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November 5, 2003

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Ms. Wilson and Mr. Rosenlieb:

The purpose of this letter is to provide you with the results of the Level-1 Water-Quality Inventory and Monitoring (WAQIM) Program conducted from November 2000 to November 2001, at the Colorado National Monument in Colorado. The primary objective of this program was to inventory and collect water-quality data from streams and springs in the Colorado National Monument (the monument) and to document these results in a data-management system consistent with the National Park Service (NPS) management needs. The following includes a brief description of the study area and a discussion of the sampling plan, protocols used, and resulting data. The U.S. Geological Survey (USGS), Grand Junction, Colorado, was the principal investigator of the WAQIM. Also enclosed is a compact disk and 3.5" diskette containing the five files, CNM.REPORT.DOC, CNM.RECON.DOC (table 1), CNM.STATIONS.DOC (table 2), CNM.QWDATA.XLS (table 3), and PARAMETER.DOC (table 4), documenting the water-quality inventory results in the format requested by the National Park Service.

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## Description of Study Area

The Colorado National Monument is in central Mesa County about 5 miles southwest of downtown Grand Junction, Colorado (figure 1). The total area of the park is about 20,530 acres. The monument was established in 1911, primarily through the efforts of John Otto and local residents, to preserve the scenic wonders of the canyon country adjacent to Grand Junction.

Water resources in the monument are limited and include perennial and seasonal springs and ephemeral and intermittent streams. The springs and streams are the primary water sources for wildlife in the monument and also provide habitat for various plants, amphibians, and aquatic life. In the past, a small amount of water was developed (springs and cisterns) to provide water for wildlife. These facilities were not functional when inventoried in late 2000. Human use of water within the monument is probably limited to occasional use and contact by hikers. The pipelines of the Ute Water Conservancy District bring drinking water to the west entrance of the monument. From there, the NPS pumps it up the hill into two 100,000 gallon storage tanks for use at the visitor center and the campground.

Residential development and agricultural activities border the monument in the Glade Park area to the south and southwest of the monument. Homes in Glade Park generally are on 35-40 acre lots and use ground water as their primary water source. Some residents have horses and other livestock. Residential development in Glade Park has shown increasing growth in the 1990's. Cattle and sheep ranching is the primary agricultural use in Glade Park, but that land use is gradually being replaced by residential homes. The effects, if any, of water use and development in Glade Park on water quantity and water quality in the monument are not known. Most of the surface-water discharge from Glade Park flows to the west and does not drain into the monument, but the headwater areas of No Thoroughfare Canyon and Ute Canyon drain some of the developed areas in Glade Park. Thus, the potential for introduction of contaminants into surface water in the monument is possible, particularly from runoff. The principal aquifer in which wells are completed in Glade Park is the Wingate Sandstone of the Glen Canyon Group of Jurassic age (Lohman, 1965). Ground water from the Wingate Sandstone could be a source of part of the base flow in canyons and could be a water source for some of the springs in the monument. It is not known if there is a hydrologic connection between ground water in Glade Park and ground water in the monument; therefore, it is not known if continuing development in Glade Park will affect the ground-water resources of the monument.

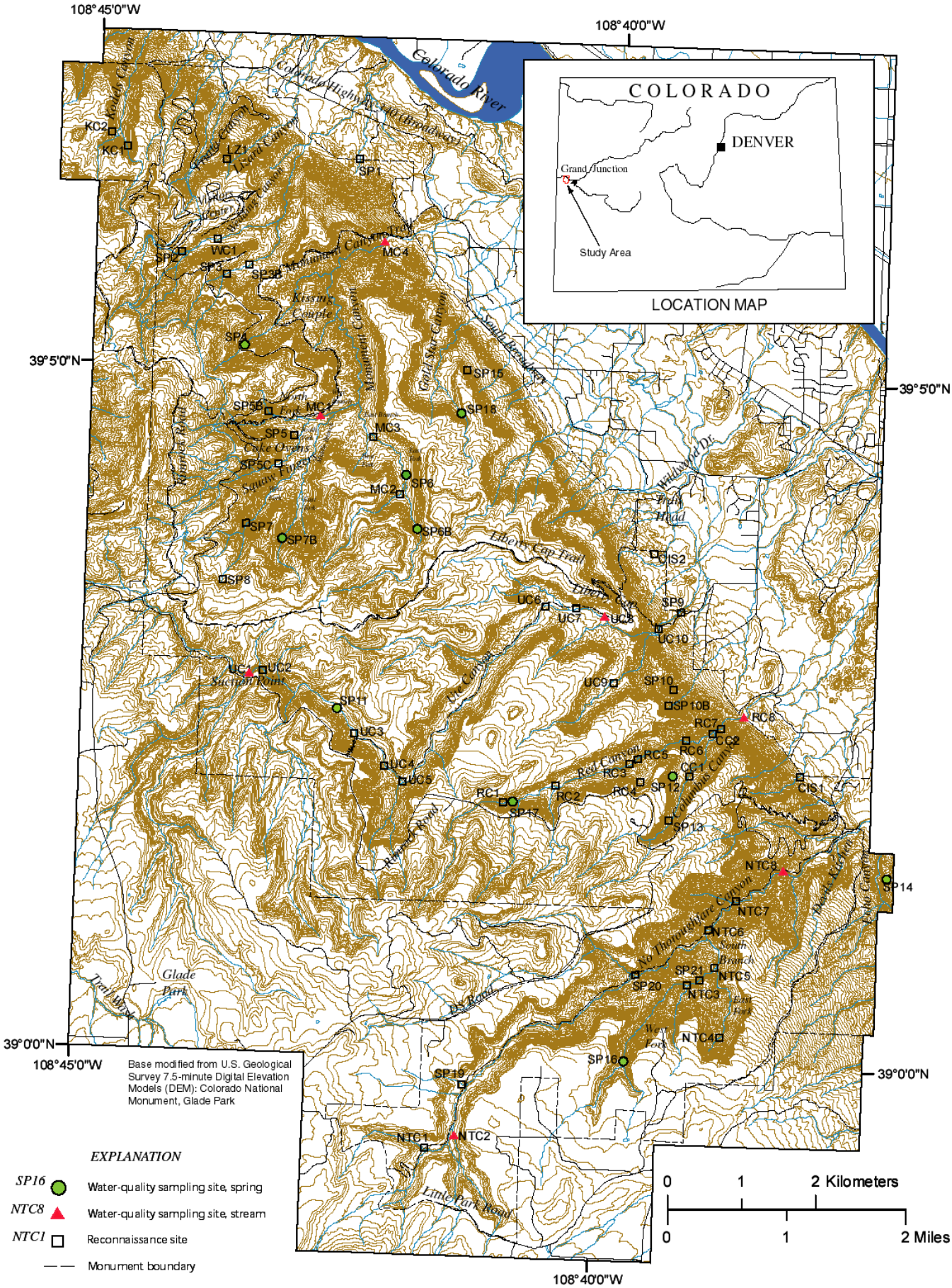


Figure 1. Location of water-quality sampling sites and field reconnaissance sites for Colorado National Monument water-quality inventory, 2000-2001.

## Sampling Plan

Before sampling sites were selected, an initial screening and reconnaissance of water resources in the monument was needed. In August 2000, USGS personnel met with NPS staff (Dave Price, Judi Lofland) to review maps and historical documents to identify known springs and seeps. Using that list of sites identified from the August meeting as a starting point, the USGS conducted a field reconnaissance of the monument from November 2000 to early January 2001 to locate the sites identified by NPS and also to locate other springs and water sources that were not shown or described in historical documents. The reconnaissance trips were done by USGS personnel from the Grand Junction office. Most of the sites identified by NPS were found, but not all had water, and other springs were found that were not shown on the NPS maps. A subset of the springs found during the reconnaissance trips was selected for sampling. A synopsis of the field reconnaissance of the monument by the USGS is in the attached WORD document, table 1 (CNM.RECON.DOC).

The original WAQIM sampling plan for the monument identified seven springs and six surface-water sites as water-quality sites. Selection of springs for sample collection was limited to sites that had water during the reconnaissance study phase and was designed to provide areal coverage of the monument. The six surface-water sites included an upper and lower site in the three largest canyons--No Thoroughfare, Ute, and Monument Canyons. Springs were to be sampled in the spring and summer of 2001. The upper surface-water sites were to be sampled only during the snowmelt runoff in March/April 2001; the lower canyon sampling sites were scheduled to be sampled during snowmelt and also at base-flow conditions.

After the site reconnaissance revisions to the original sampling plan were made. In the spring sampling period (March-May 2001), 8 samples were collected at 7 surface-water sites (2 samples at site NTC 8, table 5) and 10 springs were sampled. The sites that were sampled are listed in table 5, and site locations are shown on the enclosed map (figure 1). Snowmelt runoff in 2001, as in most years, was limited, but samples that represented recent runoff or snowmelt recharge were collected at the upper sites in No Thoroughfare, Ute, and Monument Canyons. Because of the limited runoff, some samples may have included some ground-water discharge. The water sample from upper Ute Canyon (site UC1) was collected from a pool of water that was probably composed primarily of localized runoff of melting snow that fell on the day the sample was collected (April 8). The two samples at the lower site in No Thoroughfare Canyon (site NTC8) probably represent local alluvial ground-water discharge to the stream that was recharged by recent snowmelt. The stream water at site NTC8 had little turbidity, which implies that there was little overland runoff occurring at the time. According to observations by USGS personnel, it appeared that much of the winter snow that melted had infiltrated into the ground and was not runoff. The snowmelt that occurred in upper Monument Canyon (site MC1) apparently infiltrated into alluvial deposits in the canyon bottom, and the runoff did not appear as streamflow at the lower site near the monument boundary. The sample collected from lower Monument Canyon (site MC4) was the result of runoff from a rain/snowstorm in the monument on April 8, 2001. The water samples from lower Red and

Ute Canyons (sites RC8 and UC8) were considered base-flow samples. Base-flow samples were not collected at the lower sites in No Thoroughfare and Monument Canyons because there was no flowing water at these sites after the snowmelt period ended unless there was a recent runoff event. No other surface-water samples were collected for the study. No attempt was made to sample storm runoff from the thunderstorms that occurred in July and August 2001 because such sampling was beyond the scope of this study.

In the revised sampling plan, three more water samples from springs that were not in the original plan were collected in April and May 2001 during the first sampling period. Two sites were added to provide information on springs in No Thoroughfare Canyon (site SP16) and Red Canyon (site SP17). Spring site SP6B was essentially a resampling for site SP6 because, after further investigation, it was determined that site SP6 was too low to be at the original source of the spring and that site SP6B was more representative of ground-water discharge not affected by the resurfacing of underflow from the streambed. Spring site SP7B was sampled instead of spring site SP7. The original sampling was designed to sample springs a second time in the summer of 2001. That sampling plan was revised because during the summer, most if not all of the water at the springs was consumed by evapotranspiration. Therefore, the summer sampling period was moved to the fall of 2001 when evaporation and transpiration were greatly diminished and there was a better chance of finding water at the springs. Seven springs were sampled in early November 2001 (table 5).

Field measurements of water temperature, pH, specific conductance, dissolved oxygen, and flow rates were made at every site. Fecal coliform bacteria samples were scheduled to be collected only during the first sampling round, (March-May). Water samples collected for inorganic analysis were sent to the USGS National Water Quality Laboratory in Lakewood, Colorado, to be analyzed for concentrations of selected major ions, hardness, dissolved solids, nutrients, and trace elements. Water samples were analyzed for 22 selected trace elements, and iron was added to the analysis for springs. Samples for tritium analysis were collected at four springs and were sent to the USGS Isotope Laboratory in Menlo Park, California. Suspended-sediment samples were collected only at surface-water sites during runoff periods and were sent to the USGS Sediment Laboratory in Iowa City, Iowa. The constituents and frequency of sampling at each site are listed in table 5.

The purpose of this water-quality study was to collect water samples, analyze for constituents that describe general water chemistry of water in the monument, and determine baseline water-quality data for the monument. There had been no previous water-quality sampling by USGS within the monument boundary. The field measurements and concentrations of major ions, nutrients, and trace elements describe the general inorganic-water chemistry. Baseline data will be useful if concerns and questions arise in the future about contaminants from areas upgradient from the monument affecting water resources in the monument. The tritium data were collected as an initial attempt to age-date some of the springwater in the monument (table 3).

## Sampling Protocols

Because of the small volumes of water at sampling sites, water-quality samples from intermittent streams and springs were collected as point (grab) samples. Water samples for chemical analysis were composited in a 3-liter bottle. The bottle was cleaned to the specifications of the USGS National Field Manual (U.S. Geological Survey, 1998 and Horowitz and others, 1994) before samples were collected. Tritium samples were collected in 500-milliliter high density polyethylene bottles directly from the water source. Streams were too shallow to use depth-integrating samplers; therefore, using 1-liter sediment bottles, suspended-sediment samples were collected as point samples from the centroid of flow. Except for water temperature and specific conductance measurements, other field measurements and sample processing had to be completed offsite for most sites because of the remote location of the sites. The water samples were carried back to a field truck for sample processing. Samples were processed within about ½ hour to 3 hours after collection, depending on the time required to hike out from the site. Filtered samples were collected from the composite sample. Samples for the analysis of bacteria were collected at the sampling site in a sterilized 1-liter glass bottle. Bacteria-sample processing and the Winkler titrations for dissolved oxygen were done at the USGS office in Grand Junction. Discharge or flow rate was measured or estimated during the water-sample collection, if possible. Where discharge of streams was measured, current meters or the float method (to estimate velocity) was used (Rantz and others, 1982). Flow from springs either was estimated visually or measured using the volumetric method (Rantz and others, 1982). Some sampling sites consisted of pools with no discernible flow.

Temperature, pH, and specific conductance were measured using meters by methods outlined by the USGS (1998). Dissolved oxygen was measured either with a meter or by the Winkler titration method. Samples for bacteria were analyzed for concentrations of fecal coliform by using membrane filtration methods described by the USGS (1998). Fecal coliforms were analyzed using m-FC agar media. Except for the analysis of tritium and suspended sediment, all other constituents (major ions, nutrients, and trace elements) were analyzed by the USGS National Water Quality Laboratory in Lakewood, Colorado. Analytical procedures used at the National Water Quality Laboratory are described by Faires (1993), Fishman and Friedman (1989), Fishman (1993), Garbarino (1999), McLain (1993), and National Water Quality Laboratory (1999). Tritium was analyzed by the USGS Isotope Tracers Project laboratory in Menlo Park, California, by a method described in Thatcher and others (1977). Suspended-sediment samples were analyzed by the USGS sediment laboratory in Iowa City, Iowa, by a method described in Guy (1969). For more specific information on water-quality laboratory procedures, the reader is referred to "Summary of selected information for water-quality constituents" (table 4) in the supplemental data section at the back of this report.

As part of the study's quality-assurance program, pH and specific-conductance meters were calibrated daily with known standards, and sampling equipment was cleaned before the collection of each sample. Dissolved-oxygen meters, when used, were calibrated onsite by using the air calibration-chamber technique (U.S. Geological Survey, 1998).

In accordance with the study's quality-assurance plan, a field blank was collected during the April sampling period and a duplicate sample was collected in the November sampling period. The field blank was

composed of deionized water. The quality-assurance samples were analyzed for the same chemical constituents as environmental samples except for tritium and suspended sediment.

The results of the analyses of the quality-assurance samples are given in table 9. The concentrations of all constituents in the field blank were less than minimum reporting limits except for an alkalinity concentration of 1.82 mg/L.. The duplicate sample collected at site SP14 in November had results the same or within 1 milligram per liter or 2 micrograms per liter for all constituents.

## Water-Quality Results

The water-quality results are presented in table 6, and a statistical summary is presented in table 7. In general, concentrations of chemical constituents sampled for this study were not unusual or at adverse levels for humans and wildlife. For comparative purposes, Colorado water-quality standards for surface water are listed in table 8 (Colorado Department of Public Health and Environment, 1998). The water bodies within the monument have not been classified by the State Water Quality Control Commission; therefore, the standards are not directly applicable to the springs and streams in the monument. However, the standards provide a basis for evaluating the results of this study.

There were no unusual values for field parameters compared to standards. Fecal coliform bacteria were detected in 3 of the 15 samples analyzed. The colony counts were considerably less than the standard of 200 colonies/100 mL for recreation class I uses (table 6), which is for full body contact by humans. Fecal coliforms are indicators of pollution from humans or warm-blooded animals; however, their presence does not mean that harmful pathogens or bacteria are actually present in the water sample.

Major-ion concentrations generally were higher in stream samples than in spring samples. Trace-element concentrations generally were low. Dissolved iron was the only constituent sampled from a spring that had concentrations exceeding the water-quality standard for water supply (300 $\mu$g/L); concentrations ranged from 7.6 to 862 $\mu$g/L (table 7). The median concentrations of dissolved selenium in surface-water samples was 5 $\mu$g/L, which exceeds the State of Colorado instream standard of 4.6 $\mu$g/L (table 7).

Tritium concentrations in four springs ranged from 2.2 to 9.0 picocuries per liter (pCi/L). Tritium concentrations in rainwater in western Colorado is about 30 pCi/L or greater (Robert Michel, U.S. Geological Survey, Menlo Park, California, written commun., 2001). During atmospheric testing of hydrogen bombs in the 1950s and 1960s, tritium concentrations in precipitation were significantly higher than 30 pCi/L. Assuming pre-bomb tritium concentrations of about 20 to 25 pCi/L, water recharged in 1952, and assuming the half-life of tritium is 12.4 years, tritium in recharge from precipitation would have decayed to about 2 pCi/L. The sample from the spring in the east fork of the middle branch of Monument Canyon (site SP7B, figure 1) with a concentration of 2.2 pCi/L (table 6) represents recharge that predates 1952. Samples from the Echo Canyon spring (site SP14), Columbus Canyon spring (site SP12), and the spring in the middle Canyon near Kissing Couple (site SP4) (figure 1) represent a mixture of waters with different ages, with most water sampled predating 1952 (Robert Michel, U.S. Geological Survey, Menlo Park, California, written commun., 2001).

## Conclusions

In conclusion, this letter summarizes the objectives, sampling plan, and protocols used by the USGS in conducting the Level-1 Water-Quality Inventory and Monitoring Program. The resulting water-quality data indicate that the stream water and springs at the Colorado National Monument when compared to Colorado instream water-quality standards are of generally good quality. In general, the constituents analyzed were at concentrations that do not pose a health risk for humans or cause adverse effects in aquatic life. Determining effects on water quality in the monument from continuing development in the Glade Park area is beyond the scope of this study. The data collected during this study, however, will provide baseline information describing general water quality in the monument. Should questions arise about the Water-Quality Inventory and Monitoring Program conducted at the Colorado National Monument, please contact Paul von Guerard at (970) 245-5257, ext. 14, or Ken Leib at (970) 245-5257, ext. 29. The principal author of this report, David Butler, has retired from the USGS.

Sincerely,

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## REFERENCES CITED


Colorado Department of Public Health and Environment, 1998, The basic standards and methodologies for surface water: Water Quality Control Commission, regulation no. 31, Denver, Colo., 140 p.

Faires, L.M., 1993, Methods of analysis by the U.S. Geological Survey National Water Quality Laboratory--Determination of metals in water by inductively coupled plasma-mass spectrometry: U.S. Geological Survey Open-File Report 92-634, 28 p.

Fishman, M.J., 1993, Methods of analysis by the U.S. Geological Survey National Water Quality Laboratory--Determination of inorganic and organic constituents in water and fluvial sediments: U.S. Geological Survey Open-File Report 93-125, 217 p.

Fishman, M.J., and Friedman, L.C., 1989, Method for determination of inorganic substances in water and fluvial sediments: U.S. Geological Survey Techniques of Water-Resources Investigations, book 5, 545 p.

Garbarino, J.R., 1999, Methods of analysis by the U.S. Geological Survey National Water Quality Laboratory--Determination of dissolved arsenic, boron, lithium, selenium, strontium, thallium, and vanadium using inductively coupled plasma-mass spectrometry: U.S. Geological Survey Open-File Report 99-093, 31 p.

Guy, H.P., 1969, Laboratory theory and methods for sediment analysis: U.S. Geological Survey Techniques of Water-Resources Investigations, book 5, chapter C1, 58 p.

Horowitz, A.J., Demas, C.R., Fitzgerald, K.K., Miller, T.L., and Rickert, D.A., 1994, U.S. Geological Survey protocol for the collection and processing of surface-water samples for the subsequent determination of inorganic constituents in filtered water: U.S. Geological Survey Open-File Report 94-539, 57 p.

Lohman, S.W., 1965, Geology and Artesian Water Supply, Grand Junction, Colorado, U.S. Geological Survey Professional Paper 451, 148p.

McLain, Betty, 1993, Methods of analysis by the U.S. Geological Survey National Water Quality Laboratory--Determination of chromium in water by graphite furnace atomic absorption spectrophotometry: U.S. Geological Survey Open-File Report 93-449, 16 p.

National Water Quality Laboratory, 1999, Validation of U.S. Environmental Protection Agency method 365.1 to replace U.S. Geological Survey TWRI methods I-2607-90 and I-4607-90 for determination of phosphorus in the concentration range 0.004 to 0.200 mg/L: USGS National Water Quality Laboratory Technical Memorandum 99.05, January 7, 1999.

Rantz, S.E., and others, 1982, Measurement and computation of streamflow, Measurement of stage and discharge: U.S. Geological Survey Water-Supply Paper 2175, v.2, 284 p.

Thatcher, L.L., Janzer, V.J., and Edwards, K.W., 1977, Methods for determination of radioactive substances in water and fluvial sediments: U.S. Geological Survey Techniques of Water-Resources Investigations, book 5, chapter A5, 95 p.

U.S. Geological Survey, 1998, National field manual for the collection of water-quality data: U.S. Geological Survey Techniques of Water-Resources Investigations, book 9, variously paginated.

**Table 5.** Constituents analyzed and sampling frequency for water-quality sampling sites in the Colorado National Monument, 2001

[F, field measurements; FC, fecal coliform; M, major ions, including dissolved solids; N, nutrients; TE, trace elements; TR, tritium; SS, suspended sediment; --, not sampled]

| Site Code | Site Name | Spring (March-May) | Fall (November) |
|---|---|---|---|
| SP14 | Echo Canyon spring | F, FC, M, N, TE, TR | F, M, N, TE |
| NTC2 | Upper No Thoroughfare Canyon | F, FC, M, N, TE, SS | -- |
| SP16 | Spring in south branch of No Thoroughfare Canyon | F, FC, M, N, TE | -- |
| NTC8 | No Thoroughfare Canyon above Devils Kitchen | F, FC, M, N, TE, SS | -- |
| SP17 | Upper Red Canyon spring | F, FC, M, N, TE | F, M, N, TE |
| SP12 | Columbus Canyon spring | F, FC, M, N, TE, TR | F, M, N, TE |
| RC8 | Red Canyon below Columbus Canyon | F, FC, M, N, TE | -- |
| UC1 | Upper Ute Canyon at suction point | F, M, N, TE | -- |
| SP11 | Upper Ute Canyon spring | F, FC, M, N, TE | F, M, N, TE |
| UC8 | Lower Ute Canyon near Liberty Cap | F, FC, M, N, TE | -- |
| SP18 | Gold Star Canyon spring | F, FC, M, N, TE | -- |
| MC1 | West branch of upper Monument Canyon | F, FC, M, N, TE, SS | -- |
| SP7B | Spring in east fork of middle branch of upper Monument Canyon | F, FC, M, N, TE, TR | F, M, N, TE |
| SP6B | Spring in east fork of east branch of upper Monument Canyon | F, M, N, TE | F, M, N, TE |
| SP6 | East branch of upper Monument Canyon below forks | F, FC, M, N, TE | -- |
| SP4 | Spring in middle Monument Canyon near Kissing Couple | F, FC, M, N, TE, TR | F, M, N, TE |
| MC4 | Monument Canyon about 0.5 mile above monument boundary | F, M, N, TE, SS | -- |

Field measurements: discharge or flow rate, specific conductance, pH, water temperature, and dissolved oxygen.

Major ions: calcium, magnesium, sodium, potassium, lab alkalinity, sulfate, chloride, fluoride, and silica. Hardness is computed using the calcium and magnesium concentrations; dissolved solids is computed from the major-ion concentrations.

Nutrients: dissolved nitrite plus nitrate and dissolved phosphorus.

Trace elements (all dissolved): aluminum, antimony, arsenic, barium, beryllium, boron, cadmium, chromium, cobalt, copper, iron (springs only), lead, lithium, manganese, molybdenum, nickel, selenium, silver, strontium, thallium, uranium, vanadium, and zinc.

**Table 6.** Field measurements and water-quality data for the Colorado National Monument water-quality inventory, March-November 2001

[$ft^3/s$, cubic feet per second; gpm, gallons per minute; µS/cm, microsiemens per centimeter; <, less than; mg/L, milligrams per liter; µg/L, micrograms per liter; K, non-ideal colony count; E, estimated; pCi/L, picocuries per liter; --, not determined]

| Site code | Site name | Date | Discharge ($ft^3/s$) | Flow rate (gpm) | Specific conductance (µS/cm) | pH, (standard units) | Water temperature (degrees Celsius) | Dissolved oxygen (mg/L) |
|---|---|---|---|---|---|---|---|---|
| SP14 | Echo Canyon spring | 04/17/01 | -- | 4.9 | 628 | 7.38 | 12.7 | 5.2 |
| SP14 | | 11/05/01 | -- | 5.4 | 611 | 7.53 | 14.0 | 4.0 |
| NTC2 | Upper No Thoroughfare Canyon | 03/07/01 | 0.10 | -- | 950 | 8.30 | 2.3 | 10.0 |
| SP16 | Spring in south branch, No Thoroughfare Canyon | 05/15/01 | -- | 0.20 | 826 | 7.7 | 10.0 | 9.0 |
| NTC8 | No Thoroughfare Canyon above Devils Kitchen | 03/07/01 | 0.16 | -- | 1,100 | 8.7 | 7.3 | 9.7 |
| NTC8 | | 03/12/01 | 0.21 | -- | 1,020 | 8.55 | 5.8 | 9.0 |
| SP17 | Upper Red Canyon spring | 04/18/01 | -- | 0.38 | 696 | 7.88 | 11.9 | 3.4 |
| SP17 | | 11/06/01 | -- | -- | 579 | 7.4 | 8.9 | 0.4 |
| SP12 | Columbus Canyon spring | 04/18/01 | -- | 0.48 | 646 | 7.95 | 10.3 | 7.2 |
| SP12 | | 11/06/01 | -- | < 0.1 | 775 | 7.9 | 11.3 | 7.4 |
| RC8 | Red Canyon below Columbus Canyon | 03/07/01 | 0.004 | -- | 1,650 | 8.2 | 8.1 | 6.6 |
| UC1 | Upper Ute Canyon at suction point | 04/08/01 | -- | -- | 194 | 8.16 | 4.7 | 7.4 |
| SP11 | Upper Ute Canyon spring | 04/17/01 | -- | 5.8 | 589 | 7.51 | 10.5 | 5.0 |
| SP11 | | 11/05/01 | -- | 8.2 | 727 | 7.30 | 11.6 | 1.5 |
| UC8 | Lower Ute Canyon near Liberty Cap | 03/12/01 | 0.01 | -- | 2,770 | 8.65 | 10.2 | 9.3 |
| SP18 | Gold Star Canyon spring | 04/17/01 | -- | < 0.01 | 646 | 8.83 | 13.0 | 5.2 |
| MC1 | West branch of upper Monument Canyon | 03/07/01 | 0.03 | -- | 485 | 8.36 | 6.7 | 10.3 |
| SP7B | Spring in east fork of middle branch, Upper Monument Canyon | 04/17/01 | -- | 0.72 | 590 | 8.3 | 9.7 | 8.0 |
| SP7B | | 11/05/01 | -- | -- | 632 | 8.3 | 8.2 | 7.8 |

**Table 6.** Field measurements and water-quality data for the Colorado National Monument water-quality inventory, March-November 2001--Continued

| Site code | Site name | Date | Discharge ($ft^3/s$) | Flow rate (gpm) | Specific conductance (µS/cm) | pH, (standard units) | Water temperature (degrees Celsius) | Dissolved oxygen (mg/L) |
|---|---|---|---|---|---|---|---|---|
| SP6B | Spring in east Fork of east branch, upper Monument Canyon | 05/12/01 | -- | -- | 767 | 7.21 | 9.9 | 3.1 |
| SP6B | | 11/05/01 | -- | -- | 275 | 8.0 | 7.2 | 5.4 |
| SP6 | East branch of upper Monument Canyon below forks | 04/17/01 | -- | 0.48 | 1,430 | 8.01 | 22.0 | 5.6 |
| SP4 | Spring in middle Monument Canyon near Kissing Couple | 04/19/01 | -- | E 0.50 | 580 | 8.56 | 14.6 | 6.6 |
| SP4 | | 11/08/01 | -- | < 0.1 | 544 | 8.71 | 8.0 | 11.3 |
| MC4 | Monument Canyon about 0.5 mile above Monument boundary | 04/08/01 | E 0.01 | -- | 1,150 | 8.10 | 8.1 | 5.6 |

**Table 6.** Field measurements and water-quality data for the Colorado National Monument water-quality inventory, March-November 2001--Continued

| Site code | Date | Dissolved oxygen, percent saturation | Fecal coliform (colonies/100 mL) | Hardness (mg/L as $CaCO_3$) | Calcium, dissolved (mg/L as Ca) | Magnesium, dissolved (mg/L as Mg) | Sodium, dissolved (mg/L as Na) | Potassium, dissolved (mg/L as K) |
|---|---|---|---|---|---|---|---|---|
| SP14 | 04/17/01 | 58 | <1 | 300 | 65 | 32 | 22 | 2.9 |
| SP14 | 11/05/01 | 46 | -- | 290 | 62 | 33 | 23 | 3.0 |
| NTC2 | 03/07/01 | 92 | K2 | 390 | 110 | 31 | 61 | 7.1 |
| SP16 | 05/15/01 | 100 | <1 | 340 | 58 | 47 | 46 | 7.4 |
| NTC8 | 03/07/01 | 97 | <1 | 360 | 67 | 46 | 99 | 9.3 |
| NTC8 | 03/12/01 | 89 | <1 | 350 | 65 | 45 | 90 | 9.3 |
| SP17 | 04/18/01 | 39 | <1 | 330 | 76 | 35 | 26 | 3.4 |
| SP17 | 11/06/01 | 4 | -- | 280 | 95 | 11 | 6.3 | 9.8 |
| SP12 | 04/18/01 | 79 | <1 | 250 | 28 | 43 | 47 | 4.8 |
| SP12 | 11/06/01 | 83 | -- | 290 | 32 | 51 | 58 | 6.0 |
| RC8 | 03/07/01 | 66 | <1 | 530 | 78 | 80 | 180 | 7.6 |
| UC1 | 04/08/01 | 72 | -- | 76 | 24 | 3.8 | 8.9 | 2.2 |
| SP11 | 04/17/01 | 55 | <1 | 260 | 43 | 37 | 29 | 3.6 |
| SP11 | 11/05/01 | 17 | -- | 330 | 66 | 41 | 33 | 4.4 |
| UC8 | 03/12/01 | 103 | <1 | 510 | 26 | 110 | 430 | 4.7 |
| SP18 | 04/17/01 | -- | <1 | 270 | 56 | 32 | 39 | 3.6 |
| MC1 | 03/07/01 | 102 | K23 | 55 | 17 | 3.2 | 89 | 3.5 |
| SP7B | 04/17/01 | 87 | <1 | 260 | 39 | 40 | 28 | 3.8 |
| SP7B | 11/05/01 | 82 | -- | 290 | 38 | 46 | 25.5 | 4.0 |
| SP6B | 05/12/01 | 33 | -- | 360 | 67 | 46 | 32 | 3.8 |
| SP6B | 11/05/01 | 56 | -- | 130 | 45 | 4.6 | 1.7 | 4.4 |
| SP6 | 04/17/01 | 80 | <1 | 500 | 60 | 84 | 140 | 12 |
| SP4 | 04/19/01 | 81 | 41 | 170 | 34 | 20 | 64 | 4.5 |
| SP4 | 11/08/01 | 115 | -- | 160 | 35 | 18 | 62.4 | 4.9 |
| MC4 | 04/08/01 | 57 | -- | 250 | 53 | 28 | 160 | 7.1 |

**Table 6.** Field measurements and water-quality data for the Colorado National Monument water-quality inventory, March-November 2001--Continued

| Site code | Date | Alkalinity, lab, dissolved (mg/L as $CaCO_3$) | Sulfate, dissolved (mg/L as $SO_4$) | Chloride, dissolved, (mg/L as Cl) | Fluoride, dissolved (mg/L as F) | Silica, dissolved (mg/L as $SiO_2$) | Dissolved solids, sum of constituents (mg/L) | Dissolved solids discharge, (tons per day) |
|---|---|---|---|---|---|---|---|---|
| SP14 | 04/17/01 | 270 | 72 | 8.2 | 0.3 | 15 | 380 | -- |
| SP14 | 11/05/01 | 281 | 71 | 10 | 0.3 | 15 | 386 | -- |
| NTC2 | 03/07/01 | 340 | 140 | 9.2 | 1.4 | 15 | 580 | 0.16 |
| SP16 | 05/15/01 | 380 | 50 | 22 | 0.5 | 21 | 480 | -- |
| NTC8 | 03/07/01 | 310 | 240 | 18 | 1.6 | 11 | 680 | 0.30 |
| NTC8 | 03/12/01 | 320 | 210 | 17 | 1.4 | 11 | 640 | 0.37 |
| SP17 | 04/18/01 | 340 | 33 | 13 | 0.4 | 11 | 400 | -- |
| SP17 | 11/06/01 | 323 | 6 | 5.5 | E 0.08 | 8.7 | 338 | -- |
| SP12 | 04/18/01 | 310 | 39 | 10 | 0.4 | 14 | 380 | -- |
| SP12 | 11/06/01 | 389 | 52 | 15.7 | 0.4 | 17 | 467 | -- |
| RC8 | 03/07/01 | 380 | 440 | 61 | 0.9 | 8.9 | 1,090 | 0.01 |
| UC1 | 04/08/01 | 64 | 17 | 9.3 | E 0.09 | 0.8 | 100 | -- |
| SP11 | 04/17/01 | 300 | 26 | 7.7 | 0.3 | 13 | 340 | -- |
| SP11 | 11/05/01 | 276 | 15.3 | 10.4 | 0.4 | 15.3 | 353 | -- |
| UC8 | 03/12/01 | 760 | 500 | 120 | 1.2 | 13 | 1,650 | 0.05 |
| SP18 | 04/17/01 | 220 | 91 | 13 | 0.4 | 7.2 | 400 | -- |
| MC1 | 03/07/01 | 210 | 33 | 3.9 | 0.4 | 8.6 | 290 | 0.02 |
| SP7B | 04/17/01 | 290 | 32 | 8.3 | 0.3 | 12 | 340 | -- |
| SP7B | 11/05/01 | 319 | 40 | 13 | 0.3 | 12 | 371 | -- |
| SP6B | 05/12/01 | 400 | 23 | 9.7 | 0.5 | 14 | 440 | -- |
| SP6B | 11/05/01 | 149 | 2.2 | 1.8 | E 0.12 | 5.2 | 155 | -- |
| SP6 | 04/17/01 | 490 | 260 | 71 | 0.7 | 12 | 940 | -- |
| SP4 | 04/19/01 | 270 | 42 | 5.4 | 0.4 | 7.8 | 340 | -- |
| SP4 | 11/08/01 | 284 | 38 | 5.9 | 0.4 | 8 | 344 | -- |
| MC4 | 04/08/01 | 310 | 240 | 47 | 0.5 | 6.2 | 730 | 0.02 |

**Table 6.** Field measurements and water-quality data for the Colorado National Monument water-quality inventory, March-November 2001--Continued

| Site code | Date | Nitrate plus nitrite nitrogen, dissolved (mg/L as N) | Phosphorus, dissolved (µg/L as P) | Aluminum, dissolved (µg/L as Al) | Antimony, dissolved (µg/L as Sb) | Arsenic, dissolved (µg/L as As) | Barium, dissolved (µg/L as Ba) | Beryllium, dissolved (µg/L as Be) |
|---|---|---|---|---|---|---|---|---|
| SP14 | 04/17/01 | 0.023 | < 0.006 | <1 | 0.07 | 0.2 | 46 | < 0.06 |
| SP14 | 11/05/01 | 0.019 | < 0.004 | <1 | < 0.05 | 0.2 | 41 | < 0.06 |
| NTC2 | 03/07/01 | 0.011 | 0.006 | <1 | 0.06 | 0.9 | 100 | < 0.06 |
| SP16 | 05/15/01 | < 0.005 | < 0.006 | <1 | 0.06 | 2.3 | 130 | < 0.06 |
| NTC8 | 03/07/01 | 0.006 | E 0.003 | 1.8 | 0.16 | 2.2 | 56 | < 0.06 |
| NTC8 | 03/12/01 | < 0.005 | < 0.006 | 1.5 | 0.14 | 2.2 | 57 | < 0.06 |
| SP17 | 04/18/01 | < 0.005 | 0.009 | 1.1 | 0.33 | 2.2 | 130 | < 0.06 |
| SP17 | 11/06/01 | -- | -- | 4.9 | 0.14 | 3.6 | 105 | < 0.06 |
| SP12 | 04/18/01 | 0.17 | < 0.006 | 1.0 | E 0.04 | 4.6 | 57 | < 0.06 |
| SP12 | 11/06/01 | 0.10 | < 0.004 | <1 | < 0.05 | 3.6 | 67 | < 0.06 |
| RC8 | 03/07/01 | 0.048 | E 0.005 | 1.9 | 0.23 | 3.6 | 120 | < 0.06 |
| UC1 | 04/08/01 | 0.014 | 0.006 | 6.9 | 0.13 | 0.9 | 68 | < 0.06 |
| SP11 | 04/17/01 | 0.077 | E 0.003 | <1 | 0.08 | 1.0 | 140 | < 0.06 |
| SP11 | 11/05/01 | E 0.010 | < 0.004 | 1.3 | E 0.03 | 2.3 | 278 | < 0.06 |
| UC8 | 03/12/01 | 0.016 | 0.007 | 1.4 | 0.26 | 8.3 | 71 | < 0.06 |
| SP18 | 04/17/01 | 5.1 | E 0.004 | 1.4 | 1.1 | 2.7 | 89 | < 0.06 |
| MC1 | 03/07/01 | 1.0 | 0.013 | 6.8 | 0.19 | 4.1 | 70 | < 0.06 |
| SP7B | 04/17/01 | 0.008 | E 0.003 | 1.2 | 0.09 | 0.8 | 89 | < 0.06 |
| SP7B | 11/05/01 | < 0.013 | < 0.004 | <1 | < 0.05 | 0.4 | 77 | < 0.06 |
| SP6B | 05/12/01 | < 0.005 | < 0.006 | <1 | E 0.05 | 1.2 | 210 | < 0.06 |
| SP6B | 11/05/01 | < 0.013 | 0.007 | 4.3 | 0.09 | 2.6 | 144 | < 0.06 |
| SP6 | 04/17/01 | 0.006 | < 0.006 | 1.4 | 0.35 | 4.6 | 105 | < 0.06 |
| SP4 | 04/19/01 | 0.006 | < 0.006 | 1.6 | 0.23 | 1.8 | 140 | < 0.06 |
| SP4 | 11/08/01 | 0.12 | < 0.004 | <1 | 0.14 | 2.4 | 150 | < 0.06 |
| MC4 | 04/08/01 | 0.008 | < 0.006 | 2.3 | 0.35 | 3.0 | 120 | < 0.06 |

**Table 6.** Field measurements and water-quality data for the Colorado National Monument water-quality inventory, March-November 2001--Continued

| Site code | Date | Boron, dissolved (µg/L as B) | Cadmium, dissolved (µg/L as Cd) | Chromium, dissolved (µg/L as Cr) | Cobalt, dissolved (µg/L as Co) | Copper, dissolved (µg/L as Cu) | Iron, dissolved (µg/L as Fe) | Lead, dissolved (µg/L as Pb) |
|---|---|---|---|---|---|---|---|---|
| SP14 | 04/17/01 | 55 | < 0.04 | < 0.8 | 0.1 | 0.6 | <10 | < 0.08 |
| SP14 | 11/05/01 | 46 | < 0.04 | < 0.8 | 0.1 | 0.3 | <10 | < 0.08 |
| NTC2 | 03/07/01 | 170 | < 0.04 | < 0.8 | 0.2 | 1.5 | -- | < 0.08 |
| SP16 | 05/15/01 | 130 | < 0.04 | < 0.8 | 0.1 | 1.5 | <10 | E 0.06 |
| NTC8 | 03/07/01 | 260 | 0.06 | < 0.8 | 0.2 | 3.6 | -- | 0.15 |
| NTC8 | 03/12/01 | 250 | < 0.04 | E 0.5 | 0.2 | 2.8 | -- | < 0.08 |
| SP17 | 04/18/01 | 70 | < 0.04 | < 0.8 | 0.4 | 1.1 | 24 | < 0.08 |
| SP17 | 11/06/01 | 41 | < 0.04 | < 0.8 | 1.5 | 0.4 | 862 | E 0.06 |
| SP12 | 04/18/01 | 130 | < 0.04 | < 0.8 | 0.08 | 0.9 | <10 | E 0.05 |
| SP12 | 11/06/01 | 145 | < 0.04 | < 0.8 | 0.07 | 0.6 | <10 | < 0.08 |
| RC8 | 03/07/01 | 380 | 0.11 | < 0.8 | 0.2 | 5.1 | -- | 0.13 |
| UC1 | 04/08/01 | 23 | < 0.04 | < 0.8 | 0.1 | 3.8 | -- | < 0.08 |
| SP11 | 04/17/01 | 85 | < 0.04 | < 0.8 | 0.2 | 1.0 | 12 | < 0.08 |
| SP11 | 11/05/01 | 81 | < 0.04 | < 0.8 | 1.6 | 0.3 | 312 | < 0.08 |
| UC8 | 03/12/01 | 720 | 0.05 | < 0.8 | 0.3 | 7.2 | -- | 0.16 |
| SP18 | 04/17/01 | 100 | < 0.04 | E 0.7 | 0.1 | 2.7 | <10 | 0.10 |
| MC1 | 03/07/01 | 69 | < 0.04 | < 0.8 | 0.1 | 3.0 | -- | E 0.06 |
| SP7B | 04/17/01 | 62 | < 0.04 | < 0.8 | 0.09 | 1.1 | <10 | E 0.06 |
| SP7B | 11/05/01 | 49 | < 0.04 | < 0.8 | 0.05 | 0.3 | <10 | < 0.08 |
| SP6B | 05/12/01 | 110 | < 0.04 | < 0.8 | 0.2 | 0.5 | E 7.6 | < 0.08 |
| SP6B | 11/05/01 | 39 | < 0.04 | < 0.8 | 0.2 | 2.8 | 17 | < 0.08 |
| SP6 | 04/17/01 | 250 | 0.04 | < 0.8 | 0.2 | 4.9 | <10 | E 0.04 |
| SP4 | 04/19/01 | 88 | < 0.04 | < 0.8 | 0.1 | 1.4 | <10 | < 0.08 |
| SP4 | 11/08/01 | 83 | < 0.04 | < 0.8 | 0.07 | 1.0 | <10 | < 0.08 |
| MC4 | 04/08/01 | 180 | E 0.02 | < 0.8 | 0.2 | 3.6 | -- | E 0.06 |

**Table 6.** Field measurements and water-quality data for the Colorado National Monument water-quality inventory, March-November 2001--Continued

| Site code | Date | Lithium, dissolved (µg/L as Li) | Manganese, dissolved (µg/L as Mn) | Molybdenum, dissolved (µg/L as Mo) | Nickel, dissolved (µg/L as Ni) | Selenium, dissolved (µg/L as Se) | Silver, dissolved (µg/L as Ag) | Strontium, dissolved (µg/L as Sr) |
|---|---|---|---|---|---|---|---|---|
| SP14 | 04/17/01 | 35 | 1.3 | 1.1 | < 0.06 | 1.0 | <1 | 480 |
| SP14 | 11/05/01 | 28 | < 0.1 | 1.1 | < 0.06 | 0.9 | <1 | 438 |
| NTC2 | 03/07/01 | 120 | 16 | 0.6 | < 0.06 | 0.4 | <1 | 1,070 |
| SP16 | 05/15/01 | 70 | 2.5 | 2.9 | 0.18 | 3.5 | <1 | 750 |
| NTC8 | 03/07/01 | 180 | 0.8 | 3.9 | < 0.06 | 5.9 | <1 | 1,150 |
| NTC8 | 03/12/01 | 170 | 1.6 | 3.6 | < 0.06 | 4.5 | <1 | 1,080 |
| SP17 | 04/18/01 | 38 | 140 | 2.3 | < 0.06 | E 0.2 | <1 | 450 |
| SP17 | 11/06/01 | 11 | 1186 | E 0.2 | 9.9 | E 0.2 | <1 | 282 |
| SP12 | 04/18/01 | 69 | 0.5 | 1.3 | < 0.06 | 11 | <1 | 1,000 |
| SP12 | 11/06/01 | 68 | 0.4 | 1.5 | 0.11 | 10.6 | <1 | 1170 |
| RC8 | 03/07/01 | 140 | 1.4 | 8.1 | < 0.06 | 28 | <1 | 3,080 |
| UC1 | 04/08/01 | 10 | 1.0 | 0.7 | 0.21 | 0.5 | <1 | 210 |
| SP11 | 04/17/01 | 41 | 60 | 0.7 | < 0.06 | 3.2 | <1 | 550 |
| SP11 | 11/05/01 | 37 | 688 | 0.8 | 0.27 | 0.5 | <1 | 747 |
| UC8 | 03/12/01 | 290 | 9.2 | 24 | 1.1 | 5.6 | <1 | 2,390 |
| SP18 | 04/17/01 | 52 | 0.4 | 2.2 | < 0.06 | 1.0 | <1 | 950 |
| MC1 | 03/07/01 | 31 | 2.1 | 1.4 | 0.13 | 20 | <1 | 500 |
| SP7B | 04/17/01 | 42 | 7.5 | 1.3 | < 0.06 | 0.5 | <1 | 490 |
| SP7B | 11/05/01 | 30 | 0.2 | 1.5 | < 0.06 | 1.3 | <1 | 453 |
| SP6B | 05/12/01 | 46 | 120 | 2.4 | < 0.06 | E 0.2 | <1 | 1,220 |
| SP6B | 11/05/01 | 2.9 | 37 | 0.3 | 0.12 | < 0.3 | <1 | 361 |
| SP6 | 04/17/01 | 170 | 7.1 | 7.6 | 0.24 | 30 | <1 | 2,740 |
| SP4 | 04/19/01 | 73 | 0.9 | 2.1 | < 0.06 | 0.8 | <1 | 750 |
| SP4 | 11/08/01 | 58 | 0.3 | 1.7 | 0.07 | 0.5 | <1 | 705 |
| MC4 | 04/08/01 | 110 | 25 | 5.6 | 0.11 | 1.4 | <1 | 1,840 |

**Table 6.** Field measurements and water-quality data for the Colorado National Monument water-quality inventory, March-November 2001--Continued

| Site code | Date | Thallium, dissolved (µg/L as Tl) | Uranium, dissolved (µg/L as U) | Vanadium, dissolved (µg/L as V) | Zinc, dissolved (µg/L as Zn) | Tritium, total (pCi/L) | Suspended sediment (mg/L) | Suspended-sediment discharge (tons per day) |
|---|---|---|---|---|---|---|---|---|
| SP14 | 04/17/01 | < 0.04 | 3.3 | 0.6 | <1 | 5.8 | -- | -- |
| SP14 | 11/05/01 | < 0.04 | 3.0 | E 0.1 | <1 | -- | -- | -- |
| NTC2 | 03/07/01 | < 0.04 | 5.0 | 1.7 | <1 | -- | 2.1 | 0.001 |
| SP16 | 05/15/01 | < 0.04 | 9.9 | 12 | <1 | -- | -- | -- |
| NTC8 | 03/07/01 | < 0.04 | 20 | 4.3 | 3.9 | -- | 1.8 | 0.001 |
| NTC8 | 03/12/01 | < 0.04 | 37 | 4.6 | 1.0 | -- | 6.0 | 0.003 |
| SP17 | 04/18/01 | < 0.04 | 10 | 1.7 | 1.8 | -- | -- | -- |
| SP17 | 11/06/01 | < 0.04 | 0.5 | 0.4 | <1 | -- | -- | -- |
| SP12 | 04/18/01 | < 0.04 | 11 | 6.6 | <1 | 2.9 | -- | -- |
| SP12 | 11/06/01 | < 0.04 | 11.6 | 4.4 | <1 | -- | -- | -- |
| RC8 | 03/07/01 | E 0.02 | 46 | 4.7 | 2.6 | -- | -- | -- |
| UC1 | 04/08/01 | < 0.04 | 1.4 | 1.0 | <1 | -- | -- | -- |
| SP11 | 04/17/01 | < 0.04 | 3.8 | 2.1 | 1.1 | -- | -- | -- |
| SP11 | 11/05/01 | < 0.04 | 1.8 | 0.3 | <1 | -- | -- | -- |
| UC8 | 03/12/01 | < 0.04 | 55 | 14 | 2.3 | -- | -- | -- |
| SP18 | 04/17/01 | < 0.04 | 3.3 | 4.1 | 1.1 | -- | -- | -- |
| MC1 | 03/07/01 | < 0.04 | 5.8 | 9.8 | <1 | -- | 1,640 | 0.13 |
| SP7B | 04/17/01 | < 0.04 | 1.6 | 2.1 | 1.5 | 2.2 | -- | -- |
| SP7B | 11/05/01 | < 0.04 | 2.2 | 0.3 | <1 | -- | -- | -- |
| SP6B | 05/12/01 | < 0.04 | 10 | 2.8 | 1.5 | -- | -- | -- |
| SP6B | 11/05/01 | E 0.03 | 0.6 | 1.7 | <1 | -- | -- | -- |
| SP6 | 04/17/01 | < 0.04 | 52 | 8.1 | 1.7 | -- | -- | -- |
| SP4 | 04/19/01 | < 0.04 | 3.0 | 4.3 | <1 | 9.0 | -- | -- |
| SP4 | 11/08/01 | < 0.04 | 1.8 | 3.6 | <1 | -- | -- | -- |
| MC4 | 04/08/01 | E 0.04 | 28 | 3.9 | 1.5 | -- | 89 | 0.002 |

**Table 7.** Statistical summary of water-quality data for the Colorado National Monument, 2001
[N, Number of samples; Max, maximum value; Min, minimum value; $ft^3/s$, cubic feet per second; gpm, gallons per minute; µS/cm, microsiemens per centimeter; $^oC$, degrees Celsius; mg/L, milligrams per liter; col/100 mL, colonies per 100 milliliters; pCi/L, picocuries per liter; µg/L, micrograms per liter; <, less than; --, no data or not determined; E, estimated value]

| Parameter | N | Median | Max | Min | N | Median | Max | Min |
|---|---|---|---|---|---|---|---|---|
| | SPRINGS | | | | STREAMS | | | |
| Discharge ($ft^3/s$) | 0 | -- | -- | -- | 7 | 0.03 | 0.21 | 0.004 |
| Flow rate (gpm) | 12 | 0.48 | 8.2 | < 0.01 | 0 | -- | -- | -- |
| Conductance (µS/cm) | 17 | 639 | 1,430 | 275 | 8 | 1,060 | 2,770 | 194 |
| pH | 17 | 8.0 | 8.83 | 7.21 | 8 | 8.38 | 8.7 | 8.16 |
| Temperature ($^oC$) | 17 | 10.1 | 22.0 | 7.2 | 8 | 7.0 | 10.2 | 2.3 |
| Dissolved oxygen (mg/L) | 17 | 6.6 | 11.3 | 0.4 | 8 | 9.2 | 10.3 | 5.6 |
| Fecal coliform (col/100 mL) | 9 | <1 | 41 | <1 | 6 | <1 | 23 | <1 |
| Hardness (mg/L) | 17 | 290 | 500 | 130 | 8 | 354 | 530 | 55 |
| Calcium (mg/L) | 17 | 57.7 | 95 | 28 | 8 | 59.0 | 106 | 17 |
| Magnesium (mg/L) | 17 | 37.5 | 84 | 11.0 | 8 | 37.8 | 110 | 3.2 |
| Sodium (mg/L) | 17 | 38.6 | 141 | 1.7 | 8 | 94.6 | 428 | 8.9 |
| Potassium (mg/L) | 17 | 4.4 | 12.0 | 2.9 | 8 | 7.1 | 9.3 | 2.2 |
| Alkalinity (mg/L) | 17 | 306 | 492 | 149 | 8 | 316 | 756 | 64 |
| Sulfate (mg/L) | 17 | 42 | 256 | 2.2 | 8 | 226 | 498 | 17 |
| Chloride (mg/L) | 17 | 10 | 71 | 1.8 | 8 | 17.2 | 116 | 3.9 |
| Fluoride (mg/L) | 17 | 0.40 | 0.72 | 0.26 | 8 | 1.06 | 1.6 | 0.09 |
| Silica (mg/L) | 17 | 12.6 | 21 | 7.2 | 8 | 9.9 | 14.8 | 0.81 |
| Dissolved solids (mg/L) | 17 | 386 | 936 | 155 | 8 | 664 | 1,650 | 105 |
| Nitrite+nitrate (mg/L) | 16 | 0.02 | 5.08 | < 0.005 | 8 | 0.013 | 1.04 | < 0.005 |
| Phosphorus (mg/L) | 16 | < 0.006 | 0.009 | 0.003 | 8 | 0.006 | 0.013 | 0.003 |
| Aluminum (µg/L) | 17 | 1.0 | 4.9 | <1 | 8 | 1.9 | 6.9 | <1 |
| Antimony (µg/L) | 17 | 0.087 | 1.08 | 0.037 | 8 | 0.17 | 0.35 | 0.06 |
| Arsenic (µg/L) | 17 | 2.2 | 4.6 | 0.19 | 8 | 2.6 | 8.3 | 0.85 |
| Barium (µg/L) | 17 | 89 | 278 | 41 | 8 | 70.7 | 123 | 56 |
| Beryllium (µg/L) | 17 | < 0.06 | < 0.06 | < 0.06 | 8 | < 0.06 | < 0.06 | < 0.06 |
| Boron (µg/L) | 17 | 85 | 253 | 46 | 8 | 210 | 722 | 23 |
| Cadmium (µg/L) | 17 | < 0.037 | 0.042 | < 0.037 | 8 | < 0.037 | 0.11 | < 0.037 |
| Chromium (µg/L) | 17 | < 0.8 | 0.72 | < 0.8 | 8 | < 0.8 | 0.47 | < 0.8 |
| Cobalt (µg/L) | 17 | 0.15 | 1.6 | 0.07 | 8 | 0.20 | 0.28 | 0.11 |
| Copper (µg/L) | 17 | 1.1 | 4.9 | 0.30 | 8 | 3.6 | 7.2 | 1.5 |
| Iron (µg/L) | 17 | <10 | 862 | 7.6 | 0 | -- | -- | -- |
| Lead (µg/L) | 17 | < 0.08 | 0.097 | 0.043 | 8 | 0.057 | 0.16 | < 0.08 |
| Lithium (µg/L) | 17 | 45.8 | 166 | 11 | 8 | 135 | 294 | 10 |
| Manganese (µg/L) | 17 | 2.1 | 688 | < 0.1 | 8 | 1.8 | 25 | 0.85 |
| Molybdenum (µg/L) | 17 | 1.5 | 7.6 | 0.20 | 8 | 3.7 | 24 | 0.62 |
| Nickel (µg/L) | 17 | < 0.06 | 9.9 | < 0.06 | 8 | 0.11 | 1.0 | < 0.06 |
| Selenium (µg/L) | 17 | 1.3 | 30 | 0.17 | 8 | 5.0 | 28 | 0.41 |
| Silver (µg/L) | 17 | <1 | <1 | <1 | 8 | <1 | <1 | <1 |
| Strontium (µg/L) | 17 | 747 | 2,740 | 282 | 8 | 1,113 | 3,080 | 211 |
| Thallium (µg/L) | 17 | < 0.041 | < 0.041 | < 0.041 | 8 | < 0.041 | E 0.036 | E 0.022 |
| Uranium (µg/L) | 17 | 3.8 | 52 | 0.60 | 8 | 23.9 | 55 | 1.4 |
| Vanadium (µg/L) | 17 | 3.6 | 12.1 | 0.10 | 8 | 4.5 | 14 | 1.0 |
| Zinc (µg/L) | 17 | <1 | 1.8 | <1 | 8 | 1.3 | 3.9 | <1 |
| Tritium (pCi/L) | 4 | 4.4 | 9.0 | 2.2 | 0 | -- | -- | -- |
| Suspended sediment (mg/L) | 0 | -- | -- | -- | 5 | 6.0 | 1,640 | 1.8 |

**Table 8.** Colorado water-quality standards for selected use classifications (Colorado Department of Public Health and Environment, 1998)

[ mg/L, milligrams per liter; $^{o}$C, degrees Celsius; µg/L, micrograms per liter; --, no standard; mL, milliliters; *, aquatic-life criteria for metal computed using hardness-based equations. A hardness range of 50 to 500 mg/L was used to calculate the standards]

| **PHYSICAL PARAMETERS** | | | |
|---|---|---|---|
| **Parameter** | **Water supply** | **Cold-water biota** | **Class 1 recreation** |
| Dissolved oxygen (mg/L) | 3.0 | 6.0 | 3.0 |
| pH (standard units) | 5.0-9.0 | 6.5-9.0 | 6.5-9.0 |
| Water temperature ($^{o}$C) | -- | Maximum 20 | -- |
| Fecal coliform (colonies per 100 mL) | 2,000 | -- | 200 |
| | | | |
| **INORGANIC PARAMETERS (DISSOLVED)** | | | |
| Chloride (mg/L) | 250 | -- | -- |
| Sulfate (mg/L) | 250 | -- | -- |
| Fluoride (mg/L) | 2.0 | -- | -- |
| Nitrate (mg/L) | 10 | -- | -- |
| | | | |
| **TRACE ELEMENTS (TOTAL RECOVERABLE UNLESS NOTED)** | | | |
| **Parameter** | **Water supply** | **Aquatic life** | |
| | | **Chronic** | **Acute** |
| Aluminum (µg/L) | -- | 87 | 750 |
| Antimony (µg/L) | 6.0 | -- | -- |
| Arsenic (µg/L) | 50 | 150 | 360 |
| Barium (µg/L) | 1,000 | -- | -- |
| Beryllium (µg/L) | 4.0 | -- | -- |
| Cadmium (µg/L)* | 5.0 | 0.66-4.0 | 4.5-61 |
| Chromium, trivalent (µg/L) * | 50 | 117-773 | 984-6,490 |
| Chromium, hexavalent (µg/L) | 50 | 11 | 16 |
| Copper (µg/L) * | 1,000 | 6.5-47 | 9.2-81 |
| Iron (µg/L) | [1]300 | 1,000 | -- |
| Lead (µg/L) * | 50 | 1.5-38 | 31-1,290 |
| Manganese (µg/L) * | 50 | 1,000-3,510 | 1,820-10,700 |
| Nickel (µg/L) * | 100 | 56-325 | 545-3,130 |
| Selenium (µg/L) | 50 | 4.6 | 20 |
| Silver (µg/L) * | 100 | 0.10-5.1 | 0.62-32 |
| Thallium (µg/L) | 0.5 | 15 | -- |
| Uranium (µg/L) * | -- | 699-8,840 | 1,120-14,200 |
| Zinc (µg/L) * | 5,000 | 59-414 | 65-458 |

[1] Standard is for dissolved iron.

**Table 9.** Water-quality data for quality-assurance samples for the Colorado National Monument water-quality inventory
[<, less than; mg/L, milligrams per liter; µg/L, micrograms per liter; --, no value; E, estimated]

| Site name | Sample type | Date | Hardness (mg/L as $CaCO_3$) | Calcium, dissolved (mg/L as Ca) | Magnesium, dissolved (mg/L as Mg) | Sodium, dissolved (mg/L as Na) | Potassium, dissolved (mg/L as K) |
|---|---|---|---|---|---|---|---|
| Upper Red Canyon spring | Field blank | 04/18/01 | -- | < 0.01 | < 0.008 | < 0.06 | < 0.09 |
| Echo Canyon spring | Replicate | 11/05/01 | -- | -- | -- | -- | -- |

| Site name | Alkalinity, lab, dissolved (mg/L as $CaCO_3$) | Sulfate, dissolved (mg/L as $SO_4$) | Chloride, dissolved, (mg/L as Cl) | Fluoride, dissolved (mg/L as F) | Silica, dissolved (mg/L as $SiO_2$) | Dissolved solids, sum of constituents (mg/L) | Nitrate plus nitrite nitrogen, dissolved (mg/L as N) |
|---|---|---|---|---|---|---|---|
| Upper Red Canyon spring | 1.82 | < 0.11 | < 0.08 | < 0.16 | < 0.48 | -- | < 0.005 |
| Echo Canyon spring | -- | -- | -- | -- | -- | -- | 0.020 |

| Site name | Phosphorus, dissolved (mg/L as P) | Aluminum, dissolved (µg/L as Al) | Antimony, dissolved (µg/L as Sb) | Arsenic, dissolved (µg/L as As) | Barium, dissolved (µg/L as Ba) | Beryllium, dissolved (µg/L as Be) | Boron, dissolved (µg/L as B) |
|---|---|---|---|---|---|---|---|
| Upper Red Canyon spring | < 0.006 | <1 | < 0.048 | < 0.18 | <1 | < 0.06 | <7 |
| Echo Canyon spring | < 0.004 | -- | -- | -- | -- | -- | -- |

| Site name | Cadmium, dissolved (µg/L as Cd) | Chromium, dissolved (µg/L as Cr) | Cobalt, dissolved (µg/L as Co) | Copper, dissolved (µg/L as Cu) | Iron, dissolved (µg/L as Fe) | Lead, dissolved (µg/L as Pb) | Lithium, dissolved (µg/L as Li) |
|---|---|---|---|---|---|---|---|
| Upper Red Canyon spring | < 0.04 | < 0.8 | < 0.015 | < 0.23 | <10 | < 0.08 | E 0.20 |
| Echo Canyon spring | -- | -- | -- | -- | -- | -- | -- |

**Table 9.** Water-quality data for quality-control assurance samples for the Colorado National Monument water-quality inventory--Continued

| Site name | Manganese, dissolved (µg/L as Mn) | Molybdenum, dissolved (µg/L as Mo) | Nickel, dissolved (µg/L as Ni) | Selenium, dissolved (µg/L as Se) | Silver, dissolved (µg/L as Ag) | Strontium, dissolved (µg/L as Sr) | Thallium, dissolved (µg/L as Tl) |
|---|---|---|---|---|---|---|---|
| Upper Red Canyon spring | <1 | < 0.2 | < 0.06 | < 0.33 | <1 | < 0.08 | < 0.041 |
| Echo Canyon spring | -- | -- | -- | -- | -- | -- | -- |

| Site name | Uranium, dissolved (µg/L as U) | Vanadium, dissolved (µg/L as V) | Zinc, dissolved (µg/L as Zn) |
|---|---|---|---|
| Upper Red Canyon spring | < 0.018 | < 0.21 | <1 |
| Echo Canyon spring | -- | -- | -- |