	418.0
AWT1–3	09/04/96	1150	1.20	0.12	5.2	132.4
AWT1–4	10/24/95	1225	1.70	0.15	2.3	86.8
AWT1–4	06/04/96	1430	0.39	0.19	5.7	92.7
AWT1–4	07/08/96	1651	0.29	0.25	1.2	44.4
AWT1–4	09/04/96	1325	0.73	0.19	3.8	82.8
AWT2–1	10/25/95	1035	1.66	0.24	1.3	75.6
AWT2–1	05/08/96	1220	1.56	0.22	3.4	62.8
AWT2–1	06/05/96	1300	0.81	0.27	6.2	36.3
AWT2–1	07/09/96	1440	0.58	0.27	2.1	28.1
AWT2–1	09/05/96	1430	1.67	0.21	2.8	51.7
AWT2–2	10/25/95	0940	1.61	0.22	3.1	58.6
AWT2–2	05/08/96	1105	1.75	0.26	1.1	25.3
AWT2–2	06/05/96	1135	0.58	0.25	1.7	8.7
AWT2–2	07/09/96	1335	0.69	0.21	1.3	5.1
AWT2–2	09/05/96	1325	1.57	0.17	2.6	42.1
AWT2–3	10/24/95	1605	2.30	0.33	8.1	130.1
AWT2–3	05/08/96	1020	2.20	0.28	12.3	92.6
AWT2–3	06/05/96	1030	3.52	0.28	61.9	147.5
AWT2–3	07/09/96	1225	2.20	0.35	3.8	107.4
AWT2–3	09/05/96	1140	1.99	0.32	2.7	84.2
AWT2–3	09/05/96	1230	2.08	0.36	2.8	98.5
AWT2–4	10/24/95	1500	3.85	0.97	4.1	783.4
AWT2–4	05/08/96	0930	2.19	0.70	5.1	431.0
AWT2–4	06/05/96	0910	2.74	1.14	<0.23	642.9
AWT2–4	07/09/96	1120	3.05	0.96	0.7	578.9
AWT2–4	09/05/96	1000	2.49	0.74	2.4	435.8
AWT2–5	10/24/95	1315	2.94	<0.12	2.7	329.3

Table 11. Ion chromatography results for filtered surface- and ground-water samples collected during 1995–96—Continued

[mg/L, milligrams per liter; <, less than]

Sample identification	Date	Time	Chloride (mg/L)	Fluoride (mg/L)	Nitrate (mg/L)	Sulfate (mg/L)
AWT2–5	10/24/95	1320	2.93	<0.12	<0.23	308.3
AWT2–5	05/07/96	1630	2.27	0.37	0.5	422.5
AWT2–5	06/04/96	1550	2.41	0.41	0.7	329.4
AWT2–5	07/09/96	1005	2.76	0.23	1.0	363.3
AWT2–5	09/04/96	1530	1.51	0.28	1.0	208.2
AWT3–1	10/25/95	1135	1.70	0.17	53.5	46.9
AWT3–1	05/08/96	1340	1.31	0.18	4.2	39.7
AWT3–1	06/05/96	1415	0.50	0.20	3.9	14.8
AWT3–1	07/09/96	1600	0.57	0.20	4.5	16.3
AWT3–1	09/05/96	1600	1.75	0.14	13.0	45.6
AWT3–2	10/25/95	1230	1.59	<0.12	0.8	54.3
AWT3–2	05/08/96	1515	1.41	0.17	2.4	38.5
AWT3–2	06/05/96	1518	0.56	0.23	7.3	21.2
AWT3–2	07/09/96	1715	0.57	0.17	2.6	21.0
AWT3–2	09/06/96	0955	1.82	0.14	0.3	42.7
AWT3–3	06/05/96	1620	1.77	0.27	12.4	82.6
AWT3–4	10/25/95	1330	1.85	0.23	7.0	232.6
AWT3–4	05/08/96	1635	2.76	0.19	22.7	176.7
AWT3–4	05/08/96	1640	2.79	0.19	16.8	170.4
AWT3–4	06/06/96	0930	2.48	0.24	3.8	290.7
AWT3–4	07/10/96	1000	2.41	0.34	2.9	233.5
AWT3–4	09/06/96	1110	1.43	0.22	3.5	186.3
AWT3–5	10/25/95	1430	1.08	0.37	<0.23	292.6
AWT3–5	05/09/96	0950	2.97	0.94	1.4	726.0
AWT3–5	06/06/96	1035	3.17	0.70	31.9	611.9
AWT3–5	07/10/96	1105	2.33	0.26	1.5	368.6
AWT3–5	09/06/96	1230	0.92	0.30	1.9	111.6
AWT3–6	10/25/95	1550	2.07	0.35	1.9	31.2
AWT3–6	05/09/96	1115	2.33	0.33	10.7	18.8
AWT3–6	06/06/96	1135	2.65	0.33	3.0	16.0
AWT3–6	07/10/96	1205	0.64	0.47	1.7	9.5
AWT3–6	09/06/96	1435	0.62	0.58	2.6	5.0
AWT4–1	10/26/95	1305	2.14	0.21	15.8	112.5
AWT4–1	05/09/96	1732	1.19	0.32	18.0	37.6
AWT4–1	06/07/96	1030	0.44	0.13	1.4	12.0
AWT4–1	07/11/96	1050	0.62	0.20	0.9	17.2
AWT4–1	09/07/96	1410	1.80	0.19	0.5	54.8
AWT4–2	10/26/95	1220	1.74	0.22	14.3	79.0
AWT4–2	05/09/96	1645	1.73	0.22	1.5	128.6
AWT4–2	06/07/96	0935	1.84	0.21	0.5	122.2
AWT4–2	07/11/96	0940	1.29	0.24	0.5	103.4
AWT4–2	09/07/96	1250	1.74	0.25	12.2	67.3
AWT4–3	10/26/95	1025	4.77	0.18	7.2	273.0
AWT4–3	05/09/96	1520	2.09	0.40	27.5	172.7
AWT4–3	06/06/96	1515	1.81	0.19	11.9	188.4
AWT4–3	07/10/96	1630	1.70	0.19	3.5	175.0

Table 11. Ion chromatography results for filtered surface- and ground-water samples collected during 1995–96—Continued

[mg/L, milligrams per liter; <, less than]

Sample identification	Date	Time	Chloride (mg/L)	Fluoride (mg/L)	Nitrate (mg/L)	Sulfate (mg/L)
AWT4–3	09/07/96	1140	1.84	0.15	2.4	132.9
AWT4–4	10/26/95	0910	1.59	0.72	77.1	106.3
AWT4–4	05/09/96	1427	2.30	0.58	23.9	116.9
AWT4–4	06/06/96	1405	2.82	0.48	21.6	195.9
AWT4–4	07/10/96	1435	1.74	0.37	10.9	119.8
AWT4–4	09/07/96	0945	0.68	0.21	1.8	43.9
AWT4–5	10/25/95	1710	1.64	0.45	13.8	9.5
AWT4–5	05/09/96	1245	0.89	0.45	1.2	3.6
AWT4–5	06/06/96	1305	1.54	0.53	0.7	10.0
AWT4–5	07/10/96	1330	0.34	0.57	0.6	2.8
AWT4–5	09/06/96	1615	0.33	0.65	0.4	3.2
CHIN	10/26/95	1050	1.46	0.16	11.5	40.2
CHIN	05/10/96	1025	1.32	0.16	3.7	35.2
CHIN	05/10/96	1030	1.34	0.15	5.5	36.2
CHIN	06/07/96	1155	0.47	0.13	0.9	11.2
CHIN	07/11/96	1430	0.73	0.14	6.1	16.5
CHOT–LC	10/26/95	1450	1.09	0.27	14.5	20.8
CHOT–LC	05/10/96	1340	1.51	0.18	2.5	34.3
CHOT–LC	06/07/96	1415	0.46	<0.12	7.7	10.7
CHOT–LC	07/11/96	1650	0.72	0.14	4.2	16.7
CHOT–RC	10/26/95	1445	1.69	0.32	6.1	67.8
CHOT–RC	05/10/96	1255	1.37	0.16	9.9	35.1
CHOT–RC	06/07/96	1315	0.46	<0.12	0.8	11.1
CHOT–RC	07/11/96	1600	0.73	0.15	3.3	17.0
Pond 1	09/04/96	1220	0.82	0.29	0.6	68.6
Pond 2	09/04/96	1435	0.94	0.25	2.1	62.6
Pond 3	09/04/96	1605	0.61	0.17	0.9	42.2
Pond 4	09/04/96	1725	0.65	0.45	2.8	20.9
Pond 5	09/07/96	1000	1.39	0.17	0.7	25.0
Pond 6	09/07/96	0900	1.00	0.27	2.7	13.2
Pond 7	09/06/96	1630	0.68	0.44	1.3	13.6
Pond 8	09/06/96	1500	0.71	0.40	0.7	15.2
Pond 9	09/06/96	1325	0.57	0.34	0.3	17.1
Pond 10	09/06/96	0930	0.69	0.29	0.6	25.2
Pond 11	09/05/96	1200	0.77	0.35	8.8	109.4
Pond 12	09/05/96	1100	0.83	0.56	3.2	112.1
Pond 13	09/05/96	1030	0.52	0.61	<0.23	32.1
PP2	09/07/96	0945	1.55	0.15	0.4	35.3
Spring	10/25/95	1600	0.67	0.25	20.2	9.8
Spring	05/09/96	1315	0.71	0.30	24.2	8.0
Spring	06/07/96	0825	0.35	0.26	11.1	5.5
Spring	06/07/96	0830	<0.29	0.23	7.8	5.6
Spring	07/11/96	0855	<0.29	0.21	<0.23	7.1
Spring	09/06/96	1030	0.86	0.23	0.7	6.8

APPENDIX 2. FIELD NOTES FROM 1992 SOIL- AND WATER-SAMPLE COLLECTION

Field Notes from Each Site in Figure 2

Soil Samples and Descriptions

TYS1: Background soil sample from old flood plain. Some grass and sagebrush. Hardpan less than 1 foot below surface; zone of accumulation is very near surface (top 2 inches); B horizon very thin; dry soil. Soil is grayish-brown [2.5Y 5/2 (Munsell soil color from Macbeth Division of Kollmorgen Instruments Corporation, 1992)], very fine-grained loam to silty loam with moderate sorting, visible horizons, no hydrogen sulfide odor, and roots and root hairs starting about 2 to 6 inches below surface. Sample from 2- to 8-inch depth.

TYS2: Soil sample near north boundary of site, slightly uphill from gravel bar parallel to seeps at TYW12; 25 to 30 feet from seep; north of site was vegetated in 1981 aerial photograph, but no vegetation at site currently (1992). Soil is wet, yellow-brown, reddish-brown, and gray-colored sandy loam, well sorted, with pods of clay loam. Few organics, but colored gray to black around organic matter, and contains some peaty (black-colored) layers. Sampled 6 to 12 inches below surface.

TYS3: Soil sample from nonvegetated stream deposits. Soil is greenish-gray, yellowish-brown, and gray sand to loamy sand and gravel with some distinct bedding and only a few root hairs; strong hydrogen sulfide odor. Cobble layer at about 12 inches down with finer grained soil above. Sample from 3- to 7-inch depth.

TYS4: Nonvegetated area with strong hydrogen sulfide odor and very fine-grained, greenish-gray soils. Occasional crust of yellow mineral. Sample from 2- to 9-inch depth. Cutbank described.

TYS5: Nonvegetated area of multiple depositional channels. Some very clean-looking soils and some reddish-stained pebbles and cobbles, especially in old channel. Possibly buried mats of old vegetation. Some greenish-gray soil accumulation on very top (1/2 inch) of ground surface. Hydrogen sulfide odor. Fine to medium, reddish (7.5YR 5/8) sand above dark brown (7.5YR 3/1) loamy clay. Sample from 6- to 10-inch depth.

TYS6: Nonvegetated area just west (20 feet) of meander in Arkansas River; abundant reddish staining and lots of stems, roots, and grasses buried at about 4-inch depth. The east side of stream meander is well vegetated with much less reddish staining and lots of black peat visible. Sample from 4- to 9-inch depth. Sampling holes had grayish, fine-grained, semicrystalline crust of fine loamy sand above mottled, banded, reddish-stained (10YR 5/6, 7.5YR 5/8) fine sand, having abundant roots, root hairs overlying black (2.5Y 2.5/1) clay loam with dense mat of root hairs, sooty appearance, hydrogen sulfide odor, and some mottling with reddish sands from above.

TYS7: Point-bar deposits with abundant coarse gravels and cobbles, moderate hydrogen sulfide odor. Zone of accumulation appears to be just above black peaty layer. Sample from 2- to 18-inch depth. Sampling holes contained tan (2.5Y 7/4), medium-grained sand, poorly sorted with some organics, above a very mottled, fine-grained, yellowish-red (5YR 4/6) and dark-gray (2.5Y 4/1) sand with abundant roots and root hairs, above a black (10YR 2/1) peaty, silty loam with abundant organics and a stronger hydrogen sulfide odor.

TYS8: Duplicate of TYS7.

TYS9: Nonvegetated area about 4.5 feet from the stream. White crystals on surface. Sample from 4- to 11-inch depth. Sampling holes have matted organic fragments in a tan (10YR 5/4), subrounded, medium-grained sand at the surface above a subrounded, poorly sorted, very mottled (10YR 3/2, 5YR 4/4, 10YR 4/6), medium-grained sand with abundant roots and color banding. Cobbles with some reddish staining at 11-inch depth.

TYS10: Point-bar deposit in nonvegetated area. Very discontinuous lenses of reddish-stained (7.5YR 4/6) sands and very fine-grained, dark-gray (10YR 4/1) clay loam (strong hydrogen sulfide odor) with some coarse, yellowish (2.5Y 7/3) sand. Few organics, but some coarse roots in reddish sands. Sample from 2- to 8-inch depth.

TYS11: Point-bar deposits in nonvegetated area. Fewer cobbles on surface compared to most upstream sites. Some hydrogen sulfide odor. Sample from 2- to 7-inch depth. Gray (2.5Y 5/3), fine-grained sandy loam above a very mottled (7.5YR 4/6, 10YR 5/2, 10YR 4/1), damp, loamy sand with abundant roots and root hairs. Lenses of fine-grained, dark-gray (10YR 4/1) clay loam with hydrogen sulfide odor. Below is black (10YR 3/2), peaty, organic-rich, loamy sand with reddish mottles.

TYS12: Point bar near meander of small cutoff. Directly west of reddish-colored seep along bank. Nonvegetated area with only occasional roots in a zone at 2- to 8-inch depth. Very mottled, banded, loamy sand with some hydrogen sulfide odor. Cobbles and pebbles at 8-inch depth. Sample at about 2- to 8-inch depth.

TYS13: Background sample taken uphill on glacial till a few hundred feet from road. Sparse vegetation, including sagebrush and grasses. Some small white crystals on surface, along with coarse mineral fragments.

Gray-brown (2.5Y 5/2, 10YR 5/2), poorly sorted, angular, sandy loam to loamy clay. Rooted zone at 2- to 5-inch depth. Sample from 2- to 8-inch depth.

TYS14: Point-bar deposit adjacent to cobbles. Nonvegetated surface with abundant organics (roots, stems) in all zones. Massive dark-gray (10YR 4/1) clay loam in localized deposits (strong hydrogen sulfide odor). Very mottled. Sample from 3- to 8-inch depth.

TYO1: Flood-plain deposits with reddish-stained pebbles and cobbles. Some surface vegetation; peaty vegetation layer, possibly from buried previous land surface. Light reddish-brown, yellow-brown, and brownish-gray, poorly sorted sandy loam to loam.

TYO2: Stream deposits consisting of pale-yellow, reddish-brown, olive-brown, and grayish-brown loamy sand to clayey loam; some gravels. Slight hydrogen sulfide odor. Some surface vegetation.

TYO3: Nonvegetated stream deposits that contain fine-grained, yellowish-brown, brownish-gray, and black (very mottled) sandy loam. Some oxidation around roots, twigs, and stems. Cobbles at 6-inch depth. Some hydrogen sulfide odor.

TYO4: Nonvegetated stream deposits consisting of very mottled, fine-grained, yellowish-brown, brown, and brownish-gray sand. Some large branches, stems, and roots at 3- to 6-inch depth. Cutbank described.

TYO5: Thick-grass surface vegetation and well-developed soil. Dark-gray and grayish-brown loam with some roots. Cutbank described.

TYO6: Stream deposits below good topsoil. Well vegetated with potentilla, vegetated hummocks, and some willows. Grayish-brown, brown, yellowish-brown, and dark-gray silty loam with thick root mat. Water table at about 3- to 4-foot depth.

TYO7: Nonvegetated stream deposits with recently dead willows adjacent to stream. Reddish staining localized. Core described.

TYO8: Change in vegetation to dying willows and eroding hummocks adjacent (and possibly transitional) to nonvegetated area; healthy vegetation nearby. Some reddish-stained soils.

TYO9: Sparse vegetation, but well rooted. Cutbank described.

TYO10: Nonvegetated area along stream with evidence of recent cattle activity. Fairly fine-grained, reddish-stained, mottled sand with abundant stems, roots, and root hairs and some clay lenses. Damp sand.

TYO11: Point-bar deposit. Core described.

TYO12: Fairly coarse-grained (pebbles and cobbles) stream deposits with some reddish-colored staining. No living vegetation, but some willow and hummock remnants.

TYO13: Point-bar deposit between two stream channels. The stream has switched channels since a 1981 aerial photograph. Used to be vegetated with moss and willow hummocks. Currently (1992), clean, well-sorted sand grades downward to coarse sand above a dark layer with dense roots and plant matter above a reddish-stained cobble layer.

TYO14: Nonvegetated, gray surface mat above reddish-stained sand (coarsening downward) with abundant organics; cobbles at about 11-inch depth. Cutbank described.

TYO15: Nonvegetated area (vegetated on a 1981 aerial photograph) with dead hummock and willow remnants. Stream more braided than on photograph. Peaty, brown soil only slightly mottled with reddish stain; fine-grained, gray surface mat. Densely rooted 1- to 9-inch depth.

TYO16: More reddish staining than at site TYO15. Gray-brown loamy sand above slightly mottled, black, peaty, silty loam; dense root hairs and roots. Some banding of even blacker material.

TYO17: Nonvegetated area surrounded by unhealthy vegetation. Very soft, fine-grained loam with mottles, color banding, and some roots to 12-inch depth.

TYO18: Clean, brown, silty dirt to about 8-inch depth, then reddish-stained cobbles. Near reddish seep. Farther north, reddish staining is very localized and near surface, possibly indicating recent redeposition.

TYO19: Some hydrogen sulfide odor. Very mottled, loamy sand with some banding. Cobbles and pebbles at 6-inch depth.

TYO20: Nonvegetated; fairly clean sediment near edge of vegetated area. Only slight reddish staining. Core described.

TYO21: Nonvegetated area. Soil looks fairly clean with only a little reddish staining.

TYO22: Many fine-grained, dark-gray and reddish stream deposits. Core described.

TYO23: Dark-gray, fine-grained clay loam with amorphous, yellow mineral crust in discrete groups. Coarser deposits nearby.

TYO24: Area just west of site TYS14. Some reddish staining. Mostly fine-grained deposits.

TYO25: Healthy vegetation on surface (grasses and vegetated hummocks), dark-gray and reddish, fine-grained soil below. Cutbank described.

TYO26: Linear bar-type deposits. Some fine-grained, dark-gray clay loam deposits. Core described.

Water

TYW1: Water sample from near southern study-area boundary at mouth of tributary. Temperature, 8 degrees Celsius (°C).

TYW2: Western channel of two distributary channels near site TYO26. Black-colored staining noted on rocks in channel. Temperature, 13°C.

TYW3: Eastern channel of two distributary channels near TYO26. Some reddish-colored staining noted on rocks in channel. Temperature, 12°C.

TYW4: Small, red-colored seep at study-area boundary. Temperature, 13°C. Visible microbial film.

TYW5: Red-colored seep in bank of channel adjacent to site TYW2. Red-colored floc along channel bank. Temperature, 20°C.

TYW6: Stream near road, probably drainage from upper lakes.

TYW7: Red-colored seep meets lake drainage. Temperature, 16.5°C. Not much flow (possibly 4–10 liters per minute). Abundant reddish-colored floc (mineral + algae + bacteria) and red-stained rocks. Some reeds growing. Fairly good mixing with lake drainage.

TYW8: Northern tributary (sampled at mouth) draining denuded, mineralized area (site TYS4). Temperature, 16°C. Stream discharge registers 0.32 foot in stilling well of 3-inch Parshall flume, which is 0.188 cubic foot per second.

TYW9: Southern tributary (sampled at mouth) draining marshy area to the east. Temperature, 16°C.

TYW10: Apparent backwater that is actually a tributary to the Arkansas main stem. Temperature, 12°C.

TYW11: Small tributary near site TYO3. Very narrow channel. Temperature, 16.5°C.

TYW12: Multiple red-colored seeps flowing around a meander deposit. Some unusual aquatic vegetation along reach. Three-inch Parshall flume was used to measure discharge, but not enough gradient to be truly useful (discharge, 0.13 foot in stilling well, which is 0.045 cubic foot per second). Temperature, 14.5°C.

TYW13: Outflow from marshy area near northeast study-area boundary. Black-colored, peaty sediments with quicksand-type characteristics in channel. Diverse vegetation; ducks in marsh.

Field Notes from Core Holes and Cutbanks

(On following page)

Site location: **TYO7**
Description: **Core**
Date: **09–22–92**
Weather: **Clear, sunny, windy**

[Soil colors determined using Munsell soil color charts (Macbeth Division of Kollmorgen Instruments Corporation, 1992)]

Interval (feet)	Munsell soil color	Texture	Mottled	Sorting	Organic material	Moisture	Odor
0–0.9	10YR 5/8, yellowish-brown	Sandy loam	Very	Good	Some coarse plant fragments	Dry	None
0.9–1.4	2.5Y 3/1, very dark gray	Loamy clay	Some	Poor	Many stems, roots	Dry	None
1.4–2	10YR 5/4, yellowish-brown	Fine sand, cobbles at 2 feet	Slight	Poor	Many stems, roots	Dry	None
2–2.5	2.5Y 5/3, light olive-brown	Coarse sand	None	Very poor	Few	Medium	None
2.5–2.9	10YR 4/3, brown	Coarse sand, some cobbles	Slight	Poor	Coarse stem fragments	Wetter	None

Site location: **TYO11**
Description: **Core**
Date: **09–22–92**
Weather: **Clear, sunny, breezy**

[Soil colors determined using Munsell soil color charts (Macbeth Division of Kollmorgen Instruments Corporation, 1992)]

Interval (feet)	Munsell soil color	Texture	Mottled	Sorting	Organic material	Moisture	Odor
0–0.9	10YR 5/6, 7.5YR 3/2, 7.5YR 5/8, yellowish-brown, dark brown, strong brown	Fine sand	Very	Medium	Many stems, roots	Some	None
0.9–1.4	Same as above	Fine sand to loam	Very	Medium	Same as above	Some	Some hydrogen sulfide
1.4–1.6	5YR 5/8, 7.5YR 5/8, 7.5YR 4/22, yellowish-red, strong brown, brown	Coarse sand	Very	Medium	Same as above	Wet	None
1.6	--	Pebbles and cobbles	No	Poor	None	Wet	None

Site location: **TYO20**
Description: **Core**
Date: **09–23–92**
Weather: **Clear, sunny, windy**

[Soil colors determined using Munsell soil color charts (Macbeth Division of Kollmorgen Instruments Corporation, 1992)]

Interval (feet)	Munsell soil color	Texture	Mottled	Sorting	Organic material	Moisture	Odor
0–0.1	10YR 5/4, yellowish-brown	Sandy loam	No	Fair	Some coarse fragments, stems	Dry	Manure
0.1–0.5	7.5YR 5/6, strong brown	Silty loam	Some	Fair	Fine roots	Dry	None
0.5–1	10YR 4/6, dark yellowish-brown	Sandy loam to clayey loam	Slight	Good	Roots, root hairs	Some	None
1–1.5	10YR 3/3, dark brown	Clay loam to gravel, cobbles at 1.5 feet	Slight	Good	Sparse roots, root hairs	Some	None

Site location: **TYO22**
Description: **Core**
Date: **09–24–92**
Weather: **Clear, sunny, cool**

[Soil colors determined using Munsell soil color charts (Macbeth Division of Kollmorgen Instruments Corporation, 1992)]

Interval (feet)	Munsell soil color	Texture	Mottled	Sorting	Organic material	Moisture	Odor
0–0.13	10YR 4/4, dark yellowish-brown	Sandy loam	Slight	Medium	Few	Dry	Manure
0.13–0.21	7.5YR 4/6, brown	Fine sand	Some	Poor	Few	Dry	None
0.21–0.3	7.5YR 4/2, strong brown	Silty loam	Very	Good	Black fragments	Some	Slight hydrogen sulfide
0.3–1	10YR 2/2, 10YR 3/1, very dark brown, very dark gray	Loam	Some	Good	Many stems, roots, root hairs	Some	Hydrogen sulfide
1–1.2	7.5YR 4/6, brown	Sand	Some	Medium	Coarse fragments	Some	None
1.2–1.4	10YR 2/1, black	Clay loam	Slight	Good	Many roots	Some	Hydrogen sulfide
1.4–1.6	10YR 4/2, dark grayish-brown	Silty sand	Very	Very poor	Roots and stems	Wet	Slight hydrogen sulfide

Site location: **TYO26**
Description: **Core**
Date: **09–24–92**
Weather: **Partly cloudy**

[Soil colors determined using Munsell soil color charts (Macbeth Division of Kollmorgen Instruments Corporation, 1992)]

Interval (feet)	Munsell soil color	Texture	Mottled	Sorting	Organic material	Moisture	Odor
0–0.34	10YR 4/2, 7.5YR 4/6, dark grayish to strong brown	Sandy loam to medium sand	Very	Good	Few	Dry	None
0.34–0.67	10YR 4/3, 2.5Y 5/1, 7.5YR 4/6, brown, gray, strong brown	Sandy loam	Very	Poor	Coarse and fine stems and roots	Some	Hydrogen sulfide
0.67–0.75	2.5Y 7/4, 10YR 5/6, pale yellow, yellowish-brown	Sandy loam	No	Good	Few	Some	Hydrogen sulfide
0.75–1.7	5Y 4/2, 10YR 4/6, 10YR 3/1, olive gray, dark yellowish-brown, very dark gray	Sandy loam	Some	Poor	Many roots, root hairs	Some	Strong hydrogen sulfide
1.7–2.5	5Y 3/1, very dark gray	Loamy sand	No	Good	Some fine fragments, root hairs	Some	Hydrogen sulfide
2.5–3	5Y 2.5/1, black	Clay loam, cobbles at 3 feet	No	Good	Dense roots, stems; peat	Wet	Hydrogen sulfide

Site location: **TYS4**
Description: **Cutbank facing east**
Date: **09–22–92**

[Soil colors determined using Munsell soil color charts (Macbeth Division of Kollmorgen Instruments Corporation, 1992)]

Interval (feet)	Munsell soil color	Texture	Organic material	Comments
0–0.8	2.5Y 6/2, light brownish-gray	Silt loam	None; no surface vegetation	Very fine grained, strong hydrogen sulfide odor
0.8–1	2.5Y 6/4, light yellowish-brown	Silt loam	None	Same as above
1–2.2	10YR 5/4, 10YR 6/6, yellowish-brown, brownish-yellow	Silt loam	Black around coarse fragments	Sandier, many red-gray-orange mottles
2.2–2.8	10YR 2/1, black	Silt loam	Dense root hairs; peat	Cobbles below 2.8 feet

Site location: **TYO4**
Description: **Cutbank**
Date: **09–22–92**

[Soil colors determined using Munsell soil color charts (Macbeth Division of Kollmorgen Instruments Corporation, 1992)]

Interval (feet)	Munsell soil color	Texture	Organic material	Comments
0–0.5	10YR 4/2, dark grayish-brown	Sandy loam	Many roots, no surface vegetation	Some bedding
0.5–0.7	10YR 5/4, yellowish-brown	Loamy sand	Many roots, root hairs	
0.7–0.8	10YR 4/3, brown	Sandy clay loam	Less than preceding interval	Finer grained
0.8–0.9	10YR 3/1, very dark gray	Sandy clay loam	Same as above	
0.9–1.1	10YR 4/3, brown	Sandy loam	Few	Mottled, damp
1.1–1.2	10YR 3/2, very dark grayish-brown	Clay loam	Some roots	Finer grained
1.2–1.3	10YR 5/3, brown	Sandy loam	Some roots	Coarse sand
1.3–1.4	10YR 3/2, very dark grayish-brown	Clay loam	Some roots	Finer grained
1.4–1.8	10YR 4/3, brown	Sandy loam	Some roots	Mottled; more red-orange near bottom; cobbles and roots in a sandy matrix below 1.8 feet

Site location: **TYO9**
Description: **Cutbank facing west**
Date: **09–22–92**

[Soil colors determined using Munsell soil color charts (Macbeth Division of Kollmorgen Instruments Corporation, 1992)]

Interval (feet)	Munsell soil color	Texture	Organic material	Comments
0–0.33	10YR 5/8, yellowish-brown	Sandy loam	Many roots, but sparse surface vegetation	Eolian-looking
0.33–0.38	5YR 5/8, yellowish-red	Loamy sand	Some roots	Coarse sand
0.38–0.71	10YR 2/1, black	Clay loam	Some roots, root hairs	
0.71–1	10YR 5/2, grayish-brown	Sandy loam	Same as above	Some red-orange mottling
1–3	10YR 4/2, dark grayish-brown	Sandy loam	Same as above	More mottled, some cobbles at 1.5 feet

Site location: **TYO14**
Description: **Cutbank**
Date: **09–23–92**

[Soil colors determined using Munsell soil color charts (Macbeth Division of Kollmorgen Instruments Corporation, 1992)]

Interval (feet)	Munsell soil color	Texture	Organic material	Comments
0–0.2	7.5YR 4/2, brown	Clay loam	Fine grained; dense root, grass masses	Very fine-grained, spotty 2-millimeter white crust
0.2–1	7.5YR 5/6, strong brown	Sandy loam	Much, fine grained	Orange banding, coarser, sandier
1–1.1	10YR 5/6, yellowish-brown	Sandy clay loam	None	Well-sorted, fine grained
1.1–1.5	2.5YR 2.5/4, dark reddish-brown	Loamy sand	Roots, root hairs	Cobbles and coarse sand

Site location: **TYO25**
Description: **Cutbank**
Date: **09–22–92**

[Soil colors determined using Munsell soil color charts (Macbeth Division of Kollmorgen Instruments Corporation, 1992)]

Interval (feet)	Munsell soil color	Texture	Organic material	Comments
0–0.5	2.5Y 5/2, grayish-brown	Clay Loam	Grasses, hummock vegetation on surface, many roots	
0.5–0.6	5Y 3/2, dark olive gray	Silt loam	Few roots	
0.6–0.85	10YR 5/6, yellowish-brown	Sandy loam	Some roots	Coarser, sandier than upper layers
0.85–1.1	10YR 5/1, gray	Clay	Few	Banded
1.1–1.3	10YR 3/2, very dark grayish-brown	Silt loam	Dense root hairs; peat	Fairly continuous
1.3–1.5	10YR 5/6, yellowish-brown	Sandy loam	Some roots	Coarser, sandier
1.5–1.8	10YR 5/1, gray	Clay	Few	Banded
1.8–2.1	10YR 3/2, very dark grayish-brown	Silt loam	Dense root hairs; peat	Fairly continuous
2.1–2.5	5YR 4/2, dark reddish-gray	Loamy sand, gravel, cobbles	Some roots, stems	

APPENDIX 3. WATER-LEVEL MEASUREMENTS

APPENDIX 3. WATER-LEVEL MEASUREMENTS

Table 12. Water-level measurements

[Outside indicates measurements made outside wells; Staffs 1–3 are located in or adjacent to Arkansas River channel; outside Staff 3 is a low water measurement made using a reference on Staff 3; NM, not measured; CH#1 and CH#2 are measuring points in the distributary channel]

Site identification	Water-level measurements (feet above sea level)						
	10/23/95	10/24/95	10/25/95	10/26/95	03/28/96	04/02/96	04/30/96
AWT1–1	9,253.00	NM	NM	NM	NM	9,252.91	9,252.98
Outside 1–1	NM	NM	NM	NM	NM	NM	NM
AWT1–2	NM	9,253.26	NM	NM	9,252.85	9,253.10	9,253.22
AWT1–3	NM	9,253.22	NM	NM	9,253.41	9,253.94	9,253.97
AWT1–4	NM	9,255.45	NM	NM	NM	9,255.39	NM
Outside 1–4	NM	9,256.19	NM	NM	NM	NM	NM
AWT2–1	NM	NM	9,254.00	NM	NM	NM	NM
Outside 2–1	NM	NM	NM	NM	NM	NM	NM
AWT2–2	NM	NM	9,254.25	NM	NM	NM	9,254.42
Outside 2–2	NM	NM	NM	NM	NM	NM	NM
AWT2–3	NM	9,254.47	NM	NM	9,254.00	9,254.32	9,254.43
AWT2–4	NM	9,255.15	NM	NM	NM	NM	NM
AWT2–5	NM	9,256.10	NM	NM	NM	9,255.70	9,255.42
Outside 2–5	NM	9,256.43	NM	NM	NM	NM	NM
AWT3–1	NM	NM	9,254.87	NM	NM	9,255.58	NM
Outside 3–1	NM	NM	9,254.90	NM	NM	NM	NM
AWT3–2	NM	NM	9,254.82	NM	NM	NM	NM
Well top 3–2	NM	NM	NM	NM	NM	NM	NM
AWT3–3	NM	NM	NM	NM	NM	NM	NM
AWT3–4	NM	NM	9,255.53	NM	9,255.24	9,255.62	9,255.59
AWT3–5	NM	NM	NM	NM	NM	9,256.43	NM
Outside 3–5	NM	NM	9,255.95	NM	NM	NM	NM
AWT3–6	NM	NM	9,259.13	NM	NM	9,258.74	9,258.72
Outside 3–6	NM	NM	NM	NM	NM	NM	NM
AWT4–1	NM	NM	NM	9,255.64	NM	NM	9,255.74
Outside 4–1	NM	NM	NM	NM	NM	NM	NM
AWT4–2	NM	NM	NM	9,255.93	9,255.40	9,255.56	9,255.65
AWT4–3	NM	NM	NM	9,256.38	9,256.03	9,256.31	9,256.29
AWT4–4	NM	NM	NM	9,256.91	9,256.46	9,256.89	9,256.86
AWT4–5	NM	NM	9,260.19	NM	NM	NM	9,260.10
Outside 4–5	NM	NM	9,260.01	NM	NM	NM	NM
Staff 1	NM	9,252.83	NM	NM	9,253.43	9,252.75	9,253.00
Staff 2	NM	NM	9,254.80	NM	9,254.82	9,254.64	9,254.68
Staff 3	NM	NM	NM	NM	NM	NM	NM
Outside Staff 3	NM	NM	NM	NM	NM	NM	NM
CHIN	NM	NM	NM	9,263.99	NM	NM	NM
CH#1	NM	NM	NM	NM	NM	NM	NM
CH#2	NM	NM	NM	NM	NM	NM	NM
CHOT	NM	NM	NM	9,253.07	NM	NM	NM

Table 12. Water-level measurements—Continued

Water-level measurements (feet above sea level)							
05/07/96	**05/08/96**	**05/09/96**	**05/18/96**	**05/26/96**	**06/02/96**	**06/04/96**	**06/05/96**
9,253.86	NM	NM	NM	NM	9,254.33	9,254.60	NM
NM	NM	NM	NM	NM	9,254.55	NM	NM
9,253.93	NM	NM	9,254.69	9,254.77	9,254.23	9,254.53	NM
9,254.38	NM	NM	9,254.91	9,254.97	9,254.53	9,254.77	NM
NM	NM	NM	9,255.97	9,255.94	9,255.65	9,255.87	NM
NM	NM	NM	9,255.87	9,256.23	9,255.87	9,256.26	NM
NM	9,254.64	NM	9,255.64	9,255.50	9,255.11	NM	9,255.58
NM	NM	NM	9,255.68	9,255.51	9,255.13	NM	NM
NM	9,254.93	NM	9,255.92	9,255.76	9,255.32	NM	9,255.86
NM	9,254.98	NM	9,256.05	9,255.85	9,255.37	NM	NM
NM	9,255.01	NM	9,255.77	9,256.09	9,255.47	NM	9,255.73
NM	9,255.61	NM	9,256.10	9,256.39	9,255.82	NM	9,256.04
9,255.94	NM	NM	9,256.55	9,256.74	9,256.30	9,256.47	NM
NM	NM	NM	9,256.79	9,256.51	9,256.33	9,256.52	NM
NM	9,255.40	NM	9,256.56	9,256.31	9,255.87	NM	9,256.48
NM	9,255.51	NM	9,256.53	9,256.33	9,255.87	NM	NM
NM	9,255.31	NM	9,256.40	9,256.25	9,255.74	NM	9,256.34
NM	NM	NM	9,256.45	9,256.18	9,255.71	NM	NM
NM	NM	NM	9,256.41	9,256.74	9,256.01	NM	9,256.34
NM	9,255.99	NM	9,256.58	9,257.01	9,256.28	NM	NM
NM	NM	9,256.52	9,256.95	9,257.09	9,256.67	NM	NM
NM	NM	9,256.43	9,257.35	9,257.10	NM	NM	NM
NM	NM	9,259.21	9,259.01	9,259.93	9,258.93	NM	NM
NM	NM	NM	NM	9,259.00	NM	NM	NM
NM	NM	9,256.29	9,257.18	9,257.06	9,256.63	NM	NM
NM	NM	9,256.58	9,257.30	9,257.06	9,256.61	NM	NM
NM	NM	9,256.24	9,257.17	9,257.41	9,256.72	NM	NM
NM	NM	9,256.77	9,257.34	9,257.85	9,257.01	NM	NM
NM	NM	9,257.31	9,257.78	9,258.16	9,257.60	NM	NM
NM	NM	9,260.22	9,260.14	9,260.40	9,260.16	NM	NM
NM	NM	9,259.99	9,260.04	9,260.02	9,259.97	NM	NM
9,253.65	NM	NM	9,254.75	9,254.63	9,254.11	9,254.51	NM
NM	9,254.92	NM	9,256.12	9,255.92	9,255.32	NM	9,255.76
NM	9,255.26	NM	9,256.43	9,256.05	9,255.69	NM	9,256.41
NM	NM	NM	NM	NM	NM	NM	NM
NM	NM	NM	NM	NM	NM	NM	NM
NM	NM	NM	NM	NM	NM	NM	NM
NM	NM	NM	NM	NM	NM	NM	NM
NM	NM	NM	NM	NM	NM	NM	NM

Table 12. Water-level measurements—Continued

[Outside indicates measurements made outside wells; Staffs 1–3 are located in or adjacent to Arkansas River channel; outside Staff 3 is a low water measurement made using a reference on Staff 3; NM, not measured; CH#1 and CH#2 are measuring points in the distributary channel]

Site identification	Water-level measurements (feet above sea level)						
	06/06/96	06/07/96	06/09/96	06/16/96	06/23/96	06/30/96	07/07/96
AWT1–1	NM	NM	NM	NM	NM	9,254.32	9,254.13
Outside 1–1	NM	NM	NM	NM	NM	9,254.68	9,254.45
AWT1–2	NM	NM	9,254.97	9,254.87	9,254.83	9,254.29	9,254.09
AWT1–3	NM	NM	9,255.08	9,254.98	9,254.98	9,254.58	9,254.43
AWT1–4	NM	NM	9,256.14	9,256.02	9,255.97	9,255.64	9,255.55
Outside 1–4	NM	NM	9,256.42	9,256.39	9,256.35	9,256.18	9,256.18
AWT2–1	NM	NM	9,255.76	9,255.65	9,255.58	9,255.14	9,254.94
Outside 2–1	NM	NM	9,255.80	9,255.68	9,255.62	9,255.17	9,254.98
AWT2–2	NM	NM	NM	9,255.99	9,255.92	9,255.39	9,255.20
Outside 2–2	NM	NM	NM	9,256.21	9,256.09	9,255.45	9,255.28
AWT2–3	NM	NM	9,256.25	9,256.07	9,256.05	9,255.48	9,255.25
AWT2–4	NM	NM	9,256.41	9,256.33	9,256.31	9,255.88	9,255.72
AWT2–5	NM	NM	9,256.71	9,256.72	9,256.68	9,256.29	9,256.12
Outside 2–5	NM	NM	9,256.89	9,256.77	9,256.57	9,256.31	9,256.18
AWT3–1	NM	NM	9,257.04	9,256.88	9,256.71	9,256.05	9,255.75
Outside 3–1	NM	NM	9,257.03	9,256.97	9,256.88	9,256.18	9,255.75
AWT3–2	NM	NM	NM	9,256.60	9,256.53	9,255.86	9,255.66
Well top 3–2	NM	NM	NM	9,256.63	9,256.60	9,255.85	9,255.63
AWT3–3	NM	NM	9,257.29	9,256.73	9,255.99	9,256.10	9,256.06
AWT3–4	9,256.60	NM	9,257.31	9,256.95	9,257.61	9,256.36	9,256.14
AWT3–5	9,256.99	NM	9,257.24	9,257.09	9,257.05	9,256.66	9,256.53
Outside 3–5	9,256.83	NM	9,256.91	9,256.90	9,256.89	9,256.31	9,256.32
AWT3–6	9,259.38	NM	9,259.66	9,259.86	9,259.87	9,259.56	9,258.66
Outside 3–6	NM	NM	9,259.96	9,260.00	9,259.95	NM	NM
AWT4–1	NM	9,257.28	9,257.47	9,257.24	9,257.17	9,256.67	9,256.51
Outside 4–1	NM	NM	9,257.46	9,257.29	9,256.62	9,256.62	9,256.51
AWT4–2	NM	9,257.33	9,258.00	9,257.37	9,257.34	9,256.78	9,256.57
AWT4–3	9,257.38	NM	9,258.95	9,257.67	9,257.63	9,257.07	9,256.85
AWT4–4	9,257.80	NM	9,258.40	9,258.01	9,257.96	9,257.51	9,257.36
AWT4–5	9,260.35	NM	9,260.38	9,260.43	9,260.44	9,260.37	9,259.95
Outside 4–5	9,259.99	NM	9,260.03	9,260.03	9,260.05	9,260.03	9,259.94
Staff 1	NM	NM	9,254.97	9,254.77	9,254.69	9,254.09	9,253.89
Staff 2	NM	NM	9,256.62	9,256.22	9,256.07	9,255.32	9,255.20
Staff 3	NM	NM	9,256.79	9,256.59	9,256.55	9,255.77	9,255.57
Outside Staff 3	NM	NM	NM	NM	NM	NM	NM
CHIN	NM	9,265.18	NM	NM	NM	NM	NM
CH#1	NM	NM	NM	NM	NM	NM	NM
CH#2	NM	NM	NM	NM	NM	NM	NM
CHOT	NM	9,254.01	NM	NM	NM	NM	NM

Table 12. Water-level measurements—Continued

				Water-level measurements (feet above sea level)				
07/08/96	**07/09/96**	**07/10/96**	**07/11/96**	**07/14/96**	**07/20/96**	**07/28/96**	**08/04/96**	**08/11/96**
9,254.24	NM	NM	NM	9,253.95	9,253.72	9,253.34	9,253.37	9,252.94
NM	NM	NM	NM	9,254.30	9,254.21	9,253.99	9,254.02	9,252.81
9,254.12	NM	NM	NM	9,253.85	9,253.65	9,253.39	9,253.42	9,253.24
9,254.46	NM	NM	NM	9,254.28	9,254.13	9,253.96	9,254.02	9,253.95
9,255.59	NM	NM	NM	9,255.37	9,255.18	9,255.03	9,255.09	9,255.03
NM	NM	NM	NM	9,255.96	9,255.78	9,255.67	9,255.85	9,255.63
NM	9,254.94	NM	NM	9,254.73	9,254.51	9,254.33	9,254.29	9,254.15
NM	NM	NM	NM	9,254.96	9,254.70	9,254.72	9,254.64	9,254.67
NM	9,255.22	NM	NM	9,255.00	9,254.84	9,254.64	9,254.62	9,254.41
NM	NM	NM	NM	9,255.07	9,254.96	9,254.78	9,254.86	9,254.57
NM	9,255.29	NM	NM	9,255.04	9,254.90	9,254.66	9,254.70	9,254.54
NM	9,255.79	NM	NM	9,255.54	9,255.37	9,255.18	9,255.23	9,255.14
NM	9,256.26	NM	NM	9,255.97	9,255.85	9,255.64	9,255.74	9,255.69
NM	NM	NM	NM	9,256.06	9,255.83	9,255.71	9,255.73	9,255.73
NM	9,255.73	NM	NM	9,255.52	9,255.34	9,255.19	9,255.18	9,255.11
NM	NM	NM	NM	9,255.33	9,255.31	9,255.28	9,255.14	9,255.08
NM	9,255.63	NM	NM	9,255.43	9,255.26	9,255.10	9,255.09	9,255.01
NM	NM	NM	NM	9,255.40	9,255.20	9,255.05	9,255.05	9,255.00
NM	NM	NM	NM	NM	NM	NM	NM	NM
NM	NM	9,256.12	NM	9,255.97	9,255.82	9,255.61	9,255.64	9,255.52
NM	NM	9,256.48	NM	9,256.37	9,256.17	9,256.04	9,256.07	9,256.03
NM	NM	NM	NM	9,256.20	9,255.90	9,255.90	9,255.73	9,255.80
NM	NM	9,259.13	NM	9,258.70	9,259.65	9,258.68	9,259.16	9,258.99
NM	NM	NM	NM	NM	9,260.02	NM	NM	NM
NM	NM	NM	9,256.40	9,256.29	9,256.07	9,255.86	9,255.88	9,255.78
NM	NM	NM	9,256.47	9,256.29	9,256.09	9,255.85	9,255.90	9,255.82
NM	NM	NM	9,256.48	9,256.35	9,256.15	9,255.95	9,255.97	9,255.87
NM	NM	9,256.81	NM	9,256.67	9,256.51	9,256.30	9,256.34	9,256.23
NM	NM	9,257.32	NM	9,257.21	9,257.05	9,256.88	9,256.93	9,256.85
NM	NM	9,260.30	NM	9,259.98	9,260.31	9,259.78	9,260.18	9,260.03
NM	NM	NM	NM	9,259.95	9,260.03	NM	9,259.98	9,259.92
9,253.95	NM	NM	NM	9,253.69	9,253.33	9,252.89	9,252.89	9,252.74
NM	9,255.02	NM	NM	9,255.00	9,254.78	9,254.68	9,254.68	9,254.64
NM	9,255.64	NM	9,255.43	NM	NM	NM	NM	NM
NM	9,255.64	NM	NM	9,255.35	9,255.22	9,255.07	9,255.05	9,255.03
NM	NM	NM	9,264.44	NM	NM	NM	NM	NM
NM	NM	NM	NM	NM	NM	NM	NM	NM
NM	NM	NM	NM	NM	NM	NM	NM	NM
NM	NM	NM	9,253.44	NM	NM	NM	NM	NM

Table 12. Water-level measurements—Continued

[Outside indicates measurements made outside wells; Staffs 1–3 are located in or adjacent to Arkansas River channel; outside Staff 3 is a low water measurement made using a reference on Staff 3; NM, not measured; CH#1 and CH#2 are measuring points in the distributary channel]

Site identification	Water-level measurements (feet above sea level)				
	08/18/96	08/24/96	08/29/96	09/04/96	09/05/96
AWT1–1	9,252.84	9,252.89	9,252.86	9,252.83	NM
Outside 1–1	9,252.68	9,252.86	9,252.60	NM	NM
AWT1–2	9,253.17	9,253.22	9,253.19	9,253.08	NM
AWT1–3	9,253.94	9,253.97	9,253.96	9,253.83	NM
AWT1–4	9,255.03	9,255.06	9,255.04	9,254.82	NM
Outside 1–4	9,255.64	9,255.84	9,255.86	NM	NM
AWT2–1	9,254.06	9,254.08	9,254.04	NM	9,254.04
Outside 2–1	9,254.63	9,254.73	9,254.76	NM	NM
AWT2–2	9,254.29	9,254.32	9,254.28	NM	9,254.22
Outside 2–2	9,254.90	9,255.21	9,254.97	NM	NM
AWT2–3	9,254.47	9,254.52	9,254.48	NM	9,254.38
AWT2–4	9,255.13	9,255.16	9,255.15	NM	9,254.97
AWT2–5	9,255.70	9,255.73	9,255.71	9,255.60	NM
Outside 2–5	9,255.71	9,255.69	9,255.70	NM	NM
AWT3–1	9,255.05	9,255.08	9,255.03	NM	9,255.04
Outside 3–1	9,255.09	9,255.10	9,255.00	NM	NM
AWT3–2	9,254.95	9,254.97	9,254.94	NM	NM
Well top 3–2	9,254.90	9,254.95	9,255.00	NM	NM
AWT3–3	NM	NM	NM	NM	NM
AWT3–4	9,255.48	9,255.51	9,255.49	NM	NM
AWT3–5	9,256.04	9,256.06	9,256.05	NM	NM
Outside 3–5	9,255.75	9,255.80	9,255.79	NM	NM
AWT3–6	9,259.07	9,259.22	9,258.97	NM	NM
Outside 3–6	NM	NM	NM	NM	NM
AWT4–1	9,255.69	9,255.79	9,255.71	NM	NM
Outside 4–1	9,255.69	9,255.77	9,255.67	NM	NM
AWT4–2	9,255.79	9,255.83	9,255.80	NM	NM
AWT4–3	9,256.19	9,256.24	9,256.21	NM	NM
AWT4–4	9,256.84	9,256.87	9,256.85	NM	NM
AWT4–5	9,260.09	9,260.20	9,260.06	NM	NM
Outside 4–5	9,259.98	9,259.98	9,259.99	NM	NM
Staff 1	9,252.61	9,252.67	9,252.62	NM	NM
Staff 2	9,254.62	9,254.64	9,254.63	NM	NM
Staff 3	NM	NM	NM	NM	NM
Outside Staff 3	9,254.95	9,254.95	9,254.91	NM	NM
CHIN	NM	9,263.92	9,263.90	NM	NM
CH#1	NM	9,257.11	9,257.11	NM	NM
CH#2	NM	9,254.16	9,254.16	NM	NM
CHOT	NM	9,253.09	9,253.09	NM	NM

Table 12. Water-level measurements—Continued

Water-level measurements (feet above sea level)						
09/06/96	09/07/96	09/08/96	09/13/96	09/20/96	09/26/96	10/04/96
NM	NM	9,252.85	9,252.90	9,252.88	9,252.87	9,252.88
NM	NM	9,253.03	9,253.02	9,253.02	9,252.98	9,252.87
NM	NM	9,253.16	9,253.20	9,253.20	9,253.19	9,253.19
NM	NM	9,253.92	9,253.97	9,254.01	9,253.98	9,254.00
NM	NM	9,255.02	9,255.06	9,255.12	9,255.09	9,255.09
NM	NM	9,255.94	9,255.80	9,255.84	9,255.79	9,255.73
NM	NM	9,253.99	9,254.04	9,254.00	9,253.99	9,254.00
NM	NM	9,254.55	9,254.69	9,254.72	9,254.82	9,254.65
NM	NM	9,254.23	9,254.28	9,254.23	9,254.25	9,254.26
NM	NM	9,255.07	9,255.13	9,255.15	9,255.16	9,255.17
NM	NM	9,254.44	9,254.49	9,254.49	9,254.49	9,254.50
NM	NM	9,255.11	9,255.15	9,255.20	9,255.19	9,255.19
NM	NM	9,255.71	9,255.79	9,256.04	9,255.87	9,255.81
NM	NM	9,255.66	9,255.83	9,255.88	9,255.88	9,255.89
NM	NM	9,254.98	9,255.01	9,254.97	9,254.96	9,254.95
NM	NM	9,255.14	9,255.16	9,255.15	9,255.12	9,255.13
9,254.97	NM	9,254.89	9,254.92	9,254.88	9,254.87	9,254.86
NM	NM	9,254.96	9,254.88	9,254.84	9,254.84	9,254.89
NM	NM	NM	NM	NM	NM	NM
9,255.43	NM	9,255.45	9,255.48	9,255.51	9,255.51	9,255.51
9,256.15	NM	9,256.04	9,256.07	9,256.11	9,256.10	9,256.09
NM	NM	9,255.85	9,255.90	9,255.81	9,256.00	9,255.85
9,258.89	NM	9,259.11	9,259.66	9,259.96	9,259.84	9,259.23
NM	NM	NM	9,260.02	9,259.94	9,260.02	NM
NM	9,255.78	9,255.68	9,255.72	9,255.71	9,255.71	9,255.71
NM	9,255.75	9,255.71	9,255.75	9,255.71	9,255.68	9,255.77
NM	9,255.89	9,255.77	9,255.81	9,255.81	9,255.81	9,255.75
NM	9,256.30	9,256.19	9,256.22	9,256.23	9,256.25	9,256.25
NM	9,256.91	9,256.83	9,256.86	9,256.88	9,256.88	9,256.88
9,259.91	NM	9,260.12	9,260.26	9,260.43	9,260.32	9,260.07
NM	NM	9,259.94	9,260.01	9,260.04	9,260.02	9,260.04
NM	9,252.57	9,252.61	9,252.68	9,252.65	9,252.65	9,252.63
NM	9,254.64	9,254.66	9,254.66	9,254.66	9,254.66	9,254.66
NM	NM	NM	NM	NM	NM	NM
NM	NM	9,254.88	9,254.92	9,254.87	9,254.85	9,254.90
NM	NM	9,263.90	9,263.90	9,263.90	9,263.92	9,263.91
NM	NM	9,257.13	9,257.17	9,257.17	9,257.15	9,257.13
NM	NM	9,254.17	9,254.17	9,254.26	9,254.20	9,254.18
NM	NM	9,253.07	9,253.10	9,253.18	9,253.19	9,253.13

APPENDIX 4. QUALITY-ASSURANCE/QUALITY-CONTROL PROCEDURAL DETAILS AND RESULTS

All equipment that contacted sample water was cleaned using the procedure described in Horowitz and others (1994). Because inexpensive, disposable 0.1-µm filters were not commercially available, 142-millimeter (mm) polycarbonate filter holders with disposable cellulose nitrate filter membranes were used. The filter pods were washed using a sequence of tap water and nonphosphate laboratory soap, rinsed with deionized water, rinsed with dilute nitric acid, and rinsed with deionized water before reusing. In addition, based on previous experience at mine-drainage sites, an extra rinse step was inserted to prevent trace-element contamination and carryover. The new filter was rinsed using a sequence of 250 mL of deionized water, 250 mL dilute nitric-acid-wash water (less than 5 percent), and 500 mL deionized water followed by 500 mL sample water prior to sample collection. Unfortunately, this procedure resulted in contamination of some samples with nitrate and acidity that affected alkalinity determinations. However, the problem was usually detected in time to conduct a repeat alkalinity titration on an uncontaminated aliquot of sample. In addition, the procedure was successful in that blank samples contained negligible concentrations of the trace elements of concern. A field-equipment blank was obtained on alternate surface-water sampling trips, and two field-equipment blanks were collected during each ground-water sampling trip. One blank was collected using the sampling procedure and equipment for surface water, and the other blank was collected using the procedure and equipment for ground water. Sequential-replicate samples were collected during most surface-water sampling trips. The site for the replicate was chosen randomly before the sampling trip. There are two sequential replicates from site AR40, six from site AR65, and four from site AR70. Two sequential replicates were collected during each sampling trip to the detailed study area: one replicate was collected from a surface-water site and another from a ground-water site. Analysis of equipment blanks was used to evaluate contamination of samples. Analysis of sequential replicates was used to assess short-term variability of surface- and ground-water quality and variability introduced by sampling procedures.

Quality-assurance/quality-control procedures for laboratory alkalinity determinations included analysis of a blank, a standard solution of known alkalinity, and a replicate analysis for every group of 15 samples. These results indicated that analysis of standard solutions was within 5 percent of accepted values, blanks contained no measurable alkalinity, and replicates were within the expected range of analytical variability. Quality-assurance/quality-control procedures for ion chromatography included analysis of standard reference solutions and repeated analysis of an environmental sample for estimates of variability of the method.

Quality-assurance/quality-control procedures for ICP-AES included analysis of USGS standard reference water samples (T–117 and AMW–3), replicate analysis of an environmental sample, replicate analysis of two serial dilutions of a Certified Control Standard, and analysis of a blind sample within the USGS round-robin sampling program. Results of the round-robin sampling program indicated a score of 3.2, where 3 is good and 4 is excellent. Most probable values of analyte concentrations for USGS Standard Reference Water Sample T–145 are: aluminum = 67.6 µg/L; arsenic = 9.88 µg/L; cadmium = 9.33 µg/L; calcium = 30.7 mg/L; iron = 101 µg/L; lead = 12.7 µg/L; magnesium = 8.68 mg/L; manganese = 20.9 µg/L; silica (SiO_2) = 11.3 mg/L; and zinc = 10.0 µg/L (Farrar and Long, 1997). Values for copper, potassium, and sodium were not submitted.

Results of the analysis of control samples and equipment blanks were used to determine reporting limits for each analyte for ICP-AES. The mean of all detectable blank values multiplied by 5 was chosen as the initial reporting level. A maximum of 10 percent relative standard deviation (RSD) of the mean value of control samples was chosen as the cutoff for the acceptable range of analyses. Likewise, a maximum of 10 percent bias between the mean and the most probable or certified value was chosen as the cutoff for acceptable analyses. In addition, an analysis of the trends in percent RSD of the median value and in percent bias compared with analyte concentration was used to determine the reporting level for analytes. These values are listed for all ICP-AES analytes and control samples in table 13. In this table, the control samples are listed with the most probable or certified value increasing from left to right across the table to facilitate examination of the trends of percent RSD and percent bias with concentration of the analyte. Three examples of how these data were used to choose reporting levels (table 14) follows. For calcium, the initial reporting level was 0.050 mg/L (table 14). The lowest concentration control standard showed acceptable bias and variability at a concentration of 0.199 mg/L (table 13). There were no control samples or environmental samples that contained lower concentrations. Therefore, the final, reporting level for calcium was 0.050 mg/L (table 14). In contrast, for cadmium, the mean value of detectable blanks was 0.0003 mg/L, and the initial reporting level was 0.0015 mg/L (table 14). Trends in variability (percent RSD) and bias indicated that acceptable variability was reached at a level of about 0.100 mg/L, whereas acceptable bias occurred at a level of about 0.002 mg/L (table 13). Because bias was acceptable, a relatively low reporting level of 0.005 mg/L was assigned to cadmium. For aluminum, arsenic, and lead, there are two reporting levels shown in the last column of table 14. For these elements, the analyte was definitely present at concentrations greater than the reporting limit (the first number), but variability or bias, or both, remained high until values of the second number were reached (tables 13 and 14). Therefore, for these elements, environmental samples whose values were between the first and second numbers were qualified as being estimated: the analyte was present, but the concentration listed failed the accepted criteria for precision and accuracy.

Table 13. Statistics for quality-assurance/quality-control samples analyzed using inductively coupled plasma atomic-emission spectroscopy

[ASRO is environmental "precision" sample; T–117 is U.S. Geological Survey standard reference water sample T–117; CCVL is low concentration of certified control standard; CCVH is high concentration of certified control standard; AMW–3 is U.S. Geological Survey standard reference water sample AMW–3; % RSD is percent relative standard deviation; MPV is most probable or certified value; Med. value is median value; % bias is percent bias or difference between MPV and median value compared to MPV]

Variable			**Aluminum**		
	ASRO	T–117	CCVL	CCVH	AMW–3
% RSD	279	100	26	3.9	6.7
MPV	--	0.079	0.199	2.0	21
Med. value	0.0037	0.042	0.155	1.83	21.7
% bias	--	47	18	8.5	3.3

Variable			**Arsenic**		
	ASRO	T–117	AMW–3	CCVL	CCVH
% RSD	121	40.5	6.9	4.1	3.8
MPV	--	0.0069	0.0725	0.2	2.0
Med. value	0.003	0.0097	0.109	0.195	1.91
% bias	--	41	50	2.5	4.5

Variable			**Cadmium**		
	ASRO	T–117	CCVL	AMW–3	CCVH
% RSD	67	22	3.3	4.7	2.9
MPV	--	0.0022	0.099	0.121	1.0
Med. value	0.0006	0.0023	0.100	0.129	0.99
% bias	--	4.5	1	6.6	1

Variable			**Calcium**		
	CCVL	CCVH	T–117	ASRO	AMW–3
% RSD	7.3	2.8	3.4	3.6	5.9
MPV	0.199	2.0	20.9	--	320
Med. value	0.183	1.8	20.6	26.6	306
% bias	8.5	10	1.4	--	4.4

Variable			**Copper**		
	ASRO	T–117	CCVL	CCVH	AMW–3
% RSD	624	104	6	3.7	5.5
MPV	--	0.0069	0.199	2.0	4.7
Med. value	0.002	0.006	0.189	1.9	5.14
% bias	--	14	5.3	5	9.4

Variable			**Iron**		
	ASRO	CCVL	T–117	CCVH	AMW–3
% RSD	56	5.5	4.6	3.8	8.5
MPV	--	0.199	0.474	2.0	143
Med. value	0.0189	0.197	0.482	1.93	127
% bias	--	1	1.7	3.5	16

Table 13. Statistics for quality-assurance/quality-control samples analyzed using inductively coupled plasma atomic-emission spectroscopy

[ASR0 is environmental "precision" sample; T–117 is U.S. Geological Survey standard reference water sample T–117; CCVL is low concentration of certified control standard; CCVH is high concentration of certified control standard; AMW–3 is U.S. Geological Survey standard reference water sample AMW–3; % RSD is percent relative standard deviation; MPV is most probable or certified value; Med. value is median value; % bias is percent bias or difference between MPV and median value compared to MPV]

Variable	**Lead**				
	ASR0	T–117	AMW–3	CCVL	CCVH
% RSD	986	48	29	4.6	3.8
MPV	--	0.005	0.016	0.199	2.00
Med. value	0.0002	0.0014	0.031	0.189	1.83
% bias	--	22	94	5	8.5

Variable	**Magnesium**				
	CCVL	CCVH	ASR0	T–117	AMW–3
% RSD	7	2.4	2.9	2.8	3.2
MPV	0.199	2.0	--	10.05	114
Med. value	0.187	1.87	8.42	10.04	117
% bias	6	6.5	--	0.1	2.6

Variable	**Manganese**				
	CCVL	ASR0	T–117	CCVH	AMW–3
% RSD	6.2	4.1	5.0	5.0	10
MPV	0.102	--	0.220	1.0	82.8
Med. value	0.099	0.125	0.233	0.99	71.5
% bias	2.9	--	5.9	1	12.4

Variable	**Potassium**				
	CCVL	ASR0	T–117	CCVH	AMW–3
% RSD	6.5	5.0	6.0	12.9	8.9
MPV	0.5	--	2.11	5.0	3.5
Med. value	0.43	1.05	2.56	5.14	6.0
% bias	14	--	22	2.8	42

Variable	**Silica (SiO_2)**				
	CCVL	CCVH	ASR0	T–117	AMW–3
% RSD	27.2	5.3	3.8	3.2	2.8
MPV	1.07	10.7	--	11.85	48
Med. value	0.96	9.75	8.21	11.85	47.5
% bias	10	8.9	--	0	1

Variable	**Sodium**				
	CCVL	ASR0	CCVH	T–117	AMW–3 (n = 3)
% RSD	11.2	10.5	10	11	50
MPV	0.81	--	8.1	20.0	30.8
Med. value	0.59	3.12	6.9	18.7	39.4
% bias	27.2	--	15	6.5	8.6

Variable	**Zinc**				
	CCVL	ASR0	T–117	CCVH	AMW–3
% RSD	6.4	4.6	4.5	4.2	6.2
MPV	0.099	--	0.176	1.009	41.4
Med. value	0.094	0.175	0.166	0.95	39.2
% bias	5	--	5.7	5	5.3

Table 14. Summary statistics for blank samples and reporting levels for analytes on inductively coupled plasma atomic-emission spectroscopy

[For analytes where final, assigned reporting level contains two values: the first is the reporting limit, and values in environmental samples that fall between the first and second values are estimated; ICP-AES, inductively coupled plasma atomic-emission spectroscopy; mg/L, milligrams per liter]

Element	Number of sample analyses	Number of samples where element had positive absorbance on ICP-AES	Mean of values greater than zero (mg/L)	Maximum value (mg/L)	Initial reporting level (mg/L)	Final, assigned reporting level (mg/L)
Aluminum	41	10	0.005	0.0146	0.025	0.05 1.0
Arsenic	41	33	0.0027	0.0128	0.010	0.01 0.100
Cadmium	41	33	0.0003	0.0012	0.0015	0.005
Calcium	41	27	0.010	0.037	0.050	0.050
Copper	41	33	0.004	0.024	0.020	0.050
Iron	41	20	0.0026	0.012	0.013	0.020
Lead	41	22	0.00096	0.0033	0.005	0.005 0.050
Magnesium	41	18	0.0044	0.015	0.020	0.020
Manganese	41	11	0.00056	0.0014	0.003	0.005
Potassium	41	33	0.0035	0.010	0.018	0.025
Silica	41	26	0.256	1.98	1.25	1.25
Sodium	41	36	0.0107	0.035	0.055	0.055
Zinc	41	13	0.0021	0.0102	0.010	0.010

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