

Prepared in cooperation with  
San Juan County  
San Juan Resource Conservation and Development Council  
U.S. Environmental Protection Agency

## **Geochemical Data for Upper Mineral Creek, Colorado, Under Existing Ambient Conditions and During an Experimental pH Modification, August 2005**



Data Series 442



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By Robert L. Runkel, Briant A. Kimball, Judy I. Steiger, and Katherine Walton-Day

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## Conversion Factors

Multiply	By	To obtain
<b>Length</b>		
centimeter (cm)	0.3937	inch (in.)
millimeter (mm)	0.03937	inch (in.)
meter (m)	3.281	foot (ft)
kilometer (km)	0.6214	mile (mi)
<b>Area</b>		
square meter (meter <sup>2</sup> )	0.0002471	acre
square kilometer (kilometer <sup>2</sup> )	247.1	acre
square centimeter (centimeter <sup>2</sup> )	0.001076	square foot (ft <sup>2</sup> )
square meter (meter <sup>2</sup> )	10.76	square foot (ft <sup>2</sup> )
square centimeter (centimeter <sup>2</sup> )	0.1550	square inch (in <sup>2</sup> )
<b>Volume</b>		
liter	33.82	ounce, fluid (fl. oz)
liter	0.2642	gallon (gal)
cubic meter (meter <sup>3</sup> )	264.2	gallon (gal)
cubic centimeter (centimeter <sup>3</sup> )	0.06102	cubic inch (in <sup>3</sup> )
cubic meter (meter <sup>3</sup> )	35.31	cubic foot (ft <sup>3</sup> )
cubic meter (meter <sup>3</sup> )	0.0008107	acre-foot (acre-ft)
<b>Flow rate</b>		
cubic meter per second (meter <sup>3</sup> /s)	70.07	acre-foot per day (acre-ft/d)
meter per second (meter/s)	3.281	foot per second (ft/s)
cubic meter per second (meter <sup>3</sup> /s)	35.31	cubic foot per second (ft <sup>3</sup> /s)
liter per second (liter/s)	15.85	gallon per minute (gal/min)
cubic meter per day (meter <sup>3</sup> /d)	264.2	gallon per day (gal/d)
<b>Mass</b>		
gram (g)	0.03527	ounce, avoirdupois (oz)
kilogram (kg)	2.205	pound avoirdupois (lb)

Temperature in degrees Celsius (°C) may be converted to degrees Fahrenheit (°F) as follows:

$$^{\circ}\text{F} = (1.8 \times ^{\circ}\text{C}) + 32$$

Temperature in degrees Fahrenheit (°F) may be converted to degrees Celsius (°C) as follows:

$$^{\circ}\text{C} = (^{\circ}\text{F} - 32) / 1.8$$

Horizontal coordinate information is referenced to the North American Datum of 1983 (NAD 83).

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

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





# Geochemical Data for Upper Mineral Creek, Colorado, Under Existing Ambient Conditions and During an Experimental pH Modification, August 2005

By Robert L. Runkel, Briant A. Kimball, Judy I. Steiger, and Katherine Walton-Day

## Abstract

Mineral Creek, an acid mine drainage stream in southwestern Colorado, was the subject of a water-quality study that employed a paired synoptic approach. Under the paired synoptic approach, two synoptic sampling campaigns were conducted on the same study reach. The initial synoptic campaign, conducted August 22, 2005, documented stream-water quality under existing ambient conditions. A second synoptic campaign, conducted August 24, 2005, documented stream-water quality during a pH-modification experiment that elevated the pH of Mineral Creek. The experimental pH modification was designed to determine the potential reductions in dissolved constituent concentrations that would result from the implementation of an active treatment system for acid mine drainage. During both synoptic sampling campaigns, a solution containing lithium bromide was injected continuously to allow for the calculation of streamflow using the tracer-dilution method. Synoptic water-quality samples were collected from 30 stream sites and 11 inflow locations along the 2-kilometer study reach. Data from the study provide spatial profiles of pH, concentration, and streamflow under both existing and experimentally-altered conditions. This report presents the data obtained August 21–24, 2005, as well as the methods used for sample collection and data analysis.

## Introduction

Streams and rivers affected by acid mine drainage are complex systems in which hydrologic and geochemical processes interact to determine the fate and transport of trace metals. Many of the watersheds affected by mining activities are headwater systems that gain substantial amounts of water as they flow down valley. The sources of additional water range from well-defined tributary inflows that appear on topographic maps, to diffuse ground-water inflows that are not visible to the naked eye. The water quality associated with these sources of water also can vary substantially, ranging from dilute mountain springs to metal-rich waters emanating from mineralized areas.

The situation is further complicated in extensively mined watersheds where numerous adits, shafts, mine dumps, and prospect pits litter the landscape. The challenge facing those interested in improving water quality is thus one of source determination: in a given watershed, what sources of water are most detrimental to streamwater quality? In response to this question, synoptic sampling<sup>1</sup> techniques have been developed within the U.S. Geological Survey's (USGS) Toxic Substances Hydrology Program that allow for the quantification of mass loads associated with various sources (Kimball and others, 2002; Kimball and others, 2007). Given this information, sources contributing the highest mass loads may be targeted for remediation.

In August 2005, the USGS conducted a water-quality study on Mineral Creek using the synoptic sampling techniques described above. The study, conducted in cooperation with San Juan County, the San Juan Resource Conservation and Development Council, and the U.S. Environmental Protection Agency (EPA), provides detailed spatial information on pH, constituent concentrations, and streamflow along a 2-kilometer study reach under both existing ambient conditions and during an experimental pH modification.

## Purpose and Scope

The purpose of this report is to summarize data collected August 21–24, 2005, during a water-quality study on Mineral Creek. The overall objectives of the study were to (1) determine the effects of remedial activities conducted from 1999 to 2005 on Mineral Creek water quality, (2) determine the potential of an active treatment system to improve the water quality of Mineral Creek, and (3) assess the ability of a simulation model to provide estimates of post-remediation water quality. Data collected to meet study objectives include pH and inorganic constituent concentrations (cations and anions) from 30

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<sup>1</sup>Synoptic sampling refers to the collection of water-quality samples at numerous locations over a short period of time. Given steady hydrologic and geochemical conditions, the synoptic samples represent a spatial "snapshot" of stream-water quality at a given point in time.

## 2 Geochemical Data for Upper Mineral Creek, Colorado

stream sites and 11 inflow locations. Streamflow estimates for the 30 stream sites were obtained using the tracer-dilution method (Kilpatrick and Cobb, 1985).

### Study Area

The San Juan Mountains of southwestern Colorado contain numerous headwater streams that are contaminated by acid mine drainage. Mineral Creek originates at the top of Red Mountain Pass north of Silverton, Colorado (fig. 1), and flows approximately 15 kilometers before entering the Animas River. The study reach considered in this report begins in a small unnamed drainage that collects water from hillsides in the vicinity of the Longfellow mine and Koehler tunnel (fig. 1). Waters in this upper part of the study reach are primarily mine drainage, including acidic discharge from the Junction mine and Koehler tunnel. This unnamed drainage merges with Mineral Creek, and the remainder of the study reach follows Mineral Creek (fig. 1). The 2-kilometer study reach is constrained by a steep canyon (stream gradient is approximately 0.08), with stream depth during low-flow periods being less than 0.5 meter, and stream width ranging from 1 to 3 meters. Numerous inflows along the study reach introduce metals and acidic waters. The metal-rich, acidic inflows drain alteration zones of the Silverton Volcanics, which are porphyritic andesitic flows, containing 15 to 25 percent phenocrysts of plagioclase and augite. In the study area, there is local alteration to a quartz-sericite-pyrite assemblage, which contains complete replacement of plagioclase and potassium feldspar by fine-grained quartz, illite (sericite), and 10 to 20 percent finely disseminated and fracture-filling pyrite (Bove and others, 2007). Inflows consist of both mine drainage and natural sources draining mineralized areas. Elevated concentrations of iron, aluminum, copper, and zinc are observed, and pH ranges from 2.5 to 5.0 throughout the study reach. Under these conditions, precipitated hydrous iron oxides coat the streambed and the stream is virtually devoid of typical montane aquatic life.

## Methods

### Overview

Quantification of metal sources and constituent loads requires estimates of streamflow and solute concentration. An approach used in acid mine drainage streams is to combine the tracer-dilution method with synoptic sampling (Bencala and McKnight, 1987; Kimball and others, 1994; Kimball and others, 2002; Runkel and Kimball, 2002; Runkel and others, 2007). The tracer-dilution method provides estimates of streamflow (Kilpatrick and Cobb, 1985), and synoptic sampling provides a description of instream and inflow chemistry. Implementation of the tracer-dilution method typically involves the continuous injection of a conservative (non-reactive) tracer at a constant rate. Because the tracer is conser-

vative, downstream decreases in tracer concentration are attributed solely to dilution. Potential tracers include lithium chloride, lithium bromide, sodium bromide, and sodium chloride. Lithium salts (lithium chloride or lithium bromide) are typically used in acidic streams due to the conservative behavior of lithium at low pH and the low background concentration of lithium in most fresh waters.

In order to meet the overall objectives of the Mineral Creek study, a paired synoptic approach was employed. Under the paired synoptic approach, two synoptic sampling campaigns were conducted in August 2005. The initial synoptic campaign, conducted August 22, 2005, documented stream-water quality under existing ambient conditions. A second synoptic campaign, conducted August 24, 2005, documented stream-water quality during a pH-modification experiment that elevated the pH of Mineral Creek. The experimental pH modification was designed to determine the potential reductions in dissolved constituent concentrations that would result from the implementation of an active treatment system for acid mine drainage. Elevation of instream pH during the second synoptic campaign was achieved using a continuous, constant-rate injection of a solution containing a strong base. Both synoptic sampling campaigns used a continuous, constant-rate injection of a conservative tracer to allow for the calculation of streamflow using the tracer-dilution method. Additional details on the conservative tracer injection, base addition, synoptic and temporal sampling, and estimation of streamflow by tracer dilution are provided below.

### Tracer Injection and Base Addition

Continuous, constant rate injections for both synoptic sampling campaigns were initiated at the upstream end of the study reach, located approximately 100 meters upstream from the intersection of San Juan County Road 14 and U.S. Highway 550 (one meter downstream of stream sampling location 270, fig. 1). The conservative tracer was prepared by adding anhydrous lithium bromide (LiBr) to stream water collected at the injection site. The resultant injectate solution had a concentration of approximately 1.7 moles LiBr per liter. An injectate solution containing the strong base was prepared by mixing approximately 110 gallons of 50 percent sodium hydroxide (NaOH) solution with approximately 110 gallons of water from a circumneutral-pH tributary (inflow sampling location 850, fig. 1). The conservative tracer injection for the initial synoptic campaign was initiated at 1407 hours on August 21, and terminated at 1630 hours on August 22 following the completion of synoptic sampling. The injection rate of the conservative tracer during this time period was approximately 123 milliliters per minute. Tracer injections (conservative tracer and strong base) for the second synoptic campaign were initiated at 1430 hours on August 23, and terminated at 1358 hours on August 24. Injection rates for the conservative tracer and strong base were approximately 104 and 340 milliliters per minute, respectively.

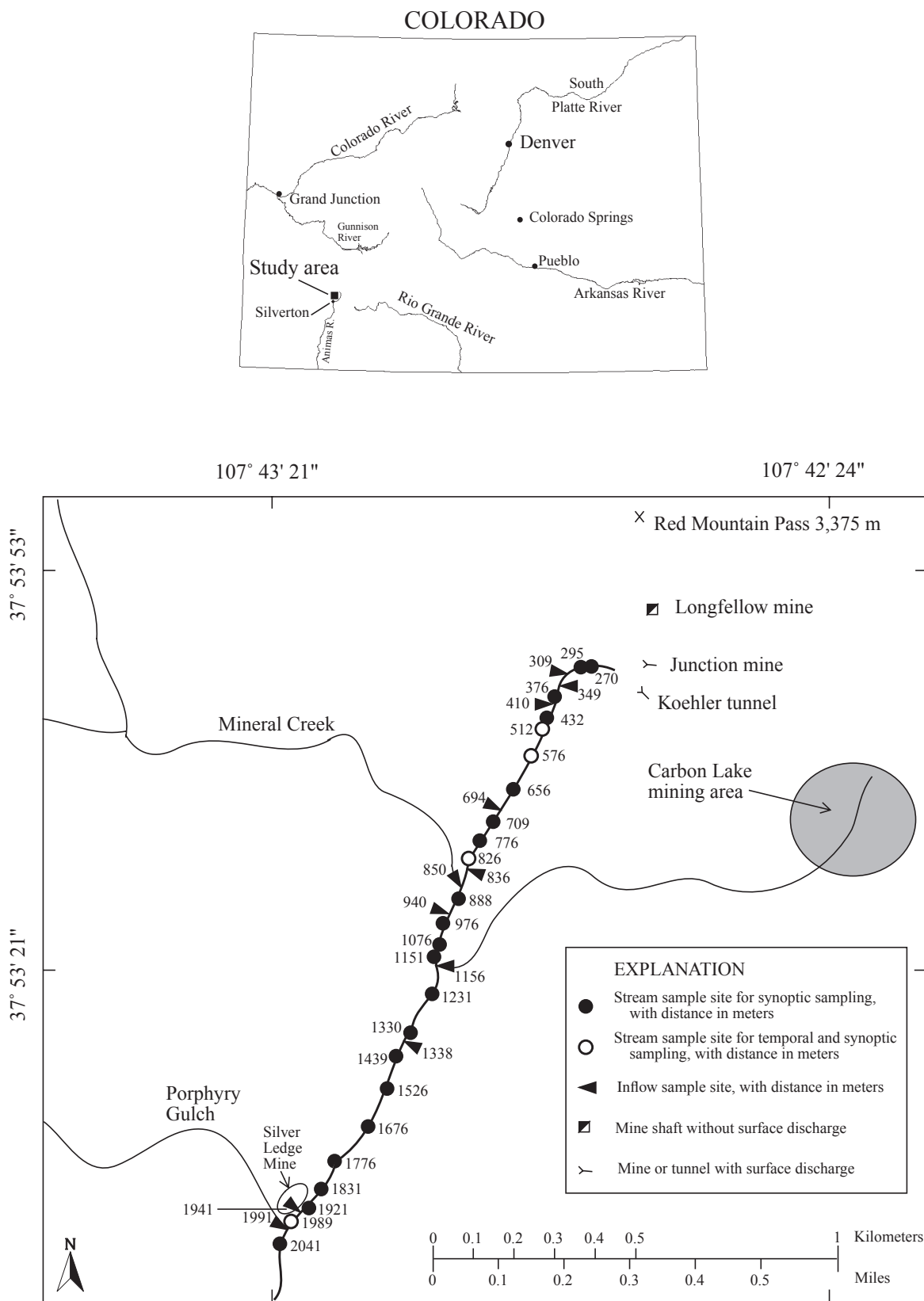


Figure 1. Upper Mineral Creek study reach for August 2005 synoptic sampling. Streamflow direction is from top to bottom.

## Synoptic Sampling

Synoptic samples were collected at 30 stream sites and 11 inflow locations (fig. 1, stream sites 533–566 not shown) on August 22 and August 24, after instream concentrations of the conservative tracer had reached steady-state plateau.<sup>2</sup> Collection of stream samples proceeded in the downstream-to-upstream direction, to avoid contaminating samples with resuspended streambed materials. Stream samples were collected as rapidly as possible in an effort to minimize effects of diel metal fluctuations (Nimick and others, 2003). Sampled inflows ranged from small springs to well-defined tributaries such as Porphyry Gulch (fig. 1). Inflow samples were collected close (0 to 3 meters) to where each inflow entered the study reach.<sup>3</sup> A complete listing of sampling locations, sample information, and associated data for the August 22 and August 24 synoptic sampling campaigns is provided in tables 1–15, following the main body of this report.

Samples were collected in 1.8-liter high-density polyethylene (HDPE) bottles after triple rinsing with water collected on-site (stream or inflow water, as appropriate). Stream samples were collected by submersing the neck of each bottle into the water near the thalweg (shallow depths precluded the collection of samples using a width- and depth-integrated approach). Water temperature was measured in situ using an alcohol thermometer. Samples were transported to a central processing area where 125-milliliter aliquots were prepared for cation and anion analyses. Processing included filtration, measurement of pH and specific conductance, and preservation of samples for iron speciation. Filtration was completed using 0.45-micrometer disposable filters. Aliquots for cation analysis were acidified to pH <2.0 with ultrapure nitric acid (HNO<sub>3</sub>). Total-recoverable and dissolved cation concentrations were determined from unfiltered and filtered samples, respectively, using inductively coupled argon plasma-mass spectrometry (ICP-MS). ICP-MS analyses were performed at the University of Southern Mississippi, in a laboratory approved by the USGS Branch of Quality Assurance. Cation concentrations are reported for aluminum (Al), arsenic (As), barium (Ba), calcium (Ca), cadmium (Cd), cobalt (Co), chromium (Cr), copper (Cu), iron (Fe), potassium (K), lithium (Li), magnesium (Mg), manganese (Mn), molybdenum (Mo), sodium (Na), nickel (Ni), lead (Pb), sulfur (converted to sulfate, SO<sub>4</sub>), silicon (Si), strontium (Sr), uranium (U), vanadium (V), and zinc (Zn) (tables 3–6, 8, 10–13, 15). Dissolved anion concentrations were determined from filtered, unacidified samples by ion chromatogra-

phy (IC). IC analyses were performed at the USGS in Salt Lake City, Utah, using the quality-assurance procedures described by Kimball and others (1999). Anion concentrations are reported for bromide (Br) and chloride (Cl) (tables 7–8 and 14–15). Aliquots for iron speciation were placed in amber bottles and preserved with concentrated HCl to fix the ratio of ferrous to ferric iron in filtered samples (To and others, 1999). Ferrous and total dissolved iron concentrations were determined by spectrophotometry (Brown and others, 1970) and are reported in tables 7 and 14. Alkalinity was determined from filtered, unacidified samples (tables 2 and 9).

Quality-assurance procedures included the analysis of sequential replicates, field blanks, and standard reference samples. Sequential replicate samples (Wilde and others, 1999) were collected at two stream sites (MC-0888 and MC-1231, table 1) during both synoptic sampling campaigns to assess sampling and analytical error. Inorganic blank water was poured into a 1.8-liter HDPE sample bottle that was processed in a manner identical to the stream and inflow samples. Analytical results from blank aliquots for most constituents were less than method detection limits,<sup>4</sup> such that contamination during sample processing is not suspected. Standard reference samples collected in the field were analyzed repeatedly to assess precision; standard reference samples obtained from the USGS Branch of Quality Assurance were analyzed repeatedly to assess bias and precision. Data obtained from these quality-assurance procedures indicate that all sampling and analytical errors were within acceptable limits.

## Temporal Sampling

Successful application of the tracer-dilution method used in conjunction with synoptic sampling requires the attainment of steady-state tracer concentrations at all of the stream sites. Steady-state tracer concentrations are attained when the tracer-laden water has fully mixed with water in all of the pools, eddies, and hyporheic zones between the injection site and a given stream site. Upon reaching steady state, tracer concentrations stop increasing and a steady concentration, known as the plateau, is maintained. Attainment of the plateau is typically documented by collecting a time series of samples at a number of “transport sites” located along the study reach. These temporal samples are collected manually and (or) by using automatic samplers that collect samples at fixed time intervals and store them for later processing. Transport sites for the 2005 study were located at stream sites 512, 576, 826, and 1989 (fig. 1).<sup>5</sup> Temporal samples from the transport sites were filtered

<sup>2</sup>Stream- and inflow-sampling sites are identified herein using a numeric value that indicates the distance (in meters) from the top of the study reach to the given sampling location. These distances are identical to those used for the 1999 study on Mineral Creek described by Runkel and Kimball (2002).

<sup>3</sup>“Left bank inflow” (LBI) and “right bank inflow” (RBI) as used throughout this report refer to the side of the stream from which a given inflow enters the study reach (where “left” and “right” are from the point of view of an observer who is looking downstream).

<sup>4</sup>Exceptions to this statement include aluminum and chromium. The aluminum concentration in the unfiltered blank aliquot from August 24, 2005 and the chromium concentrations from filtered and unfiltered blank aliquots from August 22 and August 24, 2005 were above the method detection limits. In all cases the detected amount of contamination was inconsequential relative to the high concentrations of both constituents observed in the acid mine drainage waters of Mineral Creek.

<sup>5</sup>Sites 512, 826, and 1989 were selected for temporal sampling to provide spatial coverage (representing the top, middle, and bottom of the study reach); transport site 576 was added to meet the objectives of a separate study.

within 24 hours and analyzed for bromide and sulfate by ion chromatography at the USGS in Salt Lake City, Utah, in the fall of 2005. Additional laboratory analyses of the temporal samples from August 21 and 22, 2005 were conducted to investigate the temporal change in specific conductance that was observed at stream site 826 during the August 2005 sampling period. These additional analyses included determination of lithium, sodium, and zinc concentrations by atomic-absorption spectroscopy in the spring and summer of 2007. Results for the temporal samples are provided in tables 16–19, following the main body of this report.

Although the analyses of lithium, sodium, and zinc concentrations provide considerable information on the temporal variation at the transport sites, the uncertainty of the concentrations reported for these samples is likely higher than the uncertainty associated with the synoptic samples. The increase in uncertainty is attributable to several factors, including (1) the automatic samplers were initially intended to collect samples for the analysis of tracer concentrations only; as such the automatic sampling units were not thoroughly cleaned prior to use, (2) some of the samples remained in the automatic samplers for a number of hours before being filtered, (3) the filtered, unacidified samples were analyzed by atomic-absorption spectroscopy (versus ICP-MS for the filtered, acidified synoptic samples), and (4) laboratory analyses were performed in the spring and summer of 2007, long after the August 2005 study. To assess this uncertainty, a subset of temporal samples are compared with synoptic samples collected at the same locations (table 20). Although a direct comparison of temporal and synoptic samples is not possible due to differing times of sample collection and temporal variation, this comparison suggests that the four factors listed above result in higher concentrations for the temporal samples. Despite this potential bias, the temporal data included in tables 16–19 provide qualitative evidence that significant temporal variation occurred during the August 22 synoptic sampling campaign.

## Estimating Streamflow by Tracer Dilution

Under the tracer-dilution method, a conservative tracer is continuously injected at a constant rate and concentration. Given sufficient time, all portions of the stream have become fully mixed with the tracer-laden water, and concentrations at a given instream site reach a steady-state plateau. Decreases in plateau concentration with stream length reflect dilution of the tracer by additional water entering the channel (surface and (or) ground-water inflow). Consideration of this dilution allows for the calculation of streamflow at each site (Kilpatrick and Cobb, 1985; Kimball and others 2007):

$$Q = \frac{Q_{INJ} C_{INJ}}{C_P - C_B} \quad (1)$$

where  $C_B$  is the background tracer concentration,  $C_P$  is the tracer concentration at plateau,  $C_{INJ}$  is the injectate concentration,  $Q_{INJ}$  is the injection rate, and  $Q$  is the streamflow estimate.<sup>6</sup>

**Table 20.** Comparison of synoptic samples (filtered, acidified samples analyzed by ICP-MS) and temporal samples (filtered, unacidified samples analyzed by IC) for lithium (Li), sodium (Na), and zinc (Zn) at the Transport Sites, Mineral Creek, Colorado, August 22, 2005.

[mg/L, milligrams per liter]

Sample Type	Time	Li (mg/L)	Na (mg/L)	Zn (mg/L)
Transport Site #1 (MC-0512)				
Temporal	13:00	5.91	16.9	42.2
Synoptic	13:30	6.42	16.0	43.8
Temporal	14:00	6.26	18.0	43.9
Synoptic	14:30	5.45	16.1	43.3
Temporal	15:00	5.77	17.4	44.5
Transport Site #2 (MC-0576)				
Synoptic	12:45	5.52	13.3	31.3
Temporal	13:00	6.02	14.8	36.0
Transport Site #3 (MC-0826)				
Temporal	12:00	5.46	14.4	31.1
Synoptic	12:15	4.84	13.1	27.2
Transport Site #4 (MC-1989)				
Synoptic	09:25	0.48	2.96	5.03
Temporal	09:30	0.52	3.14	4.86

For the paired synoptic approach, streamflow estimates are needed for both the acidic ambient conditions (August 22, 2005) and at the experimentally-elevated pH (August 24, 2005). Because of these differing conditions, a lithium-bromide tracer was selected based on theoretical considerations that indicate conservative transport of the cation (lithium) under the acidic conditions, and conservative transport of the anion (bromide) at elevated pH. Lithium concentrations are therefore used with equation 1 ( $C_P$ ) to develop streamflow estimates for the August 22 synoptic campaign, whereas bromide concentrations are used with equation 1 for the August 24 syn-

<sup>6</sup>Streamflow estimates reported herein have units of cubic feet per second (cfs). These units may be obtained by expressing the injection rate in terms of cfs and all concentration variables in terms of milligrams per liter (concentration units in the numerator and denominator of equation 1 cancel out).

## 6 Geochemical Data for Upper Mineral Creek, Colorado

optic campaign. Although use of equation 1 is theoretically straightforward, practical application is often confounded by laboratory and sampling errors that affect the plateau concentrations. For the case considered here, the spatial profile of lithium from August 22 exhibits increases in concentration with distance that are theoretically impossible (table 8; given negligible background concentrations of lithium and bromide in most headwater systems, the addition of inflow waters should result in a continuously decreasing tracer profile). In contrast, the spatial profile of bromide from August 24 exhibits continuous dilution over the length of the study reach (table 15).

Given the lithium profile described above, the observed lithium concentrations cannot be used directly in equation 1 as the resulting streamflow profile would exhibit decreases in streamflow with distance that are an artifact of laboratory and (or) sampling error, rather than physical loss. An alternate lithium concentration was therefore developed for the August 22 synoptic campaign by considering the observed bromide dilution on August 24:

$$Li_D^{alt} = Li_U^{alt} \frac{Br_D}{Br_U} \quad (2)$$

where  $Li^{alt}$  is the alternate lithium concentration on August 22,  $Br$  is the observed bromide concentration on August 24,  $D$  and  $U$  subscripts denote quantities at upstream and downstream sites, and all concentrations are in milligrams per liter.<sup>7</sup> Calculation of alternate lithium concentrations by equation 2 results in a spatial profile that is generally similar to the observed lithium data, while being free from the spatial increases that appear in both the dissolved and total-recoverable lithium concentrations (table 8). Streamflow estimates based on  $Li^{alt}$  (August 22, 2005) and observed plateau bromide concentrations (August 24, 2005) are presented in tables 8 and 15, respectively.

Tracer-dilution streamflow estimates for the August 22 and August 24 synoptic sampling campaigns are consistently higher than current meter measurements made on August 22 at several stream sites (fig. 2). Shallow depths, narrow cross sections, and irregular streambed surfaces led to current meter measurements that are rated either “poor” or “fair” (Jeff Foster, USGS, written commun., 2005).<sup>8</sup> The consistent difference between the tracer-dilution estimates and current meter measurements of streamflow may be attributed to two factors.

<sup>7</sup>The development of alternative lithium concentrations using equation 2 is predicated on two assumptions: (1) the relative increase in flow (amount of dilution) from one site to the next was the same on August 22 and 24, 2005; this assumption is based on the relatively steady streamflow conditions observed at low flow and the absence of any large rainfall events from August 22 to August 24, and (2) the bromide tracer was transported conservatively on August 24; this assumption is supported by theory (Br is conservative at elevated pH) and a lithium/bromide molar ratio that is close to unity (average value on August 24 of 1.02).

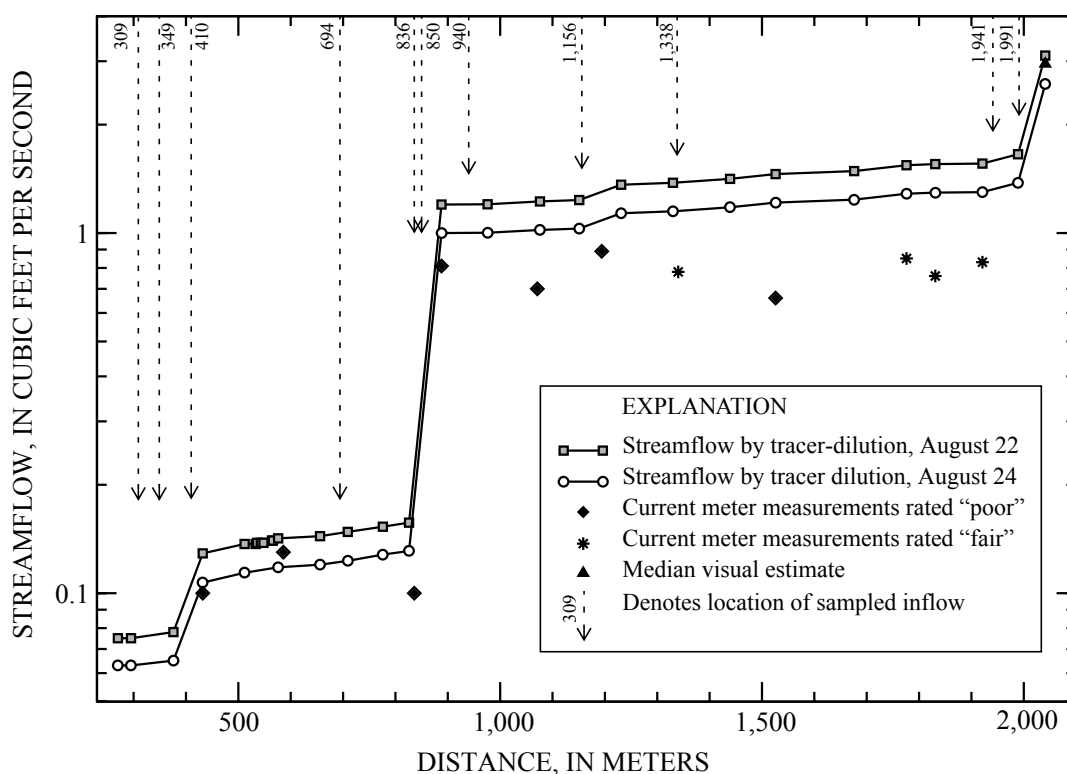
<sup>8</sup>Current meter measurements were made using the six-tenths method and a pygmy meter (Rantz and others, 1982). An additional current meter measurement, rated “very poor,” is not included in fig. 2.

First, tracer-dilution estimates of streamflow account for subsurface (hyporheic) components of streamflow that are not part of the current meter measurement. Second, current meter measurements are known to under report stream velocity when stream depths are less than 0.75 feet (Rantz and others, 1982). Although these factors explain the differences shown in figure 2, two additional checks on the tracer-dilution profile of streamflow were implemented. First, visual estimates of streamflow were made by several experienced stream gagers using a photograph of stream site 2041 (fig. 1) taken during the August 22 synoptic campaign. Each visual estimate was made without knowledge of the tracer-dilution estimate or the other visual estimates. The median visual estimate is remarkably close to the tracer-dilution estimate (table 21, fig. 2), lending credence to the tracer-dilution estimates for the downstream portion of the study reach. Second, measured discharges from the Junction mine and Koehler tunnel on August 12, 2005 contribute approximately 0.04 cubic feet per second of streamflow to the head of the study reach (William Simon, Animas River Stakeholders Group, written commun., 2008), a quantity that compares favorably with the tracer-dilution estimates at stream site 295 (fig. 1, tables 8 and 15).<sup>9</sup> This second check lends credence to the tracer-dilution estimates for the upstream portion of the study reach.

**Table 21.** Comparison of tracer-dilution streamflow estimate and visual estimates provided by experienced stream gagers, for stream site 2041, Mineral Creek, Colorado, August 22, 2005.

Estimate provided by:	Streamflow estimate (cubic feet per second)
Jon Evans	3.1
Greg O’Neill	2.9
Jeff Deacon	3.0
Richard Kiah	2.3–3.0
Median of visual estimates	3.0
Tracer-dilution estimate	3.1

<sup>9</sup>The 0.04 cubic feet per second discharge from the Junction mine and Koehler tunnel is lower than the tracer-dilution estimates of 0.075 and 0.063 cubic feet per second for stream site 295 on August 22, and August 24, 2005, respectively. The difference is attributable to other sources of water in the subwatershed upgradient from stream site 295 (fig. 1). These other sources of water were observed during a September 2008 site visit and found to be of similar magnitude to the combined mine/tunnel discharge.



**Figure 2.** Spatial profile of streamflow estimates from the tracer-dilution method (August 22 and 24, 2005) and current meter measurements (August 22, 2005), Mineral Creek, Colorado.

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## References Cited

- Bencala, K.E., and McKnight, D.M., 1987, Identifying in-stream variability—Sampling iron in an acidic stream, *in* Averett, R.C., and McKnight, D.M., eds., *Chemical quality of water and the hydrologic cycle*: Chelsea, Mich., Lewis Publishers, Inc., p. 255–269.
- Bove, D.J., Yager, D.B., Mast, M.A., and Dalton, J.B., 2007, Alteration map showing major faults and veins and associated water-quality signatures of the Animas River watershed headwaters near Silverton, southwest Colorado: U.S. Geological Survey Scientific Investigations Map 2976, pamphlet 18 p., scale 1:24,000.
- Brown, E., Skougstad, M.W., and Fishman, M.J., 1970, Methods for collection and analysis of water samples for dissolved minerals and gases: U.S. Geological Survey Techniques of Water-Resource Investigations, book 5, chap. A1, 103 p.
- Kilpatrick, F.A., and Cobb, E.D., 1985, Measurement of discharge using tracers: U.S. Geological Survey Techniques of Water-Resource Investigations, book 3, chap. A16, 52 p.
- Kimball, B.A., Broshears, R.E., Bencala, K.E., and McKnight, D.M., 1994, Coupling of hydrologic transport and chemical reactions in a stream affected by acid mine drainage: *Environmental Science and Technology*, v. 28, no. 12, p. 2065–2073.
- Kimball, B.A., Nimick, D.A., Gerner, L.J., and Runkel, R.L., 1999, Quantification of metal loading in Fisher Creek by tracer injection and synoptic sampling, Park County, Montana, August 1997: U.S. Geological Survey Water-Resources Investigations Report 99–4119, 40 p.

## 8 Geochemical Data for Upper Mineral Creek, Colorado

- Kimball, B.A., Runkel, R.L., Walton-Day, Katherine, and Bencala, K.E., 2002, Assessment of metal loads in watersheds affected by acid mine drainage by using tracer injection synoptic sampling—Cement Creek, Colorado, USA: *Applied Geochemistry*, v. 17, no. 9, p. 1183–1207.
- Kimball, B.A., Walton-Day, Katherine, and Runkel, R.L., 2007, Quantification of metal loading by tracer injection and synoptic sampling, 1996–2000, Chapter E9 *in* Church, S.E., von Guerard, P., Finger, S.E., eds., *Integrated investigations of environmental effects of historical mining in the Animas River Watershed, San Juan County, Colorado*: U.S. Geological Survey Professional Paper 1651, p. 417–495.
- Nimick, D.A., Gammons, C.H., Cleasby, T.E., Madison, J.P., Skaar, D., Brick, C.M., 2003, Diel cycles in dissolved metal concentrations in streams—Occurrence and possible causes: *Water Resources Research*, v. 39, 1247, doi:10.1029/2002WR001571.
- Rantz, S.E., and others, 1982, Measurement and computation of streamflow—Volume 1. Measurement of stage and discharge: U.S. Geological Survey Water Supply Paper 2175, 284 p.
- Runkel, R.L., and Kimball, B.A., 2002, Evaluating remedial alternatives for an acid mine drainage stream—Application of a reactive transport model: *Environmental Science and Technology*, v. 36, no. 5, p. 1093–1101.
- Runkel, R.L., Kimball, B.A., Walton-Day, Katherine, and Verplanck, P.L., 2007, A simulation-based approach for estimating premining water quality—Red Mountain Creek, Colorado: *Applied Geochemistry*, v. 22, no. 9, p. 1899–1918.
- To, T.B., Nordstrom, D.K., Cunningham, K.M., Ball, J.W., and McCleskey, R.B., 1999, A new method for the direct determination of dissolved Fe(III) concentration in acid mine waters: *Environmental Science and Technology*, v. 33, no. 5, p. 807–813.
- Wilde, F.D., Radtke, D.B., Gibs, J., and Iwatsubo, R.T., 1999, National field manual for the collection of water-quality data—Collection of water samples: *Techniques of Water-Resources Investigations of the U.S. Geological Survey*, book 9, chap. A4, 156 p.



## **Tables 1–19**

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The following tables include all of the relevant data from the upper Mineral Creek synoptic sampling campaigns, conducted August 21–24, 2005.

## 10 Geochemical data for upper Mineral Creek, Colorado, August 2005

**Table 1.** Site descriptions and locations for all sites sampled on August 22 and August 24, 2005, Mineral Creek, Colorado.

[Distance, distance downstream, in meters; Source, type of sample collected where S denotes stream sample from Mineral Creek, LBI denotes left bank inflow, and RBI denotes right bank inflow; Easting and Northing, Universal Transverse Mercator (UTM) coordinates in zone 13 S using the North American Datum of 1983 (NAD83); Altitude, elevation provided by GPS unit, in meters; NS, not sampled in 1999; —, no data]

Site (fig. 1)	1999 Site	Distance	Source	Description	Easting	Northing	Altitude
MC-T0	NS	270	S	Immediately upstream of injection (Transport Site #0).	261472	4197716	—
MC-0295	NS	295	S	First site downstream of injection, in newly engineered channel.	261417	4197707	—
MC-0309	MIN3-131	309	RBI	Ponded water near downstream end of culvert that passes under San Juan County Road 14.	261392	4197708	3,373
MC-0349	NS	349	LBI	Flowing to stream with algae	261379	4197672	3,376
MC-0376	MIN3-200	376	S	Stream upstream from culvert	261356	4197659	3,376
MC-0410	MIN3-234	410	RBI	Culvert under Highway 550	261342	4197624	3,373
MC-0432	MIN3-206	432	S	Downstream of culvert	261336	4197602	3,370
MC-0512	MIN3-286	512	S	At bedrock outcrop (Transport Site #1)	261309	4197530	3,361
MC-0533	NS	533	S	Part of intensive study reach	261333	4197564	3,362
MC-0536	NS	536	S	Part of intensive study reach	261332	4197560	3,362
MC-0543	NS	543	S	Part of intensive study reach	261329	4197555	3,362
MC-0548	NS	548	S	Part of intensive study reach	261329	4197551	3,362
MC-0564	NS	564	S	Part of intensive study reach	261317	4197537	3,360
MC-0566	NS	566	S	Part of intensive study reach	261316	4197635	3,359
MC-0576	MIN3-350	576	S	Transport site #2	261280	4197472	3,359
MC-0656	MIN3-430	656	S	Transport site #1 in 1999	261238	4197401	3,351
MC-0694	NS	694	RBI	Small inflow seeping from rocks along Highway 550.	261220	4197370	
MC-0709	MIN3-483	709	S	—	261207	4197352	3,344
MC-0776	MIN3-550	776	S	—	261181	4197310	3,337
MC-0826	MIN3-600	826	S	Transport Site #3	261158	4197272	3,331
MC-0836	MIN3-610	836	LBI	Wet grassy area ≈15 meters long, starting at 826 meters.	261153	4197261	3,332
MC-0850	MIN3-624	850	RBI	Inflow from Mineral Creek headwaters	261146	4197246	3,329
MC-0888	MIN3-662	888	S	Downstream from Mineral Creek inflow	261126	4197215	3,318
MC-0940	MIN3-714	940	RBI	—	261102	4197170	3,318
MC-0976	MIN3-750	976	S	—	261091	4197139	3,317
MC-1076	MIN3-850	1,076	S	Through long reach with cascades	261051	4197057	3,311
MC-1151	MIN3-925	1,151	S	Upstream from Carbon Lake inflow	261044	4196994	3,312

**Table 1.** Site descriptions and locations for all sites sampled on August 22 and August 24, 2005, Mineral Creek, Colorado.—Continued

[Distance, distance downstream, in meters; Source, type of sample collected where S denotes stream sample from Mineral Creek, LBI denotes left bank inflow, and RBI denotes right bank inflow; Easting and Northing, Universal Transverse Mercator (UTM) coordinates in zone 13 S using the North American Datum of 1983 (NAD83); Altitude, elevation provided by GPS unit, in meters; NS, not sampled in 1999; —, no data]

Site (fig. 1)	1999 Site	Distance	Source	Description	Easting	Northing	Altitude
MC-1156	MIN3-930	1,156	LBI	Inflow from Carbon Lake mining area	261046	4196992	3,307
MC-1231	NS	1,231	S	Downstream from water fall	261031	4196929	3,300
MC-1330	MIN3-1104	1,330	S	At cabin up right-bank hill	260979	4196825	3,292
MC-1338	NS	1,338	LBI	Inflow with moss	260972	4196824	3,293
MC-1439	MIN3-1213	1,439	S	Stream in narrow canyon	260926	4196760	3,293
MC-1526	MIN3-1300	1,526	S	At old Ford	260907	4196709	3,279
MC-1676	MIN3-1450	1,676	S	Narrow, below cascade	260827	4196567	3,269
MC-1776	MIN3-1550	1,776	S	Upstream from right-bank adit/prospect pit	260764	4196487	3,258
MC-1831	MIN3-1605	1,831	S	Upstream from waste rocks of Silver Ledge	260732	4196436	3,258
MC-1921	MIN3-1695	1,921	S	Downstream from Silver Ledge head frame	260700	4196369	3,248
MC-1941	MIN3-1715	1,941	RBI	Substantial flow coming out of mine dump	260680	4196360	3,244
MC-1989	MIN3-1763	1,989	S	Upstream from Porphyry Gulch (Transport Site #4).	260644	4196345	3,239
MC-1991	MIN3-1765	1,991	RBI	Porphyry Gulch	260636	4196339	3,236
MC-2041	MIN3-1815	2,041	S	Downstream from Porphyry Gulch	260632	4196286	3,233

## 12 Geochemical data for upper Mineral Creek, Colorado, August 2005

**Table 2.** Data for samples collected August 22, 2005, including pH, specific conductance, temperature, and alkalinity, Mineral Creek, Colorado.

[Sample, "Site" from table 1 with an optional letter suffix ("A" or "B") to denote samples that are part of a field replicate; pH measured at central processing location, in standard units; Specific conductance, in microsiemens per centimeter at 25 degrees Celsius; Temperature, water temperature measured onsite, in degrees Celsius; Alkalinity, in milligrams per liter as calcium carbonate; —, no data]

Sample	Time	pH	Specific conductance	Temperature	Alkalinity
MC1-T0	14:50	2.96	—	14.0	—
MC1-0295	13:55	2.98	2,430	13.0	—
MC1-0376	14:45	2.94	2,430	15.0	—
MC1-0410	13:40	5.79	228	11.0	12.0
MC1-0432	14:35	3.10	—	14.0	—
MC1-0512A	13:30	3.10	1,557	13.0	—
MC1-0512B	14:30	3.11	1,410	15.0	—
MC1-0533	13:25	3.10	1,524	13.0	—
MC1-0536	13:20	3.09	1,530	13.5	—
MC1-0543	13:15	3.09	1,548	13.0	—
MC1-0548	13:00	3.10	1,526	13.0	—
MC1-0564	12:56	3.11	1,481	13.0	—
MC1-0566	12:53	3.11	1,436	13.0	—
MC1-0576	12:45	3.14	1,368	13.0	—
MC1-0656	12:40	3.11	1,342	14.5	—
MC1-0709	12:30	3.10	1,162	13.0	—
MC1-0776	12:25	3.10	1,256	12.5	—
MC1-0826	12:15	3.09	1,286	11.5	—
MC1-0836	12:00	7.02	66	7.0	20.4
MC1-0850	11:55	7.04	89	9.0	31.0
MC1-0888A	11:45	4.18	296	9.0	—
MC1-0888B	11:50	4.17	263	9.0	—
MC1-0940	11:40	7.11	309	8.0	42.4
MC1-0976	11:30	4.02	296	9.5	—
MC1-1076	11:25	3.97	310	9.0	—
MC1-1151	11:20	3.93	324	9.5	—
MC1-1156	11:15	5.39	140	10.0	3.1
MC1-1231A	10:45	4.06	302	8.5	—
MC1-1231B	10:50	4.03	288	8.5	—

**Table 2.** Data for samples collected August 22, 2005, including pH, specific conductance, temperature, and alkalinity, Mineral Creek, Colorado.—Continued

[Sample, “Site” from table 1 with an optional letter suffix (“A” or “B”) to denote samples that are part of a field replicate; pH measured at central processing location, in standard units; Specific conductance, in microsiemens per centimeter at 25 degrees Celsius; Temperature, water temperature measured onsite, in degrees Celsius; Alkalinity, in milligrams per liter as calcium carbonate; —, no data]

<b>Sample</b>	<b>Time</b>	<b>pH</b>	<b>Specific conductance</b>	<b>Temperature</b>	<b>Alkalinity</b>
MC1-1330	10:35	4.14	282	7.5	—
MC1-1338	10:30	7.40	259	6.0	38.1
MC1-1439	10:15	4.30	266	6.0	—
MC1-1526	10:05	4.26	255	5.5	—
MC1-1676	09:55	4.24	258	5.5	—
MC1-1776	09:45	4.21	263	5.5	—
MC1-1831	09:40	4.22	252	5.5	—
MC1-1921	09:35	4.22	261	5.5	—
MC1-1941	09:30	3.50	366	5.5	—
MC1-1989	09:25	4.19	269	5.5	—
MC1-1991	09:20	6.58	93	6.5	11.2
MC1-2041	09:10	4.75	180	6.0	0.0

## 14 Geochemical data for upper Mineral Creek, Colorado, August 2005

**Table 3.** Total-recoverable concentrations from unfiltered samples for aluminum (Al), arsenic (As), barium (Ba), calcium (Ca), cadmium (Cd), cobalt (Co), chromium (Cr), copper (Cu), iron (Fe), potassium (K), and magnesium (Mg), Mineral Creek, Colorado, August 22, 2005.

[Sample, "Site" from table 1 with an optional letter suffix ("A" or "B") to denote samples that are part of a field replicate; µg/L, micrograms per liter; mg/L, milligrams per liter; <, less than; reported concentrations are unrounded values from the laboratory analysis—unrounded values are not meant to reflect accuracy beyond three significant figures]

Sample	Al (mg/L)	As (mg/L)	Ba (µg/L)	Ca (mg/L)	Cd (µg/L)	Co (µg/L)	Cr (µg/L)	Cu (mg/L)	Fe (mg/L)	K (mg/L)	Mg (mg/L)
MC1-T0	39.88	3.479	18.5	220.4	254.6	187.3	19.0	13.63	227.2	1.756	40.38
MC1-0295	38.85	3.270	20.6	216.8	245.4	181.5	17.9	13.22	217.8	1.748	39.32
MC1-0376	38.44	2.872	18.5	212.8	244.3	180.9	17.2	13.15	205.3	1.678	37.53
MC1-0410	1.551	0.001	42.4	25.93	9.59	8.56	0.61	0.448	1.397	0.493	3.207
MC1-0432	20.37	1.364	30.8	120.8	133.6	96.4	9.42	6.658	99.91	1.085	21.90
MC1-0512A	20.22	1.278	27.5	123.4	133.9	98.5	9.27	6.830	94.31	1.037	20.48
MC1-0512B	20.10	1.372	29.6	128.7	133.6	98.7	9.48	7.582	95.37	1.079	20.57
MC1-0533	19.51	1.171	30.6	116.3	124.9	93.1	8.63	6.404	86.30	1.011	20.72
MC1-0536	19.90	1.213	29.4	122.3	131.1	97.9	8.77	6.923	89.63	1.099	20.21
MC1-0543	20.00	1.245	30.6	119.3	130.7	96.3	8.85	6.668	91.13	1.089	20.99
MC1-0548	19.56	1.145	30.5	114.5	124.4	92.2	8.46	6.252	85.00	1.058	21.32
MC1-0564	17.70	0.927	28.7	112.1	116.6	87.8	7.61	5.997	74.25	0.957	18.67
MC1-0566	17.31	0.780	28.2	114.2	110.0	84.9	7.78	6.201	69.73	0.964	18.59
MC1-0576	15.24	0.575	27.1	101.6	95.3	75.2	6.19	4.691	58.03	0.901	17.18
MC1-0656	14.56	0.611	27.9	103.5	90.7	72.1	5.72	4.467	56.72	0.979	16.78
MC1-0709	12.89	0.573	28.7	87.12	80.4	64.5	4.92	3.980	51.30	0.947	14.95
MC1-0776	12.83	0.562	29.0	88.35	80.0	64.6	5.04	4.009	48.61	0.906	14.92
MC1-0826	13.53	0.594	28.8	91.06	85.6	67.1	5.29	4.289	49.93	0.895	15.34
MC1-0836	0.135	0.001	38.6	9.499	<0.11	0.13	0.29	0.005	0.517	0.206	1.050
MC1-0850	0.026	<0.0005	31.1	13.88	<0.11	<0.07	0.15	<0.003	<0.025	0.230	0.913
MC1-0888A	2.138	0.109	31.2	25.83	14.1	10.5	1.12	0.774	8.672	0.300	3.015
MC1-0888B	2.027	0.112	32.2	27.26	14.4	10.7	1.15	0.790	9.181	0.342	3.047
MC1-0940	0.033	<0.0005	81.0	35.79	<0.11	<0.07	0.26	<0.003	<0.025	0.786	2.853
MC1-0976	4.669	0.135	31.7	27.48	16.6	12.0	1.26	0.906	10.15	0.339	3.271
MC1-1076	2.483	0.156	32.9	28.30	17.5	12.6	1.31	0.987	11.20	0.351	3.400
MC1-1151	2.635	0.175	33.6	28.67	18.6	12.9	1.38	1.042	12.09	0.355	3.379
MC1-1156	0.612	0.021	44.9	15.80	3.58	3.40	0.41	0.484	1.811	0.475	2.408
MC1-1231A	2.493	0.166	34.4	27.48	17.3	12.1	1.33	1.004	11.51	0.346	3.332
MC1-1231B	2.363	0.169	34.7	27.06	17.2	12.0	1.31	1.001	11.61	0.378	3.249

**Table 3.** Total-recoverable concentrations from unfiltered samples for aluminum (Al), arsenic (As), barium (Ba), calcium (Ca), cadmium (Cd), cobalt (Co), chromium (Cr), copper (Cu), iron (Fe), potassium (K), and magnesium (Mg), Mineral Creek, Colorado, August 22, 2005.—Continued

[Sample, “Site” from table 1 with an optional letter suffix (“A” or “B”) to denote samples that are part of a field replicate; µg/L, micrograms per liter; mg/L, milligrams per liter; <, less than]

Sample	Al (mg/L)	As (mg/L)	Ba (µg/L)	Ca (mg/L)	Cd (µg/L)	Co (µg/L)	Cr (µg/L)	Cu (mg/L)	Fe (mg/L)	K (mg/L)	Mg (mg/L)
MC1-1330	2.239	0.145	35.2	26.82	16.0	11.2	1.18	0.914	10.32	0.327	3.190
MC1-1338	0.485	<0.0005	39.6	22.84	<0.11	0.61	0.44	0.003	1.218	0.816	1.996
MC1-1439	2.033	0.117	33.6	25.87	14.2	10.4	1.03	0.821	8.945	0.334	3.092
MC1-1526	1.980	0.113	33.6	26.33	14.1	10.1	1.05	0.823	8.793	0.350	3.056
MC1-1676	1.918	0.112	34.6	25.79	13.9	10.1	1.01	0.820	8.711	0.338	3.003
MC1-1776	2.007	0.111	34.5	25.96	13.8	10.2	1.00	0.818	8.392	0.365	3.013
MC1-1831	1.953	0.110	35.3	25.97	14.1	10.1	1.06	0.821	8.404	0.350	2.997
MC1-1921	2.004	0.113	34.8	26.18	14.5	10.2	1.04	0.838	8.525	0.352	3.016
MC1-1941	1.096	0.002	19.3	23.15	31.2	5.91	0.34	0.325	1.516	0.697	2.344
MC1-1989	2.036	0.106	34.2	25.76	14.8	10.1	0.99	0.807	8.038	0.366	3.041
MC1-1991	0.062	<0.0005	23.4	13.84	0.54	<0.07	0.26	<0.003	<0.025	0.213	0.892
MC1-2041	1.152	0.057	30.2	20.87	8.15	5.31	0.60	0.431	4.467	0.320	2.031

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**Table 4.** Total-recoverable concentrations from unfiltered samples for manganese (Mn), molybdenum (Mo), sodium (Na), nickel (Ni), lead (Pb), sulfate (SO<sub>4</sub>), silicon (Si), strontium (Sr), uranium (U), vanadium (V), and zinc (Zn), Mineral Creek, Colorado, August 22, 2005.

[Sample, "Site" from table 1 with an optional letter suffix ("A" or "B") to denote samples that are part of a field replicate; µg/L, micrograms per liter; mg/L, milligrams per liter; <, less than; reported concentrations are unrounded values from the laboratory analysis—unrounded values are not meant to reflect accuracy beyond three significant figures]

Sample	Mn (mg/L)	Mo (µg/L)	Na (mg/L)	Ni (µg/L)	Pb (µg/L)	SO <sub>4</sub> <sup>1</sup> (mg/L)	Si (mg/L)	Sr (mg/L)	U (µg/L)	V (µg/L)	Zn (mg/L)
MC1-T0	32.11	0.89	24.72	218.0	194.6	1672	17.63	7.188	23.1	34.1	89.64
MC1-0295	31.06	0.84	24.24	209.7	198.2	1606	17.77	6.929	22.1	31.3	84.58
MC1-0376	30.76	0.65	23.86	210.1	190.6	1585	17.72	6.954	22.2	26.4	85.49
MC1-0410	1.538	<0.13	8.958	10.3	1.32	83.92	3.710	0.670	0.66	0.13	3.417
MC1-0432	16.88	0.20	15.90	114.3	104.8	830.3	10.54	3.796	11.7	12.6	45.19
MC1-0512A	16.82	0.35	16.57	117.0	102.9	823.1	11.43	3.855	12.1	11.4	44.46
MC1-0512B	16.80	0.41	15.84	117.3	110.7	837.6	11.65	3.797	11.8	12.6	44.54
MC1-0533	16.12	0.30	15.80	108.7	105.6	792.9	10.79	3.698	11.0	10.6	42.66
MC1-0536	16.41	0.31	16.56	114.4	108.9	795.0	11.20	3.783	11.7	10.5	43.58
MC1-0543	16.17	0.19	16.24	112.2	106.1	820.2	10.65	3.767	11.6	11.0	44.15
MC1-0548	15.54	0.15	15.79	107.6	106.5	780.5	10.35	3.639	11.0	10.1	42.05
MC1-0564	14.57	0.27	14.82	101.3	111.6	704.9	11.07	3.442	10.9	8.24	37.89
MC1-0566	14.40	0.33	14.31	99.5	103.2	717.5	11.42	3.364	9.89	6.92	36.51
MC1-0576	12.58	0.21	13.63	86.5	103.7	632.0	10.45	3.026	8.60	5.13	31.42
MC1-0656	11.77	0.17	12.93	81.6	115.3	623.1	10.45	2.951	8.10	5.21	29.69
MC1-0709	9.960	0.16	12.47	71.5	129.0	539.3	9.771	2.666	7.51	4.99	25.25
MC1-0776	9.966	0.14	12.32	69.5	120.5	534.7	9.732	2.679	7.52	4.92	25.54
MC1-0826	10.68	0.15	12.81	75.8	108.7	558.7	10.06	2.775	7.94	5.22	27.42
MC1-0836	0.039	<0.13	1.764	<0.14	2.10	11.07	2.473	0.379	0.01	0.44	<0.014
MC1-0850	<0.006	<0.13	0.776	<0.14	0.12	24.58	1.304	0.253	<0.01	0.03	<0.014
MC1-0888A	1.648	<0.13	2.542	11.8	12.9	110.0	2.437	0.664	1.30	1.02	5.001
MC1-0888B	1.695	<0.13	2.564	12.4	12.7	113.8	2.701	0.664	1.30	1.05	4.999
MC1-0940	0.007	<0.13	20.08	<0.14	0.81	29.02	2.352	0.758	<0.01	0.05	<0.014
MC1-0976	1.928	<0.13	2.875	13.8	11.8	123.2	2.580	0.711	1.47	1.24	5.826
MC1-1076	2.067	<0.13	3.044	14.9	11.9	129.2	2.617	0.739	1.59	1.43	6.321
MC1-1151	2.109	<0.13	2.986	15.3	12.4	132.0	2.630	0.747	1.65	1.68	6.655
MC1-1156	0.224	<0.13	3.115	2.56	42.9	58.00	3.798	0.402	0.17	0.63	0.984
MC1-1231A	2.015	<0.13	3.365	14.2	14.2	126.5	2.730	0.724	1.55	1.63	6.196
MC1-1231B	1.904	<0.13	3.082	14.3	13.9	123.8	2.715	0.705	1.51	1.70	6.101



**Table 4.** Total-recoverable concentrations from unfiltered samples for manganese (Mn), molybdenum (Mo), sodium (Na), nickel (Ni), lead (Pb), sulfate (SO<sub>4</sub>), silicon (Si), strontium (Sr), uranium (U), vanadium (V), and zinc (Zn), Mineral Creek, Colorado, August 22, 2005.—Continued

[Sample, “Site” from table 1 with an optional letter suffix (“A” or “B”) to denote samples that are part of a field replicate; µg/L, micrograms per liter; mg/L, milligrams per liter; <, less than]

Sample	Mn (mg/L)	Mo (µg/L)	Na (mg/L)	Ni (µg/L)	Pb (µg/L)	SO <sub>4</sub> <sup>1</sup> (mg/L)	Si (mg/L)	Sr (mg/L)	U (µg/L)	V (µg/L)	Zn (mg/L)
MC1-1330	1.792	<0.13	3.101	13.3	14.1	117.3	2.753	0.688	1.45	1.48	5.594
MC1-1338	0.071	0.70	26.33	0.31	2.27	88.93	3.112	1.159	0.05	0.92	<0.014
MC1-1439	1.583	<0.13	2.907	12.1	12.4	111.8	2.646	0.663	1.25	1.16	5.073
MC1-1526	1.609	<0.13	2.999	11.8	12.1	111.2	2.769	0.649	1.19	1.14	4.890
MC1-1676	1.614	<0.13	3.049	11.6	11.9	111.4	2.740	0.648	1.18	1.16	4.929
MC1-1776	1.587	<0.13	2.793	12.0	21.8	110.7	2.717	0.642	1.16	1.09	4.984
MC1-1831	1.617	<0.13	2.739	12.2	22.1	109.4	2.692	0.644	1.19	1.14	4.986
MC1-1921	1.667	<0.13	2.948	12.1	27.8	112.7	2.877	0.648	1.21	1.16	5.006
MC1-1941	1.851	<0.13	4.359	5.26	3837	114.8	3.492	0.734	3.06	0.05	10.05
MC1-1989	1.660	<0.13	3.077	11.6	245.1	110.6	2.722	0.662	1.31	1.08	5.278
MC1-1991	0.015	<0.13	0.689	0.17	3.08	33.85	1.413	0.169	0.03	0.02	0.221
MC1-2041	0.896	<0.13	1.887	6.17	167.8	75.14	2.260	0.427	0.70	0.63	2.838

<sup>1</sup>SO<sub>4</sub> concentrations were calculated using the sulfur (S) results obtained by ICP-MS, under the assumption that all S was in the form of SO<sub>4</sub>.

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**Table 5.** Dissolved concentrations from filtered samples for aluminum (Al), arsenic (As), barium (Ba), calcium (Ca), cadmium (Cd), cobalt (Co), chromium (Cr), copper (Cu), iron (Fe), potassium (K), and magnesium (Mg), Mineral Creek, Colorado, August 22, 2005.

[Sample, "Site" from table 1 with an optional letter suffix ("A" or "B") to denote samples that are part of a field replicate; µg/L, micrograms per liter; mg/L, milligrams per liter; <, less than; reported concentrations are unrounded values from the laboratory analysis—unrounded values are not meant to reflect accuracy beyond three significant figures]

Sample	Al (mg/L)	As (mg/L)	Ba (µg/L)	Ca (mg/L)	Cd (µg/L)	Co (µg/L)	Cr (µg/L)	Cu (mg/L)	Fe (mg/L)	K (mg/L)	Mg (mg/L)
MC1-T0	39.75	3.195	17.5	217.6	256.0	184.6	18.8	13.86	224.8	1.710	39.23
MC1-0295	38.33	2.983	18.6	211.5	244.4	178.4	18.0	13.29	212.9	1.775	38.04
MC1-0376	38.44	2.707	17.9	217.8	241.2	179.8	17.2	13.11	201.7	1.712	38.72
MC1-0410	0.340	0.001	42.6	25.68	9.43	8.38	0.21	0.389	0.391	0.465	3.178
MC1-0432	20.21	1.161	29.4	120.8	134.0	97.1	9.31	6.780	97.10	1.076	20.12
MC1-0512A	19.63	1.025	29.2	118.7	131.8	97.0	9.03	6.824	89.01	1.044	19.74
MC1-0512B	20.07	0.942	29.1	118.1	127.5	97.2	8.80	6.799	88.62	0.973	18.99
MC1-0533	19.22	0.923	29.3	118.8	123.5	93.5	8.41	6.398	83.09	1.062	20.14
MC1-0536	19.42	0.973	29.0	118.3	127.6	94.6	8.38	6.998	85.74	1.082	21.43
MC1-0543	20.64	1.044	29.7	120.2	130.1	97.1	8.79	6.728	91.04	1.067	22.19
MC1-0548	19.47	0.936	28.9	114.8	124.2	92.8	8.26	6.312	84.01	1.035	21.26
MC1-0564	17.96	0.709	28.6	110.9	112.5	87.0	7.24	5.812	72.23	0.979	20.66
MC1-0566	17.41	0.635	28.4	107.8	108.7	83.7	7.00	5.537	67.39	0.935	20.36
MC1-0576	15.16	0.447	28.3	100.7	93.9	74.6	6.02	4.765	55.15	0.916	18.82
MC1-0656	14.49	0.464	29.2	96.57	87.1	70.4	5.57	4.402	53.53	0.991	17.84
MC1-0709	12.97	0.381	28.3	88.02	76.8	63.0	4.77	3.837	47.37	0.885	13.54
MC1-0776	13.19	0.356	28.1	88.85	78.3	63.0	4.74	3.981	46.04	0.843	13.76
MC1-0826	13.43	0.405	26.3	91.26	83.1	65.3	4.81	4.205	47.32	0.847	15.38
MC1-0836	0.015	0.001	35.2	8.996	<0.11	<0.07	0.14	0.003	0.111	0.180	0.989
MC1-0850	0.028	<0.0005	31.7	13.42	<0.11	<0.07	0.12	<0.003	<0.025	0.253	0.928
MC1-0888A	1.924	0.018	33.4	24.63	13.6	10.0	0.41	0.749	3.126	0.358	2.976
MC1-0888B	1.911	0.018	31.2	24.63	13.3	10.0	0.47	0.752	3.133	0.355	3.006
MC1-0940	0.013	<0.0005	85.0	33.78	<0.11	<0.07	0.22	0.003	<0.025	0.710	2.747
MC1-0976	2.318	0.023	32.3	25.68	15.3	11.5	0.62	0.871	3.822	0.364	3.212
MC1-1076	2.448	0.025	34.0	27.19	16.8	12.0	0.62	0.933	4.428	0.372	3.328
MC1-1151	2.623	0.026	33.9	27.51	17.6	12.3	0.74	0.989	4.984	0.376	3.378
MC1-1156	0.084	<0.0005	41.4	15.30	3.37	3.21	0.16	0.367	0.282	0.338	2.319
MC1-1231A	2.382	0.027	34.8	25.96	16.7	11.8	0.63	0.985	4.898	0.344	3.288
MC1-1231B	2.418	0.027	34.8	26.13	16.8	12.0	0.64	0.969	5.068	0.337	3.335

**Table 5.** Dissolved concentrations from filtered samples for aluminum (Al), arsenic (As), barium (Ba), calcium (Ca), cadmium (Cd), cobalt (Co), chromium (Cr), copper (Cu), iron (Fe), potassium (K), and magnesium (Mg), Mineral Creek, Colorado, August 22, 2005.—Continued

[Sample, “Site” from table 1 with an optional letter suffix (“A” or “B”) to denote samples that are part of a field replicate; µg/L, micrograms per liter; mg/L, milligrams per liter; <, less than]

Sample	Al (mg/L)	As (mg/L)	Ba (µg/L)	Ca (mg/L)	Cd (µg/L)	Co (µg/L)	Cr (µg/L)	Cu (mg/L)	Fe (mg/L)	K (mg/L)	Mg (mg/L)
MC1-1330	2.208	0.024	34.6	26.03	15.3	11.0	0.54	0.903	4.283	0.367	3.208
MC1-1338	0.018	<0.0005	30.4	21.89	<0.11	<0.07	0.20	<0.003	<0.025	0.687	1.829
MC1-1439	1.956	0.021	34.3	24.95	13.4	9.72	0.44	0.786	3.490	0.351	3.019
MC1-1526	1.963	0.020	35.4	25.10	13.1	9.66	0.37	0.790	3.432	0.363	3.070
MC1-1676	1.965	0.021	34.9	25.07	13.5	9.78	0.41	0.782	3.440	0.351	3.048
MC1-1776	1.967	0.020	35.6	25.05	13.3	9.88	0.43	0.801	3.440	0.357	3.056
MC1-1831	1.910	0.020	34.5	25.04	13.6	10.1	0.41	0.815	3.468	0.377	3.064
MC1-1921	1.950	0.020	35.2	24.91	13.9	10.0	0.36	0.801	3.408	0.356	3.017
MC1-1941	1.068	0.002	20.2	21.36	29.2	5.61	0.29	0.319	1.445	0.655	2.310
MC1-1989	1.894	0.018	35.2	24.66	14.4	9.66	0.42	0.790	3.265	0.335	3.025
MC1-1991	0.012	<0.0005	23.5	13.29	0.47	<0.07	0.17	<0.003	<0.025	0.222	0.871
MC1-2041	0.949	0.009	29.7	19.24	7.84	5.18	0.25	0.412	1.572	0.328	1.986

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**Table 6.** Dissolved concentrations from filtered samples for manganese (Mn), molybdenum (Mo), sodium (Na), nickel (Ni), lead (Pb), sulfate (SO<sub>4</sub>), silicon (Si), strontium (Sr), uranium (U), vanadium (V), and zinc (Zn), Mineral Creek, Colorado, August 22, 2005.

[Sample, "Site" from table 1 with an optional letter suffix ("A" or "B") to denote samples that are part of a field replicate; µg/L, micrograms per liter; mg/L, milligrams per liter; <, less than; reported concentrations are unrounded values from the laboratory analysis—unrounded values are not meant to reflect accuracy beyond three significant figures]

Sample	Mn (mg/L)	Mo (µg/L)	Na (mg/L)	Ni (µg/L)	Pb (µg/L)	SO <sub>4</sub> <sup>1</sup> (mg/L)	Si (mg/L)	Sr (mg/L)	U (µg/L)	V (µg/L)	Zn (mg/L)
MC1-T0	31.97	0.80	24.42	215.6	182.7	1681	17.37	7.166	23.1	33.2	88.15
MC1-0295	30.52	0.63	24.46	207.8	180.1	1567	17.06	6.920	22.2	29.3	86.43
MC1-0376	30.90	0.62	24.32	209.5	175.4	1595	17.66	6.847	21.9	26.0	83.78
MC1-0410	1.546	<0.13	8.400	10.2	0.23	82.02	3.368	0.648	0.33	<0.008	3.326
MC1-0432	16.42	0.15	15.59	113.6	98.1	829.0	10.57	3.780	12.0	9.78	45.21
MC1-0512A	16.32	0.19	16.03	112.8	92.6	809.3	10.95	3.747	11.8	8.55	43.82
MC1-0512B	16.45	<0.13	16.15	114.1	86.6	786.0	10.33	3.655	11.0	8.45	43.31
MC1-0533	15.63	<0.13	16.09	108.1	95.9	785.0	10.50	3.658	11.0	7.57	42.03
MC1-0536	16.13	0.13	15.76	110.2	99.0	805.4	10.79	3.687	11.3	8.01	43.25
MC1-0543	16.42	0.26	16.59	113.5	99.4	821.0	10.63	3.828	11.4	8.75	45.05
MC1-0548	15.82	0.27	15.85	108.4	98.8	791.6	10.52	3.685	11.1	7.60	42.71
MC1-0564	14.85	<0.13	15.11	101.1	97.3	728.6	10.58	3.463	10.0	5.69	39.00
MC1-0566	14.06	0.32	14.32	96.8	96.8	706.6	10.32	3.333	9.62	5.18	36.74
MC1-0576	12.35	<0.13	13.30	84.3	97.9	634.9	9.948	3.004	8.37	3.69	31.26
MC1-0656	11.47	<0.13	13.10	79.3	110.5	610.6	9.691	2.876	7.72	3.81	29.51
MC1-0709	9.826	0.17	12.93	68.0	110.6	545.9	8.998	2.643	6.62	3.25	25.53
MC1-0776	10.08	0.16	13.03	69.5	102.5	547.5	9.447	2.669	6.77	3.16	25.65
MC1-0826	10.52	0.15	13.07	75.5	91.8	568.7	9.421	2.774	7.39	3.24	27.15
MC1-0836	0.028	<0.13	1.471	<0.14	<0.11	10.87	2.678	0.355	<0.01	0.03	<0.014
MC1-0850	0.007	<0.13	0.858	<0.14	<0.11	24.47	1.296	0.239	0.01	<0.008	<0.014
MC1-0888A	1.621	<0.13	2.559	11.6	8.45	105.7	2.450	0.606	1.16	<0.008	4.653
MC1-0888B	1.629	<0.13	2.442	11.9	8.40	107.3	2.446	0.612	1.15	<0.008	4.685
MC1-0940	<0.006	<0.13	20.54	<0.14	<0.11	28.42	2.168	0.727	0.01	0.02	<0.014
MC1-0976	1.883	<0.13	2.712	13.5	8.27	115.3	2.537	0.650	1.32	<0.008	5.444
MC1-1076	2.050	0.16	2.911	14.0	8.52	123.2	2.547	0.680	1.43	<0.008	5.913
MC1-1151	2.154	<0.13	3.057	14.7	8.98	127.9	2.613	0.699	1.53	<0.008	6.251
MC1-1156	0.213	<0.13	2.936	2.24	6.33	55.43	3.922	0.374	0.05	<0.008	0.916
MC1-1231A	1.956	1.50	3.021	13.7	9.40	119.4	2.657	0.672	1.42	<0.008	5.809
MC1-1231B	1.979	0.31	3.133	14.0	9.41	122.0	2.747	0.675	1.41	<0.008	5.917
MC1-1330	1.829	<0.13	2.918	13.0	8.39	113.9	2.756	0.648	1.30	<0.008	5.472

**Table 6.** Dissolved concentrations from filtered samples for manganese (Mn), molybdenum (Mo), sodium (Na), nickel (Ni), lead (Pb), sulfate (SO<sub>4</sub>), silicon (Si), strontium (Sr), uranium (U), vanadium (V), and zinc (Zn), Mineral Creek, Colorado, August 22, 2005.—Continued

[Sample, “Site” from table 1 with an optional letter suffix (“A” or “B”) to denote samples that are part of a field replicate; µg/L, micrograms per liter; mg/L, milligrams per liter; <, less than]

Sample	Mn (mg/L)	Mo (µg/L)	Na (mg/L)	Ni (µg/L)	Pb (µg/L)	SO <sub>4</sub> <sup>1</sup> (mg/L)	Si (mg/L)	Sr (mg/L)	U (µg/L)	V (µg/L)	Zn (mg/L)
MC1-1338	<0.006	0.37	27.36	<0.14	0.14	82.42	2.415	1.107	0.02	0.02	<0.014
MC1-1439	1.604	<0.13	2.840	11.3	7.20	106.6	2.599	0.606	1.09	<0.008	4.723
MC1-1526	1.600	<0.13	3.035	11.3	6.95	105.9	2.795	0.614	1.05	<0.008	4.688
MC1-1676	1.611	<0.13	2.945	11.4	7.17	107.6	2.716	0.609	1.10	<0.008	4.818
MC1-1776	1.632	0.13	2.871	11.6	19.6	106.5	2.850	0.614	1.09	<0.008	4.752
MC1-1831	1.646	<0.13	2.924	12.0	15.7	107.6	2.762	0.614	1.11	<0.008	4.869
MC1-1921	1.634	<0.13	2.867	11.9	19.8	106.2	2.682	0.604	1.10	<0.008	4.792
MC1-1941	1.806	0.58	4.403	5.07	3595	111.4	3.640	0.685	2.82	0.04	9.617
MC1-1989	1.642	<0.13	2.962	11.5	201.6	107.0	2.793	0.613	1.16	<0.008	5.029
MC1-1991	0.013	<0.13	0.664	0.15	1.71	32.48	1.451	0.156	0.01	<0.008	0.206
MC1-2041	0.825	<0.13	1.777	6.21	114.8	71.89	2.048	0.400	0.53	<0.008	2.788

<sup>1</sup>SO<sub>4</sub> concentrations were calculated using the sulfur (S) results obtained by ICP-MS, under the assumption that all S was in the form of SO<sub>4</sub>.

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**Table 7.** Dissolved concentrations from filtered samples for chloride (Cl), ferrous iron [Fe(II)], and ferrous plus ferric iron [Fe(II+III)], Mineral Creek, Colorado, August 22, 2005.

[Sample, "Site" from table 1 with an optional letter suffix ("A" or "B") to denote samples that are part of a field replicate; mg/L, milligrams per liter; —, no data]

Sample	Cl (mg/L)	Fe(II) (mg/L)	Fe(II+III) (mg/L)
MC1-T0	0.660	—	—
MC1-0295	0.352	—	—
MC1-0376	0.547	—	—
MC1-0410	10.98	0.36	0.36
MC1-0432	3.881	—	—
MC1-0512A	6.372	—	—
MC1-0512B	6.686	—	—
MC1-0533	7.445	—	—
MC1-0536	6.891	—	—
MC1-0543	7.072	—	—
MC1-0548	7.012	—	—
MC1-0564	7.047	—	—
MC1-0566	7.477	—	—
MC1-0576	7.118	—	—
MC1-0656	7.067	—	—
MC1-0709	7.219	—	—
MC1-0776	7.220	—	—
MC1-0826	8.232	—	—
MC1-0836	0.356	0.17	0.10
MC1-0850	0.315	0.05	<0.05
MC1-0888A	2.344	2.68	3.15
MC1-0888B	2.260	2.68	3.13
MC1-0940	52.11	0.13	<0.05
MC1-0976	1.628	3.18	3.80
MC1-1076	1.981	3.50	3.69
MC1-1151	1.918	3.61	3.79
MC1-1156	0.336	0.32	0.32
MC1-1231A	1.823	3.58	3.74
MC1-1231B	1.697	3.65	3.85

**Table 7.** Dissolved concentrations from filtered samples for chloride (Cl), ferrous iron [Fe(II)], and ferrous plus ferric iron [Fe(II+III)], Mineral Creek, Colorado, August 22, 2005.—Continued

[Sample, “Site” from table 1 with an optional letter suffix (“A” or “B”) to denote samples that are part of a field replicate; mg/L, milligrams per liter; —, no data]

<b>Sample</b>	<b>Cl (mg/L)</b>	<b>Fe(II) (mg/L)</b>	<b>Fe(II+III) (mg/L)</b>
MC1-1330	1.660	3.68	3.89
MC1-1338	0.647	0.06	<0.05
MC1-1439	1.667	2.89	3.21
MC1-1526	1.995	2.89	3.41
MC1-1676	1.719	2.92	3.41
MC1-1776	1.746	2.90	3.38
MC1-1831	2.019	2.84	3.36
MC1-1921	1.997	2.93	3.47
MC1-1941	4.688	0.68	1.53
MC1-1989	1.770	2.80	3.42
MC1-1991	0.502	0.05	<0.05
MC1-2041	1.318	1.39	1.61

## 24 Geochemical data for upper Mineral Creek, Colorado, August 2005

**Table 8.** Data used to estimate streamflow using the tracer-dilution method, Mineral Creek, Colorado, August 22, 2005.

[Sample, "Site" from table 1 with an optional letter suffix ("A" or "B") to denote samples that are part of a field replicate; Plateau Br concentration, bromide concentration from synoptic sample, in milligrams per liter; Plateau Li concentration, lithium concentration from synoptic sample, in milligrams per liter; Alternate Li concentration, lithium concentration used in equation 1 in lieu of plateau values, in milligrams per liter; Streamflow estimate, tracer-dilution estimate of streamflow, in cubic feet per second; —, no data/not applicable]

<b>Sample</b>	<b>Plateau Br concentration (dissolved)</b>	<b>Plateau Li concentration (dissolved)</b>	<b>Plateau Li concentration (total recoverable)</b>	<b>Alternate Li concentration</b>	<b>Streamflow estimate</b>
MC1-T0	—	0.11	0.10	—	—
MC1-0295	124.21	11.31	11.71	11.31	0.075
MC1-0376	121.39	11.59	11.31	10.85	0.078
MC1-0410	—	0.015	0.021	—	—
MC1-0432	65.89	5.44	5.29	6.59	0.129
MC1-0512A	68.3	6.42	5.62	6.20	0.137
MC1-0512B	61.33	5.45	4.92	6.20	0.137
MC1-0533	66.93	5.63	5.52	6.17	0.137
MC1-0536	66.77	5.70	6.43	6.14	0.138
MC1-0543	66.01	5.62	5.58	6.14	0.138
MC1-0548	65.26	5.39	5.30	6.14	0.138
MC1-0564	64.46	5.35	6.02	6.05	0.140
MC1-0566	65.58	5.53	5.59	6.04	0.140
MC1-0576	65.85	5.52	5.86	5.98	0.142
MC1-0656	64.74	5.42	5.58	5.88	0.144
MC1-0709	62.54	5.08	5.85	5.73	0.148
MC1-0776	60.96	4.88	5.68	5.53	0.153
MC1-0826	60.25	4.84	5.58	5.39	0.157
MC1-0836	—	<0.015	<0.015	—	—
MC1-0850	—	<0.015	<0.015	—	—
MC1-0888A	8.36	0.59	0.70	0.71	1.200
MC1-0888B	8.29	0.65	0.70	0.71	1.200
MC1-0940	—	<0.015	<0.015	—	—
MC1-0976	8.11	0.64	0.71	0.71	1.202
MC1-1076	7.96	0.57	0.71	0.69	1.224
MC1-1151	7.81	0.58	0.67	0.69	1.235
MC1-1156	—	<0.015	0.017	—	—
MC1-1231A	6.89	0.52	0.60	0.62	1.362
MC1-1231B	6.87	0.51	0.58	0.62	1.362



**Table 8.** Data used to estimate streamflow using the tracer-dilution method, Mineral Creek, Colorado, August 22, 2005.—Continued

[Sample, “Site” from table 1 with an optional letter suffix (“A” or “B”) to denote samples that are part of a field replicate; Plateau Br concentration, bromide concentration from synoptic sample, in milligrams per liter; Plateau Li concentration, lithium concentration from synoptic sample, in milligrams per liter; Alternate Li concentration, lithium concentration used in equation 1 in lieu of plateau values, in milligrams per liter; Streamflow estimate, tracer-dilution estimate of streamflow, in cubic feet per second; —, no data/not applicable]

<b>Sample</b>	<b>Plateau Br concentration (dissolved)</b>	<b>Plateau Li concentration (dissolved)</b>	<b>Plateau Li concentration (total recoverable)</b>	<b>Alternate Li concentration</b>	<b>Streamflow estimate</b>
MC1-1330	6.76	0.56	0.60	0.61	1.379
MC1-1338	—	0.07	0.09	—	—
MC1-1439	6.7	0.49	0.59	0.60	1.414
MC1-1526	6.86	0.54	0.57	0.58	1.458
MC1-1676	6.56	0.50	0.55	0.57	1.486
MC1-1776	6.34	0.53	0.54	0.55	1.543
MC1-1831	6.57	0.50	0.53	0.55	1.554
MC1-1921	6.59	0.48	0.52	0.54	1.559
MC1-1941	0.05	0.02	0.03	—	—
MC1-1989	5.94	0.48	0.54	0.51	1.655
MC1-1991	—	<0.015	<0.015	—	—
MC1-2041	3.14	0.24	0.27	0.27	3.110

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**Table 9.** Data for samples collected August 24, 2005, including pH, specific conductance, temperature, and alkalinity, Mineral Creek, Colorado.

[Sample, "Site" from table 1 with an optional letter suffix ("A" or "B") to denote samples that are part of a field replicate; pH (field), pH measured in field immediately after sample collection, in standard units; pH (processing), pH measured at central processing location, in standard units; Specific conductance, in microsiemens per centimeter at 25 degrees Celsius; Temperature, water temperature measured onsite, in degrees Celsius; Alkalinity, in milligrams per liter as calcium carbonate; —, no data]

Sample	Time	pH (field)	pH (processing)	Specific conductance	Temperature	Alkalinity
MC2-T0	13:15	3.10	3.00	2,050	14.0	—
MC2-0295	13:05	11.50	11.76	3,390	15.0	137.7
MC2-0309	10:31	—	8.13	333	9.0	126.7
MC2-0349	10:37	—	2.97	1,458	9.0	—
MC2-0376	14:00	11.15	11.64	3,140	—	164.5
MC2-0432	12:50	10.15	10.46	1,975	14.5	43.8
MC2-0512	12:45	8.36	7.56	2,210	15.0	25.9
MC2-0576	12:35	9.03	9.01	2,060	14.5	21.1
MC2-0656	12:30	9.48	9.51	1,841	15.5	38.1
MC2-0694	15:00	—	—	—	—	—
MC2-0709	12:15	9.07	9.31	1,715	15.0	36.0
MC2-0776	12:10	8.57	8.44	1,725	14.5	29.7
MC2-0826	12:00	—	7.98	1,752	12.0	25.4
MC2-0850	11:45	—	7.46	90	11.0	32.6
MC2-0888A	11:35	7.76	7.28	351	11.0	20.6
MC2-0888B	11:36	7.76	8.46	353	11.0	37.1
MC2-0976	11:25	7.56	7.29	358	10.5	32.8
MC2-1076	11:15	7.62	6.96	353	9.5	31.1
MC2-1151	11:05	7.45	6.78	358	9.0	35.2
MC2-1156	11:02	—	6.21	140	9.5	1.4
MC2-1231A	10:50	7.23	6.81	345	8.0	26.7
MC2-1231B	10:53	7.23	6.90	339	8.0	27.0
MC2-1330	10:45	7.19	6.70	343	7.0	29.1
MC2-1439	10:40	7.21	6.51	334	6.0	16.8
MC2-1526	10:35	7.04	6.40	323	5.5	13.6
MC2-1676	10:25	7.12	6.39	315	5.0	11.1
MC2-1776	10:20	6.75	6.36	320	4.5	8.2
MC2-1831	10:15	7.00	6.37	321	4.5	8.0
MC2-1921	10:10	7.01	6.23	313	4.0	7.9
MC2-1989	10:04	7.19	6.24	303	4.0	7.3
MC2-1991	09:55	—	6.48	93	6.5	12.9
MC2-2041	10:00	7.17	6.07	213	5.5	9.6

**Table 10.** Total-recoverable concentrations from unfiltered samples for aluminum (Al), arsenic (As), barium (Ba), calcium (Ca), cadmium (Cd), cobalt (Co), chromium (Cr), copper (Cu), iron (Fe), potassium (K), and magnesium (Mg), Mineral Creek, Colorado, August 24, 2005.

[Sample, “Site” from table 1 with an optional letter suffix (“A” or “B”) to denote samples that are part of a field replicate; µg/L, micrograms per liter; mg/L, milligrams per liter; <, less than; reported concentrations are unrounded values from the laboratory analysis—unrounded values are not meant to reflect accuracy beyond three significant figures]

Sample	Al (mg/L)	As (mg/L)	Ba (µg/L)	Ca (mg/L)	Cd (µg/L)	Co (µg/L)	Cr (µg/L)	Cu (mg/L)	Fe (mg/L)	K (mg/L)	Mg (mg/L)
MC2-T0	32.91	2.174	14.1	199.1	209.3	159.2	16.3	11.09	174.7	1.396	33.98
MC2-0295	40.14	3.176	16.2	230.5	250.1	191.4	15.7	13.01	219.6	2.495	38.75
MC2-0376	34.87	2.253	14.2	200.6	218.5	174.1	17.1	11.32	183.3	2.073	37.00
MC2-0432	21.95	1.547	22.7	124.5	150.3	116.6	11.1	7.680	118.5	1.341	24.39
MC2-0512	32.82	3.462	28.6	172.8	206.3	149.1	13.0	11.23	195.5	2.002	24.27
MC2-0576	28.29	2.567	28.0	154.3	193.0	139.8	14.4	9.794	160.0	1.560	25.42
MC2-0656	20.96	1.989	26.3	122.4	154.7	117.3	8.69	7.643	127.8	1.625	23.57
MC2-0694	6.947	0.049	44.0	78.77	46.26	39.3	0.92	1.523	3.768	1.152	11.70
MC2-0709	16.07	1.532	24.0	103.2	123.4	96.4	9.10	5.881	105.9	1.566	20.28
MC2-0776	17.68	1.679	24.1	108.7	135.0	103.9	9.11	5.893	109.3	1.601	22.79
MC2-0826	17.58	1.705	25.3	118.3	135.4	100.0	9.37	5.739	104.2	1.556	22.56
MC2-0850	0.033	<0.0005	31.7	14.04	<0.11	0.07	0.21	0.004	0.113	0.287	0.913
MC2-0888A	2.671	0.271	32.8	29.52	20.81	14.9	1.43	1.107	16.37	0.431	3.743
MC2-0888B	2.856	0.275	31.2	29.58	21.35	15.7	1.68	1.168	17.13	0.426	3.843
MC2-0976	2.817	0.280	31.9	31.93	21.69	15.8	1.40	1.163	17.02	0.444	4.021
MC2-1076	2.931	0.285	32.6	29.21	21.71	16.1	1.81	1.175	17.51	0.417	3.893
MC2-1151	2.559	0.248	33.0	29.55	19.96	14.9	1.58	1.057	15.42	0.400	3.766
MC2-1156	0.463	0.010	42.8	15.81	3.70	3.46	0.33	0.525	1.464	0.412	2.381
MC2-1231A	2.656	0.256	34.9	29.26	20.98	14.8	1.42	1.097	15.86	0.454	3.747
MC2-1231B	2.621	0.250	35.5	29.43	20.17	14.4	1.46	1.034	15.30	0.474	3.673
MC2-1330	3.289	0.312	33.7	30.84	22.70	16.4	1.91	1.265	18.59	0.424	4.007
MC2-1439	3.161	0.296	34.4	29.92	20.75	14.8	1.43	1.262	17.19	0.454	3.737
MC2-1526	3.070	0.274	34.0	29.21	19.09	13.8	1.72	1.213	16.37	0.411	3.596
MC2-1676	3.148	0.298	34.7	29.02	18.89	14.0	1.83	1.271	17.92	0.375	3.645
MC2-1776	3.768	0.367	36.7	31.63	20.96	15.8	1.95	1.435	20.09	0.447	4.033
MC2-1831	3.251	0.330	33.9	29.50	18.84	13.9	1.81	1.250	17.44	0.478	3.586
MC2-1921	3.269	0.320	34.1	29.71	18.89	14.1	1.75	1.273	18.03	0.413	3.631
MC2-1989	3.256	0.320	35.2	27.67	18.85	13.5	1.90	1.240	17.67	0.434	3.523
MC2-1991	0.050	<0.0005	24.1	14.04	0.53	<0.07	0.25	<0.003	<0.025	0.290	0.901
MC2-2041	1.734	0.157	29.2	21.79	10.49	7.08	1.01	0.654	8.761	0.360	2.281

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**Table 11.** Total-recoverable concentrations from unfiltered samples for manganese (Mn), molybdenum (Mo), sodium (Na), nickel (Ni), lead (Pb), sulfate (SO<sub>4</sub>), silicon (Si), strontium (Sr), uranium (U), vanadium (V), and zinc (Zn), Mineral Creek, Colorado, August 24, 2005.

[Sample, "Site" from table 1 with an optional letter suffix ("A" or "B") to denote samples that are part of a field replicate; µg/L, micrograms per liter; mg/L, milligrams per liter; <, less than; reported concentrations are unrounded values from the laboratory analysis—unrounded values are not meant to reflect accuracy beyond three significant figures]

Sample	Mn (mg/L)	Mo (µg/L)	Na (mg/L)	Ni (µg/L)	Pb (µg/L)	SO <sub>4</sub> <sup>1</sup> (mg/L)	Si (mg/L)	Sr (mg/L)	U (µg/L)	V (µg/L)	Zn (mg/L)
MC2-T0	25.61	0.64	19.07	180.7	221.0	1,436	19.40	5.968	19.4	24.1	69.17
MC2-0295	30.67	1.20	612.8	212.7	214.1	1,788	22.10	6.968	24.4	26.9	81.64
MC2-0376	27.50	1.07	575.0	192.2	220.9	1,649	22.85	5.733	20.7	24.7	71.72
MC2-0432	18.94	0.87	344.4	131.4	146.0	975.7	14.93	3.697	13.8	16.6	48.85
MC2-0512	21.42	0.96	334.1	173.4	147.1	1,255	15.51	5.466	19.9	29.2	71.75
MC2-0576	21.94	0.80	310.3	161.0	124.6	1,109	15.26	4.718	16.8	27.5	63.21
MC2-0656	18.24	1.17	303.4	129.7	171.7	952.2	14.38	3.657	14.0	17.5	49.21
MC2-0694	6.988	<0.13	18.42	43.6	14.5	348.4	9.968	2.044	1.40	1.97	16.49
MC2-0709	14.82	1.00	254.7	106.0	198.2	841.7	13.29	3.025	11.1	17.3	38.76
MC2-0776	16.23	0.68	275.4	114.0	178.9	904.9	13.24	3.240	12.0	17.0	42.69
MC2-0826	16.02	0.38	258.3	113.3	146.3	926.5	12.65	3.498	12.0	17.7	41.36
MC2-0850	0.019	<0.13	0.852	<0.14	0.14	25.56	1.376	0.250	0.01	0.04	0.020
MC2-0888A	2.434	<0.13	32.31	17.7	18.2	140.9	3.090	0.716	1.82	2.60	7.054
MC2-0888B	2.507	<0.13	35.36	18.3	18.0	144.7	3.084	0.739	1.78	2.84	7.448
MC2-0976	2.627	<0.13	35.00	18.5	18.2	153.4	3.289	0.771	1.89	2.44	7.315
MC2-1076	2.614	<0.13	30.06	18.6	15.4	148.1	3.121	0.746	1.81	3.16	7.375
MC2-1151	2.494	<0.13	30.90	17.0	13.5	148.7	2.873	0.742	1.59	2.81	6.714
MC2-1156	0.222	<0.13	3.114	2.6	18.3	59.54	3.992	0.386	0.15	0.15	0.985
MC2-1231A	2.401	<0.13	30.45	17.1	15.9	144.4	3.188	0.729	1.63	2.52	7.014
MC2-1231B	2.337	<0.13	29.40	16.2	18.0	144.1	3.163	0.718	1.61	2.55	6.624
MC2-1330	2.552	<0.13	29.64	19.2	14.1	160.1	3.254	0.756	1.71	3.36	7.611
MC2-1439	2.228	<0.13	26.50	17.8	15.8	146.7	3.383	0.740	1.84	2.64	7.529
MC2-1526	2.140	<0.13	24.77	16.6	15.0	142.3	3.172	0.726	1.80	3.09	7.028
MC2-1676	2.172	<0.13	24.28	16.8	15.7	142.7	3.161	0.746	1.83	3.44	7.184
MC2-1776	2.407	<0.13	22.96	18.8	32.2	161.0	3.681	0.806	2.19	3.61	7.699
MC2-1831	2.129	<0.13	22.11	17.1	28.0	144.3	3.362	0.714	1.91	3.40	6.782
MC2-1921	2.153	0.41	22.82	16.8	30.4	145.9	3.336	0.730	1.92	3.35	6.891
MC2-1989	2.122	<0.13	19.15	16.2	267.6	140.6	3.321	0.712	2.01	3.57	6.866
MC2-1991	0.009	<0.13	0.724	0.16	3.53	34.94	1.492	0.165	0.03	0.02	0.225
MC2-2041	1.137	<0.13	11.87	8.76	185.0	91.14	2.372	0.474	1.06	1.72	3.938

<sup>1</sup>SO<sub>4</sub> concentrations were calculated using the sulfur (S) results obtained by ICP-MS, under the assumption that all S was in the form of SO<sub>4</sub>.

**Table 12.** Dissolved concentrations from filtered samples for aluminum (Al), arsenic (As), barium (Ba), calcium (Ca), cadmium (Cd), cobalt (Co), chromium (Cr), copper (Cu), iron (Fe), potassium (K), and magnesium (Mg), Mineral Creek, Colorado, August 24, 2005.

[Sample, “Site” from table 1 with an optional letter suffix (“A” or “B”) to denote samples that are part of a field replicate; µg/L, micrograms per liter; mg/L, milligrams per liter; <, less than; reported concentrations are unrounded values from the laboratory analysis—unrounded values are not meant to reflect accuracy beyond three significant figures]

Sample	Al (mg/L)	As (µg/L)	Ba (µg/L)	Ca (mg/L)	Cd (µg/L)	Co (µg/L)	Cr (µg/L)	Cu (µg/L)	Fe (mg/L)	K (mg/L)	Mg (mg/L)
MC2-T0	32.35	2,063	14.7	193.2	202.3	157.1	15.2	11,187	169.8	1.405	31.19
MC2-0295	14.73	22.1	6.99	147.9	<0.11	0.15	0.40	8.83	0.029	2.316	0.087
MC2-0309	0.009	3.49	61.6	49.77	<0.11	0.32	0.17	7.30	<0.025	1.481	2.931
MC2-0349	23.65	40.6	12.1	122.4	139.3	110.7	4.77	7,714	24.15	0.506	22.72
MC2-0376	13.21	17.7	5.68	130.6	<0.11	0.19	0.36	7.35	<0.025	2.299	0.087
MC2-0432	4.501	8.09	10.5	96.07	<0.11	0.39	0.37	4.64	<0.025	1.479	1.015
MC2-0512	0.066	7.87	21.1	156.0	10.6	8.07	0.33	4.77	<0.025	1.836	17.64
MC2-0576	0.454	5.46	16.8	136.9	1.32	1.21	0.38	3.93	<0.025	1.539	12.77
MC2-0656	1.693	5.96	11.8	99.75	0.13	0.66	0.29	5.00	<0.025	1.729	6.777
MC2-0694	6.291	0.52	30.7	75.78	47.3	39.6	0.33	1,549	0.221	0.874	11.69
MC2-0709	1.509	5.10	10.0	84.63	<0.11	0.37	0.32	4.26	<0.025	1.647	7.089
MC2-0776	0.807	4.81	12.0	91.97	0.30	0.55	0.32	3.27	<0.025	1.409	9.156
MC2-0826	0.404	4.74	14.5	104.8	0.97	1.20	0.31	3.41	<0.025	1.349	11.56
MC2-0850	0.016	1.85	31.5	14.20	<0.11	<0.07	0.16	<2.57	<0.025	0.248	0.913
MC2-0888A	0.124	4.33	27.6	28.36	0.95	2.38	0.24	<2.57	<0.025	0.398	2.772
MC2-0888B	0.119	4.10	27.6	27.97	0.99	1.79	0.21	<2.57	<0.025	0.377	2.762
MC2-0976	0.088	4.14	28.6	28.76	1.56	2.50	0.23	<2.57	<0.025	0.410	2.911
MC2-1076	0.048	5.35	30.2	27.04	3.76	5.29	0.21	3.05	<0.025	0.375	3.229
MC2-1151	0.042	5.36	31.4	27.28	4.29	5.17	0.23	3.49	<0.025	0.453	3.221
MC2-1156	0.139	0.56	41.3	15.45	3.63	3.39	0.19	419.5	0.345	0.380	2.315
MC2-1231A	0.036	6.86	32.5	28.48	6.58	6.89	0.28	8.64	0.050	0.375	3.030
MC2-1231B	0.024	5.13	32.9	28.29	6.62	6.53	0.26	4.17	<0.025	0.391	3.035
MC2-1330	0.021	4.86	33.2	29.19	10.8	8.63	0.21	7.79	<0.025	0.382	3.183
MC2-1439	0.021	5.03	34.7	28.85	12.7	8.92	0.25	12.1	<0.025	0.381	3.155
MC2-1526	0.011	3.62	34.5	28.38	13.5	10.2	0.30	12.0	<0.025	0.392	3.195
MC2-1676	0.012	3.63	34.3	28.82	14.7	10.5	0.27	16.8	<0.025	0.384	3.283
MC2-1776	0.018	3.91	35.3	28.02	15.8	11.0	0.24	28.1	<0.025	0.380	3.276
MC2-1831	0.019	3.67	35.5	28.28	16.0	11.1	0.18	29.1	<0.025	0.379	3.224
MC2-1921	0.017	3.47	33.5	26.15	16.9	11.0	0.19	30.9	<0.025	0.396	3.439
MC2-1989	0.033	3.50	34.1	26.23	18.0	10.9	0.20	57.6	<0.025	0.483	3.432
MC2-1991	0.014	<0.45	24.3	14.08	0.51	<0.07	0.20	<2.57	<0.025	0.228	0.897
MC2-2041	0.011	2.60	29.8	21.35	9.34	5.6	0.20	27.7	<0.025	0.344	2.138

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**Table 13.** Dissolved concentrations from filtered samples for manganese (Mn), molybdenum (Mo), sodium (Na), nickel (Ni), lead (Pb), sulfate (SO<sub>4</sub>), silicon (Si), strontium (Sr), uranium (U), vanadium (V), and zinc (Zn), Mineral Creek, Colorado, August 24, 2005.

[Sample, "Site" from table 1 with an optional letter suffix ("A" or "B") to denote samples that are part of a field replicate; µg/L, micrograms per liter; mg/L, milligrams per liter; <, less than; reported concentrations are unrounded values from the laboratory analysis—unrounded values are not meant to reflect accuracy beyond three significant figures]

Sample	Mn (mg/L)	Mo (µg/L)	Na (mg/L)	Ni (µg/L)	Pb (µg/L)	SO <sub>4</sub> <sup>1</sup> (mg/L)	Si (mg/L)	Sr (mg/L)	U (µg/L)	V (µg/L)	Zn (mg/L)
MC2-T0	25.80	0.57	18.43	176.0	206.3	1,356	17.95	6.007	18.7	21.6	69.21
MC2-0295	0.006	1.23	559.6	<0.14	<0.11	1,632	0.456	5.678	0.03	0.49	0.079
MC2-0309	0.248	1.84	25.04	0.33	<0.11	42.69	2.272	0.305	0.25	0.05	<0.014
MC2-0349	17.90	<0.13	14.49	124.6	23.5	767.0	21.29	3.559	11.4	0.57	44.56
MC2-0376	<0.006	1.29	565.2	<0.14	<0.11	1,542	0.584	4.716	0.04	0.48	0.076
MC2-0432	0.007	0.79	316.3	<0.14	<0.11	961.0	0.375	3.032	0.05	0.18	<0.014
MC2-0512	10.83	0.48	297.7	4.17	<0.11	1,204	0.954	4.800	0.04	0.02	0.520
MC2-0576	2.492	0.55	285.3	0.38	<0.11	1,069	0.342	4.147	0.12	0.02	0.025
MC2-0656	0.147	1.08	301.4	<0.14	<0.11	945.9	0.236	3.147	0.25	0.06	<0.014
MC2-0694	7.053	0.30	17.05	44.2	2.32	348.0	8.226	1.976	1.32	0.02	16.18
MC2-0709	0.110	0.88	284.2	<0.14	<0.11	843.4	0.264	2.649	0.31	0.06	<0.014
MC2-0776	0.460	0.57	259.4	<0.14	<0.11	843.6	0.313	2.815	0.31	0.03	<0.014
MC2-0826	1.752	0.38	250.2	0.42	<0.11	885.4	0.387	3.229	0.26	0.02	0.030
MC2-0850	<0.006	<0.13	0.99	<0.14	<0.11	25.11	1.319	0.253	0.01	0.03	<0.014
MC2-0888A	1.138	<0.13	31.71	0.94	<0.11	138.2	0.823	0.705	0.01	0.01	0.064
MC2-0888B	1.151	<0.13	31.49	0.91	<0.11	137.4	0.840	0.709	0.01	0.01	0.070
MC2-0976	1.380	<0.13	32.75	1.31	<0.11	140.9	0.917	0.722	0.01	0.01	0.130
MC2-1076	1.859	<0.13	31.77	3.17	<0.11	149.0	1.066	0.735	0.01	0.01	0.427
MC2-1151	1.940	<0.13	33.74	3.52	<0.11	148.6	1.099	0.728	<0.01	0.01	0.552
MC2-1156	0.217	<0.13	2.843	2.51	6.51	56.84	3.896	0.387	0.07	0.01	0.983
MC2-1231A	1.891	<0.13	27.97	5.20	<0.11	139.7	1.465	0.712	0.01	0.02	1.126
MC2-1231B	1.899	<0.13	28.04	5.01	<0.11	139.6	1.456	0.720	<0.01	0.01	1.122
MC2-1330	2.063	<0.13	28.37	7.08	<0.11	145.4	1.644	0.754	<0.01	0.01	2.149
MC2-1439	1.956	<0.13	24.64	8.43	<0.11	137.7	1.726	0.731	0.01	0.02	2.886
MC2-1526	1.917	<0.13	22.87	9.20	<0.11	135.4	1.828	0.717	<0.01	0.01	3.342
MC2-1676	1.996	<0.13	21.98	10.0	<0.11	138.1	1.921	0.729	0.01	<0.008	3.990
MC2-1776	2.020	<0.13	20.97	10.5	<0.11	137.5	2.018	0.727	0.01	0.01	4.501
MC2-1831	2.022	<0.13	21.57	10.8	<0.11	137.1	2.006	0.729	0.01	0.01	4.680
MC2-1921	2.093	<0.13	21.65	11.2	<0.11	141.4	1.960	0.711	0.01	<0.008	4.705
MC2-1989	2.070	<0.13	21.65	10.9	2.79	139.7	2.110	0.710	0.02	<0.008	5.235
MC2-1991	0.008	<0.13	0.782	0.17	2.01	34.49	1.423	0.167	0.01	0.01	0.230
MC2-2041	1.095	<0.13	10.75	5.81	2.23	87.38	1.779	0.463	<0.01	0.01	2.786

<sup>1</sup>SO<sub>4</sub> concentrations were calculated using the sulfur (S) results obtained by ICP-MS, under the assumption that all S was in the form of SO<sub>4</sub>.

**Table 14.** Dissolved concentrations from filtered samples for chloride (Cl), ferrous iron [Fe(II)], and ferrous plus ferric iron [Fe(II+III)], Mineral Creek, Colorado, August 24, 2005.

[Sample, “Site” from table 1 with an optional letter suffix (“A” or “B”) to denote samples that are part of a field replicate;  $\mu\text{g/L}$ , micrograms per liter;  $\text{mg/L}$ , milligrams per liter; —, no data]

Sample	Cl (mg/L)	Fe(II) (mg/L)	Fe(II+III) (mg/L)
MC2-T0	0.690	—	—
MC2-0295	6.320	—	—
MC2-0309	28.84	—	—
MC2-0349	0.666	—	—
MC2-0376	5.977	0.002	0.002
MC2-0432	7.894	0.011	—
MC2-0512	8.801	—	—
MC2-0576	8.690	—	—
MC2-0656	8.509	—	—
MC2-0694	14.30	—	—
MC2-0709	8.550	—	0.033
MC2-0776	8.642	0.002	—
MC2-0826	8.522	—	—
MC2-0850	0.113	0.059	—
MC2-0888A	1.222	—	—
MC2-0888B	1.218	—	—
MC2-0976	1.384	—	—
MC2-1076	1.469	0.020	0.028
MC2-1151	1.466	—	—
MC2-1156	0.185	0.299	0.330
MC2-1231A	1.386	—	—
MC2-1231B	1.344	0.011	—
MC2-1330	1.356	0.017	—
MC2-1439	1.452	—	0.072
MC2-1526	1.386	—	—
MC2-1676	1.396	—	—
MC2-1776	1.413	—	0.051
MC2-1831	1.409	0.033	—
MC2-1921	1.427	—	—
MC2-1989	1.543	0.013	0.028
MC2-1991	0.307	0.011	—
MC2-2041	0.948	0.028	—

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**Table 15.** Data used to estimate streamflow using the tracer-dilution method, Mineral Creek, Colorado, August 24, 2005.

[Plateau Br concentration, bromide concentration from synoptic sample, in milligrams per liter; Plateau Li concentration, lithium concentration from synoptic sample, in milligrams per liter; Streamflow estimate, estimate of streamflow, in cubic feet per second; —, no data/not applicable]

Sample	Plateau Br concentration (dissolved)	Plateau Li concentration (dissolved)	Plateau Li concentration (total recoverable)	Streamflow estimate
MC2-T0	—	0.12	0.11	—
MC2-0295	129.46	12.06	13.10	0.063
MC2-0309	0.04	<0.01	<0.01	—
MC2-0349	10.41	0.85	<0.01	—
MC2-0376	124.20	12.10	12.58	0.065
MC2-0432	75.42	6.34	6.76	0.107
MC2-0512	70.98	5.59	6.35	0.114
MC2-0576	68.53	5.54	6.35	0.118
MC2-0656	67.44	6.10	6.01	0.120
MC2-0694	3.20	0.29	0.28	—
MC2-0709	65.66	6.04	5.47	0.123
MC2-0776	63.40	5.80	4.97	0.128
MC2-0826	61.75	5.84	5.10	0.131
MC2-0850	—	<0.01	<0.01	—
MC2-0888A	8.10	0.73	0.70	0.999
MC2-0888B	8.09	0.71	0.72	0.999
MC2-0976	8.08	0.73	0.75	1.002
MC2-1076	7.94	0.74	0.68	1.020
MC2-1151	7.87	0.73	0.69	1.029
MC2-1156	0.05	<0.01	0.01	—
MC2-1231A	7.14	0.62	0.62	1.133
MC2-1231B	7.12	0.61	0.62	1.133
MC2-1330	7.04	0.62	0.63	1.149
MC2-1439	6.87	0.60	0.60	1.179
MC2-1526	6.66	0.59	0.57	1.215
MC2-1676	6.54	0.56	0.58	1.238
MC2-1776	6.30	0.54	0.59	1.286
MC2-1831	6.25	0.54	0.53	1.295
MC2-1921	6.23	0.56	0.54	1.299
MC2-1989	5.87	0.54	0.50	1.379
MC2-1991	0.02	<0.01	0.01	—
MC2-2041	3.12	0.27	0.27	2.592



**Table 16.** Dissolved concentrations from filtered samples at Transport Site #1 (MC-0512) for bromide (Br), lithium (Li), sodium (Na), sulfate (SO<sub>4</sub>), and zinc (Zn), Mineral Creek, Colorado, August 21–22, 2005.

[mg/L, milligrams per liter; —, no data]

Date	Time	Br <sup>1</sup> (mg/L)	Li <sup>1</sup> (mg/L)	Na (mg/L)	SO <sub>4</sub> (mg/L)	Zn (mg/L)
08/21/05	14:01	—	0.07	19.73	970.9	54.85
08/21/05	14:07	—	0.07	19.43	968.2	53.49
08/21/05	14:10	—	0.07	20.50	968.1	57.26
08/21/05	14:16	—	0.07	20.18	958.3	52.86
08/21/05	14:21	—	0.08	17.51	952.1	50.17
08/21/05	14:26	—	0.07	18.13	959.6	54.27
08/21/05	14:30	—	0.06	17.61	951.2	52.65
08/21/05	14:35	—	0.07	18.23	949.8	52.90
08/21/05	14:40	—	0.07	18.98	944.7	54.66
08/21/05	14:45	0.14	0.08	17.57	950.9	53.16
08/21/05	14:50	5.27	0.34	18.37	954.8	52.84
08/21/05	14:55	18.15	1.67	15.86	957.8	53.32
08/21/05	15:00	35.55	3.31	20.14	977.3	55.65
08/21/05	15:05	51.19	4.71	17.94	994.7	55.25
08/21/05	15:10	58.20	5.69	20.70	1,012.	56.64
08/21/05	15:15	66.59	6.10	20.86	1,025.	58.60
08/21/05	15:20	67.12	6.23	19.23	1,005.	58.34
08/21/05	15:35	71.48	6.41	19.75	978.3	54.66
08/21/05	15:50	69.03	6.51	19.65	980.2	53.91
08/21/05	16:01	72.44	6.44	17.71	950.0	51.10
08/21/05	16:10	68.49	6.08	18.02	935.2	51.73
08/21/05	16:20	67.99	6.29	18.71	926.3	49.48
08/21/05	16:30	71.68	6.39	19.47	944.3	51.93
08/21/05	16:35	71.72	6.46	19.71	948.0	52.44
08/21/05	16:40	71.51	6.53	18.18	943.0	53.67
08/21/05	16:45	72.45	6.63	17.56	956.6	53.88
08/21/05	16:50	73.65	6.50	18.40	973.4	55.28
08/21/05	17:00	69.32	6.42	19.43	960.3	56.47
08/21/05	18:00	73.65	6.59	19.27	1,043.	58.91
08/21/05	19:00	72.89	6.30	18.23	949.8	54.84

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**Table 16.** Dissolved concentrations from filtered samples at Transport Site #1 (MC-0512) for bromide (Br), lithium (Li), sodium (Na), sulfate (SO<sub>4</sub>), and zinc (Zn), Mineral Creek, Colorado, August 21–22, 2005.—Continued

[mg/L, milligrams per liter; —, no data]

Date	Time	Br <sup>1</sup> (mg/L)	Li <sup>1</sup> (mg/L)	Na (mg/L)	SO <sub>4</sub> (mg/L)	Zn (mg/L)
08/21/05	20:00	41.49	3.77	15.59	718.1	37.31
08/21/05	21:00	53.56	4.66	15.89	797.3	43.51
08/21/05	22:00	59.76	5.19	15.99	834.6	45.23
08/21/05	23:00	61.83	5.72	18.69	900.2	49.15
08/22/05	00:00	61.32	5.62	18.87	898.1	51.14
08/22/05	01:00	61.71	5.54	18.92	900.1	50.55
08/22/05	02:00	63.36	5.58	16.66	876.0	48.79
08/22/05	03:00	62.96	5.68	18.88	877.6	44.90
08/22/05	04:00	62.27	5.67	18.73	884.5	52.12
08/22/05	05:00	63.12	5.60	17.61	815.9	44.92
08/22/05	06:00	62.43	5.82	17.80	800.2	45.33
08/22/05	07:00	63.61	5.81	17.47	821.6	46.91
08/22/05	08:00	63.33	5.73	16.84	773.1	42.09
08/22/05	09:00	64.17	5.77	18.76	913.1	53.12
08/22/05	10:00	63.56	5.85	18.35	817.5	45.75
08/22/05	11:00	63.23	5.85	14.63	616.1	29.99
08/22/05	12:00	66.11	5.99	12.87	566.6	25.56
08/22/05	13:00	65.07	5.91	16.88	774.3	42.22
08/22/05	14:00	67.23	6.26	18.01	834.3	43.91
08/22/05	15:00	63.51	5.77	17.44	815.7	44.50
08/22/05	16:00	67.77	6.17	18.95	879.3	48.67
08/22/05	16:30	69.58	6.54	19.05	876.4	48.81
08/22/05	16:45	70.48	6.65	—	883.8	48.34
08/22/05	17:00	70.24	6.57	19.88	884.8	51.18
08/22/05	17:15	64.40	5.81	18.83	890.6	47.51
08/22/05	17:30	23.46	2.04	18.95	898.7	50.03
08/22/05	17:45	7.59	0.64	19.46	900.1	51.77
08/22/05	18:00	4.53	0.45	20.49	959.1	55.32
08/22/05	18:15	3.74	0.34	20.60	994.7	54.80
08/22/05	18:30	3.53	0.29	22.45	960.9	53.93
08/22/05	18:45	3.30	0.32	20.32	960.1	53.98

**Table 16.** Dissolved concentrations from filtered samples at Transport Site #1 (MC-0512) for bromide (Br), lithium (Li), sodium (Na), sulfate (SO<sub>4</sub>), and zinc (Zn), Mineral Creek, Colorado, August 21–22, 2005.—Continued

[mg/L, milligrams per liter; —, no data]

Date	Time	Br <sup>1</sup> (mg/L)	Li <sup>1</sup> (mg/L)	Na (mg/L)	SO <sub>4</sub> (mg/L)	Zn (mg/L)
08/22/05	19:00	3.08	0.31	20.47	956.8	54.89
08/22/05	19:15	2.90	0.27	20.09	951.4	54.70
08/22/05	19:30	3.03	—	19.67	952.5	54.44
08/22/05	19:45	2.60	0.28	20.82	959.6	55.17
08/22/05	20:00	2.45	0.27	20.38	974.3	54.04
08/22/05	20:15	2.30	0.28	21.56	987.1	56.07
08/22/05	20:30	2.26	0.28	22.76	1,010.	58.03
08/22/05	20:45	2.09	0.24	25.08	1,051.	58.33
08/22/05	21:00	2.06	0.25	22.83	999.7	57.11
08/22/05	21:15	2.02	0.26	22.63	1,001.	55.62
08/22/05	21:30	2.06	0.26	22.41	1,000.	57.63
08/22/05	21:45	1.97	0.23	22.43	988.7	55.96
08/22/05	22:00	2.55	0.22	20.55	923.5	51.96
08/22/05	22:15	2.17	0.26	21.07	935.4	52.70

<sup>1</sup>Br and Li concentrations are elevated relative to natural conditions due to the lithium-bromide tracer injection.

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**Table 17.** Dissolved concentrations from filtered samples at Transport Site #2 (MC-0576) for bromide (Br), lithium (Li), sodium (Na), sulfate (SO<sub>4</sub>) and zinc (Zn), Mineral Creek, Colorado, August 21–22, 2005.

[mg/L, milligrams per liter; —, no data]

Date	Time	Br <sup>1</sup> (mg/L)	Li <sup>1</sup> (mg/L)	Na (mg/L)	SO <sub>4</sub> (mg/L)	Zn (mg/L)
08/21/05	14:00	—	0.09	19.85	979.7	59.03
08/21/05	14:10	—	0.09	19.16	962.8	53.76
08/21/05	14:20	—	0.08	19.20	956.5	44.68
08/21/05	14:30	—	0.08	18.89	951.1	54.33
08/21/05	14:40	—	0.08	18.75	942.6	52.86
08/21/05	14:50	—	0.08	19.36	935.5	54.71
08/21/05	14:56	—	0.09	19.07	933.4	52.16
08/21/05	15:00	0.59	0.15	19.46	944.5	53.05
08/21/05	15:05	5.88	0.65	18.66	952.2	53.23
08/21/05	15:10	16.56	1.64	18.91	957.0	56.38
08/21/05	15:15	31.94	3.04	19.33	979.2	49.52
08/21/05	15:20	46.07	4.32	19.85	989.3	55.16
08/21/05	15:25	54.43	5.18	20.15	995.3	56.65
08/21/05	15:30	60.85	5.53	19.86	1,011.	56.67
08/21/05	15:35	64.02	5.90	20.12	1,009.	48.50
08/21/05	15:40	64.91	5.95	19.67	994.4	55.15
08/21/05	15:45	65.80	6.06	18.98	986.6	58.16
08/21/05	15:50	66.53	6.08	19.27	974.2	53.49
08/21/05	16:00	67.14	6.11	18.93	967.2	55.57
08/21/05	16:10	68.54	6.14	19.08	959.8	55.95
08/21/05	16:20	67.90	6.09	18.79	934.7	51.28
08/21/05	16:30	66.60	6.14	18.29	914.1	49.53
08/21/05	16:40	67.02	6.16	18.52	928.6	40.72
08/21/05	16:50	68.65	6.24	18.96	940.0	52.13
08/21/05	17:00	69.41	6.36	18.93	950.5	58.28
08/21/05	18:00	69.24	6.24	20.06	1,024.	61.43
08/21/05	18:20	70.55	—	—	1,049.	—
08/21/05	19:00	69.27	6.29	18.46	943.4	51.54
08/21/05	20:00	43.80	4.05	15.37	743.7	39.56
08/21/05	21:00	48.43	4.39	15.26	755.8	41.35

**Table 17.** Dissolved concentrations from filtered samples at Transport Site #2 (MC-0576) for bromide (Br), lithium (Li), sodium (Na), sulfate (SO<sub>4</sub>) and zinc (Zn), Mineral Creek, Colorado, August 21–22, 2005.—Continued

[mg/L, milligrams per liter; —, no data]

Date	Time	Br <sup>1</sup> (mg/L)	Li <sup>1</sup> (mg/L)	Na (mg/L)	SO <sub>4</sub> (mg/L)	Zn (mg/L)
08/21/05	22:00	56.98	5.16	17.24	848.7	43.74
08/21/05	23:00	59.15	5.42	18.30	901.1	50.22
08/22/05	00:00	59.82	5.67	17.76	888.5	49.53
08/22/05	01:00	60.27	5.77	18.82	899.5	50.35
08/22/05	02:00	61.02	5.72	17.86	875.1	47.13
08/22/05	03:00	61.79	5.75	17.82	871.4	46.59
08/22/05	04:00	62.31	6.07	17.75	874.9	46.82
08/22/05	05:00	61.73	5.84	16.47	823.6	45.22
08/22/05	06:00	62.79	5.88	16.48	820.4	45.14
08/22/05	07:00	62.53	5.77	16.63	817.1	44.95
08/22/05	08:00	62.84	5.83	16.34	784.4	41.34
08/22/05	09:00	62.94	5.78	17.68	886.2	48.73
08/22/05	10:00	63.17	5.71	17.26	873.9	47.61
08/22/05	10:32	62.94	—	—	717.9	—
08/22/05	11:00	62.65	5.83	15.11	718.7	36.71
08/22/05	12:00	64.92	5.98	11.99	562.6	23.23
08/22/05	13:00	64.80	6.02	14.81	720.6	36.01
08/22/05	14:00	66.56	6.13	16.35	826.2	43.05
08/22/05	15:00	61.77	5.61	16.39	824.8	43.39
08/22/05	16:00	66.33	6.18	17.94	867.6	46.23
08/22/05	16:30	67.31	6.16	17.70	868.1	—
08/22/05	16:50	68.87	6.20	18.25	874.1	—
08/22/05	17:10	69.39	6.37	17.78	884.7	—
08/22/05	17:30	58.23	5.27	17.92	885.8	—
08/22/05	17:50	13.89	1.23	18.13	893.2	—
08/22/05	18:10	6.79	0.60	18.67	942.5	—
08/22/05	18:30	5.04	0.50	19.30	1,001.	—
08/22/05	18:50	4.62	0.46	18.71	951.8	—
08/22/05	19:10	4.32	0.42	18.96	957.5	—
08/22/05	19:30	3.92	0.40	18.96	950.7	—
08/22/05	19:50	3.55	0.38	18.71	955.7	—

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**Table 17.** Dissolved concentrations from filtered samples at Transport Site #2 (MC-0576) for bromide (Br), lithium (Li), sodium (Na), sulfate (SO<sub>4</sub>) and zinc (Zn), Mineral Creek, Colorado, August 21–22, 2005.—Continued

[mg/L, milligrams per liter; —, no data]

Date	Time	Br <sup>1</sup> (mg/L)	Li <sup>1</sup> (mg/L)	Na (mg/L)	SO <sub>4</sub> (mg/L)	Zn (mg/L)
08/22/05	20:10	3.47	0.37	19.18	971.1	—
08/22/05	20:30	3.53	0.34	20.11	1,009.	—
08/22/05	20:50	3.13	0.36	21.63	1,030.	—
08/22/05	21:10	3.12	0.34	21.38	1,006.	—
08/22/05	21:30	3.11	0.30	20.72	1,002.	—
08/22/05	21:50	3.18	0.33	20.80	998.7	—
08/22/05	22:10	3.16	0.31	19.21	937.6	—
08/22/05	22:30	3.19	0.32	19.51	959.1	—
08/22/05	22:50	2.85	0.31	21.02	1,023.	—
08/22/05	23:10	2.51	0.31	20.94	1,045.	—
08/22/05	23:30	2.47	0.31	21.26	1,032.	—
08/22/05	23:50	2.76	0.30	20.38	1,004.	—
08/23/05	00:10	2.37	0.24	20.45	988.0	—

<sup>1</sup>Br and Li concentrations are elevated relative to natural conditions due to the lithium-bromide tracer injection.

**Table 18.** Dissolved concentrations from filtered samples at Transport Site #3 (MC-0826) for bromide (Br), lithium (Li), sodium (Na), sulfate (SO<sub>4</sub>) and zinc (Zn), Mineral Creek, Colorado, August 21–22, 2005.

[mg/L, milligrams per liter; —, no data]

Date	Time	Br <sup>1</sup> (mg/L)	Li <sup>1</sup> (mg/L)	Na (mg/L)	SO <sub>4</sub> (mg/L)	Zn (mg/L)
08/21/05	14:00	—	—	16.41	790.6	43.26
08/21/05	14:10	—	—	17.21	840.4	45.37
08/21/05	14:20	—	—	17.30	861.2	45.65
08/21/05	14:30	—	—	17.47	872.0	49.00
08/21/05	14:40	—	—	18.72	923.9	51.03
08/21/05	14:50	—	—	18.02	947.4	51.39
08/21/05	15:00	—	—	18.96	947.4	51.17
08/21/05	15:10	—	—	18.59	933.8	50.30
08/21/05	15:20	—	—	18.93	924.6	50.13
08/21/05	15:30	—	—	18.76	910.1	50.47
08/21/05	15:40	—	—	18.90	904.6	49.71
08/21/05	15:50	0.26	—	18.51	906.5	49.04
08/21/05	16:00	4.75	—	18.68	913.6	49.45
08/21/05	16:10	18.66	—	18.38	930.8	49.86
08/21/05	16:20	38.79	3.75	19.16	960.8	52.53
08/21/05	16:30	51.86	4.74	19.54	969.3	52.51
08/21/05	16:40	57.57	5.23	19.50	955.1	52.21
08/21/05	16:50	60.45	5.39	18.62	945.1	50.74
08/21/05	17:00	60.85	5.46	18.09	924.6	50.91
08/21/05	18:00	65.46	5.73	18.40	925.3	50.35
08/21/05	19:00	64.35	5.79	19.93	978.4	53.78
08/21/05	20:00	62.59	5.66	18.02	887.9	48.00
08/21/05	21:00	38.27	3.43	13.86	665.2	33.56
08/21/05	22:00	48.33	4.35	15.73	784.7	41.44
08/21/05	23:00	53.97	4.83	16.47	824.5	42.64
08/22/05	00:00	55.81	4.99	17.95	949.4	47.06
08/22/05	01:00	57.31	5.11	18.16	917.9	47.71
08/22/05	02:00	57.26	5.08	18.01	866.1	47.06
08/22/05	03:00	55.53	5.36	17.25	925.5	46.59
08/22/05	04:00	58.06	5.19	17.36	870.7	46.42

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**Table 18.** Dissolved concentrations from filtered samples at Transport Site #3 (MC-0826) for bromide (Br), lithium (Li), sodium (Na), sulfate (SO<sub>4</sub>) and zinc (Zn), Mineral Creek, Colorado, August 21–22, 2005.—Continued

[mg/L, milligrams per liter; —, no data]

Date	Time	Br <sup>1</sup> (mg/L)	Li <sup>1</sup> (mg/L)	Na (mg/L)	SO <sub>4</sub> (mg/L)	Zn (mg/L)
08/22/05	05:00	58.50	5.32	17.44	866.9	47.13
08/22/05	06:00	59.02	5.37	16.60	867.0	42.97
08/22/05	07:00	59.34	5.37	16.44	864.7	41.93
08/22/05	08:00	59.33	5.31	16.66	813.9	41.89
08/22/05	09:00	59.93	5.56	16.27	782.4	40.46
08/22/05	10:00	58.06	5.47	17.93	960.2	47.30
08/22/05	11:00	59.63	5.27	16.78	834.6	43.39
08/22/05	12:00	60.01	5.46	14.37	669.4	31.10
08/22/05	13:00	59.17	5.30	12.82	603.2	24.83
08/22/05	14:00	59.47	5.32	15.28	760.3	36.47
08/22/05	14:36	62.10	—	—	825.5	—
08/22/05	15:00	64.27	5.80	16.60	812.1	43.76
08/22/05	16:00	59.42	5.49	16.50	828.5	42.44

<sup>1</sup>Br and Li concentrations are elevated relative to natural conditions due to the lithium-bromide tracer injection.



**Table 19.** Dissolved concentrations from filtered samples at Transport Site #4 (MC-1989) for bromide (Br), lithium (Li), sodium (Na), sulfate (SO<sub>4</sub>) and zinc (Zn), Mineral Creek, Colorado, August 21–22, 2005.

[mg/L, milligrams per liter; —, no data]

Date	Time	Br <sup>1</sup> (mg/L)	Li <sup>1</sup> (mg/L)	Na (mg/L)	SO <sub>4</sub> (mg/L)	Zn (mg/L)
08/21/05	15:53	—	0.01	3.02	169.0	4.38
08/21/05	16:00	—	0.01	3.06	163.7	4.69
08/21/05	16:15	—	0.01	3.16	199.0	4.85
08/21/05	16:30	—	0.01	3.21	220.4	5.15
08/21/05	16:45	—	0.01	3.21	209.0	5.10
08/21/05	17:00	—	0.01	3.25	227.2	5.28
08/21/05	17:15	—	0.01	3.22	231.9	5.20
08/21/05	17:30	—	0.01	3.22	171.6	5.08
08/21/05	18:30	4.67	0.39	3.29	146.3	5.26
08/21/05	19:30	5.00	0.45	3.00	155.9	4.89
08/21/05	20:30	5.13	0.45	3.07	155.6	4.68
08/21/05	21:30	7.83	0.66	3.56	200.7	6.22
08/21/05	22:30	3.57	0.30	2.65	163.8	4.22
08/21/05	23:30	4.23	0.36	2.73	156.4	4.22
08/22/05	00:30	5.17	0.43	2.95	165.8	4.60
08/22/05	01:30	5.42	0.46	3.09	194.7	5.89
08/22/05	02:30	5.60	0.47	3.09	202.4	5.20
08/22/05	03:30	5.90	0.48	3.15	159.2	5.12
08/22/05	04:30	5.90	0.49	3.12	209.2	5.05
08/22/05	05:30	5.67	0.49	3.12	192.9	5.05
08/22/05	06:30	6.08	0.50	3.12	210.6	4.97
08/22/05	07:30	5.84	0.51	3.11	121.7	4.86
08/22/05	08:30	5.98	0.52	3.08	143.1	4.86
08/22/05	09:30	6.04	0.52	3.14	131.0	4.88
08/22/05	10:30	6.16	0.52	3.17	129.5	4.70
08/22/05	11:30	6.53	0.53	3.23	210.0	5.08
08/22/05	12:30	6.45	0.53	3.50	220.1	5.46
08/22/05	13:30	6.24	0.53	3.09	120.2	4.42
08/22/05	14:30	6.11	0.52	2.84	157.1	3.37
08/22/05	15:30	6.33	0.54	2.99	119.4	4.29
08/22/05	16:30	6.78	0.56	3.32	206.4	—

<sup>1</sup>Br and Li concentrations are elevated relative to natural conditions due to the lithium-bromide tracer injection.

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