Water Quality and Trend Analysis of Colorado–Big Thompson System Reservoirs and Related Conveyances, 1969 Through 2000

By Michael R. Stevens

Prepared in cooperation with the
NORTHERN COLORADO WATER CONSERVANCY DISTRICT,
BUREAU OF RECLAMATION, and the
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Conversion Factors, Vertical Datum, and Abbreviations

Multiply	By	To obtain
acre	0.00156	square mile
acre-foot (acre-ft)	1,233	cubic meter
cubic foot per second (ft^3/s)	0.02832	cubic meter per second
foot (ft)	0.3048	meter
inch	2.54	centimeter
mile	1.609	kilometer
millimeter	0.03937	inch
square centimeter (cm^2)	0.1550	square inch (in^2)
square foot (ft^2)	0.0929	square meter
square mile (mi^2)	2.590	square kilometer (km^2)

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

°F = 1.8(°C) + 32

Vertical coordinate information is referenced to the National Geodectic Vertical Datum of 1929 (NGVD 29); horizontal coordinate information is referenced to the North American Datum of 1927 (NAD 27).

Additional Abbreviations

MRL minimum reporting level
mg milligrams
mg/L milligrams per liter
mm millimeters
mL milliliters
NTU nephelometric turbidity units
ROE residue on evaporation
μg/L micrograms per liter
μS/cm microsiemens per centimeter at 25 degrees Celsius
WY water year, begins on October 1 and ends on September 30 of the following year. Identified by year in which it ends (water year 2000 ended on September 30, 2000).

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Abstract

The U.S. Geological Survey, in an ongoing cooperative monitoring program with the Northern Colorado Water Conservancy District, Bureau of Reclamation, and City of Fort Collins, has collected water-quality data in north-central Colorado since 1969 in reservoirs and conveyances, such as canals and tunnels, related to the Colorado–Big Thompson Project, a water-storage, collection, and distribution system. Ongoing changes in water use among agricultural and municipal users on the eastern slope of the Rocky Mountains in Colorado, changing land use in reservoir watersheds, and other water-quality issues among Northern Colorado Water Conservancy District customers necessitated a reexamination of water-quality trends in the Colorado–Big Thompson system reservoirs and related conveyances. The sampling sites are on reservoirs, canals, and tunnels in the headwaters of the Colorado River (on the western side of the transcontinental diversion operations) and the headwaters of the Big Thompson River (on the eastern side of the transcontinental diversion operations). Carter Lake Reservoir and Horsetooth Reservoir are off-channel water-storage facilities, located in the foothills of the northern Colorado Front Range, for water supplied from the Colorado–Big Thompson Project. The length of water-quality record ranges from approximately 3 to 30 years depending on the site and the type of measurement or constituent. Changes in sampling frequency, analytical methods, and minimum reporting limits have occurred repeatedly over the period of record.

The objective of this report was to complete a retrospective water-quality and trend analysis of reservoir profiles, nutrients, major ions, selected trace elements, chlorophyll-*a*, and hypolimnetic oxygen data from 1969 through 2000 in Lake Granby, Shadow Mountain Lake, and the Granby Pump Canal in Grand County, Colorado, and Horsetooth Reservoir, Carter Lake, Lake Estes, Alva B. Adams Tunnel, and Olympus Tunnel in Larimer County, Colorado.

This report summarizes and assesses:

1. Water-quality and field-measurement profile data collected by the U.S. Geological Survey and stored in the U.S. Geological Survey National Water Information System,
2. Time-series trends of chemical constituents and physical properties,
3. Trends in oxygen deficits in the hypolimnion of the reservoirs in the late summer season by the seasonal Kendall trend test method,
4. Nutrient limitation and trophic status indicators, and
5. Water-quality data in terms of Colorado water-quality standards.

Water quality was generally acceptable for primary uses throughout the Colorado–Big Thompson system over the site periods of record, which are all within the span of 1969 to 2000. Dissolved solids and nutrient concentrations were low and typical of a forested/mountainous/crystalline bedrock hydrologic setting. Most of the more toxic trace elements were rarely detected or were found in low concentrations, due at least in part to a relative lack of ore-mineral deposits within the drainage areas of the Colorado–Big Thompson Project.

Constituent concentrations consistently met water-quality standard thresholds set by the State of Colorado. Trophic-State Index Values indicated mesotrophic conditions generally prevailed at reservoirs, based on available Secchi depth, total phosphorus concentrations, and chlorophyll-*a* concentrations.

Based on plots of time-series values and concentrations and seasonal Kendall nonparametric trends testing, dissolved solids and most major ions are decreasing at most sites. Many of the nutrient data did not meet the minimum criteria for time-series testing; but for those that did, nutrient concentrations were generally stable (no statistical trend) or decreasing (ammonia plus organic nitrogen and total phosphorus). Iron and manganese concentrations were stable or decreasing at most sites that met testing criteria. Chlorophyll-*a* data were only collected for 11 years but generally indicated quasi-stable or downward temporal trends.

Introduction

The U.S. Geological Survey (USGS), in an ongoing cooperative monitoring program with the Northern Colorado Water Conservancy District (NCWCD), Bureau of Reclamation (BOR), and City of Fort Collins, has collected water-quality data in north-central Colorado since 1969 in reservoirs and conveyances such as canals and tunnels related to the Colorado–Big Thompson (CBT) Project, a water-storage, collection, and distribution system. The sampling sites are on reservoirs, canals, and tunnels in the headwaters of the Colorado River (on the western side of the transcontinental diversion operations) and the headwaters of the Big Thompson River (on the eastern side of the transcontinental diversion operations). Carter Lake and Horsetooth Reservoir are off-channel water-storage facilities, located in the foothills of the northern Colorado Front Range, for water supplied from the CBT Project (table 1, fig. 1). The length of water-quality record ranges from approximately 3 to 30 years depending on the site and the type of measurement or constituent. Sampling frequency, analytical methods, and minimum reporting limits have changed repeatedly over the period of record.

The CBT Project was authorized by Congress in 1937 and completed in 1956, resulting in the construction of several reservoirs, more than 120 miles of tunnels and canals, and numerous power-generation facilities. The USGS became involved in monitoring in the CBT Project area as part of a cooperative water-quality evaluation of the BOR Pick-Sloan Missouri Basin Program. When operation of the CBT Project was assumed by NCWCD, collection of baseline water-quality information continued. A report by Mueller (1990) summarized water-quality data available at the time, analyzed time-series trends, and evaluated the sampling network design for most of the sampling sites considered in this report and other sites on the eastern plains where the water is used for agricultural purposes.

Purpose and Scope

Part of the value of such a long-term monitoring record is the ability to test for temporal trends in water quality. Temporal trends in nutrients, major ions, trophic variables, and oxygen can indicate changes in water quality related to eutrophication. Ongoing changes in water use among agricultural and municipal users on the eastern slope of Colorado, changing land uses in reservoir watersheds, and other water-quality issues among NCWCD customers necessitated a reexamination of water-quality trends in CBT system reservoirs and related conveyances.

The overall objective of the project is to complete a retrospective analysis of reservoir profiles, nutrients, major ions, selected trace elements, chlorophyll-*a*, and hypolimnetic oxygen data from 1969 through 2000 in Lake Granby, Shadow Mountain Lake, and the Granby Pump Canal in Grand County, Colo., and Horsetooth Reservoir, Carter Lake, Lake Estes, east portal of the Alva B. Adams Tunnel (hereinafter "Adams Tunnel"), and Olympus Tunnel in Larimer County, Colo. Sampling sites in this report are in the headwater areas of the CBT Project where diversion and storage facilities are located. Areas downstream from Lake Granby on the western slope and water delivery areas downstream from Carter Lake and Horsetooth Reservoir are beyond the scope of this report.

Table 1. Water-quality sampling sites.

[15-digit U.S. Geological Survey (USGS) identification numbers are latitude and longitude of site location with a 2-digit code at the end; 8-digit identification numbers are USGS downstream order numbering]

Site number (fig. 1)	U.S. Geological Survey identification number	Site name	Number of samples	Period of record
1	09018500	Lake Granby near Granby, Colo. (near spillway)	154	1973–75, 1979–present
2	400844105530800	Lake Granby near Granby, Colo. (near dam in Rainbow Bay)	123	1989–present
3	09018300	Granby Pump Canal near Grand Lake, Colo.	179	1970–present
4	09014500	Shadow Mountain Lake near Grand Lake, Colo.	125	1989–present
5	09013000	Alva B. Adams Tunnel east portal, near Estes Park, Colo.	283	1970–present
6	402231105291900	Lake Estes near dam near Estes Park, Colo.	16	1998–present
7	06734900	Olympus Tunnel at Lake Estes, Colo.	247	1970–present
8	06742500	Carter Lake near Berthoud, Colo.	309	1970–present
9	06737500	Horsetooth Reservoir near Fort Collins, Colo. (Soldier Canyon Dam)	518	1969–present
10	403147105083800	Horsetooth Reservoir near Fort Collins, Colo. (Spring Canyon Dam)	100	1983–present
11	09010500	Colorado River below Baker Gulch near Grand Lake, Colo.	--	1953–present

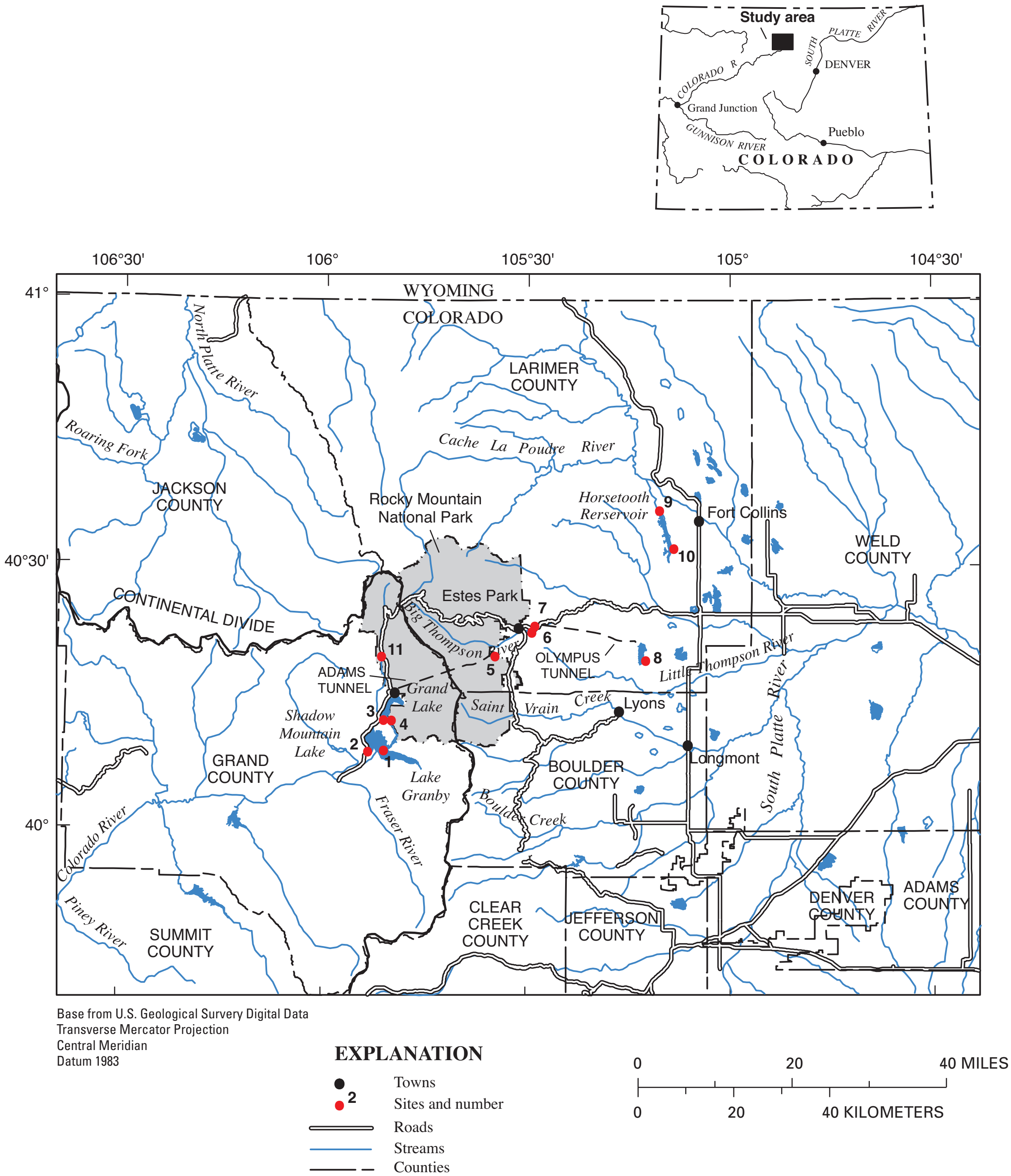

Figure 1. Location of study area and sampling sites (modified from Mueller, 1990).

This report summarizes water-quality and field-measurement profile data collected by the USGS and stored in the USGS National Water Information System; assesses time-series trends of selected chemical constituents and physical properties, trends in oxygen deficits in the hypolimnion of the reservoirs in the late summer season by the seasonal Kendall trend test method, and nutrient limitation and trophic status indicators; and evaluates water-quality data in terms of Colorado water-quality standards.

Previous Studies and Acknowledgments

A report by Mueller (1990) discussed trends determined by using the seasonal Kendall method; general water-quality analysis and sampling network evaluation were the primary focus of that report. Trend analysis at the Adams Tunnel east portal that is included in this report also was computed for selected chemical constituents in Middelburg (1993, p. 204). Jassby and Goldman (1999) studied water-quality and biological conditions in Horsetooth Reservoir and Carter Lake in 1998–99. Greve (1999) designed a water-quality monitoring network for the Big Thompson watershed in cooperation with the Big Thompson Watershed Forum, a watershed group within the study area. Johnson and Goettl (1999) studied food web changes for 14 years following the introduction of rainbow smelt into Horsetooth Reservoir.

The author thanks Don Carlson at the NCWCD and Gene Price and Jeff Lucero at the BOR for their assistance in bringing this report to fruition, and Dave Dzurovshin at the Colorado State Engineers Office for assistance in retrieving discharge data at some sites.

Description of Study Area

The study area involves parts of two mountainous watersheds. On the western side of the Continental Divide, several major tributaries in the headwaters of the Colorado River (North Fork Colorado River, North Inlet, East Inlet, and Arapaho Creek) are connected to parts of the western slope CBT reservoir system (Lake Granby, Shadow Mountain Lake, and Grand Lake) and, thus, are the primary sources of water diverted by the CBT Project (fig. 2). Other water sources include the Willow Creek Canal, which conveys water stored in Willow Creek Reservoir, and water pumped from Windy Gap Reservoir (built in 1985 by the Municipal Subdistrict of the NCWCD to use the unused capacity in CBT facilities), located on the Colorado River downstream from the confluence with the Fraser River. Storage on the western slope is primarily in Lake Granby (539,800 acre-ft total capacity). Water is pumped through the Farr Pumping Plant and the Granby Pump Canal into Shadow Mountain Lake. Shadow Mountain Lake and Grand Lake are similar (hydraulically connected) and relatively nonfluctuating. Their function is to convey project water into the Adams Tunnel, the largest transcontinental diversion in Colorado (average 230,000 acre-ft diverted annually).

On the eastern side of the Continental Divide, project water is conveyed through tunnels and eventually to Lake Estes, where it mixes with water from the Big Thompson River, a watershed with headwaters located primarily within Rocky Mountain National Park. The Olympus Tunnel then conveys water from Lake Estes to a series of tunnels and small reservoirs to Carter Lake or the Hansen Feeder Canal. The Hansen Feeder Canal can convey the water (and accept water diverted at the mouth of Big Thompson Canyon through the Dille Tunnel) to Horsetooth Reservoir.

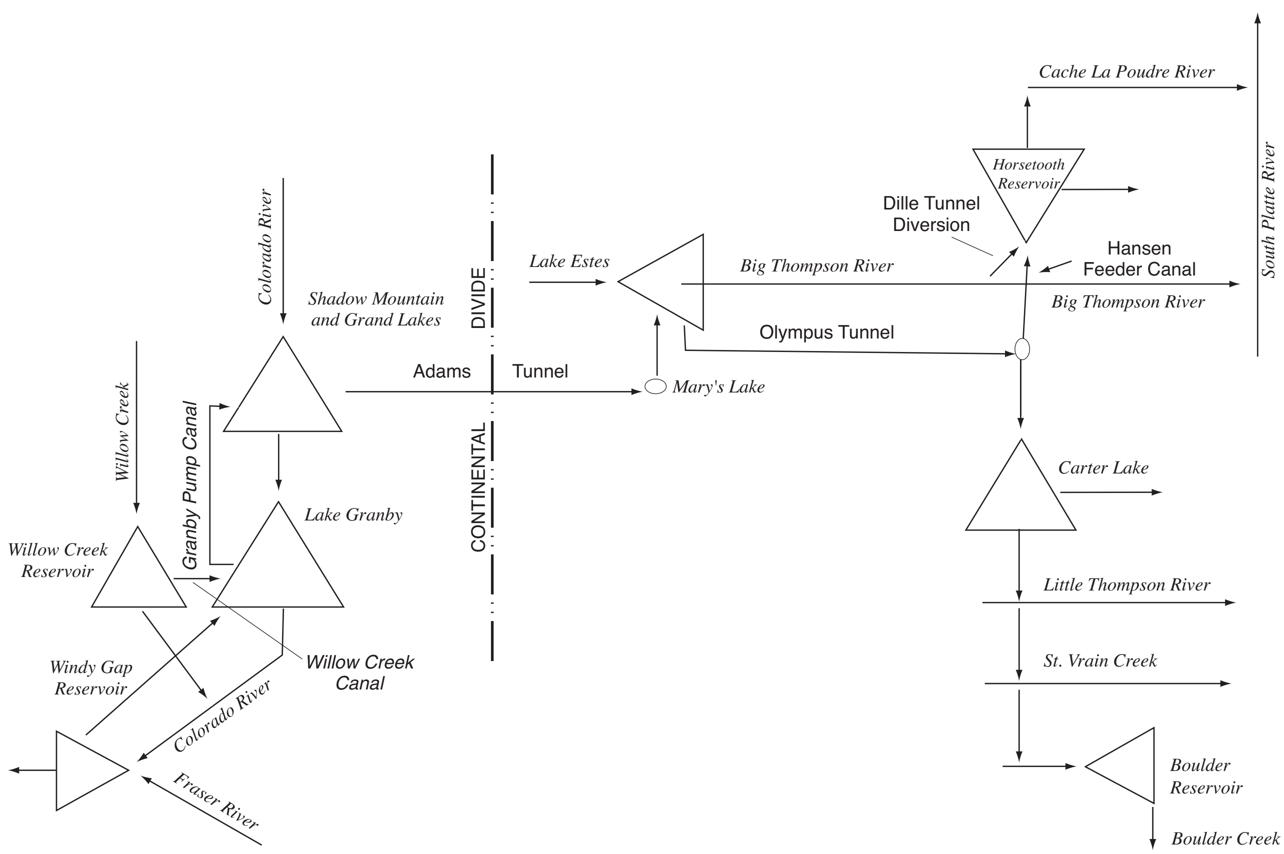

Figure 2. Schematic diagram of CBT Project facilities (from Mueller, 1990).

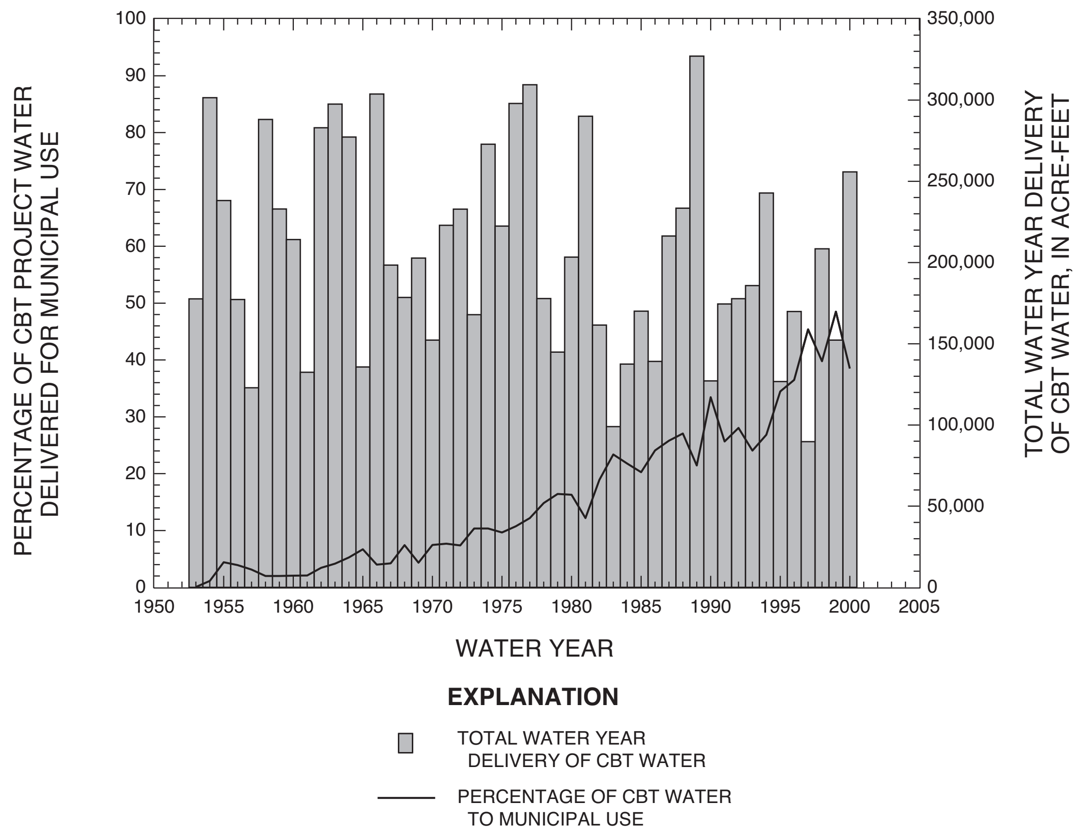

Figure 3. Percentage of Colorado–Big Thompson (CBT) water supplied for municipal use.

Carter Lake (112,230 acre-ft total capacity) and Horsetooth Reservoir (156,735 acre-ft total capacity) are the primary storage facilities on the eastern slope and were constructed by damming valleys of intermittent drainages along the Front Range. Project water is then conveyed to water users by way of streams, canals, and pipelines within the NCWCD boundaries to Boulder Creek, Saint Vrain Creek, Big Thompson River, Cache La Poudre River, and the main-stem South Platte River. Drinking water is supplied to 30 Front Range cities and towns, and water for supplemental irrigation is provided to more than 600,000 acres of agricultural land. Project water was initially used primarily for agriculture, but municipal uses have increased in recent years (fig. 3).

Primary land uses within the parts of the watersheds where CBT project water is diverted and stored are undeveloped forest and rangelands under the management of the U.S. Department of Agriculture Forest Service and National Park Service (figs. 4 and 5). The facilities on the western slope and those near Estes Park are located in mountainous terrain (greater than 6,000-ft elevation) covered in coniferous forest, underlain by mostly crystalline bedrock. Annual precipitation is in the range of 16 to more than 40 inches per year (Colorado Climate Center, 1984). Horsetooth Reservoir and Carter Lake are located in more arid foothills on the edge of the mountain front, are surrounded by grass/shrublands, and are underlain by sedimentary rock (fig. 6). While one of the primary uses of water resources is recreation, there are two developed urban areas that could affect the water quality within the study area: Grand Lake and Estes Park. Grand Lake is a town of approximately 250 people, on the shores of Grand Lake. Similar, though less dense, residential development is present along the shores of Shadow Mountain and Granby Lakes (fig. 4). Before 1982, individual sewage disposal systems (ISDS) were used for sanitation. Due to increasing water-quality concerns, a municipal sanitation system that pumps waste downstream from Lake Granby for treatment was completed in 1982.

The town of Estes Park is located around Lake Estes and has a population of approximately 3,000 (fig. 5). Less dense development is located along the Big Thompson Canyon from Estes Park to the mouth of the canyon west of Loveland. Water quality is potentially affected by treated sewage effluent from Estes Park discharged into the Big Thompson River upstream from Lake Estes. Smaller sewage-treatment facilities and ISDS's located along the Big Thompson River downstream from Lake Estes could affect the quality of water diverted to Horsetooth Reservoir through the Dille Tunnel (located just upstream from the mouth of Big Thompson Canyon) and Hansen Feeder Canal. Development around Carter Lake is minimal, but residential development around Horsetooth Reservoir could affect water quality (fig. 6).

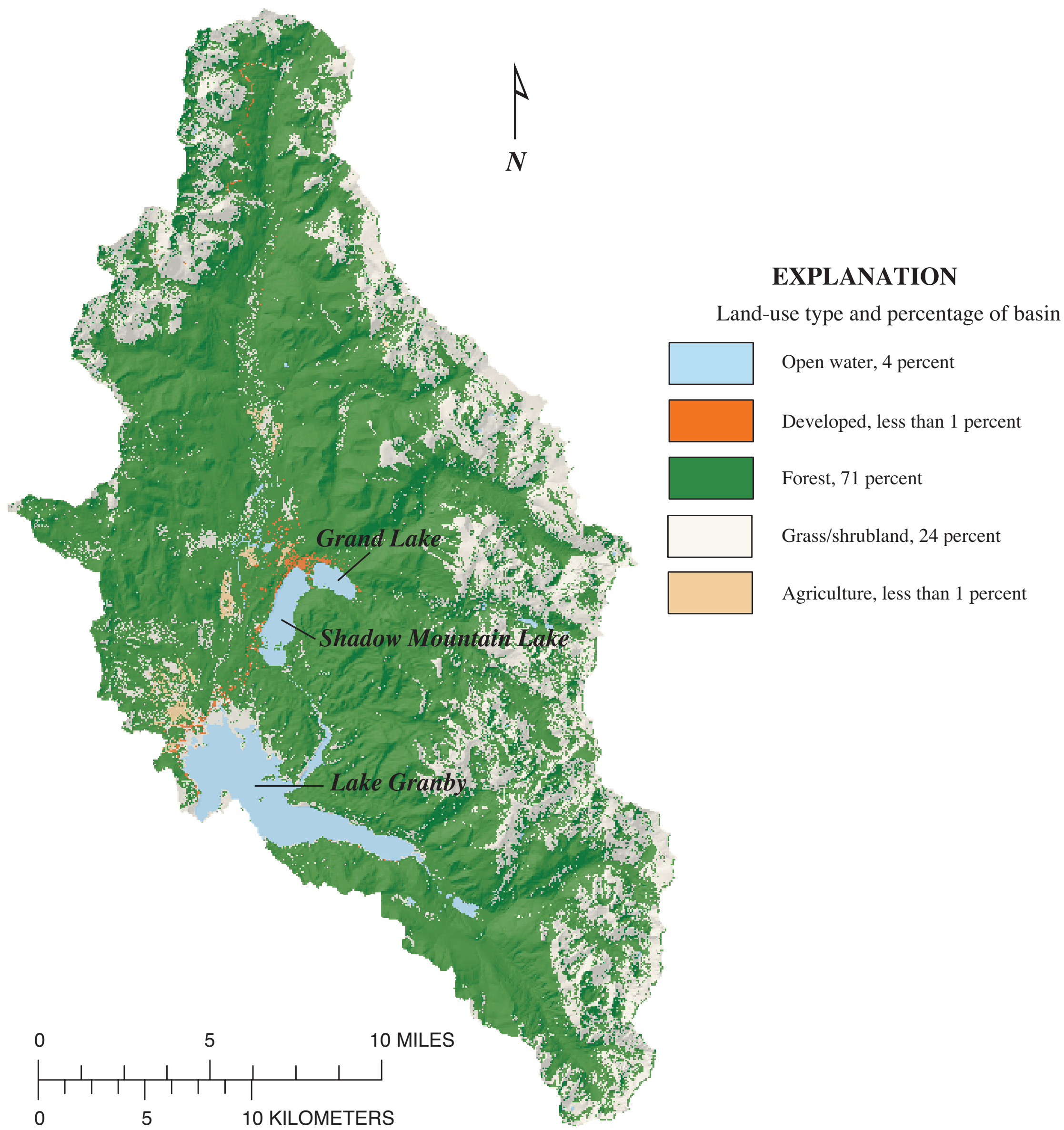

Figure 4. Land uses in watershed upstream from Lake Granby.

Hydrology

The study area, because of its location in high mountains, derives annual streamflow primarily from snowmelt during May through July as shown in the streamflow statistics for the period of record at the Colorado River below Baker Gulch stream gage (fig. 7). The watershed area upstream from Lake Granby outlet is about 310 square miles. The watershed area upstream from the mouth of Big Thompson Canyon is about 306 square miles. The high-elevation areas of these catchments receive large amounts of snow from September to May. Maximum snowpack accumulation generally occurs about the beginning of May and is mostly melted by about mid-June when daily streamflow runoff peaks. Daily fluctuations in streamflow, which can substantially affect stream-water quality by influencing dilution and particle transport, may be largely due to diurnal variations in air temperatures, affecting snowmelt.

Operation of reservoirs and conveyances can affect seasonal water quality, streamflow, and limnological characteristics of storage reservoirs. Some streamflow and reservoir data were available from USGS sources, but most was obtained from either NCWCD or the Colorado State Engineers Office. Seasonal and annual operational characteristics of selected conveyances and reservoirs are shown in figure 8. Release and storage patterns are relatively similar over the period of record

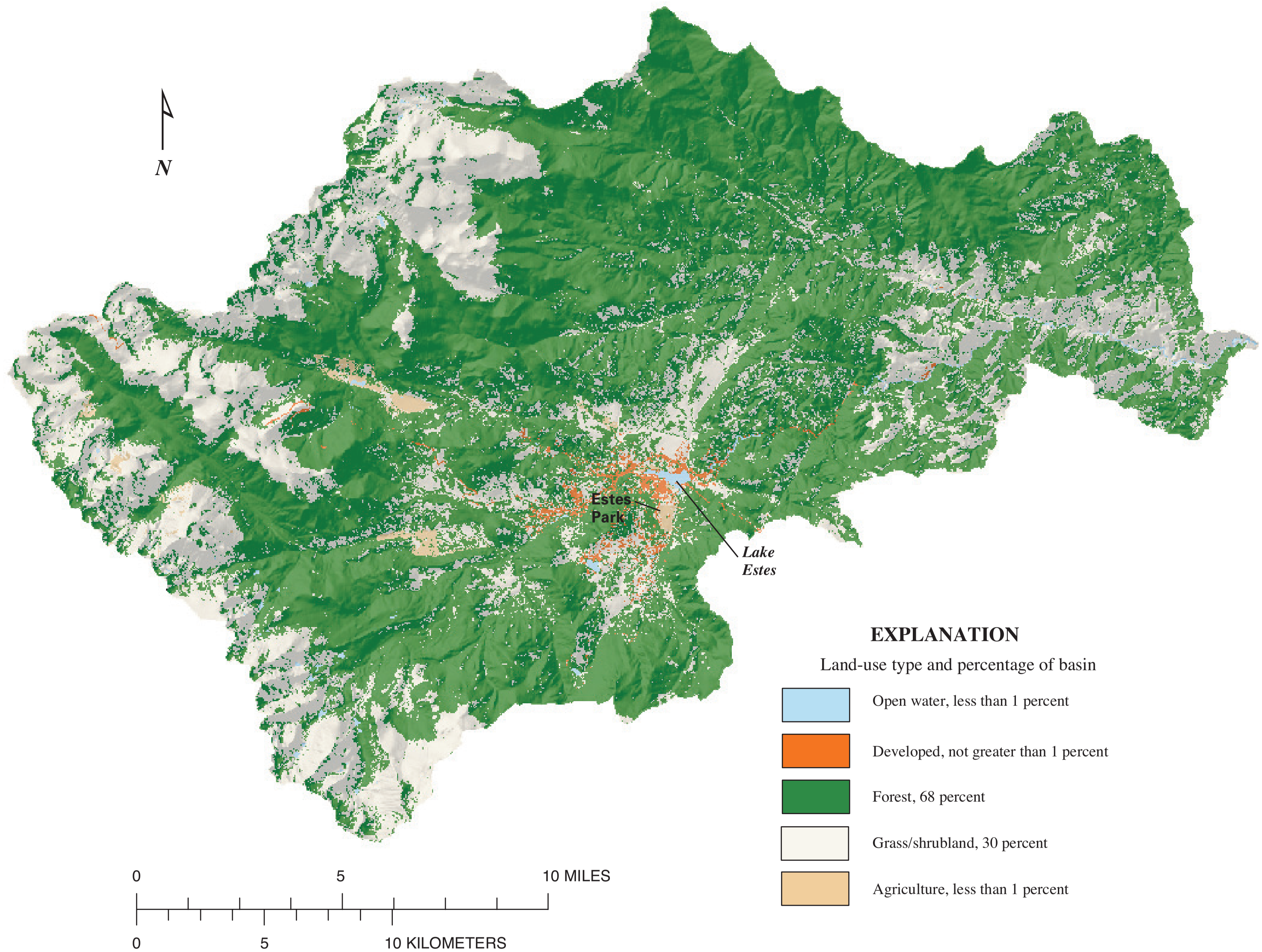

Figure 5. Land uses in watershed upstream from the mouth of Big Thompson Canyon.

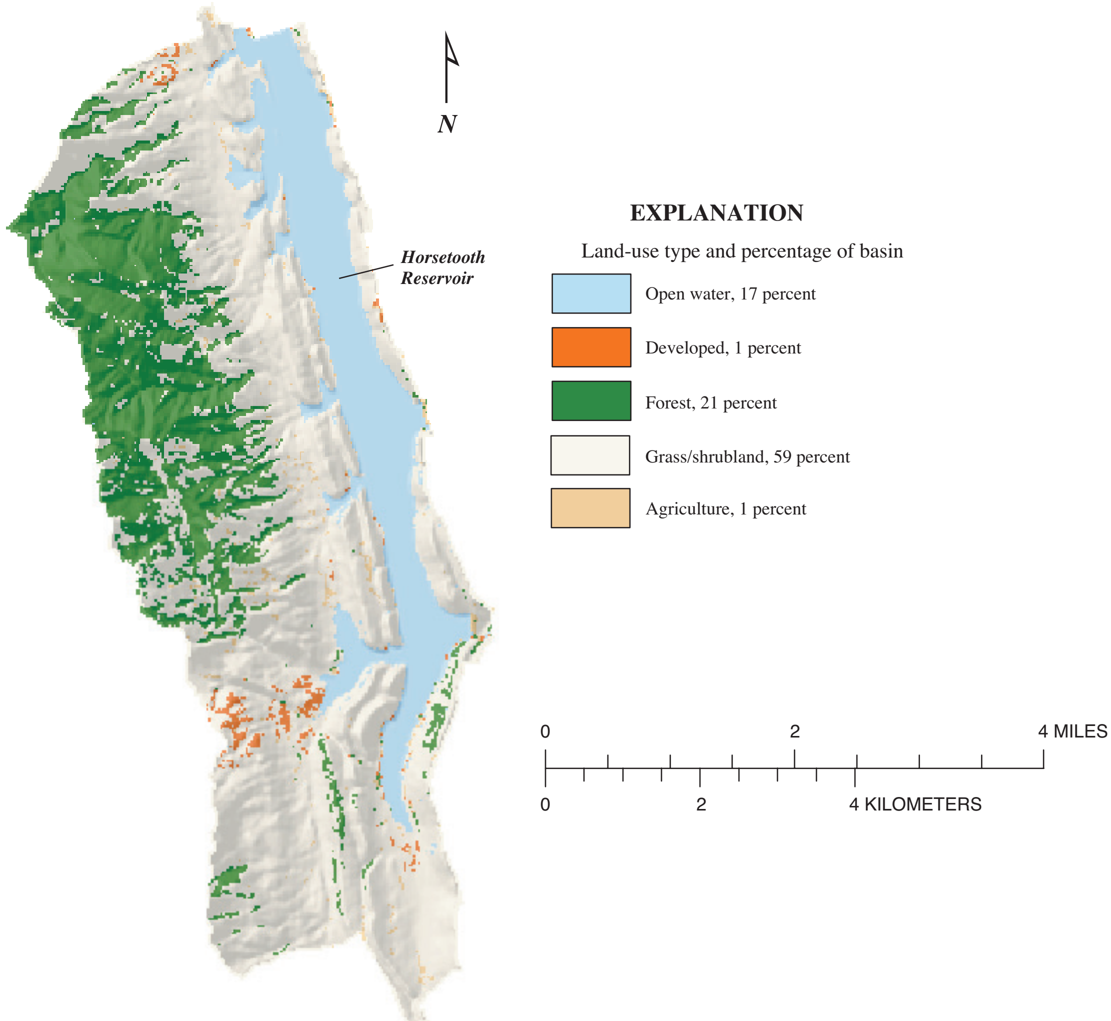

Figure 6. Land uses in watershed draining directly to Horsetooth Reservoir.

on a year-to-year basis at Shadow Mountain Lake, Horsetooth Reservoir, and Carter Lake (fig. 9). The contents of Shadow Mountain Lake, and consequently Grand Lake, vary little because the reservoir is controlled to minimize fluctuations in water-surface elevation. Multiyear patterns of storage can be seen in plots of contents for Lake Granby. Storage accumulated in wet years can persist for several years. Similarly, when depleted, Lake Granby can take several years to refill. The effects of drought years such as 1977 can be seen clearly in plots of reservoir contents for Lake Granby and Horsetooth Reservoir.

Seasonal flow patterns among the conveyances are evident in the plots. Highest flow rates occur at the Willow Creek Canal and the Windy Gap pipeline during snowmelt season (fig. 10). Flow rates are highest in Granby Pump Canal, Adams Tunnel, and Carter Lake inflow during the winter months. Hansen Feeder Canal conveys flow mostly in winter and summer and generally maintains lower rates of flow in early spring and fall. On average, Lake Granby reaches maximum elevation in July of each year, falling steadily through summer and winter until April, when storage of the next snowmelt begins (fig. 11). Storage in Horsetooth Reservoir is somewhat different from Lake Granby in that average storage in Horsetooth increases from November through May or June and is then depleted during the summer season. In Carter Lake, storage increases from about October through April.

Water Quality

In this report, water quality will be described in two general categories: chemical characteristics and limnology. The discussion of chemical characteristics will present summary statistics, boxplots of chemical constituents, and descriptions of general water-quality conditions at the sampling sites. The number of samples may differ from boxplot to summary statistics because of the automated nature of the summary statistics/database and the use of estimated values in the

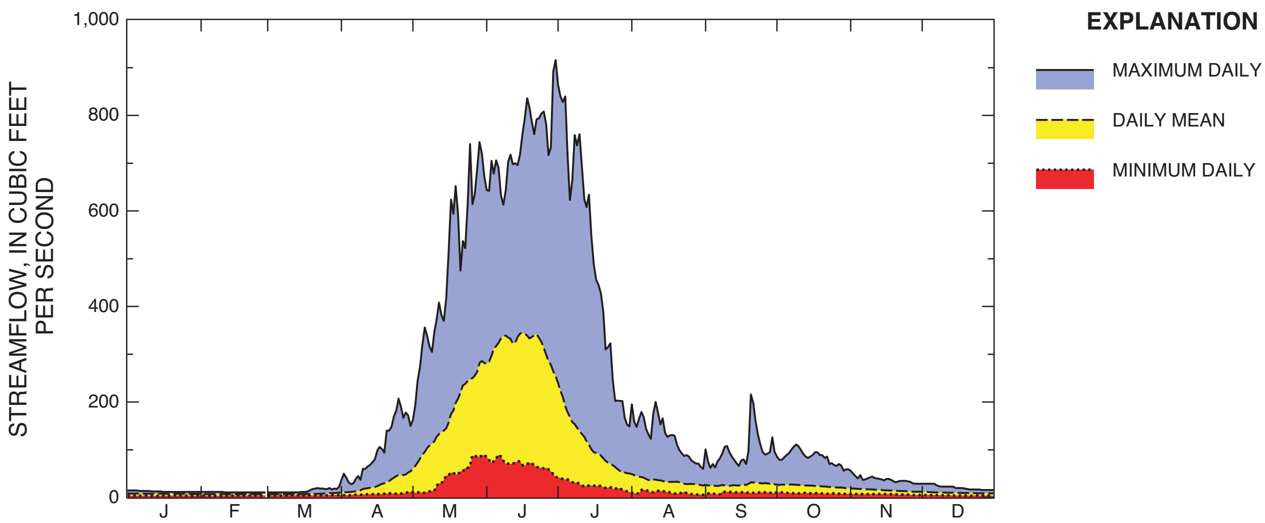

Figure 7. Maximum, mean, and minimum daily streamflows for the period of record (1953 to 2000) at Colorado River below Baker Gulch (09010500).

boxplots. The discussion of limnology will present reservoir field-measurement profiles, hypolimnetic oxygen dynamics, trophic indicators, and nutrient limitation at reservoir sites.

Chemical Characteristics

The types of water-quality data collected at most sites that are part of the scope of this report include field measurements (water temperature, specific conductance, pH, and dissolved oxygen), major ions (calcium, magnesium, sodium, potassium, acid-neutralizing capacity or alkalinity, sulfate, chloride, fluoride), nutrients (ammonia plus organic nitrogen, ammonia, nitrite, nitrite plus nitrate, total phosphorus, dissolved phosphorus, orthophosphorus), and selected trace elements (iron, manganese, barium, strontium, and zinc). Summary statistics were compiled for the 10 sites in this study and are listed in tables 4 to 20 in the "Hydrologic Data" section (appendices at back of this report).

Surface and near-bottom sampling from each reservoir included field-measurement profiles. Some reservoir sites during the 1970's had only a surface sample collected or an additional intermediate depth sample collected in addition to the surface and near-bottom samples. Sampling frequency has not remained constant throughout the history of the program. The frequency history described here includes only the sites considered for this report. Other discontinued sampling sites on Carter Lake and Horsetooth Reservoir are not described in this report but are described in Mueller (1990).

Lake Granby (site 1, fig. 1) near the dam was sampled quarterly at the surface from 1973 to 1975. During 1979 to 1988, annual samples were collected from the surface and near bottom. From 1989 to 1990, samples were collected at surface and bottom, three times during the growing season (May to October). From 1991 to 1997, samples were collected approximately monthly from May to October. In 1998, sampling frequency decreased to four times per year during the growing season. Sampling at Lake Granby (site 2) in Rainbow Bay was started in 1989 and followed a schedule of one per month during May to September until 2000. Sampling at Granby Pump Canal (site 3) was approximately bimonthly on average from 1970 to 2000. The exact months sampled varied because samples were not collected in a particular month if there was no flow at the time of the visit. Sampling at Shadow Mountain Lake (site 4) began consistently in 1989 at a frequency of three per year during the growing season, increased to six per year from 1991 to 1997, and decreased to four per year from 1998 to 2000. Sampling at the Adams Tunnel East Portal (site 5) began in 1970 at a monthly frequency until 1988, when the bimonthly schedule that continued through 2000 was implemented. Sampling at Lake Estes (site 6) was begun in 1998 at a frequency of two per year, with samples collected at the surface and near the bottom in May and August. Monthly sampling at Olympus Tunnel (site 7) began in the fall of 1970 until 1986. By 1989, frequency had dropped to three samples per year, one each in spring, summer, and fall, and continued at the same frequency until 2000. Sampling at Carter Lake Reservoir (site 8) began in 1970 at a frequency of 9 or 10 per year, April to November until 1979. By 1983, sampling frequency was reduced to three per year during the spring through fall and continued to 2000. Sampling at Horsetooth Reservoir (Soldier Canyon Dam) (site 9) began in 1969, and samples were collected at surface, bottom, and an intermediate depth from April to October or November until 1978. By 1982, frequency was down to one surface and one near-bottom sample in spring, summer, and fall. Sample collection began at the Spring Canyon Dam (site 10) on Horsetooth in 1983 at a frequency of three per year, surface and near bottom.

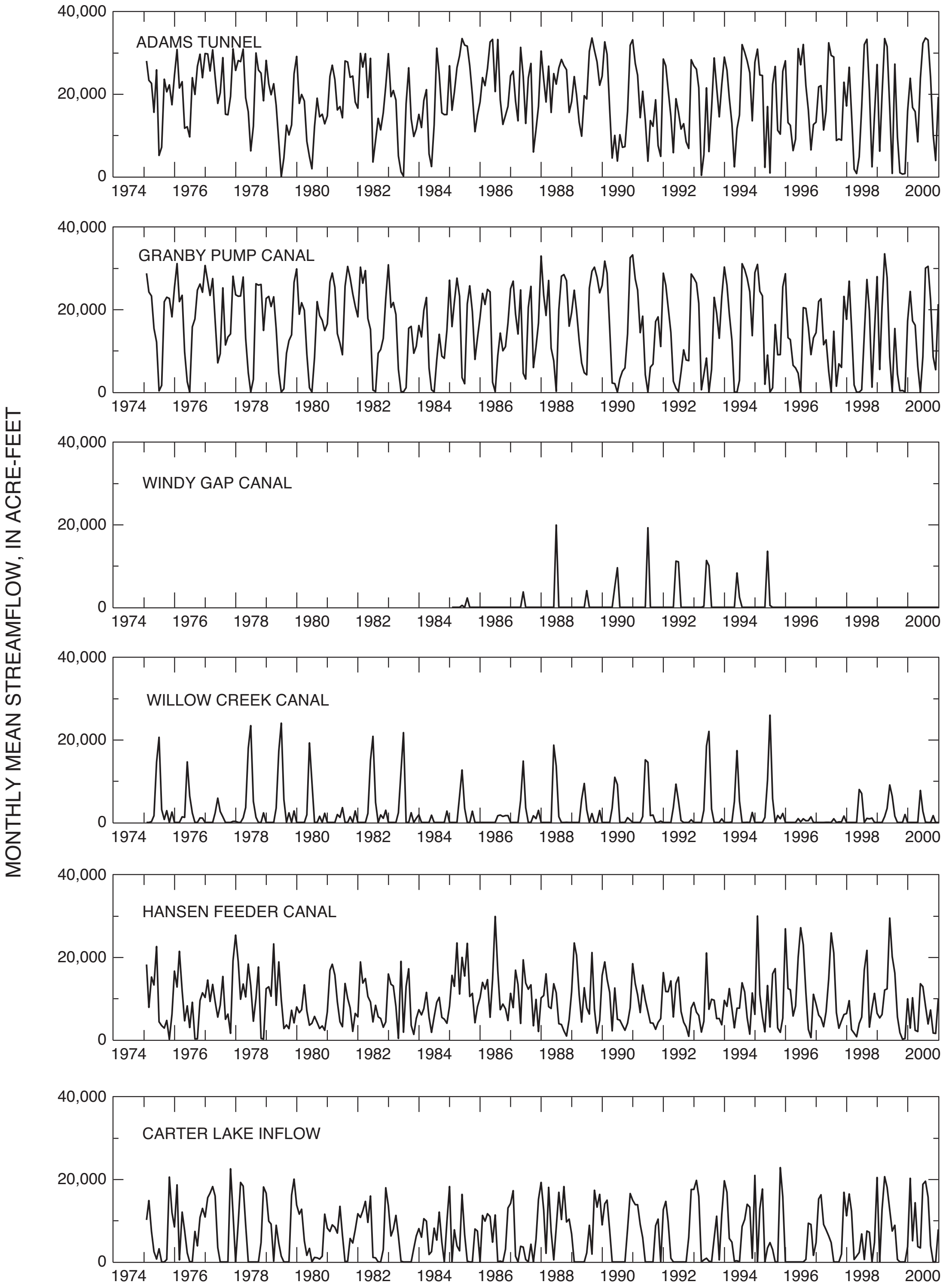

Figure 8. Time-series plots of operation of selected Colorado–Big Thompson conveyances.

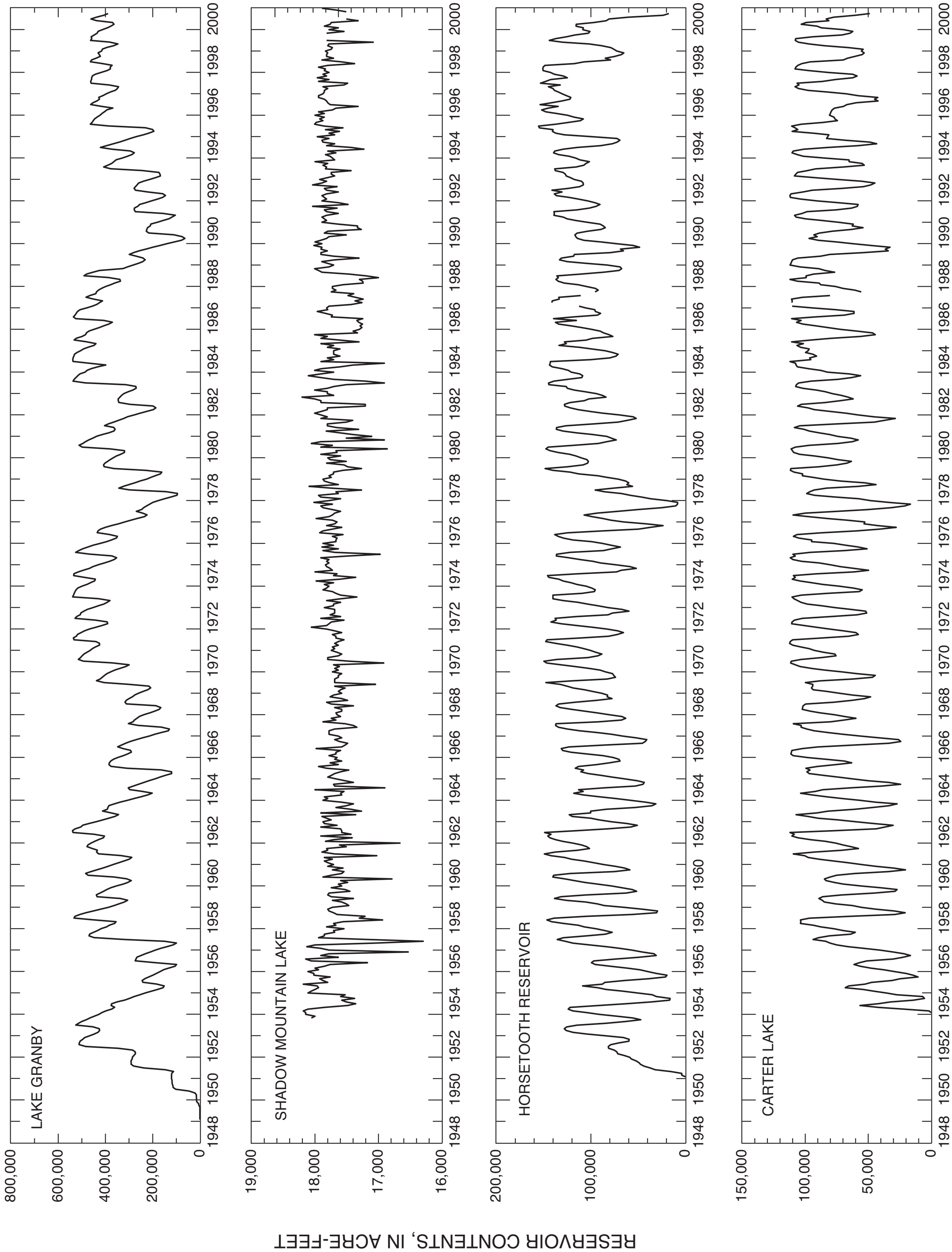

Figure 9. Time-series plots of operation of selected Colorado–Big Thompson reservoirs.

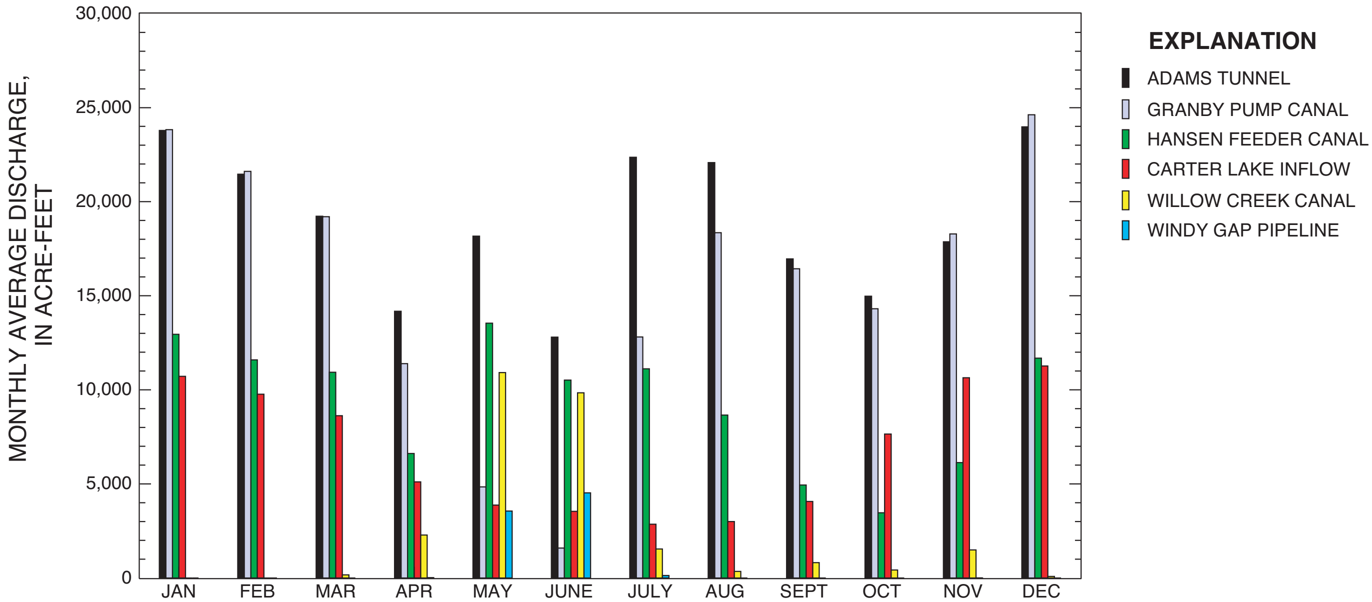

Figure 10. Monthly average discharge characteristics of selected Colorado–Big Thompson conveyances.

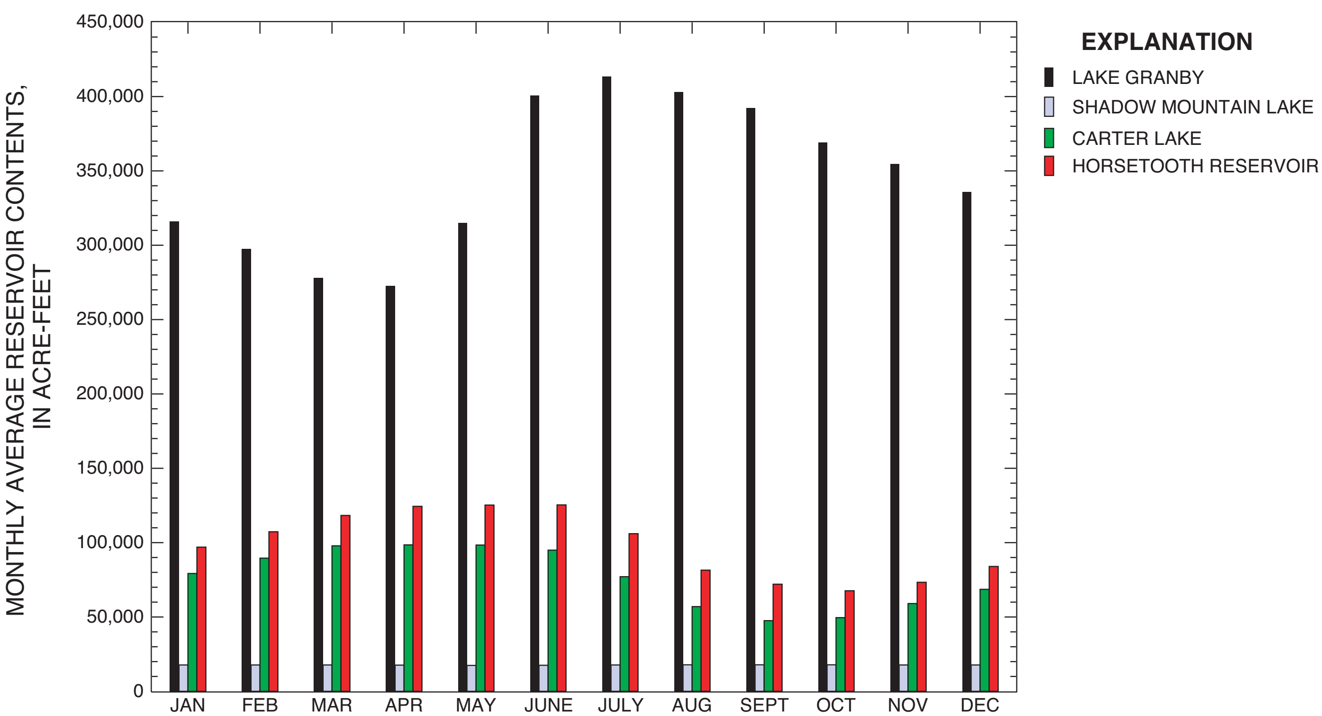

Figure 11. Monthly average reservoir contents of selected Colorado–Big Thompson reservoirs.

Field Measurements and Major-Ion Concentrations

In snowmelt-dominated mountain streams, one of the primary processes controlling specific-conductance and major-ion concentrations is dilution; minimum values of specific conductance occur during peak snowmelt discharge and maximum values occur during winter low-flow conditions (Stevens, 2001; Clark and others, 2000). Daily fluctuations of specific conductance in streams not affected by reservoirs also reflect dilution by the daily diurnal fluctuation of flow during high snowmelt (Stevens, 2001). In reservoirs and conveyances that move water from reservoirs, these fluctuations are tempered by mixing that occurs during storage. Thus, concentrations are smoothed substantially in a reservoir like Lake Granby that can potentially store multiple years of runoff.

Water at CBT sampling sites was dilute and typical of high-elevation snowmelt runoff (fig. 12). Median concentrations of specific conductance at sites on the western slope (such as Lake Granby and Shadow Mountain Lake) and the high-elevation sites on the eastern slope (such as Adams Tunnel, Lake Estes, and Olympus Tunnel) were generally below 60 microsiemens per centimeter at 25 degrees Celsius (μS/cm). These sites are indicative of a hydrologic setting that is typical of snowmelt-source water—low rates of evapotranspiration (ET) and crystalline bedrock geology. Specific conductance at sites at Carter Lake and Horsetooth Reservoir were generally greater than 70 μS/cm. These sites possibly show the cumulative effects of development and ET from the rest of the storage and conveyance system. These sites are at lower elevations (higher ET) in areas of sedimentary rocks that can increase dissolved-solids content. Even so, all water sampled in this system should be considered to be high quality because of its low dissolved-solids content.

Water temperature varied seasonally, with reservoir sites developing strong stratification patterns. The pH at CBT sites was generally in a neutral range of 7 to 8. Dissolved oxygen was generally in the range of 6 to 10 mg/L except in the hypolimnetic water of the reservoirs, where seasonal stratification sometimes produced dissolved-oxygen concentrations approaching 2 mg/L or less.

Major-ion composition of selected waters was plotted on a Piper diagram (fig. 13) to determine if the composition of water is changing as it moves from one part of the system to another. Adams Tunnel east portal was chosen because it represents the composition of water that is diverted from the western slope and reflects any urban influences present on the west side of the Continental Divide. Olympus Tunnel represents water with urban influences from Estes Park. Horsetooth Reservoir represents water with urban influences around the reservoir and sedimentary substrate, and any influences of wastewater treatment, septic tanks, and highway runoff in water diverted from the Dille Tunnel near the mouth of Big Thompson Canyon. Cation compositions in water from all three sites are somewhat mixed calcium-magnesium-sodium, but calcium is predominant (fig. 13). Anion compositions are primarily bicarbonate. Adams and Olympus Tunnel water had the most variability, with some samples containing relatively less bicarbonate and more sulfate. Horsetooth Reservoir composition was less variable but is mostly within the range of water sampled from the tunnels. Despite having larger concentration of dissolved solids, Horsetooth Reservoir water seemed to be a more concentrated version of the tunnel water.

Nutrients

Compounds of nitrogen and phosphorus are referred to as "nutrients" because they are the major building blocks of plant growth. In excess quantities, nutrients can promote nuisance algae growth in streams and reservoirs. Natural sources of nutrients include precipitation and biochemical processes in the watershed. Possible anthropogenic sources of nutrients in the CBT system include the following:

1. *Urban runoff*.—Associated with developed areas and roads, storm runoff may have higher nutrient concentrations and, as road runoff, may bypass natural removal processes in soil by rapid delivery to a receiving stream or reservoir;
2. *Sewage effluent*.—Septic-tank effluent can move with ground water into surface-water systems. Rural areas are often developed beyond the practical extent of municipal sewer lines, necessitating the use of septic leach fields. Although the town of Grand Lake has installed a sewer system (Three Lakes Sanitation District), not all residences within the watershed are connected to it. Estes Park effluent is treated (Estes Park Sanitation District and Upper Thompson Sanitation District) and returned to the Big Thompson River. Other scattered development in the Big Thompson watershed is not connected to municipal sewer systems; and
3. Erosion of soil and plant materials exposed near roads or streams can cause loading of organic nitrogen and particulate phosphorus when transported to a stream.

Nutrient concentrations at CBT sites generally were low (fig. 12). Data censoring levels changed many times throughout the study, and data analyses at times were of insufficient precision to fully characterize concentration. Median concentrations of ammonia plus organic nitrogen were less than 0.3 mg/L at all sites. Median concentrations of dissolved nitrite plus nitrate concentrations were generally less than 0.2 mg/L, and median concentrations of total phosphorus were less than 0.05 mg/L at all sites. Concentrations of nitrite and orthophosphorus were rarely reported. The largest concentrations of nutrients tended to be at Carter Lake and Horsetooth Reservoir. The smallest concentrations were generally measured at Lake Granby and Shadow Mountain Lake. Bottom samples tended to have larger concentrations of most nutrients than surface samples at the same site.

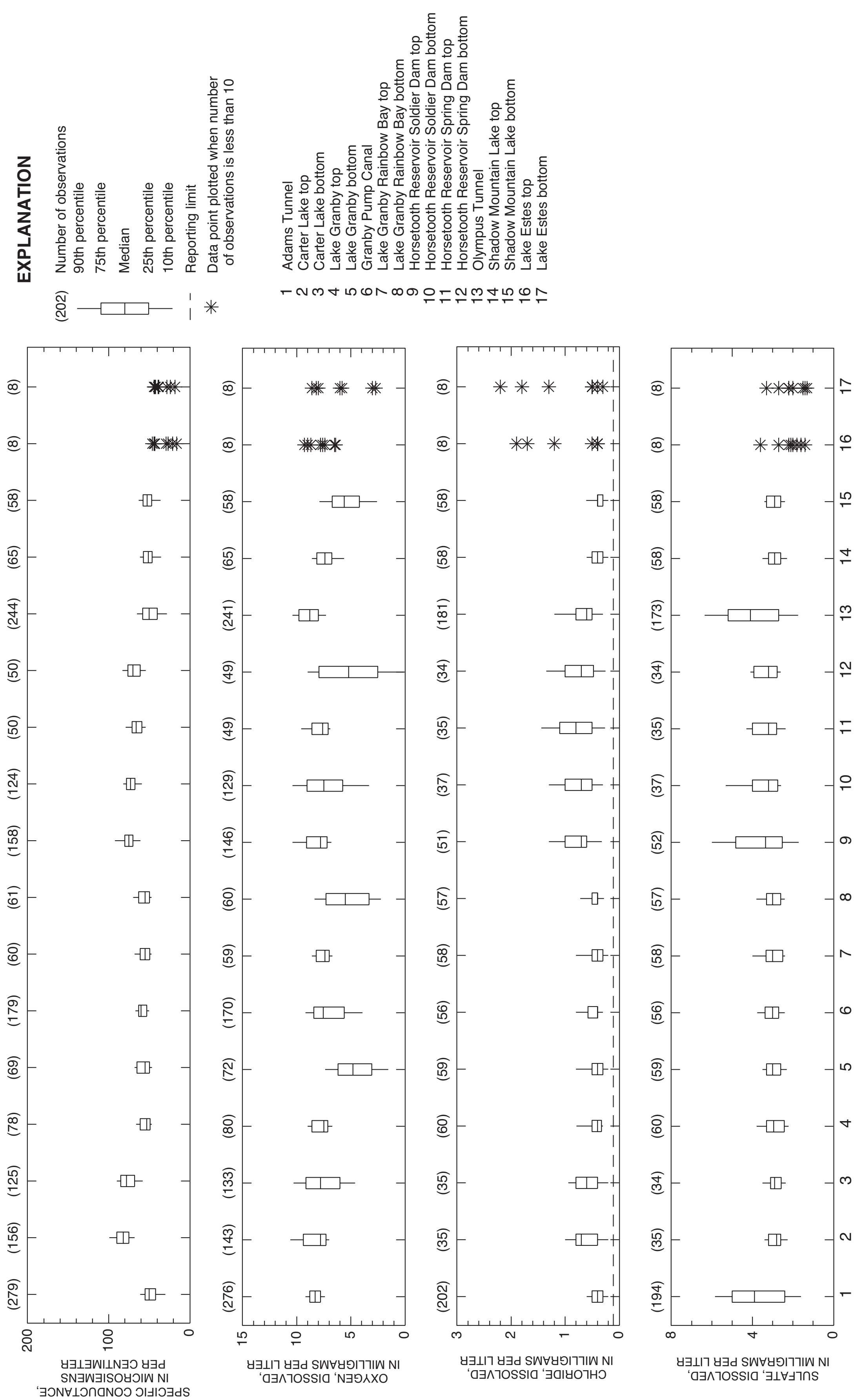

Figure 12. Boxplots of selected water-quality constituents.

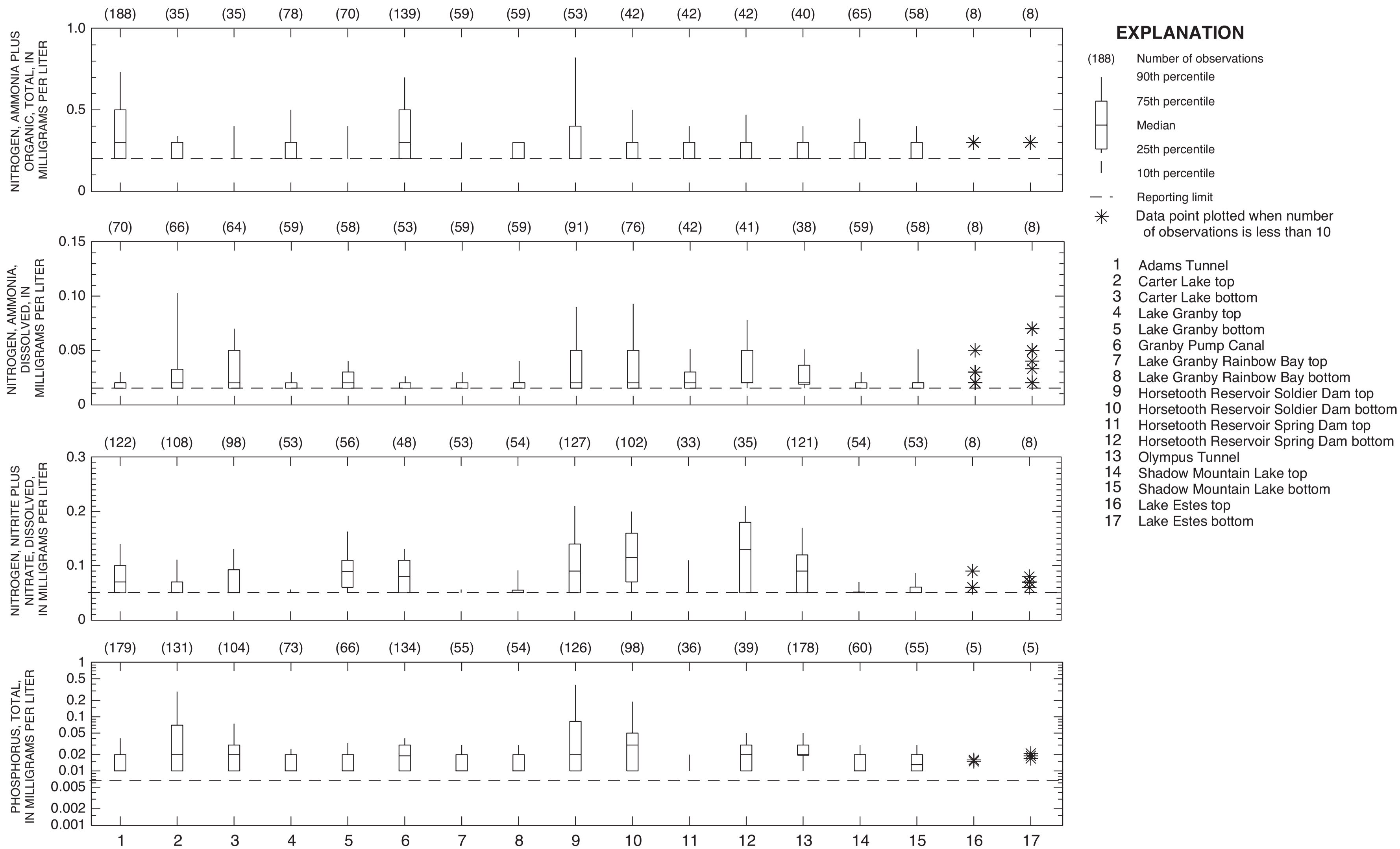

Figure 12. Boxplots of selected water-quality constituents.—Continued

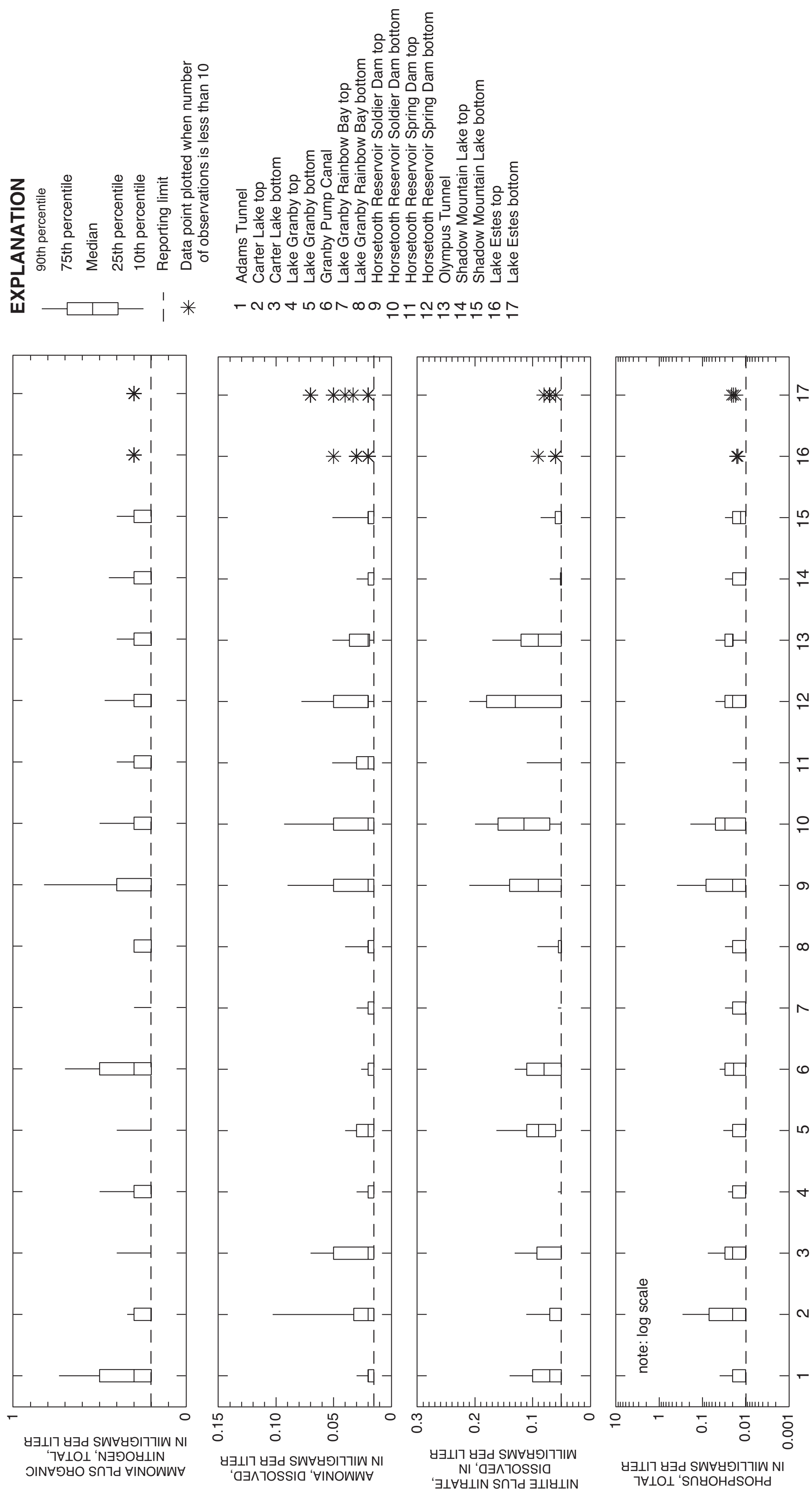

Figure 12. Boxplots of selected water-quality constituents.—Continued

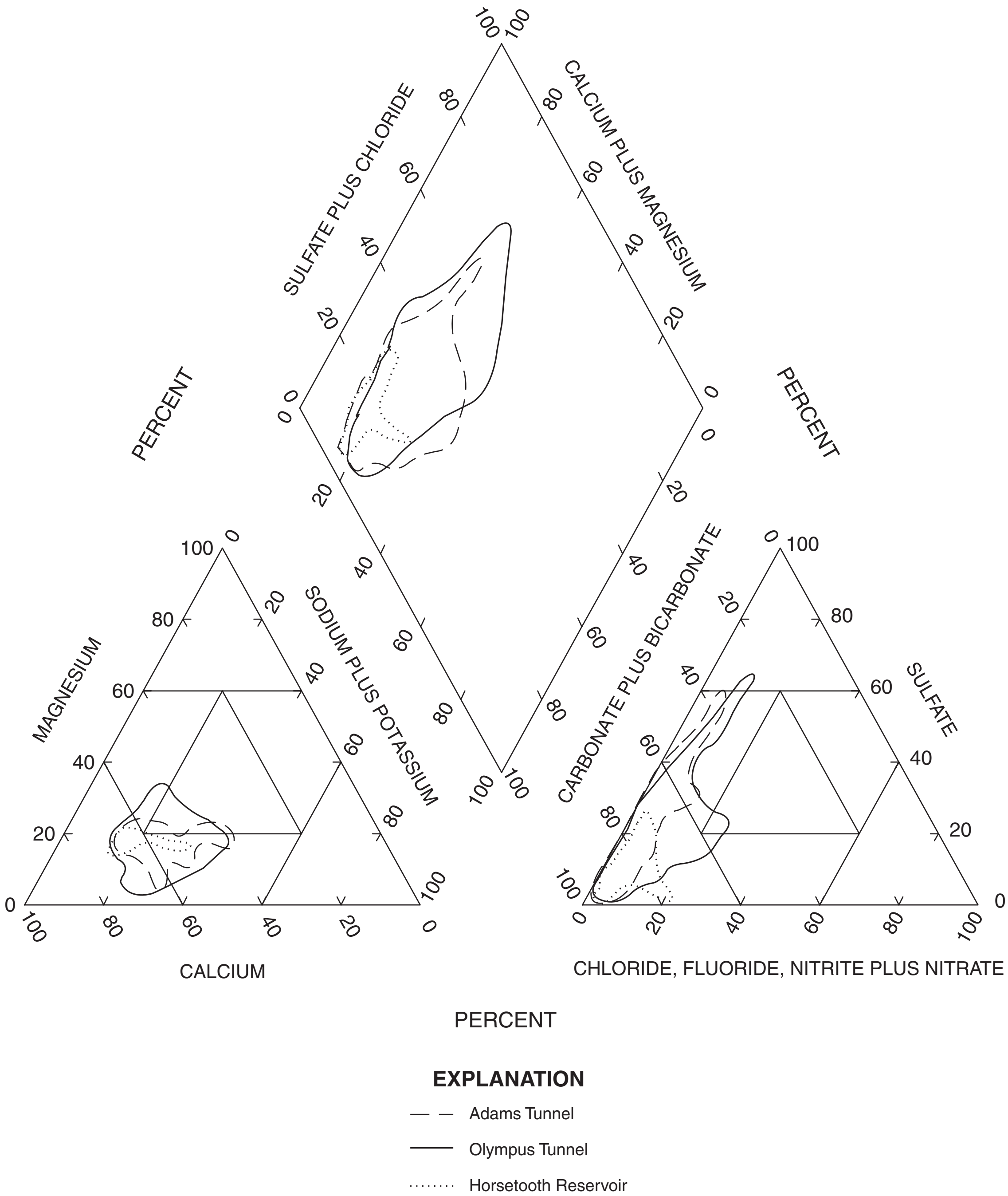

Figure 13. Piper diagram showing major-ion composition of samples at selected sites.

Trace Elements

Trace elements, for the purpose of this report, are metal and transition metal elements commonly found in small (less than 1 milligram per liter) concentrations. Analytes commonly detected at most sites in this study included barium, iron, manganese, strontium, and zinc. Most samples also were analyzed for barium, beryllium, boron, cadmium, chromium, cobalt, copper, lead, lithium, molybdenum, nickel, silver, and vanadium. Trace elements are important indicators of water quality because, in large concentrations, they are toxic to aquatic life; a large proportion of Colorado's regulated constituents are trace elements (Colorado Department of Public Health and Environment, Water Quality Control Commission, 2001).

Concentrations of common dissolved trace elements (such as iron and manganese) were commonly above Minimum Reporting Limits (MRL's) but usually less than 1 milligram per liter (fig. 12). Others, such as beryllium, chromium, cobalt, lithium, molybdenum, nickel, silver, and vanadium, were almost never reported. Zinc, lead, cadmium,

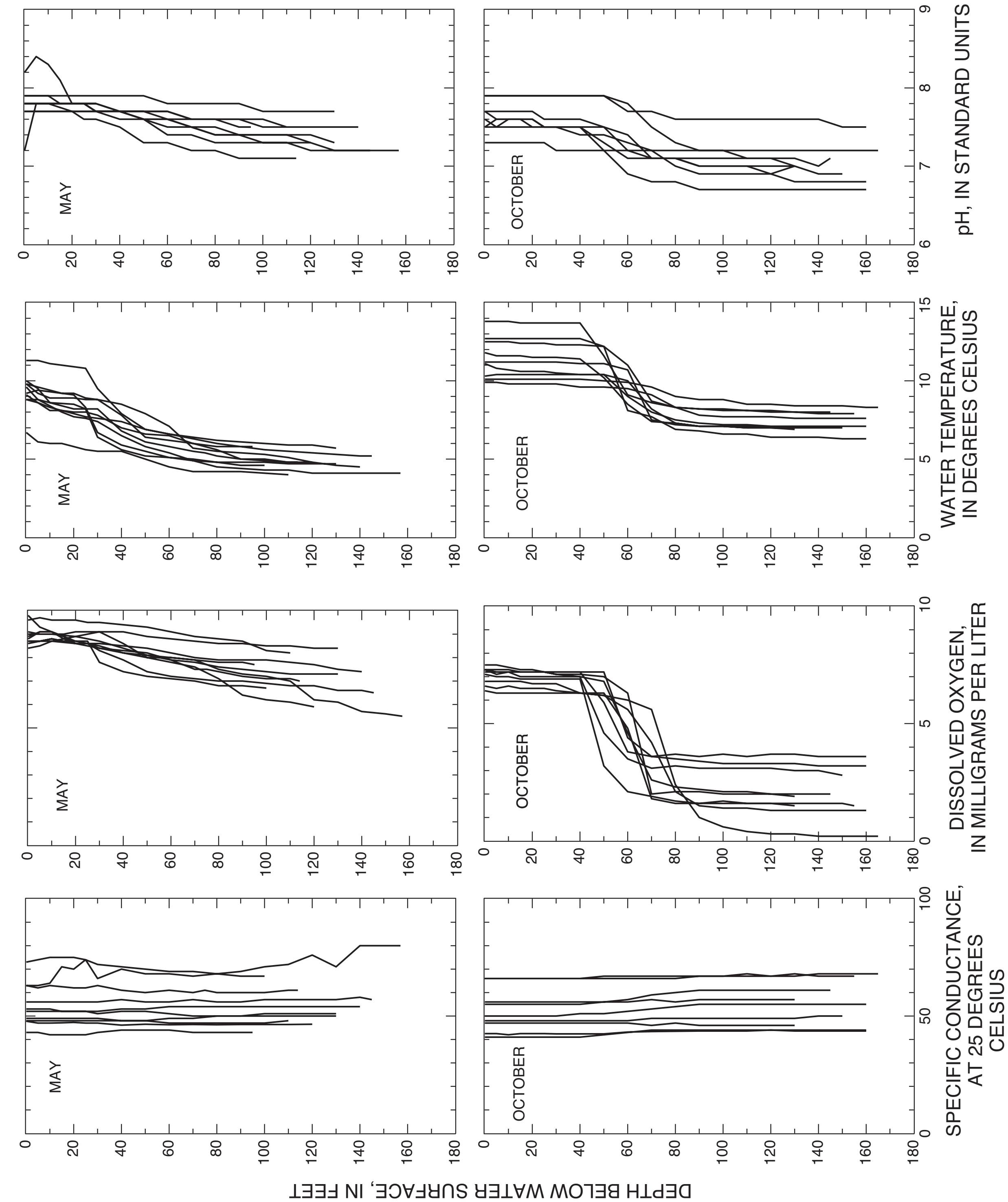

Figure 14. May and October field-measurement profiles at Lake Granby (dam).

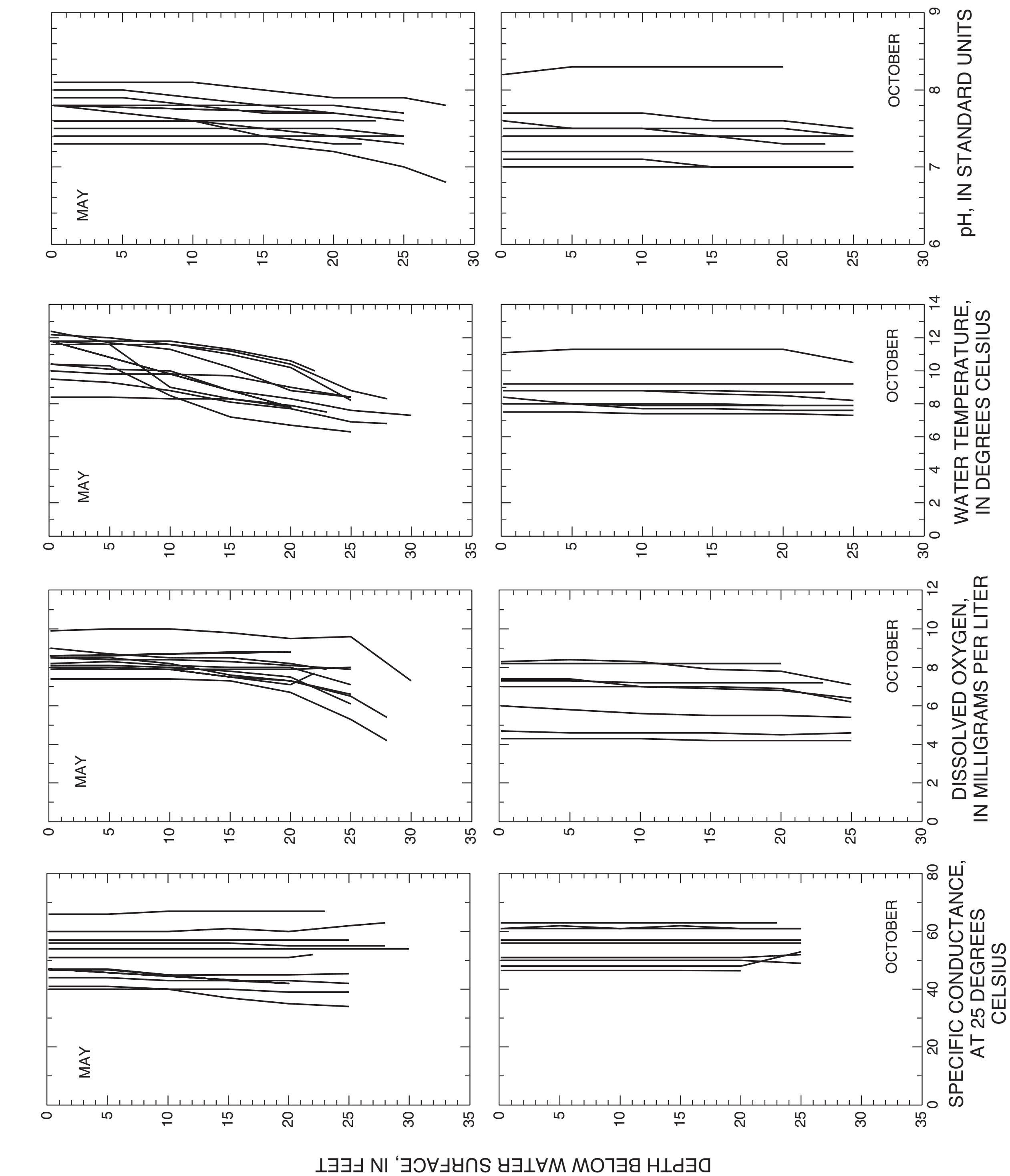

Figure 15. May and October field-measurement profiles at Shadow Mountain Lake.

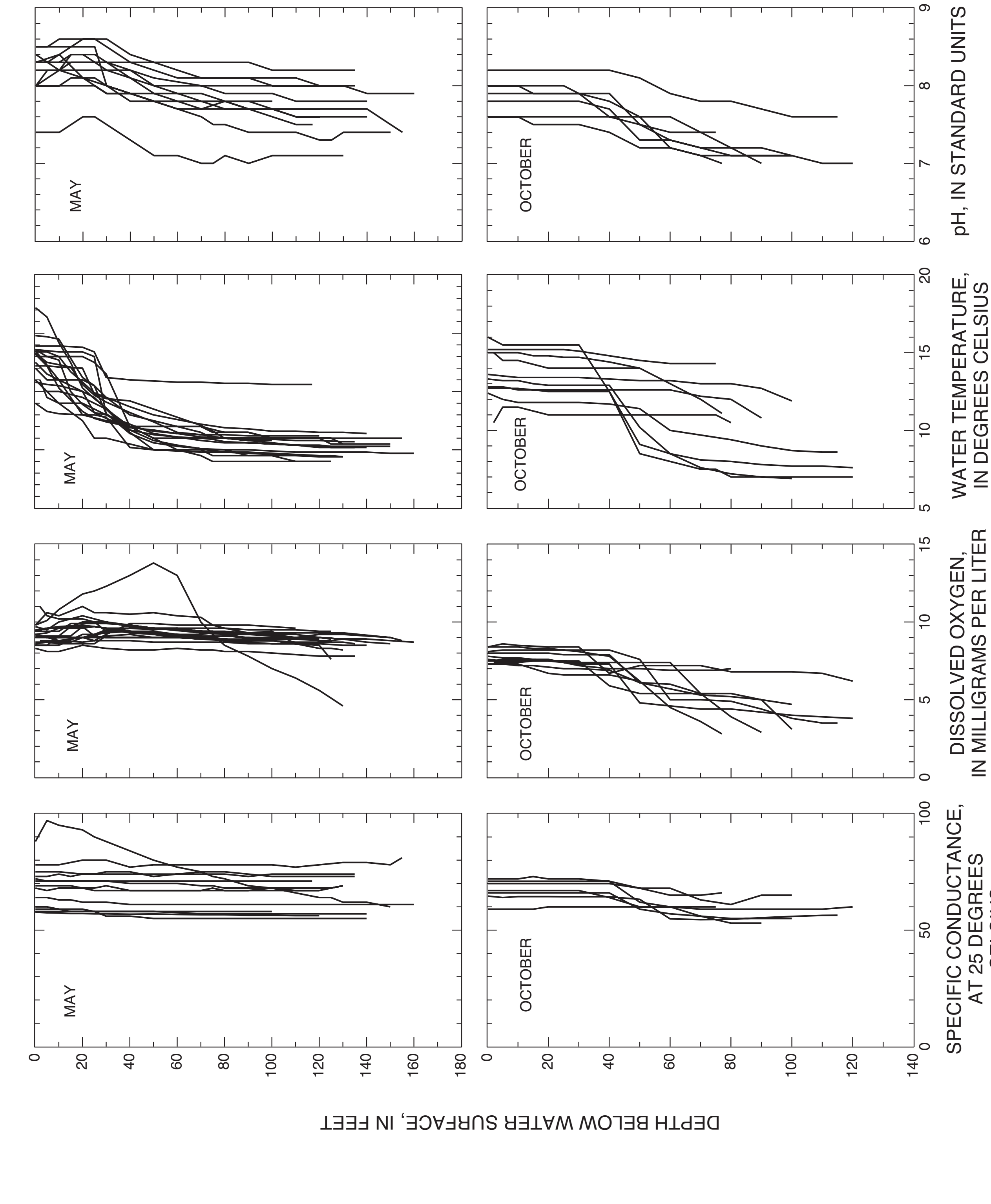

Figure 16. May and October field-measurement profiles at Carter Lake.

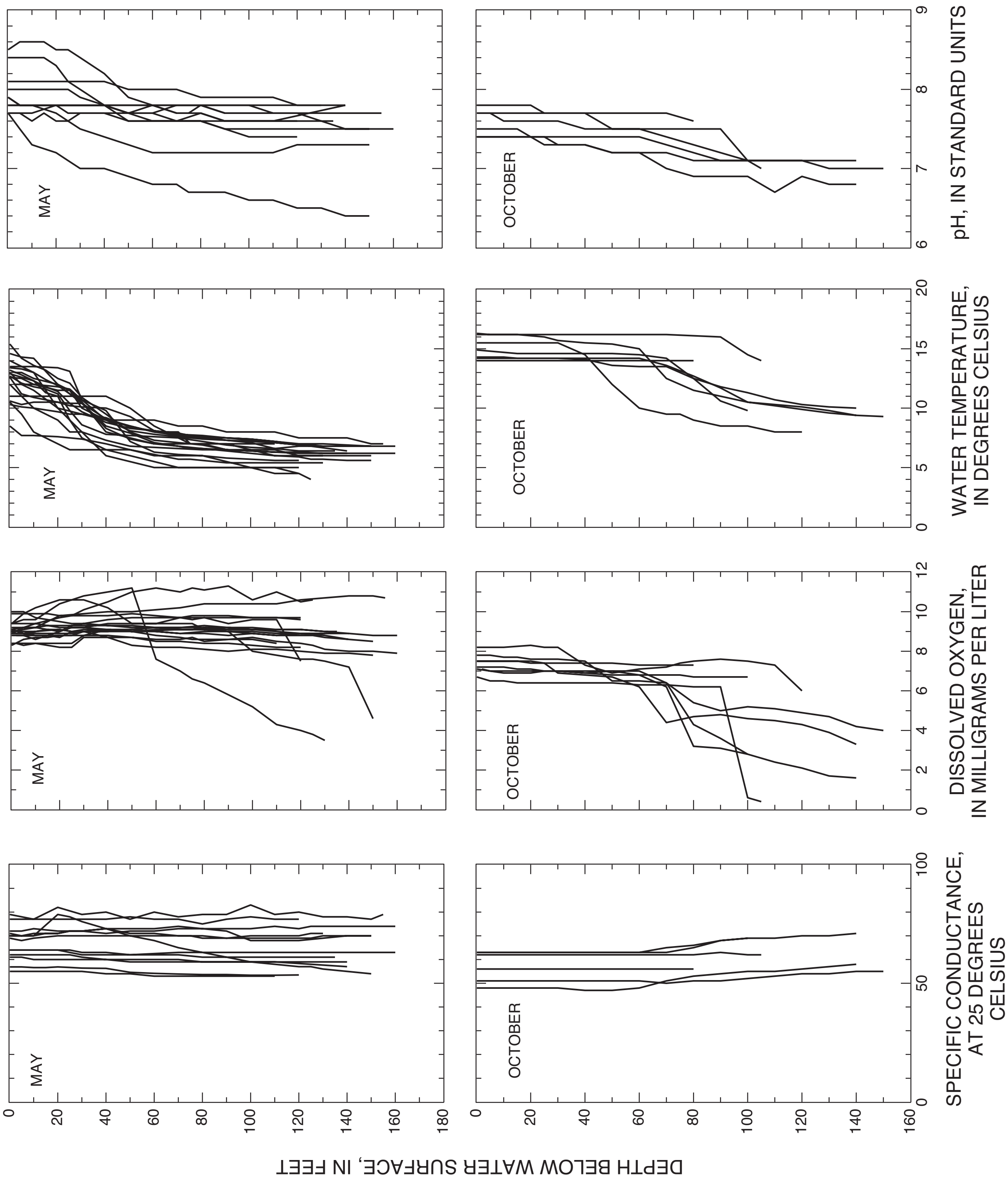

Figure 17. May and October field-measurement profiles at Horsetooth Reservoir (Soldier Canyon Dam).

boron, and copper concentrations were reported infrequently, and when reported, ranged from a few micrograms per liter to a few tens of micrograms per liter (zinc). Sources of the more toxic trace elements (such as copper, cadmium, lead, and zinc) are generally associated with ore deposits or urban runoff. The relative lack of such ore deposits and the relatively low density of development in the drainage areas of the CBT project will tend to limit concentrations of these toxic trace elements to relatively low levels.

Colorado Water-Quality Standards

In Colorado, water-quality standards are determined by the Colorado Water Quality Control Commission and consist of a narrative or numeric restriction established to protect the beneficial uses of water. Water-quality standards for streams in Colorado are based on use classifications such as aquatic life, recreation, water supply, and agriculture. Some water-quality standards for streams are set to specific values or concentrations (such as dissolved oxygen, pH, nitrite, nitrate, chloride, sulfate, iron, and manganese). Others, such as un-ionized ammonia and some trace elements, are usually site specific and use hardness data and equations for each element to calculate standards (Colorado Department of Public Health and Environment, Water Quality Control Commission, 2001). In certain cases, fixed numeric standards have been established that reflect site-specific conditions and may specify trace-element phases and analytical techniques (such as dissolved or total recoverable methods).

Trace-element concentrations are assumed to be dissolved unless designated otherwise by the numeric standards (Colorado Department of Public Health and Environment, Water Quality Control Commission, 2001). Acute standards are values or concentrations not to be exceeded for 1 day. Chronic standards are not to be exceeded by the 85th percentile of sample concentrations in a representative period. Extraordinary ephemeral or seasonal conditions do not constitute violations. Stream-standard concentrations and values are not to be exceeded more than once every 3 years on average (Colorado Department of Public Health and Environment, Water Quality Control Commission, 2001). Thus, continued systematic monitoring is needed to determine compliance or noncompliance with a standard.

The State of Colorado specifies that hardness concentrations used to calculate the trace-element standards be computed from the lower 95-percent confidence limit of the mean hardness at the periodic low-flow criteria determined from regression analysis of site-specific or regional data. In this study, however, hardness concentrations were determined from analysis of water samples collected at the time of sampling. The comparison of standards in this report, therefore, is a general indicator.

The use classifications for CBT sampling sites for this report are Aquatic life cold 1, Recreation 1, Water supply, and Agriculture (Colorado Department of Public Health and Environment, Water Quality Control Commission, 2001). Estimates of the Colorado water-quality standards for samples collected at the 10 sampling sites were calculated on the basis of numeric fixed standards or equations (Table of Value Standards [TVS]) for each element (Colorado Department of Public Health and Environment, Water Quality Control Commission, 2001). Laboratory MRL's for trace elements such as cadmium, mercury, silver, and lead were commonly too high to determine concentrations at the level of the standard. These constituents might be present in the sample at concentrations lower than the laboratory MRL but higher than the standard. Samples were not analyzed for some constituents listed in the Colorado water-quality standards (for example, arsenic, chlorine, cyanide, selenium, and sulfide).

Based on all samples collected over the period of record, standards for chloride, sulfate, un-ionized ammonia, nitrate, dissolved chromium, and dissolved nickel were not exceeded at any of the sampling sites in the study area. Dissolved oxygen exceeded minimum concentrations, and pH was not below or above standards. Silver, lead, and cadmium concentrations occasionally exceeded computed standard values. The fixed standard for dissolved iron (300 μg/L) was exceeded at Lake Granby (two samples), Adams Tunnel (one sample), and Shadow Mountain Lake (one sample). The fixed standard for dissolved manganese (50 μg/L) was exceeded at Lake Granby (10 samples), Horsetooth Reservoir (17 samples), and Shadow Mountain Lake (17 samples). Many of the manganese exceedances were in the early 1990's, mainly in near-bottom samples. The fixed standard for manganese was not exceeded at Carter Lake. The presence of manganese is a common problem in the bottom water of lakes and reservoirs and can adversely affect drinking-water treatment, cause staining of laundry when used for washing, and when it precipitates in excessive quantities, can smother aquatic life (Niyogi and others, 1999).

Limnology

The following sections of the report will discuss issues of water quality that pertain to the reservoir sites. Conditions in the reservoirs affect not only that particular water body but the conveyances and streams into which that water is released, diverted, or pumped.

Reservoir Profile Characteristics

Reservoir profile data are routinely measured when water-quality samples are collected. These measurements are typically made with an instrument that contains sensors for water temperature, specific conductance, pH, and dissolved oxygen. The instrument is lowered beneath the surface from a boat that is held as stationary as possible over the sampling location. Successive readings are taken throughout the depth profile when the instrument stabilizes at a particular depth.

Plots of profiles measured in May and October at Lake Granby, Shadow Mountain Lake, Carter Lake, and Horsetooth Reservoir are shown in figures 14 to 17. The profiles are intended to show how these measurements vary with depth at the beginning of the ice-free season (May) and the end of the ice-free season (October). May and October also were the two months commonly measured at all sites a number of times during the study period.

By May, water-temperature stratification had already begun at most of the reservoirs, particularly at the lower elevations of Carter Lake and Horsetooth Reservoir, where conditions may be ice-free a couple of months earlier. Specific conductance, pH, and dissolved oxygen have not yet become strongly stratified with depth in May, and dissolved-oxygen concentrations are relatively high throughout the profiles.

In the fall (October), conditions at the deeper reservoirs usually remained strongly stratified from summer heating except at Shadow Mountain Lake, where shallow depths (mean depth approximately 15 ft) interfere with the full development of a thermocline. In the other reservoirs, the top of the thermocline was at approximately 30 to 60 ft of depth most years in October (figs. 14–17). During stratification, specific conductance sometimes increased slightly with depth in Lake Granby and Horsetooth Reservoir. Dissolved oxygen was sometimes hypoxic in October profiles in the hypolimnion of the deeper reservoirs, and pH generally decreased with depth in May and October profiles at Lake Granby, Horsetooth Reservoir, and Carter Lake. The lowest hypolimnetic dissolved-oxygen concentrations in October were from Lake Granby and Horsetooth Reservoir, where near-bottom concentrations in some years were less than 2 mg/L.

Hypolimnetic Oxygen Dynamics

Dissolved-oxygen profiles show the distribution of oxygen concentrations with depth, but the shape of the profiles, their seasonal characteristics, reservoir water level, and hydraulic residence time (flushing rate) can be highly variable. This variation makes it difficult to compare from year to year or site to site. One approach to using the dissolved-oxygen profile data involves making computations that take into account reservoir bathymetry, reservoir contents, and the development of the oxygen profile during the growing season. In this way, there is the potential to compare dissolved-oxygen dynamics from year to year. Because low concentrations of dissolved oxygen can be cited as a consequence of eutrophic conditions, a comprehensive measure of those concentrations can contribute to the understanding of trends in eutrophication.

The zone in a reservoir where oxygen depletion is generally greatest is in the hypolimnion. The hypolimnion is the deep portion of the water-temperature profile, below the thermocline, that becomes isolated from the epilimnion and metalimnion during temperature stratification. After becoming isolated from the atmosphere and other sources of oxygen, the oxygen concentration begins to decrease steadily throughout the stratification season as a result of decay processes that steadily consume oxygen. The rate at which oxygen is consumed is indicative of the rate of biological activity, which is indicative of the level of eutrophication (Green, 1996). The hypolimnion does not remix and reoxygenate until fall overturn in lakes that are stratified in summer. These lakes restratify in winter and remix again in spring.

The technique of computing and using areal hypolimnetic oxygen deficits for analysis of eutrophication is described in detail in Green (1996) and will be described briefly in this report. Through the use of one of the PROFILE routines in the U.S. Army Corps of Engineers BATHTUB model (Walker, 1996), areal hypolimnetic oxygen deficit (AHOD) was computed for each growing season in each of four reservoirs (Lake Granby, Shadow Mountain Lake, Carter Lake, and Horsetooth Reservoir) when sufficient profile data were available. The model can be used with data inputs of bathymetry, profile data, estimates of the elevation of the hypolimnion for each profile, and time series of reservoir water levels to make computations of AHOD, which is defined as the change in oxygen per square meter of hypolimnetic surface per day through the stratification season (approximately May to September or October). To ensure that fall overturn reoxygenation has not begun, Walker (1996) recommends that the profile period of computation for AHOD begin with a spring profile in which stratification has already been established (usually May in this study) and end with a profile that is not beyond the peak of near-bottom oxygen depletion (usually July or August in this study). AHOD is computed as the rate of change (slope) of the areal hypolimnetic oxygen content (AHOC) computed by the model through the stratification season.

Time-series plots of computed annual AHOD are shown in figure 18 for Shadow Mountain Lake, Lake Granby, Carter Lake, and Horsetooth Reservoir. There may be patterns present in the AHOD data, and the cycles are not necessarily the same for each reservoir. These patterns suggest that climatic, biological, or operational cycles may influence the rates of oxygen consumption in these reservoirs. The AHODs for each reservoir should not be directly compared to one another because they include the influences of water temperature and morphological characteristics, which may vary in each reservoir.

Trophic Indicators and Nutrient Limitation

The relative fertility of a lake or reservoir can be evaluated by assessing the trophic status. Oligotrophic (nutrient-poor) lakes have characteristics such as high transparency, small organic-matter content, relatively large dissolved-oxygen concentrations, small nutrient concentrations, and small algal biomass. Eutrophic (nutrient-rich) lakes have the opposite characteristics (Woods, 1992). On the basis of data collected over the period of record at each site, CBT reservoirs were assessed using the method developed by Carlson (1977).

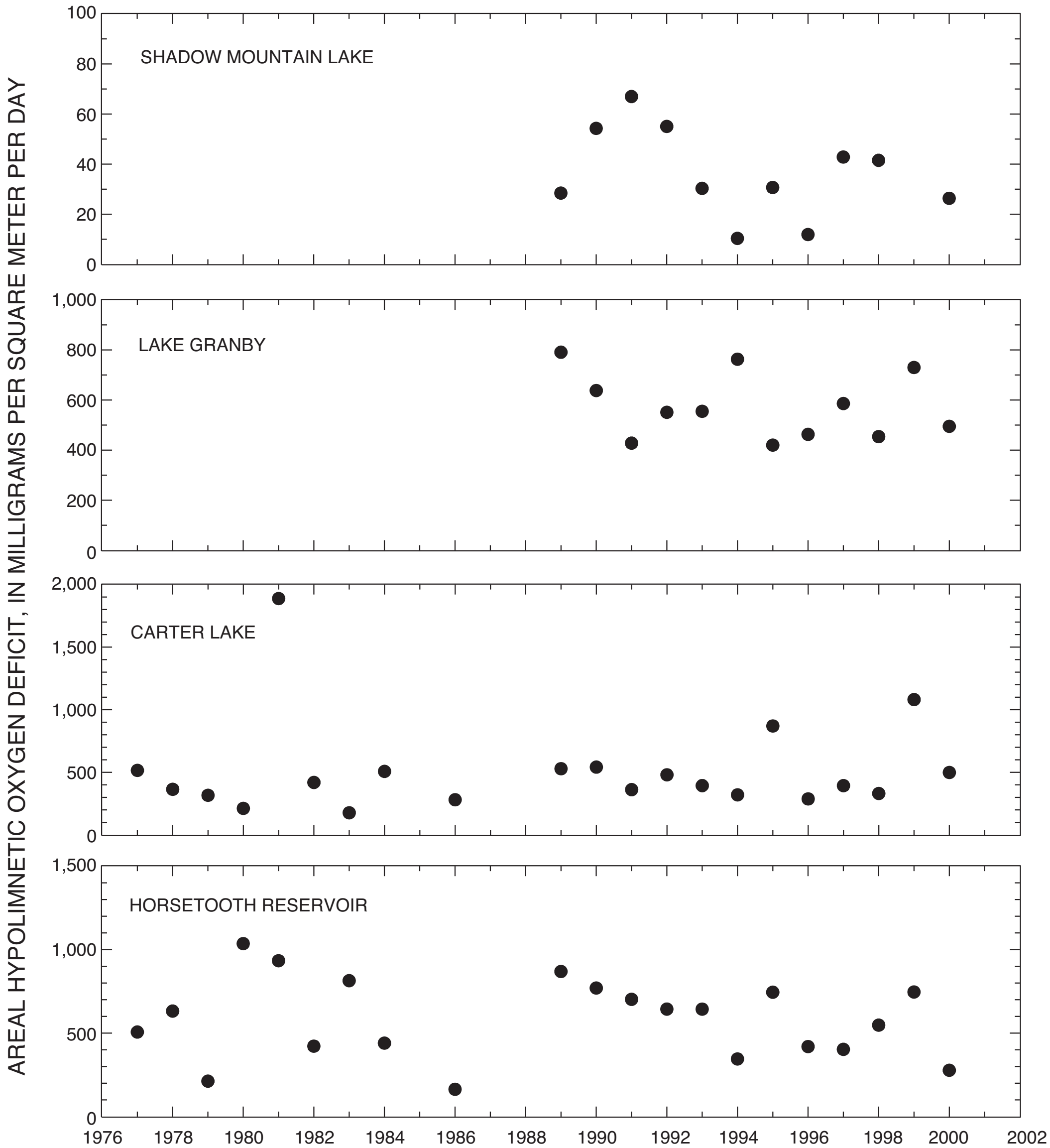

Figure 18. Time-series plots of annual areal hypolimnetic oxygen deficit in reservoirs.

Trophic-state index (TSI) values were calculated from the following equations:

$$TSI(SD) = 60 - 14.41(\ln SD) \quad (1)$$

$$TSI(TP) = 14.42(\ln TP) + 4.15 \quad (2)$$

$$TSI(CHLA) = 9.81(\ln CHLA) + 30.6 \quad (3)$$

where

SD is Secchi-disk depth, in meters;

TP is total phosphorus concentration, in micrograms per liter;

CHLA is chlorophyll-*a* concentration (high-performance liquid chromatography was used), in micrograms per liter;

and

ln is the natural logarithm of the indicated variable.

Secchi-disk depth, total phosphorus (surface only), and chlorophyll-*a* values were averaged for each year to compute mean values. The annual mean values were then used to compute annual TSI values plotted in figure 19. Censored values of total phosphorus were common in the 1990's, and not all TSI's could be computed. The Carlson (1977) TSI index assumes phosphorus limitation. The boundary between oligotrophic (nutrient-poor) and mesotrophic (moderate nutrients) is a TSI value of 30. The boundary between mesotrophic and eutrophic (nutrient-rich) is a TSI value of 50. Most of the TSI values for the reservoirs in this study are in the mesotrophic range. A tendency toward decreasing trophic status in the 1990's at Lake Granby and Shadow Mountain Lake is based primarily on Secchi depth, and chlorophyll-*a* concentrations and can be seen in the plots.

The indices are meant to normalize the three indicators so that any of the three could describe the conditions in the water body. At Lake Granby and Shadow Mountain Lake, the three indices agree fairly well. At Carter Lake and Horsetooth Reservoir, the index for phosphorus does not compare well with the indices for Secchi depth and chlorophyll-*a*. Turbid conditions caused by suspended sediment could raise both the total phosphorus and Secchi-depth TSI's relatively but might not affect or might even decrease the chlorophyll-*a* index due to reduced light penetration. Other cyclic factors such as grazing of phytoplankton by zooplankton can make interpretation of chlorophyll-*a* indices problematic. The use of TSI can give a qualitative indication of relative status of water bodies but should not be used exclusively to evaluate whether lakes and reservoirs are meeting the criteria of their water-quality classifications.

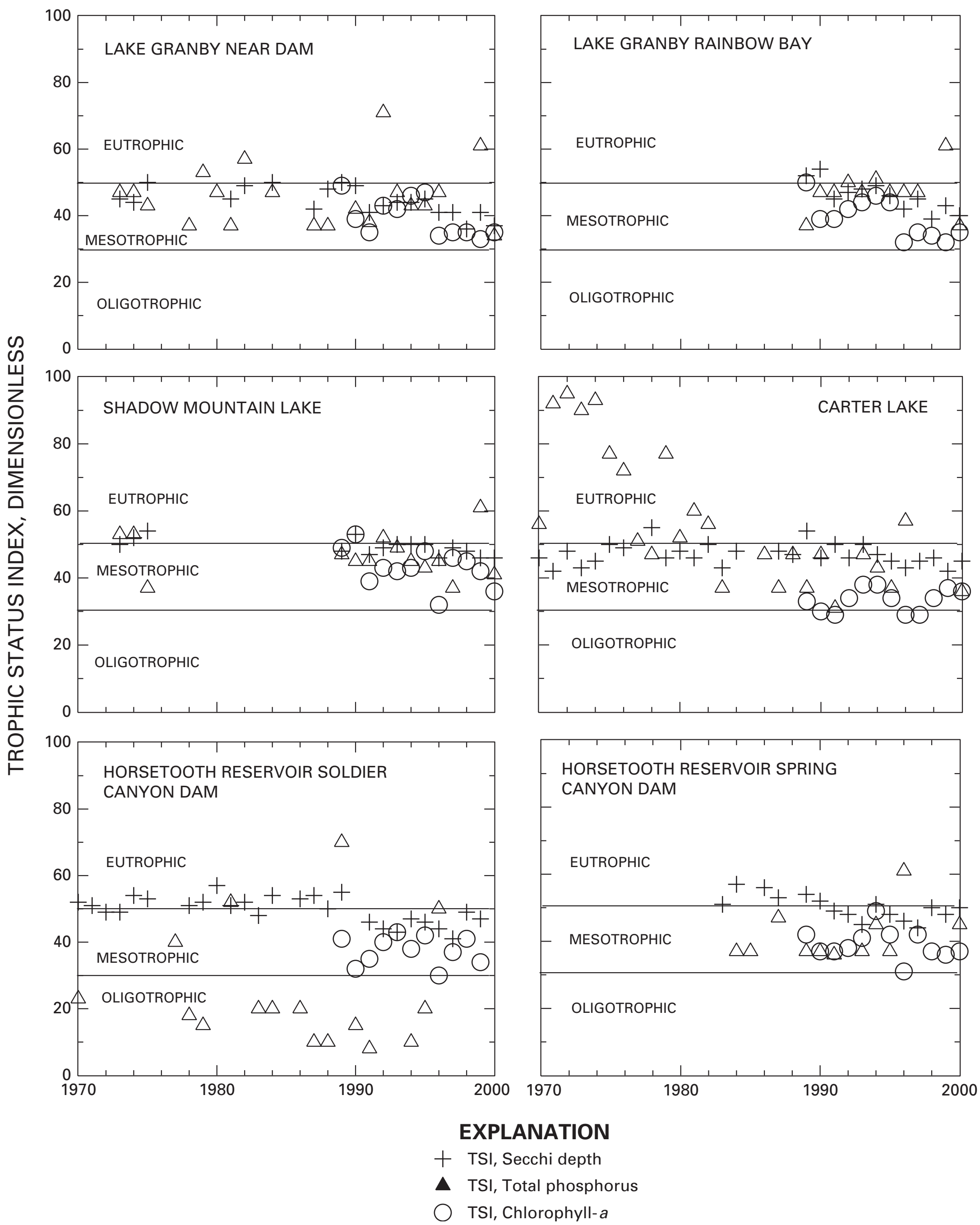

Figure 19. Annual trophic status index (TSI) computations for Secchi depth, total phosphorus, and chlorophyll-*a* by the Carlson (1977) method.

Nitrogen (N) to phosphorus (P) mass ratios have been used to characterize the limiting nutrient for algal growth present in water (Britton and Gaggiani, 1987; Woods, 1992). If a nutrient is limiting, the hypothesis is that the addition of that nutrient would then cause an increase in algal production (in the absence of other limiting factors) (Britton and Gaggiani, 1987; Woods, 1992). Due to the large number of censored nitrogen and phosphorus concentrations, the N/P ratios were not analyzed. An analysis of N/P ratios would indicate only certain conditions when nutrient concentrations were high (greater than minimum reporting limits) and not the full range of ratios for different concentration conditions in the reservoirs.

Trend Analysis

Time-series trend analysis is a common approach to evaluating the temporal changes in long-term data sets. The method chosen for the CBT data is the seasonal Kendall nonparametric test. The test is robust in that it does not require normality, can be used with censored data, and seasonal effects that can obscure the detection of a trend can be removed. The test is computed on the ranks of the data and will indicate the significance of monotonic trends (generally increasing or decreasing with time) and provide an estimate of the slope of the change in the median of the data. Further details on the method and applications can be found in publications such as Helsel and Hirsch (1995), Middelburg (1993), Clark and others (2000), and Mueller (1990).

Time-Series Data

Time-series data were compiled from the USGS database for the period of record at each site. To help with visual assimilation of these large data sets, scatterplots of each constituent of interest were made and a trace of a LOWESS smooth regression was drawn unless periods of data were missing or a series of values were less than MRL (see figs. 23–37 in “Hydrologic and Water-Quality Data” section at back of report). The LOWESS smooth curve was estimated using the MRL in cases where data were censored. Total ammonia and total nitrate were considered similar to dissolved ammonia and dissolved nitrite plus nitrate for plotting and trend-testing purposes. Mueller (1990) made a comparison of the total and dissolved data for these constituents and found no statistical difference. If a field specific conductance or pH value was missing or erroneous, the laboratory value was substituted.

Certain characteristics of the data are visible in the plots that are not evident in the application of the statistical trend test. Variability, nonmonotonic trends, and nonseasonal cycles are important information that are not conveyed by a *p*-value or slope.

A few general observations about the data from the time-series plots (see figs. 23–37 in “Hydrologic and Water-Quality Data” section at back of report) are listed here:

1. Many time-series data are not exclusively monotonic, a condition that could obscure small-scale trends in the trend testing. For example, a normal distribution curve would represent strong trends if it were a time series, but the symmetrical qualities would cancel out the monotonic properties and no significant trends would be computed. This problem is particularly evident in the nutrient data at some of the sites that have long periods of record. Sites such as Granby Pump Canal, Olympus Tunnel, Adams Tunnel east portal, Horsetooth Reservoir at Soldier Canyon Dam, and Lake Granby Dam show clearly some peaking of nutrient concentrations in the early 1980’s (despite the problematic changes in minimum reporting limits) that might not be assessed adequately by monotonic trend testing of the full period of record (fig. 20). Other constituents are well characterized as monotonic distributions (fig. 21).
2. In general, specific conductance, dissolved solids, and most of the major ions at most sites have similar LOWESS curve shapes, indicating that some of the data for constituents and properties may be providing redundant trend information.
3. Because the data at most sites are collected in a very limited number of seasons, some of the variability and representativeness of the annual water-quality changes at the sites are potentially lost. Trend results apply to seasons represented in the data set.
4. Apparent decreases in nutrient concentrations throughout the system are accompanied by decreases in iron (Fe) and manganese (Mn) concentrations. This pattern could indicate a relation between fertility and bottom-water hypoxia (which can cause reducing conditions that release Fe and Mn).
5. The degree of variability is high in the chlorophyll-*a* data, indicating that sampling frequency may not be sufficient to adequately describe algal population dynamics that occur in short time scales.

Some qualitative temporal trend information based on visual inspection of the time-series plots is summarized here:

1. Field measurements of dissolved oxygen and pH are relatively stable through time at most sites. Small fluctuations are probably related to factors such as changes in water temperature, water depth, collection date, and reservoir contents. Slight decreases in dissolved oxygen are shown by the LOWESS curves in the near-bottom samples at Lake Granby (Rainbow Bay) (fig. 26), Carter Lake (fig. 33), and Horsetooth Reservoir (fig. 35).
2. Specific conductance, dissolved solids, and most major ions show decreases in concentrations at most sites over time. Since 1998, however, downward trends have flattened at sites on the western slope (Lake Granby, Shadow Mountain Lake, Granby Pump Canal), and since 1998, upward trends are evident at Horsetooth Reservoir. Some decreases might be related to high runoff years when large volumes of water containing low dissolved solids are stored, influencing concentrations for many

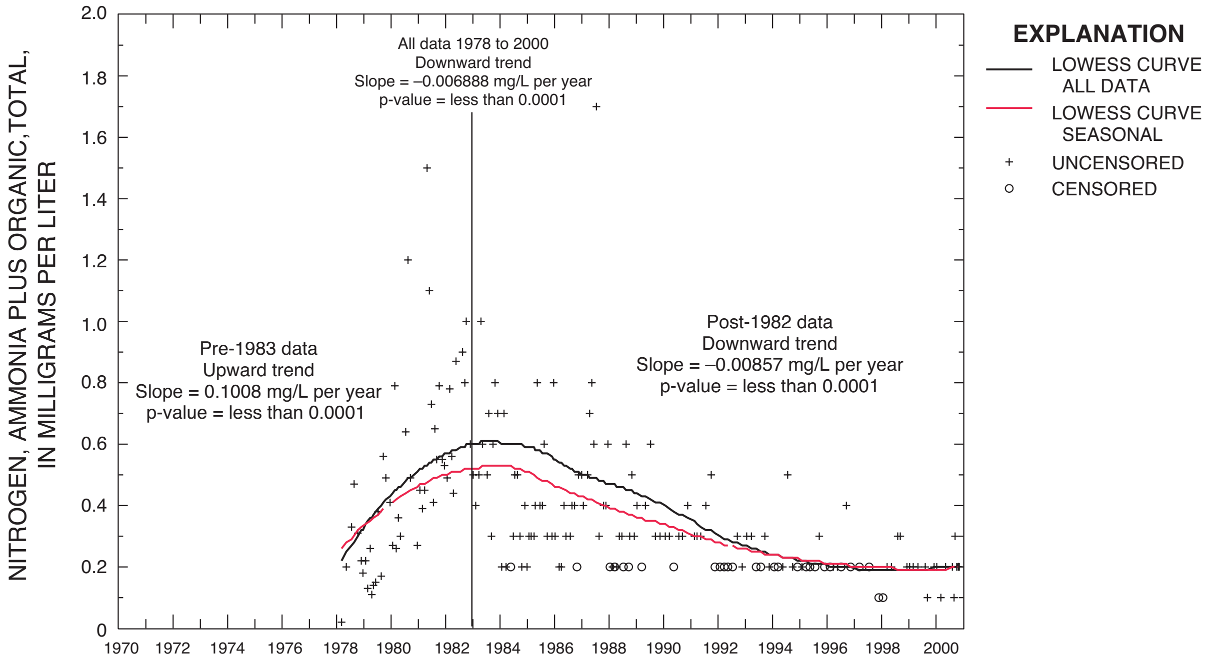

Figure 20. Nonmonotonic distribution and seasonal Kendall test results for pre-1983 and post-1983 of ammonia plus organic nitrogen (total) at Adams Tunnel east portal.

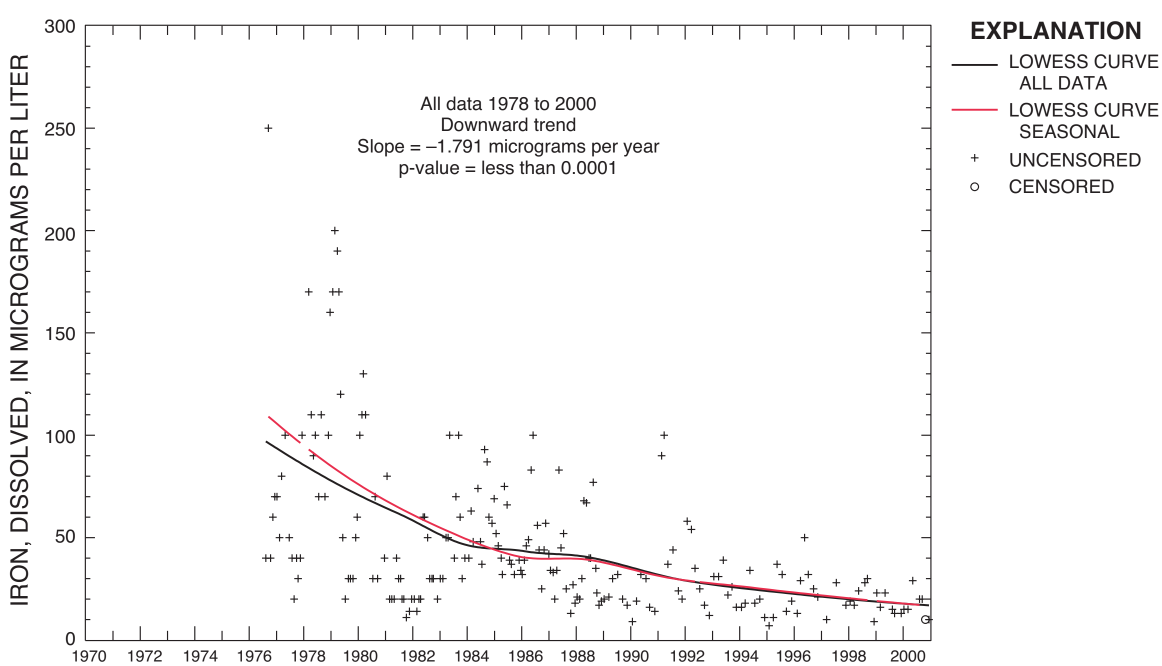

Figure 21. Monotonic distribution and seasonal Kendall test results for all samples of dissolved iron at Adams Tunnel east portal.

years afterward, as that dilute water is pumped throughout the system from the Lake Granby storage. The dilutional effects of high runoff in 1995 can be seen in many plots (figs. 23–37).

3. At sites with 20 years or more years of record, nutrient concentrations have decreased (sometimes substantially) from early 1980's levels. Multiple MRL's and large amounts of data below the MRL in recent years have made it difficult to characterize the most recent trends. It is clear, however, that nutrient concentrations seem to have peaked sometime in the 1970's and early 1980's and have stayed at relatively low levels during the 1990's. Good examples of this pattern can be seen in some plots of ammonia plus organic nitrogen, ammonia, nitrite plus nitrate, and total phosphorus for Adams Tunnel (fig. 30), Olympus Tunnel (fig. 31), Granby Pump Canal (fig. 27), Horsetooth Reservoir (Soldier Canyon Dam) (figs. 34 and 35), and Carter Lake (figs. 32 and 33). This pattern is much less definitive in Lake Granby (figs. 23 and 24).
4. Trace elements such as iron (Fe) and manganese (Mn) have a high degree of variability that is probably caused by seasonal reducing conditions. Reducing conditions can cause the release of Fe and Mn from bottom sediments and are proportional to the degree of hypolimnetic oxygen depletion in a given growing season and the proximity to which the near-bottom sample can be collected close to the reservoir bottom sediment (a variable and uncertain exercise). Similar to nutrients, concentrations of Fe and Mn in the long records at Adams Tunnel (fig. 30), Olympus Tunnel (fig. 31), and Horsetooth Reservoir (figs. 33 and 35, iron only) peak in the early 1980's and generally decline through 2000.
5. Miscellaneous measurements such as transparency, chlorophyll-*a*, and bacteria also show patterns that can be observed on time-series plots. Records of transparency generally show increasing clarity in CBT system reservoirs from 1970 to 2000, although seasonal variability is fairly high (often 50 to 100 inches or more over a few months). The record for chlorophyll-*a* is relatively short (about 11 years). Two peaks of concentration can be seen at Lake Granby (spillway) (fig. 23), Shadow Mountain Reservoir (fig. 28), and Horsetooth Reservoir (figs. 34 and 36) corresponding to approximately 1990–91 and 1995–96. Concentrations of bacteria are generally very low (less than 10 colonies per 100 milliliters) for all sites. Some large spikes in concentrations of fecal and total coliform bacteria (more than 100 colonies per 100 milliliters) fecal coliform and more than 1,000 colonies per 100 milliliters total coliform were reported in the early 1980's at Olympus Tunnel (fig. 31).

Statistical Testing

Seasonal Kendall test (Helsel and Hirsch, 1995) was used to determine the significance of monotonic temporal trends over the period of record for selected constituents. Constituents chosen for analysis included field measurements, major ions, nutrients, chlorophyll-*a* and -*b*, fecal and total coliform bacteria, and trace elements that were routinely reported above censoring levels.

Trend for a particular constituent was only computed when less than 50 percent of the data was below the MRL and more than 5 years of data was available. Lake Estes had less than 5 years of data and was therefore excluded. If more than 5 percent of the data was censored, the slope of the median was not reported. Small breaks in the time series were acceptable if they occurred in the middle one-third of the data. Many of the nutrient species at particular sites were mostly censored data and were not tested. Top- and bottom-sample constituents were tested separately. No flow adjustments were made because all sites were reservoirs or conveyances receiving water from reservoirs. Because multiple MRL's were common, all censored data were recensored to the highest MRL. Or, in a few cases, the highest MRL data in a series were ignored if the data could be eliminated by minor shortening of the beginning or ending of the period of record for the analysis. Estimated data were treated as legitimate. Most outliers were allowed to remain, as the data sets commonly were very large, and the seasonal Kendall method is relatively unaffected by outliers.

The choice of available seasons was limited as sampling frequency at most sites was down to three samples per year near the end of the period of record. Seasons were chosen to maximize the length of record for testing. The seasons and periods of record used for testing each site are listed in table 2. The period of record tested may differ slightly depending on the particular constituent or property and the sampling history. When multiple samples were available for a particular season, the most complete set of sample constituents was first criterion, and the sample closest to the beginning of the target month was the next criterion for choosing among multiple samples.

Summary results of trend testing are summarized in table 3. Detailed summaries by site that include *p*-values and any trend slopes that were computed are listed in Hydrologic and Water-Quality Data tables 21 to 35 at back of report. Three alpha-significance levels were used in the summaries: greater than 90 percent was considered significant; greater than 95 percent was moderately significant; and greater than 99 percent was highly significant. The slope is the median of all slopes between data pairs in the same season and is reported in the tables in units of change per year for the median. Positive slopes indicate upward trends (increasing concentrations or values with time); negative slopes indicate downward trends (decreasing concentrations or values) with time.

Among field measurements, a downward (decreasing) trend in specific conductance was common at all sites except surface samples in Shadow Mountain Lake (site 4S). An upward (increasing) temporal trend for pH was noted at all the conveyances and the surface samples of Carter Lake (site 8S) and Horsetooth Reservoirs (sites 9S only). A negative trend in pH was computed for the near-bottom samples from Lake Granby Rainbow Bay (site 2B). Trends for dissolved-oxygen concentrations decreased in the near-bottom samples at Lake Granby Rainbow Bay (site 2B), Carter Lake (site 8B), and

Table 2. Seasonal periods and period of record tested by seasonal Kendall test.

[Seasons are shown as ranges in months of the year; the hyphens connect months that represent ranges of the seasonal periods]

Site number (fig. 1)	Site name	Seasons	Period of record
1	Lake Granby near Granby, Colo. (near spillway)	May–June, July–Aug, Sept, Oct	1973–present
2	Lake Granby near Granby, Colo. (near dam in Rainbow Bay)	May–June, July–Aug, Sept, Oct	1989–present
3	Granby Pump Canal near Grand Lake, Colo.	No seasonal partition	1970–present
4	Shadow Mountain Lake near Grand Lake, Colo.	May, July–Aug, Sept	1989–present
5	Alva B. Adams Tunnel east portal, near Estes Park, Colo.	Bimonthly	1970–present
6	Lake Estes near dam near Estes Park, Colo.	Insufficient record (less than 5 years)	1998–present
7	Olympus Tunnel at Lake Estes, Colo.	Mar–Apr, July, Nov	1970–present
8	Carter Lake near Berthoud, Colo.	Apr–May, July–Aug, Sept–Oct	1970–present
9	Horsetooth Reservoir near Fort Collins, Colo. (Soldier Canyon Dam)	May–June, July–Aug, Sept–Oct	1970–present
10	Horsetooth Reservoir near Fort Collins, Colo. (Spring Canyon Dam)	May–June, July–Aug, Sept–Oct	1983–present

Horsetooth Reservoir (sites 9B and 10B), and increased in the near-bottom samples of Lake Granby spillway (site 1B) and Shadow Mountain Lake (site 4B).

In general, major ions and hardness at all sites showed significant downward trends. The exceptions were silica, which indicated upward trends at Shadow Mountain (site 4), Adams Tunnel (site 5), and all eastern slope sites (sites 6–10), and chloride, which indicated upward trends at Carter Lake (site 8) and Horsetooth Reservoir (sites 9 and 10). Trends for fluoride and sodium adsorption ratio were not significant. When significant, dissolved-solids trends were downward.

Among nutrients, a small number of significant trends were mostly stable (no trend) or downward. Downward trends were computed for total phosphorus at the Granby Pump Canal (site 3), Olympus Tunnel (site 7), Carter Lake (site 8), and the surface samples at Horsetooth Reservoir (site 9S). Downward trends also are noted for ammonia plus organic nitrogen (total) at Granby Pump Canal (site 3), Shadow Mountain Lake (site 4S), and Adams Tunnel east portal (site 5). Nitrite plus nitrate had a significant downward trend at the Granby Pump Canal (site 3) and an upward trend at Horsetooth Reservoir (site 10B) in the near-bottom sample.

Transparency and chlorophyll-*a* variables, which are directly related to perceptions of eutrophication, showed some improvement with time in Lake Granby (sites 1S and 2S). Transparency showed an upward trend and chlorophyll-*a* a downward trend at both of the surface sites in Lake Granby. The only other significant trend in transparency was an upward trend at Horsetooth Reservoir (site 9S). No significant trends in fecal coliform bacteria were detected.

Among trace elements, only barium, iron, manganese, strontium, and zinc had sufficient uncensored data for trend testing. Downward trends in iron and manganese were notable at Lake Granby (sites 1 and 2, Fe-Mn), Granby Pump Canal (site 3, Fe-Mn), and Shadow Mountain Lake (site 4S and 4B, Mn only). On the eastern slope, iron showed downward trends at Adams Tunnel (site 5), Olympus Tunnel (site 7), and Carter Lake (site 8S and 8B). The trend in manganese was downward at Olympus Tunnel (site 7). Strontium, a minor ion with similar chemistry to the major ions, showed a downward trend at all sites. Zinc was a downward trend at Olympus Tunnel (site 7), the only significant trend for zinc. The trend in barium was downward at Carter Lake (site 8S and 8B) and upward in the near-bottom samples at Horsetooth Reservoir (site 9B).

The AHOD data computed for Lake Granby, Shadow Mountain Lake, Carter Lake, and Horsetooth Reservoir at the dam locations (related to hypolimnetic oxygen dynamics described earlier) also were tested for temporal trends. First, the annual AHOD data were correlated with year (temporal variable) by using a parametric Pearson correlation. R-squared values ranged from less than 0.1 (Carter Lake Reservoir) to 0.14 (Granby Reservoir), indicating no linear correlation. Green (1996) established a correlation between AHOD and reciprocal hydraulic residence time (RHRT) that explained additional variance in the temporal correlation. Plots of time-series RHRT (May to August each year) at four CBT reservoirs were computed using annual inflow or outflow data and average reservoir contents for each year (fig. 22). With CBT reservoir data, a correlation of log(AHOD) with log(RHRT) yielded r-squared values ranging from 0.11 to 0.65. Encouraged by the potential of the residence time to improve the temporal correlation, a regression model for log(AHOD) that included log(RHRT) and the year was computed and yielded r-squared values ranging from 0.12 to 0.65. Residuals from a logAHOD/logRHRT regression (effects of RHRT removed) were then regressed with year. The largest r-squared obtained was 0.13, indicating little evidence of AHOD changes with time (temporal trend). The AHOD data and RHRT data were then tested for trend using Kendall's tau and testing correlation with time. None of the AHOD, RHRT, or residuals from the log(AHOD) and log(RHRT) relation data had significant temporal trends.

Table 3. Summary of significant upward and downward temporal trends at Colorado-Big Thompson sampling sites.

[--, insufficient data; (+), upward trend; (–, downward trend; 0, trend not significant; significance: *, greater than 90 percent; **, greater than 95 percent; ***, greater than 99 percent; A, no trend computation because censored values exceeded 50 percent of data; site 6 was not tested because period of record was less than 5 years; S, surface sample; B, near-bottom sample; site names listed in table 1; mg/L, milligrams per liter; µS/cm, microsiemens per centimeter at 25 degrees Celsius; °, degree Celsius; mL, milliliter; µg/L, micrograms per liter]

Property or constituent	Significant trends by study site														
	Site 1(S)	Site 1(B)	Site 2(S)	Site 2(B)	Site 3	Site 4(S)	Site 4(B)	Site 5	Site 7	Site 8(S)	Site 8(B)	Site 9(S)	Site 9(B)	Site 10(S)	Site 10(B)
Oxygen, dissolved (mg/L)	(–)**	(–)***	0	(–)*	0	0	(+)***	0	(+)**	0	(–)***	0	(–)***	0	(–)*
pH, field (standard units)	0	0	0	(–)**	(+)***	0	0	(+)***	(+)*	(+)**	0	(+)***	0	0(–)***	0
Specific conductance (µS/cm)	(–)***	(–)***	(–)***	(–)***	(–)***	0	(–)***	(–)***	(–)***	(–)***	(–)***	(–)***	(–)***	(–)***	(–)***
Water temperature (°C)	0	(–)***	0	(–)***	(+)*	--	--	(+)***	0	0	(+)**	0	(+)*	(–)*	(+)**
Hardness, total (mg/L)	(–)***	(–)***	(–)***	(–)***	(–)***	(–)*	(–)***	0	(–)**	(–)***	(–)***	(–)***	(–)***	(–)**	(–)***
Calcium (mg/L)	(–)***	(–)***	(–)***	(–)***	(–)***	(–)**	(–)***	0	(–)**	(–)***	(–)***	(–)***	(–)***	(–)**	(–)***
Magnesium (mg/L)	(–)***	(–)***	(–)***	(–)***	(–)***	0	0	(–)***	(–)***	(–)***	(–)***	(–)*	(–)***		(–)***
Potassium (mg/L)	(–)***	(–)***	(–)***	(–)***	(–)***	0	0	(–)***	0	0	0	0	0	0	0
Sodium adsorption ratio	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Sodium, dissolved (mg/L)	(–)***	(–)***	(–)***	(–)***	(–)***	(–)***	(–)***	(–)***	0	(–)***	(–)***	(–)**	(–)**	(–)**	(–)*
Sodium (percent)	(–)***	(–)***	(–)***	(–)***	(–)***	(–)***	(–)***	0	0	0	0	0	0	0	(+)**
Acid-neuralizing capacity (mg/L as $CaCO_3$)	(–)***	(–)***	(–)***	(–)***	(–)***	(–)*	(–)***	0	0	(–)***	(–)***	(–)***	(–)***	(–)*	(–)***
Chloride, dissolved (mg/L)	0	0	0	0	(–)**	0	0	0	0	(+)***	(+)***	(+)***	(+)***	(+)***	(+)***
Fluoride, dissolved (mg/L)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Silica, dissolved (mg/L)	0	0	0	0	0	(+)**	0	(+)***	(+)***	(+)***	(+)***	(+)**	(+)*	(+)*	(+)***
Sulfate, dissolved (mg/L)	(–)***	(–)***	(–)***	(–)***	(–)***	(–)***	(–)***	(–)***	(–)***	(–)***	***	--	0	(–)*	(–)***
Nitrogen, ammonia plus organic, total (mg/L as N)	0	A	0	0	(–)***	(–)***	0	(–)***	0	0	A	0	A	0	A
Nitrogen, ammonia, dissolved (mg/L as N)	A	A	A	A	A	A	0	A	0	0	0	0	0	A	0
Nitrogen, nitrite plus nitrate, dissolved (mg/L as N)	A	A	A	A	(–)***	A	A	0	0	A	A	A	0	A	(+)*
Nitrogen, nitrite, dissolved (mg/L as N)	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A
Phosphorus, dissolved (mg/L as P)	A	A	A	A	A	A	A	0	(–)***	A	A	A	A	A	A
Phosphorus, ortho, dissolved (mg/L as P)	A	A	A	A	A	A	A	0	A	A	A	A	A	A	A
Phosphorus, total (mg/L as P)	A	0	0	0	(–)***	0	0	A	(–)***	(–)***	(–)***	(–)***	0	A	0
Residue, dissolved at 180°C (mg/L)	(–)**	0	0	(–)*	(–)*	0	(–)*	0	0	(–)***	(–)***	(–)***	(–)***	0	0
Dissolved solids, sum of constituents	(–)***	(–)***	(–)***	(–)***	(–)***	0	(–)**	0	(–)**	(–)***	(–)***	(–)**	(–)***	0	(–)*
Transparency, Secchi disk (inches)	(–)***	--	(+)***	--	--	0	--	--	--	0	--	(+)***	--	0	--
Coliform, fecal (colonies per 100 mL)	A	--	A	--	--	A	--	--	--	A	--	A	--	0	--
Chlorophyll-*a* (µg/L)	(–)***	--	(–)***	--	--	0	--	--	--	0	--	0	--	0	--
Chlorophyll-*b* (µg/L)	A	--	A	--	--	A	--	--	--	--	--	A	--	A	--
Barium, dissolved (µg/L)	0	0	0	0	0	0	(0)**	0	0	(–)*	(–)*	0	(+)*	0	0
Iron, dissolved (µg/L)	(–)***	(–)***	(–)***	(–)***	(–)***	0		(–)***	(–)***	(–)***	(–)**	0	0	0	0
Manganese, dissolved (µg/L)	A	(–)***	(–)***	(–)***	(–)***	(–)***	(–)***	--	(–)**	A	0	0	A	0	0
Strontium, dissolved (µg/L)	(–)***	(–)***	(–)***	(–)***	(–)***	(–)**	(–)***	(–)***	(–)**	(–)***	(–)***	(–)***	(–)***	(–)***	(–)***
Zinc, dissolved (µg/L)	A	0	A	A	0	A	0	0	(–)**	0	0	0	0	A	A

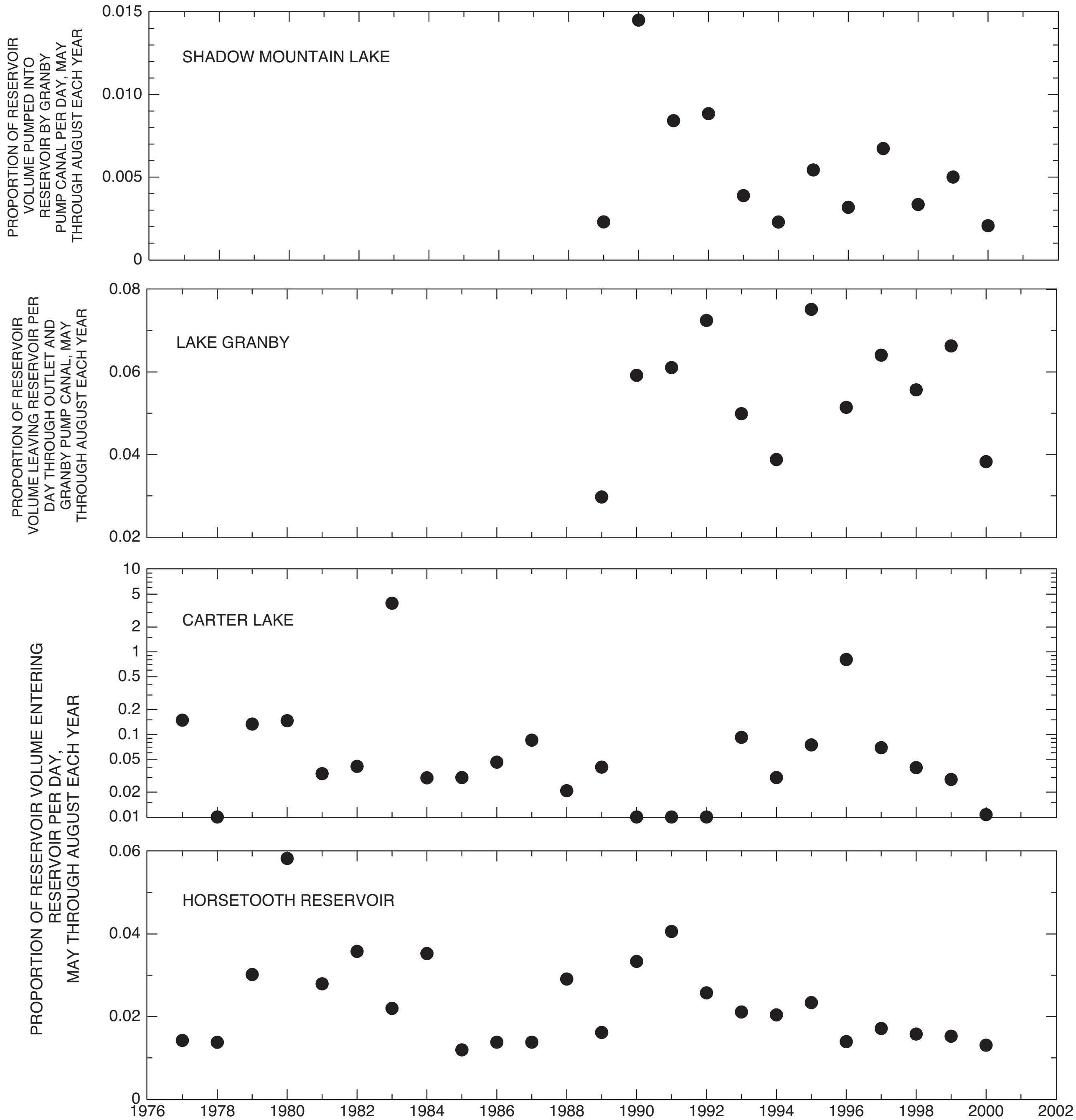

Figure 22. Time-series plots of reservoir reciprocal hydraulic residence time in terms of the proportion of water entering or leaving the water body.

Summary and Conclusions

The U.S. Geological Survey (USGS), in an ongoing cooperative monitoring program with the Northern Colorado Water Conservancy District (NCWCD), Bureau of Reclamation (BOR), and City of Fort Collins, has collected water-quality data in reservoirs and conveyances such as canals and tunnels related to the Colorado–Big Thompson (CBT) Project in north-central Colorado since 1969.

This report assessed and summarized (1) water-quality and field-measurement profile data collected by USGS and stored in the USGS National Water Information System, (2) time-series trends of chemical constituents and physical properties by using the seasonal Kendall trend test method, (3) oxygen deficits in the hypolimnion (reservoirs only), (4) trophic status indicators, and (5) water-quality data in terms of Colorado water-quality standards.

Water at CBT sites is dilute and typical of high-elevation snowmelt runoff. Median concentrations of specific conductance at sites on the western slope (Lake Granby and Shadow Mountain Lake) and the high-elevation sites on the eastern slope (Adams Tunnel east portal, Lake Estes, and Olympus Tunnel) were generally below 60 microsiemens per centimeter at 25 degrees Celsius. These sites are indicative of a hydrologic setting that is typical of snowmelt source water—low rates of evapotranspiration (ET) and crystalline bedrock geology. Sites with large specific conductances (generally greater than 70 microsiemens per centimeter at 25 degrees Celsius) and concentrations of major ions are Carter Lake and Horsetooth Reservoir. These sites show the cumulative effects of urban development and ET from the rest of the storage and conveyance system. These sites are in lower elevations (higher ET) in areas of sedimentary rocks that can increase dissolved-solids content. Even so, all water sampled in this system should be considered to be of high quality in terms of low dissolved-solids content.

Water temperature varied seasonally, with reservoir sites developing strong stratification patterns. The pH at CBT sites was generally in a neutral range of 7 to 8. Dissolved oxygen was generally in the range of 6 to 10 milligrams per liter, except in the hypolimnetic water of the reservoirs, where seasonal stratification sometimes produced dissolved-oxygen concentrations approaching 2 milligrams per liter or less.

Cation compositions at Adams Tunnel, Olympus Tunnel, and Horsetooth Reservoir are somewhat mixed calcium-magnesium-sodium, but calcium is predominant. Anion compositions are primarily bicarbonate. Despite having larger concentrations of dissolved solids, Horsetooth Reservoir water seems to be simply a more concentrated version of the tunnel waters.

Nutrient concentrations at CBT sites generally were low. Data censoring levels changed many times throughout the study and at times had insufficiently high reporting levels to fully characterize concentration. Largest nutrient concentrations tended to occur at Carter Lake and Horsetooth Reservoirs. The smallest nutrient concentrations were generally measured at Lake Granby and Shadow Mountain Lake. Bottom samples tended to have larger concentrations of most nutrients than did surface samples at the same site.

Concentrations of common dissolved trace elements such as iron and manganese commonly exceeded MRL's, but concentrations were usually less than 1 milligram per liter. Beryllium, chromium, cobalt, lithium, molybdenum, nickel, silver, and vanadium were almost never detected. Zinc, lead, cadmium, boron, and copper concentrations were reported infrequently, and concentrations ranged from a few micrograms per liter to a few tens of micrograms per liter (zinc).

Based on all samples collected over the period of record, standards for dissolved oxygen, pH, chloride, sulfate, un-ionized ammonia, nitrate, dissolved chromium, and dissolved nickel were not exceeded at any of the sampling sites in the study area. Silver, lead, copper, cadmium, and zinc concentrations occasionally exceeded computed standard values. The fixed standard for dissolved iron (300 micrograms per liter) was exceeded in two samples at Lake Granby, one sample at Adams Tunnel east portal, and one sample at Shadow Mountain Lake. The fixed standard for dissolved manganese (50 micrograms per liter) was exceeded at Lake Granby (10 samples), Horsetooth Reservoir (17 samples), and Shadow Mountain Lake (17 samples). Many of the exceedances of manganese were in the early 1990's in mainly near-bottom samples. The fixed standard for manganese was not exceeded at Carter Lake.

Time-series of computed annual areal hypolimnetic oxygen deficit (AHOD) were plotted for Shadow Mountain Lake, Lake Granby, Carter Lake, and Horsetooth Reservoir. Multi-year patterns are evident in the AHOD data, and the cycles are not necessarily the same for each reservoir. This pattern suggests that climatic, biological, or operational cycles may influence the rates of oxygen consumption in these reservoirs.

On the basis of data collected over the period of record at each site, CBT reservoirs were assessed for trophic status using the Trophic-State Index (TSI) method developed by Carlson (1977). Most of the index values for the reservoirs are in the mesotrophic range most years. A tendency toward decreasing trophic status in the 1990's at all reservoirs based mostly on Secchi depth and chlorophyll-*a* can be seen in time-series plots of index values. The use of TSI can give a qualitative indication of relative status of water bodies but should not be used exclusively to evaluate whether lakes and reservoirs are meeting the criteria of their water-quality classifications.

Time-series data were compiled from the USGS database for the period of record at each site. To help with visual assimilation of these large data sets, scatterplots of each constituent of interest were made and a trace of a LOWESS smooth regression was drawn when sufficient data over the minimum reporting limit were present.

A few general observations and interpretations from the time-series plots were made:

1. Many time-series data are not exclusively monotonic, a condition that could obscure small-scale trends in the trend testing. Other constituents are well characterized as monotonic distributions.
2. Specific conductance, dissolved solids, and most of the major ions have similar LOWESS curve shapes, indicating that some of the constituent concentrations may be providing redundant trend information.
3. Because the data at most sites are collected in a very limited number of seasons, some of the variability and representativeness of the annual water-quality changes at the sites are potentially lost. Trend results should be applied cautiously to seasons not represented in the sampling.
4. Apparent decreases in nutrient concentrations throughout the system are accompanied by decreases in iron (Fe) and manganese (Mn) concentrations. This pattern

could indicate a relation between fertility and bottom-water hypoxia (which can cause reducing conditions that release Fe and Mn).

5. The degree of variability in the chlorophyll-*a* data is high, indicating that sampling frequency is not dense enough to adequately describe algal population dynamics that occur on short time scales.

Seasonal Kendall test was used to determine the significance of monotonic temporal trends over the period of record for field measurements, major ions, nutrients, chlorophyll-*a* and -*b*, fecal and total coliform bacteria, and trace elements that were routinely reported above censoring levels.

Among field measurements, a downward trend in specific conductance was common to all sites except surface samples in Shadow Mountain Lake. In general, major ions and hardness at all sites showed significant downward trends. The exceptions were (1) silica, which had an upward trend at Shadow Mountain Lake, Adams Tunnel east portal, and all eastern slope sites, and (2) chloride, which indicated upward trends at Carter Lake and Horsetooth Reservoir. Fluoride and sodium adsorption ratio had no significant trends. When significant, dissolved-solids trends were downward.

Among nutrients that met testing criteria, most either had no evidence of trend or a downward trend. Transparency and chlorophyll-*a*, variables that are directly related to perceptions of eutrophication, showed some improvement with time in Lake Granby. The trend for transparency was upward and chlorophyll-*a* was downward at both of the surface sites in Lake Granby. The only other significant trend in these variables was an upward trend in transparency at the Horsetooth Reservoir (Soldier Canyon Dam). No significant trends in fecal coliform bacteria were detected. Among trace elements, only barium, iron, manganese, strontium, and zinc had sufficient uncensored data for trend testing. Downward trends in iron and manganese were notable at Lake Granby (Fe-Mn), Granby Pump Canal (Fe-Mn), and Shadow Mountain Lake (Mn only). On the eastern slope, the trend in iron was upward at Adams Tunnel, Olympus Tunnel, and Carter Lake. Manganese trend was downward at Adams and Olympus Tunnels. The zinc trend was downward at Olympus Tunnel, the only significant trend for zinc.

The AHOD data (computed for Lake Granby, Shadow Mountain Lake, Carter Lake, and Horsetooth Reservoir, at the dam locations) related to hypolimnetic oxygen dynamics also were tested for temporal trend. A regression model that included log(AHOD), log(RHRT), and the year, was computed. The model yielded r-squared values that ranged from 0.12 to 0.65. Residuals from a logAHOD/logRHRT regression (effects of RHRT removed) were then regressed with year. The largest r-squared obtained was 0.13, indicating little evidence of AHOD changes with time (temporal trend). The AHOD data and RHRT data were then tested for trend by using Kendall's tau and testing correlation with time. None of the AHOD, RHRT, or residuals from the log(AHOD) and log(RHRT) relation data had significant temporal trends.

Major conclusions of the study were as follows:

1. Water quality was generally good throughout the CBT system over the period of record, which ranged from 1969 to 2000. Dissolved solids and nutrient concentrations were low and typical of a forested/mountainous/crystalline bedrock hydrologic setting. Most of the more toxic trace elements were rarely detected or were found in low concentrations, which was due at least in part to a relative lack of ore-mineral deposits within the drainage areas of the CBT project.

2. Constituent concentrations consistently met water-quality standard thresholds set by the State of Colorado.

3. Trophic-state index values indicated mesotrophic conditions generally prevail at reservoirs based on available Secchi depth, total phosphorus concentrations, and chlorophyll-*a* concentrations.

4. Based on plots of time-series values and concentrations and seasonal Kendall nonparametric trend testing, concentrations of dissolved solids and most major ions were decreasing at most sites. Many of the nutrient time-series data did not meet the minimum criteria for testing. But for those that did, nutrient concentrations had insufficient evidence of trends or downward temporal trends (ammonia plus organic nitrogen and total phosphorus). Iron and manganese data either had insufficient evidence of trend or indicated downward trends. Chlorophyll-*a* data were collected for only 11 years but generally indicated insufficient evidence of trend or downward temporal trends.

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Hydrologic and Water-Quality Data

Abbreviations

$CaCO_3$	Calcium carbonate
Ca	Calcium
Mg	Magnesium
K	Potassium
Na	Sodium
Cl	Chloride
F	Fluoride
SiO_2	Silicon dioxide
SO_4	Sulfate
N	Nitrogen
P	Phosphorus
As	Arsenic
Ba	Barium
Be	Beryllium
B	Boron
Cd	Cadmium
Cr	Chromium
Co	Cobalt
Cu	Copper
Fe	Iron
Pb	Lead
Li	Lithium
Mn	Manganese
Mo	Molybdenum
Ni	Nickel
Ag	Silver
Sr	Strontium
V	Vanadium
Zn	Zinc

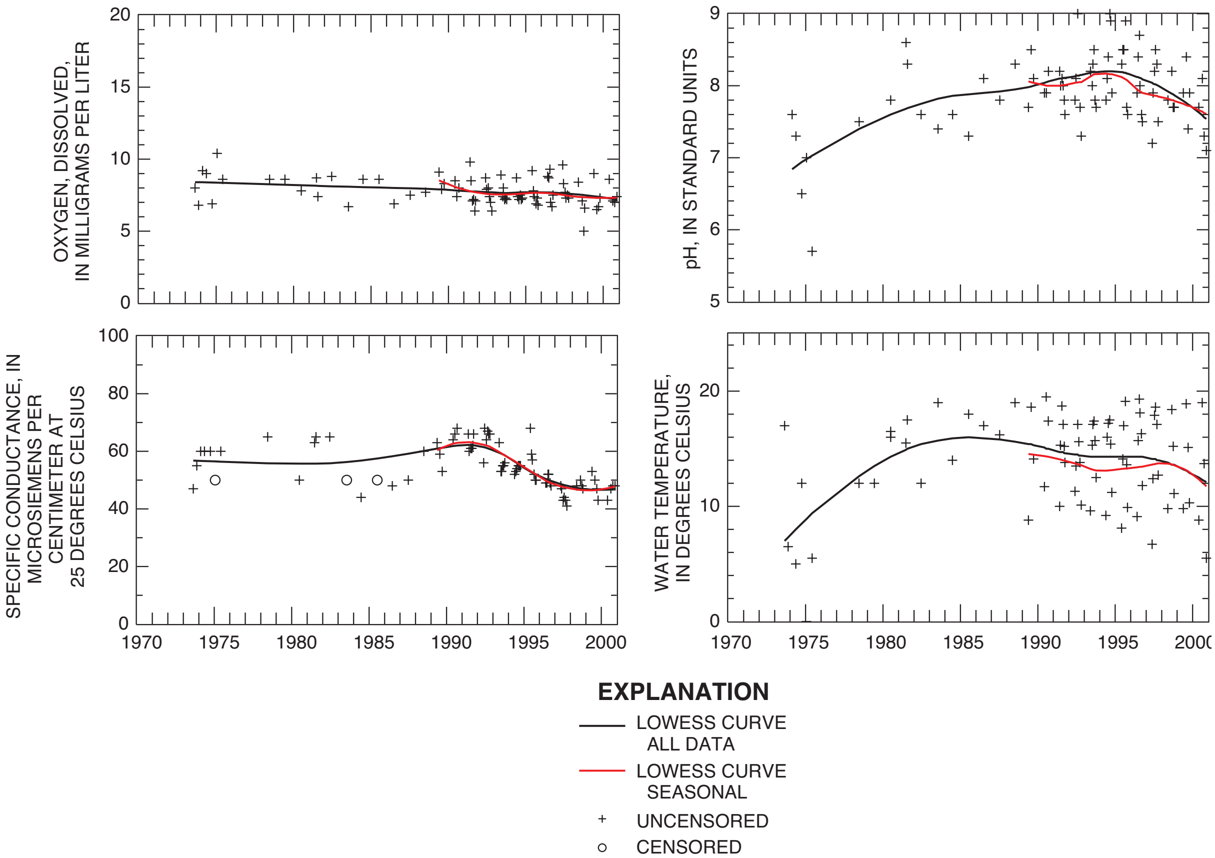

Figure 23. Temporal variations in periodic measurements and concentrations at Lake Granby near spillway, sampled near the surface.

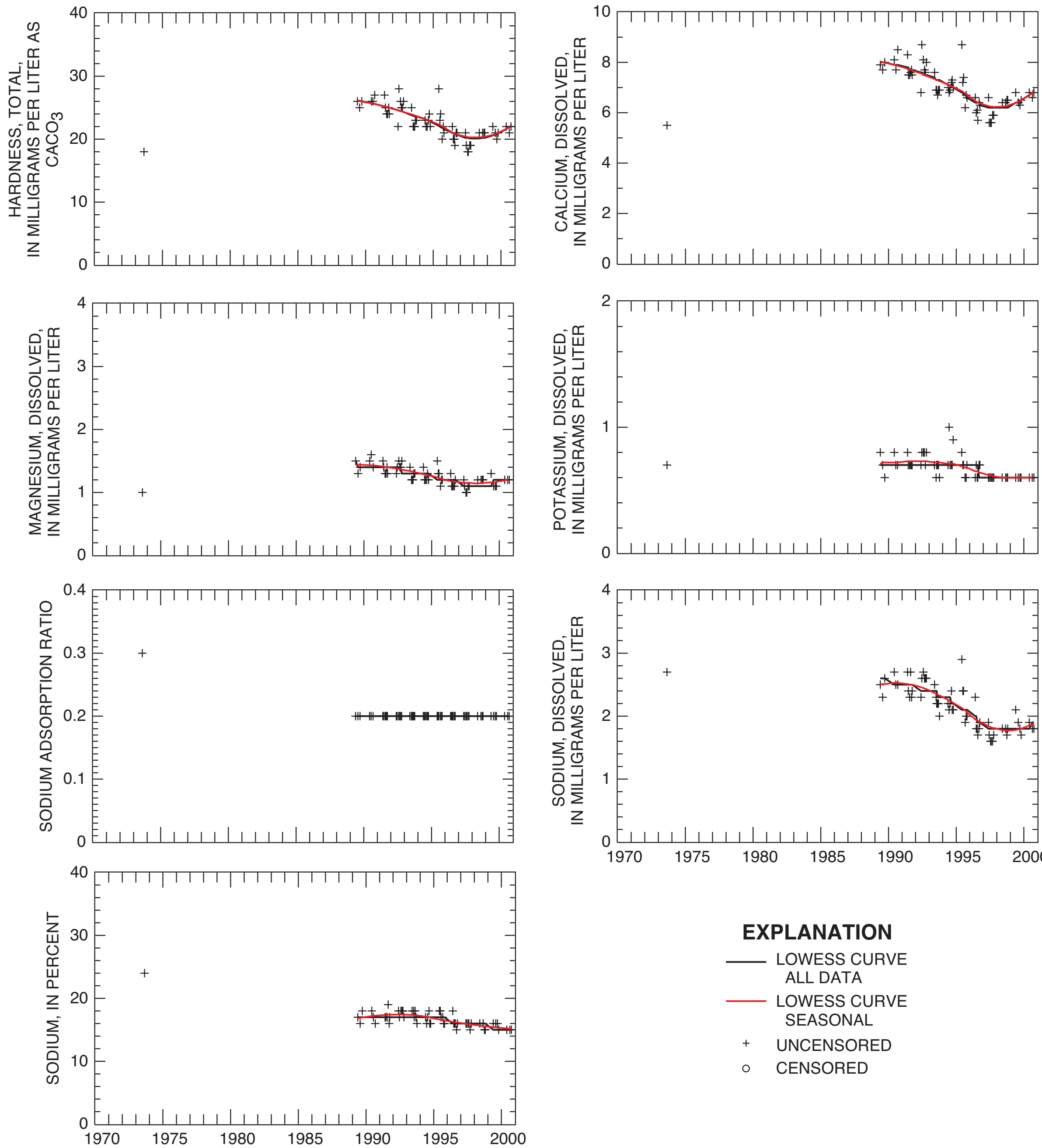

Figure 23. Temporal variations in periodic measurements and concentrations at Lake Granby near spillway, sampled near the surface.—Continued

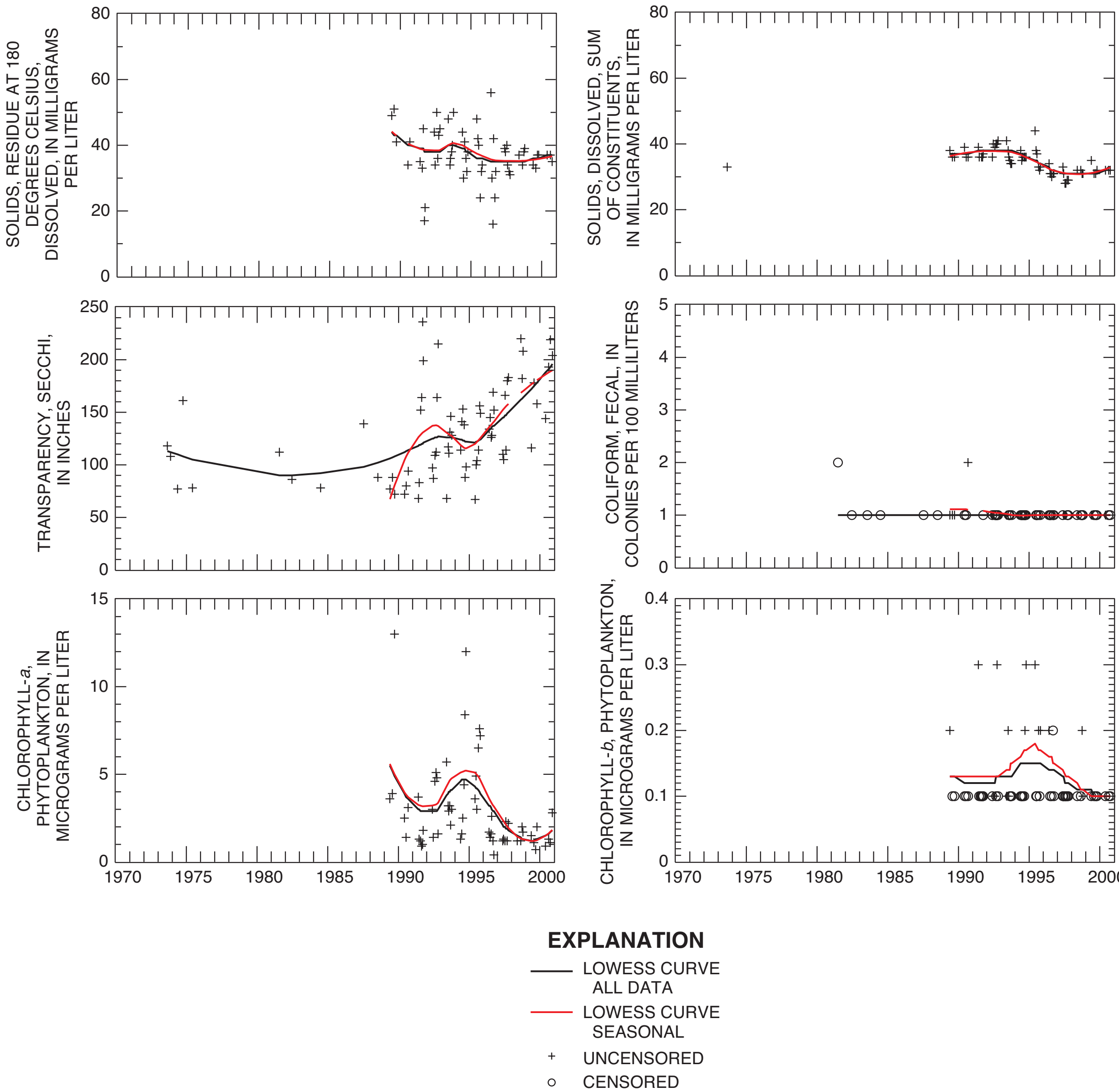

Figure 23. Temporal variations in periodic measurements and concentrations at Lake Granby near spillway, sampled near the surface.—Continued

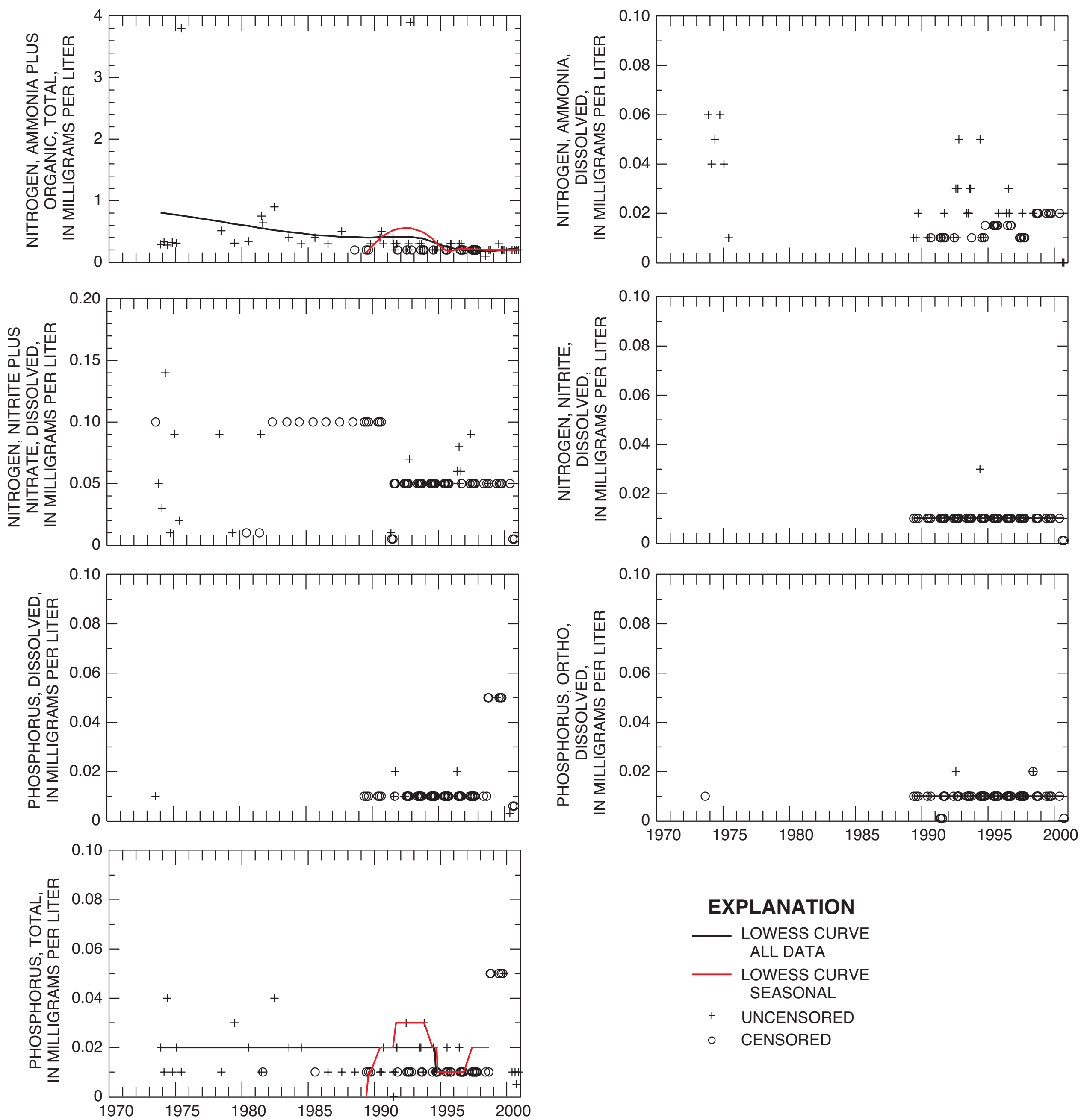

Figure 23. Temporal variations in periodic measurements and concentrations at Lake Granby near spillway, sampled near the surface.—Continued

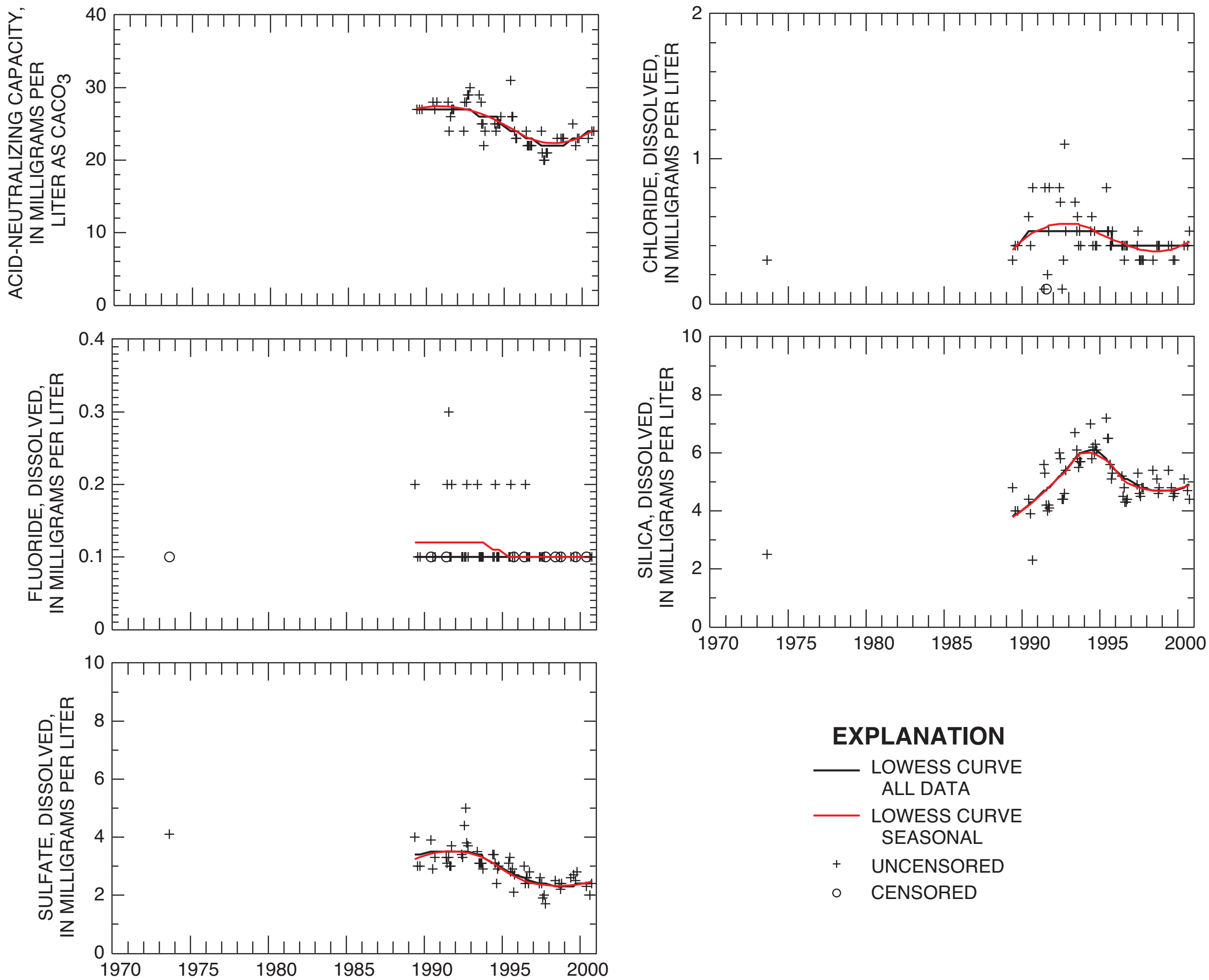

Figure 23. Temporal variations in periodic measurements and concentrations at Lake Granby near spillway, sampled near the surface.—Continued

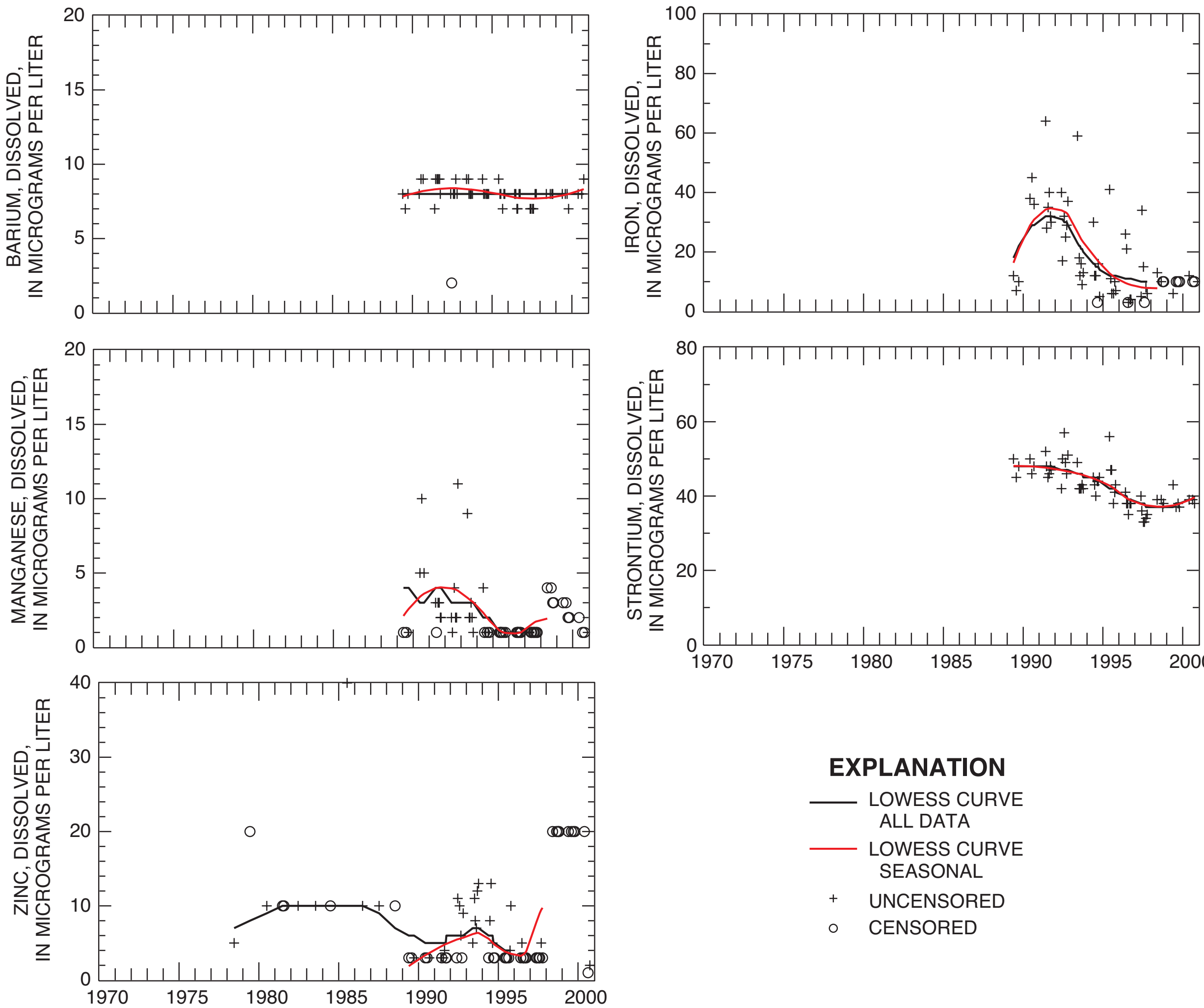

Figure 23. Temporal variations in periodic measurements and concentrations at Lake Granby near spillway, sampled near the surface.—Continued

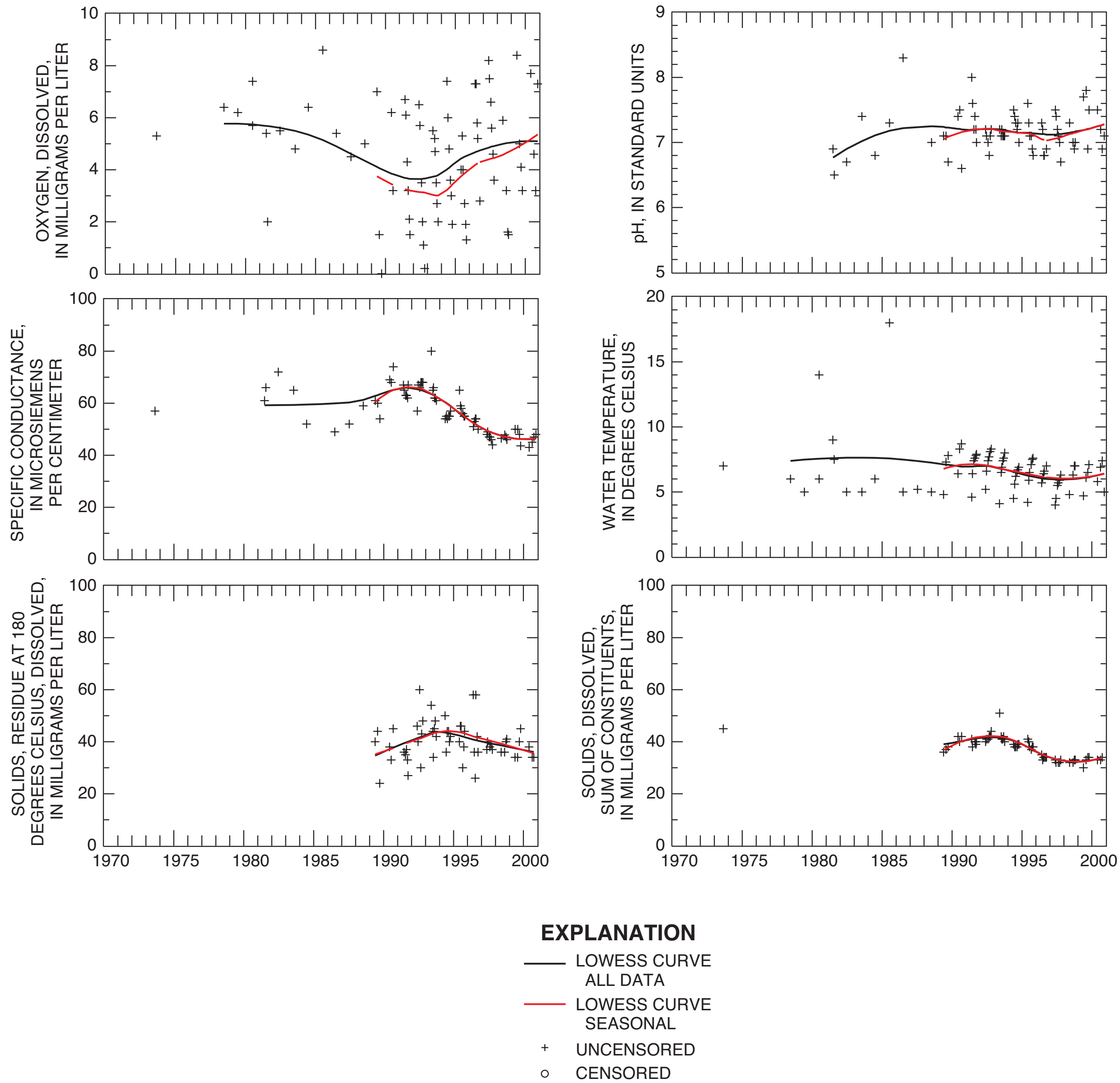

Figure 24. Temporal variations in periodic measurements and concentrations at Lake Granby near spillway, sampled near the bottom.

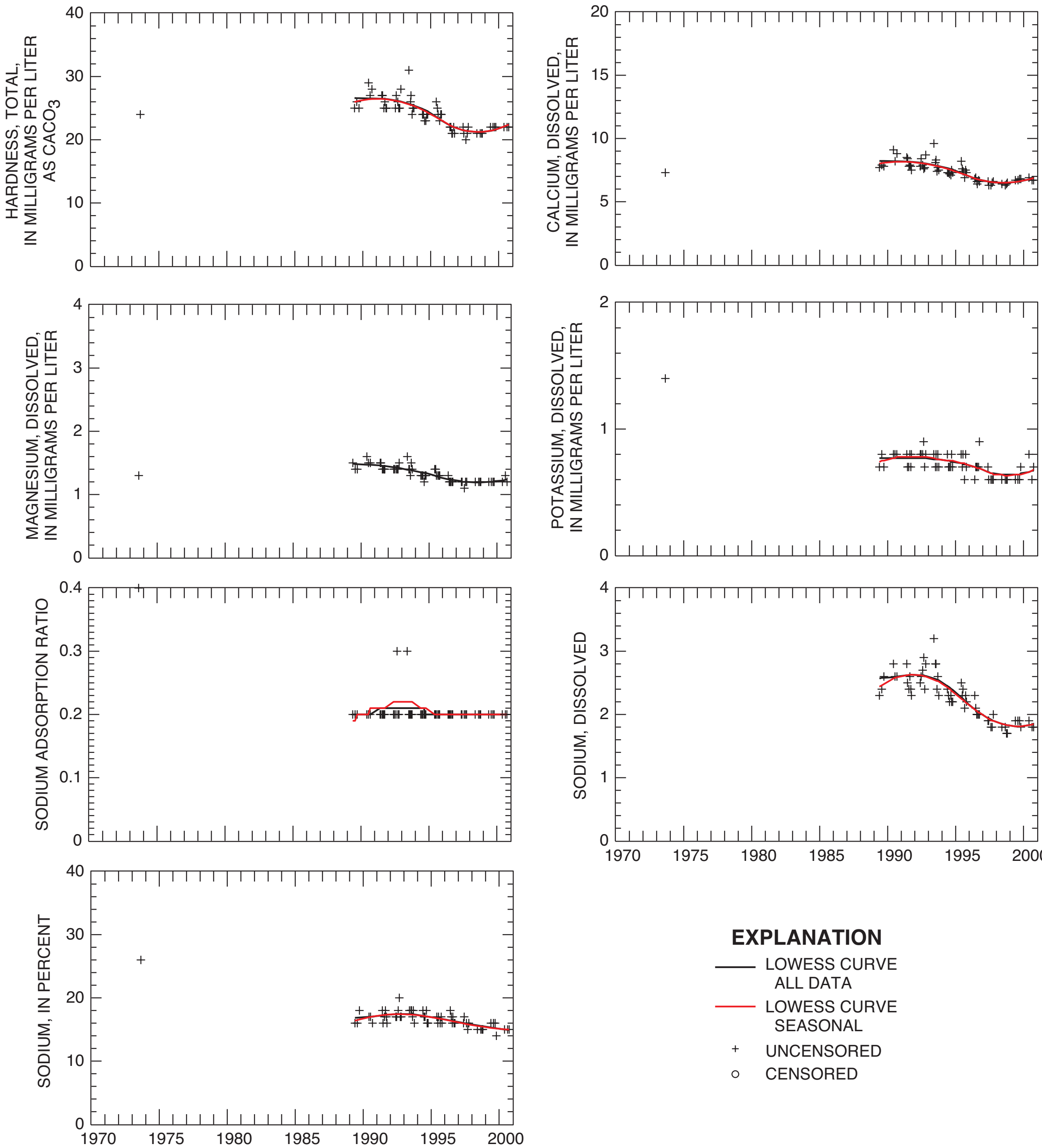

Figure 24. Temporal variations in periodic measurements and concentrations at Lake Granby near spillway, sampled near the bottom.—Continued

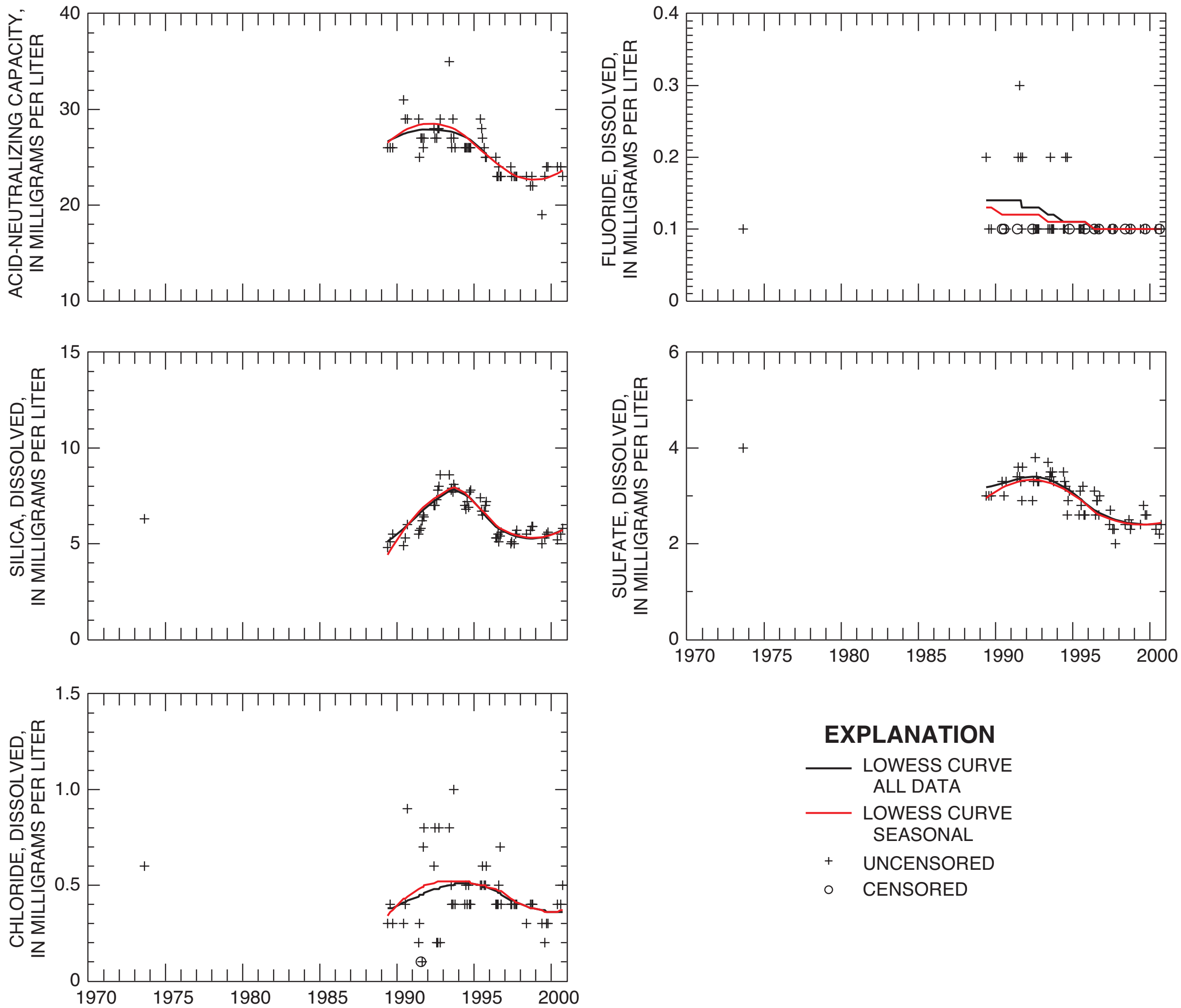

Figure 24. Temporal variations in periodic measurements and concentrations at Lake Granby near spillway, sampled near the bottom.—Continued

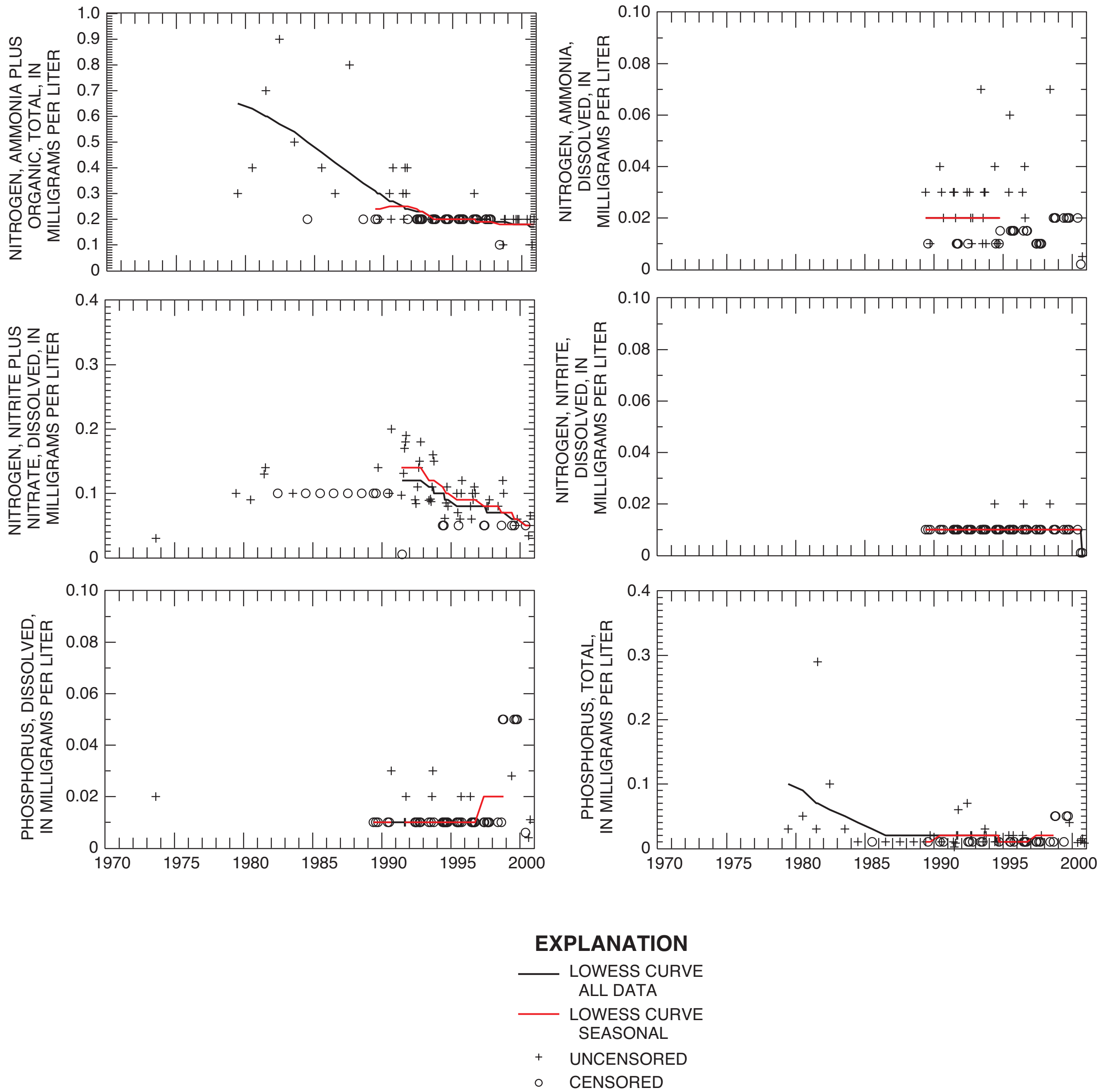

Figure 24. Temporal variations in periodic measurements and concentrations at Lake Granby near spillway, sampled near the bottom.—Continued

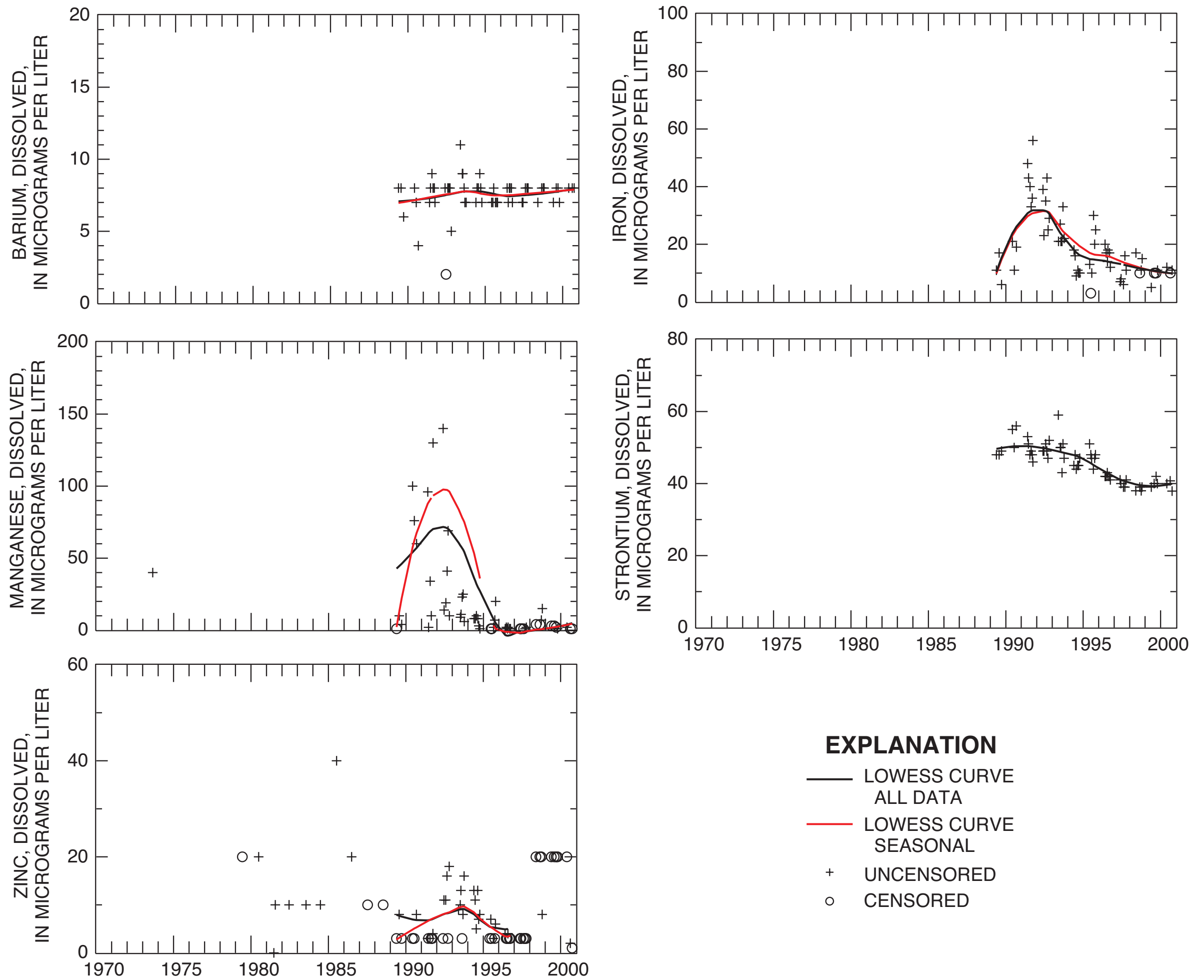

Figure 24. Temporal variations in periodic measurements and concentrations at Lake Granby near spillway, sampled near the bottom.—Continued

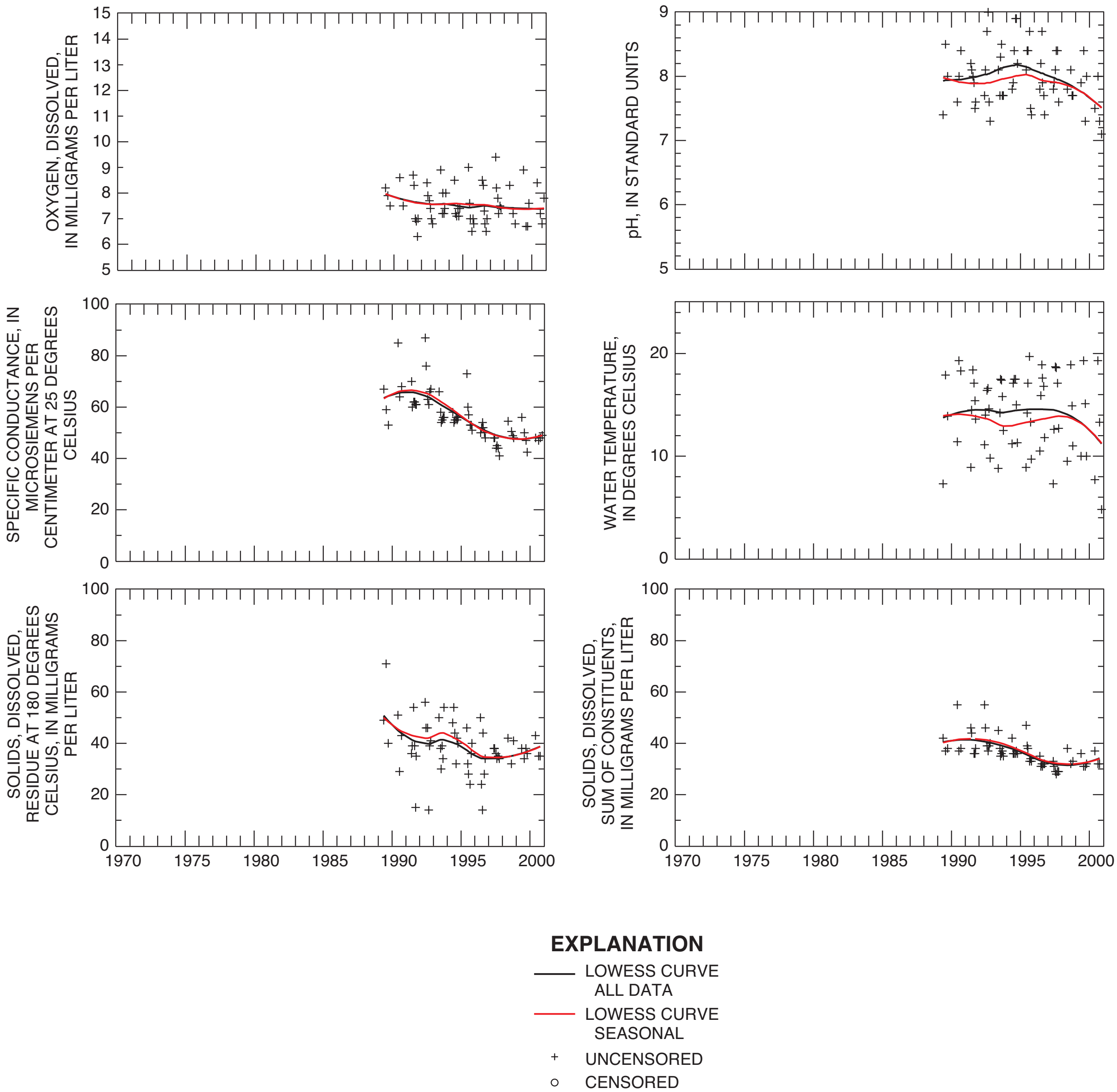

Figure 25. Temporal variations in periodic measurements and concentrations at Lake Granby near Rainbow Bay, sampled near the surface.

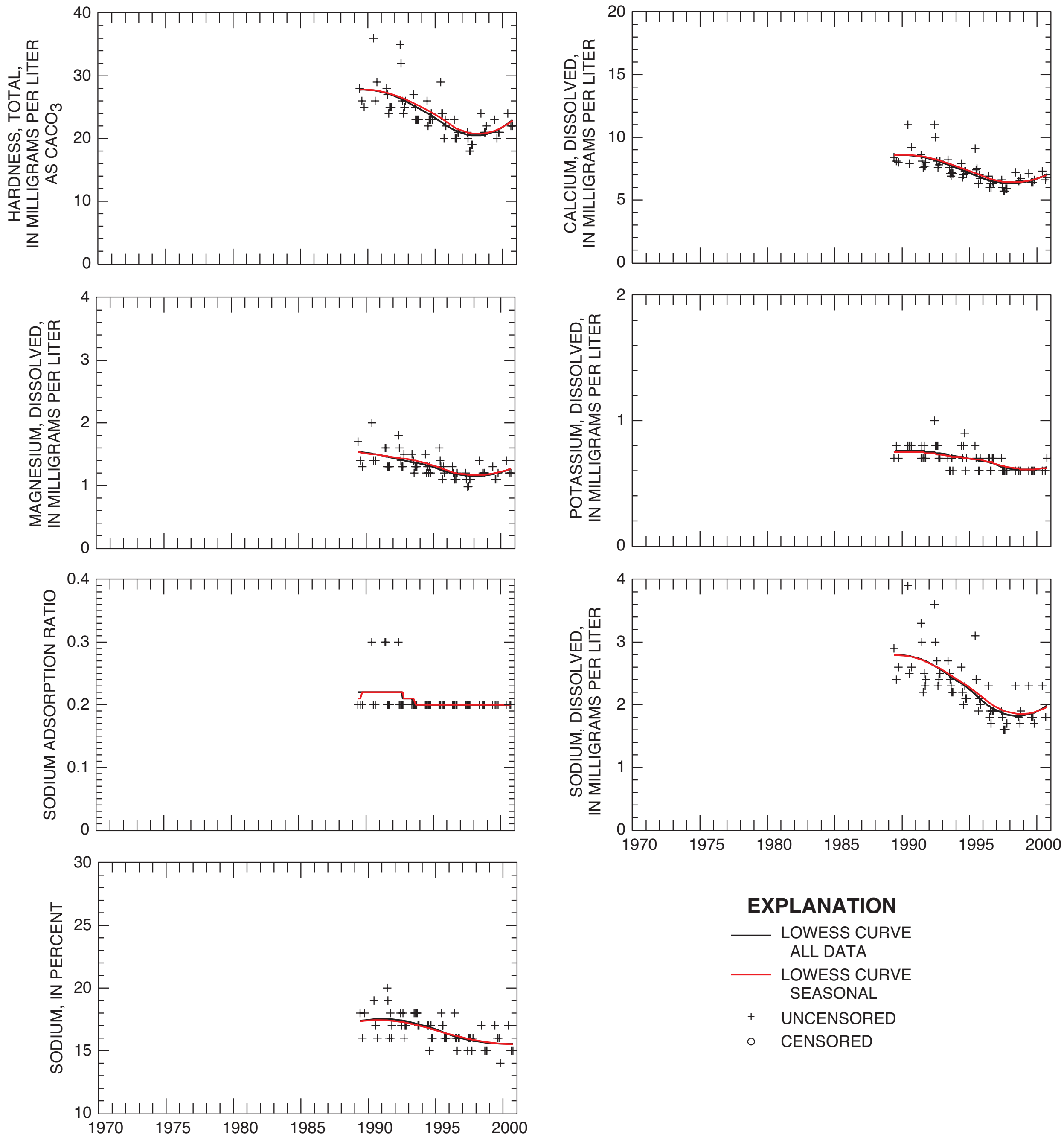

Figure 25. Temporal variations in periodic measurements and concentrations at Lake Granby near Rainbow Bay, sampled near the surface.—Continued

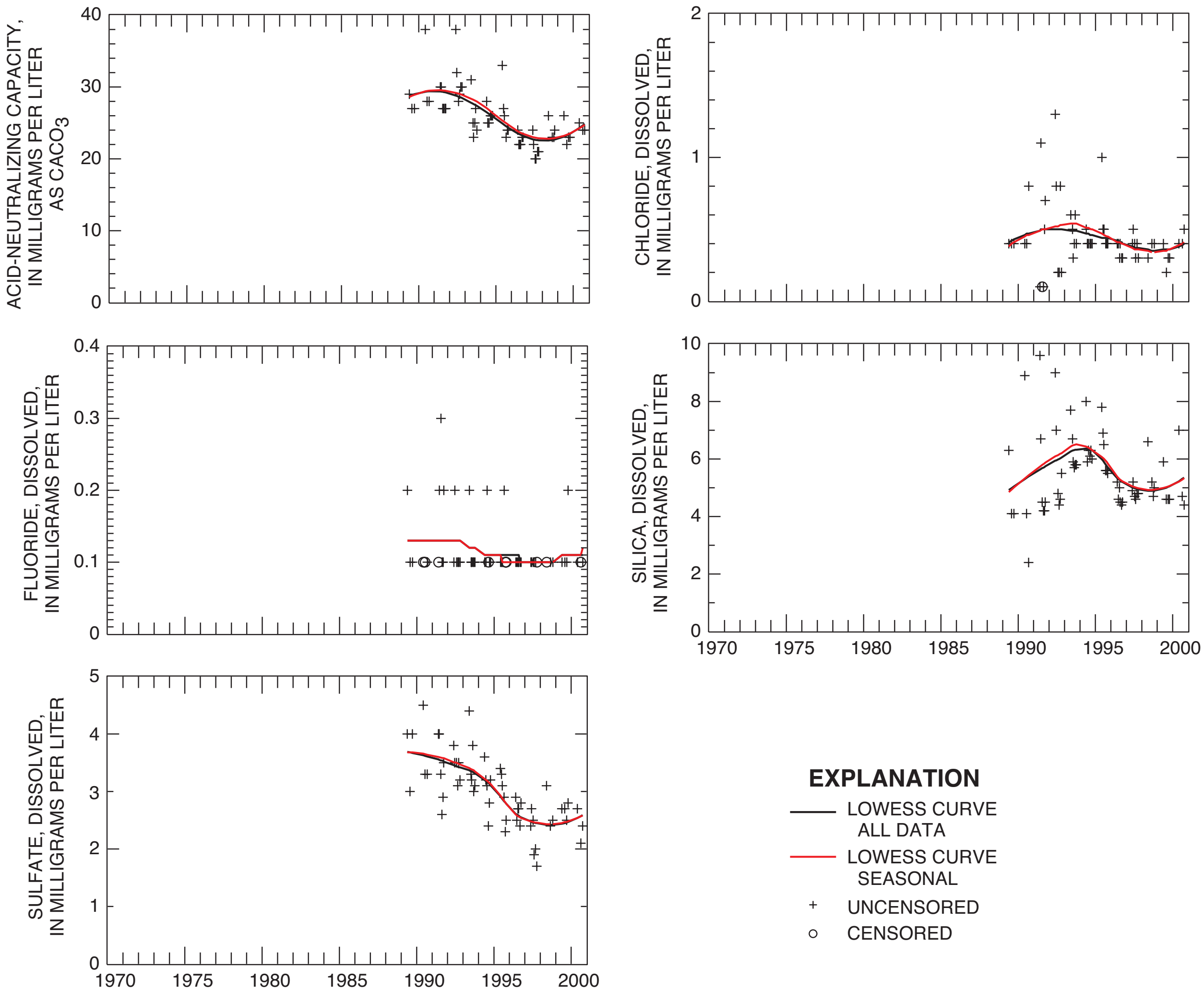

Figure 25. Temporal variations in periodic measurements and concentrations at Lake Granby near Rainbow Bay, sampled near the surface.—Continued

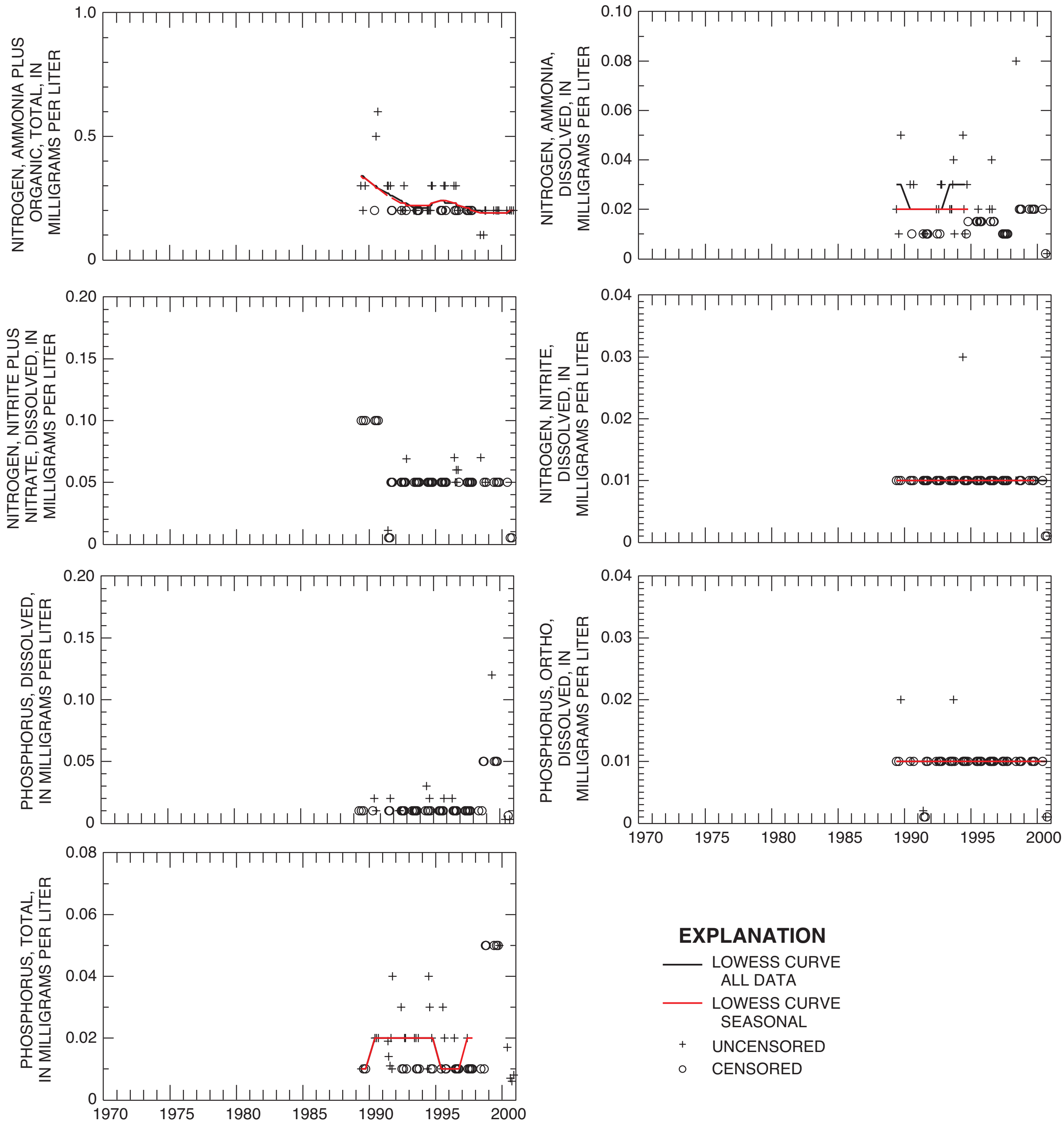

Figure 25. Temporal variations in periodic measurements and concentrations at Lake Granby near Rainbow Bay, sampled near the surface.—Continued

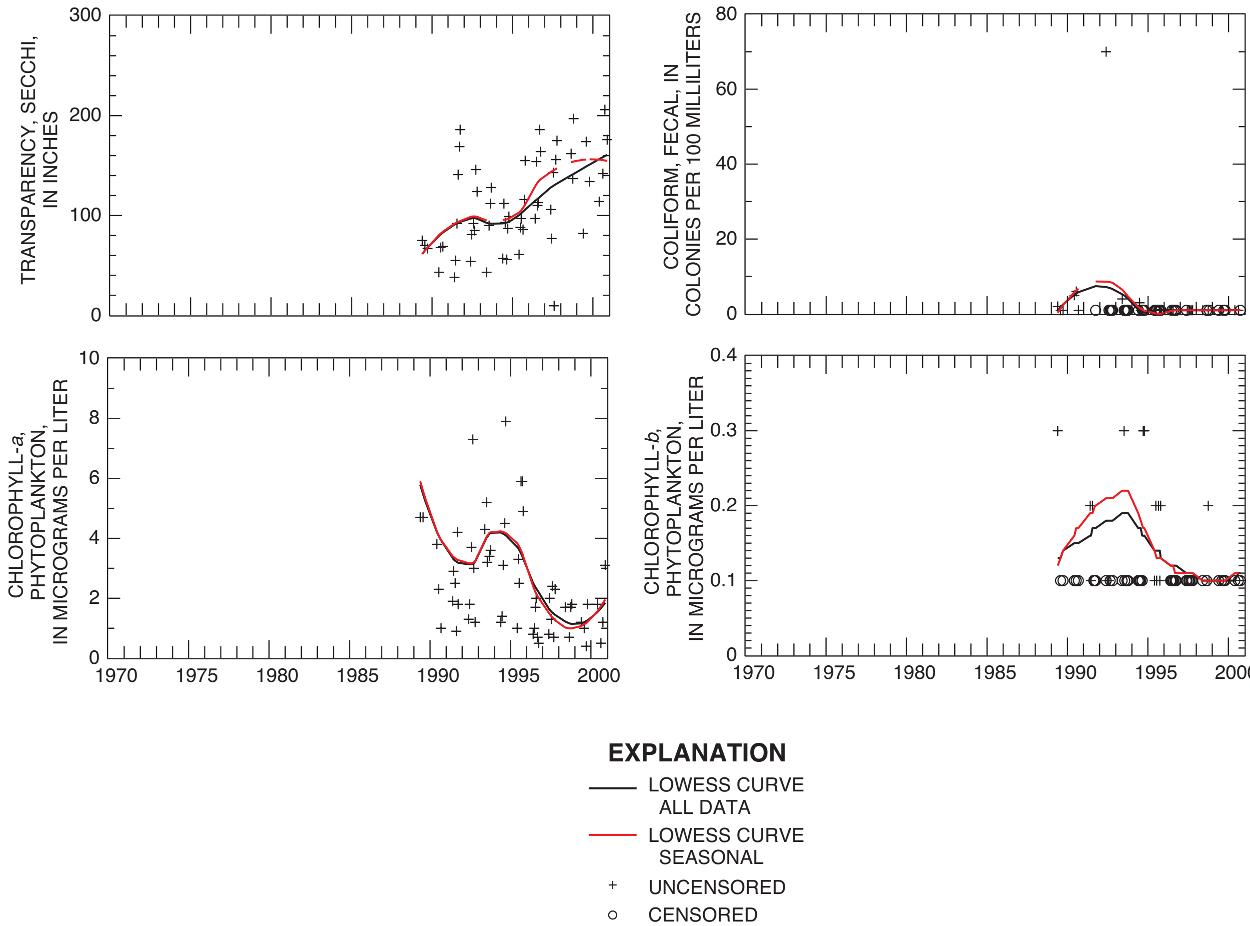

Figure 25. Temporal variations in periodic measurements and concentrations at Lake Granby near Rainbow Bay, sampled near the surface.—Continued

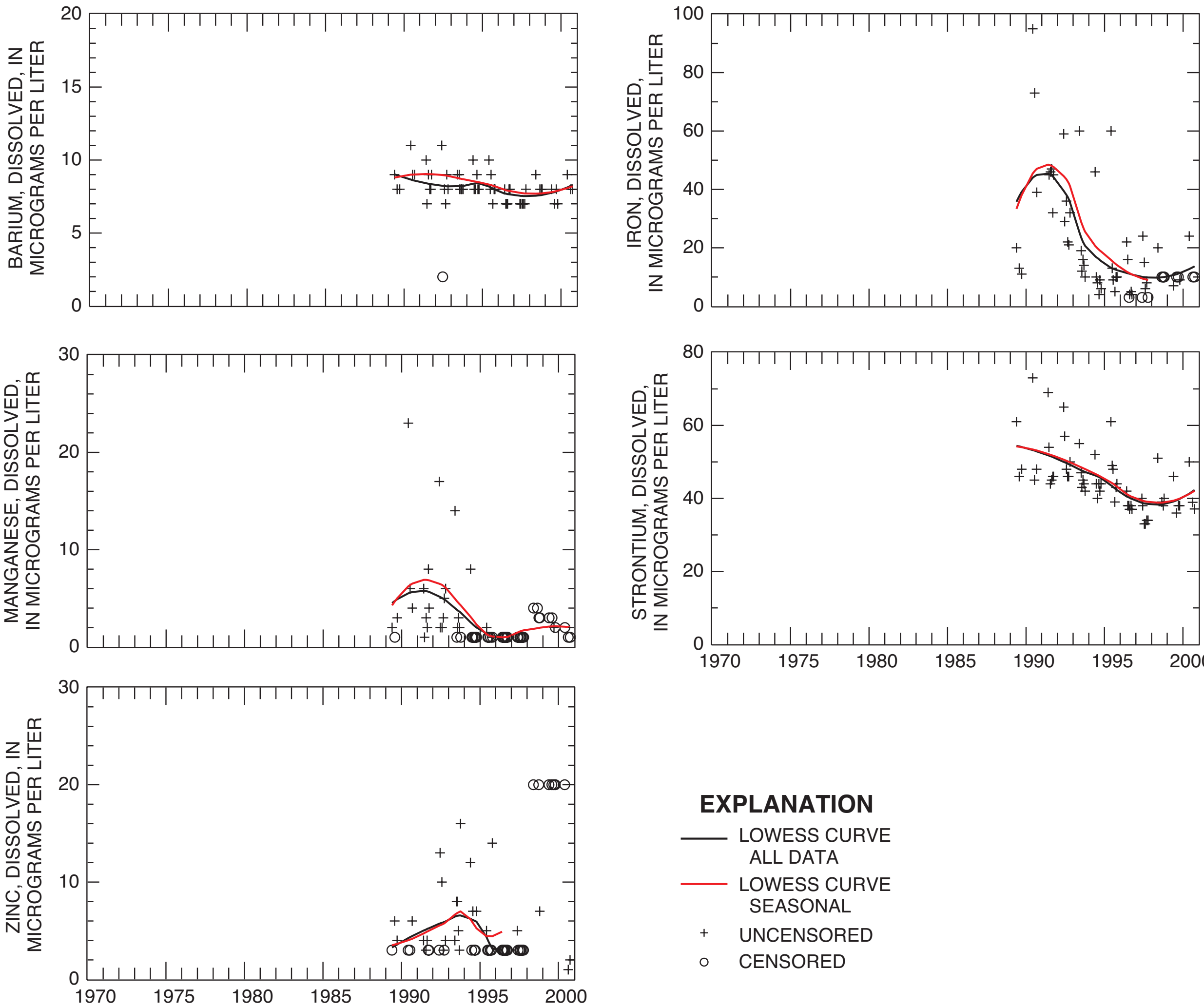

Figure 25. Temporal variations in periodic measurements and concentrations at Lake Granby near Rainbow Bay, sampled near the surface.—Continued

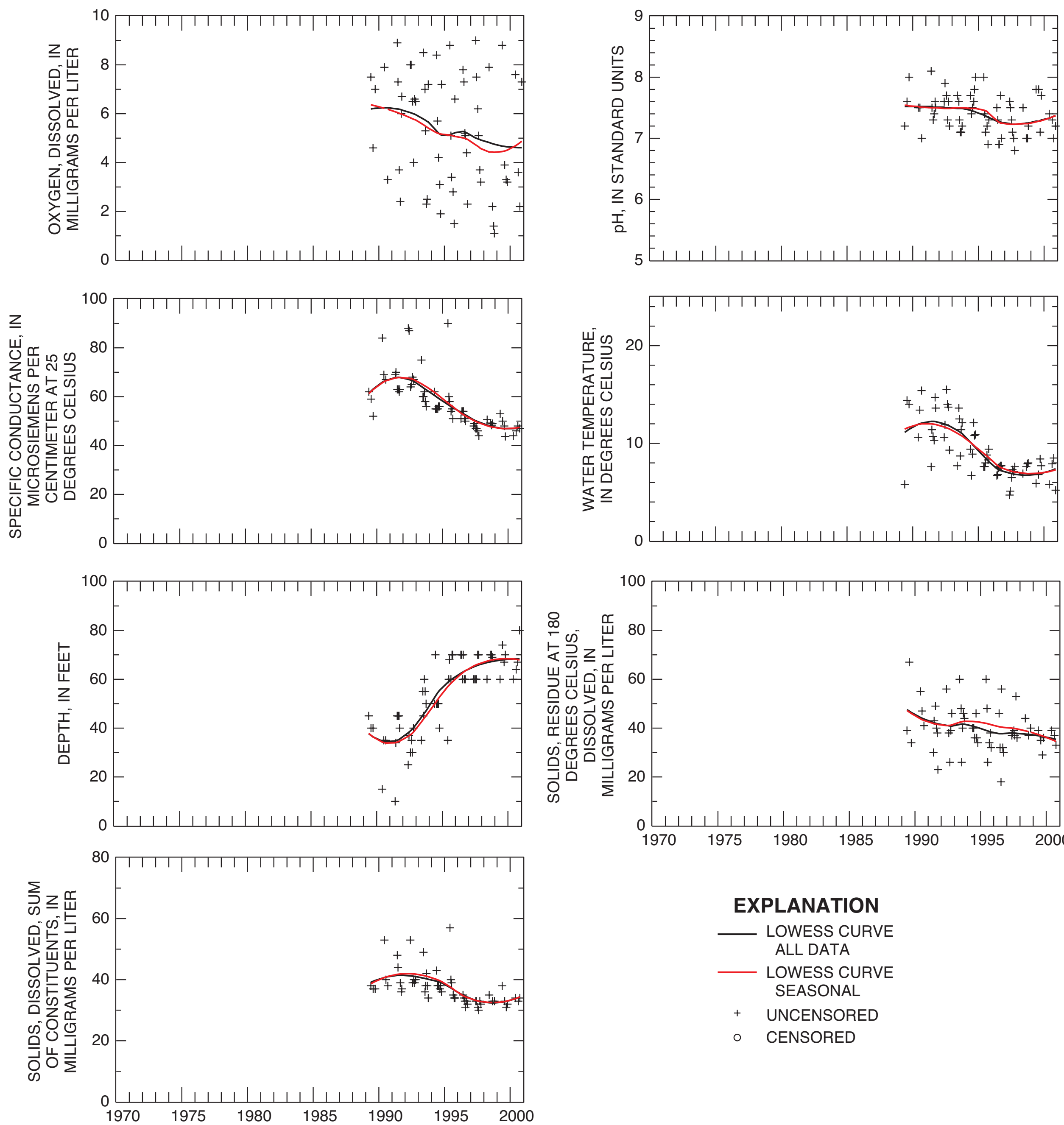

Figure 26. Temporal variations in periodic measurements and concentrations at Lake Granby near Rainbow Bay, sampled near the bottom.

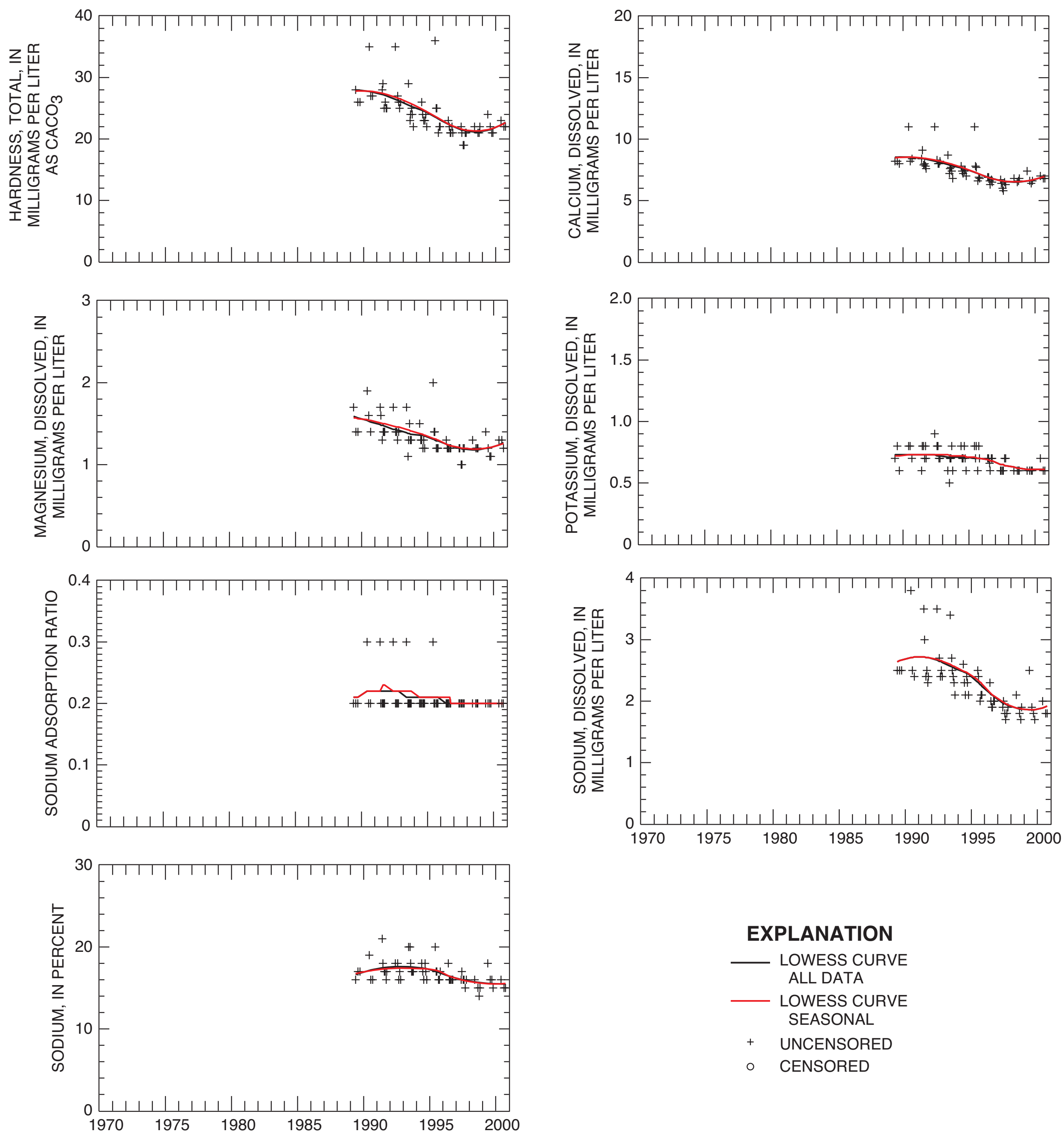

Figure 26. Temporal variations in periodic measurements and concentrations at Lake Granby near Rainbow Bay, sampled near the bottom.—Continued

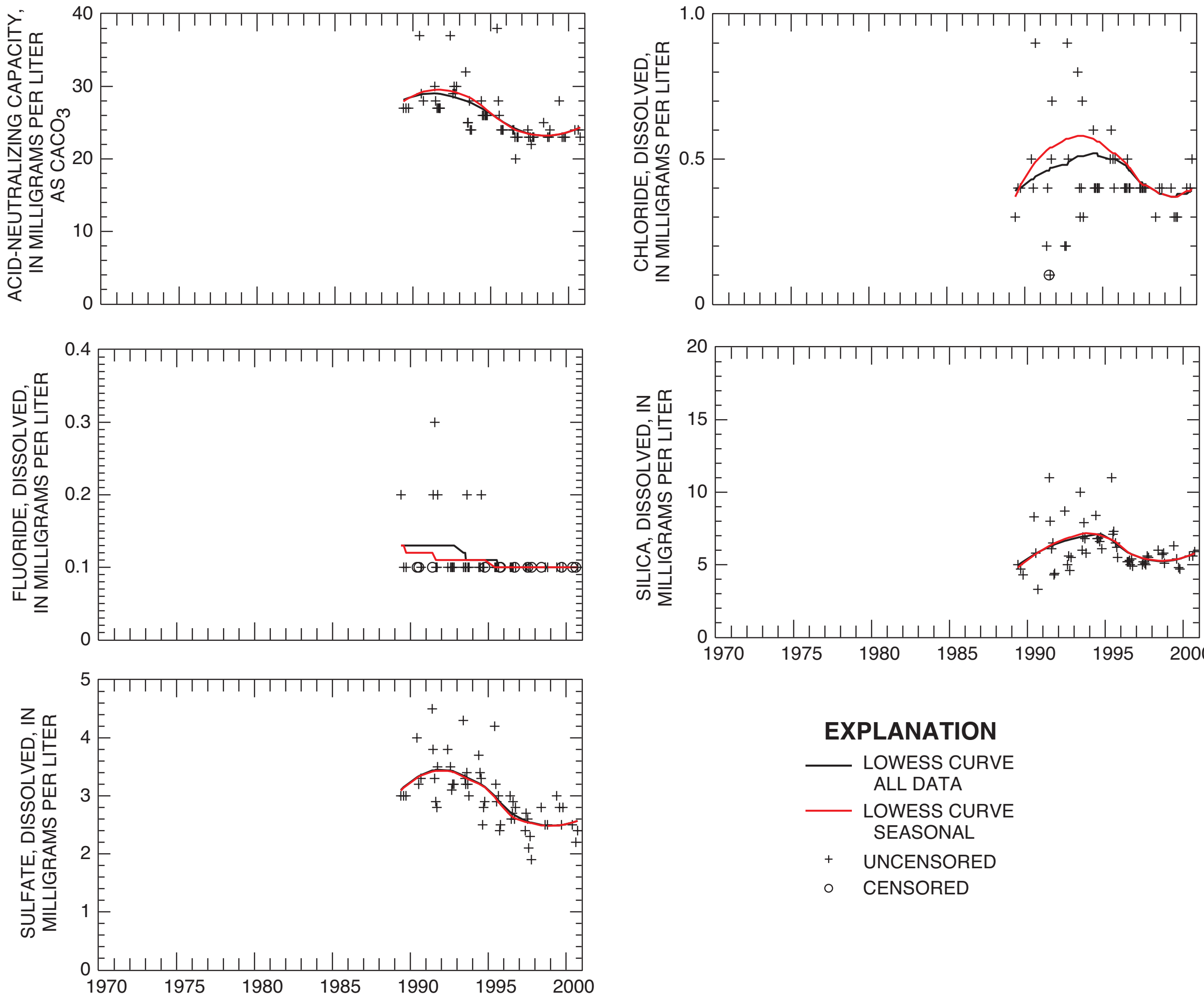

Figure 26. Temporal variations in periodic measurements and concentrations at Lake Granby near Rainbow Bay, sampled near the bottom.—Continued

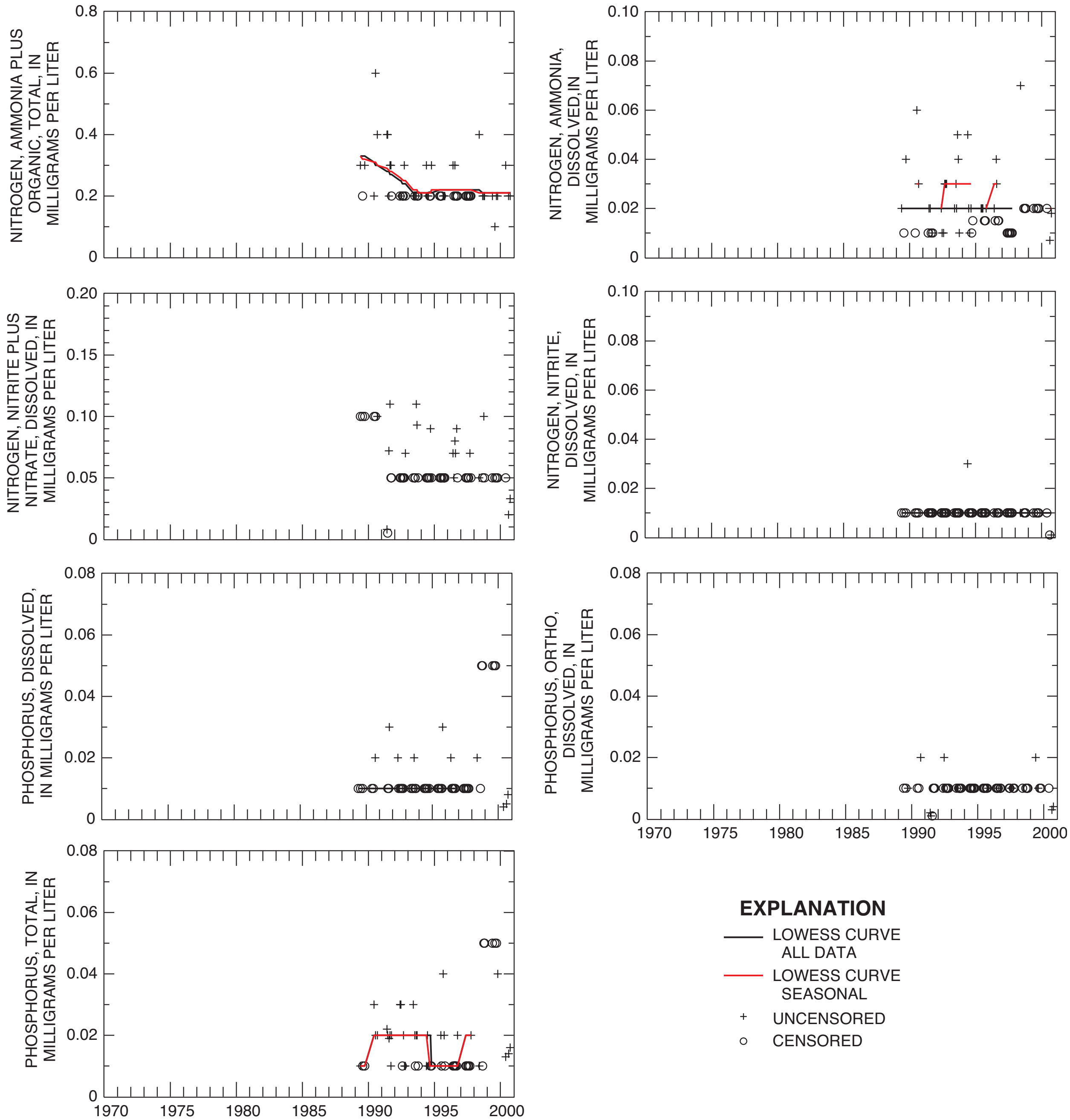

Figure 26. Temporal variations in periodic measurements and concentrations at Lake Granby near Rainbow Bay, sampled near the bottom.—Continued

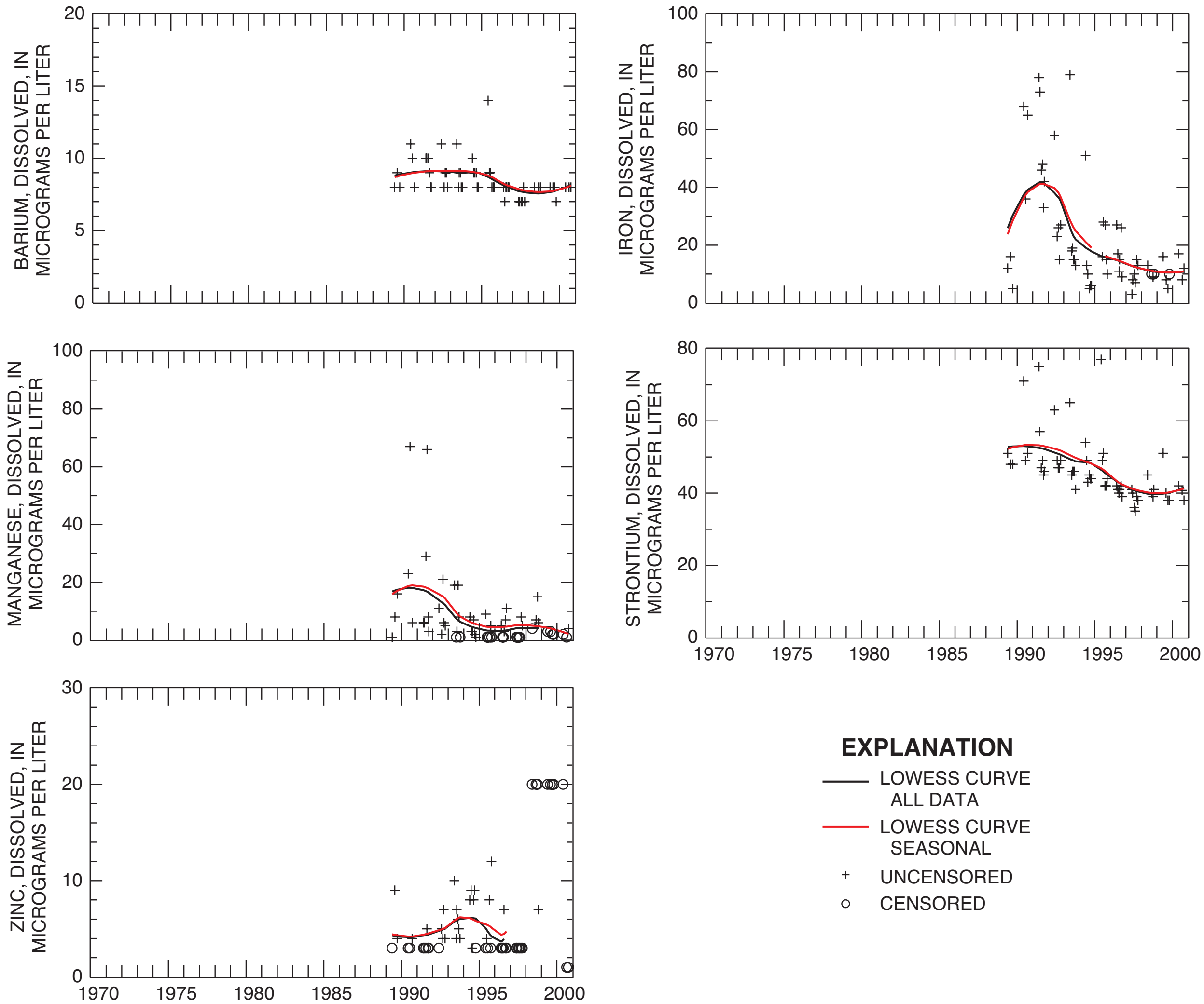

Figure 26. Temporal variations in periodic measurements and concentrations at Lake Granby near Rainbow Bay, sampled near the bottom.—Continued

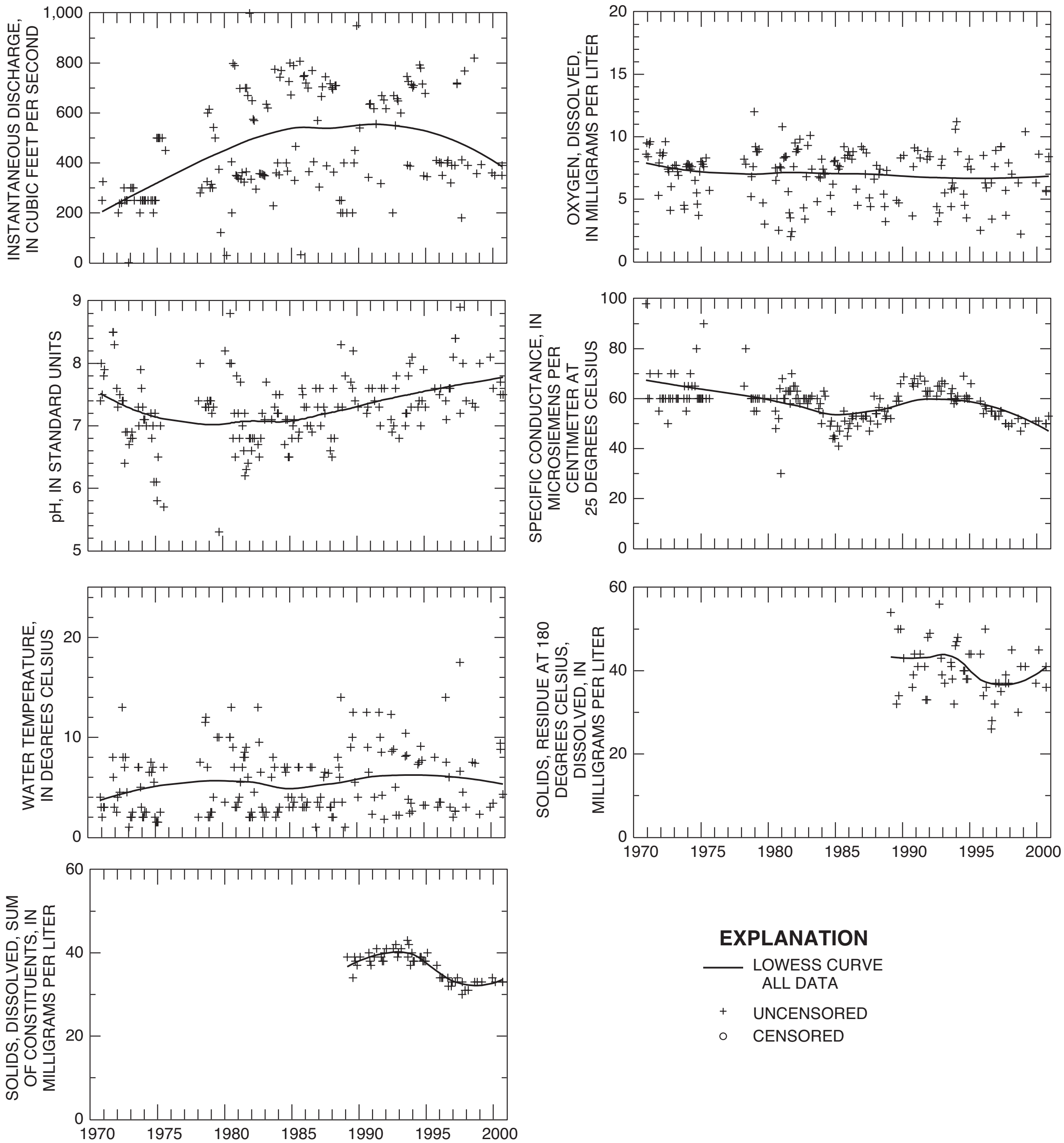

Figure 27. Temporal variations in periodic measurements and concentrations at Granby Pump Canal.

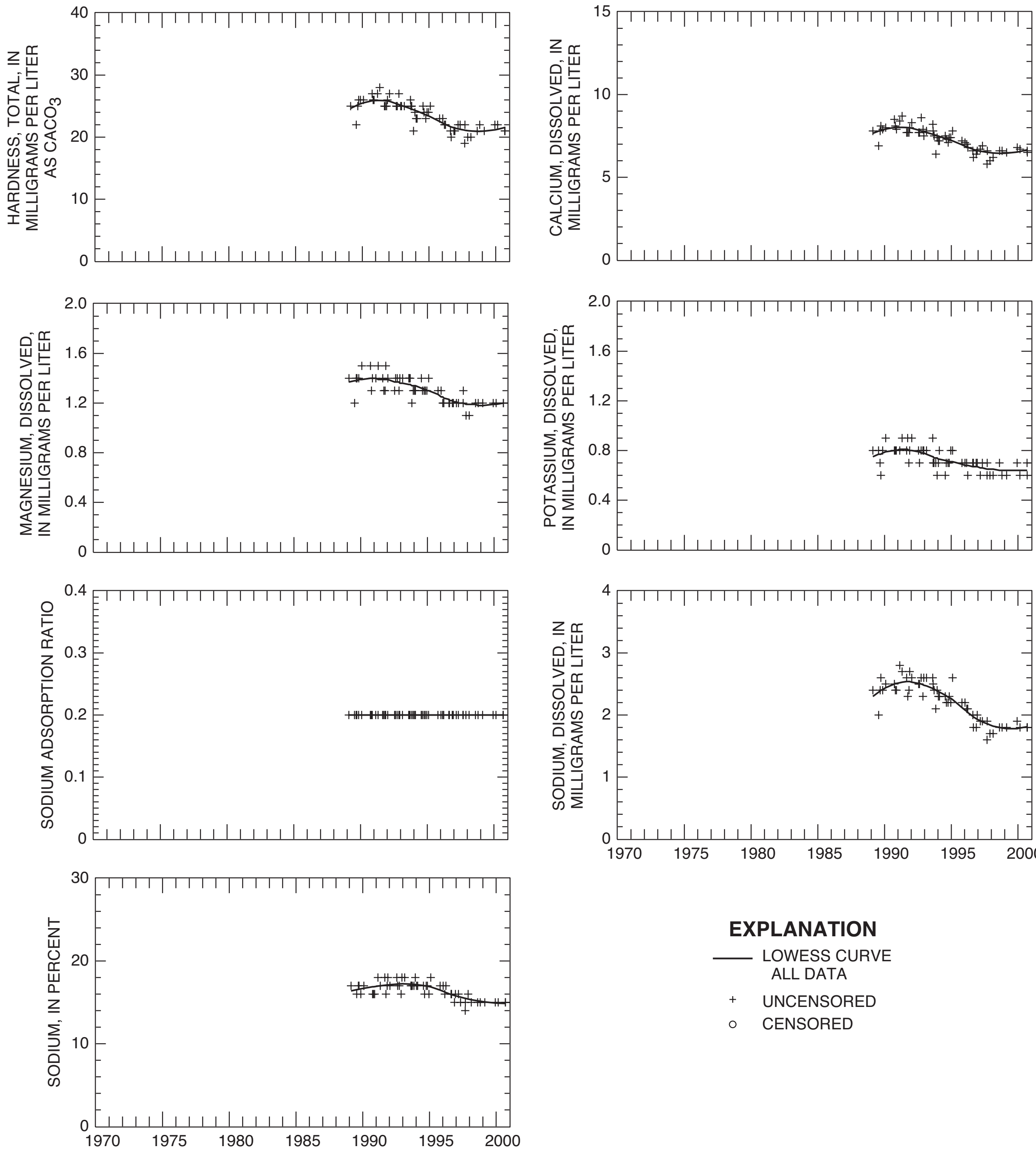

Figure 27. Temporal variations in periodic measurements and concentrations at Granby Pump Canal.—Continued

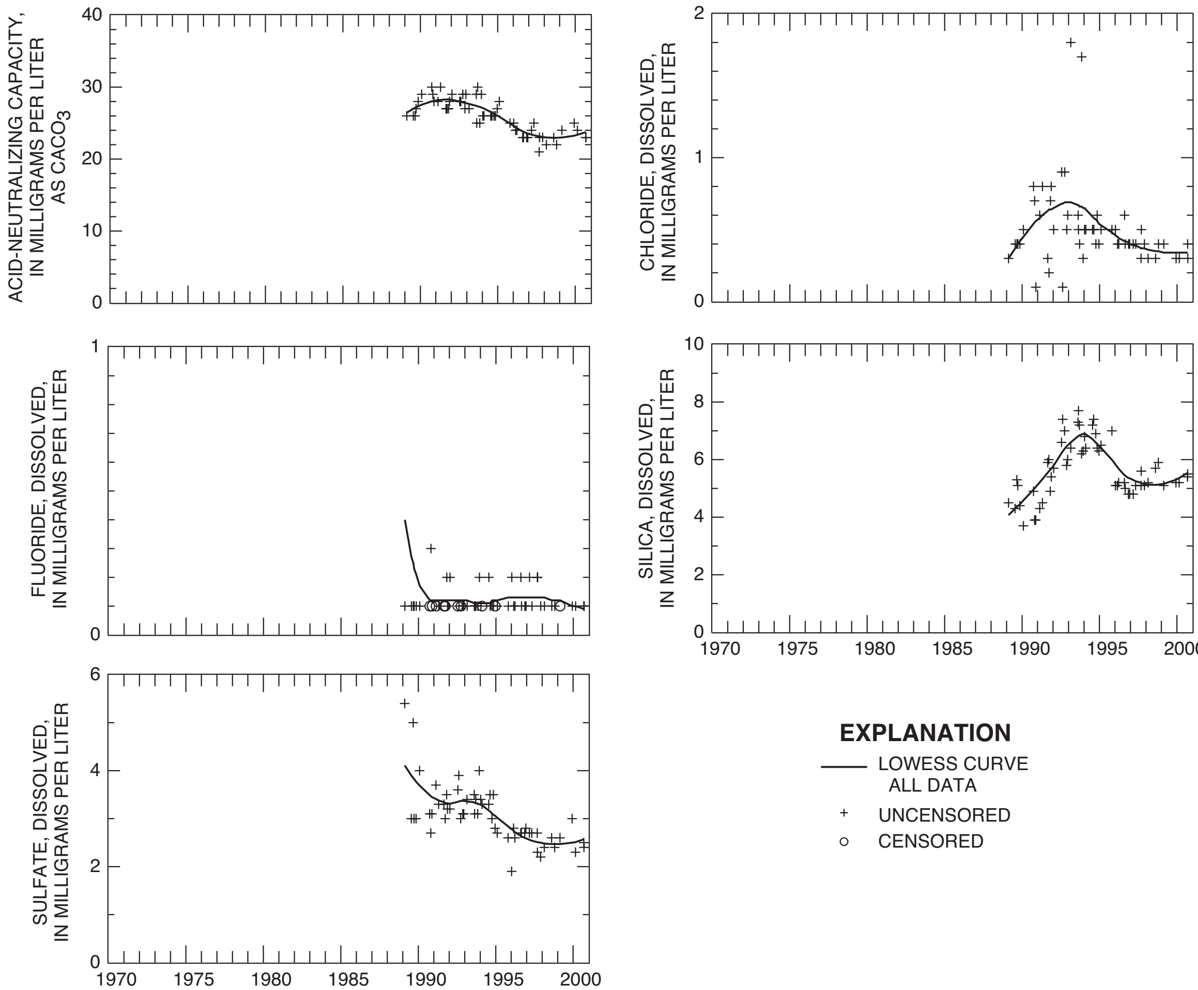

Figure 27. Temporal variations in periodic measurements and concentrations at Granby Pump Canal.—Continued

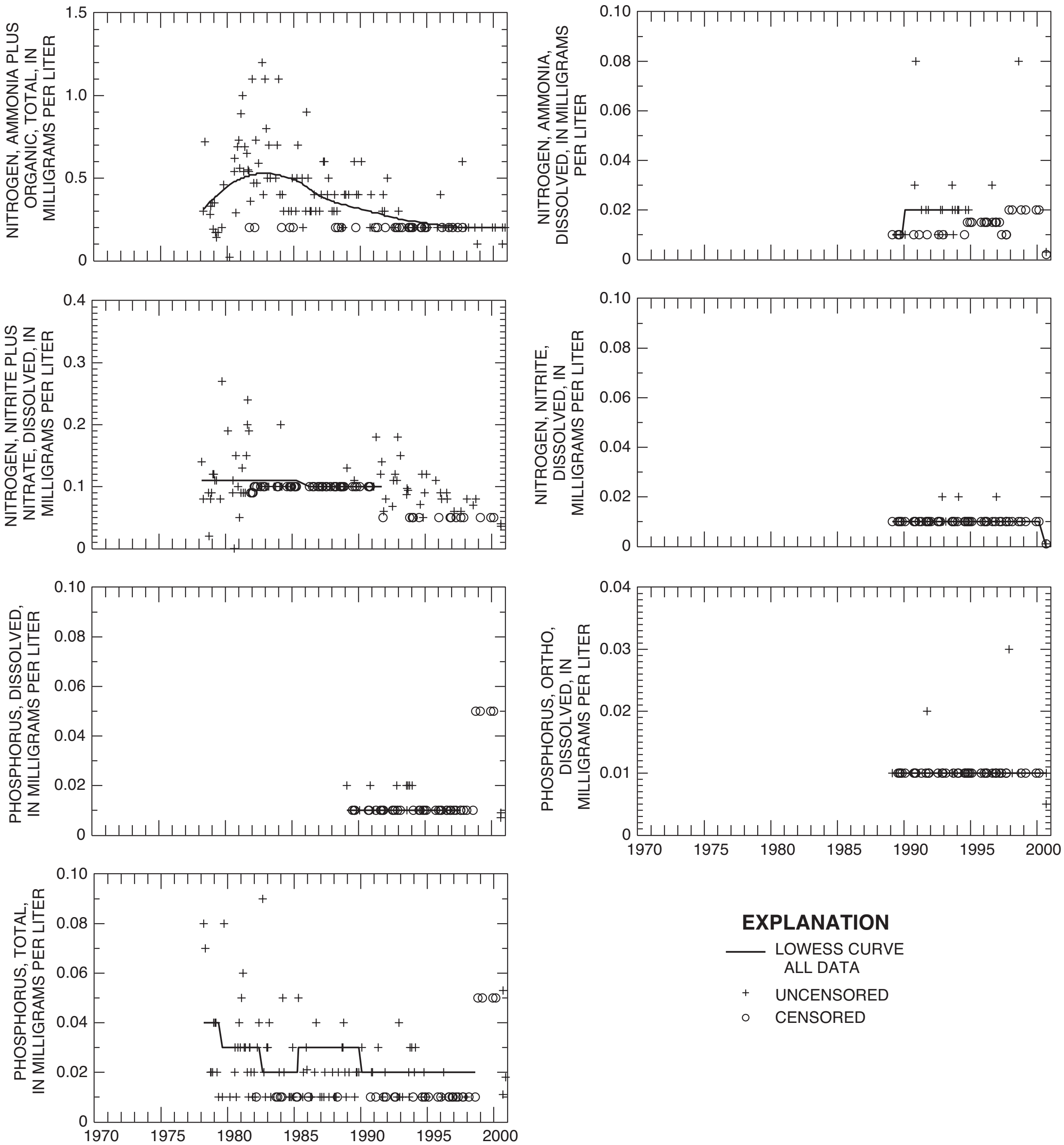

Figure 27. Temporal variations in periodic measurements and concentrations at Granby Pump Canal.—Continued

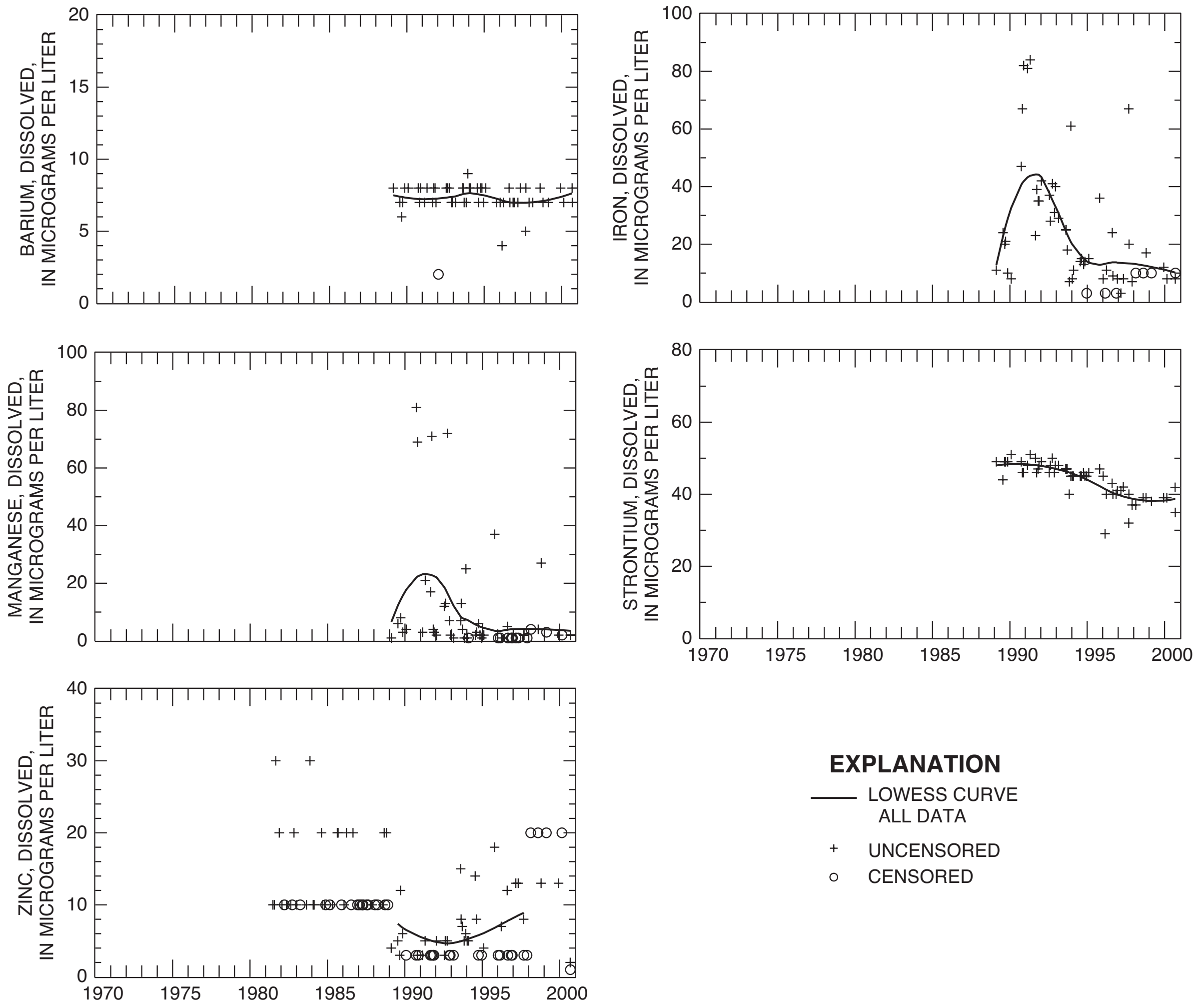

Figure 27. Temporal variations in periodic measurements and concentrations at Granby Pump Canal.—Continued

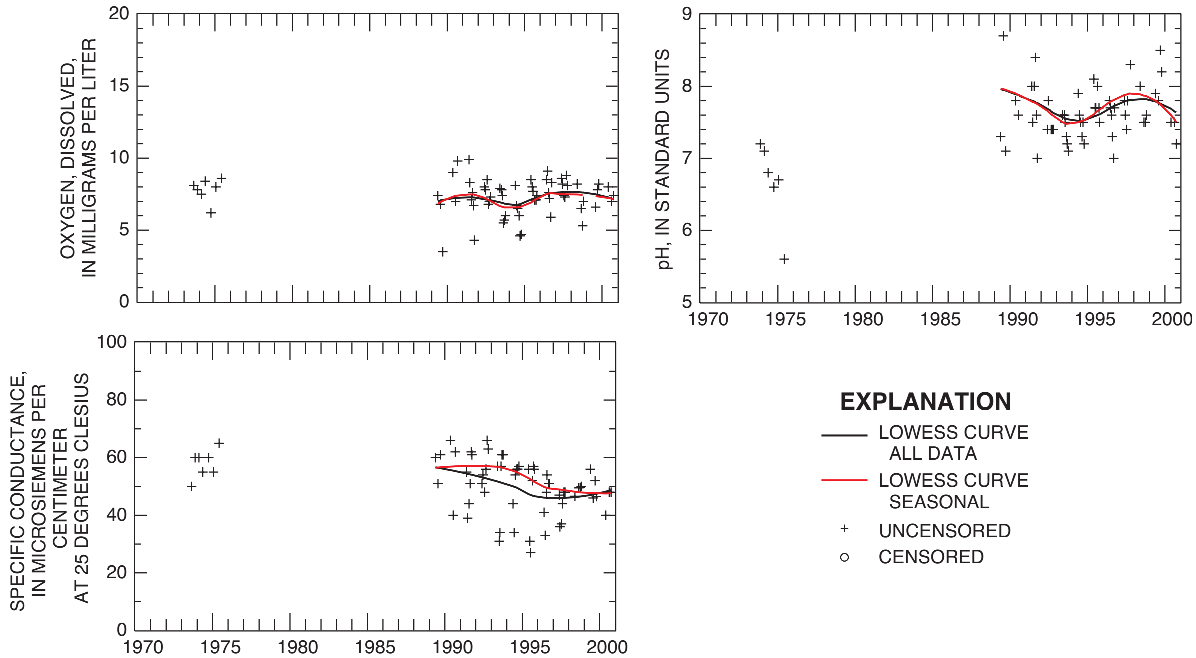

Figure 28. Temporal variations in periodic measurements and concentrations at Shadow Mountain Lake, sampled at the surface.

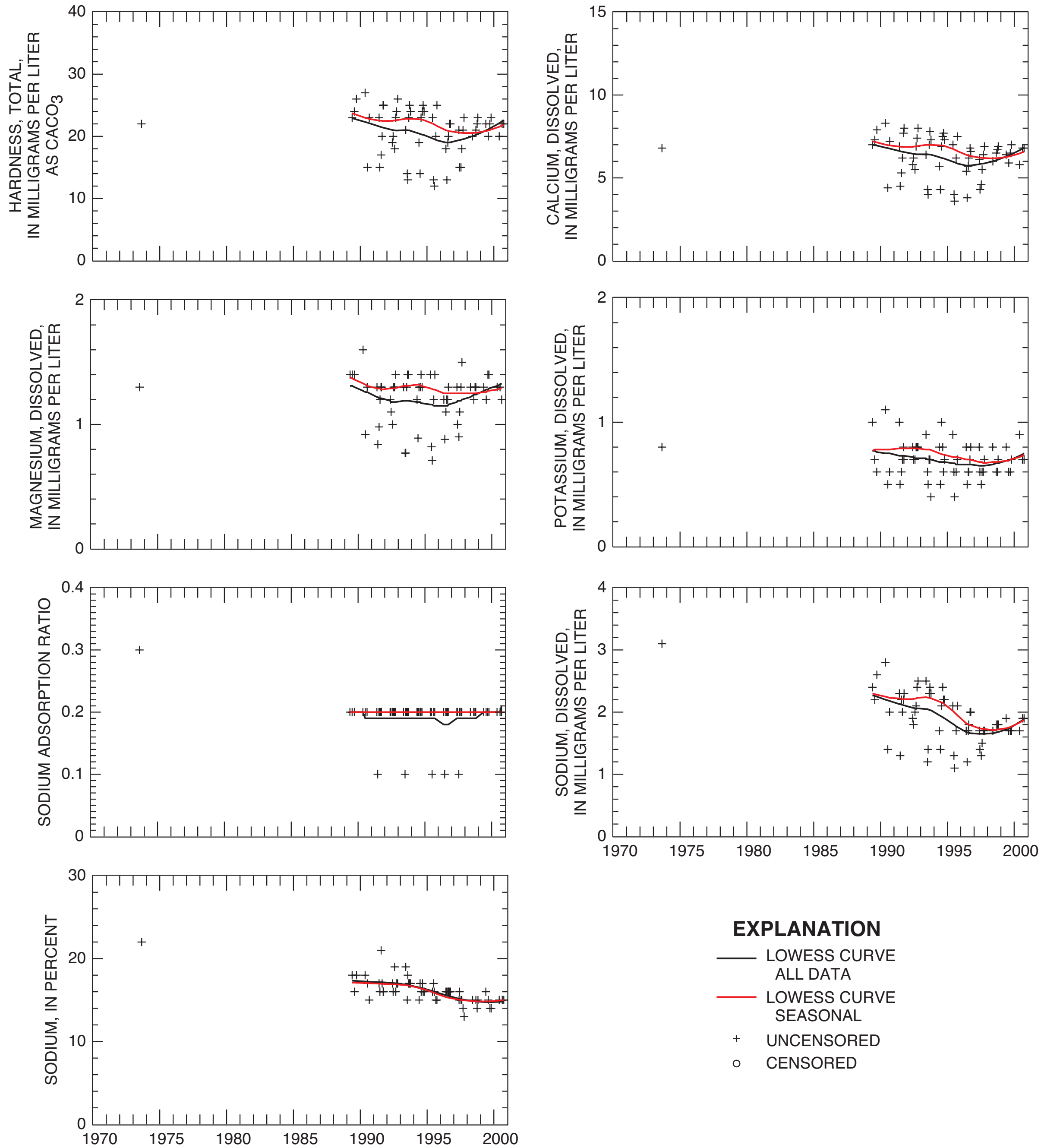

Figure 28. Temporal variations in periodic measurements and concentrations at Shadow Mountain Lake, sampled at the surface.—Continued

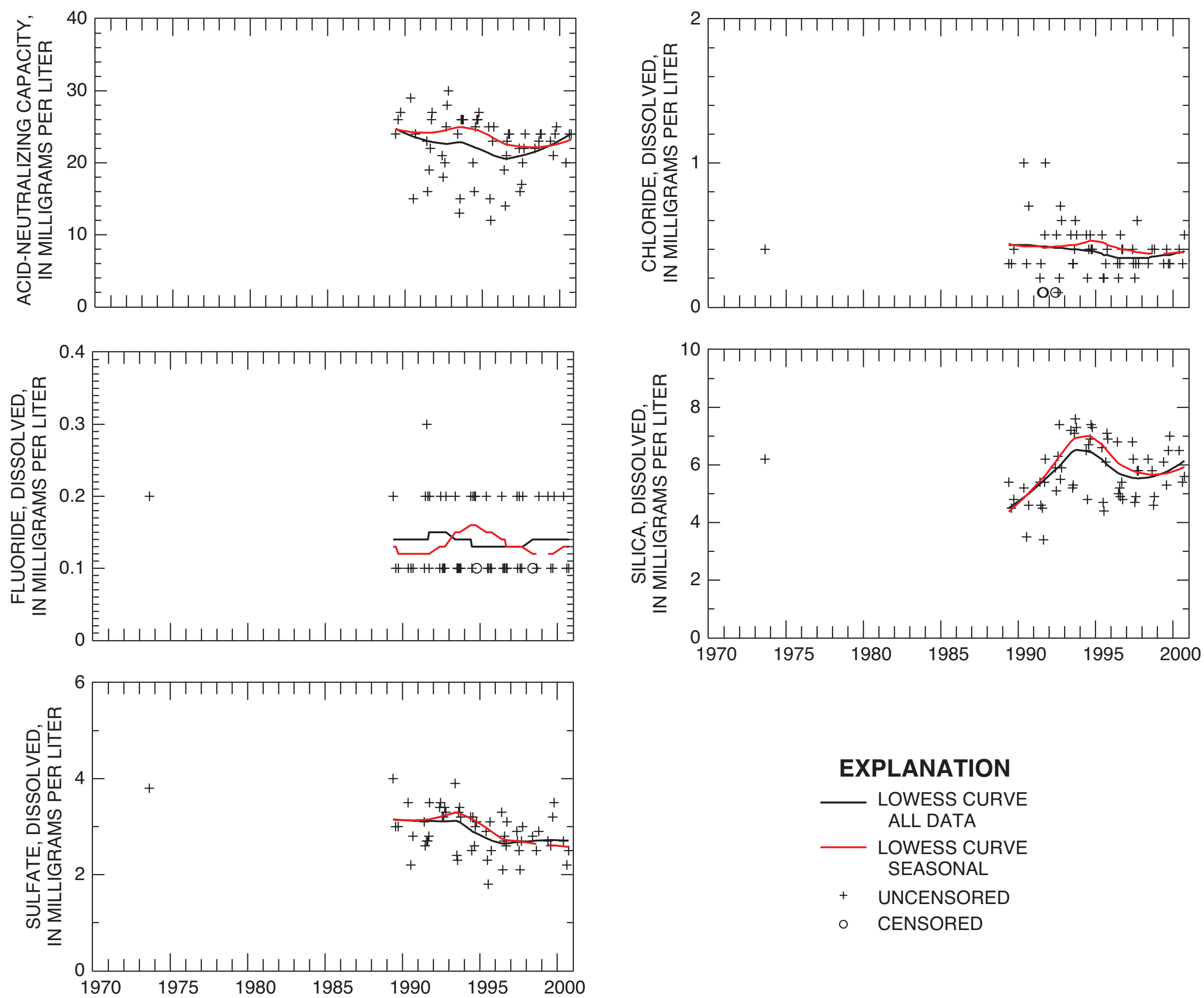

Figure 28. Temporal variations in periodic measurements and concentrations at Shadow Mountain Lake, sampled at the surface.—Continued

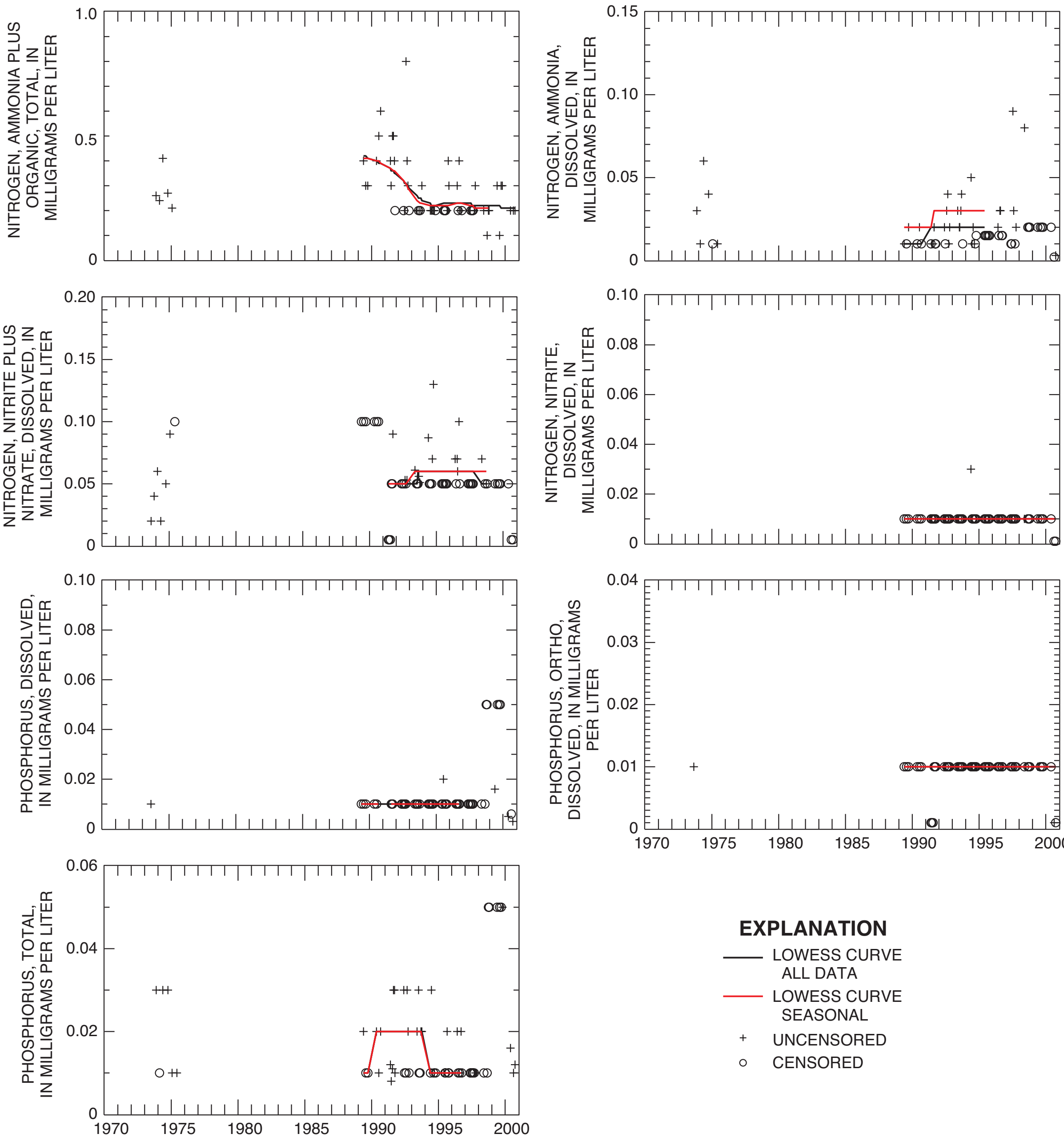

Figure 28. Temporal variations in periodic measurements and concentrations at Shadow Mountain Lake, sampled at the surface.—Continued

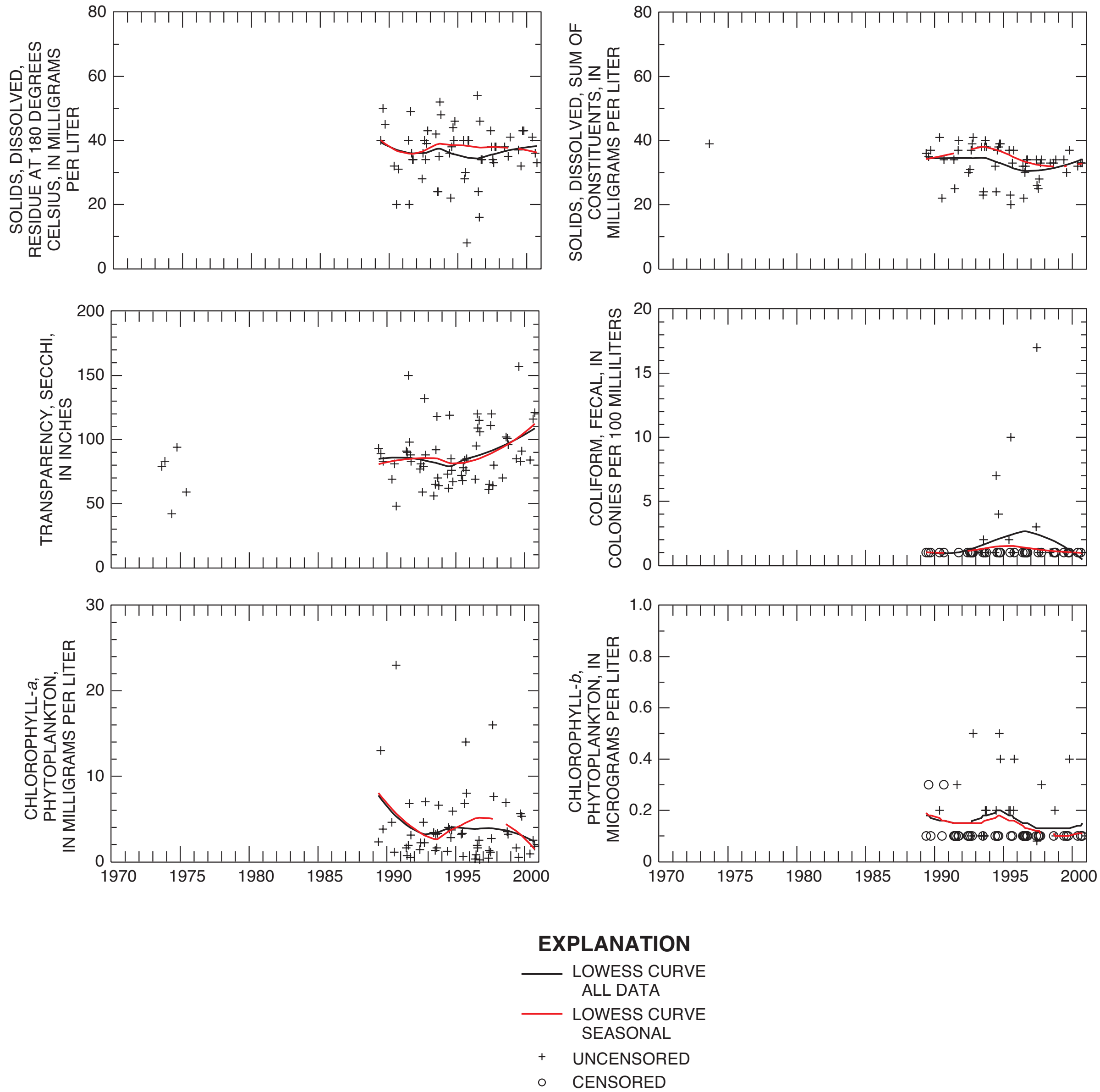

Figure 28. Temporal variations in periodic measurements and concentrations at Shadow Mountain Lake, sampled at the surface.—Continued

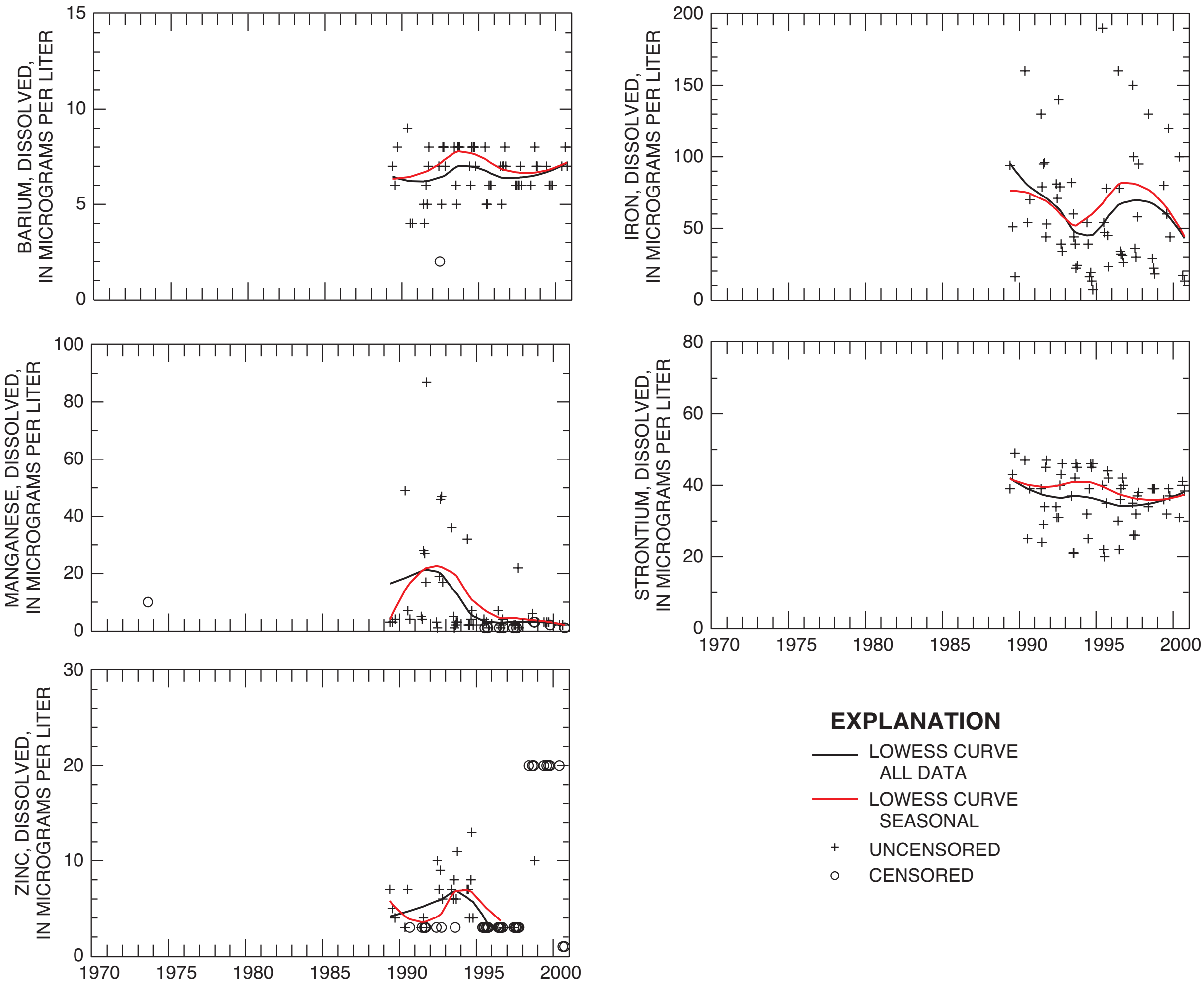

Figure 28. Temporal variations in periodic measurements and concentrations at Shadow Mountain Lake, sampled at the surface.—Continued

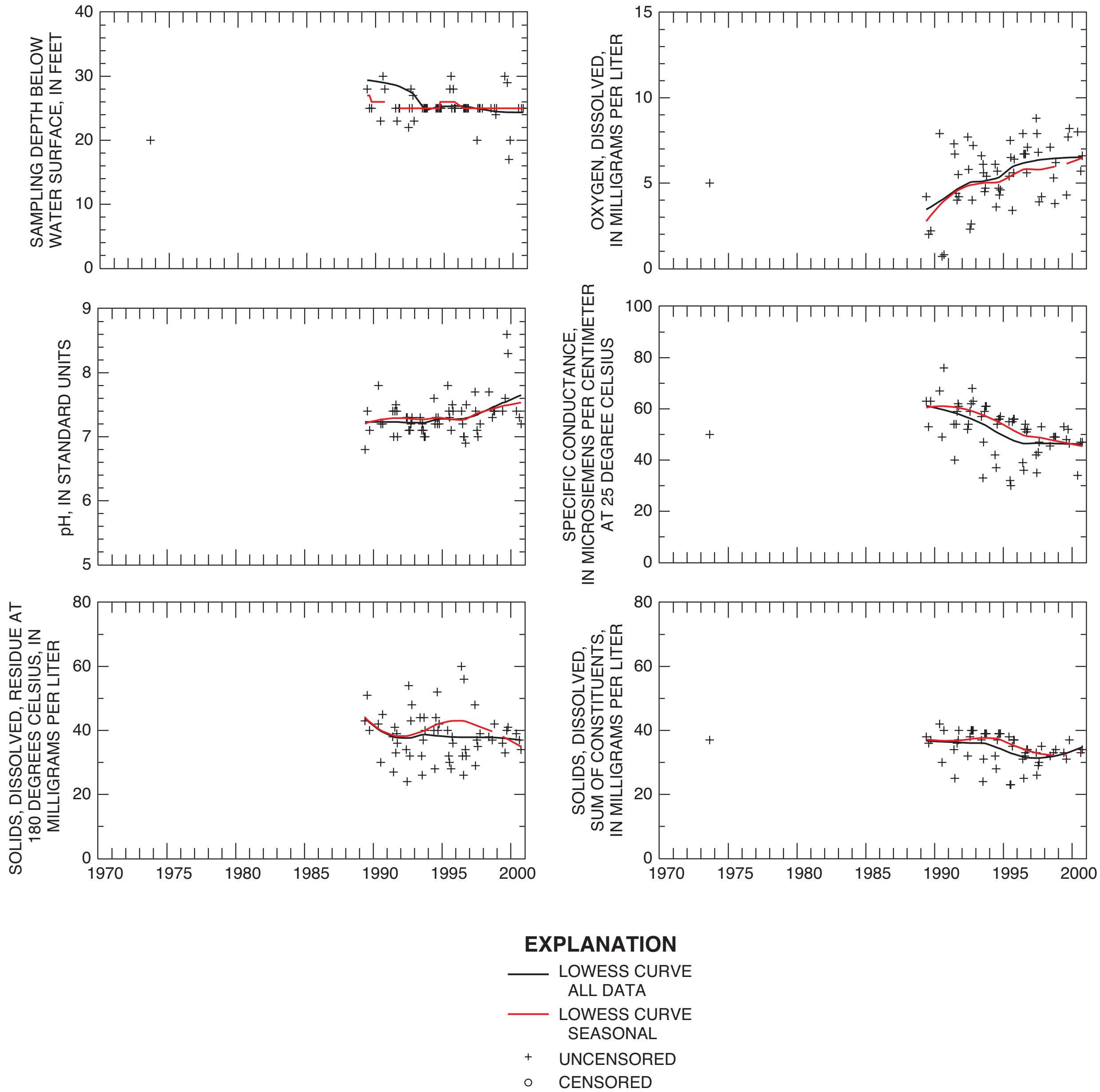

Figure 29. Temporal variations in periodic measurements and concentrations at Shadow Mountain Lake, sampled near the bottom.

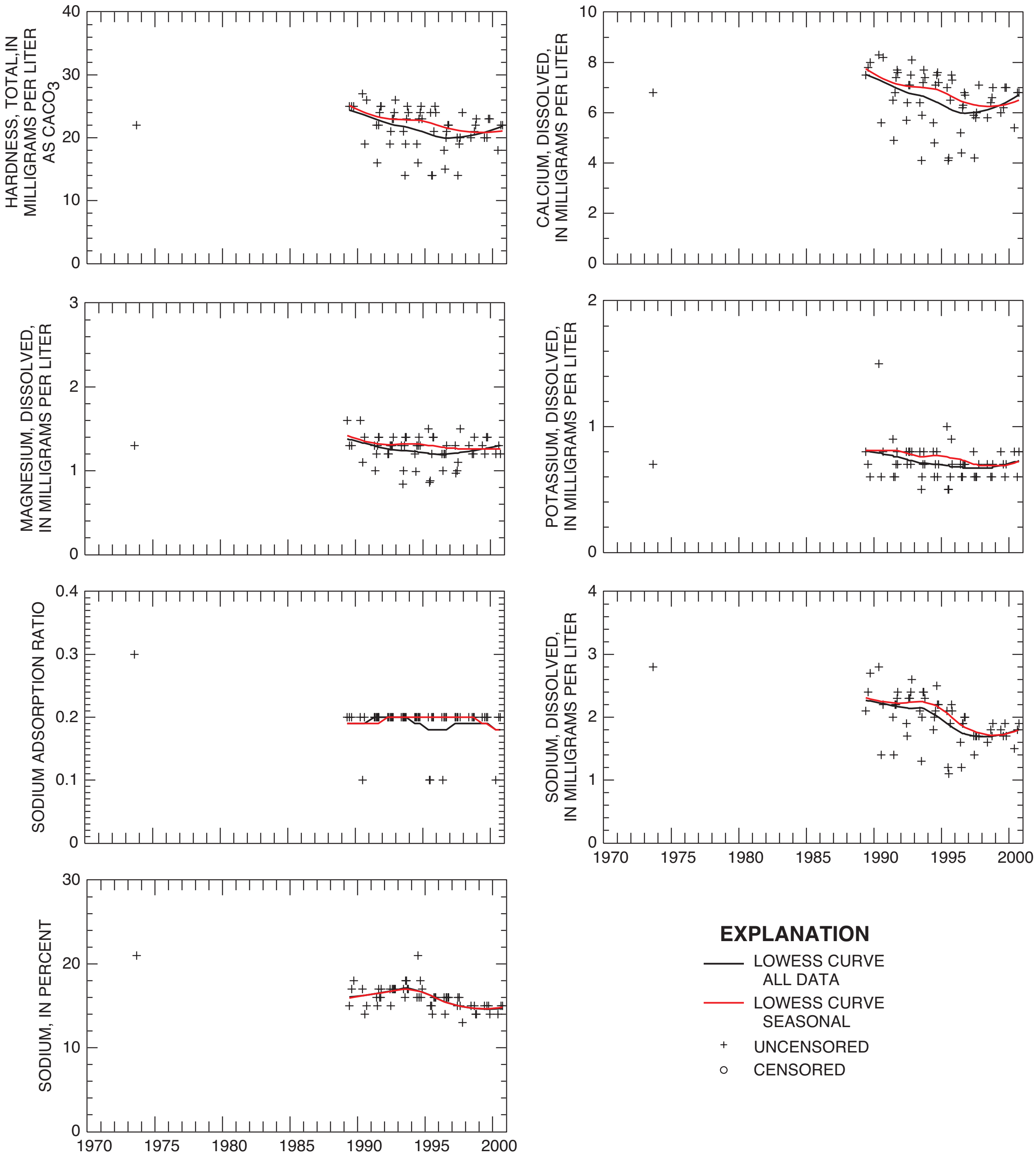

Figure 29. Temporal variations in periodic measurements and concentrations at Shadow Mountain Lake, sampled near the bottom.—Continued

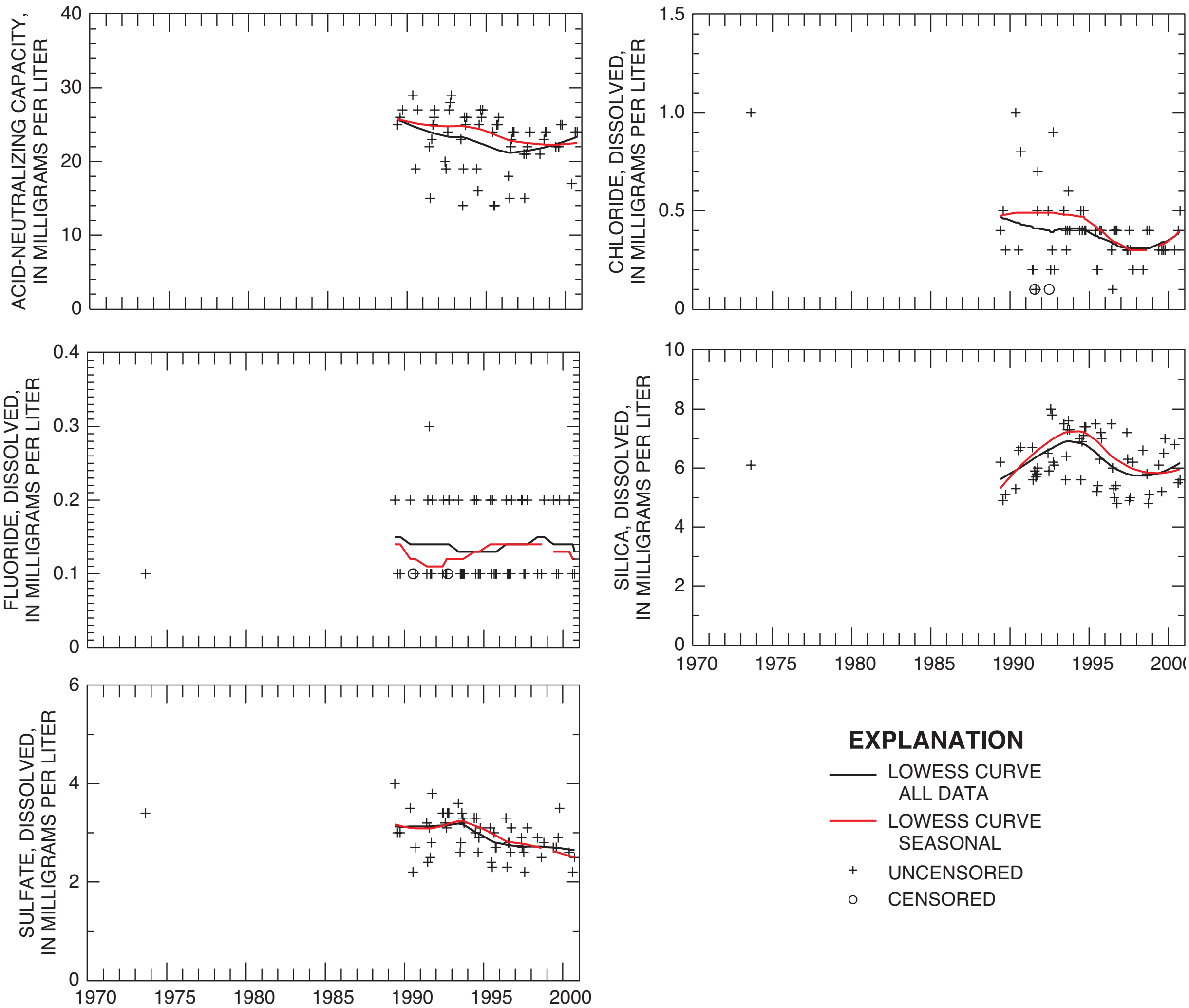

Figure 29. Temporal variations in periodic measurements and concentrations at Shadow Mountain Lake, sampled near the bottom.—Continued

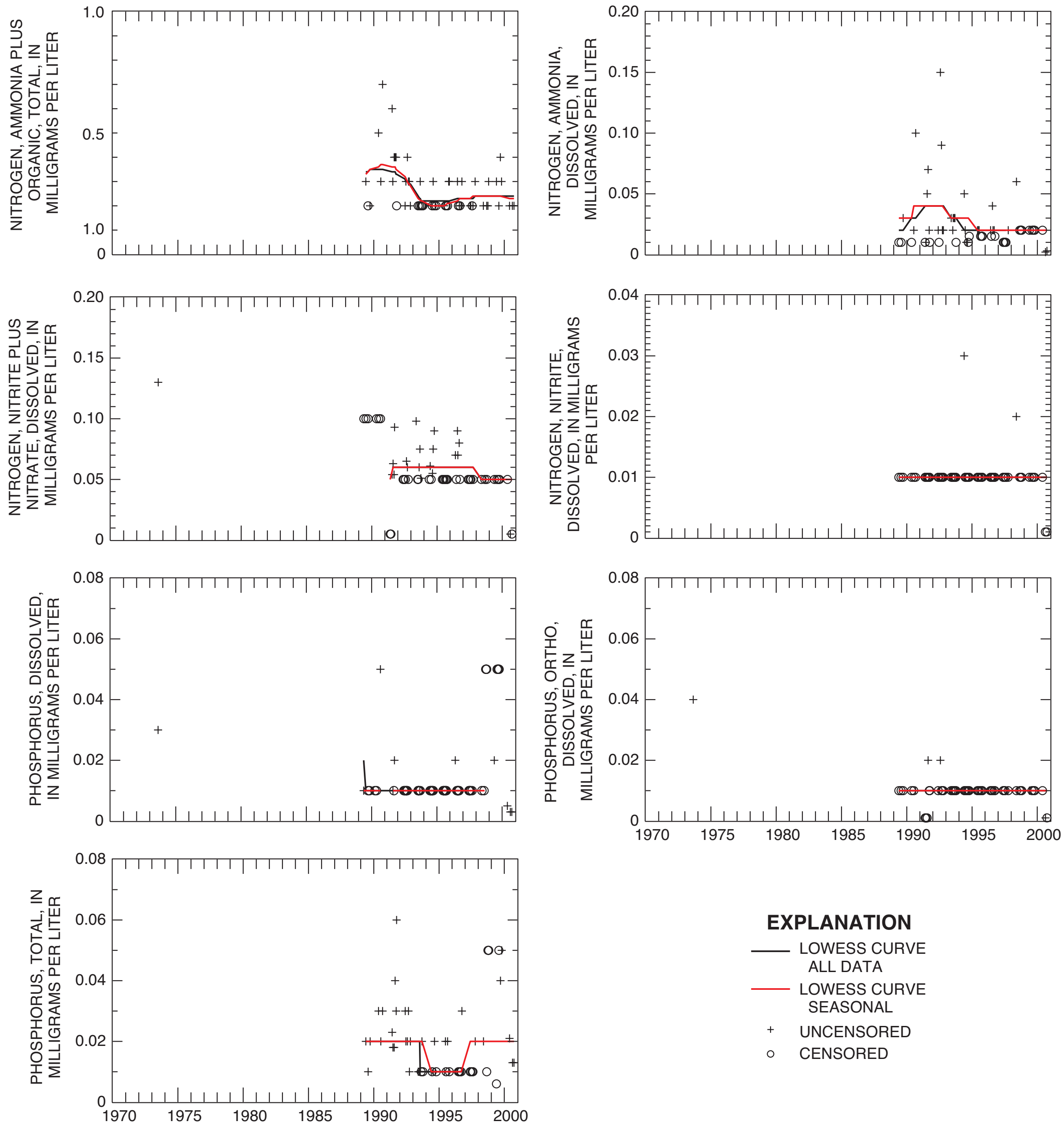

Figure 29. Temporal variations in periodic measurements and concentrations at Shadow Mountain Lake, sampled near the bottom.—Continued

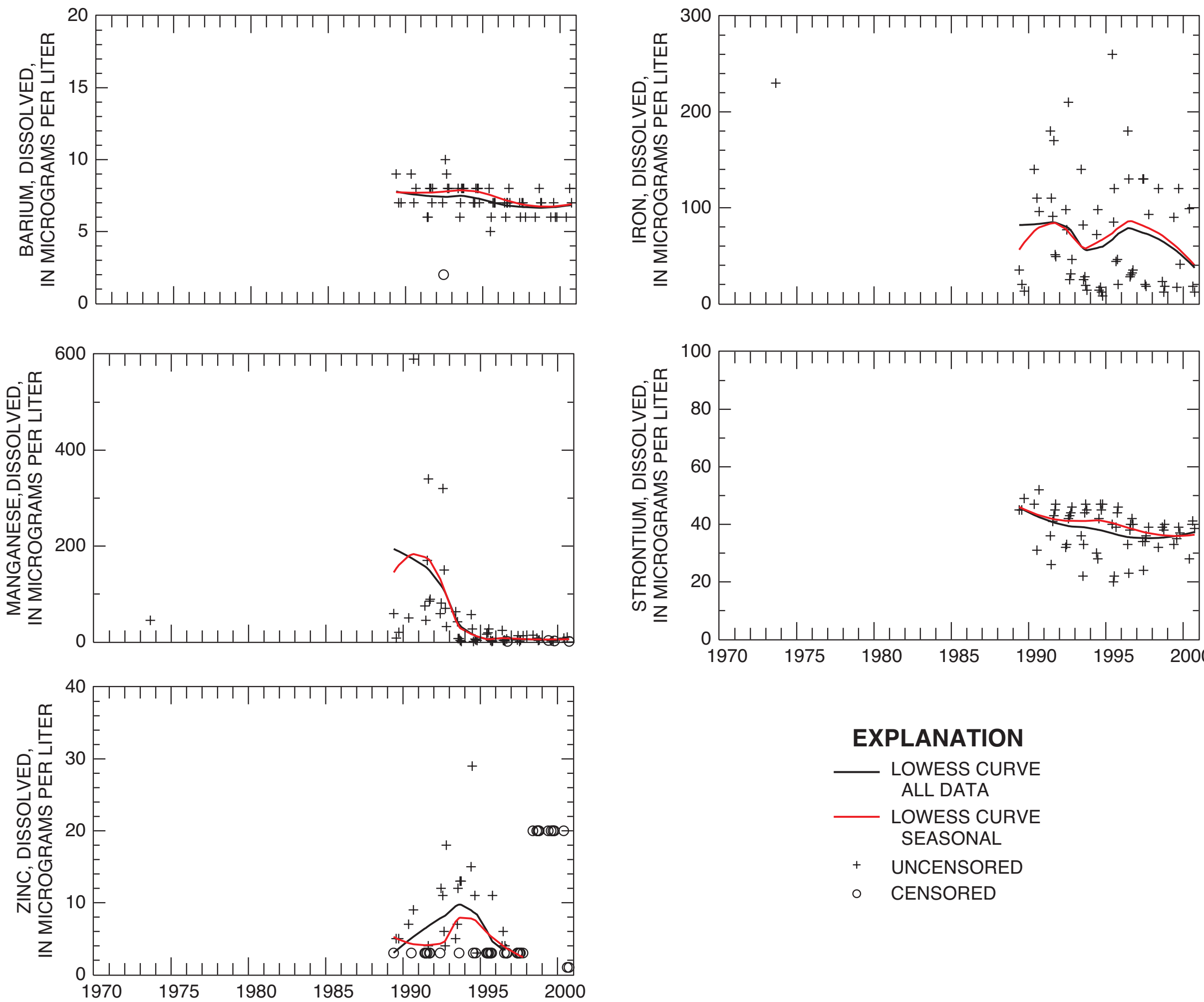

Figure 29. Temporal variations in periodic measurements and concentrations at Shadow Mountain Lake, sampled near the bottom.—Continued

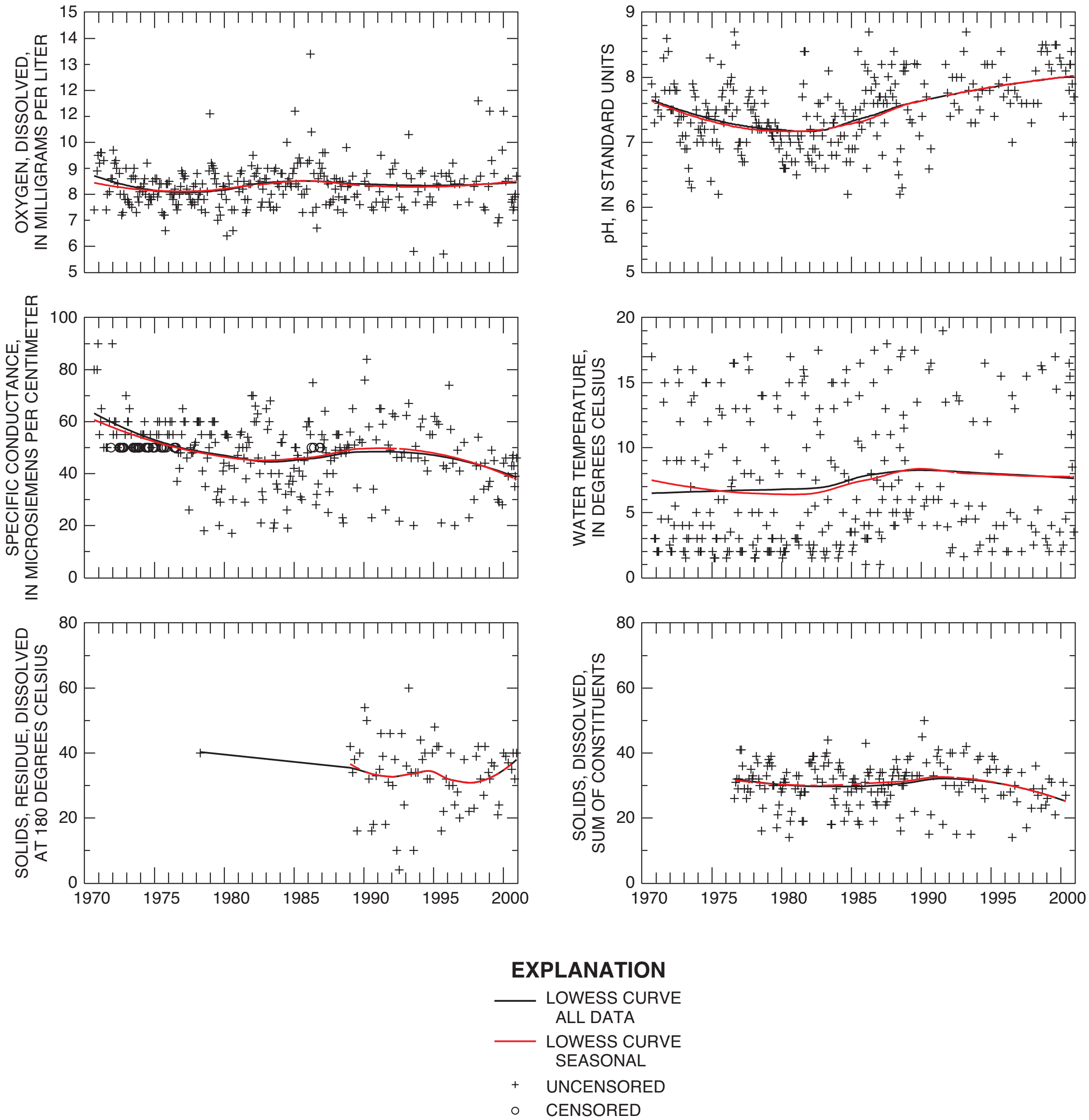

Figure 30. Temporal variations in periodic measurements and concentrations at Adams Tunnel, east portal, near Estes Park.

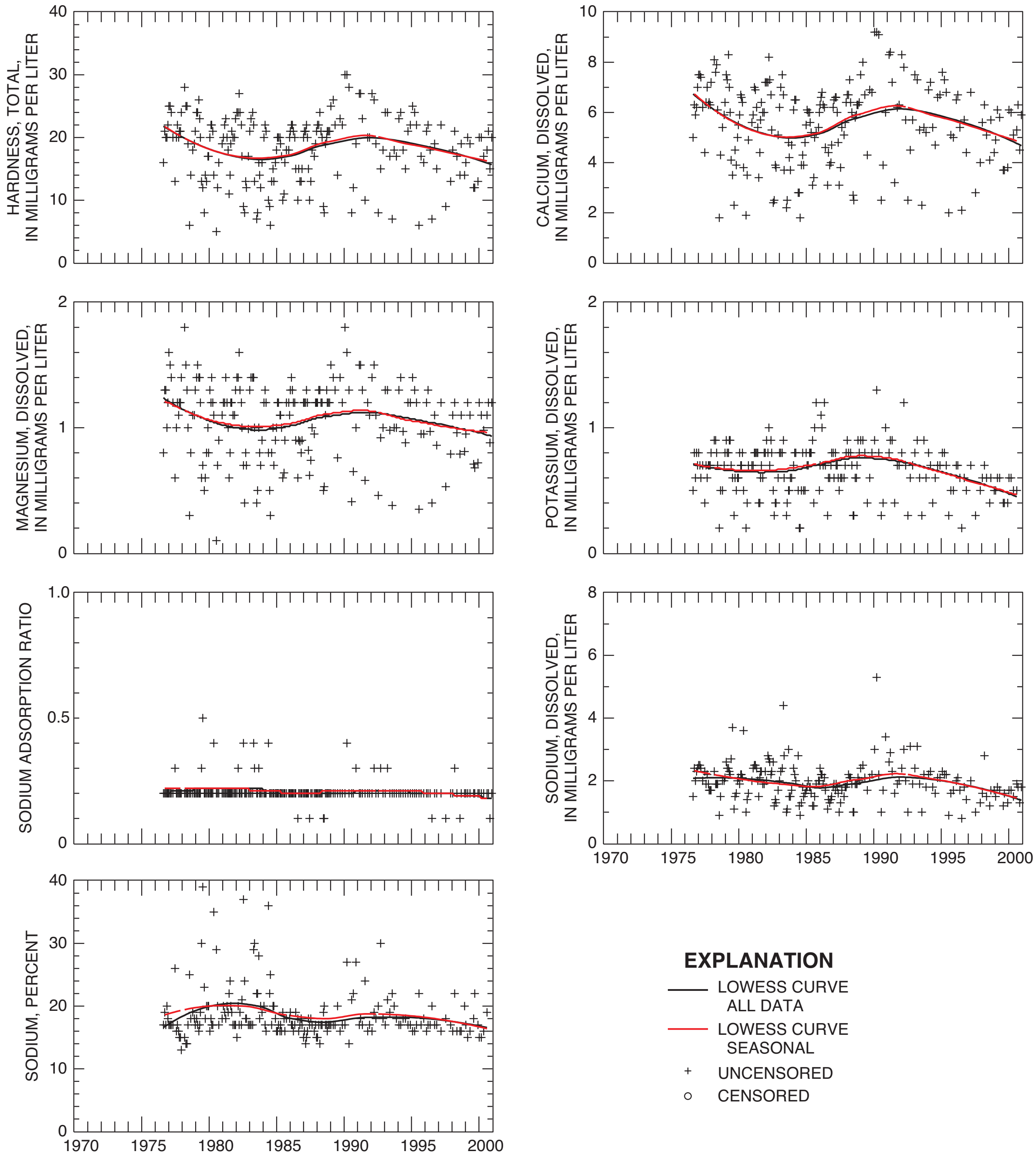

Figure 30. Temporal variations in periodic measurements and concentrations at Adams Tunnel, east portal, near Estes Park.—Continued

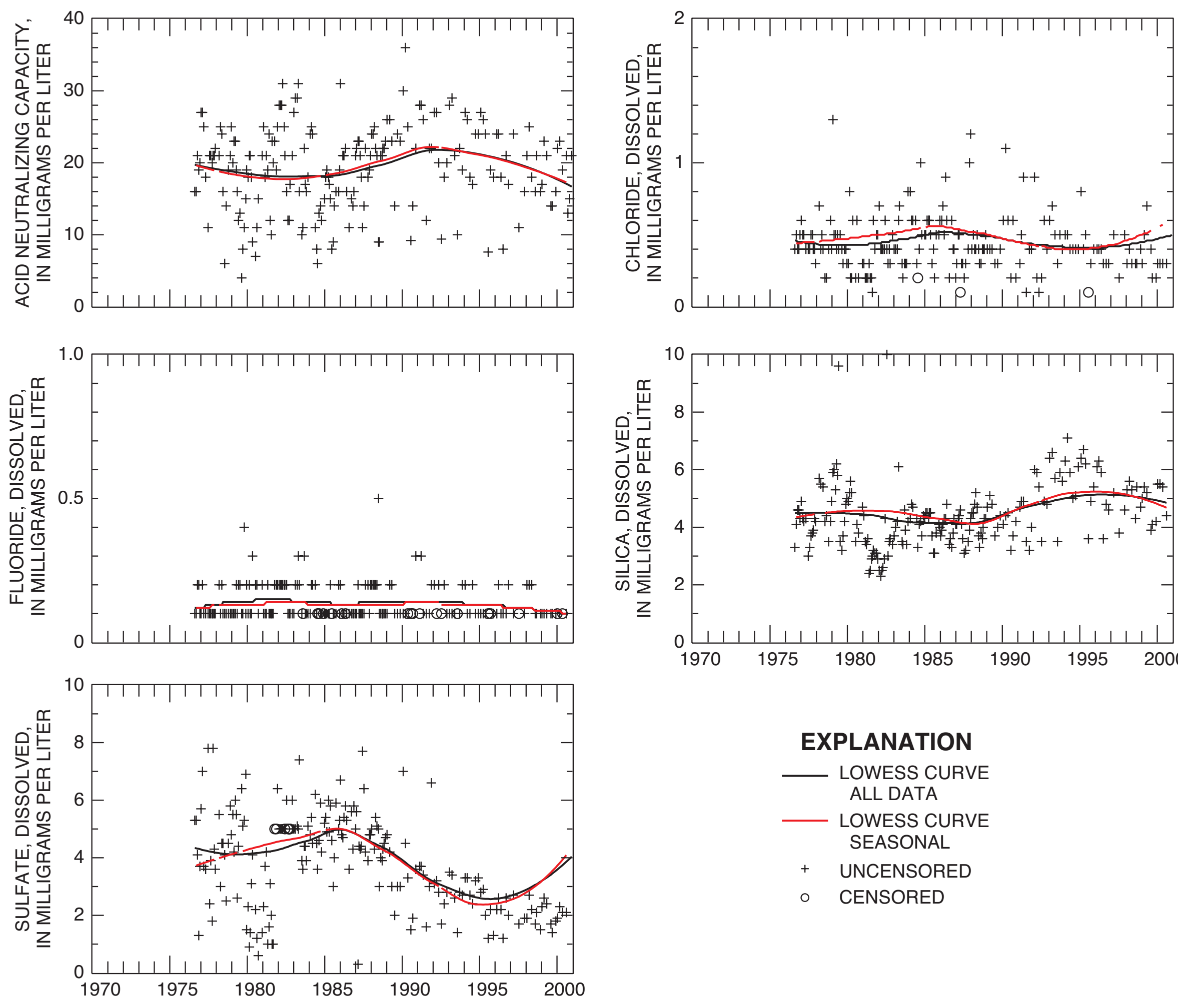

Figure 30. Temporal variations in periodic measurements and concentrations at Adams Tunnel, east portal, near Estes Park.—Continued

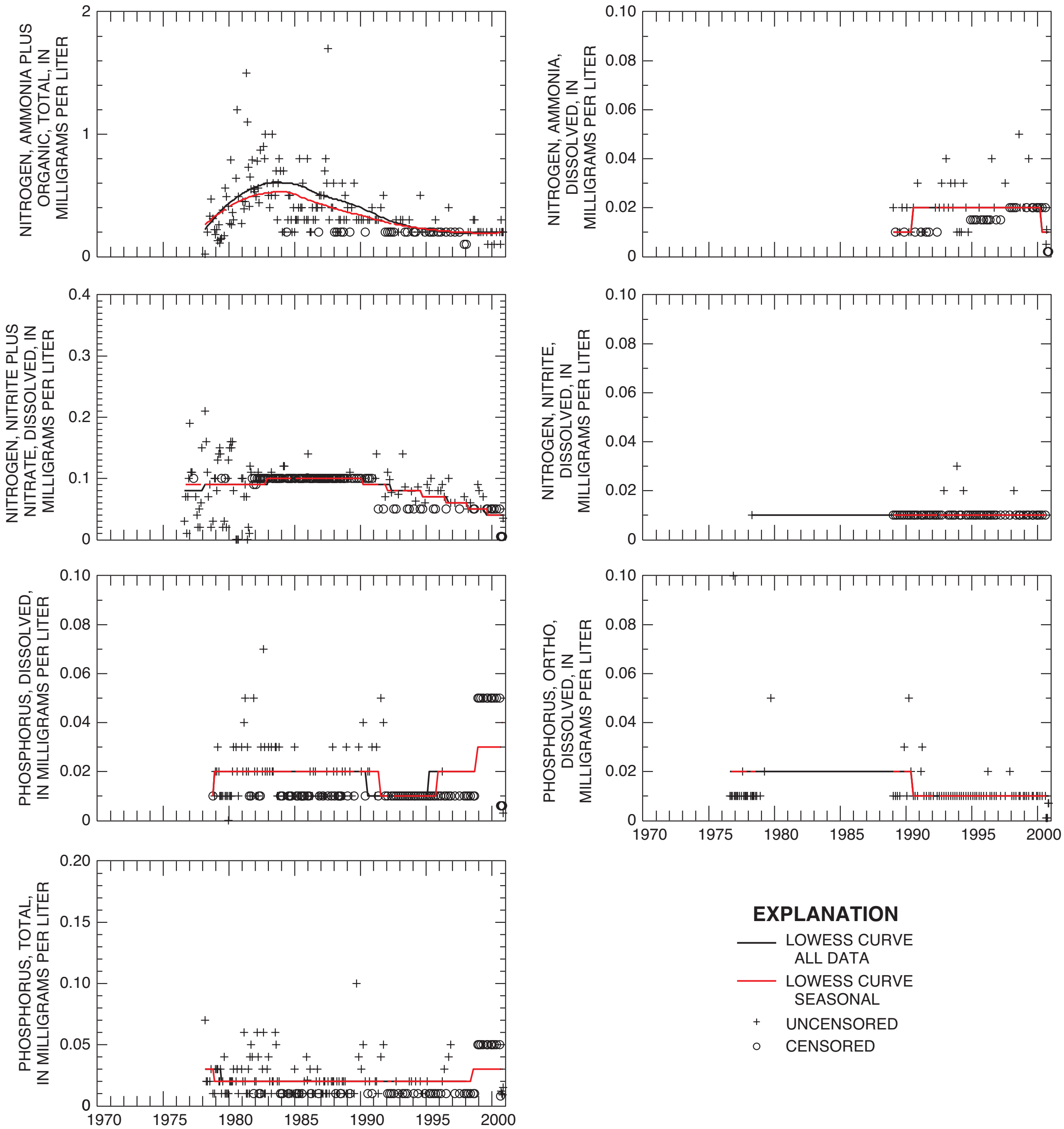

Figure 30. Temporal variations in periodic measurements and concentrations at Adams Tunnel, east portal, near Estes Park.—Continued

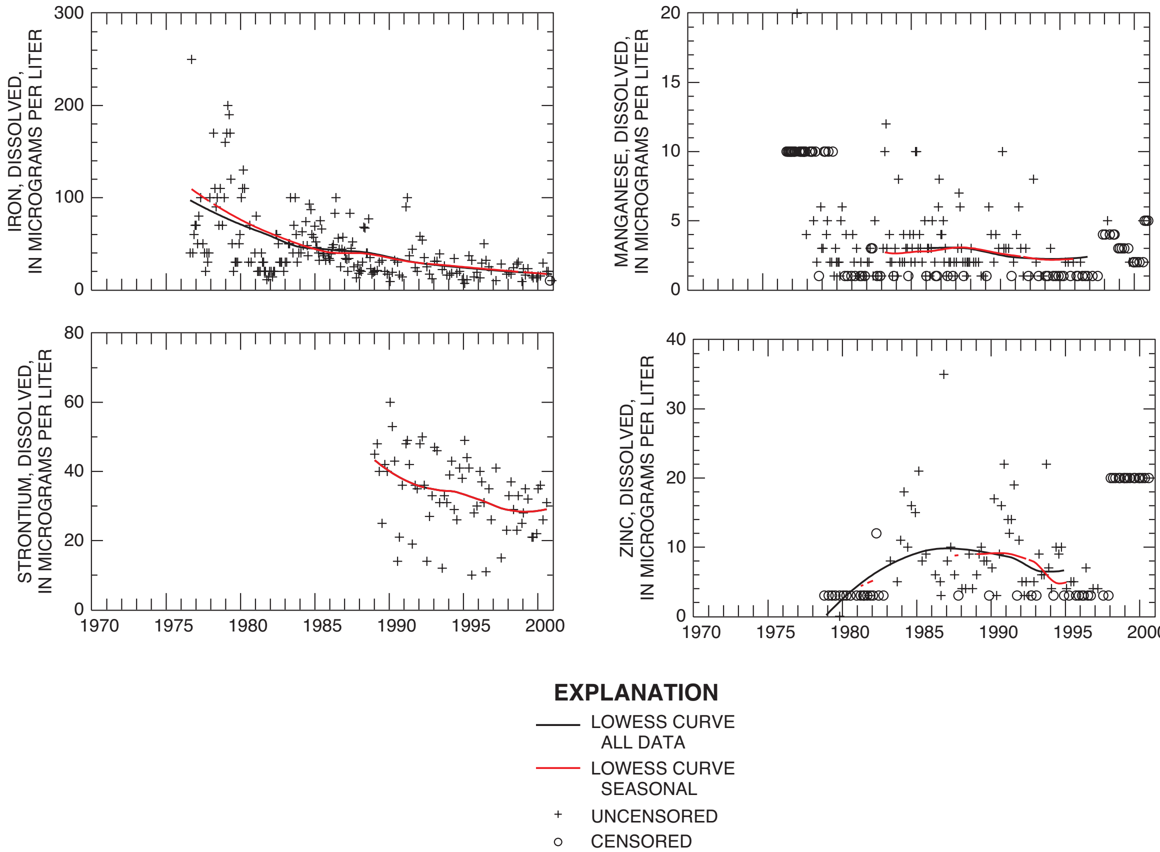

Figure 30. Temporal variations in periodic measurements and concentrations at Adams Tunnel, east portal, near Estes Park.—Continued

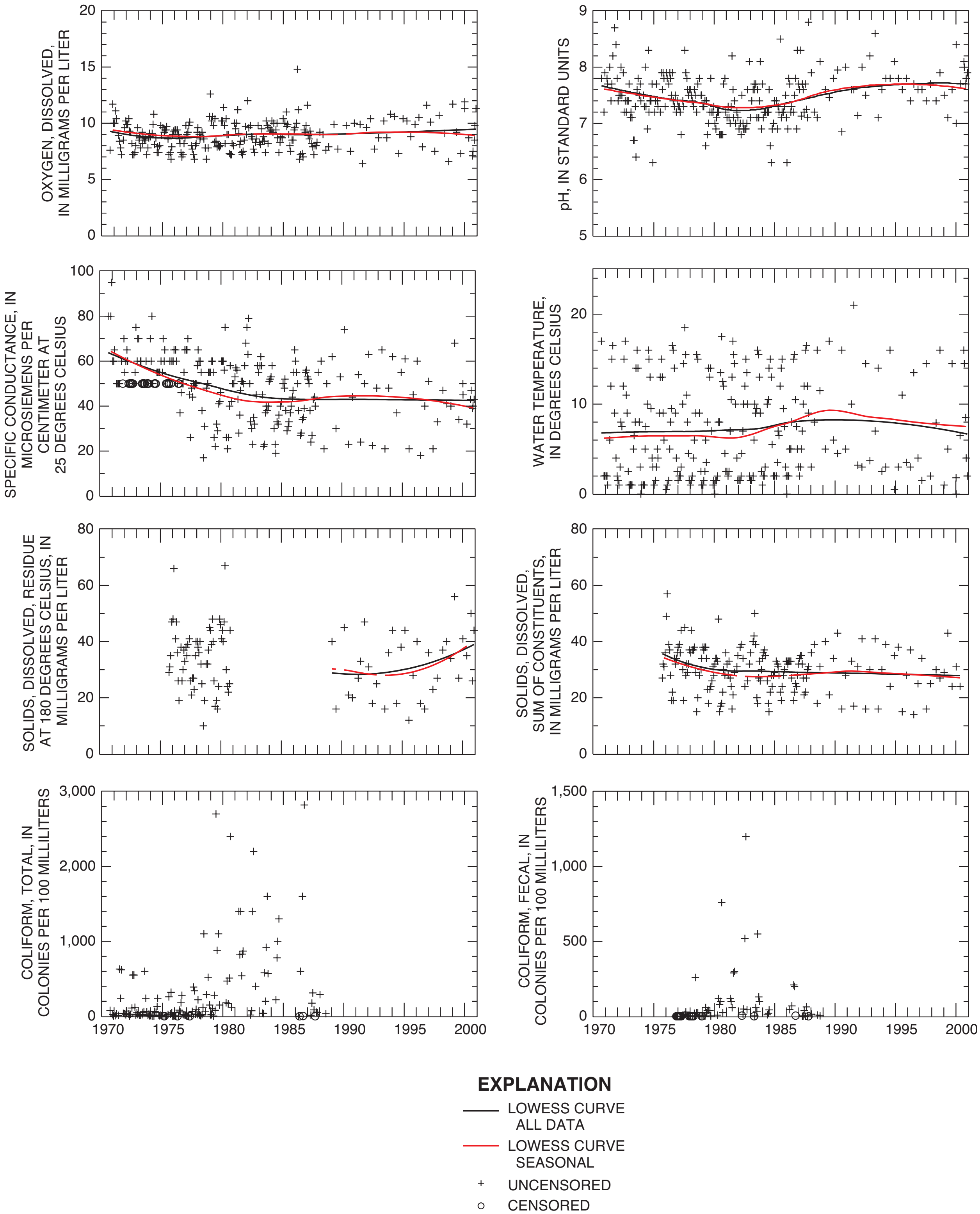

Figure 31. Temporal variations in periodic measurements and concentrations at Olympus Tunnel.

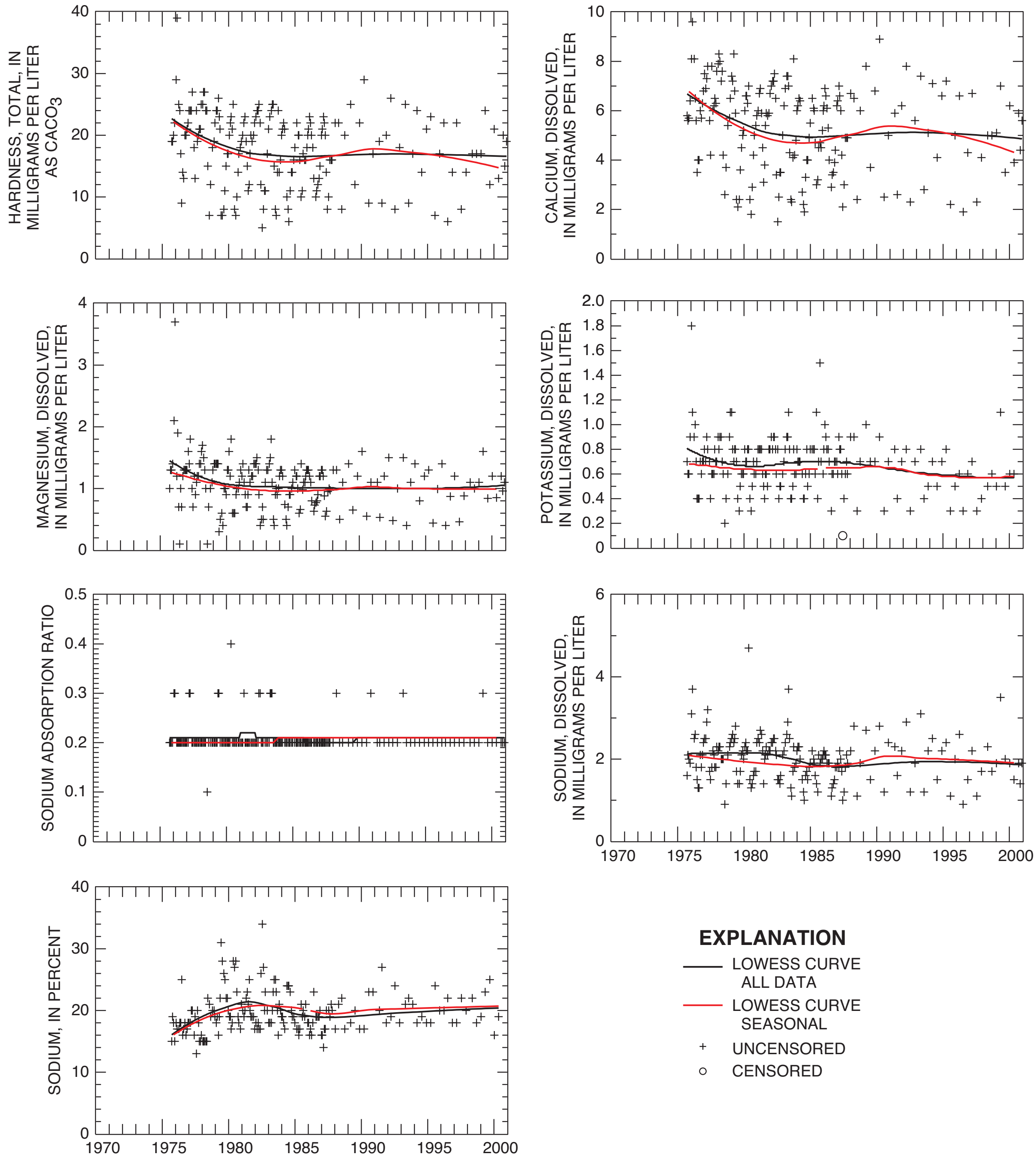

Figure 31. Temporal variations in periodic measurements and concentrations at Olympus Tunnel.—Continued

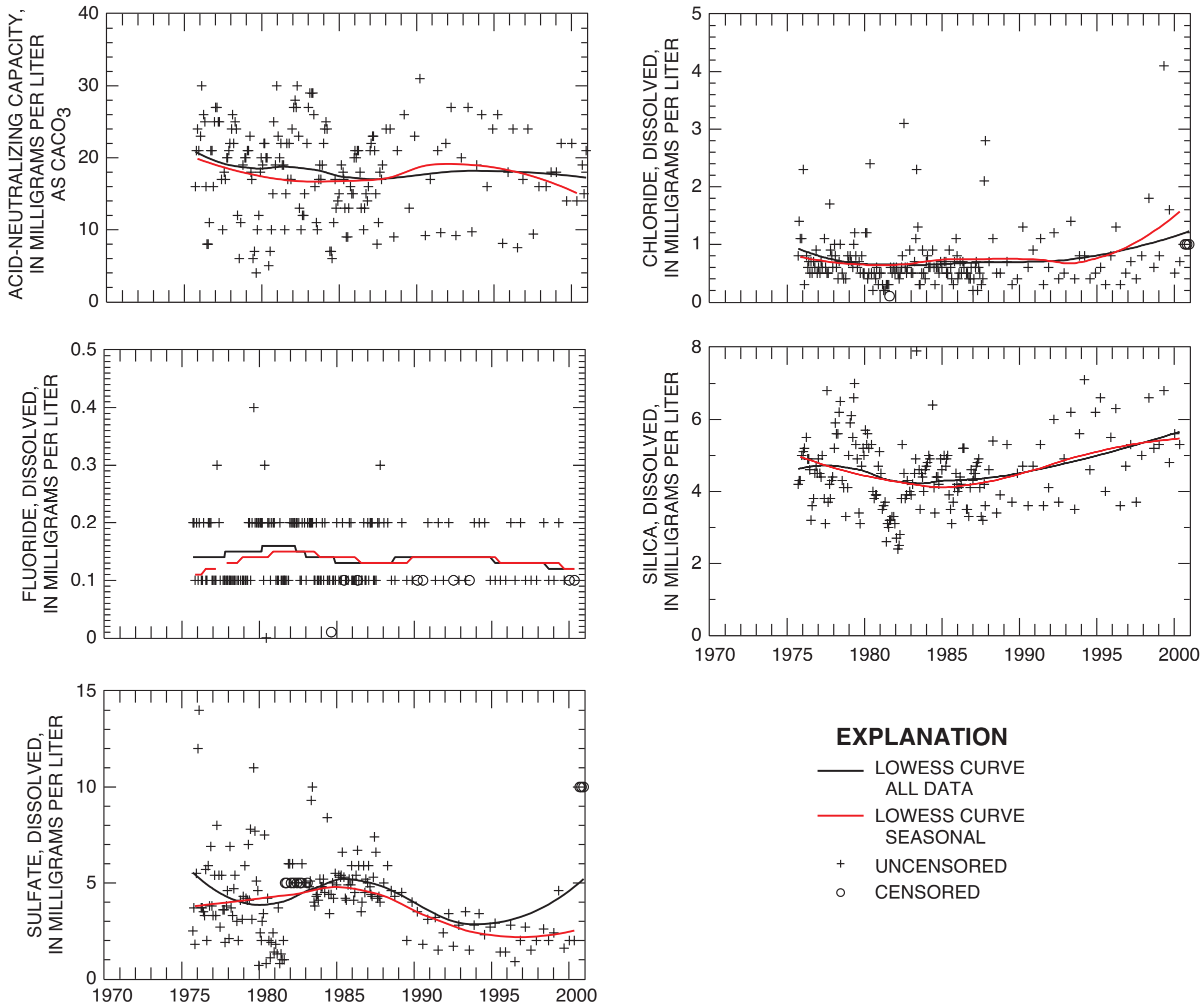

Figure 31. Temporal variations in periodic measurements and concentrations at Olympus Tunnel.—Continued

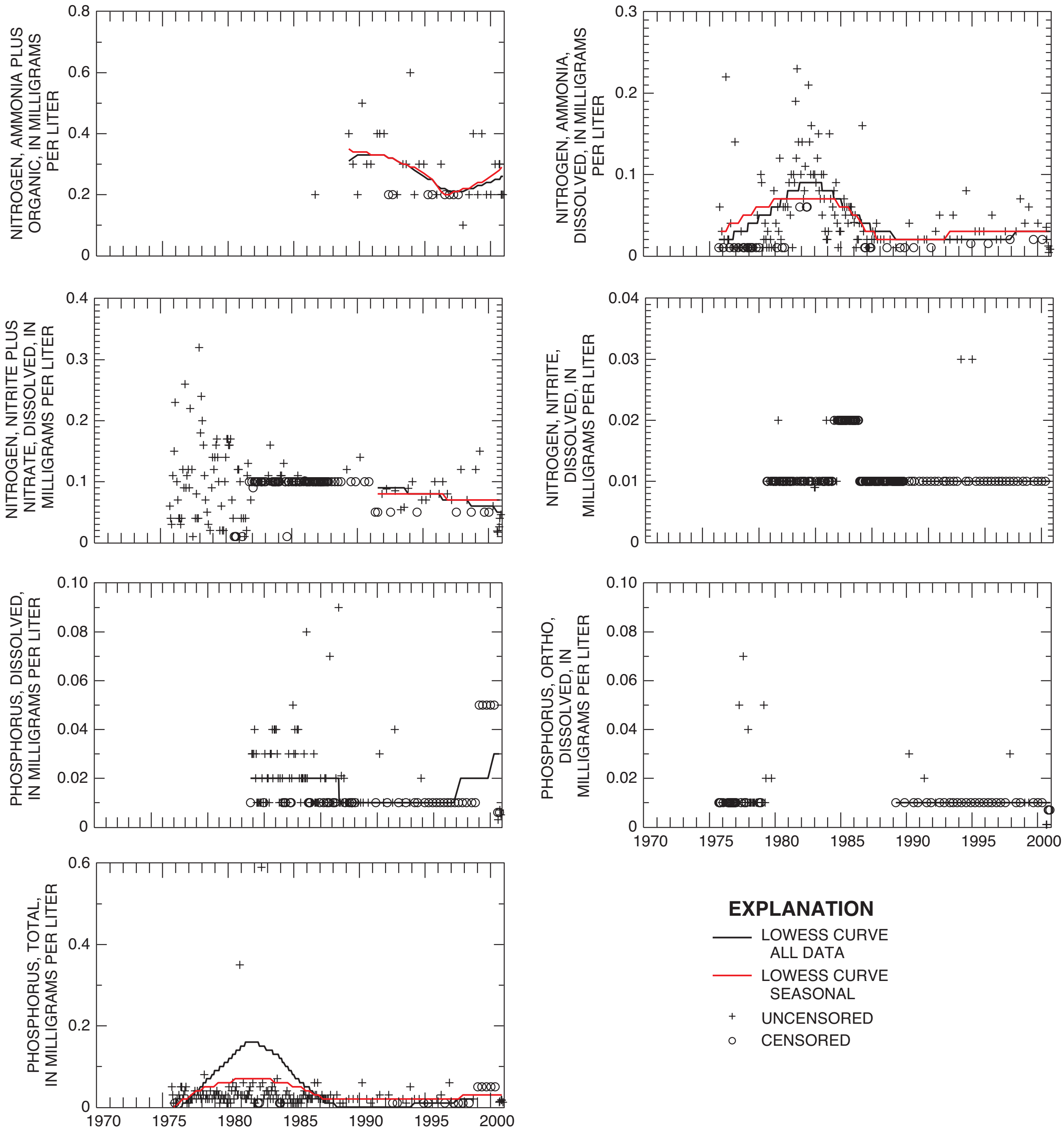

Figure 31. Temporal variations in periodic measurements and concentrations at Olympus Tunnel.—Continued

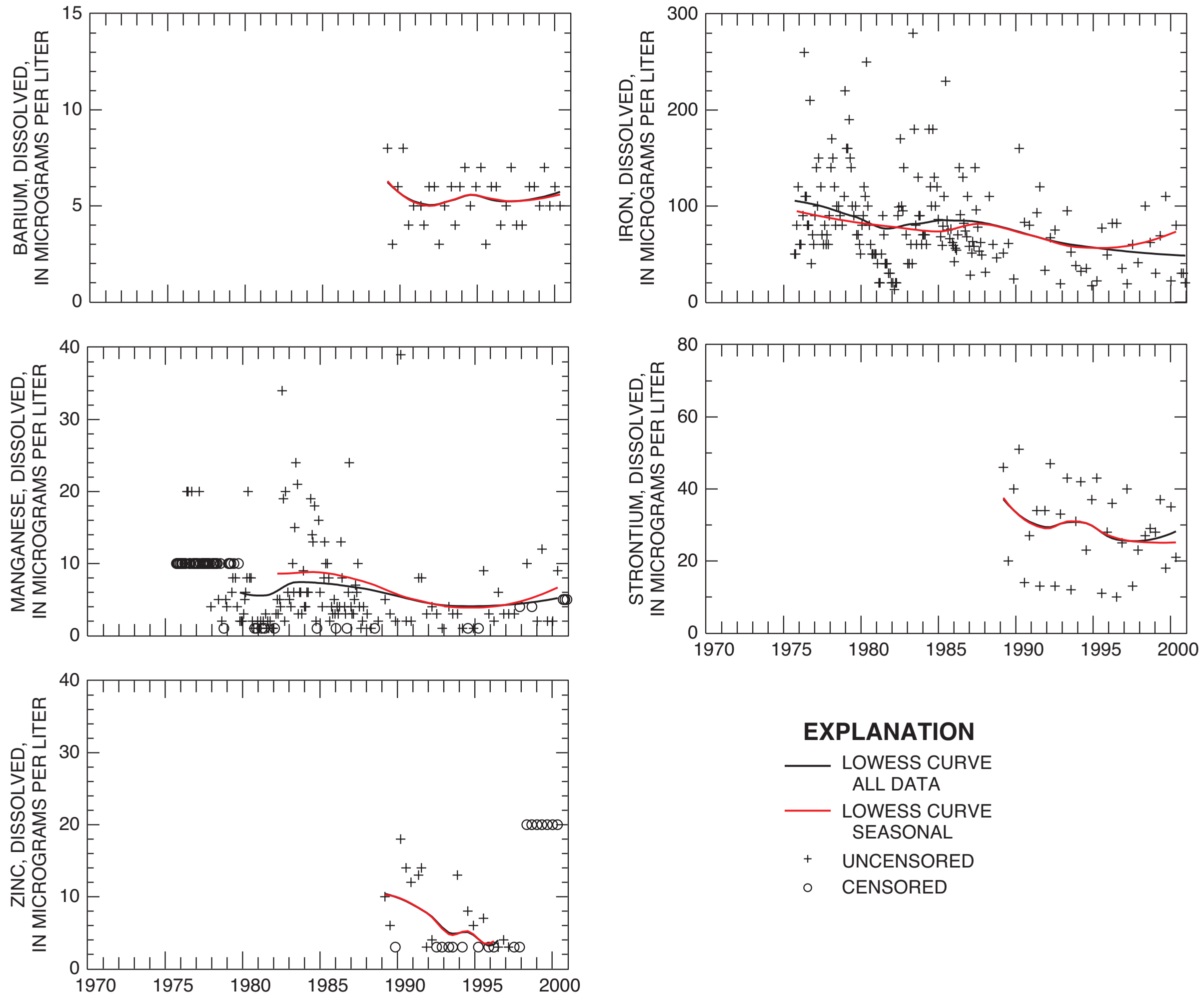

Figure 31. Temporal variations in periodic measurements and concentrations at Olympus Tunnel.—Continued

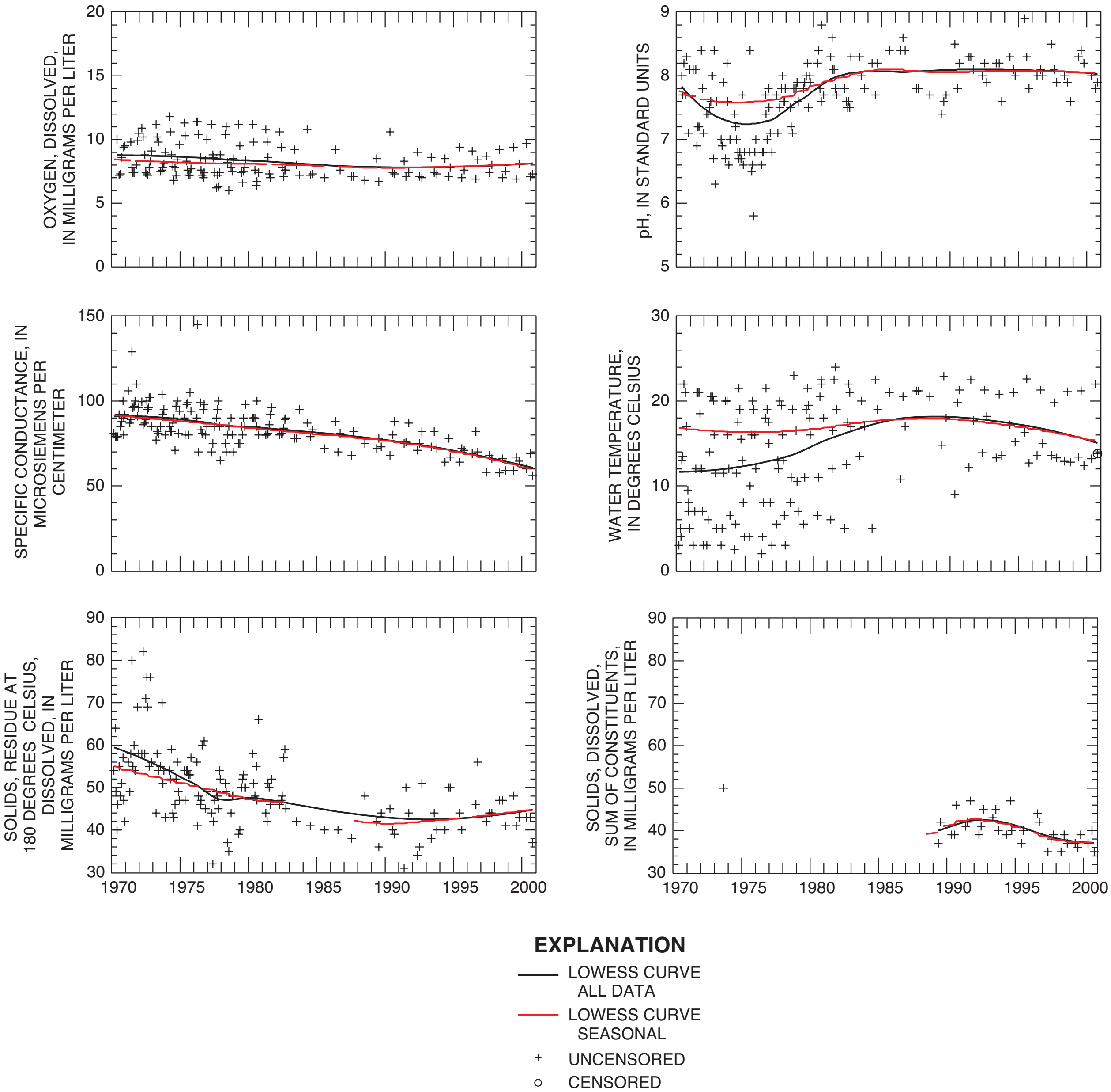

Figure 32. Temporal variations in periodic measurements and concentrations at Carter Lake, sampled near the surface.

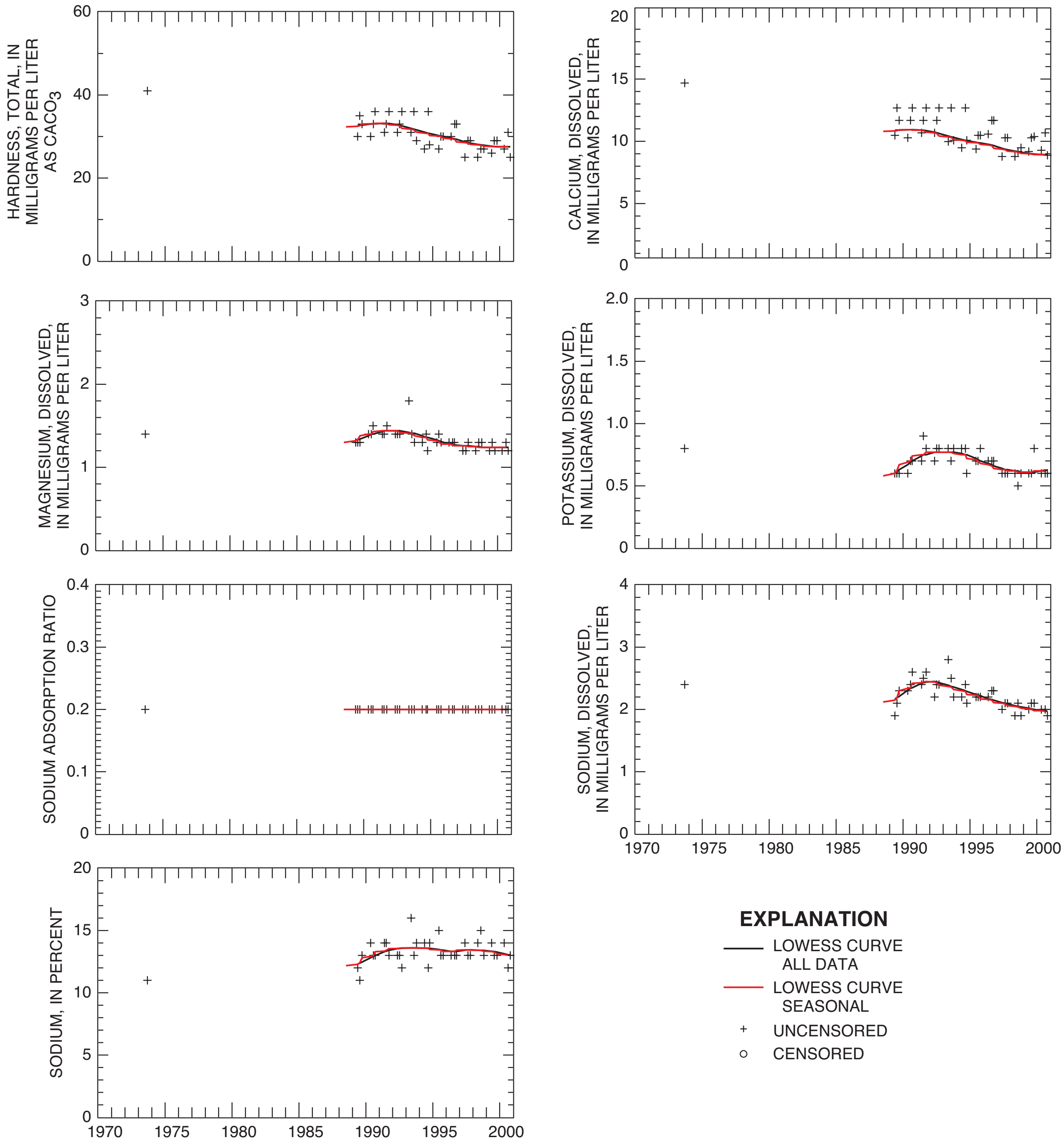

Figure 32. Temporal variations in periodic measurements and concentrations at Carter Lake, sampled near the surface.—Continued

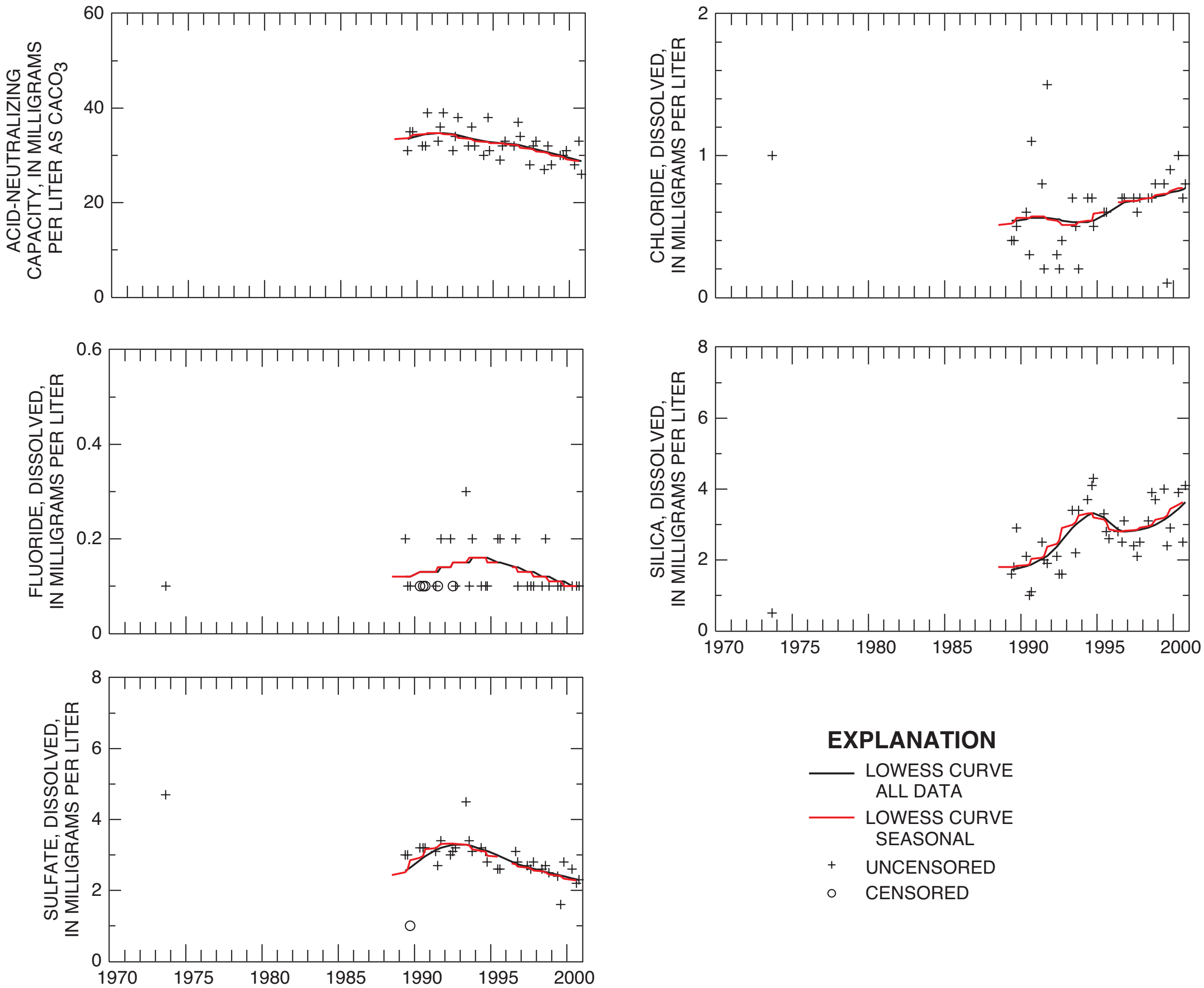

Figure 32. Temporal variations in periodic measurements and concentrations at Carter Lake, sampled near the surface. —Continued

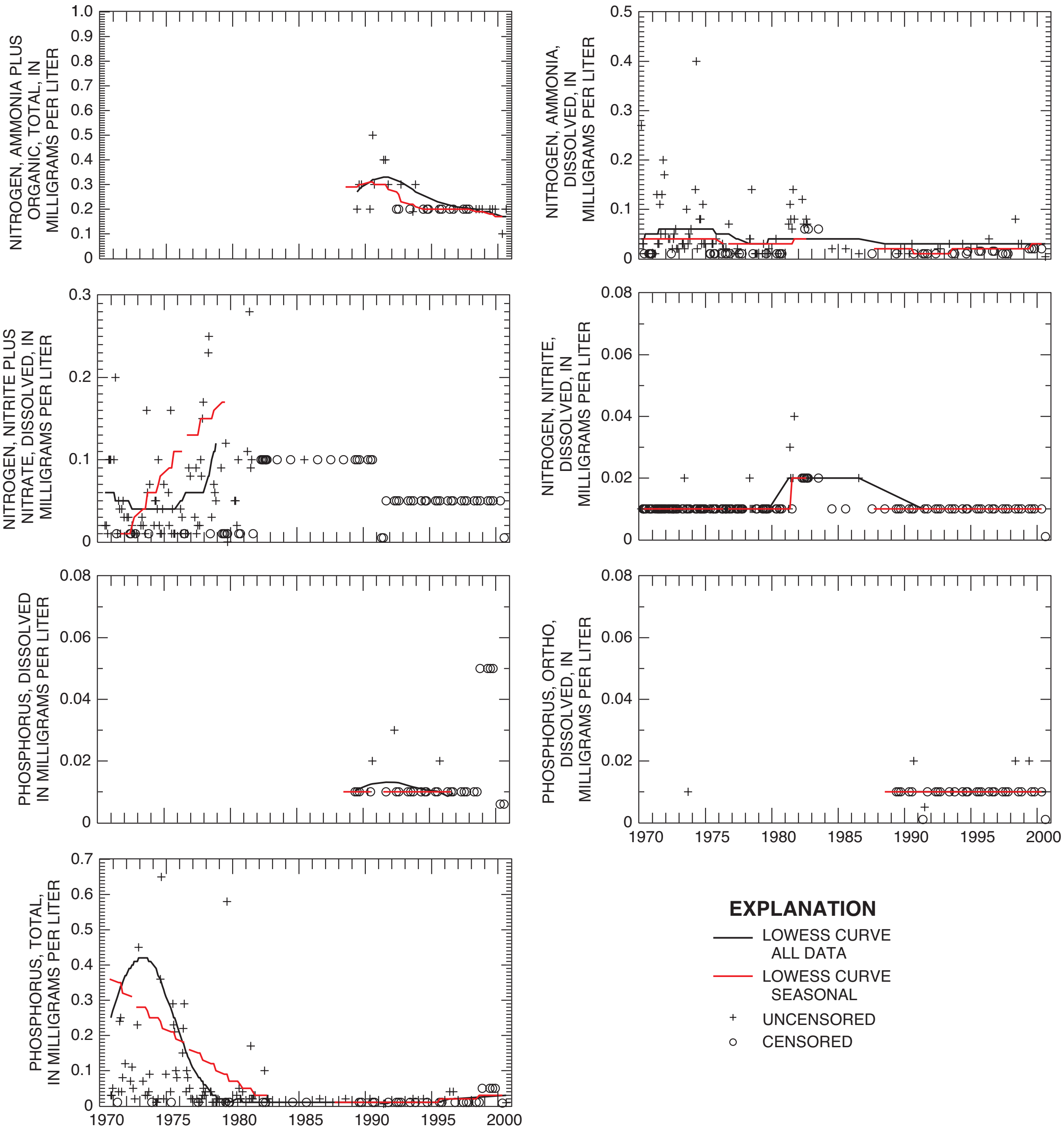

Figure 32. Temporal variations in periodic measurements and concentrations at Carter Lake, sampled near the surface.—Continued

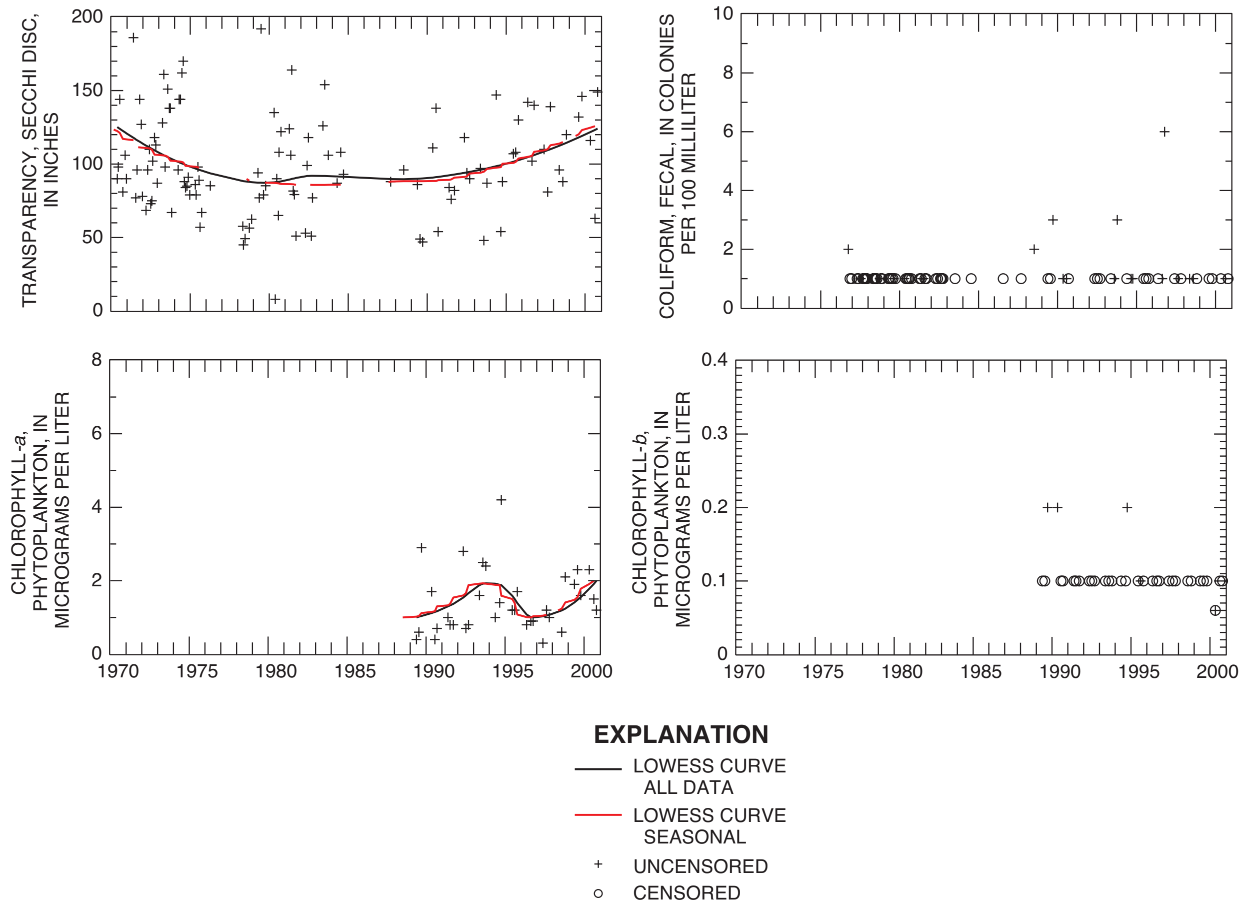

Figure 32. Temporal variations in periodic measurements and concentrations at Carter Lake, sampled near the surface. —Continued

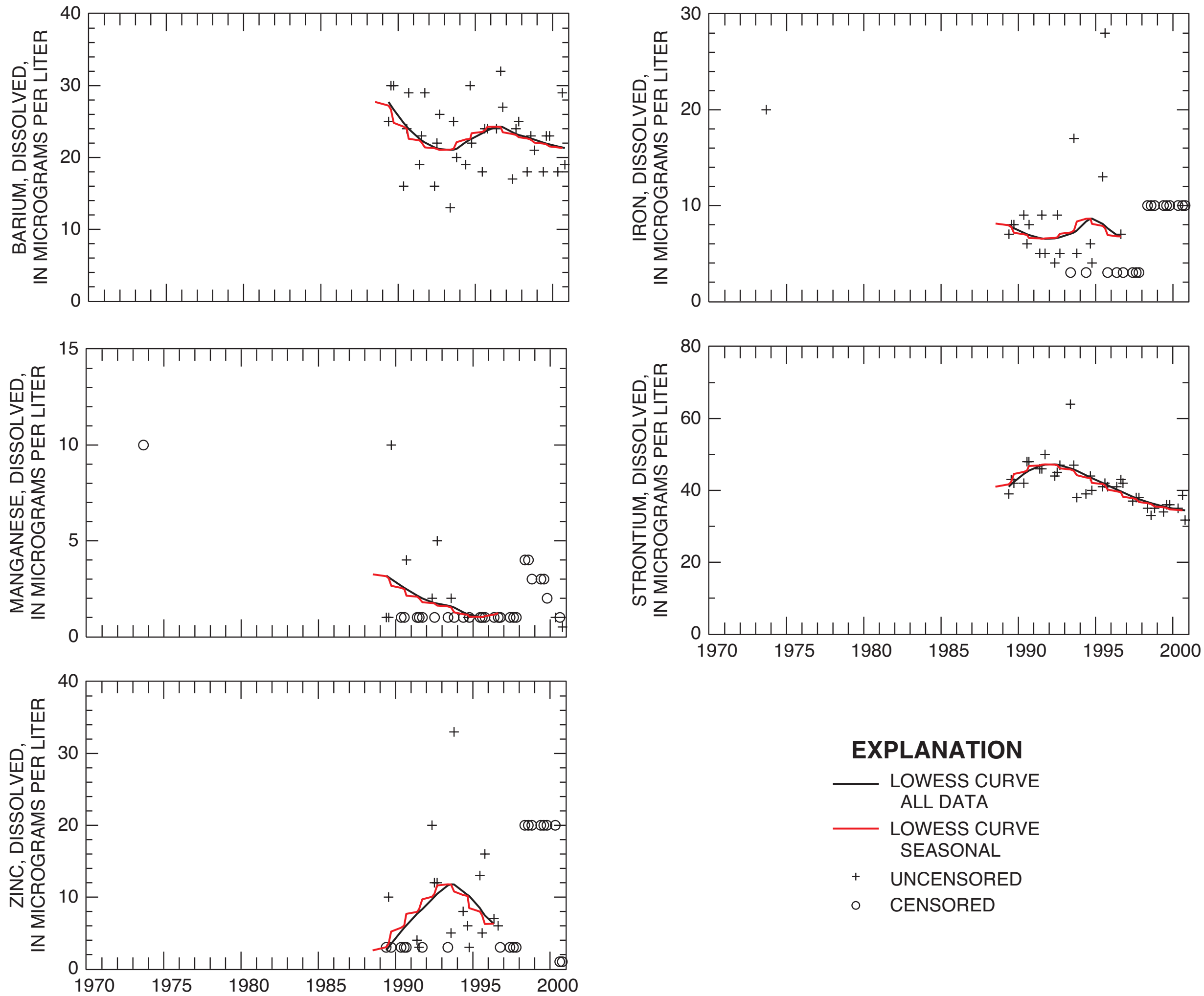

Figure 32. Temporal variations in periodic measurements and concentrations at Carter Lake, sampled near the surface. —Continued

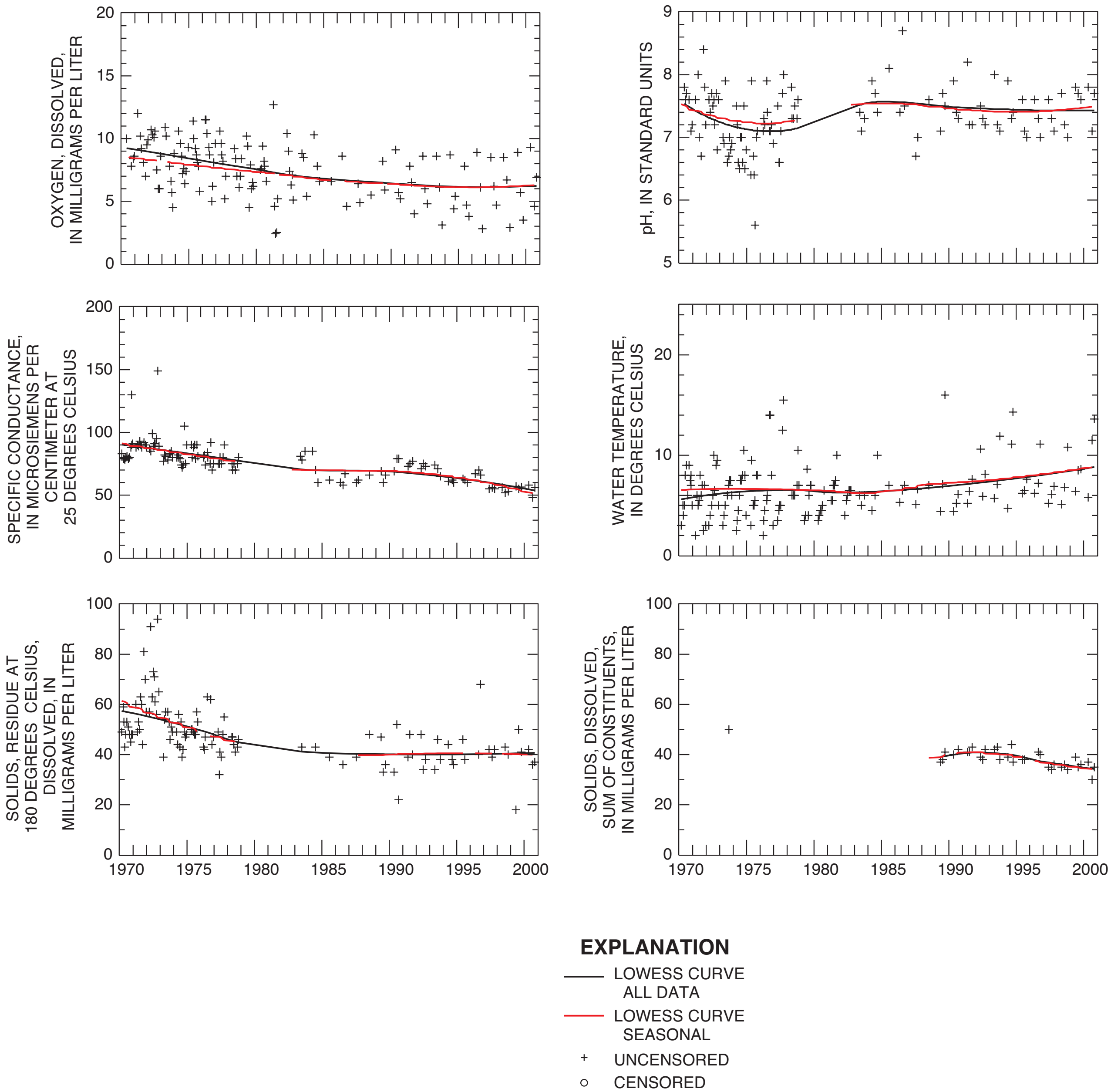

Figure 33. Temporal variations in periodic measurements and concentrations at Carter Lake, sampled near the bottom.

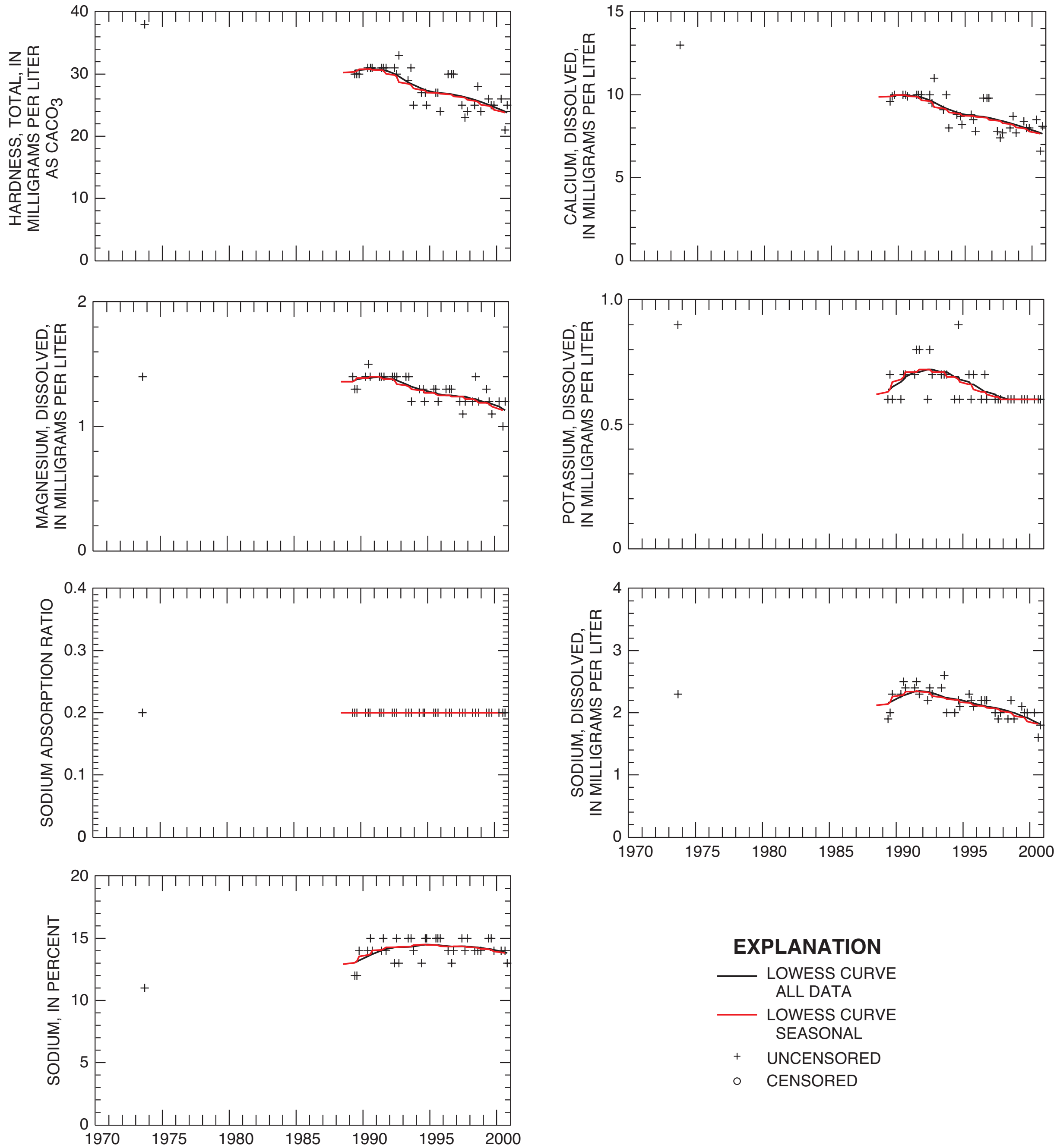

Figure 33. Temporal variations in periodic measurements and concentrations at Carter Lake, sampled near the bottom. —Continued

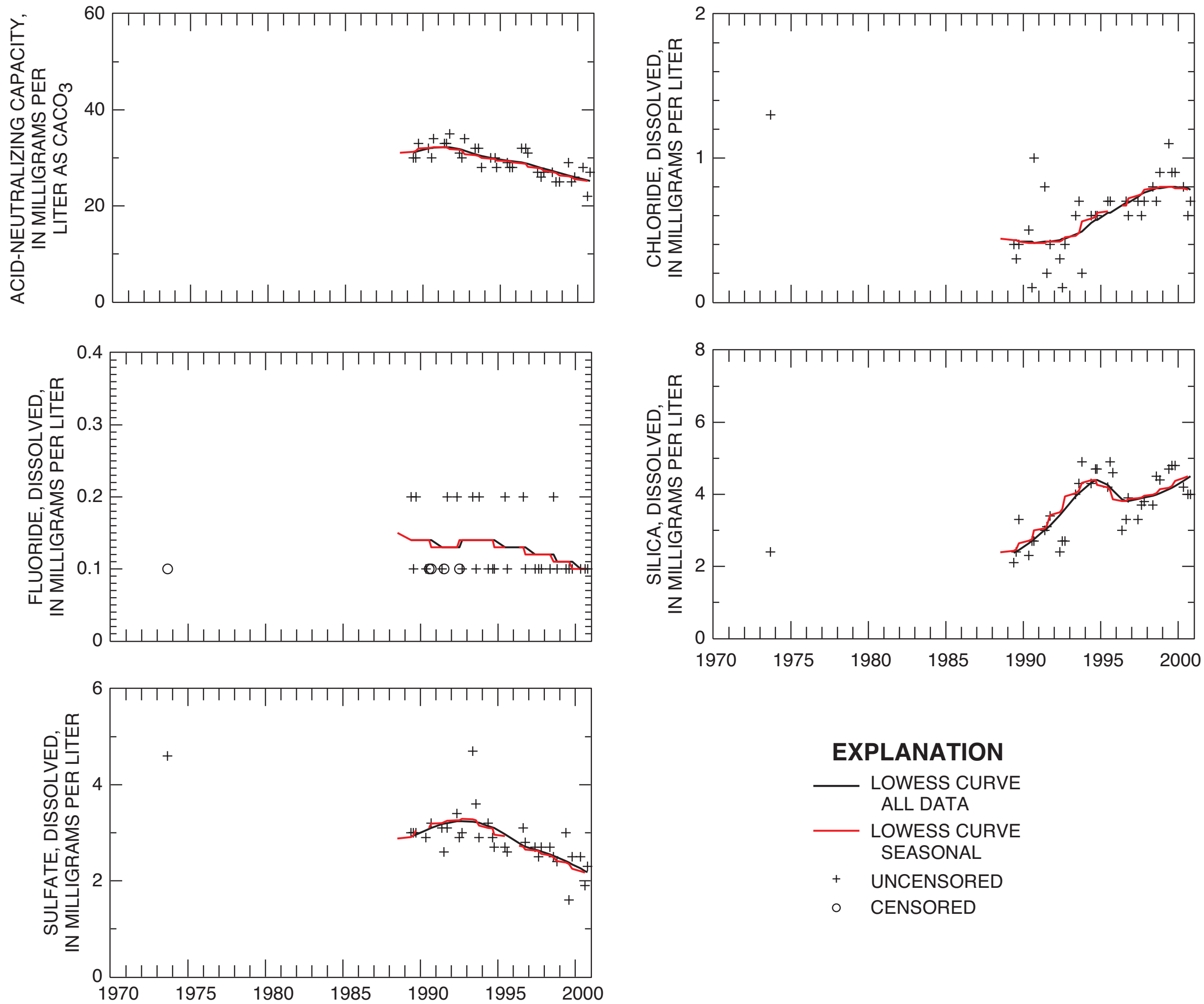

Figure 33. Temporal variations in periodic measurements and concentrations at Carter Lake, sampled near the bottom.—Continued

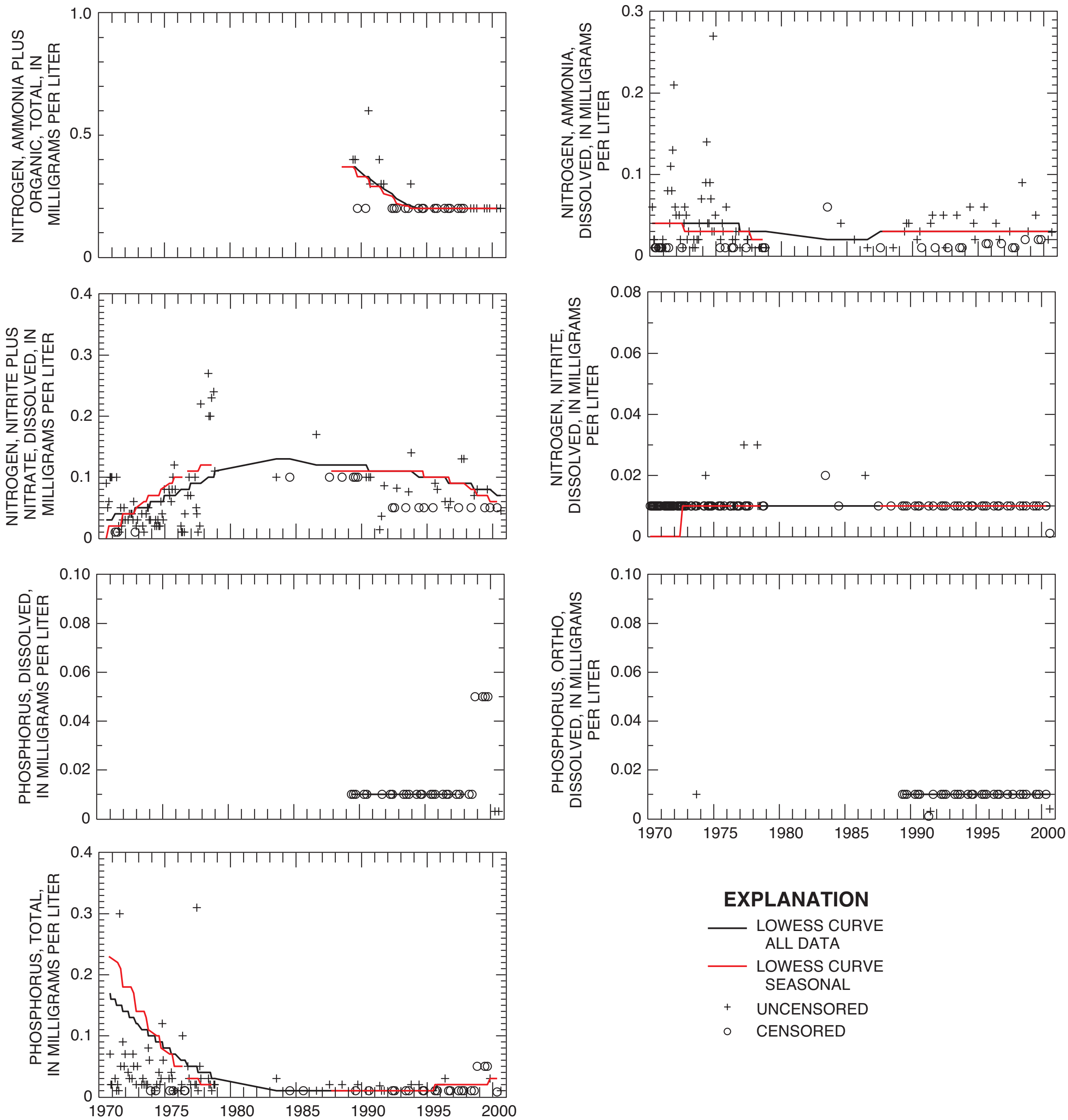

Figure 33. Temporal variations in periodic measurements and concentrations at Carter Lake, sampled near the bottom. —Continued

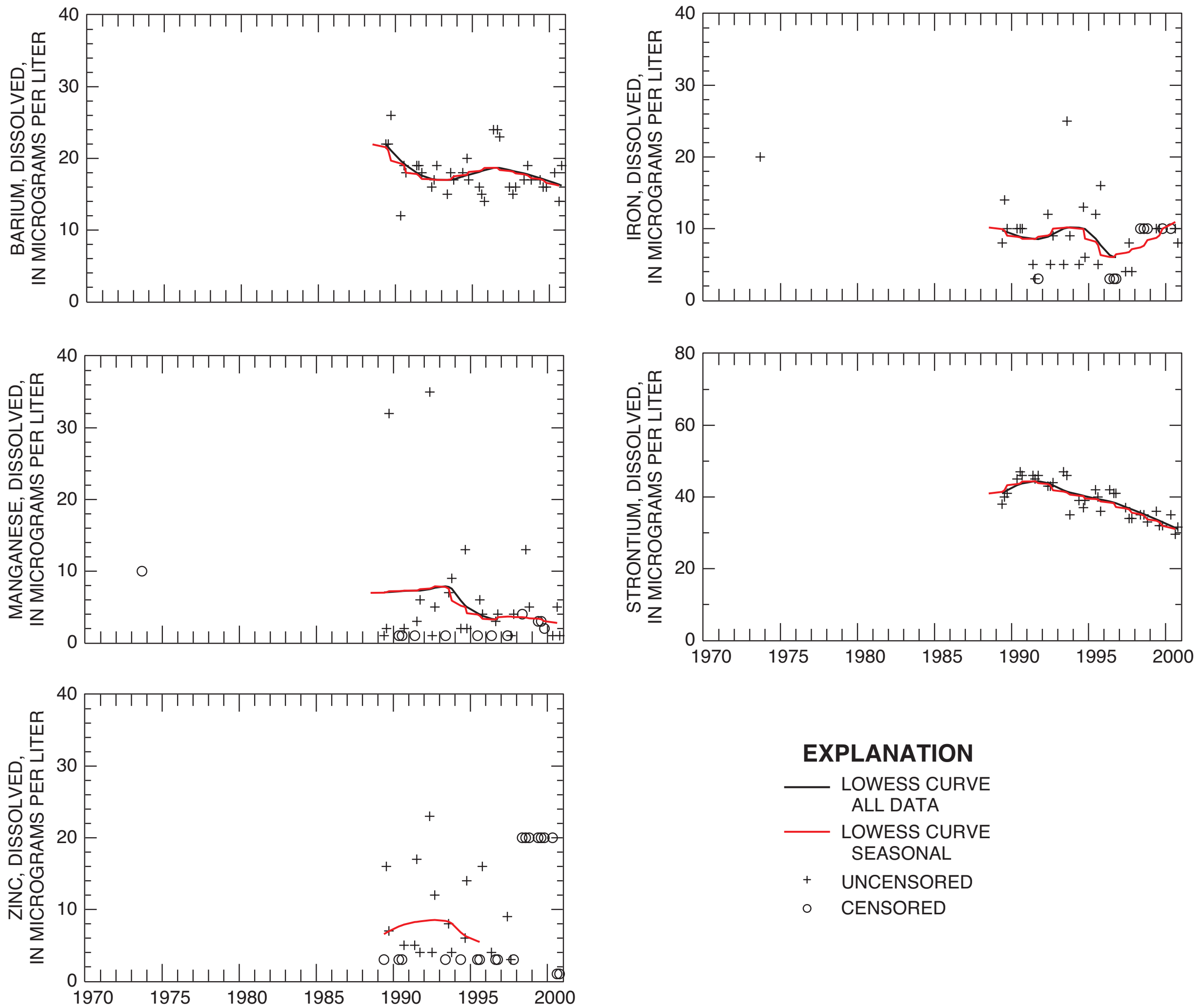

Figure 33. Temporal variations in periodic measurements and concentrations at Carter Lake, sampled near the bottom. —Continued

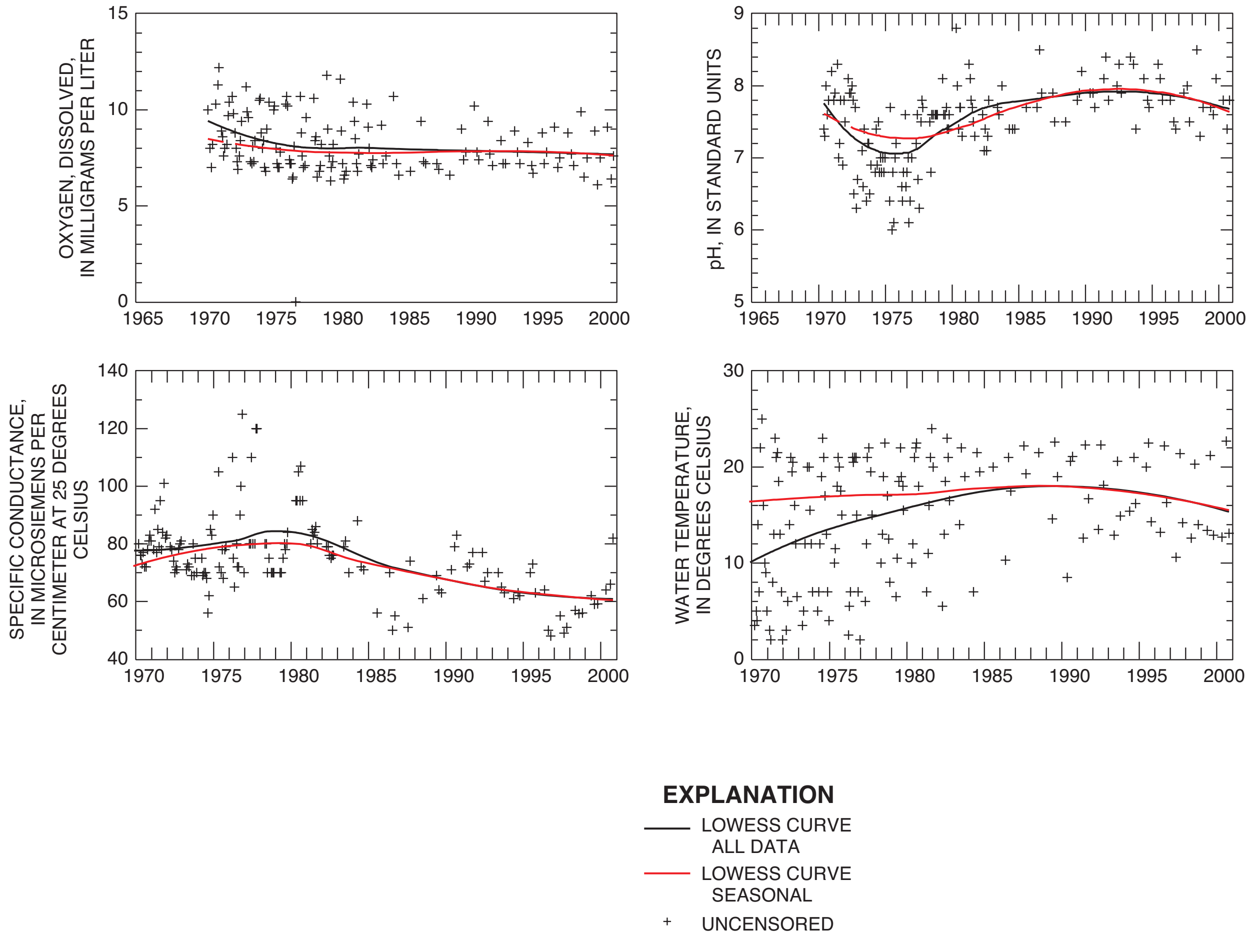

Figure 34. Temporal variations in periodic measurements and concentrations at Horsetooth Reservoir, near Soldier Canyon Dam, sampled near the surface.

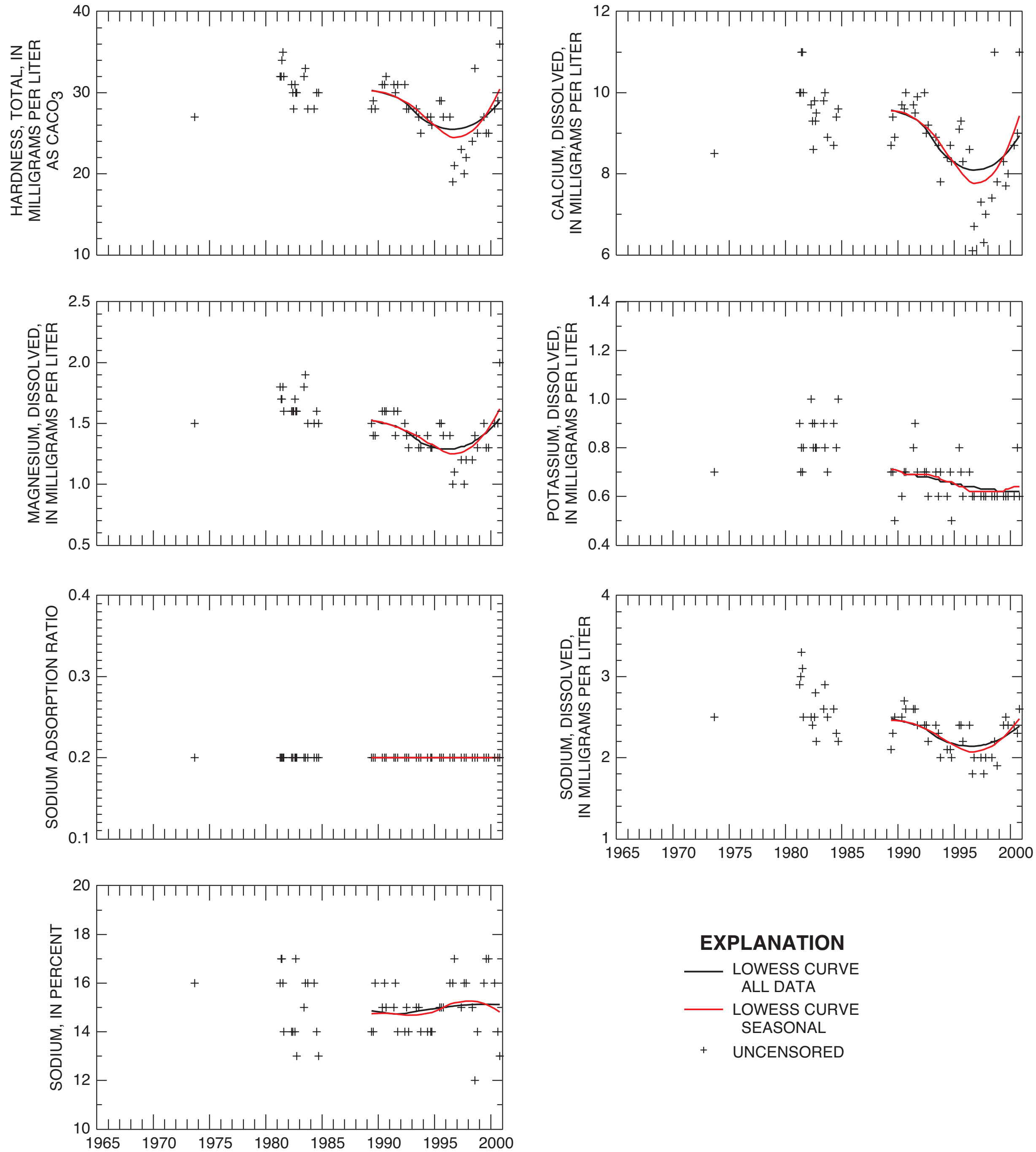

Figure 34. Temporal variations in periodic measurements and concentrations at Horsetooth Reservoir, near Soldier Canyon Dam, sampled near the surface.—Continued

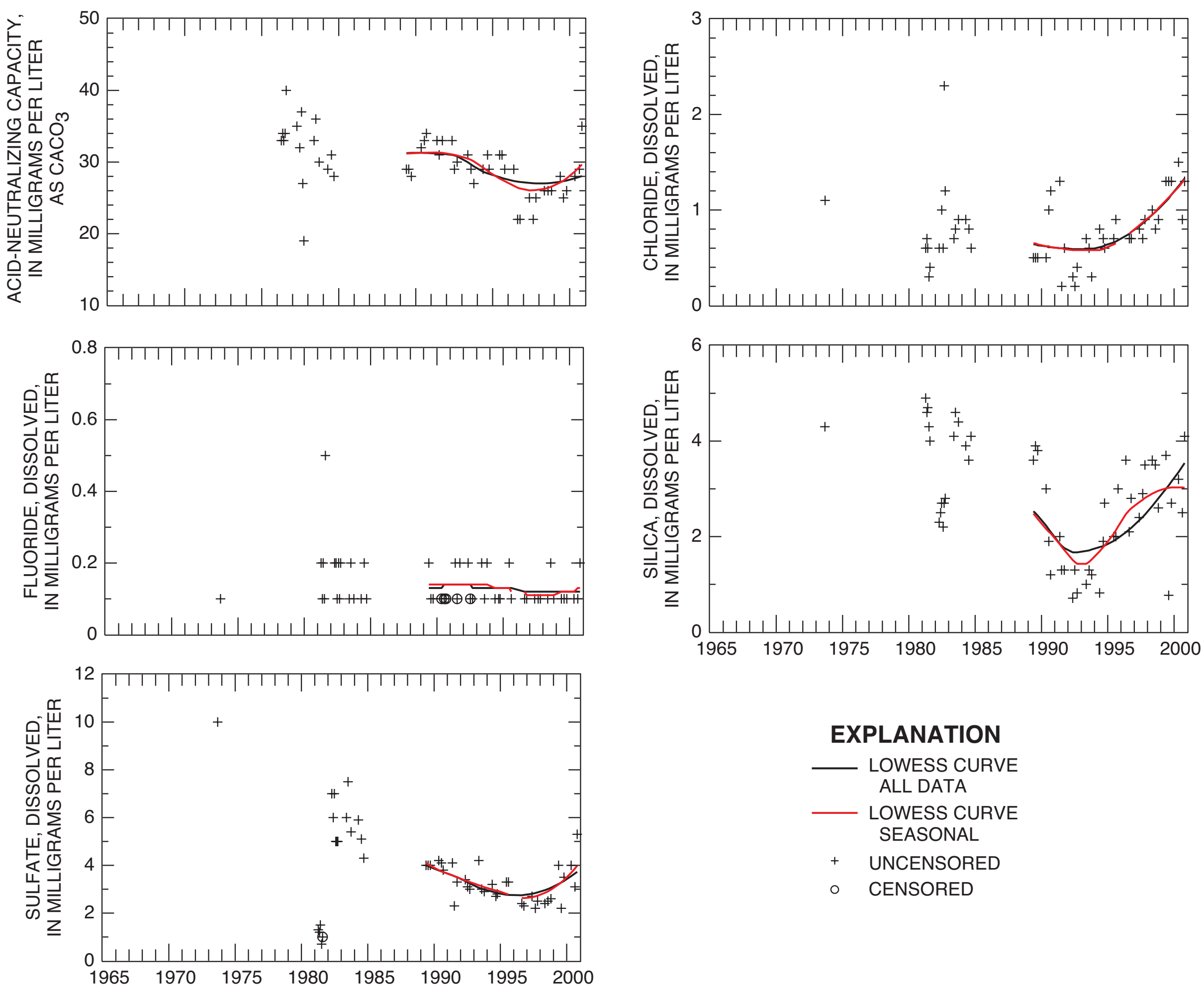

Figure 34. Temporal variations in periodic measurements and concentrations at Horsetooth Reservoir, near Soldier Canyon Dam, sampled near the surface.—Continued

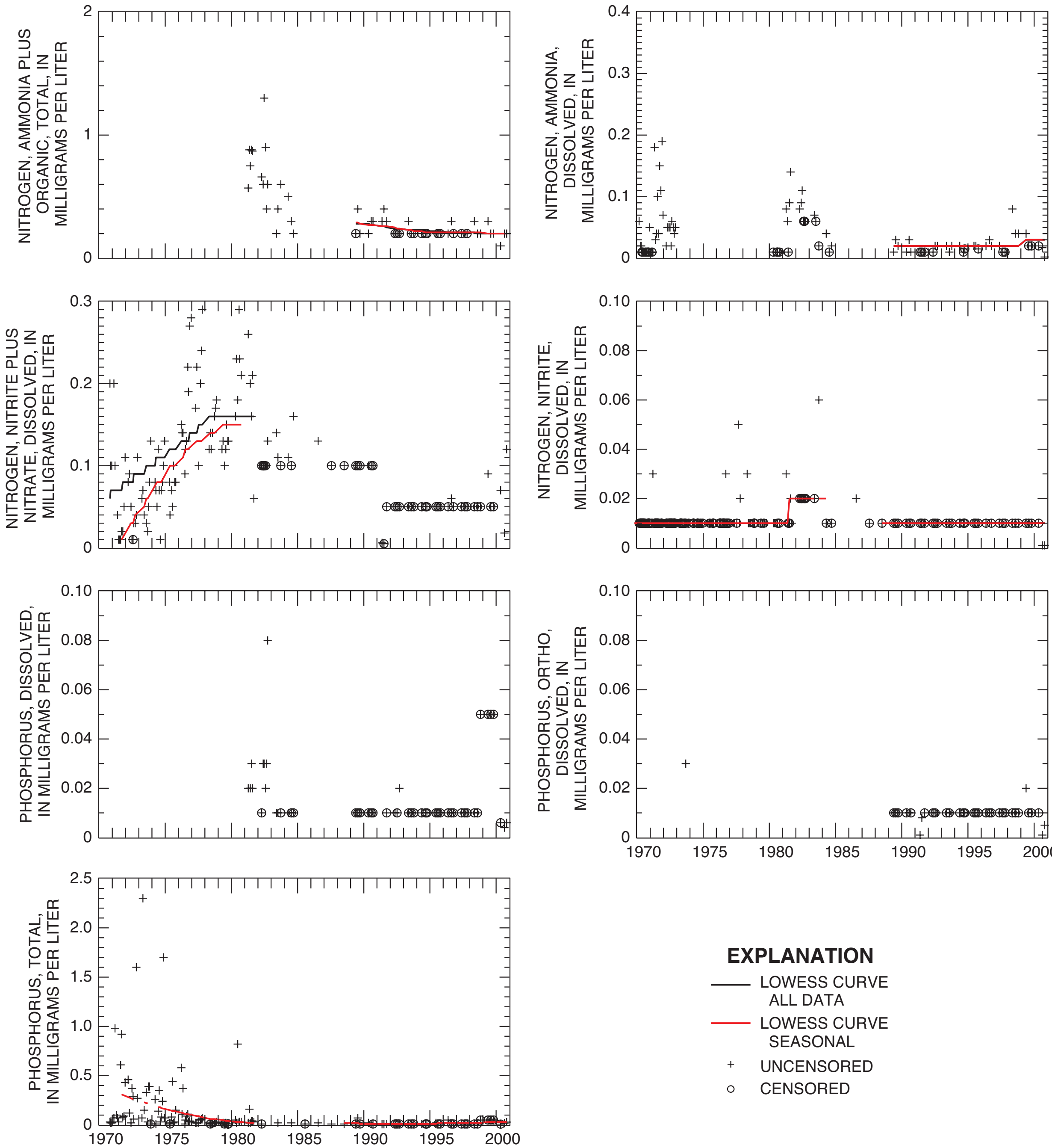

Figure 34. Temporal variations in periodic measurements and concentrations at Horsetooth Reservoir, near Soldier Canyon Dam, sampled near the surface.—Continued

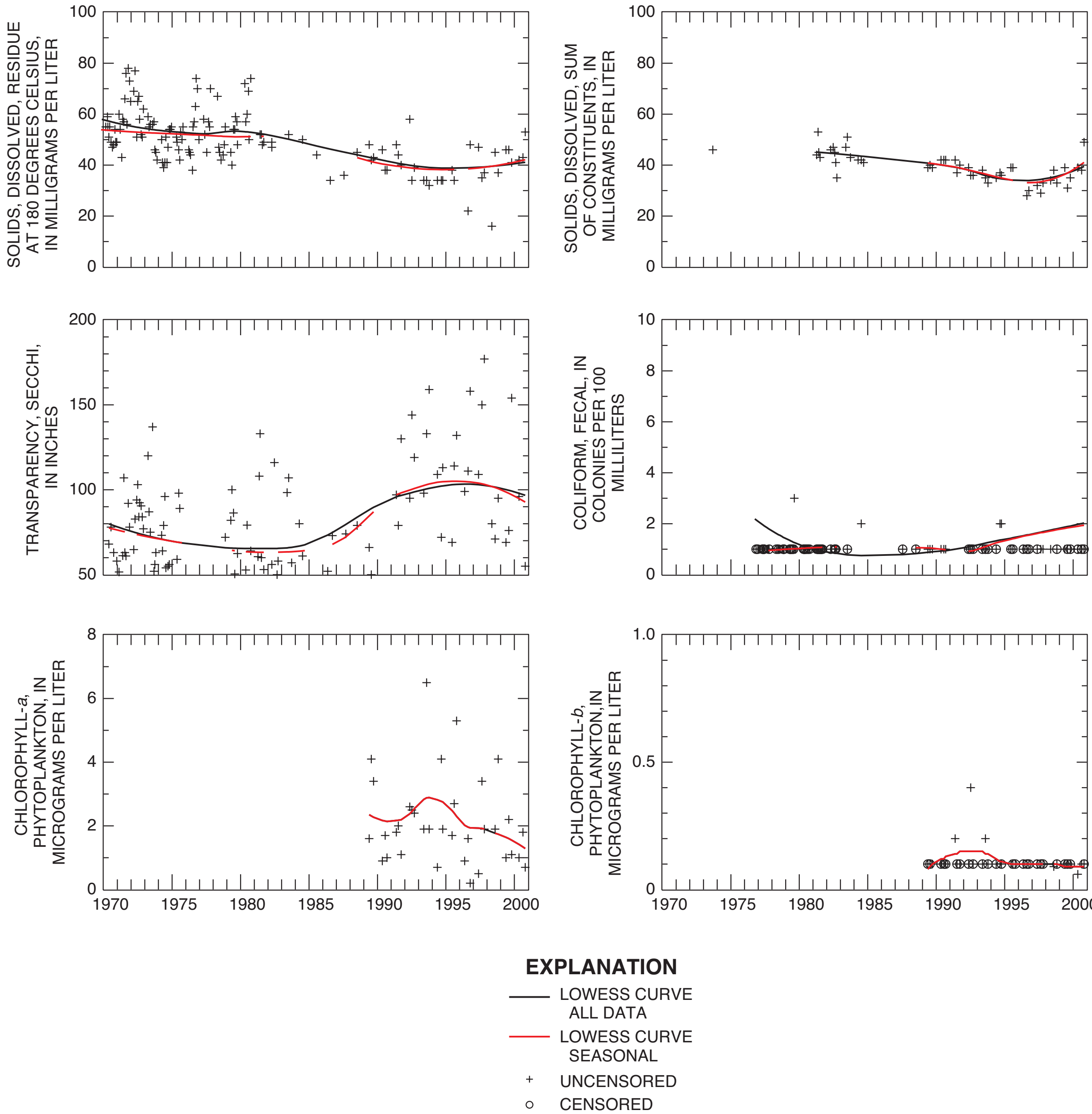

Figure 34. Temporal variations in periodic measurements and concentrations at Horsetooth Reservoir, near Soldier Canyon Dam, sampled near the surface.—Continued

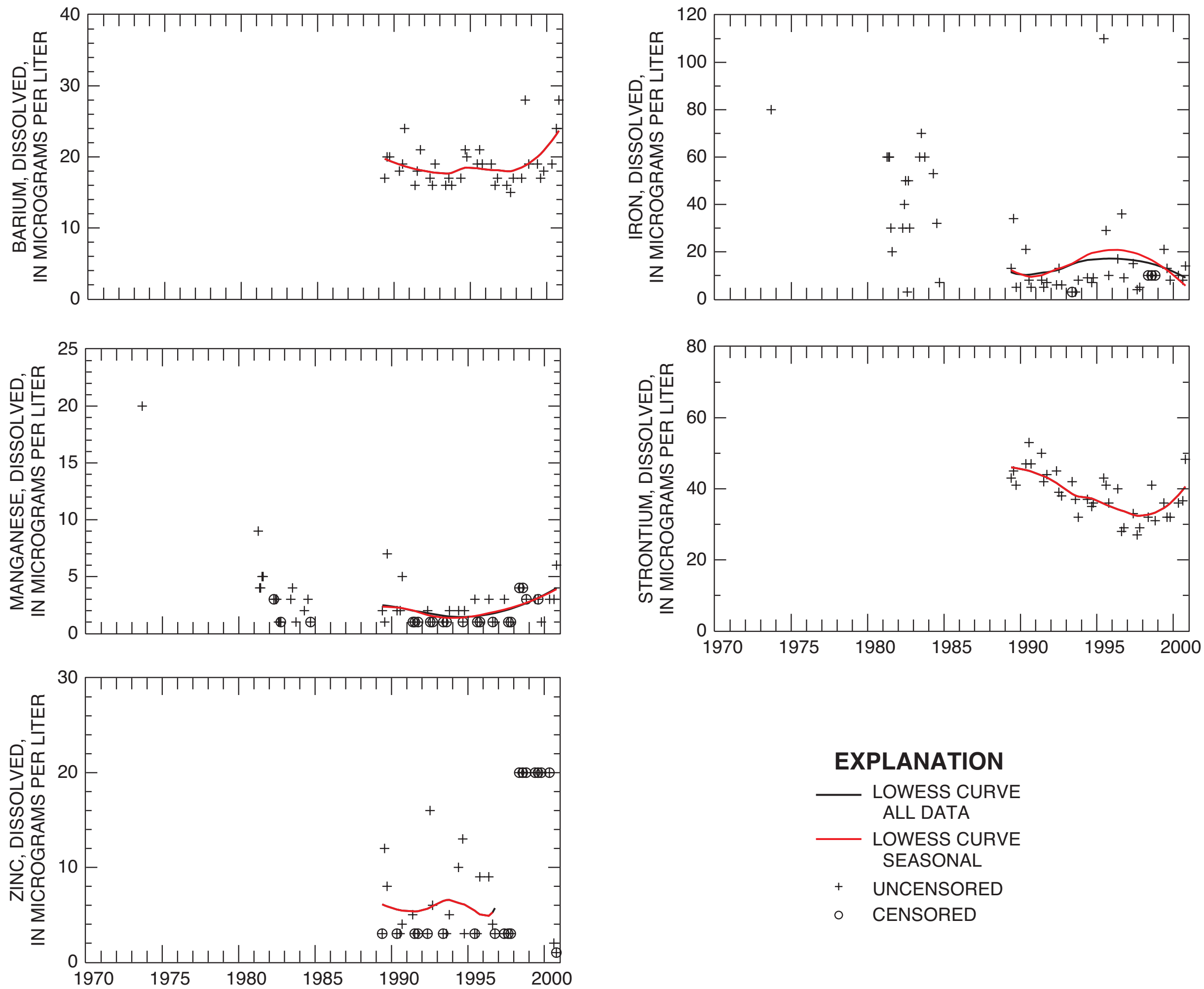

Figure 34. Temporal variations in periodic measurements and concentrations at Horsetooth Reservoir, near Soldier Canyon Dam, sampled near the surface.—Continued

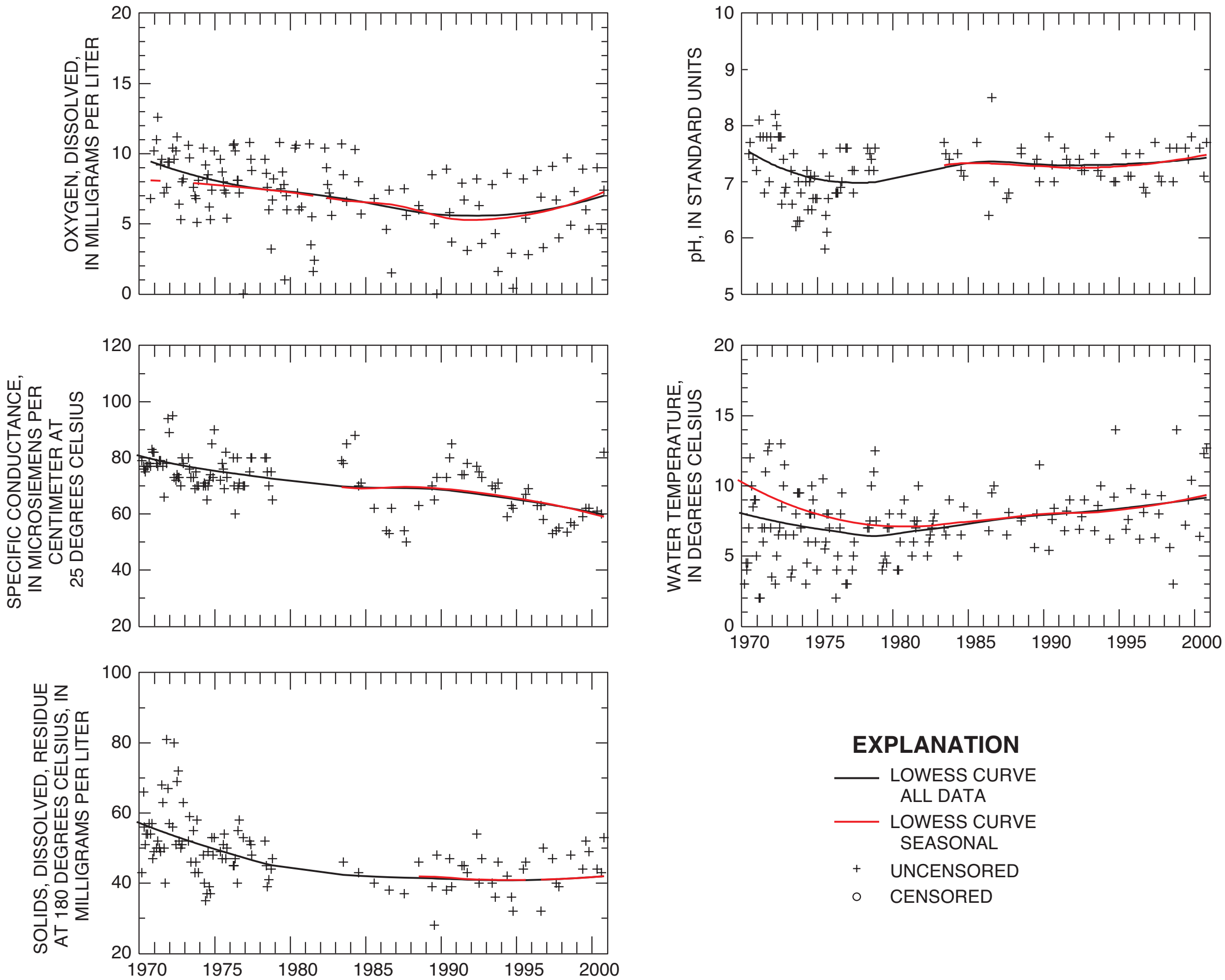

Figure 35. Temporal variations in periodic measurements and concentrations at Horsetooth Reservoir, near Soldier Canyon Dam, sampled near the bottom.

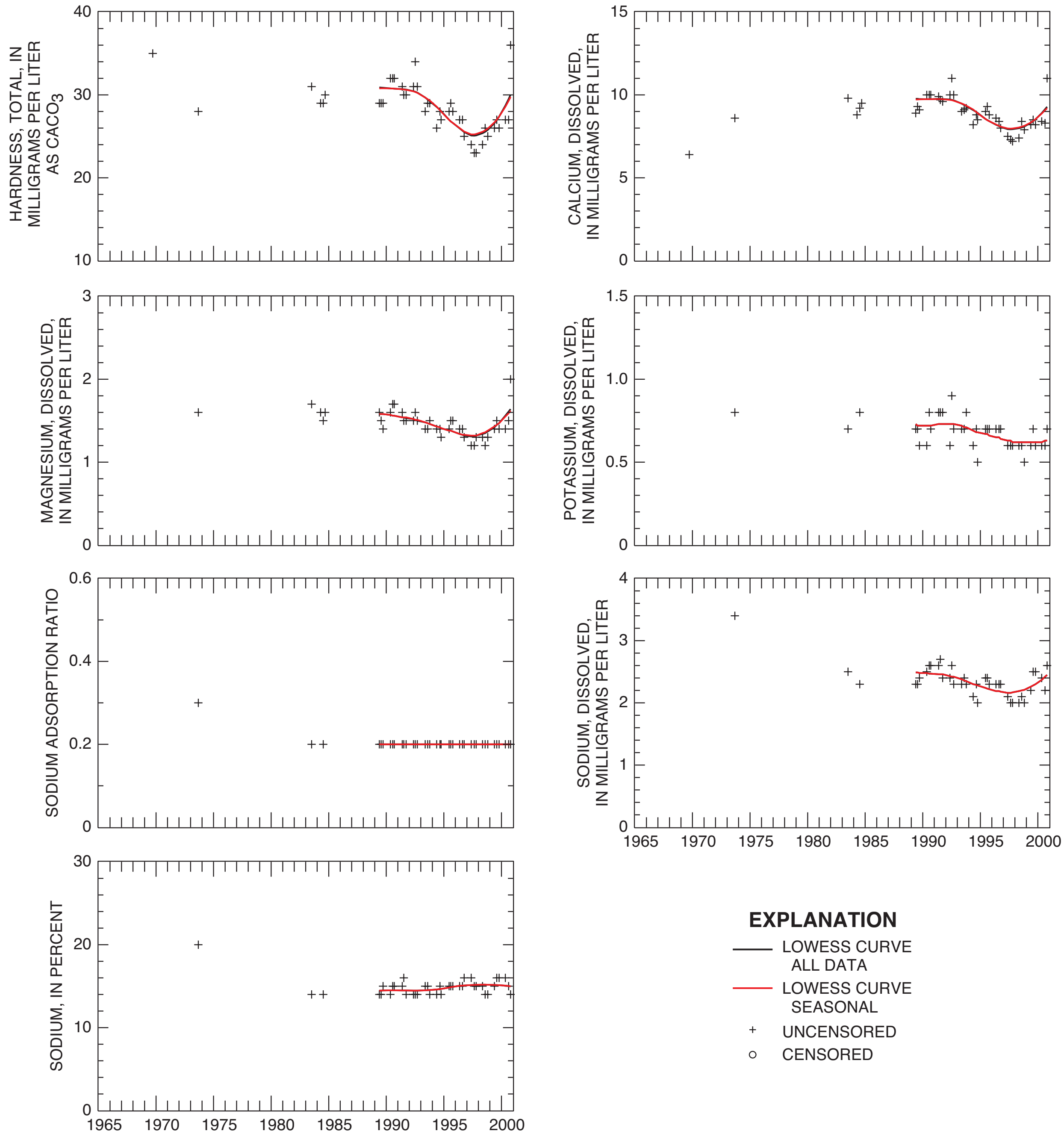

Figure 35. Temporal variations in periodic measurements and concentrations at Horsetooth Reservoir, near Soldier Canyon Dam, sampled near the bottom.—Continued

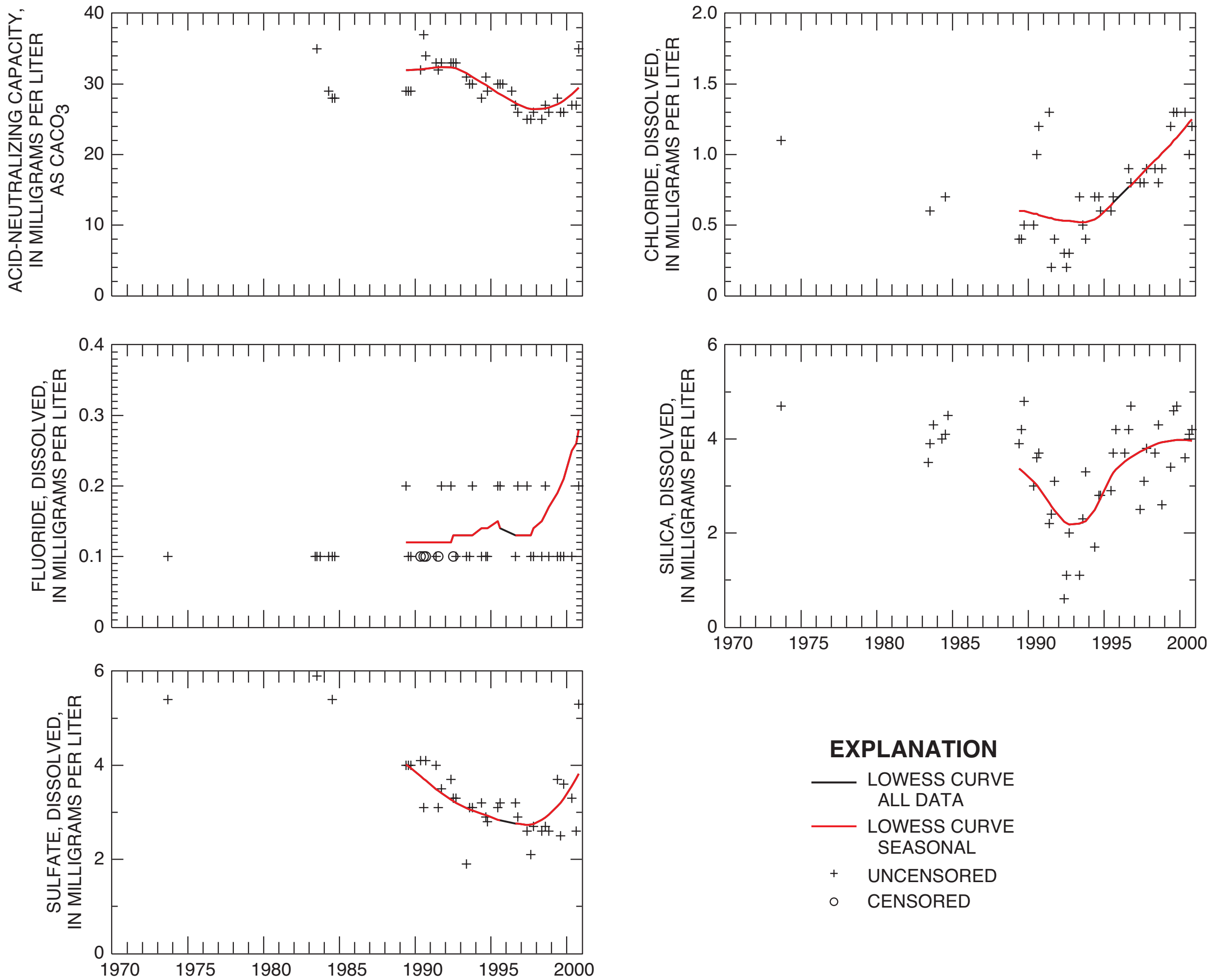

Figure 35. Temporal variations in periodic measurements and concentrations at Horsetooth Reservoir, near Soldier Canyon Dam, sampled near the bottom.—Continued

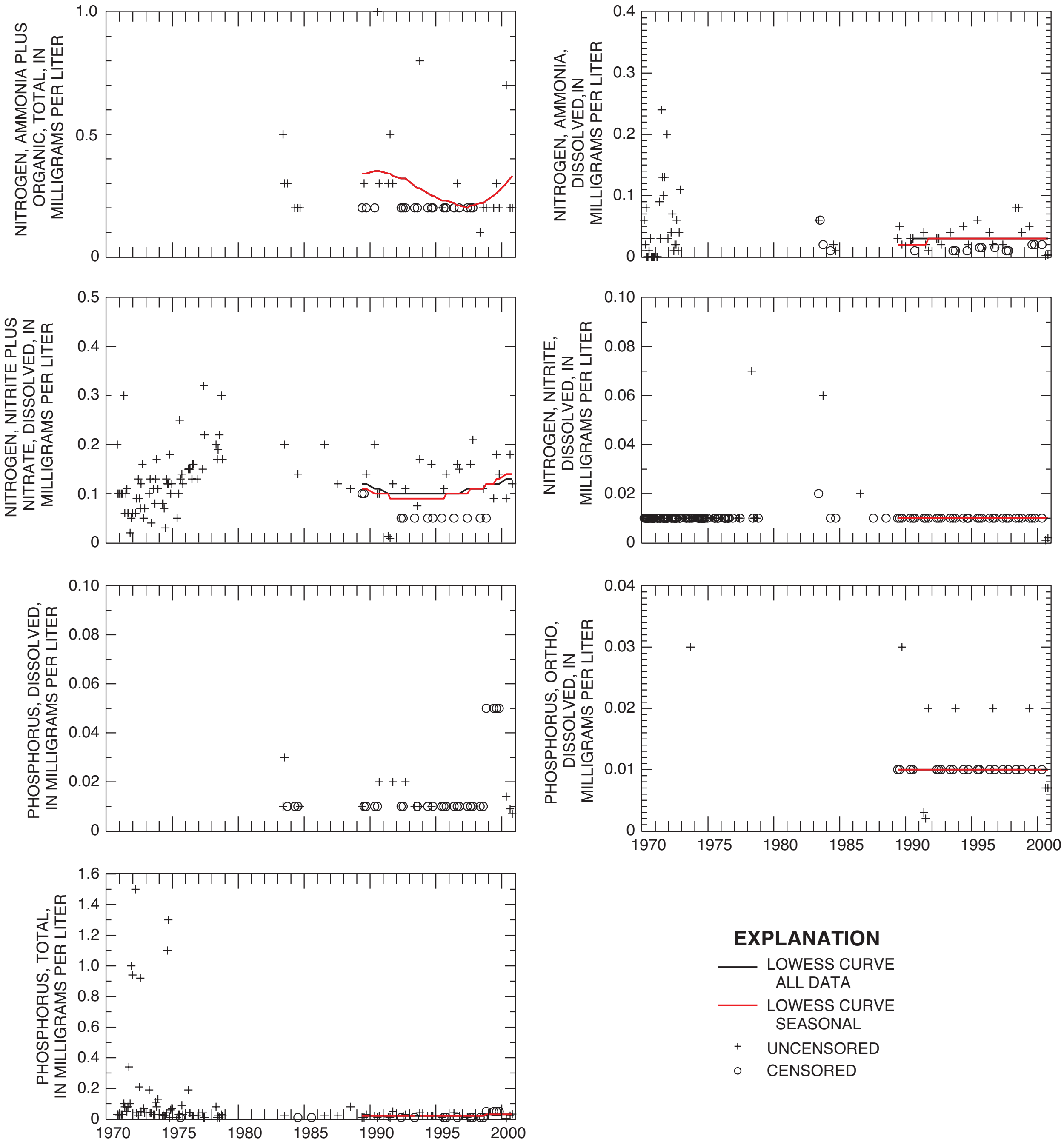

Figure 35. Temporal variations in periodic measurements and concentrations at Horsetooth Reservoir, near Soldier Canyon Dam, sampled near the bottom.—Continued

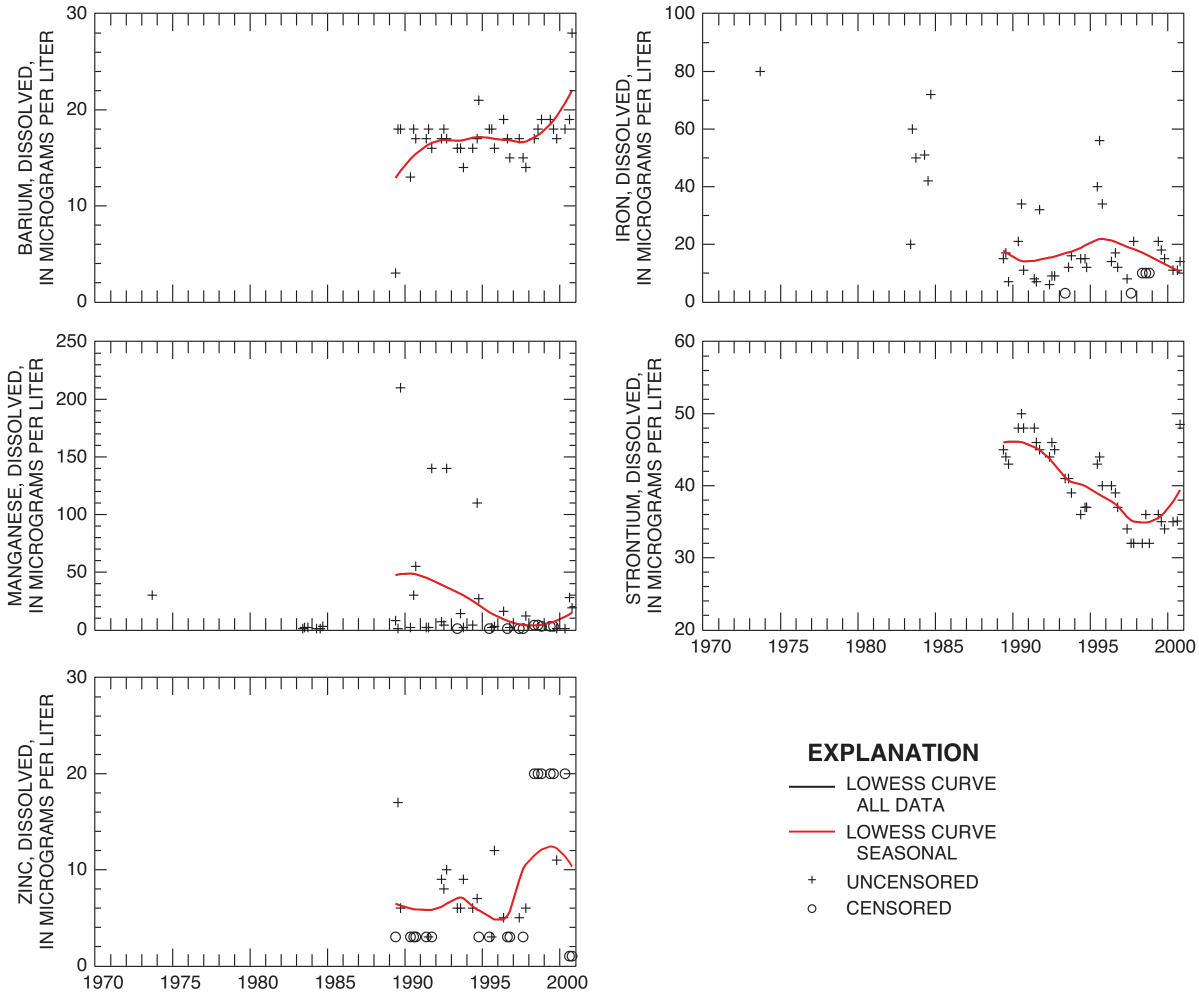

Figure 35. Temporal variations in periodic measurements and concentrations at Horsetooth Reservoir, near Soldier Canyon Dam, sampled near the bottom.—Continued

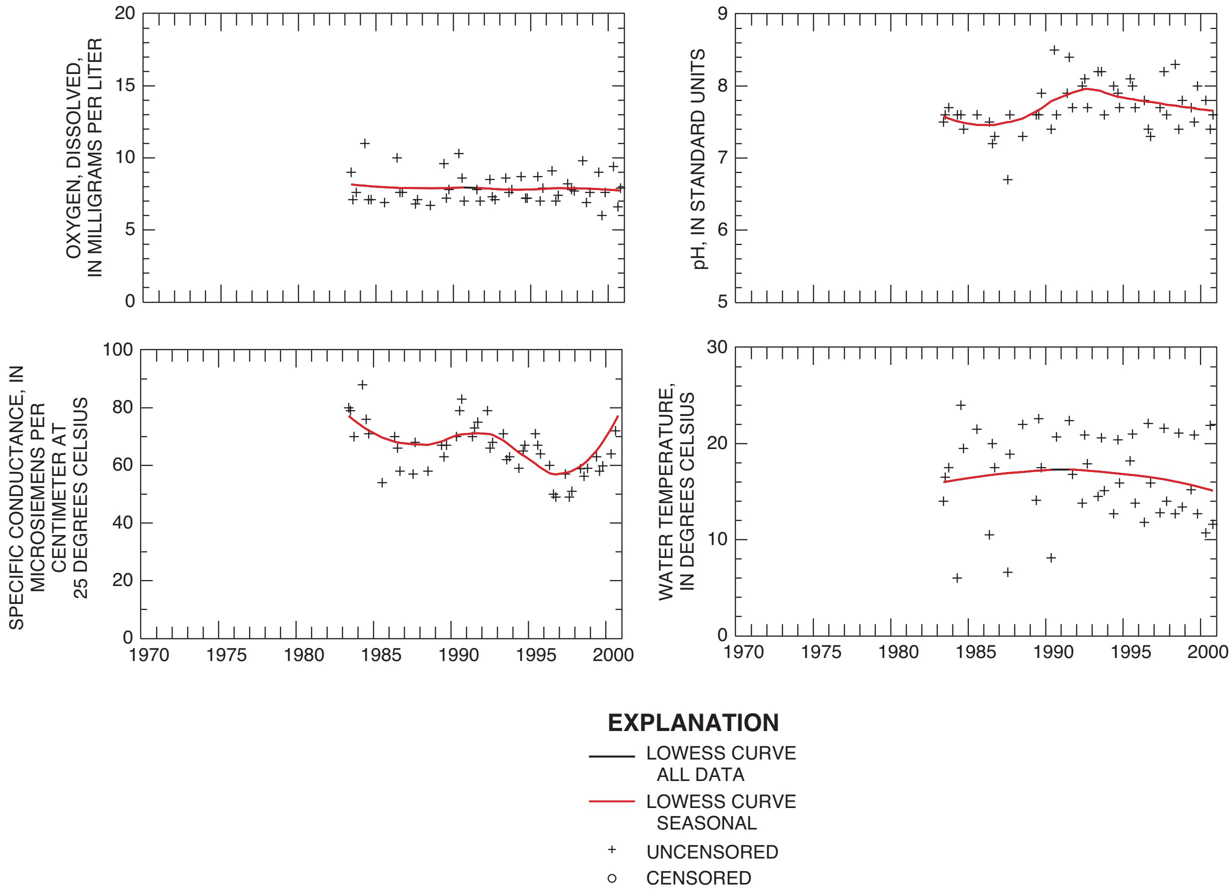

Figure 36. Temporal variations in periodic measurements and concentrations at Horsetooth Reservoir, near Spring Canyon Dam, sampled near the surface.

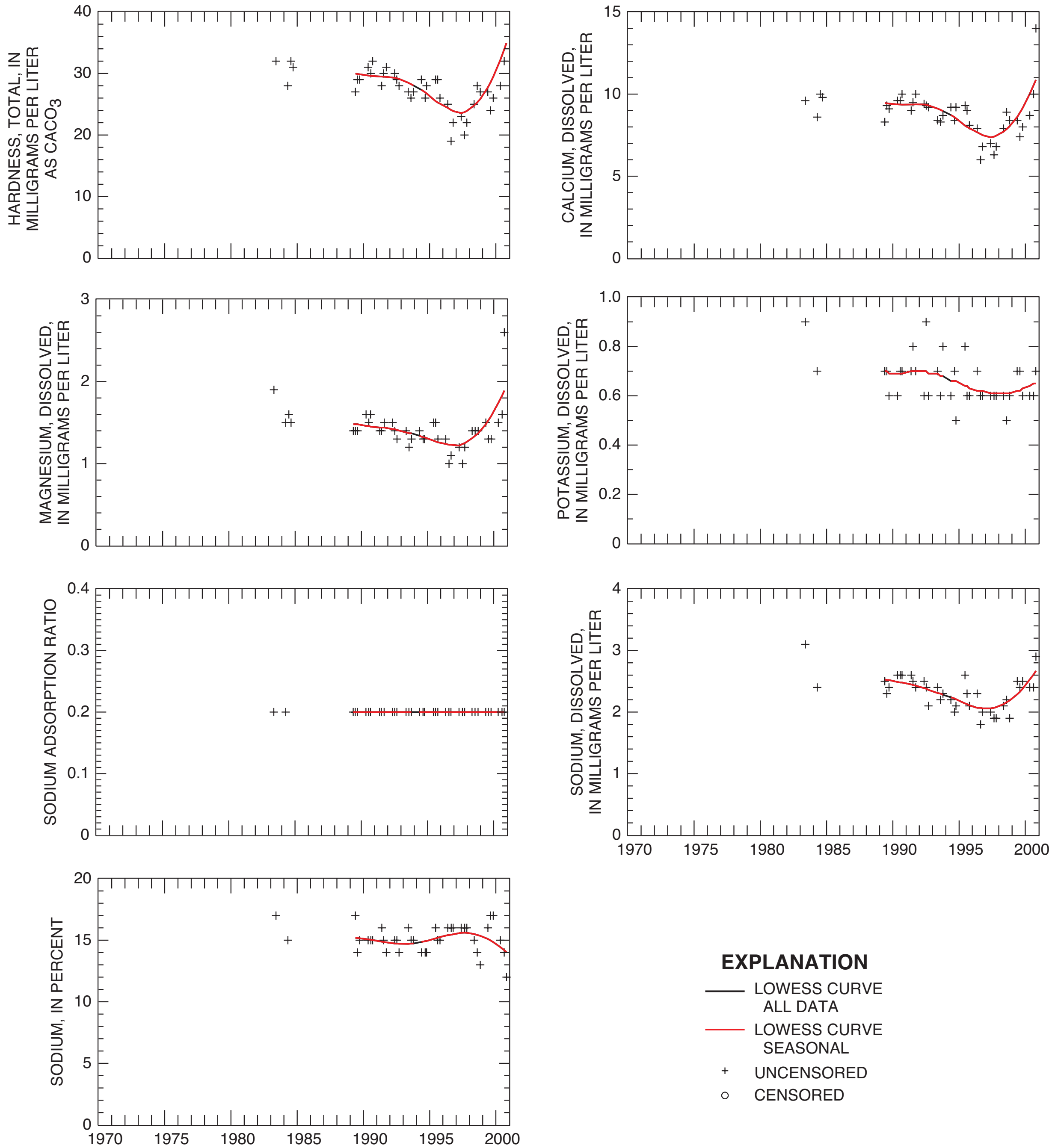

Figure 36. Temporal variations in periodic measurements and concentrations at Horsetooth Reservoir, near Spring Canyon Dam, sampled near the surface.—Continued

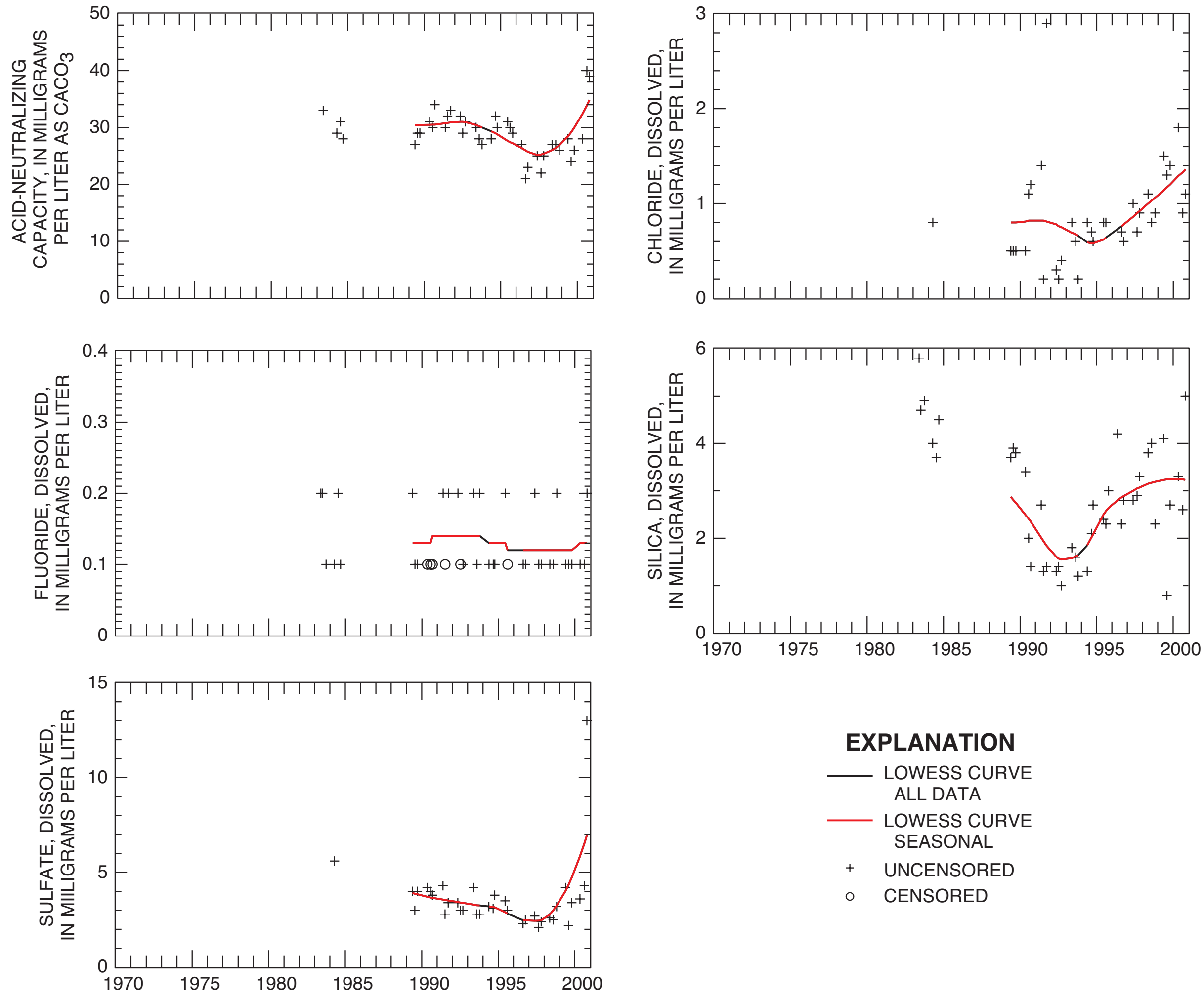

Figure 36. Temporal variations in periodic measurements and concentrations at Horsetooth Reservoir, near Spring Canyon Dam, sampled near the surface.—Continued

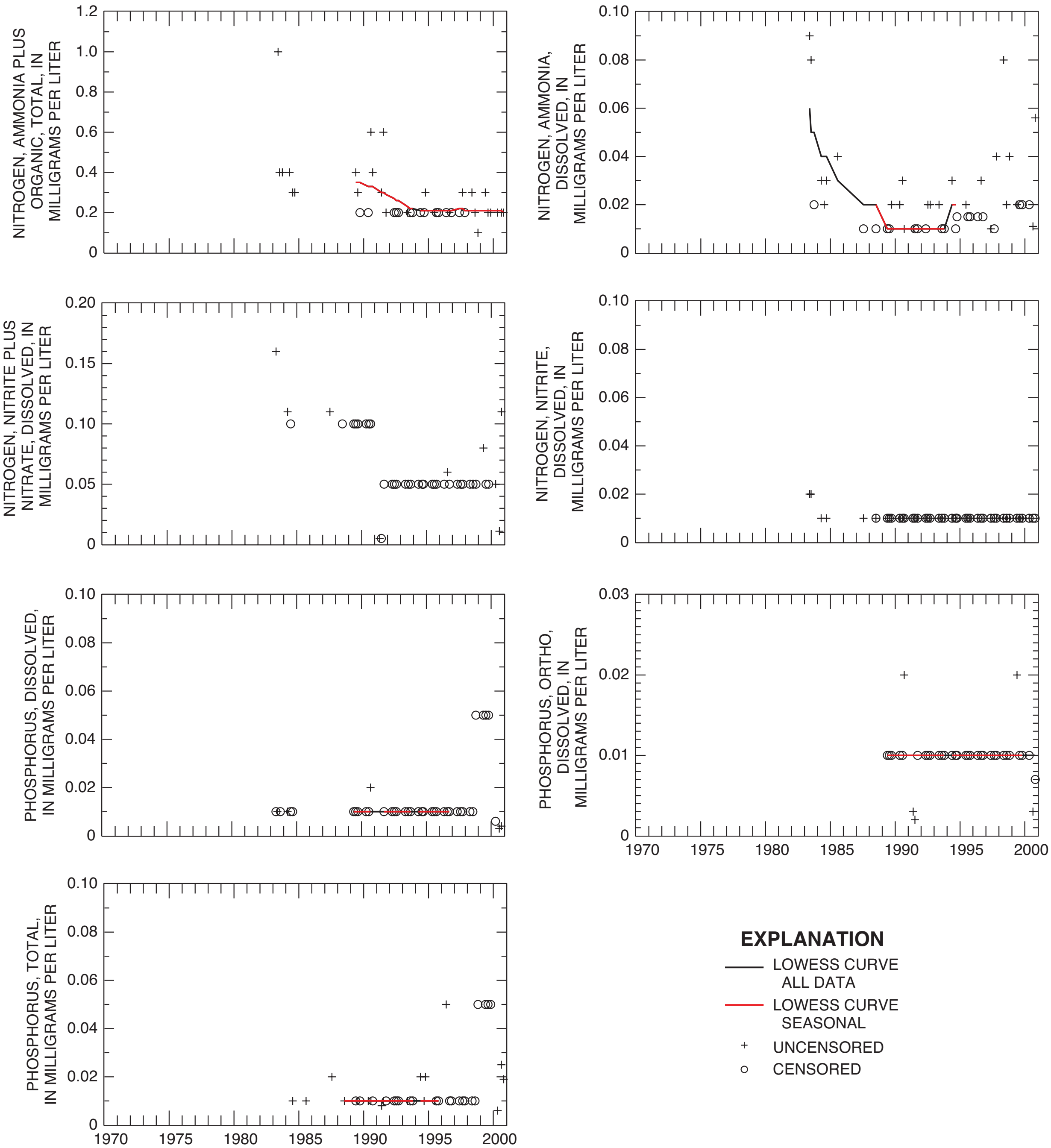

Figure 36. Temporal variations in periodic measurements and concentrations at Horsetooth Reservoir, near Spring Canyon Dam, sampled near the surface.—Continued

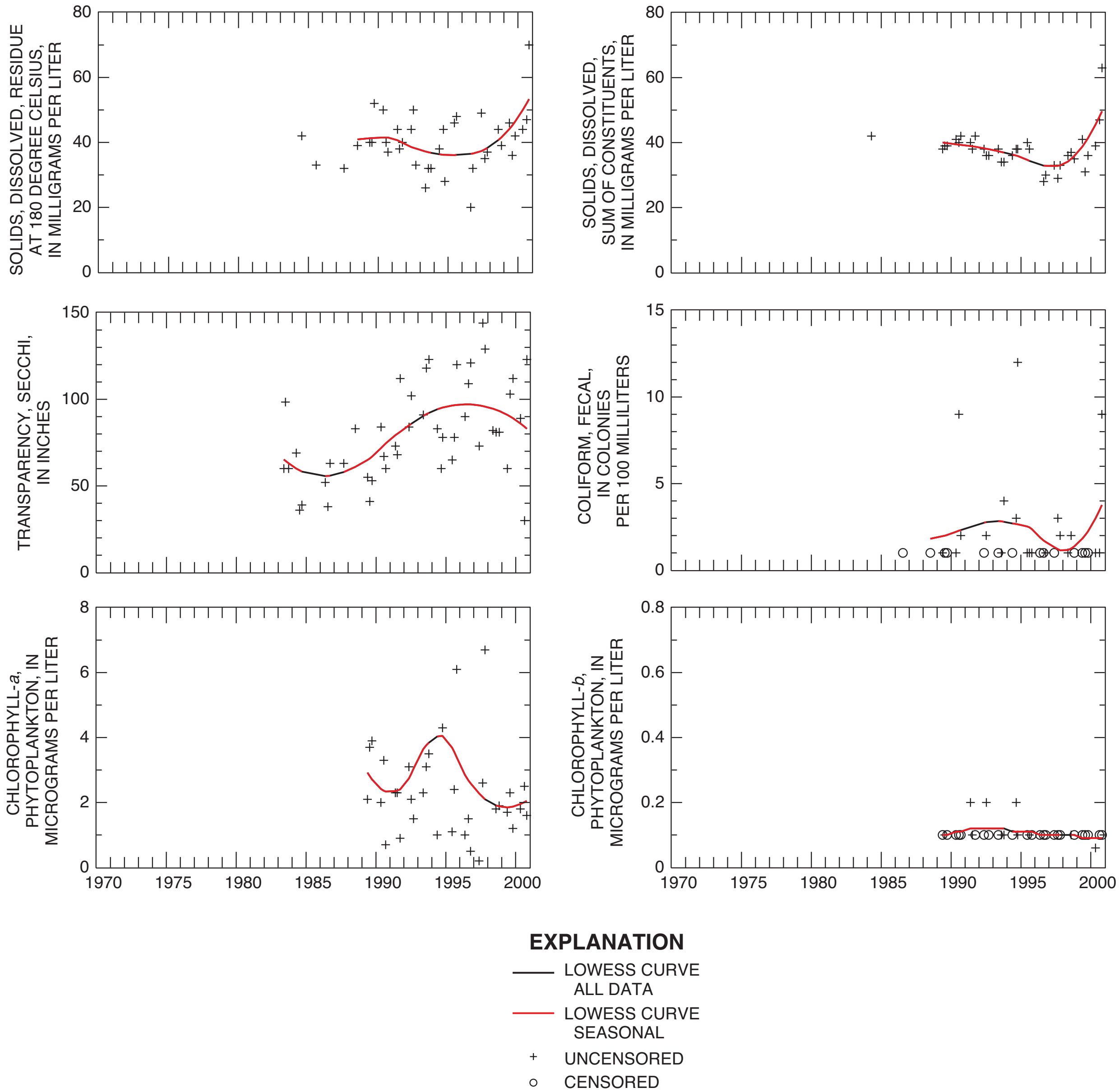

Figure 36. Temporal variations in periodic measurements and concentrations at Horsetooth Reservoir, near Spring Canyon Dam, sampled near the surface.—Continued

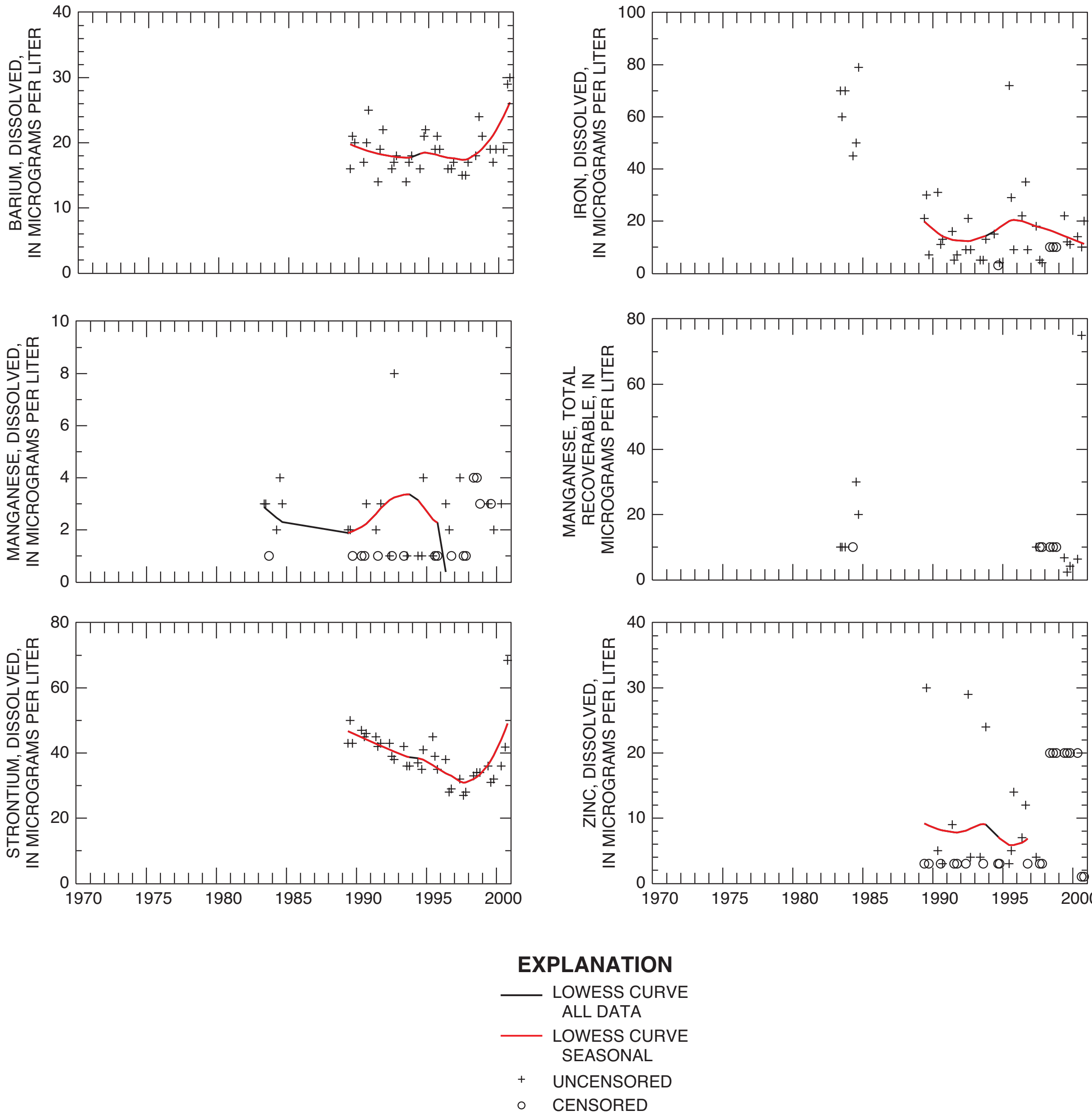

Figure 36. Temporal variations in periodic measurements and concentrations at Horsetooth Reservoir, near Spring Canyon Dam, sampled near the surface.—Continued

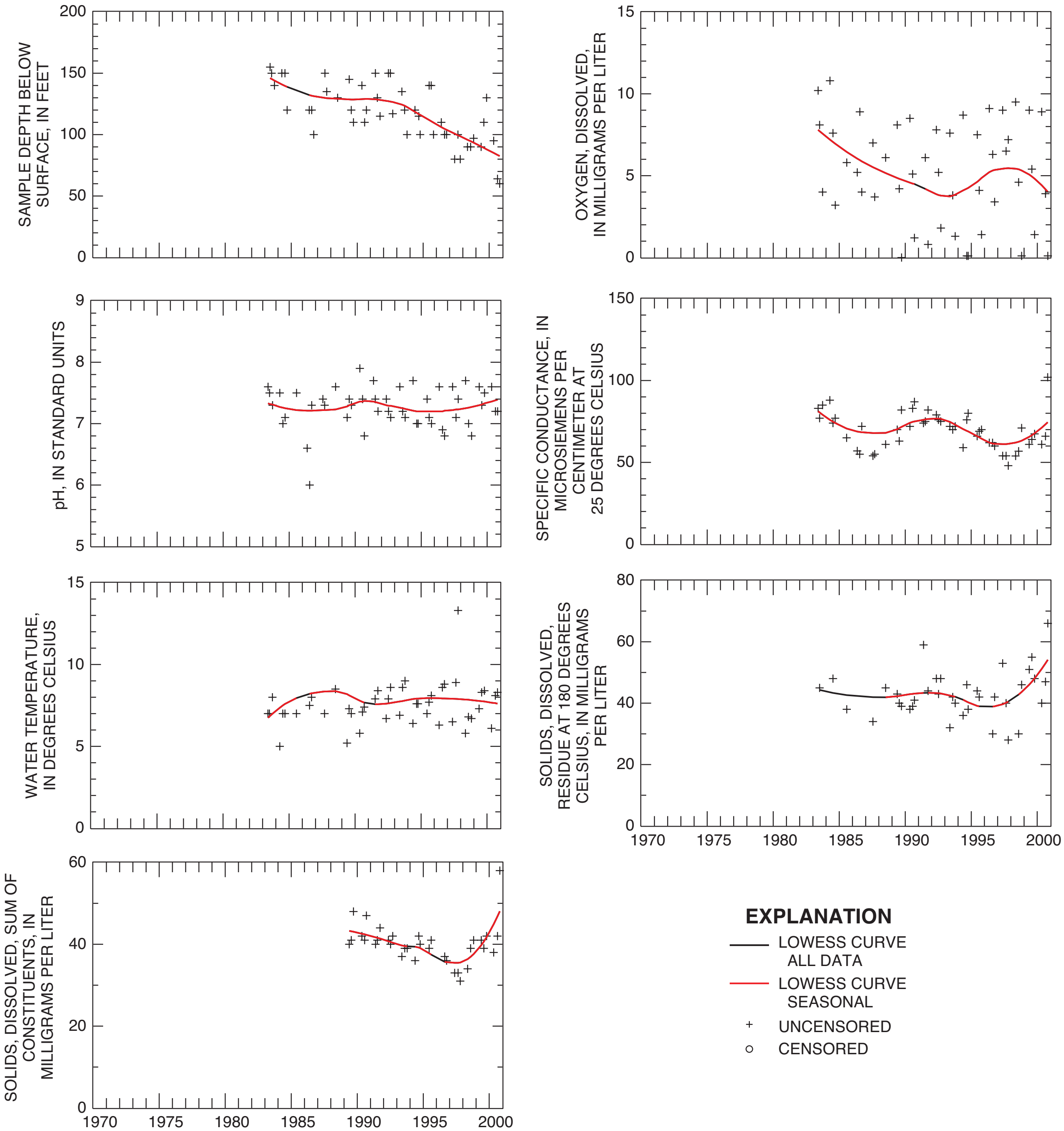

Figure 37. Temporal variations in periodic measurements and concentrations at Horsetooth Reservoir, near Spring Canyon Dam, sampled near the bottom.

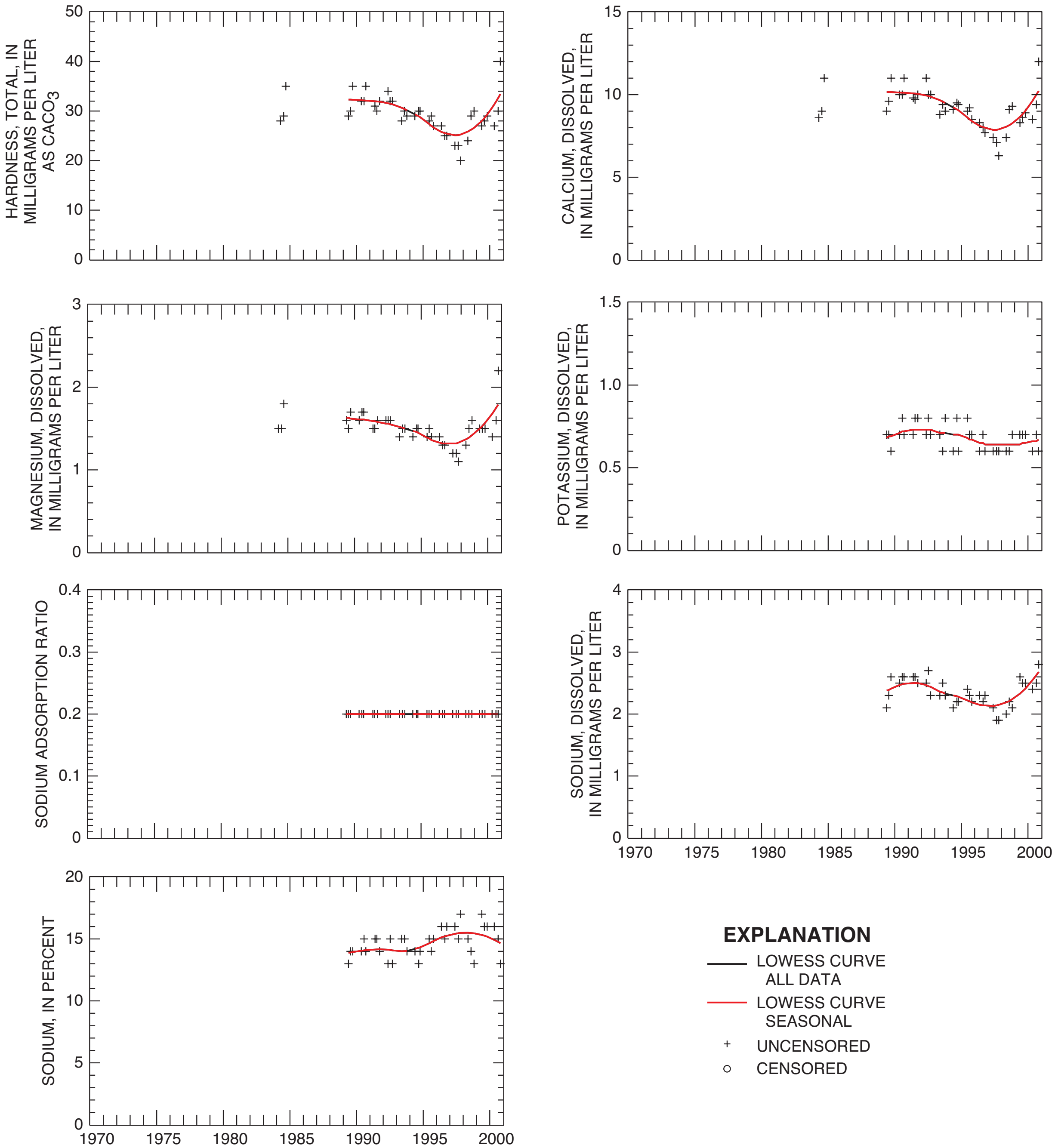

Figure 37. Temporal variations in periodic measurements and concentrations at Horsetooth Reservoir, near Spring Canyon Dam, sampled near the bottom.—Continued

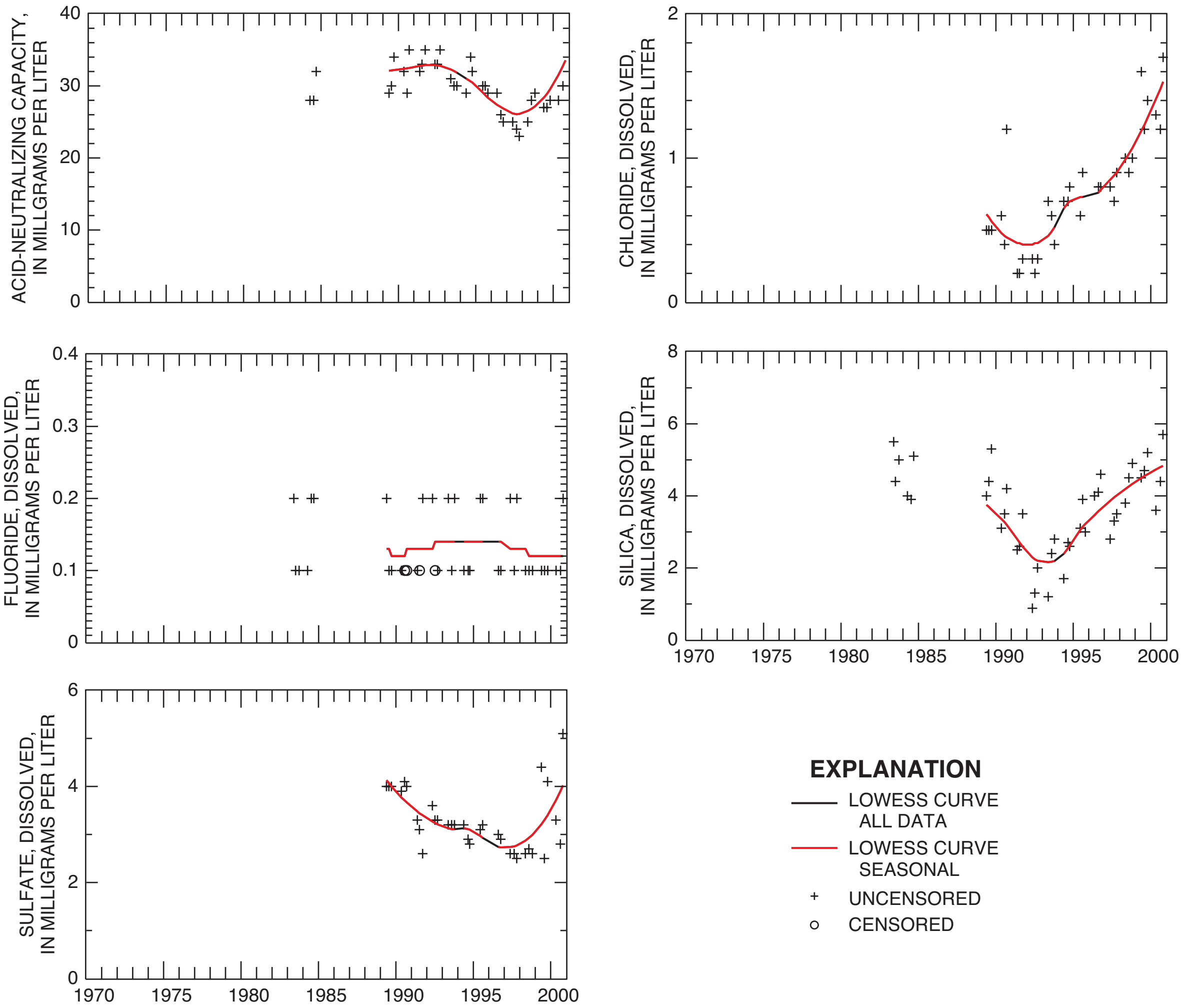

Figure 37. Temporal variations in periodic measurements and concentrations at Horsetooth Reservoir, near Spring Canyon Dam, sampled near the bottom.—Continued

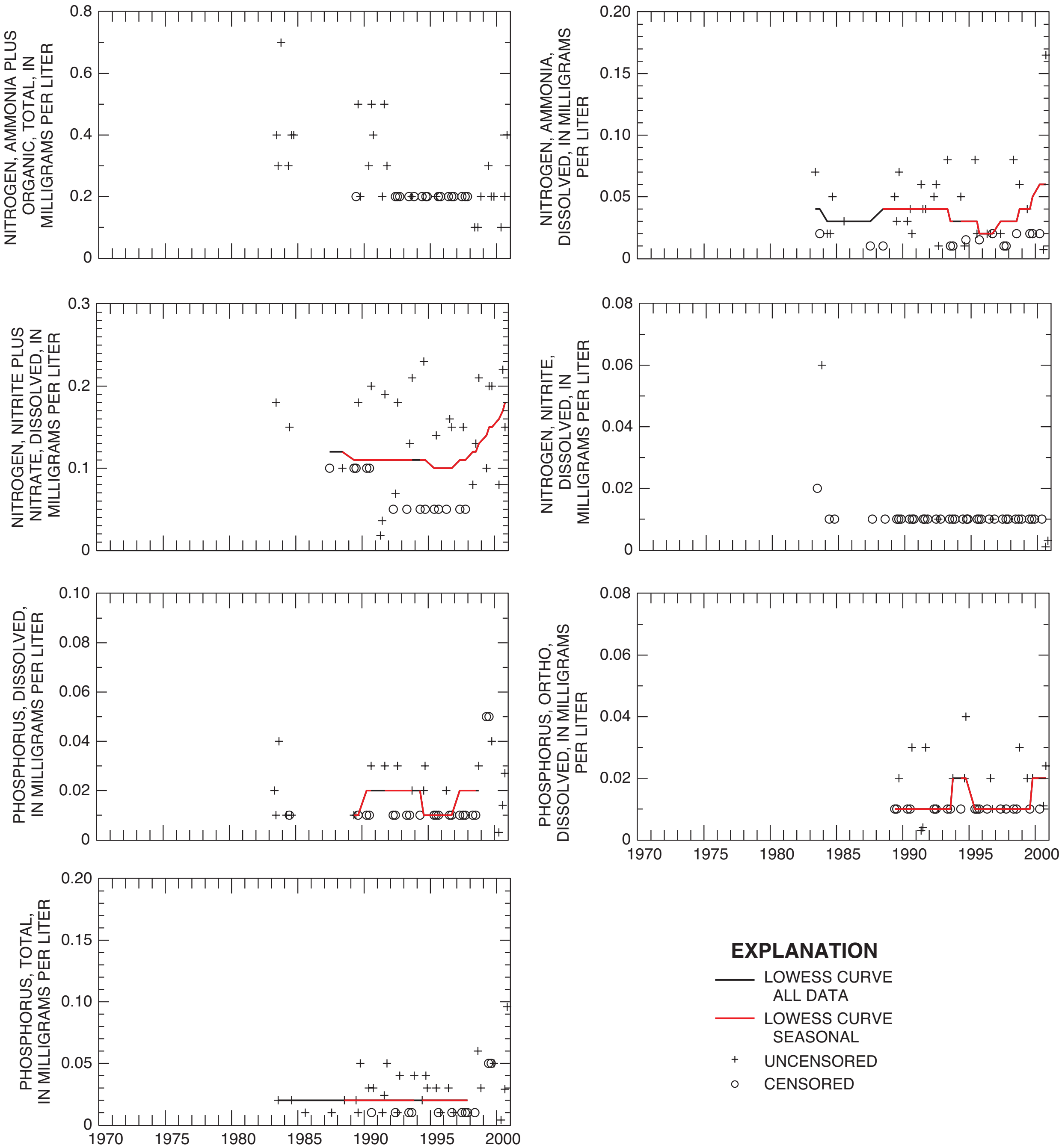

Figure 37. Temporal variations in periodic measurements and concentrations at Horsetooth Reservoir, near Spring Canyon Dam, sampled near the bottom.—Continued

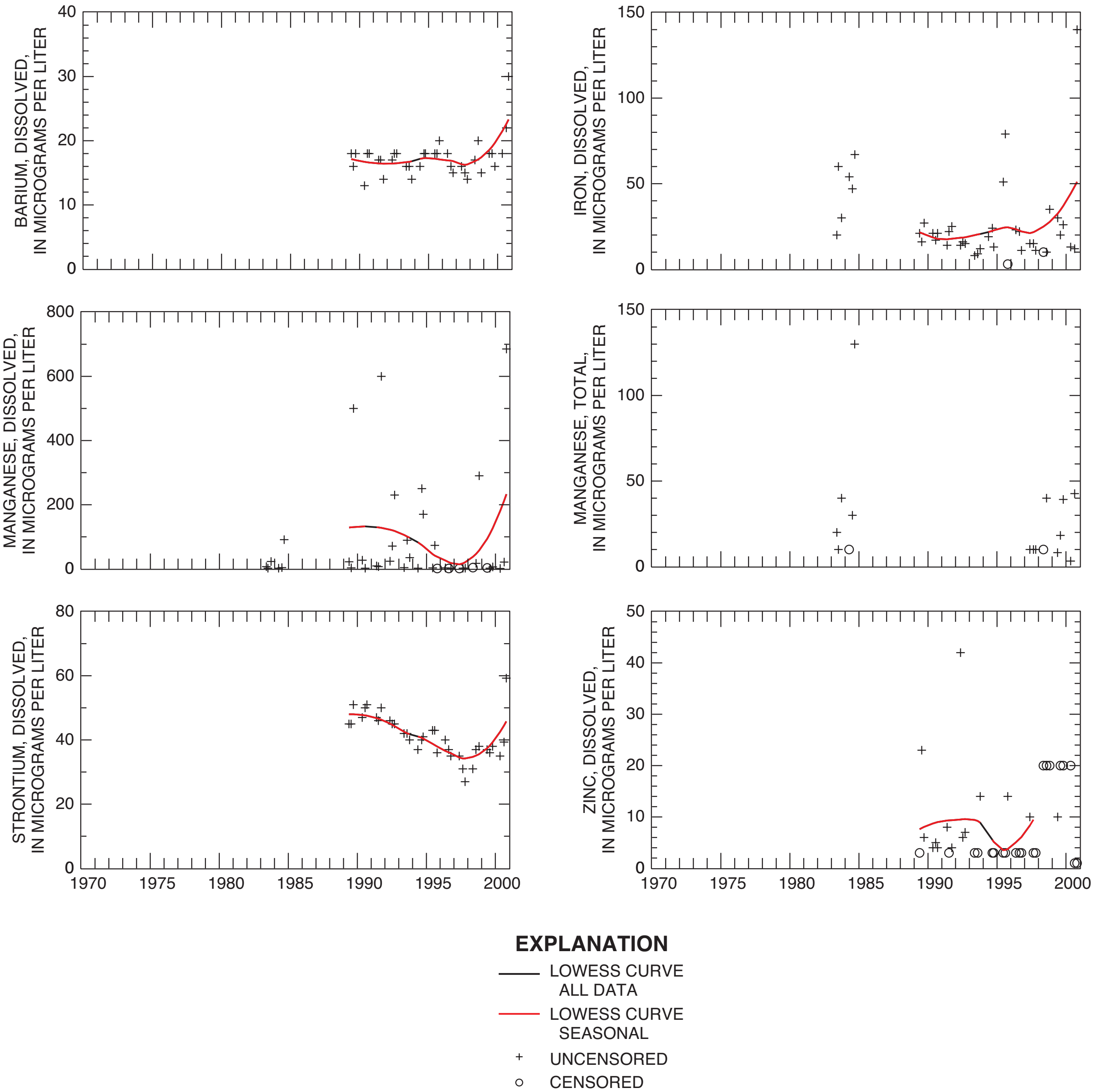

Figure 37. Temporal variations in periodic measurements and concentrations at Horsetooth Reservoir, near Spring Canyon Dam, sampled near the bottom.—Continued

Table 4. Summary statistics for site 1, Lake Granby, near spillway, near surface.

STATISTICAL SUMMARY OF SELECTED WATER QUALITY DATA COLLECTED FROM AUG 1973 TO NOV 2000

WATER-QUALITY CONSTITUENT	DESCRIPTIVE STATISTICS: SAMPLE SIZE	MAXIMUM	MINIMUM	MEAN	PERCENT OF SAMPLES IN WHICH VALUES WERE LESS THAN OR EQUAL TO THOSE SHOWN: 95 %	75 %	(MEDIAN) 50 %	25 %	5 %
70300 RESIDUE DIS 180C MG/L	57	56.000	16.000	37.158	50.100	41.500	37.000	33.500	20.600
70301 DISSOLVED SOLIDS MG/L	59	43.800	27.800	34.620	40.800	37.000	35.000	31.700	28.900
00077 TRANSPARENCY (IN (INCHES)	67	236.000	67.000	129.881	217.400	158.000	118.000	94.000	69.600
00300 OXYGEN DISSOLVED (MG/L)	79	10.400	5.000	7.794	9.300	8.600	7.500	7.200	6.500
00400 PH, WH, FIELD (STANDARD UNIT	75	9.100	5.700	7.931	8.920	8.300	7.900	7.600	7.080
00403 PH, WH, LABORATO (STANDARD UNIT	59	8.700	6.800	7.664	8.400	7.900	7.600	7.500	7.100
90095 SPECIFIC CONDUCT MICROSIEMENS/C	59	73.000	46.000	56.915	64.000	62.000	57.000	53.000	47.000
00095 SPECIFIC CONDUCT US/CM @ 25C	77	68.000	41.000	54.805	67.100	61.000	53.000	48.500	43.000
00010 WATER TEMPERATUR (DEGREES C)	78	19.500	0.000	13.887	19.005	17.125	15.150	11.175	5.500
00900 HARDNESS TOTAL (MG/L AS CAO3)	60	28.000	18.000	22.617	27.095	24.600	22.200	20.825	18.130
00915 CALCIUM DISSOLVE (MG/L AS CA)	60	8.700	5.500	6.961	8.490	7.600	6.870	6.430	5.621
00925 MAGNESIUM DISSOL (MG/L AS MG)	60	1.600	0.972	1.255	1.500	1.400	1.200	1.150	1.005
00935 POTASSIUM DISSOL (MG/L AS K)	60	1.000	0.550	0.681	0.800	0.700	0.700	0.600	0.571
00931 SODIUM ADSORPTIO (RATIO)	60	0.300	0.159	0.198	0.238	0.214	0.199	0.176	0.162
00930 SODIUM DISSOLVED (MG/L AS NA)	60	2.900	1.600	2.160	2.700	2.475	2.200	1.800	1.605
00932 SODIUM, PERCENT PERCENT	60	24.000	14.600	16.660	18.100	17.475	16.450	15.725	14.805
90410 ANC, TIT. 4.5, L MG/L AS CACO3	59	31.000	20.000	24.814	29.000	27.000	24.000	23.000	21.000
00940 CHLORIDE DISSOLV (MG/L AS CL)	60	1.100	0.100	0.447	0.800	0.500	0.400	0.325	0.105
00950 FLUORIDE DISSOLV (MG/L AS F)	60	0.300	--	0.111*	*0.200	*0.100	*0.100	*0.100	*0.064
00955 SILICA DISSOLVED (MG/L AS SIO2)	60	7.200	2.300	5.047	6.690	5.700	4.850	4.400	3.905
00945 SULFATE DISSOLVE (MG/L AS SO4)	60	5.000	1.700	2.945	4.095	3.300	2.950	2.425	2.000
00608 NITROGEN AMMONIA (MG/L AS N)	59	0.050	--	0.012*	*0.030	*0.020	*0.010	*0.005	*0.003
00625 NITROGEN AMM+ORG (MG/L AS N)	78	3.900	--	0.344*	*0.758	*0.300	*0.200	*0.156	*0.081
00610 NITROGEN AMMONIA (MG/L AS N)	24	0.060	--	0.023*	*0.060	*0.040	*0.015	*0.007	*0.003
00631 NO2 + NO3 DISSOL (MG/L AS N)	60	0.089	--	0.015*	*0.072	*0.016	*0.006	*0.002	*0.001
00630 NO2 + NO3 TOTAL (MG/L AS N)	30	0.100	--	0.100*	*0.100	*0.100	*0.100	*0.100	*0.100
00613 NITROGEN,NITRITE MG/L AS N	59	--	--	--	--	--	--	--	--
00666 PHOSPHORUS DISS. (MG/L AS P)	57	0.053	--	0.005*	*0.020	*0.006	*0.003	*0.001	*0.001
00671 PHOSPHORUS ORTHO (MG/L AS P)	60	0.020	--	0.002*	*0.011	*0.002	*0.001	*0.000	*0.000
00665 PHOSPHORUS TOTAL (MG/L AS P)	78	0.170	--	0.013*	*0.040	*0.020	*0.009	*0.005	*0.002
31625 COLIFORM FECAL 0 COLS./100 ML	58	2.000	--	0.765*	*1.000	*0.909	*0.731	*0.607	*0.460
70953 CHL-A PHY CHROMA UG/L	60	13.000	0.400	2.947	8.360	3.600	2.050	1.300	0.900
70954 CHLOROPHYLL-B, P UG/L	58	0.300	--	0.084*	*0.300	*0.100	*0.056	*0.031	*0.013
01005 BARIUM DISSOLVED (UG/L AS BA)	59	9.000	2.000	7.932	9.000	8.100	8.000	7.800	7.000
01010 BERYLLIUM DISSOL (UG/L AS BE)	59	--	--	--	--	--	--	--	--
01020 BORON DISSOLVED (UG/L AS B)	59	40.000	--	4.569*	*15.000	*5.586	*2.682	*1.345	*0.504
01025 CADMIUM DISSOLVE (UG/L AS CD)	69	2.000	--	0.516*	*2.000	*0.649	*0.380	*0.214	*0.099
01030 CHROMIUM DISSOLV (UG/L AS CR)	59	--	--	--	--	--	--	--	--
01035 COBALT DISSOLVED (UG/L AS CO)	59	--	--	--	--	--	--	--	--
01040 COPPER DISSOLVED (UG/L AS CU)	69	14.022	--	2.418*	*8.718	*3.013	*1.608	*0.759	*0.295
01046 IRON DISSOLVED (UG/L AS FE)	60	2100.000	--	51.669*	*59.000	*30.000	*10.000	*4.245	*1.165
01049 LEAD DISSOLVED (UG/L AS PB)	75	13.700	--	2.597*	*10.000	*3.307	*1.734	*0.919	*0.447
01130 LITHIUM DISSOLVE (UG/L AS LI)	59	5.000	--	1.468*	*4.000	*1.902	*1.212	*0.800	*0.424
01056 MANGANESE DISSOL (UG/L AS MN)	60	30.000	--	2.120*	*9.950	*2.000	*0.878	*0.325	*0.088
01060 MOLYBDENUM DISSO (UG/L AS MO)	59	--	--	--	--	--	--	--	--
01065 NICKEL DISSOLVED (UG/L AS NI)	73	10.000	--	1.196*	*4.987	*1.300	*0.581	*0.257	*0.087
01075 SILVER DISSOLVED (UG/L AS AG)	58	--	--	--	--	--	--	--	--
01080 STRONTIUM DISSOL (UG/L AS SR)	59	57.000	32.900	42.766	52.000	47.000	42.000	38.000	33.500
01085 VANADIUM DISSOLV (UG/L AS V)	59	--	--	--	--	--	--	--	--
01090 ZINC DISSOLVED (UG/L AS ZN)	71	40.000	--	5.077*	*12.400	*8.000	*3.000	*1.834	*0.819

* - VALUE IS ESTIMATED BY USING A LOG-PROBABILITY REGRESSION TO PREDICT THE VALUES OF DATA BELOW THE DETECTION LIMIT (Helsel and Cohn, 1988)

Table 5. Summary statistics for site 1, Lake Granby, near spillway, near bottom.

STATISTICAL SUMMARY OF SELECTED WATER QUALITY DATA COLLECTED FROM AUG 1973 TO NOV 2000

WATER-QUALITY CONSTITUENT	SAMPLE SIZE	DESCRIPTIVE STATISTICS: MAXIMUM	MINIMUM	MEAN	PERCENT OF SAMPLES IN WHICH VALUES WERE LESS THAN OR EQUAL TO THOSE SHOWN: 95 %	75 %	(MEDIAN) 50 %	25 %	5 %
70300 RESIDUE DIS 180C MG/L	57	60.000	24.000	40.088	58.000	44.000	40.000	36.000	26.900
70301 DISSOLVED SOLIDS MG/L	58	50.500	29.800	37.459	44.335	40.875	37.850	33.550	31.975
00300 OXYGEN DISSOLVED (MG/L)	72	8.600	0.000	4.571	7.875	6.175	4.800	3.050	1.230
00400 PH, WH, FIELD (STANDARD UNIT	67	8.300	6.500	7.166	7.760	7.300	7.100	7.000	6.700
00403 PH, WH, LABORATO (STANDARD UNIT	58	8.000	6.600	7.166	7.710	7.325	7.100	6.975	6.795
90095 SPECIFIC CONDUCT MICROSIEMENS/C	58	80.000	50.000	60.328	70.050	63.000	61.000	55.750	53.000
00095 SPECIFIC CONDUCT US/CM @ 25C	69	80.000	43.000	56.942	70.500	65.000	55.000	49.500	44.500
00010 WATER TEMPERATUR (DEGREES C)	73	18.000	4.000	6.658	8.790	7.400	6.500	5.550	4.410
00900 HARDNESS TOTAL (MG/L AS CAO3)	59	30.600	20.300	23.937	28.200	25.500	23.900	21.700	20.700
00915 CALCIUM DISSOLVE (MG/L AS CA)	59	9.600	6.290	7.376	8.800	7.800	7.300	6.700	6.330
00925 MAGNESIUM DISSOL (MG/L AS MG)	59	1.600	1.090	1.323	1.500	1.400	1.300	1.200	1.160
00935 POTASSIUM DISSOL (MG/L AS K)	59	1.400	0.560	0.730	0.900	0.800	0.700	0.660	0.580
00931 SODIUM ADSORPTIO (RATIO)	59	0.400	0.162	0.205	0.252	0.217	0.202	0.183	0.165
00930 SODIUM DISSOLVED (MG/L AS NA)	59	4.100	1.700	2.298	2.900	2.600	2.300	1.900	1.800
00932 SODIUM, PERCENT PERCENT	59	26.000	14.300	16.695	18.500	17.400	16.500	15.900	14.600
90410 ANC, TIT. 4.5, L MG/L AS CACO3	58	35.000	19.000	25.672	29.100	27.000	26.000	23.000	22.000
00940 CHLORIDE DISSOLV (MG/L AS CL)	59	1.000	0.100	0.444	0.800	0.500	0.400	0.300	0.200
00950 FLUORIDE DISSOLV (MG/L AS F)	59	0.300	--	0.108*	*0.200	*0.100	*0.100	*0.100	*0.061
00955 SILICA DISSOLVED (MG/L AS SIO2)	59	8.600	4.800	6.305	8.100	7.200	5.900	5.500	5.000
00945 SULFATE DISSOLVE (MG/L AS SO4)	59	4.000	2.000	2.963	3.700	3.300	3.000	2.600	2.300
00608 NITROGEN AMMONIA (MG/L AS N)	58	0.070	--	0.017*	*0.060	*0.030	*0.010	*0.006	*0.003
00625 NITROGEN AMM+ORG (MG/L AS N)	70	1.300	--	0.232*	*0.745	*0.221	*0.179	*0.135	*0.064
00610 NITROGEN AMMONIA (MG/L AS N)	18	0.040	--	0.019*	*0.040	*0.030	*0.020	*0.009	*0.004
00631 NO2 + NO3 DISSOL (MG/L AS N)	59	0.200	--	0.091*	*0.180	*0.110	*0.087	*0.059	*0.032
00630 NO2 + NO3 TOTAL (MG/L AS N)	23	0.200	--	0.107*	*0.200	*0.100	*0.100	*0.072	*0.051
00613 NITROGEN,NITRITE MG/L AS N	58	--	--	--	--	--	--	--	--
00666 PHOSPHORUS DISS. (MG/L AS P)	56	0.030	--	0.008*	*0.028	*0.010	*0.005	*0.003	*0.001
00671 PHOSPHORUS ORTHO (MG/L AS P)	59	0.030	--	0.006*	*0.020	*0.008	*0.004	*0.002	*0.001
00665 PHOSPHORUS TOTAL (MG/L AS P)	70	0.290	--	0.019*	*0.064	*0.020	*0.010	*0.005	*0.002
31625 COLIFORM FECAL 0 COLS./100 ML	2	--	--	--	--	--	--	--	--
70954 CHLOROPHYLL-B, P UG/L	1	--	--	--	--	--	--	--	--
01005 BARIUM DISSOLVED (UG/L AS BA)	58	11.000	2.000	7.545	9.000	8.000	7.900	7.000	4.950
01010 BERYLLIUM DISSOL (UG/L AS BE)	58	--	--	--	--	--	--	--	--
01020 BORON DISSOLVED (UG/L AS B)	58	10.000	--	4.679*	*10.000	*5.761	*3.997	*2.894	*1.790
01025 CADMIUM DISSOLVE (UG/L AS CD)	69	5.000	--	0.358*	*1.000	*0.376	*0.159	*0.064	*0.018
01030 CHROMIUM DISSOLV (UG/L AS CR)	58	--	--	--	--	--	--	--	--
01035 COBALT DISSOLVED (UG/L AS CO)	58	--	--	--	--	--	--	--	--
01040 COPPER DISSOLVED (UG/L AS CU)	68	12.832	--	2.858*	*8.746	*3.570	*2.000	*1.171	*0.525
01046 IRON DISSOLVED (UG/L AS FE)	59	2500.000	--	60.812*	*50.000	*20.000	*20.000	*10.000	*3.139
01049 LEAD DISSOLVED (UG/L AS PB)	68	10.000	--	2.008*	*10.000	*2.194	*1.153	*0.545	*0.226
01130 LITHIUM DISSOLVE (UG/L AS LI)	58	--	--	--	--	--	--	--	--
01056 MANGANESE DISSOL (UG/L AS MN)	57	560.000	--	28.046*	*131.000	*19.500	*6.000	*1.000	*0.141
01060 MOLYBDENUM DISSO (UG/L AS MO)	58	--	--	--	--	--	--	--	--
01065 NICKEL DISSOLVED (UG/L AS NI)	68	--	--	--	--	--	--	--	--
01075 SILVER DISSOLVED (UG/L AS AG)	58	--	--	--	--	--	--	--	--
01080 STRONTIUM DISSOL (UG/L AS SR)	58	59.000	37.900	45.545	55.050	49.000	46.500	40.950	37.995
01085 VANADIUM DISSOLV (UG/L AS V)	58	--	--	--	--	--	--	--	--
01090 ZINC DISSOLVED (UG/L AS ZN)	69	40.000	--	6.627*	*19.000	*10.000	*4.000	*2.340	*1.102

* - VALUE IS ESTIMATED BY USING A LOG-PROBABILITY REGRESSION TO PREDICT THE VALUES OF DATA BELOW THE DETECTION LIMIT (Helsel and Cohn, 1988)

Table 6. Summary statistics for site 2, Lake Granby (Rainbow Bay), sampled near surface.

STATISTICAL SUMMARY OF SELECTED WATER QUALITY DATA COLLECTED FROM MAY 1989 TO NOV 2000

WATER-QUALITY CONSTITUENT	SAMPLE SIZE	DESCRIPTIVE STATISTICS MAXIMUM	MINIMUM	MEAN	PERCENT OF SAMPLES IN WHICH VALUES WERE LESS THAN OR EQUAL TO THOSE SHOWN 95 %	75 %	(MEDIAN) 50 %	25 %	5 %
70300 RESIDUE DIS 180C MG/L	58	71.000	14.000	38.569	54.100	44.000	38.000	34.000	14.950
70301 DISSOLVED SOLIDS MG/L	57	54.600	28.100	36.440	47.570	37.800	36.200	32.050	28.890
00077 TRANSPARENCY (IN (INCHES)	56	206.000	9.500	109.812	187.650	145.250	102.500	75.500	42.250
00300 OXYGEN DISSOLVED (MG/L)	59	9.400	4.900	7.519	8.900	8.200	7.400	7.000	6.500
00400 PH, WH, FIELD (STANDARD UNIT	60	9.000	7.100	7.982	8.890	8.375	7.950	7.700	7.300
00403 PH, WH, LABORATO (STANDARD UNIT	59	8.500	7.000	7.649	8.300	7.800	7.600	7.500	7.200
90095 SPECIFIC CONDUCT MICROSIEMENS/C	59	87.000	47.000	59.508	79.000	63.000	59.000	53.000	48.000
00095 SPECIFIC CONDUCT US/CM @ 25C	60	87.000	41.000	56.367	75.850	61.000	55.000	49.250	44.000
00010 WATER TEMPERATUR (DEGREES C)	60	19.700	4.800	14.158	19.300	17.475	14.550	11.125	7.320
00900 HARDNESS TOTAL (MG/L AS CAO3)	59	35.800	18.200	23.732	31.600	25.400	23.200	21.200	19.300
00915 CALCIUM DISSOLVE (MG/L AS CA)	59	11.000	5.660	7.327	10.000	7.900	7.100	6.540	5.880
00925 MAGNESIUM DISSOL (MG/L AS MG)	59	2.000	0.981	1.305	1.700	1.400	1.300	1.180	1.090
00935 POTASSIUM DISSOL (MG/L AS K)	59	1.000	0.550	0.687	0.800	0.700	0.700	0.600	0.580
00931 SODIUM ADSORPTIO (RATIO)	59	0.284	0.160	0.201	0.265	0.215	0.203	0.175	0.165
00930 SODIUM DISSOLVED (MG/L AS NA)	59	3.900	1.600	2.263	3.300	2.500	2.300	1.900	1.600
00932 SODIUM, PERCENT PERCENT	59	19.900	14.400	16.595	18.800	17.400	16.500	15.800	14.800
90410 ANC, TIT. 4.5, L MG/L AS CACO3	59	38.000	20.000	25.881	33.000	28.000	25.000	23.000	21.000
00940 CHLORIDE DISSOLV (MG/L AS CL)	58	1.300	0.100	0.438	1.005	0.500	0.400	0.300	0.100
00950 FLUORIDE DISSOLV (MG/L AS F)	58	0.300	--	0.112*	*0.200	*0.100	*0.100	*0.100	*0.065
00955 SILICA DISSOLVED (MG/L AS SIO2)	59	9.600	2.400	5.551	8.900	6.300	5.200	4.600	4.100
00945 SULFATE DISSOLVE (MG/L AS SO4)	58	4.500	1.700	3.012	4.020	3.325	3.000	2.500	1.995
00608 NITROGEN AMMONIA (MG/L AS N)	59	0.075	--	0.014*	*0.050	*0.020	*0.009	*0.004	*0.002
00625 NITROGEN AMM+ORG (MG/L AS N)	59	0.600	--	0.215*	*0.300	*0.250	*0.200	*0.170	*0.127
00610 NITROGEN AMMONIA (MG/L AS N)	18	0.040	--	0.016*	*0.040	*0.022	*0.010	*0.007	*0.003
00631 NO2 + NO3 DISSOL (MG/L AS N)	59	0.070	--	0.018*	*0.068	*0.020	*0.011	*0.006	*0.002
00613 NITROGEN,NITRITE MG/L AS N	59	--	--	--	--	--	--	--	--
00666 PHOSPHORUS DISS. (MG/L AS P)	56	0.118	--	0.008*	*0.022	*0.008	*0.004	*0.002	*0.001
00671 PHOSPHORUS ORTHO (MG/L AS P)	59	0.020	--	0.003*	*0.012	*0.002	*0.001	*0.000	*0.000
00665 PHOSPHORUS TOTAL (MG/L AS P)	60	0.045	--	0.014*	*0.040	*0.020	*0.010	*0.007	*0.004
00680 CARBON ORGANIC T (MG/L AS C)	11	9.000	3.300	4.318	9.000	4.300	3.600	3.500	3.300
31625 COLIFORM FECAL 0 COLS./100 ML	53	70.000	--	2.077*	*5.300	*1.000	*0.301	*0.091	*0.016
70953 CHL-A PHY CHROMA UG/L	59	12.000	0.500	2.822	7.900	3.700	2.000	1.200	0.500
70954 CHLOROPHYLL-B, P UG/L	58	0.300	--	0.080*	*0.300	*0.100	*0.053	*0.028	*0.011
01005 BARIUM DISSOLVED (UG/L AS BA)	59	11.000	2.000	8.110	10.000	9.000	8.000	7.500	7.000
01010 BERYLLIUM DISSOL (UG/L AS BE)	59	--	--	--	--	--	--	--	--
01020 BORON DISSOLVED (UG/L AS B)	59	20.000	--	4.549*	*10.000	*5.958	*3.672	*2.405	*1.324
01025 CADMIUM DISSOLVE (UG/L AS CD)	59	--	--	--	--	--	--	--	--
01030 CHROMIUM DISSOLV (UG/L AS CR)	59	--	--	--	--	--	--	--	--
01035 COBALT DISSOLVED (UG/L AS CO)	59	--	--	--	--	--	--	--	--
01040 COPPER DISSOLVED (UG/L AS CU)	59	--	--	--	--	--	--	--	--
01046 IRON DISSOLVED (UG/L AS FE)	59	130.000	--	22.002*	*70.000	*30.000	*10.000	*5.379	*1.895
01049 LEAD DISSOLVED (UG/L AS PB)	58	20.000	--	3.599*	*10.060	*4.509	*2.546	*1.444	*0.628
01130 LITHIUM DISSOLVE (UG/L AS LI)	59	4.000	--	1.690*	*3.208	*2.158	*1.559	*1.101	*0.743
01056 MANGANESE DISSOL (UG/L AS MN)	59	23.000	--	2.531*	*14.000	*3.000	*1.000	*0.400	*0.107
01060 MOLYBDENUM DISSO (UG/L AS MO)	59	--	--	--	--	--	--	--	--
01065 NICKEL DISSOLVED (UG/L AS NI)	59	--	--	--	--	--	--	--	--
01075 SILVER DISSOLVED (UG/L AS AG)	59	--	--	--	--	--	--	--	--
01080 STRONTIUM DISSOL (UG/L AS SR)	59	73.000	33.200	45.022	65.000	48.000	44.000	38.100	33.900
01085 VANADIUM DISSOLV (UG/L AS V)	59	--	--	--	--	--	--	--	--
01090 ZINC DISSOLVED (UG/L AS ZN)	58	106.000	--	5.562*	*14.100	*5.556	*2.442	*1.093	*0.384

* - VALUE IS ESTIMATED BY USING A LOG-PROBABILITY REGRESSION TO PREDICT THE VALUES OF DATA BELOW THE DETECTION LIMIT (Helsel and Cohn, 1988)

Table 7. Summary statistics for site 2, Lake Granby (Rainbow Bay), sampled near bottom.

STATISTICAL SUMMARY OF SELECTED WATER QUALITY DATA COLLECTED FROM MAY 1989 TO SEPT 2000

WATER-QUALITY CONSTITUENT	SAMPLE SIZE	DESCRIPTIVE STATISTICS: MAXIMUM	MINIMUM	MEAN	PERCENT OF SAMPLES IN WHICH VALUES WERE LESS THAN OR EQUAL TO THOSE SHOWN: 95 %	75 %	(MEDIAN) 50 %	25 %	5 %
70300 RESIDUE DIS 180C MG/L	57	67.000	18.000	39.789	60.000	46.000	39.000	34.000	25.700
70301 DISSOLVED SOLIDS MG/L	56	57.400	30.000	37.329	52.790	39.050	36.550	33.100	31.155
00300 OXYGEN DISSOLVED (MG/L)	59	9.000	1.100	5.349	8.800	7.300	5.300	3.300	1.500
00400 PH, WH, FIELD (STANDARD UNIT	60	8.100	6.800	7.400	8.000	7.600	7.400	7.125	6.900
00403 PH, WH, LABORATO (STANDARD UNIT	58	8.200	6.700	7.252	7.715	7.500	7.200	7.000	6.800
90095 SPECIFIC CONDUCT MICROSIEMENS/C	58	92.000	51.000	60.690	83.100	63.250	60.000	55.000	52.950
00095 SPECIFIC CONDUCT US/CM @ 25C	60	90.000	44.000	58.017	86.850	63.000	55.500	50.000	44.100
00010 WATER TEMPERATUR (DEGREES C)	60	15.500	4.700	9.453	14.685	11.775	8.450	7.600	5.800
00900 HARDNESS TOTAL (MG/L AS CAO3)	58	35.800	18.600	24.181	34.640	25.800	23.450	21.675	20.625
00915 CALCIUM DISSOLVE (MG/L AS CA)	58	11.000	5.750	7.460	11.000	8.000	7.300	6.682	6.285
00925 MAGNESIUM DISSOL (MG/L AS MG)	58	2.000	1.010	1.334	1.710	1.400	1.300	1.200	1.096
00935 POTASSIUM DISSOL (MG/L AS K)	58	0.900	0.500	0.688	0.800	0.800	0.700	0.608	0.579
00931 SODIUM ADSORPTIO (RATIO)	58	0.299	0.160	0.204	0.278	0.215	0.203	0.182	0.168
00930 SODIUM DISSOLVED (MG/L AS NA)	58	4.100	1.700	2.317	3.515	2.500	2.300	1.900	1.700
00932 SODIUM, PERCENT PERCENT	58	21.000	14.400	16.657	20.105	17.200	16.500	15.875	14.885
90410 ANC, TIT. 4.5, L MG/L AS CACO3	58	38.000	20.000	26.103	37.000	28.000	25.500	23.000	22.950
00940 CHLORIDE DISSOLV (MG/L AS CL)	57	1.300	0.100	0.453	0.930	0.500	0.400	0.400	0.190
00950 FLUORIDE DISSOLV (MG/L AS F)	57	0.300	--	0.106*	*0.200	*0.100	*0.100	*0.100	*0.063
00955 SILICA DISSOLVED (MG/L AS SIO2)	58	11.000	3.300	6.086	10.050	6.800	5.650	5.075	4.300
00945 SULFATE DISSOLVE (MG/L AS SO4)	57	4.500	1.900	3.000	4.210	3.300	3.000	2.600	2.190
00608 NITROGEN AMMONIA (MG/L AS N)	59	0.070	--	0.018*	*0.050	*0.020	*0.013	*0.008	*0.004
00625 NITROGEN AMM+ORG (MG/L AS N)	59	0.600	--	0.215*	*0.400	*0.300	*0.195	*0.156	*0.108
00610 NITROGEN AMMONIA (MG/L AS N)	18	0.070	--	0.022*	*0.070	*0.030	*0.020	*0.010	*0.005
00631 NO2 + NO3 DISSOL (MG/L AS N)	59	0.110	--	0.036*	*0.100	*0.053	*0.025	*0.014	*0.006
00613 NITROGEN,NITRITE MG/L AS N	59	0.030	--	0.002*	*0.010	*0.001	*0.000	*0.000	*0.000
00666 PHOSPHORUS DISS. (MG/L AS P)	56	0.501	--	0.017*	*0.030	*0.011	*0.005	*0.003	*0.001
00671 PHOSPHORUS ORTHO (MG/L AS P)	59	0.020	--	0.004*	*0.017	*0.005	*0.002	*0.001	*0.000
00665 PHOSPHORUS TOTAL (MG/L AS P)	59	0.040	--	0.014*	*0.030	*0.020	*0.010	*0.008	*0.004
00680 CARBON ORGANIC T (MG/L AS C)	11	9.300	3.200	4.018	9.300	3.800	3.500	3.300	3.200
31625 COLIFORM FECAL 0 COLS./100 ML	1	1.000	--	--	--	--	--	--	--
01005 BARIUM DISSOLVED (UG/L AS BA)	58	14.000	7.000	8.510	11.000	9.000	8.000	7.975	7.295
01010 BERYLLIUM DISSOL (UG/L AS BE)	58	--	--	--	--	--	--	--	--
01020 BORON DISSOLVED (UG/L AS B)	59	10.000	--	4.358*	*10.000	*5.448	*4.000	*2.785	*1.811
01025 CADMIUM DISSOLVE (UG/L AS CD)	58	2.000	--	0.416*	*1.007	*0.522	*0.323	*0.192	*0.096
01030 CHROMIUM DISSOLV (UG/L AS CR)	58	--	--	--	--	--	--	--	--
01035 COBALT DISSOLVED (UG/L AS CO)	58	--	--	--	--	--	--	--	--
01040 COPPER DISSOLVED (UG/L AS CU)	58	--	--	--	--	--	--	--	--
01046 IRON DISSOLVED (UG/L AS FE)	57	80.000	--	22.992*	*71.000	*30.000	*20.000	*8.020	*3.245
01049 LEAD DISSOLVED (UG/L AS PB)	58	--	--	--	--	--	--	--	--
01130 LITHIUM DISSOLVE (UG/L AS LI)	58	--	--	--	--	--	--	--	--
01056 MANGANESE DISSOL (UG/L AS MN)	58	67.000	--	7.927*	*30.850	*8.000	*4.300	*1.108	*0.403
01060 MOLYBDENUM DISSO (UG/L AS MO)	58	--	--	--	--	--	--	--	--
01065 NICKEL DISSOLVED (UG/L AS NI)	58	--	--	--	--	--	--	--	--
01075 SILVER DISSOLVED (UG/L AS AG)	58	--	--	--	--	--	--	--	--
01080 STRONTIUM DISSOL (UG/L AS SR)	58	77.000	35.100	46.384	71.200	49.000	45.000	40.675	37.715
01085 VANADIUM DISSOLV (UG/L AS V)	58	--	--	--	--	--	--	--	--
01090 ZINC DISSOLVED (UG/L AS ZN)	58	12.000	--	4.181*	*9.050	*5.843	*3.279	*2.172	*1.224

* - VALUE IS ESTIMATED BY USING A LOG-PROBABILITY REGRESSION TO PREDICT THE VALUES OF DATA BELOW THE DETECTION LIMIT (Helsel and Cohn, 1988)

Table 8. Summary statistics for site 3, Granby Pump Canal.

STATISTICAL SUMMARY OF SELECTED WATER QUALITY DATA COLLECTED FROM NOV 1970 TO NOV 2000

WATER-QUALITY CONSTITUENT	SAMPLE SIZE	DESCRIPTIVE STATISTICS MAXIMUM	MINIMUM	MEAN	PERCENT OF SAMPLES IN WHICH VALUES WERE LESS THAN OR EQUAL TO THOSE SHOWN 95 %	75 %	(MEDIAN) 50 %	25 %	5 %
70300 RESIDUE DIS 180C MG/L	55	66.000	26.000	40.691	54.400	44.000	40.000	36.000	29.600
70301 DISSOLVED SOLIDS MG/L	55	42.500	30.100	36.747	41.780	39.400	37.700	33.200	31.400
00300 OXYGEN DISSOLVED (MG/L)	170	12.000	2.000	7.014	9.600	8.425	7.550	5.600	3.310
00400 PH, WH, FIELD (STANDARD UNIT	171	8.900	5.300	7.270	8.240	7.600	7.300	6.900	6.400
00403 PH, WH, LABORATO (STANDARD UNIT	56	8.800	6.600	7.489	8.030	7.775	7.500	7.200	6.785
90095 SPECIFIC CONDUCT MICROSIEMENS/C	56	70.000	49.000	60.554	70.000	64.000	62.000	56.000	52.700
00095 SPECIFIC CONDUCT US/CM @ 25C	179	105.000	30.000	58.827	70.000	63.000	60.000	53.000	47.000
00020 AIR TEMPERATURE DEGREES C	8	22.100	-6.000	4.525	22.100	12.400	3.250	-4.500	-6.000
00010 WATER TEMPERATUR (DEGREES C)	180	17.500	1.000	5.426	12.490	7.500	4.100	3.000	2.000
00900 HARDNESS TOTAL (MG/L AS CAO3)	56	28.000	19.300	23.682	27.330	25.300	23.900	21.700	20.110
00915 CALCIUM DISSOLVE (MG/L AS CA)	56	8.700	5.760	7.305	8.515	7.800	7.400	6.632	6.160
00925 MAGNESIUM DISSOL (MG/L AS MG)	56	1.500	1.120	1.306	1.500	1.400	1.300	1.200	1.155
00935 POTASSIUM DISSOL (MG/L AS K)	56	0.900	0.560	0.726	0.900	0.800	0.700	0.665	0.597
00931 SODIUM ADSORPTIO (RATIO)	56	0.236	0.154	0.199	0.229	0.216	0.202	0.178	0.169
00930 SODIUM DISSOLVED (MG/L AS NA)	56	2.800	1.600	2.229	2.700	2.500	2.300	1.900	1.700
00932 SODIUM, PERCENT PERCENT	56	18.200	14.500	16.452	17.915	17.100	16.500	15.625	15.055
90410 ANC, TIT. 4.5, L MG/L AS CACO3	56	30.000	21.000	25.964	30.000	28.000	26.000	24.000	22.000
00940 CHLORIDE DISSOLV (MG/L AS CL)	56	1.800	0.100	0.507	1.020	0.575	0.400	0.400	0.185
00950 FLUORIDE DISSOLV (MG/L AS F)	57	3.000	--	0.162*	*0.210	*0.100	*0.100	*0.100	*0.044
00955 SILICA DISSOLVED (MG/L AS SIO2)	56	7.700	3.700	5.636	7.400	6.400	5.400	5.025	3.900
00945 SULFATE DISSOLVE (MG/L AS SO4)	56	5.400	1.900	3.068	4.150	3.375	3.000	2.700	2.285
00608 NITROGEN AMMONIA (MG/L AS N)	55	0.080	--	0.013*	*0.039	*0.020	*0.010	*0.004	*0.002
00625 NITROGEN AMM+ORG (MG/L AS N)	139	1.200	--	0.358*	*0.890	*0.500	*0.300	*0.180	*0.099
00610 NITROGEN AMMONIA (MG/L AS N)	21	0.070	--	0.019*	*0.066	*0.020	*0.020	*0.010	*0.005
00631 NO2 + NO3 DISSOL (MG/L AS N)	55	0.180	--	0.078*	*0.156	*0.100	*0.074	*0.048	*0.033
00630 NO2 + NO3 TOTAL (MG/L AS N)	87	0.300	--	0.092*	*0.200	*0.100	*0.100	*0.065	*0.045
00613 NITROGEN,NITRITE MG/L AS N	55	0.020	--	0.002*	*0.020	*0.002	*0.001	*0.000	*0.000
00615 NITROGEN,NITRITE MG/L AS N	14	--	--	--	--	--	--	--	--
00666 PHOSPHORUS DISS. (MG/L AS P)	55	0.040	--	0.010*	*0.020	*0.010	*0.008	*0.005	*0.003
00671 PHOSPHORUS ORTHO (MG/L AS P)	55	0.032	--	0.007*	*0.016	*0.010	*0.005	*0.004	*0.002
70507 PHOS ORTHO TOT A MG/L AS P	14	0.020	--	0.011*	*0.020	*0.020	*0.009	*0.006	*0.004
00665 PHOSPHORUS TOTAL (MG/L AS P)	139	0.350	--	0.022*	*0.053	*0.030	*0.018	*0.010	*0.004
31501 TOT COLI,MENDO M COLS./100 ML	104	110.000	--	10.110*	*43.800	*13.000	*3.000	*0.818	*0.142
31625 COLIFORM FECAL 0 COLS./100 ML	72	10.000	--	0.483*	*3.000	*0.279	*0.068	*0.017	*0.002
31616 FECAL COLI,MFC M COLS./100 ML	38	1.000	--	1.000*	*1.000	*1.000	*1.000	*1.000	*1.000
01005 BARIUM DISSOLVED (UG/L AS BA)	56	9.000	2.000	7.298	8.030	8.000	7.350	7.000	5.020
01010 BERYLLIUM DISSOL (UG/L AS BE)	56	--	--	--	--	--	--	--	--
01025 CADMIUM DISSOLVE (UG/L AS CD)	99	5.000	--	0.390*	*1.000	*0.433	*0.197	*0.090	*0.027
01030 CHROMIUM DISSOLV (UG/L AS CR)	55	--	--	--	--	--	--	--	--
01035 COBALT DISSOLVED (UG/L AS CO)	56	--	--	--	--	--	--	--	--
01040 COPPER DISSOLVED (UG/L AS CU)	100	11.000	--	2.743*	*6.716	*3.939	*2.000	*1.311	*0.696
01046 IRON DISSOLVED (UG/L AS FE)	56	80.000	--	23.657*	*80.000	*40.000	*20.000	*7.787	*3.104
01049 LEAD DISSOLVED (UG/L AS PB)	100	37.000	--	2.074*	*10.000	*2.000	*0.842	*0.318	*0.089
01130 LITHIUM DISSOLVE (UG/L AS LI)	55	11.000	--	1.951*	*4.480	*2.461	*1.457	*0.933	*0.459
01056 MANGANESE DISSOL (UG/L AS MN)	54	81.000	--	10.307*	*71.250	*7.250	*2.350	*1.000	*0.166
01060 MOLYBDENUM DISSO (UG/L AS MO)	56	--	--	--	--	--	--	--	--
01065 NICKEL DISSOLVED (UG/L AS NI)	99	15.000	--	1.932*	*6.000	*2.599	*1.134	*0.649	*0.277
01075 SILVER DISSOLVED (UG/L AS AG)	55	2.000	--	0.700*	*2.000	*0.884	*0.568	*0.364	*0.189
01080 STRONTIUM DISSOL (UG/L AS SR)	56	51.000	29.000	44.086	50.150	48.000	45.000	40.000	34.465
01085 VANADIUM DISSOLV (UG/L AS V)	56	--	--	--	--	--	--	--	--
01090 ZINC DISSOLVED (UG/L AS ZN)	98	30.000	--	7.703*	*20.000	*10.000	*5.000	*2.988	*1.452

* - VALUE IS ESTIMATED BY USING A LOG-PROBABILITY REGRESSION TO PREDICT THE VALUES OF DATA BELOW THE DETECTION LIMIT (Helsel and Cohn, 1988)

Table 9. Summary statistics for site 4, Shadow Mountain Lake, sampled at the surface.

STATISTICAL SUMMARY OF SELECTED WATER QUALITY DATA COLLECTED FROM AUG 1973 TO SEPT 2000

WATER-QUALITY CONSTITUENT	DESCRIPTIVE STATISTICS: SAMPLE SIZE	MAXIMUM	MINIMUM	MEAN	PERCENT OF SAMPLES IN WHICH VALUES WERE LESS THAN OR EQUAL TO THOSE SHOWN: 95 %	75 %	(MEDIAN) 50 %	25 %	5 %
70300 RESIDUE DIS 180C MG/L	58	54.000	8.000	36.190	50.100	41.250	37.500	32.750	19.800
70301 DISSOLVED SOLIDS MG/L	54	41.300	19.600	33.009	40.275	37.200	33.650	30.400	22.375
00077 TRANSPARENCY (IN (INCHES)	64	157.000	42.000	86.984	129.250	97.500	83.500	70.000	56.750
00300 OXYGEN DISSOLVED (MG/L)	65	9.900	3.500	7.340	9.070	8.150	7.400	6.750	4.630
00400 PH, WH, FIELD (STANDARD UNIT	64	9.500	5.600	7.625	9.150	7.800	7.600	7.300	6.725
00403 PH, WH, LABORATO (STANDARD UNIT	58	9.200	6.800	7.469	8.815	7.650	7.400	7.100	6.800
90095 SPECIFIC CONDUCT MICROSIEMENS/C	58	67.000	30.000	52.534	62.150	59.250	55.000	48.500	33.900
00095 SPECIFIC CONDUCT US/CM @ 25C	65	66.000	27.000	50.631	64.400	57.000	51.000	46.000	31.600
00900 HARDNESS TOTAL (MG/L AS CAO3)	59	27.400	11.900	20.751	25.600	23.300	21.900	18.800	13.200
00915 CALCIUM DISSOLVE (MG/L AS CA)	59	8.300	3.600	6.294	8.000	7.000	6.510	5.700	4.000
00925 MAGNESIUM DISSOL (MG/L AS MG)	59	1.600	0.710	1.212	1.420	1.340	1.280	1.100	0.770
00935 POTASSIUM DISSOL (MG/L AS K)	59	1.100	0.400	0.696	1.000	0.800	0.700	0.600	0.500
00931 SODIUM ADSORPTIO (RATIO)	59	0.300	0.139	0.183	0.233	0.199	0.175	0.163	0.144
00930 SODIUM DISSOLVED (MG/L AS NA)	59	3.100	1.100	1.919	2.600	2.200	1.900	1.700	1.200
00932 SODIUM, PERCENT PERCENT	59	22.000	13.500	16.181	19.500	16.900	16.000	15.100	14.100
90410 ANC, TIT. 4.5, L MG/L AS CACO3	58	30.000	12.000	22.241	28.050	25.000	23.500	20.000	13.950
00940 CHLORIDE DISSOLV (MG/L AS CL)	58	1.000	--	0.385*	*0.715	*0.500	*0.400	*0.300	*0.140
00950 FLUORIDE DISSOLV (MG/L AS F)	58	0.300	0.100	0.140	0.200	0.200	0.100	0.100	0.100
00955 SILICA DISSOLVED (MG/L AS SIO2)	60	7.600	3.400	5.752	7.395	6.575	5.700	4.900	4.405
00945 SULFATE DISSOLVE (MG/L AS SO4)	58	4.000	1.800	2.903	3.805	3.200	2.900	2.600	2.100
00608 NITROGEN AMMONIA (MG/L AS N)	59	0.089	--	0.015*	*0.050	*0.020	*0.010	*0.004	*0.002
00625 NITROGEN AMM+ORG (MG/L AS N)	65	3.700	--	0.308*	*0.570	*0.300	*0.210	*0.171	*0.095
00610 NITROGEN AMMONIA (MG/L AS N)	24	0.060	--	0.017*	*0.055	*0.020	*0.010	*0.006	*0.003
00631 NO2 + NO3 DISSOL (MG/L AS N)	60	0.130	--	0.035*	*0.090	*0.052	*0.027	*0.018	*0.010
00630 NO2 + NO3 TOTAL (MG/L AS N)	18	0.100	--	0.100*	*0.100	*0.100	*0.100	*0.100	*0.100
00613 NITROGEN,NITRITE MG/L AS N	59	--	--	--	--	--	--	--	--
00615 NITROGEN,NITRITE MG/L AS N	9	--	--	--	--	--	--	--	--
00605 NITROGEN ORGANIC (MG/L AS N)	30	3.700	0.105	0.401	2.100	0.373	0.261	0.182	0.130
00600 NITROGEN TOTAL (MG/L AS N)	18	3.700	0.250	0.509	3.700	0.385	0.300	0.268	0.250
00666 PHOSPHORUS DISS. (MG/L AS P)	57	0.020	--	0.005*	*0.011	*0.006	*0.004	*0.003	*0.002
00671 PHOSPHORUS ORTHO (MG/L AS P)	60	0.014	--	0.001*	*0.010	*0.001	*0.000	*0.000	*0.000
70507 PHOS ORTHO TOT A MG/L AS P	9	--	--	--	--	--	--	--	--
00665 PHOSPHORUS TOTAL (MG/L AS P)	65	0.048	--	0.014*	*0.030	*0.020	*0.010	*0.007	*0.004
31625 COLIFORM FECAL 0 COLS./100 ML	52	17.000	--	1.207*	*8.050	*1.000	*0.298	*0.092	*0.017
70953 CHL-A PHY CHROMA UG/L	57	23.000	0.200	3.942	14.200	4.950	2.800	1.350	0.390
70954 CHLOROPHYLL-B, P UG/L	58	0.500	--	0.117*	*0.405	*0.200	*0.072	*0.037	*0.013
01005 BARIUM DISSOLVED (UG/L AS BA)	59	9.000	2.000	6.541	8.000	7.700	6.800	5.700	4.000
01010 BERYLLIUM DISSOL (UG/L AS BE)	59	--	--	--	--	--	--	--	--
01020 BORON DISSOLVED (UG/L AS B)	59	20.000	--	3.734*	*10.000	*4.529	*2.836	*1.667	*0.846
01025 CADMIUM DISSOLVE (UG/L AS CD)	59	--	--	--	--	--	--	--	--
01030 CHROMIUM DISSOLV (UG/L AS CR)	59	--	--	--	--	--	--	--	--
01035 COBALT DISSOLVED (UG/L AS CO)	59	--	--	--	--	--	--	--	--
01040 COPPER DISSOLVED (UG/L AS CU)	58	--	--	--	--	--	--	--	--
01046 IRON DISSOLVED (UG/L AS FE)	60	1000.000	0.000	78.000	160.000	87.500	50.000	30.000	10.500
01049 LEAD DISSOLVED (UG/L AS PB)	64	10.000	--	3.681*	*7.484	*4.706	*3.229	*2.258	*1.439
01130 LITHIUM DISSOLVE (UG/L AS LI)	59	--	--	--	--	--	--	--	--
01056 MANGANESE DISSOL (UG/L AS MN)	60	87.000	--	9.194*	*46.950	*6.875	*3.000	*1.657	*0.302
71890 MERCURY DISSOLVE UG/L AS HG	6	--	--	--	--	--	--	--	--
01060 MOLYBDENUM DISSO (UG/L AS MO)	59	--	--	--	--	--	--	--	--
01065 NICKEL DISSOLVED (UG/L AS NI)	62	--	--	--	--	--	--	--	--
01075 SILVER DISSOLVED (UG/L AS AG)	59	--	--	--	--	--	--	--	--
01080 STRONTIUM DISSOL (UG/L AS SR)	59	49.000	20.000	36.290	47.000	42.000	38.400	31.000	21.000
01085 VANADIUM DISSOLV (UG/L AS V)	59	--	--	--	--	--	--	--	--
01090 ZINC DISSOLVED (UG/L AS ZN)	59	13.000	--	4.114*	*10.000	*6.000	*3.000	*1.896	*0.983

* - VALUE IS ESTIMATED BY USING A LOG-PROBABILITY REGRESSION TO PREDICT THE VALUES OF DATA BELOW THE DETECTION LIMIT (Helsel and Cohn, 1988)

Table 10. Summary statistics for site 4, Shadow Mountain Lake, sampled near bottom.

STATISTICAL SUMMARY OF SELECTED WATER QUALITY DATA COLLECTED FROM AUG 1973 TO SEPT 2000

WATER-QUALITY CONSTITUENT	SAMPLE SIZE	DESCRIPTIVE STATISTICS MAXIMUM	MINIMUM	MEAN	PERCENT OF SAMPLES IN WHICH VALUES WERE LESS THAN OR EQUAL TO THOSE SHOWN 95 %	75 %	(MEDIAN) 50 %	25 %	5 %
70300 RESIDUE DIS 180C MG/L	57	60.000	24.000	38.211	54.200	42.000	38.000	32.500	26.000
70301 DISSOLVED SOLIDS MG/L	54	41.800	23.100	34.239	40.100	38.050	34.750	31.850	23.850
00300 OXYGEN DISSOLVED (MG/L)	58	8.800	0.700	5.455	8.010	6.725	5.600	4.200	1.940
00400 PH, WH, FIELD (STANDARD UNIT	57	8.600	6.800	7.318	7.850	7.400	7.300	7.100	6.990
00403 PH, WH, LABORATO (STANDARD UNIT	58	8.100	6.500	7.203	7.705	7.400	7.200	7.000	6.695
90095 SPECIFIC CONDUCT MICROSIEMENS/C	58	67.000	35.000	54.224	65.000	61.000	55.500	50.000	37.850
00095 SPECIFIC CONDUCT US/CM @ 25C	58	76.000	30.000	51.448	67.050	57.500	52.500	46.750	32.950
00900 HARDNESS TOTAL (MG/L AS CAO3)	59	27.400	13.700	21.522	26.100	24.100	22.000	19.600	14.100
00915 CALCIUM DISSOLVE (MG/L AS CA)	59	8.300	4.100	6.537	8.100	7.400	6.800	5.900	4.170
00925 MAGNESIUM DISSOL (MG/L AS MG)	59	1.600	0.840	1.251	1.500	1.370	1.300	1.200	0.880
00935 POTASSIUM DISSOL (MG/L AS K)	59	1.500	0.500	0.711	0.900	0.800	0.700	0.600	0.500
00931 SODIUM ADSORPTIO (RATIO)	59	0.300	0.127	0.185	0.233	0.203	0.185	0.164	0.141
00930 SODIUM DISSOLVED (MG/L AS NA)	59	2.800	1.100	1.968	2.700	2.200	2.000	1.700	1.200
00932 SODIUM, PERCENT PERCENT	59	21.000	13.200	15.995	18.400	16.900	15.900	14.900	13.600
90410 ANC, TIT. 4.5, L MG/L AS CACO3	58	29.000	14.000	22.741	28.050	26.000	24.000	20.750	14.000
00940 CHLORIDE DISSOLV (MG/L AS CL)	58	1.000	0.100	0.386	0.905	0.400	0.400	0.300	0.100
00950 FLUORIDE DISSOLV (MG/L AS F)	58	0.300	0.100	0.138	0.200	0.200	0.100	0.100	0.100
00955 SILICA DISSOLVED (MG/L AS SIO2)	59	8.000	4.800	6.227	7.600	7.000	6.200	5.500	4.900
00945 SULFATE DISSOLVE (MG/L AS SO4)	58	4.000	2.200	2.940	3.610	3.300	2.900	2.600	2.200
00608 NITROGEN AMMONIA (MG/L AS N)	58	0.150	--	0.021*	*0.090	*0.021	*0.010	*0.004	*0.002
00625 NITROGEN AMM+ORG (MG/L AS N)	58	0.700	--	0.250*	*0.505	*0.300	*0.200	*0.170	*0.114
00610 NITROGEN AMMONIA (MG/L AS N)	18	0.140	--	0.043*	*0.140	*0.065	*0.030	*0.020	*0.007
00631 NO2 + NO3 DISSOL (MG/L AS N)	59	0.130	--	0.039*	*0.093	*0.060	*0.028	*0.017	*0.008
00630 NO2 + NO3 TOTAL (MG/L AS N)	12	0.100	--	0.100*	*0.100	*0.100	*0.100	*0.100	*0.100
00613 NITROGEN,NITRITE MG/L AS N	58	--	--	--	--	--	--	--	--
00615 NITROGEN,NITRITE MG/L AS N	9	--	--	--	--	--	--	--	--
00605 NITROGEN ORGANIC (MG/L AS N)	26	0.600	0.103	0.273	0.590	0.307	0.270	0.180	0.119
00600 NITROGEN TOTAL (MG/L AS N)	11	0.461	0.200	0.346	0.461	0.452	0.364	0.280	0.200
00666 PHOSPHORUS DISS. (MG/L AS P)	56	0.050	--	0.007*	*0.022	*0.008	*0.004	*0.002	*0.001
00671 PHOSPHORUS ORTHO (MG/L AS P)	59	0.040	--	0.003*	*0.020	*0.002	*0.000	*0.000	*0.000
70507 PHOS ORTHO TOT A MG/L AS P	9	--	--	--	--	--	--	--	--
00665 PHOSPHORUS TOTAL (MG/L AS P)	58	0.060	--	0.017*	*0.041	*0.020	*0.013	*0.008	*0.004
01005 BARIUM DISSOLVED (UG/L AS BA)	58	10.000	2.000	7.138	9.000	8.000	7.000	6.700	5.475
01010 BERYLLIUM DISSOL (UG/L AS BE)	58	1.170	--	0.221*	*0.800	*0.274	*0.157	*0.090	*0.040
01020 BORON DISSOLVED (UG/L AS B)	58	--	--	--	--	--	--	--	--
01025 CADMIUM DISSOLVE (UG/L AS CD)	58	3.000	--	0.513*	*2.000	*0.624	*0.310	*0.151	*0.057
01030 CHROMIUM DISSOLV (UG/L AS CR)	58	--	--	--	--	--	--	--	--
01035 COBALT DISSOLVED (UG/L AS CO)	58	--	--	--	--	--	--	--	--
01040 COPPER DISSOLVED (UG/L AS CU)	58	--	--	--	--	--	--	--	--
01046 IRON DISSOLVED (UG/L AS FE)	59	260.000	0.000	72.373	210.000	110.000	50.000	20.000	10.000
01049 LEAD DISSOLVED (UG/L AS PB)	58	--	--	--	--	--	--	--	--
01130 LITHIUM DISSOLVE (UG/L AS LI)	58	5.000	--	1.548*	*3.596	*1.989	*1.298	*0.890	*0.486
01056 MANGANESE DISSOL (UG/L AS MN)	59	610.000	--	56.163*	*340.000	*57.000	*10.100	*3.000	*0.898
01060 MOLYBDENUM DISSO (UG/L AS MO)	58	--	--	--	--	--	--	--	--
01065 NICKEL DISSOLVED (UG/L AS NI)	58	--	--	--	--	--	--	--	--
01075 SILVER DISSOLVED (UG/L AS AG)	57	--	--	--	--	--	--	--	--
01077 SILVER TOTAL (UG/L AS AG)	2	--	--	--	--	--	--	--	--
01080 STRONTIUM DISSOL (UG/L AS SR)	58	52.000	20.000	38.105	47.100	44.250	39.150	33.000	22.000
01085 VANADIUM DISSOLV (UG/L AS V)	58	--	--	--	--	--	--	--	--
01090 ZINC DISSOLVED (UG/L AS ZN)	58	29.000	--	5.199*	*15.150	*7.000	*3.218	*1.734	*0.739

* - VALUE IS ESTIMATED BY USING A LOG-PROBABILITY REGRESSION TO PREDICT THE VALUES OF DATA BELOW THE DETECTION LIMIT (Helsel and Cohn, 1988)

Table 11. Summary statistics for site 5, Alva B. Adams Tunnel east portal.

STATISTICAL SUMMARY OF SELECTED WATER QUALITY DATA COLLECTED FROM SEPT 1970 TO DEC 2000

WATER-QUALITY CONSTITUENT		DESCRIPTIVE STATISTICS: SAMPLE SIZE	MAXIMUM	MINIMUM	MEAN	PERCENTAGE OF SAMPLES IN WHICH VALUES WERE LESS THAN OR EQUAL TO THOSE SHOWN: 95 %	75 %	(MEDIAN) 50 %	25 %	5 %
00061 DISCHARGE, INST.	CFS	228	619.000	0.400	402.434	555.000	532.500	459.000	360.250	9.100
70300 RESIDUE DIS 180C	MG/L	69	60.000	4.000	33.333	49.000	40.000	34.000	27.500	13.000
70301 DISSOLVED SOLIDS	MG/L	186	50.000	10.000	30.263	40.000	35.000	30.000	28.750	20.000
00300 OXYGEN DISSOLVED	(MG/L)	276	13.400	5.700	8.320	9.600	8.795	8.300	7.800	7.285
00301 OXYGEN DIS. PERC	% OF SATURATIO	136	130.000	8.000	91.776	114.000	102.000	92.000	86.400	75.950
00400 PH, WH, FIELD	(STANDARD UNIT	270	8.700	6.200	7.472	8.400	7.800	7.500	7.100	6.600
00403 PH, WH, LABORATO	(STANDARD UNIT	161	9.300	6.800	7.619	8.400	7.850	7.600	7.375	7.100
90095 SPECIFIC CONDUCT	MICROSIEMENS/C	157	89.000	17.000	48.089	68.000	57.000	50.000	39.500	23.000
00095 SPECIFIC CONDUCT	US/CM @ 25C	279	90.000	--	47.088*	*66.000	*55.000	*48.000	*38.077	*23.000
00010 WATER TEMPERATUR	(DEGREES C)	279	23.800	1.000	7.280	16.500	12.000	5.000	3.000	1.900
00900 HARDNESS TOTAL	(MG/L AS CAO3)	207	30.000	5.000	18.227	26.000	22.000	20.000	15.000	8.000
00915 CALCIUM DISSOLVE	(MG/L AS CA)	207	9.200	1.800	5.552	7.960	6.700	5.900	4.400	2.500
00925 MAGNESIUM DISSOL	(MG/L AS MG)	207	1.800	0.100	1.054	1.500	1.300	1.100	0.860	0.500
00935 POTASSIUM DISSOL	(MG/L AS K)	203	2.700	0.200	0.671	0.980	0.800	0.700	0.500	0.300
00931 SODIUM ADSORPTIO	(RATIO)	207	0.500	0.130	0.201	0.300	0.200	0.200	0.180	0.150
00930 SODIUM DISSOLVED	(MG/L AS NA)	207	5.300	0.800	1.949	2.960	2.200	1.900	1.600	1.000
00932 SODIUM, PERCENT	PERCENT	203	39.000	13.000	18.995	28.600	20.000	18.000	17.000	15.000
90410 ANC, TIT. 4.5, L	MG/L AS CACO3	156	36.000	6.000	19.726	29.000	24.000	21.000	16.000	9.000
00421 ALKALINITY,DIS,F	(MG/L AS CACO3	3	21.000	13.000	--	--	--	--	--	--
00410 ANC, FET, FIELD	(MG/L AS CACO3	45	27.000	4.000	17.778	26.400	21.000	19.000	14.500	6.300
00940 CHLORIDE DISSOLV	(MG/L AS CL)	205	2.700	0.100	0.451	0.900	0.500	0.400	0.300	0.200
00950 FLUORIDE DISSOLV	(MG/L AS F)	203	0.500	--	0.132*	*0.200	*0.200	*0.100	*0.100	*0.064
00955 SILICA DISSOLVED	(MG/L AS SIO2)	203	14.000	2.300	4.532	6.380	5.000	4.300	3.700	3.000
00945 SULFATE DISSOLVE	(MG/L AS SO4)	203	10.000	0.300	3.924	6.860	5.000	4.000	2.500	1.300
00608 NITROGEN AMMONIA	(MG/L AS N)	73	0.040	--	0.014*	*0.040	*0.020	*0.010	*0.006	*0.003
00625 NITROGEN AMM+ORG	(MG/L AS N)	189	5.400	--	0.400*	*0.885	*0.500	*0.300	*0.200	*0.083
00610 NITROGEN AMMONIA	(MG/L AS N)	25	0.060	--	0.020*	*0.057	*0.030	*0.020	*0.010	*0.005
00631 NO2 + NO3 DISSOL	(MG/L AS N)	205	0.210	--	0.061*	*0.140	*0.084	*0.053	*0.030	*0.015
00613 NITROGEN,NITRITE	MG/L AS N	68	0.030	--	0.004*	*0.020	*0.004	*0.002	*0.001	*0.000
00666 PHOSPHORUS DISS.	(MG/L AS P)	183	0.200	--	0.014*	*0.030	*0.020	*0.010	*0.005	*0.002
00671 PHOSPHORUS ORTHO	(MG/L AS P)	96	0.100	--	0.007*	*0.030	*0.010	*0.003	*0.001	*0.000
00665 PHOSPHORUS TOTAL	(MG/L AS P)	192	0.100	--	0.018*	*0.050	*0.020	*0.010	*0.008	*0.004
01000 ARSENIC DISSOLVE	(UG/L AS AS)	3	--	--	--	--	--	--	--	--
01005 BARIUM DISSOLVED	(UG/L AS BA)	67	8.000	3.000	5.672	8.000	7.000	6.000	5.000	3.000
01010 BERYLLIUM DISSOL	(UG/L AS BE)	67	--	--	--	--	--	--	--	--
01020 BORON DISSOLVED	(UG/L AS B)	67	30.000	--	3.791*	*16.000	*4.379	*2.084	*0.981	*0.377
01025 CADMIUM DISSOLVE	(UG/L AS CD)	109	3.000	--	0.498*	*2.000	*0.614	*0.340	*0.187	*0.083
01030 CHROMIUM DISSOLV	(UG/L AS CR)	67	--	--	--	--	--	--	--	--
01035 COBALT DISSOLVED	(UG/L AS CO)	67	--	--	--	--	--	--	--	--
01040 COPPER DISSOLVED	(UG/L AS CU)	110	20.000	--	2.039*	*7.000	*2.352	*1.120	*0.784	*0.294
01046 IRON DISSOLVED	(UG/L AS FE)	207	360.000	7.000	47.425	116.000	58.000	33.000	20.000	12.400
01049 LEAD DISSOLVED	(UG/L AS PB)	111	19.000	--	1.799*	*6.728	*2.000	*0.847	*0.363	*0.127
01130 LITHIUM DISSOLVE	(UG/L AS LI)	67	--	--	--	--	--	--	--	--
01056 MANGANESE DISSOL	(UG/L AS MN)	207	20.000	--	2.487*	*6.640	*3.000	*2.000	*1.000	*0.474
01060 MOLYBDENUM DISSO	(UG/L AS MO)	67	--	--	--	--	--	--	--	--
01065 NICKEL DISSOLVED	(UG/L AS NI)	109	12.000	--	1.211*	*4.459	*1.278	*0.638	*0.294	*0.100
01075 SILVER DISSOLVED	(UG/L AS AG)	69	4.000	--	0.647*	*2.000	*0.790	*0.453	*0.257	*0.120
01080 STRONTIUM DISSOL	(UG/L AS SR)	67	60.000	10.000	33.552	49.600	41.000	35.000	26.000	12.800
01085 VANADIUM DISSOLV	(UG/L AS V)	67	--	--	--	--	--	--	--	--
01090 ZINC DISSOLVED	(UG/L AS ZN)	108	35.000	--	6.430*	*18.550	*9.000	*4.398	*2.549	*1.146

* - VALUE IS ESTIMATED BY USING A LOG-PROBABILITY REGRESSION TO PREDICT THE VALUES OF DATA BELOW THE DETECTION LIMIT (Helsel and Cohn, 1988)

Table 12. Summary statistics for site 6, Lake Estes, sampled at surface.

STATISTICAL SUMMARY OF SELECTED WATER QUALITY DATA COLLECTED FROM MAY 1998 TO SEPT 2000

WATER-QUALITY CONSTITUENT		SAMPLE SIZE	DESCRIPTIVE STATISTICS MAXIMUM	MINIMUM	MEAN	PERCENT OF SAMPLES IN WHICH VALUES WERE LESS THAN OR EQUAL TO THOSE SHOWN 95 %	75 %	(MEDIAN) 50 %	25 %	5 %
00077 TRANSPARENCY (IN	(INCHES)	8	119.000	60.000	81.750	119.000	92.250	79.000	67.500	60.000
00300 OXYGEN DISSOLVED	(MG/L)	8	9.300	6.400	7.838	9.300	8.925	7.700	6.725	6.400
00400 PH, WH, FIELD	(STANDARD UNIT	8	7.800	7.200	7.550	7.800	7.675	7.550	7.500	7.200
00403 PH, WH, LABORATO	(STANDARD UNIT	8	8.100	7.200	7.475	8.100	7.650	7.400	7.225	7.200
90095 SPECIFIC CONDUCT	MICROSIEMENS/C	8	56.000	26.000	41.500	56.000	49.000	44.500	31.250	26.000
00095 SPECIFIC CONDUCT	US/CM @ 25C	8	46.000	16.000	33.500	46.000	43.750	36.000	22.250	16.000
00010 WATER TEMPERATUR	(DEGREES C)	8	17.800	6.600	12.650	17.800	16.625	12.900	8.825	6.600
00900 HARDNESS TOTAL	(MG/L AS CAO3)	8	19.400	9.010	15.089	19.400	18.650	16.150	11.400	9.010
00915 CALCIUM DISSOLVE	(MG/L AS CA)	8	5.720	2.640	4.474	5.720	5.552	4.700	3.420	2.640
00925 MAGNESIUM DISSOL	(MG/L AS MG)	8	1.330	0.582	0.950	1.330	1.135	1.011	0.698	0.582
00935 POTASSIUM DISSOL	(MG/L AS K)	8	0.720	0.350	0.504	0.720	0.585	0.490	0.405	0.350
00931 SODIUM ADSORPTIO	(RATIO)	8	0.259	0.156	0.200	0.259	0.242	0.183	0.167	0.156
00930 SODIUM DISSOLVED	(MG/L AS NA)	8	2.600	1.100	1.787	2.600	2.250	1.800	1.250	1.100
00932 SODIUM, PERCENT	PERCENT	8	22.700	16.300	19.913	22.700	22.075	20.300	17.800	16.300
90410 ANC, TIT. 4.5, L	MG/L AS CACO3	8	21.000	10.000	16.125	21.000	19.750	16.500	12.500	10.000
00940 CHLORIDE DISSOLV	(MG/L AS CL)	8	1.900	--	0.830*	*1.900	*1.575	*0.450	*0.400	*0.136
00950 FLUORIDE DISSOLV	(MG/L AS F)	8	0.200	--	0.114*	*0.200	*0.175	*0.100	*0.072	*0.051
00955 SILICA DISSOLVED	(MG/L AS SIO2)	8	7.000	4.000	5.038	7.000	6.100	4.650	4.250	4.000
00945 SULFATE DISSOLVE	(MG/L AS SO4)	8	3.600	1.400	2.175	3.600	2.575	2.050	1.650	1.400
70300 RESIDUE DIS 180C	MG/L	8	42.000	22.000	31.875	42.000	41.000	30.500	23.500	22.000
70301 DISSOLVED SOLIDS	MG/L	7	30.700	17.200	24.700	30.700	29.800	25.800	20.400	17.200
00608 NITROGEN AMMONIA	(MG/L AS N)	8	0.052	--	0.019*	*0.052	*0.032	*0.012	*0.003	*0.002
00625 NITROGEN AMM+ORG	(MG/L AS N)	8	0.310	0.160	0.240	0.310	0.257	0.245	0.222	0.160
00631 NO2 + NO3 DISSOL	(MG/L AS N)	8	0.091	--	0.035*	*0.091	*0.063	*0.022	*0.008	*0.006
00613 NITROGEN,NITRITE	MG/L AS N	8	--	--	--	--	--	--	--	--
00666 PHOSPHORUS DISS.	(MG/L AS P)	8	--	--	--	--	--	--	--	--
00671 PHOSPHORUS ORTHO	(MG/L AS P)	8	--	--	--	--	--	--	--	--
00665 PHOSPHORUS TOTAL	(MG/L AS P)	8	--	--	--	--	--	--	--	--
31625 COLIFORM FECAL 0	COLS./100 ML	8	84.000	--	22.584*	*84.000	*37.500	*13.500	*1.626	*0.504
70953 CHL-A PHY CHROMA	UG/L	8	13.200	0.900	5.900	13.200	10.675	3.200	3.000	0.900
70954 CHLOROPHYLL-B, P	UG/L	8	--	--	--	--	--	--	--	--
01005 BARIUM DISSOLVED	(UG/L AS BA)	8	6.200	4.100	5.162	6.200	6.025	5.350	4.200	4.100
01010 BERYLLIUM DISSOL	(UG/L AS BE)	8	--	--	--	--	--	--	--	--
01020 BORON DISSOLVED	(UG/L AS B)	8	--	--	--	--	--	--	--	--
01025 CADMIUM DISSOLVE	(UG/L AS CD)	8	--	--	--	--	--	--	--	--
01030 CHROMIUM DISSOLV	(UG/L AS CR)	8	--	--	--	--	--	--	--	--
01035 COBALT DISSOLVED	(UG/L AS CO)	8	--	--	--	--	--	--	--	--
01040 COPPER DISSOLVED	(UG/L AS CU)	8	--	--	--	--	--	--	--	--
01046 IRON DISSOLVED	(UG/L AS FE)	8	90.000	30.000	53.750	90.000	70.000	50.000	32.500	30.000
01049 LEAD DISSOLVED	(UG/L AS PB)	8	--	--	--	--	--	--	--	--
01130 LITHIUM DISSOLVE	(UG/L AS LI)	8	--	--	--	--	--	--	--	--
01056 MANGANESE DISSOL	(UG/L AS MN)	8	--	--	--	--	--	--	--	--
01060 MOLYBDENUM DISSO	(UG/L AS MO)	8	--	--	--	--	--	--	--	--
01065 NICKEL DISSOLVED	(UG/L AS NI)	8	--	--	--	--	--	--	--	--
01075 SILVER DISSOLVED	(UG/L AS AG)	8	--	--	--	--	--	--	--	--
01080 STRONTIUM DISSOL	(UG/L AS SR)	7	34.600	14.500	23.686	34.600	29.300	23.400	17.600	14.500
01085 VANADIUM DISSOLV	(UG/L AS V)	8	--	--	--	--	--	--	--	--
01090 ZINC DISSOLVED	(UG/L AS ZN)	8	--	--	--	--	--	--	--	--

* - VALUE IS ESTIMATED BY USING A LOG-PROBABILITY REGRESSION TO PREDICT THE VALUES OF DATA BELOW THE DETECTION LIMIT (Helsel and Cohn, 1988)

Table 13. Summary statistics for site 6, Lake Estes, sampled near bottom.

STATISTICAL SUMMARY OF SELECTED WATER QUALITY DATA COLLECTED FROM MAY 1998 TO SEPT 2000

WATER-QUALITY CONSTITUENT	SAMPLE SIZE	DESCRIPTIVE STATISTICS: MAXIMUM	MINIMUM	MEAN	PERCENT OF SAMPLES IN WHICH VALUES WERE LESS THAN OR EQUAL TO THOSE SHOWN: 95 %	75 %	(MEDIAN) 50 %	25 %	5 %
00300 OXYGEN DISSOLVED (MG/L)	8	38.400	2.700	10.088	38.400	8.500	7.000	3.700	2.700
00400 PH, WH, FIELD (STANDARD UNIT	8	8.100	6.800	7.375	8.100	7.475	7.350	7.225	6.800
00403 PH, WH, LABORATO (STANDARD UNIT	8	7.600	7.000	7.312	7.600	7.500	7.300	7.075	7.000
90095 SPECIFIC CONDUCT MICROSIEMENS/C	8	54.000	24.000	40.125	54.000	48.000	44.500	28.500	24.000
00095 SPECIFIC CONDUCT US/CM @ 25C	8	44.000	18.000	34.500	44.000	42.750	38.500	25.000	18.000
00010 WATER TEMPERATUR (DEGREES C)	8	15.000	6.400	10.387	15.000	14.300	9.950	6.900	6.400
00900 HARDNESS TOTAL (MG/L AS CAO3)	8	18.900	8.140	14.381	18.900	18.275	16.000	9.932	8.140
00915 CALCIUM DISSOLVE (MG/L AS CA)	8	5.700	2.370	4.244	5.700	5.378	4.650	2.898	2.370
00925 MAGNESIUM DISSOL (MG/L AS MG)	8	1.220	0.538	0.911	1.220	1.125	1.003	0.632	0.538
00935 POTASSIUM DISSOL (MG/L AS K)	8	0.620	0.340	0.502	0.620	0.587	0.495	0.440	0.340
00931 SODIUM ADSORPTIO (RATIO)	8	0.251	0.157	0.200	0.251	0.241	0.183	0.170	0.157
00930 SODIUM DISSOLVED (MG/L AS NA)	8	2.400	1.000	1.750	2.400	2.275	1.800	1.225	1.000
00932 SODIUM, PERCENT PERCENT	8	23.800	16.800	20.375	23.800	21.600	20.850	18.175	16.800
90410 ANC, TIT. 4.5, L MG/L AS CACO3	8	21.000	8.000	15.125	21.000	19.750	15.500	11.000	8.000
00940 CHLORIDE DISSOLV (MG/L AS CL)	8	2.200	0.300	0.938	2.200	1.675	0.500	0.425	0.300
00950 FLUORIDE DISSOLV (MG/L AS F)	8	0.200	--	0.104*	*0.200	*0.100	*0.100	*0.078	*0.061
00955 SILICA DISSOLVED (MG/L AS SIO2)	8	6.600	4.100	5.037	6.600	6.175	4.750	4.200	4.100
00945 SULFATE DISSOLVE (MG/L AS SO4)	8	3.300	1.300	2.075	3.300	2.575	2.100	1.425	1.300
70300 RESIDUE DIS 180C MG/L	8	52.000	21.000	32.500	52.000	39.500	32.500	22.000	21.000
70301 DISSOLVED SOLIDS MG/L	8	34.100	15.600	25.162	34.100	30.150	27.150	18.575	15.600
00608 NITROGEN AMMONIA (MG/L AS N)	8	0.074	--	0.045*	*0.074	*0.066	*0.042	*0.026	*0.019
00625 NITROGEN AMM+ORG (MG/L AS N)	8	0.300	0.240	0.264	0.300	0.280	0.260	0.242	0.240
00631 NO2 + NO3 DISSOL (MG/L AS N)	8	0.081	0.014	0.057	0.081	0.072	0.067	0.036	0.014
00613 NITROGEN,NITRITE MG/L AS N	8	--	--	--	--	--	--	--	--
00666 PHOSPHORUS DISS. (MG/L AS P)	8	--	--	--	--	--	--	--	--
00671 PHOSPHORUS ORTHO (MG/L AS P)	8	--	--	--	--	--	--	--	--
00665 PHOSPHORUS TOTAL (MG/L AS P)	8	--	--	--	--	--	--	--	--
01005 BARIUM DISSOLVED (UG/L AS BA)	8	6.600	4.000	5.350	6.600	6.175	5.500	4.375	4.000
01010 BERYLLIUM DISSOL (UG/L AS BE)	8	--	--	--	--	--	--	--	--
01020 BORON DISSOLVED (UG/L AS B)	8	--	--	--	--	--	--	--	--
01025 CADMIUM DISSOLVE (UG/L AS CD)	8	--	--	--	--	--	--	--	--
01030 CHROMIUM DISSOLV (UG/L AS CR)	8	--	--	--	--	--	--	--	--
01035 COBALT DISSOLVED (UG/L AS CO)	8	--	--	--	--	--	--	--	--
01040 COPPER DISSOLVED (UG/L AS CU)	8	--	--	--	--	--	--	--	--
01046 IRON DISSOLVED (UG/L AS FE)	8	150.000	40.000	92.500	150.000	122.500	90.000	70.000	40.000
01049 LEAD DISSOLVED (UG/L AS PB)	8	--	--	--	--	--	--	--	--
01130 LITHIUM DISSOLVE (UG/L AS LI)	8	--	--	--	--	--	--	--	--
01056 MANGANESE DISSOL (UG/L AS MN)	8	9.800	--	5.854*	*9.800	*8.800	*6.000	*2.900	*1.829
01060 MOLYBDENUM DISSO (UG/L AS MO)	8	--	--	--	--	--	--	--	--
01065 NICKEL DISSOLVED (UG/L AS NI)	8	--	--	--	--	--	--	--	--
01075 SILVER DISSOLVED (UG/L AS AG)	8	--	--	--	--	--	--	--	--
01080 STRONTIUM DISSOL (UG/L AS SR)	8	34.300	12.800	23.000	34.300	28.075	24.750	15.475	12.800
01085 VANADIUM DISSOLV (UG/L AS V)	8	--	--	--	--	--	--	--	--
01090 ZINC DISSOLVED (UG/L AS ZN)	8	--	--	--	--	--	--	--	--

* - VALUE IS ESTIMATED BY USING A LOG-PROBABILITY REGRESSION TO PREDICT THE VALUES OF DATA BELOW THE DETECTION LIMIT (Helsel and Cohn, 1988)

Table 14. Summary statistics for site 7, Olympus Tunnel.

STATISTICAL SUMMARY OF SELECTED WATER QUALITY DATA COLLECTED FROM SEPT 1970 TO DEC 2000

WATER-QUALITY CONSTITUENT	SAMPLE SIZE	DESCRIPTIVE STATISTICS MAXIMUM	MINIMUM	MEAN	PERCENT OF SAMPLES IN WHICH VALUES WERE LESS THAN OR EQUAL TO THOSE SHOWN 95 %	75 %	(MEDIAN) 50 %	25 %	5 %
70300 RESIDUE DIS 180C MG/L	95	67.000	10.000	33.547	48.400	41.000	35.000	25.000	16.000
70301 DISSOLVED SOLIDS MG/L	172	57.000	13.500	30.098	43.105	35.300	31.000	24.350	16.130
00300 OXYGEN DISSOLVED (MG/L)	240	14.800	6.400	8.925	11.195	9.800	8.800	8.000	7.200
00400 PH, WH, FIELD (STANDARD UNIT	236	8.800	6.300	7.446	8.200	7.700	7.400	7.200	6.800
00403 PH, WH, LABORATO (STANDARD UNIT	123	8.500	6.900	7.590	8.200	7.800	7.600	7.400	7.100
90095 SPECIFIC CONDUCT MICROSIEMENS/C	121	76.000	19.000	46.017	66.000	56.000	47.000	36.500	22.100
00095 SPECIFIC CONDUCT US/CM @ 25C	243	95.000	--	47.294*	*70.000	*58.000	*50.000	*36.565	*22.430
00010 WATER TEMPERATUR (DEGREES C)	242	21.000	0.000	7.332	16.000	12.000	6.250	2.000	1.000
00900 HARDNESS TOTAL (MG/L AS CAO3)	184	39.000	5.000	17.769	25.600	22.000	19.000	13.625	7.450
00915 CALCIUM DISSOLVE (MG/L AS CA)	184	9.600	1.500	5.331	7.875	6.600	5.700	4.000	2.300
00925 MAGNESIUM DISSOL (MG/L AS MG)	184	3.700	0.100	1.074	1.600	1.300	1.100	0.850	0.417
00935 POTASSIUM DISSOL (MG/L AS K)	180	1.800	0.100	0.677	1.000	0.800	0.700	0.582	0.300
00931 SODIUM ADSORPTIO (RATIO)	184	0.400	0.153	0.207	0.300	0.206	0.200	0.197	0.167
00930 SODIUM DISSOLVED (MG/L AS NA)	184	4.700	0.900	2.006	2.900	2.300	2.000	1.600	1.125
00932 SODIUM, PERCENT PERCENT	179	34.000	13.000	19.658	27.000	21.000	19.000	17.500	15.000
90410 ANC, TIT. 4.5, L MG/L AS CACO3	121	31.000	6.000	18.207	28.900	23.000	18.000	13.500	8.100
00410 ANC, FET, FIELD (MG/L AS CACO3	61	30.000	4.000	18.230	26.900	23.000	20.000	13.500	6.000
00940 CHLORIDE DISSOLV (MG/L AS CL)	184	4.100	0.100	0.726	1.675	0.800	0.600	0.500	0.300
00950 FLUORIDE DISSOLV (MG/L AS F)	179	0.400	--	0.141*	*0.200	*0.200	*0.100	*0.100	*0.071
00955 SILICA DISSOLVED (MG/L AS SIO2)	181	10.000	2.400	4.580	6.600	5.200	4.500	3.800	3.100
00945 SULFATE DISSOLVE (MG/L AS SO4)	184	14.000	--	4.113*	*7.650	*5.175	*4.100	*2.700	*1.325
00608 NITROGEN AMMONIA (MG/L AS N)	39	0.080	--	0.026*	*0.066	*0.035	*0.020	*0.011	*0.006
00625 NITROGEN AMM+ORG (MG/L AS N)	40	0.600	--	0.263*	*0.495	*0.300	*0.240	*0.185	*0.128
00610 NITROGEN AMMONIA (MG/L AS N)	156	0.230	--	0.048*	*0.150	*0.070	*0.030	*0.010	*0.005
00631 NO2 + NO3 DISSOL (MG/L AS N)	186	2.300	--	0.089*	*0.176	*0.100	*0.063	*0.037	*0.016
00613 NITROGEN,NITRITE MG/L AS N	179	0.220	--	0.008*	*0.015	*0.009	*0.006	*0.004	*0.002
00666 PHOSPHORUS DISS. (MG/L AS P)	149	0.090	--	0.015*	*0.040	*0.020	*0.010	*0.006	*0.003
00671 PHOSPHORUS ORTHO (MG/L AS P)	82	0.070	--	0.008*	*0.038	*0.010	*0.004	*0.002	*0.001
00665 PHOSPHORUS TOTAL (MG/L AS P)	184	5.000	--	0.057*	*0.060	*0.030	*0.020	*0.018	*0.006
31501 TOT COLI,MENDO M COLS./100 ML	149	13000.000	0.000	370.711	1500.000	300.000	53.000	12.000	1.000
31625 COLIFORM FECAL 0 COLS./100 ML	78	1200.000	--	78.076*	*523.000	*60.000	*14.000	*1.500	*0.178
31616 FECAL COLI,MFC M COLS./100 ML	70	210.000	--	10.613*	*47.850	*9.000	*1.000	*0.288	*0.031
01000 ARSENIC DISSOLVE (UG/L AS AS)	3	--	--	--	--	--	--	--	--
01005 BARIUM DISSOLVED (UG/L AS BA)	34	8.000	3.000	5.409	8.000	6.000	5.600	4.375	3.000
01010 BERYLLIUM DISSOL (UG/L AS BE)	34	--	--	--	--	--	--	--	--
01020 BORON DISSOLVED (UG/L AS B)	34	--	--	--	--	--	--	--	--
01025 CADMIUM DISSOLVE (UG/L AS CD)	34	--	--	--	--	--	--	--	--
01030 CHROMIUM DISSOLV (UG/L AS CR)	34	--	--	--	--	--	--	--	--
01035 COBALT DISSOLVED (UG/L AS CO)	34	--	--	--	--	--	--	--	--
01040 COPPER DISSOLVED (UG/L AS CU)	37	--	--	--	--	--	--	--	--
01046 IRON DISSOLVED (UG/L AS FE)	184	280.000	10.000	82.717	180.000	100.000	70.000	50.000	20.000
01049 LEAD DISSOLVED (UG/L AS PB)	37	--	--	--	--	--	--	--	--
01130 LITHIUM DISSOLVE (UG/L AS LI)	34	--	--	--	--	--	--	--	--
01056 MANGANESE DISSOL (UG/L AS MN)	184	39.000	--	5.569*	*20.000	*6.152	*3.626	*2.000	*0.732
01055 MANGANESE TOTAL (UG/L AS MN)	12	27.000	--	13.245*	*27.000	*19.000	*11.000	*8.066	*5.629
71890 MERCURY DISSOLVE UG/L AS HG	3	--	--	--	--	--	--	--	--
01060 MOLYBDENUM DISSO (UG/L AS MO)	34	--	--	--	--	--	--	--	--
01065 NICKEL DISSOLVED (UG/L AS NI)	37	--	--	--	--	--	--	--	--
01075 SILVER DISSOLVED (UG/L AS AG)	37	2.000	--	0.698*	*2.000	*0.912	*0.547	*0.323	*0.169
01080 STRONTIUM DISSOL (UG/L AS SR)	34	51.000	10.000	28.915	48.000	37.750	28.500	19.550	10.750
01085 VANADIUM DISSOLV (UG/L AS V)	34	--	--	--	--	--	--	--	--
01090 ZINC DISSOLVED (UG/L AS ZN)	34	18.000	--	5.623*	*15.000	*8.500	*3.409	*1.880	*0.755

* - VALUE IS ESTIMATED BY USING A LOG-PROBABILITY REGRESSION TO PREDICT THE VALUES OF DATA BELOW THE DETECTION LIMIT (Helsel and Cohn, 1988)

Table 15. Summary statistics for site 8, Carter Lake, sampled near surface.

STATISTICAL SUMMARY OF SELECTED WATER QUALITY DATA COLLECTED FROM FEB 1970 TO OCT 2000

WATER-QUALITY CONSTITUENT	SAMPLE SIZE	DESCRIPTIVE STATISTICS: MAXIMUM	MINIMUM	MEAN	PERCENT OF SAMPLES IN WHICH VALUES WERE LESS THAN OR EQUAL TO THOSE SHOWN: 95 %	75 %	(MEDIAN) 50 %	25 %	5 %
70300 RESIDUE DIS 180C MG/L	145	116.000	31.000	49.966	69.700	54.000	48.000	44.000	37.000
70301 DISSOLVED SOLIDS MG/L	34	50.000	34.600	40.379	48.125	42.600	39.500	37.475	34.750
00077 TRANSPARENCY (IN (INCHES)	116	258.000	8.000	100.941	162.300	123.500	95.000	79.000	49.170
00300 OXYGEN DISSOLVED (MG/L)	143	11.800	6.000	8.347	11.200	9.400	7.800	7.300	6.720
00400 PH, WH, FIELD (STANDARD UNIT	149	8.900	5.800	7.691	8.400	8.100	7.800	7.400	6.650
00403 PH, WH, LABORATO (STANDARD UNIT	54	8.400	7.100	7.852	8.225	8.100	7.900	7.675	7.300
90095 SPECIFIC CONDUCT MICROSIEMENS/C	54	90.000	60.000	74.889	86.750	80.000	74.500	70.750	62.750
00095 SPECIFIC CONDUCT US/CM @ 25C	156	145.000	56.000	83.577	102.000	90.000	82.000	75.000	64.000
00010 WATER TEMPERATUR (DEGREES C)	157	24.000	2.000	14.378	22.500	20.000	15.200	10.250	3.000
00900 HARDNESS TOTAL (MG/L AS CAO3)	37	41.000	25.100	30.803	36.680	33.300	30.100	27.950	25.190
00915 CALCIUM DISSOLVE (MG/L AS CA)	37	14.000	8.090	10.110	12.200	11.000	9.800	9.050	8.108
00925 MAGNESIUM DISSOL (MG/L AS MG)	37	1.800	1.180	1.333	1.530	1.400	1.300	1.265	1.189
00935 POTASSIUM DISSOL (MG/L AS K)	37	0.900	0.510	0.693	0.810	0.800	0.700	0.615	0.573
00931 SODIUM ADSORPTIO (RATIO)	37	0.220	0.151	0.176	0.202	0.183	0.175	0.169	0.154
00930 SODIUM DISSOLVED (MG/L AS NA)	37	2.800	1.900	2.224	2.620	2.400	2.200	2.100	1.900
00932 SODIUM, PERCENT PERCENT	37	16.100	11.000	13.330	14.750	13.800	13.300	12.950	11.180
90410 ANC, TIT. 4.5, L MG/L AS CACO3	36	39.000	26.000	32.472	39.000	34.750	32.000	30.250	26.850
00940 CHLORIDE DISSOLV (MG/L AS CL)	35	1.500	0.100	0.634	1.180	0.800	0.700	0.400	0.180
00950 FLUORIDE DISSOLV (MG/L AS F)	35	0.300	--	0.121*	*0.220	*0.100	*0.100	*0.100	*0.059
00955 SILICA DISSOLVED (MG/L AS SIO2)	37	4.300	0.500	2.659	4.120	3.400	2.500	2.050	0.950
00945 SULFATE DISSOLVE (MG/L AS SO4)	35	4.700	1.000	2.880	4.540	3.200	2.800	2.600	1.480
00608 NITROGEN AMMONIA (MG/L AS N)	66	0.270	--	0.033*	*0.156	*0.033	*0.011	*0.005	*0.002
00625 NITROGEN AMM+ORG (MG/L AS N)	35	0.500	--	0.219*	*0.420	*0.300	*0.200	*0.158	*0.109
00610 NITROGEN AMMONIA (MG/L AS N)	87	0.400	--	0.036*	*0.132	*0.040	*0.020	*0.008	*0.002
00618 NITROGEN NITRATE (MG/L AS N)	93	2.300	0.000	0.071	0.203	0.075	0.030	0.010	0.000
00631 NO2 + NO3 DISSOL (MG/L AS N)	138	2.300	--	0.062*	*0.161	*0.060	*0.030	*0.012	*0.005
00613 NITROGEN,NITRITE MG/L AS N	146	0.040	--	0.005*	*0.016	*0.006	*0.003	*0.002	*0.001
00666 PHOSPHORUS DISS. (MG/L AS P)	33	--	--	--	--	--	--	--	--
00671 PHOSPHORUS ORTHO (MG/L AS P)	36	0.023	--	0.005*	*0.020	*0.005	*0.003	*0.001	*0.000
00665 PHOSPHORUS TOTAL (MG/L AS P)	135	2.000	--	0.139*	*1.300	*0.070	*0.020	*0.007	*0.001
00680 CARBON ORGANIC T (MG/L AS C)	9	5.000	3.400	3.878	5.000	4.100	3.800	3.450	3.400
31625 COLIFORM FECAL 0 COLS./100 ML	78	6.000	--	0.634*	*2.050	*1.000	*0.387	*0.197	*0.075
70953 CHL-A PHY CHROMA UG/L	35	4.200	0.300	1.411	3.160	1.900	1.200	0.800	0.380
70954 CHLOROPHYLL-B, P UG/L	35	0.200	--	0.053*	*0.200	*0.066	*0.035	*0.018	*0.007
01005 BARIUM DISSOLVED (UG/L AS BA)	36	32.000	13.000	22.892	30.300	25.750	23.150	18.850	15.550
01010 BERYLLIUM DISSOL (UG/L AS BE)	36	--	--	--	--	--	--	--	--
01020 BORON DISSOLVED (UG/L AS B)	36	20.000	--	6.106*	*11.500	*7.275	*5.425	*4.000	*2.773
01025 CADMIUM DISSOLVE (UG/L AS CD)	36	2.000	--	0.497*	*2.000	*0.639	*0.351	*0.196	*0.088
01030 CHROMIUM DISSOLV (UG/L AS CR)	36	--	--	--	--	--	--	--	--
01035 COBALT DISSOLVED (UG/L AS CO)	36	--	--	--	--	--	--	--	--
01040 COPPER DISSOLVED (UG/L AS CU)	36	--	--	--	--	--	--	--	--
01046 IRON DISSOLVED (UG/L AS FE)	37	--	--	--	--	--	--	--	--
01049 LEAD DISSOLVED (UG/L AS PB)	36	--	--	--	--	--	--	--	--
01130 LITHIUM DISSOLVE (UG/L AS LI)	36	--	--	--	--	--	--	--	--
01056 MANGANESE DISSOL (UG/L AS MN)	37	10.000	--	1.032*	*5.500	*0.952	*0.467	*0.242	*0.072
01055 MANGANESE TOTAL (UG/L AS MN)	12	13.000	--	3.720*	*13.000	*4.730	*2.702	*1.922	*1.294
01060 MOLYBDENUM DISSO (UG/L AS MO)	36	--	--	--	--	--	--	--	--
01065 NICKEL DISSOLVED (UG/L AS NI)	36	--	--	--	--	--	--	--	--
01075 SILVER DISSOLVED (UG/L AS AG)	36	--	--	--	--	--	--	--	--
01080 STRONTIUM DISSOL (UG/L AS SR)	36	64.000	31.700	41.422	52.100	44.750	41.000	37.475	32.975
01085 VANADIUM DISSOLV (UG/L AS V)	36	--	--	--	--	--	--	--	--
01090 ZINC DISSOLVED (UG/L AS ZN)	36	33.000	--	5.952*	*21.950	*7.750	*3.185	*1.710	*0.731

* - VALUE IS ESTIMATED BY USING A LOG-PROBABILITY REGRESSION TO PREDICT THE VALUES OF DATA BELOW THE DETECTION LIMIT (Helsel and Cohn, 1988)

Table 16. Summary statistics for site 8, Carter Lake, sampled near bottom.

STATISTICAL SUMMARY OF SELECTED WATER QUALITY DATA COLLECTED FROM FEB 1970 TO OCT 2000

WATER-QUALITY CONSTITUENT	SAMPLE SIZE	DESCRIPTIVE STATISTICS: MAXIMUM	MINIMUM	MEAN	PERCENT OF SAMPLES IN WHICH VALUES WERE LESS THAN OR EQUAL TO THOSE SHOWN: 95 %	75 %	(MEDIAN) 50 %	25 %	5 %
00003 SAMPLING DEPTH (FEET	147	160.000	25.000	105.143	146.000	120.000	100.000	90.000	60.000
70300 RESIDUE DIS 180C MG/L	113	94.000	18.000	48.230	70.300	53.000	47.000	41.000	33.700
70301 DISSOLVED SOLIDS MG/L	34	50.000	29.900	38.697	45.425	41.200	38.300	35.900	33.200
00300 OXYGEN DISSOLVED (MG/L)	133	12.700	2.400	7.530	10.760	9.150	7.800	6.000	3.710
00301 OXYGEN DIS. PERC % OF SATURATIO	10	96.000	41.200	71.680	96.000	83.725	76.800	56.900	41.200
00400 PH, WH, FIELD (STANDARD UNIT	117	8.700	5.600	7.315	8.000	7.600	7.300	7.000	6.590
00403 PH, WH, LABORATO (STANDARD UNIT	42	8.000	6.900	7.417	7.900	7.600	7.450	7.200	6.900
90095 SPECIFIC CONDUCT MICROSIEMENS/C	42	81.000	52.000	67.452	75.850	72.000	67.500	63.000	59.000
00095 SPECIFIC CONDUCT US/CM @ 25C	125	149.000	48.000	76.872	92.700	85.000	78.000	68.000	55.300
00010 WATER TEMPERATUR (DEGREES C)	151	15.500	2.000	6.599	12.140	7.500	6.000	5.000	3.000
00900 HARDNESS TOTAL (MG/L AS CAO3)	37	38.000	20.700	28.014	33.770	30.700	27.600	24.950	23.040
00915 CALCIUM DISSOLVE (MG/L AS CA)	37	13.000	6.570	9.058	11.200	10.000	8.800	8.015	7.362
00925 MAGNESIUM DISSOL (MG/L AS MG)	37	1.500	1.040	1.297	1.437	1.400	1.300	1.200	1.121
00935 POTASSIUM DISSOL (MG/L AS K)	37	0.900	0.570	0.662	0.900	0.700	0.630	0.600	0.570
00931 SODIUM ADSORPTIO (RATIO)	37	0.204	0.152	0.178	0.200	0.187	0.178	0.171	0.155
00930 SODIUM DISSOLVED (MG/L AS NA)	37	2.600	1.600	2.154	2.510	2.300	2.200	2.000	1.780
00932 SODIUM, PERCENT PERCENT	37	15.300	11.000	14.041	15.210	14.650	14.300	13.500	11.810
90410 ANC, TIT. 4.5, L MG/L AS CACO3	36	35.000	22.000	29.417	34.150	32.000	30.000	27.000	24.550
00940 CHLORIDE DISSOLV (MG/L AS CL)	35	1.300	0.100	0.617	1.140	0.800	0.600	0.400	0.100
00950 FLUORIDE DISSOLV (MG/L AS F)	35	0.200	--	0.121*	*0.200	*0.200	*0.100	*0.100	*0.062
00955 SILICA DISSOLVED (MG/L AS SIO2)	37	4.900	2.100	3.673	4.900	4.450	3.800	2.850	2.280
00945 SULFATE DISSOLVE (MG/L AS SO4)	34	4.700	1.600	2.891	4.625	3.100	2.900	2.575	1.825
00608 NITROGEN AMMONIA (MG/L AS N)	65	0.210	--	0.034*	*0.103	*0.050	*0.020	*0.010	*0.005
00625 NITROGEN AMM+ORG (MG/L AS N)	35	0.600	--	0.230*	*0.440	*0.246	*0.200	*0.174	*0.122
00610 NITROGEN AMMONIA (MG/L AS N)	60	0.270	--	0.031*	*0.090	*0.040	*0.020	*0.010	*0.004
00618 NITROGEN NITRATE (MG/L AS N)	73	0.240	0.000	0.060	0.213	0.080	0.040	0.020	0.000
00631 NO2 + NO3 DISSOL (MG/L AS N)	107	0.979	--	0.071*	*0.212	*0.082	*0.045	*0.029	*0.010
00613 NITROGEN,NITRITE MG/L AS N	115	0.030	--	0.005*	*0.011	*0.006	*0.004	*0.002	*0.001
00666 PHOSPHORUS DISS. (MG/L AS P)	33	0.012	--	0.004*	*0.011	*0.005	*0.003	*0.002	*0.001
00671 PHOSPHORUS ORTHO (MG/L AS P)	36	0.011	--	0.004*	*0.010	*0.004	*0.003	*0.002	*0.001
00665 PHOSPHORUS TOTAL (MG/L AS P)	107	1.500	--	0.061*	*0.306	*0.030	*0.020	*0.006	*0.002
00680 CARBON ORGANIC T (MG/L AS C)	9	4.100	3.200	3.556	4.100	3.850	3.400	3.350	3.200
31625 COLIFORM FECAL 0 COLS./100 ML	15	--	--	--	--	--	--	--	--
01005 BARIUM DISSOLVED (UG/L AS BA)	36	26.000	12.000	18.000	24.300	19.000	17.450	16.075	13.445
01010 BERYLLIUM DISSOL (UG/L AS BE)	36	--	--	--	--	--	--	--	--
01020 BORON DISSOLVED (UG/L AS B)	36	10.000	--	4.987*	*8.640	*6.078	*4.618	*3.606	*2.598
01025 CADMIUM DISSOLVE (UG/L AS CD)	36	2.000	--	0.293*	*1.227	*0.344	*0.145	*0.065	*0.021
01030 CHROMIUM DISSOLV (UG/L AS CR)	36	--	--	--	--	--	--	--	--
01035 COBALT DISSOLVED (UG/L AS CO)	36	--	--	--	--	--	--	--	--
01040 COPPER DISSOLVED (UG/L AS CU)	36	--	--	--	--	--	--	--	--
01046 IRON DISSOLVED (UG/L AS FE)	37	20.000	--	7.732*	*20.000	*10.000	*6.691	*4.641	*2.986
01049 LEAD DISSOLVED (UG/L AS PB)	36	--	--	--	--	--	--	--	--
01130 LITHIUM DISSOLVE (UG/L AS LI)	36	4.000	--	1.615*	*3.564	*2.033	*1.391	*0.979	*0.561
01056 MANGANESE DISSOL (UG/L AS MN)	37	35.000	--	4.753*	*32.300	*5.050	*2.000	*0.964	*0.242
01055 MANGANESE TOTAL (UG/L AS MN)	12	33.000	--	9.522*	*33.000	*11.750	*7.520	*3.668	*3.000
01060 MOLYBDENUM DISSO (UG/L AS MO)	36	--	--	--	--	--	--	--	--
01065 NICKEL DISSOLVED (UG/L AS NI)	36	--	--	--	--	--	--	--	--
01075 SILVER DISSOLVED (UG/L AS AG)	36	--	--	--	--	--	--	--	--
01080 STRONTIUM DISSOL (UG/L AS SR)	36	47.000	29.600	39.283	47.000	43.750	39.500	35.100	31.300
01085 VANADIUM DISSOLV (UG/L AS V)	36	--	--	--	--	--	--	--	--
01090 ZINC DISSOLVED (UG/L AS ZN)	36	23.000	--	5.884*	*17.900	*7.798	*4.000	*2.037	*0.931

* - VALUE IS ESTIMATED BY USING A LOG-PROBABILITY REGRESSION TO PREDICT THE VALUES OF DATA BELOW THE DETECTION LIMIT (Helsel and Cohn, 1988)

Table 17. Summary statistics for site 9, Horsetooth Reservoir (Soldier Canyon Dam), sampled near surface.

STATISTICAL SUMMARY OF SELECTED WATER QUALITY DATA COLLECTED FROM OCT 1969 TO AUG 1999

WATER-QUALITY CONSTITUENT	SAMPLE SIZE	DESCRIPTIVE STATISTICS: MAXIMUM	MINIMUM	MEAN	PERCENT OF SAMPLES IN WHICH VALUES WERE LESS THAN OR EQUAL TO THOSE SHOWN: 95 %	75 %	(MEDIAN) 50 %	25 %	5 %
70300 RESIDUE DIS 180C MG/L	137	78.000	16.000	50.416	72.100	56.500	50.000	44.000	34.000
70301 DISSOLVED SOLIDS MG/L	46	53.000	28.400	39.174	49.470	42.525	39.000	35.300	29.275
00077 TRANSPARENCY (IN (INCHES)	103	177.000	8.000	79.871	142.600	98.000	76.000	57.000	38.000
00300 OXYGEN DISSOLVED (MG/L)	142	12.200	0.000	8.208	10.700	9.125	7.800	7.200	6.500
00400 PH, WH, FIELD (STANDARD UNIT	144	8.800	6.000	7.473	8.300	7.800	7.600	7.100	6.400
00403 PH, WH, LABORATO (STANDARD UNIT	55	8.400	7.100	7.764	8.220	7.900	7.800	7.600	7.280
90095 SPECIFIC CONDUCT MICROSIEMENS/C	55	163.000	49.000	70.836	81.200	76.000	70.000	64.000	51.800
00095 SPECIFIC CONDUCT US/CM @ 25C	154	125.000	48.000	75.994	105.000	80.000	75.500	70.000	55.000
00010 WATER TEMPERATUR (DEGREES C)	154	25.000	2.000	14.769	22.500	20.700	15.500	10.000	3.500
00900 HARDNESS TOTAL (MG/L AS CAO3)	50	35.000	19.400	28.474	33.340	31.000	28.700	26.800	20.760
00915 CALCIUM DISSOLVE (MG/L AS CA)	50	11.000	6.100	8.963	10.890	9.725	9.150	8.375	6.516
00925 MAGNESIUM DISSOL (MG/L AS MG)	50	1.900	1.000	1.472	1.800	1.600	1.500	1.337	1.073
00935 POTASSIUM DISSOL (MG/L AS K)	50	1.000	0.500	0.716	0.945	0.800	0.700	0.600	0.533
00931 SODIUM ADSORPTIO (RATIO)	50	0.500	0.166	0.199	0.217	0.200	0.197	0.180	0.170
00930 SODIUM DISSOLVED (MG/L AS NA)	50	5.800	1.800	2.456	3.190	2.600	2.400	2.175	1.855
00932 SODIUM, PERCENT PERCENT	50	30.000	12.400	15.354	17.135	16.000	15.150	14.075	13.110
90410 ANC, TIT. 4.5, L MG/L AS CACO3	49	40.000	7.000	29.286	36.500	33.000	29.000	27.000	20.500
00940 CHLORIDE DISSOLV (MG/L AS CL)	48	32.000	0.200	1.410	1.850	0.900	0.700	0.600	0.245
00950 FLUORIDE DISSOLV (MG/L AS F)	48	0.500	--	0.136*	*0.200	*0.200	*0.100	*0.100	*0.060
00955 SILICA DISSOLVED (MG/L AS SIO2)	50	4.900	0.700	2.778	4.645	3.825	2.750	1.900	0.800
00945 SULFATE DISSOLVE (MG/L AS SO4)	48	10.000	0.700	3.737	7.275	4.825	3.300	2.500	1.090
00608 NITROGEN AMMONIA (MG/L AS N)	87	0.190	--	0.036*	*0.128	*0.050	*0.020	*0.009	*0.004
00625 NITROGEN AMM+ORG (MG/L AS N)	49	1.300	--	0.347*	*0.890	*0.450	*0.280	*0.147	*0.067
00610 NITROGEN AMMONIA (MG/L AS N)	81	3.600	--	0.079*	*0.159	*0.055	*0.020	*0.006	*0.002
00618 NITROGEN NITRATE (MG/L AS N)	94	2.300	0.000	0.135	0.273	0.153	0.100	0.050	0.010
71851 NITR. NO3 AS NO3 MG/L AS NO3	103	10.000	0.000	0.566	1.200	0.660	0.400	0.200	0.044
00631 NO2 + NO3 DISSOL (MG/L AS N)	138	2.300	--	0.111*	*0.261	*0.132	*0.080	*0.031	*0.010
00613 NITROGEN,NITRITE MG/L AS N	147	0.060	--	0.007*	*0.020	*0.010	*0.005	*0.003	*0.001
00666 PHOSPHORUS DISS. (MG/L AS P)	47	0.140	--	0.013*	*0.060	*0.011	*0.005	*0.002	*0.000
00671 PHOSPHORUS ORTHO (MG/L AS P)	33	0.030	--	0.005*	*0.020	*0.007	*0.003	*0.001	*0.001
00665 PHOSPHORUS TOTAL (MG/L AS P)	126	2.300	--	0.139*	*0.747	*0.082	*0.020	*0.009	*0.001
31625 COLIFORM FECAL 0 COLS./100 ML	71	14.000	--	0.889*	*2.400	*1.000	*0.353	*0.148	*0.042
70953 CHL-A PHY CHROMA UG/L	31	6.500	0.200	2.242	5.780	2.700	1.900	1.100	0.380
70954 CHLOROPHYLL-B, P UG/L	31	0.400	--	0.056*	*0.280	*0.063	*0.025	*0.010	*0.003
01005 BARIUM DISSOLVED (UG/L AS BA)	32	28.400	14.800	18.444	25.540	19.750	18.000	16.725	15.385
01010 BERYLLIUM DISSOL (UG/L AS BE)	32	--	--	--	--	--	--	--	--
01020 BORON DISSOLVED (UG/L AS B)	33	360.000	--	13.657*	*122.000	*4.581	*0.916	*0.255	*0.044
01025 CADMIUM DISSOLVE (UG/L AS CD)	32	--	--	--	--	--	--	--	--
01030 CHROMIUM DISSOLV (UG/L AS CR)	32	--	--	--	--	--	--	--	--
01035 COBALT DISSOLVED (UG/L AS CO)	32	--	--	--	--	--	--	--	--
01040 COPPER DISSOLVED (UG/L AS CU)	32	--	--	--	--	--	--	--	--
01046 IRON DISSOLVED (UG/L AS FE)	50	110.000	--	25.214*	*74.500	*40.000	*11.812	*7.367	*2.805
01049 LEAD DISSOLVED (UG/L AS PB)	32	--	--	--	--	--	--	--	--
01130 LITHIUM DISSOLVE (UG/L AS LI)	32	--	--	--	--	--	--	--	--
01056 MANGANESE DISSOL (UG/L AS MN)	50	20.000	--	2.441*	*7.900	*3.000	*1.852	*0.780	*0.303
01055 MANGANESE TOTAL (UG/L AS MN)	19	20.000	--	5.305*	*20.000	*6.704	*3.966	*2.025	*0.982
01060 MOLYBDENUM DISSO (UG/L AS MO)	32	--	--	--	--	--	--	--	--
01065 NICKEL DISSOLVED (UG/L AS NI)	32	--	--	--	--	--	--	--	--
01075 SILVER DISSOLVED (UG/L AS AG)	32	--	--	--	--	--	--	--	--
01080 STRONTIUM DISSOL (UG/L AS SR)	32	53.000	26.500	38.469	51.050	43.000	38.500	32.275	27.475
01085 VANADIUM DISSOLV (UG/L AS V)	32	--	--	--	--	--	--	--	--
01090 ZINC DISSOLVED (UG/L AS ZN)	32	16.000	--	4.657*	*14.050	*7.500	*3.000	*1.654	*0.672

* - VALUE IS ESTIMATED BY USING A LOG-PROBABILITY REGRESSION TO PREDICT THE VALUES OF DATA BELOW THE DETECTION LIMIT (Helsel and Cohn, 1988)

Table 18. Summary statistics for site 9, Horsetooth Reservoir (Soldier Canyon Dam), sampled near bottom.

STATISTICAL SUMMARY OF SELECTED WATER QUALITY DATA COLLECTED FROM SEPT 1969 TO AUG 1999

WATER-QUALITY CONSTITUENT		SAMPLE SIZE	DESCRIPTIVE STATISTICS: MAXIMUM	MINIMUM	MEAN	PERCENT OF SAMPLES IN WHICH VALUES WERE LESS THAN OR EQUAL TO THOSE SHOWN: 95 %	75 %	(MEDIAN) 50 %	25 %	5 %
70300 RESIDUE DIS 180C	MG/L	111	81.000	10.000	48.135	67.400	53.000	48.000	43.000	33.800
70301 DISSOLVED SOLIDS	MG/L	33	47.100	32.500	39.152	46.330	41.450	39.200	36.550	32.640
00077 TRANSPARENCY (IN	(INCHES)	1	48.000	--	--	--	--	--	--	--
00300 OXYGEN DISSOLVED	(MG/L)	125	12.600	0.000	7.227	10.700	9.150	7.500	5.900	1.600
00400 PH, WH, FIELD	(STANDARD UNIT	109	8.500	5.800	7.213	7.800	7.600	7.200	6.900	6.350
00403 PH, WH, LABORATO	(STANDARD UNIT	42	8.300	6.700	7.457	8.200	7.700	7.500	7.200	6.915
90095 SPECIFIC CONDUCT	MICROSIEMENS/C	42	80.000	57.000	69.405	79.700	74.000	70.000	64.750	59.000
00095 SPECIFIC CONDUCT	US/CM @ 25C	120	140.000	50.000	72.800	87.850	78.000	73.000	69.000	54.000
00010 WATER TEMPERATUR	(DEGREES C)	147	25.000	2.000	7.435	12.500	9.000	7.000	6.000	3.000
00900 HARDNESS TOTAL	(MG/L AS CAO3)	38	34.900	23.100	28.550	34.140	30.675	28.600	26.550	23.290
00915 CALCIUM DISSOLVE	(MG/L AS CA)	38	11.000	6.400	8.869	10.050	9.625	8.950	8.312	7.169
00925 MAGNESIUM DISSOL	(MG/L AS MG)	38	4.600	1.180	1.541	1.845	1.600	1.500	1.400	1.209
00935 POTASSIUM DISSOL	(MG/L AS K)	35	0.900	0.460	0.681	0.820	0.700	0.700	0.600	0.492
00931 SODIUM ADSORPTIO	(RATIO)	35	0.300	0.169	0.193	0.230	0.196	0.190	0.185	0.170
00930 SODIUM DISSOLVED	(MG/L AS NA)	35	3.400	2.000	2.349	2.840	2.500	2.300	2.200	2.000
00932 SODIUM, PERCENT	PERCENT	35	20.000	13.500	14.926	17.040	15.200	14.700	14.400	13.740
90410 ANC, TIT. 4.5, L	MG/L AS CACO3	36	37.000	25.000	29.611	35.300	32.000	29.000	27.250	25.000
00940 CHLORIDE DISSOLV	(MG/L AS CL)	33	1.300	0.200	0.706	1.300	0.900	0.700	0.450	0.200
00950 FLUORIDE DISSOLV	(MG/L AS F)	37	0.200	--	0.117*	*0.200	*0.100	*0.100	*0.100	*0.064
00955 SILICA DISSOLVED	(MG/L AS SIO2)	39	4.800	0.600	3.308	4.700	4.200	3.600	2.600	1.100
00945 SULFATE DISSOLVE	(MG/L AS SO4)	33	5.900	1.900	3.388	5.550	4.000	3.200	2.750	2.040
00608 NITROGEN AMMONIA	(MG/L AS N)	72	1.200	--	0.055*	*0.154	*0.050	*0.030	*0.010	*0.004
00625 NITROGEN AMM+ORG	(MG/L AS N)	38	1.000	--	0.244*	*0.810	*0.300	*0.194	*0.141	*0.075
00610 NITROGEN AMMONIA	(MG/L AS N)	57	0.160	--	0.031*	*0.083	*0.040	*0.030	*0.010	*0.005
00618 NITROGEN NITRATE	(MG/L AS N)	66	0.310	0.020	0.125	0.276	0.153	0.120	0.088	0.040
71851 NITR. NO3 AS NO3	MG/L AS NO3	76	1.400	0.089	0.525	1.130	0.660	0.500	0.320	0.172
00631 NO2 + NO3 DISSOL	(MG/L AS N)	100	0.320	--	0.117*	*0.220	*0.155	*0.110	*0.063	*0.028
00613 NITROGEN,NITRITE	MG/L AS N	113	0.070	--	0.004*	*0.010	*0.004	*0.002	*0.001	*0.000
00666 PHOSPHORUS DISS.	(MG/L AS P)	36	0.030	--	0.007*	*0.022	*0.010	*0.005	*0.003	*0.001
00671 PHOSPHORUS ORTHO	(MG/L AS P)	33	0.030	--	0.008*	*0.030	*0.010	*0.004	*0.002	*0.001
00665 PHOSPHORUS TOTAL	(MG/L AS P)	98	1.500	--	0.106*	*0.943	*0.050	*0.030	*0.010	*0.003
31625 COLIFORM FECAL 0	COLS./100 ML	11	--	--	--	--	--	--	--	--
01005 BARIUM DISSOLVED	(UG/L AS BA)	32	21.000	3.000	16.556	19.895	18.000	17.000	16.000	9.500
01010 BERYLLIUM DISSOL	(UG/L AS BE)	32	--	--	--	--	--	--	--	--
01020 BORON DISSOLVED	(UG/L AS B)	32	20.000	--	6.136*	*15.202	*7.985	*5.088	*3.697	*2.143
01025 CADMIUM DISSOLVE	(UG/L AS CD)	32	--	--	--	--	--	--	--	--
01030 CHROMIUM DISSOLV	(UG/L AS CR)	32	--	--	--	--	--	--	--	--
01035 COBALT DISSOLVED	(UG/L AS CO)	32	--	--	--	--	--	--	--	--
01040 COPPER DISSOLVED	(UG/L AS CU)	32	--	--	--	--	--	--	--	--
01046 IRON DISSOLVED	(UG/L AS FE)	39	80.000	--	22.618*	*70.000	*30.000	*20.000	*7.898	*3.717
01049 LEAD DISSOLVED	(UG/L AS PB)	32	--	--	--	--	--	--	--	--
01130 LITHIUM DISSOLVE	(UG/L AS LI)	32	--	--	--	--	--	--	--	--
01056 MANGANESE DISSOL	(UG/L AS MN)	39	210.000	--	21.523*	*140.000	*14.000	*2.000	*1.000	*0.100
01055 MANGANESE TOTAL	(UG/L AS MN)	14	38.000	--	8.933*	*38.000	*10.000	*6.379	*4.832	*2.694
01060 MOLYBDENUM DISSO	(UG/L AS MO)	32	--	--	--	--	--	--	--	--
01065 NICKEL DISSOLVED	(UG/L AS NI)	32	--	--	--	--	--	--	--	--
01075 SILVER DISSOLVED	(UG/L AS AG)	32	--	--	--	--	--	--	--	--
01080 STRONTIUM DISSOL	(UG/L AS SR)	32	50.000	31.600	40.409	48.700	45.000	40.500	35.700	31.600
01085 VANADIUM DISSOLV	(UG/L AS V)	32	--	--	--	--	--	--	--	--
01090 ZINC DISSOLVED	(UG/L AS ZN)	32	17.000	--	5.181*	*13.750	*6.750	*4.582	*2.471	*1.234

* - VALUE IS ESTIMATED BY USING A LOG-PROBABILITY REGRESSION TO PREDICT THE VALUES OF DATA BELOW THE DETECTION LIMIT (Helsel and Cohn, 1988)

Table 19. Summary statistics for site 10, Horsetooth Reservoir (Spring Canyon Dam), sampled at surface.

STATISTICAL SUMMARY OF SELECTED WATER QUALITY DATA COLLECTED FROM MAY 1983 TO OCT 2000

WATER-QUALITY CONSTITUENT	SAMPLE SIZE	DESCRIPTIVE STATISTICS: MAXIMUM	MINIMUM	MEAN	PERCENT OF SAMPLES IN WHICH VALUES WERE LESS THAN OR EQUAL TO THOSE SHOWN: 95 %	75 %	(MEDIAN) 50 %	25 %	5 %
70300 RESIDUE DIS 180C MG/L	37	70.000	20.000	40.243	53.800	45.000	40.000	34.000	25.400
70301 DISSOLVED SOLIDS MG/L	35	63.000	27.800	37.791	50.120	39.900	37.700	34.700	28.680
00077 TRANSPARENCY (IN (INCHES)	40	144.000	30.000	82.525	128.700	107.500	81.000	60.000	36.150
00300 OXYGEN DISSOLVED (MG/L)	49	11.000	6.000	7.884	10.150	8.600	7.600	7.100	6.650
00400 PH, WH, FIELD (STANDARD UNIT	50	8.500	6.700	7.710	8.345	7.925	7.650	7.500	7.255
00403 PH, WH, LABORATO (STANDARD UNIT	45	8.200	7.200	7.689	8.170	7.900	7.700	7.500	7.200
90095 SPECIFIC CONDUCT MICROSIEMENS/C	45	115.000	51.000	68.378	83.700	73.500	68.000	63.000	52.200
00095 SPECIFIC CONDUCT US/CM @ 25C	50	108.000	49.000	66.440	85.250	71.000	66.000	59.000	49.550
00010 WATER TEMPERATUR (DEGREES C)	48	24.000	6.000	16.562	22.510	20.850	16.650	13.500	7.275
00900 HARDNESS TOTAL (MG/L AS CAO3)	40	44.600	19.100	27.812	31.800	29.675	28.150	25.700	20.270
00915 CALCIUM DISSOLVE (MG/L AS CA)	40	13.600	6.000	8.778	10.095	9.475	8.960	8.150	6.371
00925 MAGNESIUM DISSOL (MG/L AS MG)	40	2.580	1.000	1.420	1.885	1.500	1.400	1.300	1.043
00935 POTASSIUM DISSOL (MG/L AS K)	38	0.900	0.500	0.663	0.900	0.700	0.650	0.600	0.519
00931 SODIUM ADSORPTIO (RATIO)	38	0.239	0.165	0.193	0.214	0.203	0.192	0.183	0.170
00930 SODIUM DISSOLVED (MG/L AS NA)	38	3.100	1.800	2.326	2.910	2.500	2.400	2.100	1.895
00932 SODIUM, PERCENT PERCENT	38	17.100	12.300	15.200	17.005	16.125	15.250	14.375	13.440
90410 ANC, TIT. 4.5, L MG/L AS CACO3	40	40.000	21.000	29.025	38.750	31.000	29.000	27.000	22.050
00940 CHLORIDE DISSOLV (MG/L AS CL)	35	2.900	0.200	0.871	2.020	1.100	0.800	0.500	0.200
00950 FLUORIDE DISSOLV (MG/L AS F)	40	0.200	--	0.128*	*0.200	*0.200	*0.100	*0.100	*0.062
00955 SILICA DISSOLVED (MG/L AS SIO2)	42	5.800	0.800	2.862	4.985	3.825	2.750	1.750	1.030
00945 SULFATE DISSOLVE (MG/L AS SO4)	35	12.600	2.100	3.586	7.000	4.000	3.200	2.800	2.180
00608 NITROGEN AMMONIA (MG/L AS N)	42	0.090	--	0.021*	*0.083	*0.030	*0.013	*0.007	*0.003
00625 NITROGEN AMM+ORG (MG/L AS N)	42	1.000	--	0.252*	*0.600	*0.300	*0.200	*0.138	*0.078
00610 NITROGEN AMMONIA (MG/L AS N)	16	0.050	--	0.016*	*0.050	*0.020	*0.009	*0.004	*0.001
00631 NO2 + NO3 DISSOL (MG/L AS N)	41	0.160	--	0.024*	*0.110	*0.022	*0.008	*0.003	*0.001
00630 NO2 + NO3 TOTAL (MG/L AS N)	6	--	--	--	--	--	--	--	--
00613 NITROGEN,NITRITE MG/L AS N	43	--	--	--	--	--	--	--	--
00666 PHOSPHORUS DISS. (MG/L AS P)	40	0.020	--	0.005*	*0.010	*0.006	*0.004	*0.002	*0.001
00671 PHOSPHORUS ORTHO (MG/L AS P)	36	0.020	--	0.004*	*0.017	*0.005	*0.003	*0.002	*0.001
00665 PHOSPHORUS TOTAL (MG/L AS P)	40	0.050	--	0.010*	*0.025	*0.010	*0.008	*0.005	*0.003
00680 CARBON ORGANIC T (MG/L AS C)	9	5.400	2.900	4.078	5.400	4.800	4.000	3.350	2.900
31625 COLIFORM FECAL 0 COLS./100 ML	34	12.000	--	1.879*	*9.750	*2.000	*1.000	*0.357	*0.102
70953 CHL-A PHY CHROMA UG/L	35	14.000	0.200	2.657	8.160	3.100	2.100	1.500	0.440
70954 CHLOROPHYLL-B, P UG/L	35	0.200	--	0.073*	*0.200	*0.100	*0.060	*0.040	*0.021
01005 BARIUM DISSOLVED (UG/L AS BA)	36	30.400	14.000	19.011	29.125	20.950	18.400	16.175	14.000
01010 BERYLLIUM DISSOL (UG/L AS BE)	36	--	--	--	--	--	--	--	--
01020 BORON DISSOLVED (UG/L AS B)	36	14.000	--	6.290*	*11.450	*7.959	*5.815	*4.365	*3.133
01025 CADMIUM DISSOLVE (UG/L AS CD)	36	5.000	--	0.362*	*2.450	*0.268	*0.072	*0.018	*0.003
01030 CHROMIUM DISSOLV (UG/L AS CR)	36	--	--	--	--	--	--	--	--
01035 COBALT DISSOLVED (UG/L AS CO)	36	--	--	--	--	--	--	--	--
01040 COPPER DISSOLVED (UG/L AS CU)	36	--	--	--	--	--	--	--	--
01046 IRON DISSOLVED (UG/L AS FE)	42	80.000	--	20.820*	*70.000	*30.000	*10.000	*5.478	*2.057
01049 LEAD DISSOLVED (UG/L AS PB)	36	--	--	--	--	--	--	--	--
01130 LITHIUM DISSOLVE (UG/L AS LI)	36	--	--	--	--	--	--	--	--
01056 MANGANESE DISSOL (UG/L AS MN)	42	209.000	--	8.089*	*41.330	*3.000	*1.902	*0.445	*0.100
01055 MANGANESE TOTAL (UG/L AS MN)	18	208.000	--	23.233*	*208.000	*14.000	*7.346	*3.776	*1.179
01060 MOLYBDENUM DISSO (UG/L AS MO)	36	--	--	--	--	--	--	--	--
01065 NICKEL DISSOLVED (UG/L AS NI)	36	--	--	--	--	--	--	--	--
01075 SILVER DISSOLVED (UG/L AS AG)	36	--	--	--	--	--	--	--	--
01080 STRONTIUM DISSOL (UG/L AS SR)	36	68.500	26.600	38.875	52.775	43.000	38.000	33.800	27.790
01085 VANADIUM DISSOLV (UG/L AS V)	36	--	--	--	--	--	--	--	--
01090 ZINC DISSOLVED (UG/L AS ZN)	36	30.000	--	5.381*	*29.200	*5.000	*2.208	*0.897	*0.316

* - VALUE IS ESTIMATED BY USING A LOG-PROBABILITY REGRESSION TO PREDICT THE VALUES OF DATA BELOW THE DETECTION LIMIT (Helsel and Cohn, 1988)

Table 20. Summary statistics for site 10, Horsetooth Reservoir (Spring Canyon Dam), sampled near bottom.

STATISTICAL SUMMARY OF SELECTED WATER QUALITY DATA COLLECTED FROM MAY 1983 TO OCT 2000

WATER-QUALITY CONSTITUENT		SAMPLE SIZE	DESCRIPTIVE STATISTICS MAXIMUM	MINIMUM	MEAN	PERCENT OF SAMPLES IN WHICH VALUES WERE LESS THAN OR EQUAL TO THOSE SHOWN 95 %	75 %	(MEDIAN) 50 %	25 %	5 %
70300 RESIDUE DIS 180C	MG/L	38	66.000	17.000	42.237	59.350	47.250	42.000	38.000	27.450
70301 DISSOLVED SOLIDS	MG/L	34	58.000	30.700	40.118	50.275	41.800	40.200	37.900	32.350
00300 OXYGEN DISSOLVED	(MG/L)	49	10.800	0.000	5.178	9.850	7.950	5.200	2.500	0.100
00400 PH, WH, FIELD	(STANDARD UNIT	50	7.900	6.000	7.262	7.700	7.500	7.300	7.100	6.710
00403 PH, WH, LABORATO	(STANDARD UNIT	45	8.200	6.600	7.382	8.140	7.600	7.400	7.100	6.800
90095 SPECIFIC CONDUCT	MICROSIEMENS/C	45	103.000	53.000	71.733	82.700	76.500	72.000	67.500	54.500
00095 SPECIFIC CONDUCT	US/CM @ 25C	50	102.000	48.000	69.400	87.450	76.250	70.000	61.000	54.000
00010 WATER TEMPERATUR	(DEGREES C)	48	21.500	5.000	7.831	11.365	8.375	7.450	6.925	5.470
00900 HARDNESS TOTAL	(MG/L AS CAO3)	39	40.100	20.400	29.197	34.900	31.600	29.100	27.100	22.600
00915 CALCIUM DISSOLVE	(MG/L AS CA)	39	12.300	6.300	9.186	11.000	10.000	9.100	8.500	7.090
00925 MAGNESIUM DISSOL	(MG/L AS MG)	39	2.240	1.120	1.506	1.800	1.600	1.500	1.400	1.180
00935 POTASSIUM DISSOL	(MG/L AS K)	36	0.800	0.560	0.681	0.800	0.718	0.700	0.600	0.568
00931 SODIUM ADSORPTIO	(RATIO)	36	0.216	0.170	0.190	0.210	0.199	0.192	0.181	0.170
00930 SODIUM DISSOLVED	(MG/L AS NA)	36	2.800	1.900	2.353	2.715	2.500	2.300	2.200	1.900
00932 SODIUM, PERCENT	PERCENT	36	16.700	13.100	14.692	16.615	15.375	14.700	13.800	13.185
90410 ANC, TIT. 4.5, L	MG/L AS CACO3	39	42.000	23.000	29.974	35.000	32.000	30.000	28.000	24.000
00940 CHLORIDE DISSOLV	(MG/L AS CL)	34	1.700	0.200	0.762	1.625	1.000	0.700	0.475	0.200
00950 FLUORIDE DISSOLV	(MG/L AS F)	40	0.200	--	0.129*	*0.200	*0.200	*0.100	*0.100	*0.066
00955 SILICA DISSOLVED	(MG/L AS SIO2)	42	5.700	0.900	3.624	5.470	4.500	3.850	2.775	1.215
00945 SULFATE DISSOLVE	(MG/L AS SO4)	34	5.100	2.500	3.285	4.575	3.925	3.200	2.775	2.500
00608 NITROGEN AMMONIA	(MG/L AS N)	41	0.165	--	0.035*	*0.084	*0.050	*0.020	*0.010	*0.006
00625 NITROGEN AMM+ORG	(MG/L AS N)	42	0.700	--	0.242*	*0.500	*0.300	*0.200	*0.148	*0.093
00610 NITROGEN AMMONIA	(MG/L AS N)	17	0.060	--	0.038*	*0.060	*0.050	*0.040	*0.028	*0.020
00631 NO2 + NO3 DISSOL	(MG/L AS N)	40	0.230	--	0.113*	*0.216	*0.180	*0.102	*0.052	*0.025
00630 NO2 + NO3 TOTAL	(MG/L AS N)	6	--	--	--	--	--	--	--	--
00613 NITROGEN,NITRITE	MG/L AS N	42	0.060	--	0.004*	*0.010	*0.004	*0.002	*0.001	*0.000
00666 PHOSPHORUS DISS.	(MG/L AS P)	40	0.040	--	0.013*	*0.039	*0.020	*0.008	*0.004	*0.002
00671 PHOSPHORUS ORTHO	(MG/L AS P)	36	0.040	--	0.011*	*0.034	*0.019	*0.007	*0.004	*0.001
00665 PHOSPHORUS TOTAL	(MG/L AS P)	41	0.096	--	0.022*	*0.057	*0.030	*0.020	*0.008	*0.003
00680 CARBON ORGANIC T	(MG/L AS C)	9	5.200	3.200	3.956	5.200	4.600	3.700	3.350	3.200
01005 BARIUM DISSOLVED	(UG/L AS BA)	36	30.100	13.000	17.336	23.045	18.000	17.400	16.000	13.850
01010 BERYLLIUM DISSOL	(UG/L AS BE)	36	--	--	--	--	--	--	--	--
01020 BORON DISSOLVED	(UG/L AS B)	36	20.000	--	6.469*	*11.970	*8.000	*5.978	*4.130	*2.984
01025 CADMIUM DISSOLVE	(UG/L AS CD)	36	--	--	--	--	--	--	--	--
01030 CHROMIUM DISSOLV	(UG/L AS CR)	36	--	--	--	--	--	--	--	--
01035 COBALT DISSOLVED	(UG/L AS CO)	36	--	--	--	--	--	--	--	--
01040 COPPER DISSOLVED	(UG/L AS CU)	36	--	--	--	--	--	--	--	--
01046 IRON DISSOLVED	(UG/L AS FE)	42	140.000	0.000	25.548	78.500	30.000	20.000	10.000	0.450
01049 LEAD DISSOLVED	(UG/L AS PB)	36	--	--	--	--	--	--	--	--
01130 LITHIUM DISSOLVE	(UG/L AS LI)	36	--	--	--	--	--	--	--	--
01056 MANGANESE DISSOL	(UG/L AS MN)	41	685.000	--	80.164*	*590.000	*72.000	*7.000	*2.000	*0.172
01055 MANGANESE TOTAL	(UG/L AS MN)	18	684.000	--	75.913*	*684.000	*40.750	*19.000	*9.500	*2.214
01060 MOLYBDENUM DISSO	(UG/L AS MO)	36	--	--	--	--	--	--	--	--
01065 NICKEL DISSOLVED	(UG/L AS NI)	36	--	--	--	--	--	--	--	--
01075 SILVER DISSOLVED	(UG/L AS AG)	36	--	--	--	--	--	--	--	--
01080 STRONTIUM DISSOL	(UG/L AS SR)	36	59.300	27.300	41.342	52.245	45.750	40.500	37.000	30.785
01085 VANADIUM DISSOLV	(UG/L AS V)	36	--	--	--	--	--	--	--	--
01090 ZINC DISSOLVED	(UG/L AS ZN)	36	42.000	--	5.786*	*26.800	*7.000	*3.001	*1.457	*0.520

* - VALUE IS ESTIMATED BY USING A LOG-PROBABILITY REGRESSION TO PREDICT THE VALUES OF DATA BELOW THE DETECTION LIMIT (Helsel and Cohn, 1988)

Table 21. Trend analysis results for site 1, Granby Reservoir, near dam, surface samples.

[0, no trend; (+), upward trend; (–), downward trend; significance: *, greater than 90 percent; **, greater than 95 percent; ***, greater than 99 percent; change is percent change in median since the first year of record; A, no trend computation because nondetects greater than 50 percent; B, no slope computation because nondetects greater than 20 percent; mg/L, milligrams per liter; µS/cm, microsiemens per centimeter at 25 degrees Celsius; °C, degree Celsius; in., inch; mL, milliliter; hplc, high-performance liquid chromatography; µg/L, micrograms per liter]

Seasonal Kendall season-edited data	Number	Censored	Percentage censored	Period record (years)	*p*-value	Slope	Median	Significance	Change
Oxygen, dissolved (mg/L)	46	0	0	11	0.0383	–0.05001	7.5	(–)**	–7.1
pH, field (standard units)	46	0	0	11	0.1719	–0.02519	7.9	0	–3.4
Specific conductance (µS/cm at 25°C)	46	0	0	11	0.0000	–1.768	54	(–)***	–30.1
Water temperature (°C)	46	0	0	11	0.7760	–0.02014	15.2	0	–1.4
Hardness, total (mg/L as $CaCO_3$)	45	0	0	11	0.0000	–0.5543	22	(–)***	–24.1
Calcium, dissolved (mg/L)	45	0	0	11	0.0000	–0.1662	6.85	(–)***	–23.3
Magnesium, dissolved (mg/L)	45	0	0	11	0.0000	–0.03141	1.2	(–)***	–24.9
Potassium, dissolved (mg/L)	45	0	0	11	0.0000	–0.0125	0.7	(–)***	–17.7
Sodium adsorption (ratio)	45	0	0	11	1.0000	0	0.2	0	0.0
Sodium, dissolved (mg/L)	45	0	0	11	0.0000	–0.08776	2.2	(–)***	–35.4
Sodium (percent)	45	0	0	11	0.0000	–0.2004	16	(–)***	–12.8
Acid-neutralizing capacity (mg/L)	45	0	0	11	0.0000	–0.4997	24	(–)***	–20.4
Chloride, dissolved (mg/L)	45	0	0	11	0.0554	0	0.4	0	0.0
Fluoride, dissolved (mg/L)	45	9	20	11	0.0374	0	0.1	0	B
Silica, dissolved (mg/L)	45	0	0	11	1.7247	0.04281	4.85	0	10.3
Sulfate, dissolved (mg/L)	45	0	0	11	0.0000	–0.1189	2.95	(–)***	–35.7
Nitrogen, ammonia plus organic (mg/L as N)	45	13	29	11	0.0024	0	0.3	0	B
Nitrogen, ammonia (mg/L as N)	45	32	71	11	A	A	A	A	A
Nitrite plus nitrate (mg/L as N)	45	45	100	11	A	A	A	A	A
Nitrogen, nitrite (mg/L as N)	45	43	96	11	A	A	A	A	A
Phosphorus, dissolved (mg/L as P)	39	34	87	11	A	A	A	A	A
Phophorus, ortho, dissolved (mg/L as P)	45	41	91	11	A	A	A	A	A
Phosphorus, total (mg/L as P)	41	25	61	11	A	A	A	A	A
Residue, dissolved at 180°C (mg/L)	44	0	0	11	0.0296	–0.6707	37	(–)**	–18.0
Dissolved solids, sum of constituents (mg/L)	45	0	0	11	0.0000	0.6643	35	(+)***	23.6
Transparency, Secchi disk (in.)	44	0	0	11	0.0002	8.037	122	(+)***	119.8
Coliform, fecal (colonies per 100 mL)	42	30	71	11	A	A	A	A	A
Chlorophyll-*a*, hplc (µg/L)	46	0	0	11	0.0056	–0.2268	2.05	(–)***	–73.1
Chlorophyll-*b*, hplc (µg/L)	45	33	73	11	A	A	A	A	A
Barium, dissolved (µg/L)	45	0	0	11	0.2263	0	8	0	0.0
Iron, dissolved (µg/L)	45	21	47	11	0.0000	B	26	(–)***	B
Manganese, dissolved (µg/L)	39	24	62	11	A	A	A	A	A
Strontium, dissolved (µg/L)	45	0	0	11	0.0000	–1.219	42	(–)***	–27.2
Zinc, dissolved (µg/L)	34	20	59	11	A	A	A	A	A

Table 22. Trend analysis results for site 1, Granby Reservoir, near dam, bottom samples.

[0, no trend; (+), upward trend; (–), downward trend; significance: *, greater than 90 percent; **, greater than 95 percent; ***, greater than 99 percent; change is percent change in median since the first year of record; A, no trend computation because nondetects greater than 50 percent; B, no slope computation because nondetects greater than 20 percent; mg/L, milligrams per liter; µS/cm, microsiemens per centimeter at 25 degrees Celsius; °C, degree Celsius; µg/L, micrograms per liter]

Seasonal Kendall season-edited data	Number	Censored	Percentage censored	Period record (years)	*p*-value	Slope	Median	Significance	Change
Oxygen, dissolved (mg/L)	44	0	0	11	0.0006	0.2182	4.8	(+)***	68.8
pH, field (standard units)	45	0	0	11	0.8224	0	7.1	0	0.0
Specific conductance (µS/cm at 25°C)	45	0	0	11	0.0000	–2.15	55.5	(–)***	–34.6
Water temperature (°C)	45	0	0	11	0.0016	–0.1245	6.5	(–)***	–18.9
Hardness, total (mg/L as $CaCO_3$)	45	0	0	11	0.0000	–0.5513	24	(–)***	–22.2
Calcium, dissolved (mg/L)	45	0	0	11	0.0000	–0.1789	7.3	(–)***	–23.5
Magnesium, dissolved (mg/L)	45	0	0	11	0.0000	–0.0296	1.3	(–)***	–22.0
Potassium, dissolved (mg/L)	45	0	0	11	0.0001	–0.01658	0.7	(–)***	–22.8
Sodium adsorption (ratio)	45	0	0	11	0.4789	0	0.2	0	0.0
Sodium, dissolved (mg/L)	45	0	0	11	0.0000	–0.09787	2.3	(–)***	–37.3
Sodium (percent)	45	0	0	11	0.0000	–0.2008	17	(–)***	–12.1
Acid-neutralizing capacity (mg/L)	45	0	0	11	0.0000	–0.6636	26	(–)***	–24.3
Chloride, dissolved (mg/L)	45	0	0	11	0.5170	0	0.4	0	0.0
Fluoride, dissolved (mg/L)	45	13	29	11	0.0730	B	0.1	0	B
Silica, dissolved (mg/L)	45	0	0	11	0.1085	–0.08068	5.9	0	–13.9
Sulfate, dissolved (mg/L)	45	0	0	11	0.0000	–0.08859	3	(–)***	–27.6
Nitrogen, ammonia plus organic (mg/L as N)	46	24	52	11	A	A	A	A	A
Nitrogen, ammonia (mg/L as N)	45	29	64	11	A	A	A	A	A
Nitrite plus nitrate (mg/L as N)	45	25	56	11	A	A	A	A	A
Nitrogen, nitrite (mg/L as N)	45	42	93	11	A	A	A	A	A
Phosphorus, dissolved (mg/L as P)	39	28	72	11	A	A	A	A	A
Phophorus, ortho, dissolved (mg/L as P)	45	37	82	11	A	A	A	A	A
Phosphorus, total (mg/L as P)	42	15	36	11	0.4151	B	0.02	0	B
Residue, dissolved at 180°C (mg/L)	44	0	0	11	0.3325	–0.377	40	0	–9.8
Dissolved solids, sum of constituents (mg/L)	45	0	0	11	0.0000	–0.9844	38	(–)***	–24.7
Barium, dissolved (µg/L)	45	0	0	11	0.1023	0	8	0	0.0
Iron, dissolved (µg/L)	45	8	18	11	0.0002	B	19.5	(–)***	B
Manganese, dissolved (µg/L)	39	12	31	11	0.0001	B	10	(–)***	B
Strontium, dissolved (µg/L)	45	0	0	11	0.0000	–1.218	46.5	(–)***	–24.9
Zinc, dissolved (µg/L)	34	17	50	8	0.3221	B	8	0	B

Table 23. Trend analysis results for site 2, Granby Reservoir (Rainbow Bay), surface samples.

[0, no trend; (+), upward trend; (–), downward trend; significance: *, greater than 90 percent; **, greater than 95 percent; ***, greater than 99 percent; change is percent change in median since the first year of record; A, no trend computation because nondetects greater than 50 percent; B, no slope computation because nondetects greater than 20 percent; mg/L, milligrams per liter; µS/cm, microsiemens per centimeter at 25 degrees Celsius; °C, degree Celsius; in., inch; mL, milliliter; hplc, high-performance liquid chromatography; µg/L, micrograms per liter]

Seasonal Kendall season-edited data	Number	Censored	Percentage censored	Period record (years)	*p*-value	Slope	Median	Significance	Change
Oxygen, dissolved (mg/L)	45	0	0	11	0.2757	–0.02509	7.4	0	–3.7
pH, field (standard units)	46	0	0	11	0.4714	–0.009972	7.8	0	–1.4
Specific conductance (µS/cm at 25°C)	46	0	0	11	0.0000	–1.838	54.75	(–)***	–30.7
Water temperature (°C)	46	0	0	11	0.7486	0.03633	13.45	0	3.0
Hardness, total (mg/L as $CaCO_3$)	45	0	0	11	0.0000	–0.6377	23	(–)***	–26.1
Calcium, dissolved (mg/L)	45	0	0	11	0.0000	–0.1905	7.1	(–)***	–25.4
Magnesium, dissolved (mg/L)	45	0	0	11	0.0000	–0.02791	1.3	(–)***	–20.9
Potassium, dissolved (mg/L)	45	0	0	11	0.0000	–0.01419	0.7	(–)***	–19.9
Sodium adsorption (ratio)	45	0	0	11	0.0586	0	0.2	0	0.0
Sodium, dissolved (mg/L)	45	0	0	11	0.0000	–0.09753	2.3	(–)***	–37.2
Sodium (percent)	45	0	0	11	0.0000	–0.2013	16	(–)***	–12.9
Acid-neutralizing capacity (mg/L)	45	0	0	11	0.0000	–0.6262	26	(–)***	–23.1
Chloride, dissolved (mg/L)	44	0	0	11	0.1148	0	0.4	0	0.0
Fluoride, dissolved (mg/L)	44	9	20	11	0.4901	B	0.1	0	B
Silica, dissolved (mg/L)	45	0	0	11	0.7990	0.01451	5	0	3.2
Sulfate, dissolved (mg/L)	44	0	0	11	0.0000	–0.1371	2.9	(–)***	–40.5
Nitrogen, ammonia plus organic (mg/L as N)	46	16	35	11	0.0044	0	0.2	0	B
Nitrogen, ammonia (mg/L as N)	45	30	67	11	A	A	A	A	A
Nitrite plus nitrate (mg/L as N)	39	32	82	9	A	A	A	A	A
Nitrogen, nitrite (mg/L as N)	45	42	93	11	A	A	A	A	A
Phosphorus, dissolved (mg/L as P)	35	28	80	9	A	A	A	A	A
Phophorus, ortho, dissolved (mg/L as P)	45	37	82	11	A	A	A	A	A
Phosphorus, total (mg/L as P)	41	18	44	11	0.1100	B	0.02	0	B
Residue, dissolved at 180°C (mg/L)	44	0	0	11	0.1052	–0.6271	38.5	0	–16.3
Dissolved solids, sum of constituents (mg/L)	44	0	0	11	0.0000	–0.8526	36	(–)***	–22.8
Transparency, Secchi disk (in.)	43	0	0	11	0.0009	7.043	113	(+)***	109.5
Coliform, fecal (colonies per 100 mL)	42	25	60	11	A	A	A	A	A
Chlorophyll-*a*, hplc (µg/L)	45	0	0	11	0.0059	–0.2487	1.8	(–)***	–83.1
Chlorophyll-*b*, hplc (µg/L)	44	34	77	11	A	A	A	A	A
Barium, dissolved (µg/L)	45	0	0	11	0.0036	0	8	0	0.0
Iron, dissolved (µg/L)	35	2	6	9	0.0000	B	20	(–)***	B
Manganese, dissolved (µg/L)	34	15	44	8	0.0010	B	4	(–)***	B
Strontium, dissolved (µg/L)	45	0	0	11	0.0000	–1.19	44	(–)***	–25.6
Zinc, dissolved (µg/L)	34	18	53	8	A	A	A	A	A

Table 24. Trend analysis results for site 2, Granby Reservoir (Rainbow Bay), bottom samples.

[0, no trend; (+), upward trend; (–), downward trend; significance: *, greater than 90 percent; **, greater than 95 percent; ***, greater than 99 percent; change is percent change in median since the first year of record; A, no trend computation because nondetects greater than 50 percent; B, no slope computation because nondetects greater than 20 percent; mg/L, milligrams per liter; µS/cm, microsiemens per centimeter at 25 degrees Celsius; °C, degree Celsius; µg/L, micrograms per liter]

Seasonal Kendall season-edited data	Number	Censored	Percentage censored	Period record (years)	*p*-value	Slope	Median	Significance	Change
Oxygen, dissolved (mg/L)	45	0	0	11	0.0878	–0.1285	5.1	(–)*	–24.1
pH, field (standard units)	46	0	0	11	0.0433	–0.03346	7.4	(–)**	–4.8
Specific conductance (µS/cm at 25°C)	46	0	0	11	0.0000	–2.02	54.5	(–)***	–33.4
Water temperature (°C)	46	0	0	11	0.0000	–0.6136	8.35	(–)***	–56.1
Hardness, total (mg/L as $CaCO_3$)	45	0	0	11	0.0000	–0.5703	23	(–)***	–23.7
Calcium, dissolved (mg/L)	45	0	0	11	0.0000	–0.1956	7	(–)***	–26.3
Magnesium, dissolved (mg/L)	45	0	0	11	0.0000	–0.03258	1.3	(–)***	–24.0
Potassium, dissolved (mg/L)	45	0	0	11	0.0009	–0.01109	0.7	(–)***	–15.9
Sodium adsorption (ratio)	45	0	0	11	0.1164	0	0.2	0	0.0
Sodium, dissolved (mg/L)	45	0	0	11	0.0000	–0.08457	2.3	(–)***	–33.1
Sodium (percent)	45	0	0	11	0.0001	–0.1677	16	(–)***	–10.8
Acid-neutralizing capacity (mg/L)	45	0	0	11	0.0000	–0.5325	25	(–)***	–20.8
Chloride, dissolved (mg/L)	44	0	0	11	0.1621	0	0.4	0	0.0
Fluoride, dissolved (mg/L)	44	12	27	11	0.0884	0	0.100	0	B
Silica, dissolved (mg/L)	45	0	0	11	0.7429	–0.01608	5.6	0	–3.1
Sulfate, dissolved (mg/L)	44	0	0	11	0.0000	–0.09972	2.900	(–)***	–31.4
Nitrogen, ammonia plus organic (mg/L as N)	45	18	40	11	0.0067	0	0.2	0	B
Nitrogen, ammonia (mg/L as N)	45	26	58	11	A	A	A	A	A
Nitrite plus nitrate (mg/L as N)	40	28	70	11	A	A	A	A	A
Nitrogen, nitrite (mg/L as N)	45	43	96	11	A	A	A	A	A
Phosphorus, dissolved (mg/L as P)	35	27	77	9	A	A	A	A	A
Phophorus, ortho, dissolved (mg/L as P)	45	38	84	11	A	A	A	A	A
Phosphorus, total (mg/L as P)	40	13	33	11	0.6043	B	0.02	0	B
Residue, dissolved at 80°C (mg/L)	44	0	0	11	0.0897	–0.7479	39	(–)*	–18.9
Dissolved solids, sum of constituents (mg/L)	44	0	0	11	0.0000	–0.7537	36	(–)***	–20.5
Barium, dissolved (µg/L)	45	0	0	11	0.0007	0	8	0	0.0
Iron, dissolved (µg/L)	45	3	7	11	0.0002	B	15	(–)***	B
Manganese, dissolved (µg/L)	45	12	27	11	0.0076	B	7	(–)***	B
Strontium, dissolved (µg/L)	45	1	2	11	0.0000	–1.151	44	(–)***	–24.9
Zinc, dissolved (µg/L)	46	26	57	11	A	A	A	A	A

Table 25. Trend analysis results for site 3, Granby Pump Canal, samples.

[0, no trend; (+), upward trend; (–), downward trend; significance: *, greater than 90 percent; **, greater than 95 percent; ***, greater than 99 percent; change is percent change in median since the first year of record; A, no trend computation because nondetects greater than 50 percent; B, no slope computation because nondetects greater than 20 percent; mg/L, milligrams per liter; µS/cm, microsiemens per centimeter at 25 degrees Celsius; °C, degree Celsius; µg/L, micrograms per liter]

Seasonal Kendall season-edited data	Number	Censored	Percentage censored	Period record (years)	*p*-value	Slope	Median	Significance	Change
Oxygen, dissolved (mg/L)	170	0	0	30	0.3610	0.0133	7.55	0	5.4
pH, field (standard units)	173	0	0	30	0.0004	0.01736	7.3	(+)***	7.4
Specific conductance (µS/cm at 25°C)	179	0	0	30	0.0001	–0.2482	60	(–)***	–11.7
Water temperature (°C)	180	0	0	30	0.0577	0.01998	4.1	(+)*	15.8
Hardness, total (mg/L as $CaCO_3$)	56	0	0	11	0.0000	–0.5282	24	(–)***	–21.4
Calcium, dissolved (mg/L)	56	0	0	11	0.0000	–0.176	7.4	(–)***	–22.9
Magnesium, dissolved (mg/L)	56	0	0	11	0.0000	–0.02449	1.3	(–)***	–18.6
Potassium, dissolved (mg/L)	56	0	0	11	0.0000	–0.01649	0.7	(–)***	–22.7
Sodium adsorption (ratio)	56	0	0	11	1.0000	0	0.2	0	0.0
Sodium, dissolved (mg/L)	56	0	0	11	0.0000	–0.08641	2.3	(–)***	–33.7
Sodium (percent)	56	0	0	11	0.0000	–0.1822	17	(–)***	–11.1
Acid-neutralizing capacity (mg/L)	56	0	0	11	0.0000	–0.6187	26	(–)***	–22.9
Chloride, dissolved (mg/L)	56	1	2	11	0.0160	–0.01837	0.4	(–)**	–39.6
Fluoride, dissolved (mg/L)	56	10	18	11	0.1912	B	0.1	0	B
Silica, dissolved (mg/L)	56	0	0	11	0.1479	0.06661	5.4	0	14.7
Sulfate, dissolved (mg/L)	56	0	0	11	0.0000	–0.09868	3	(–)***	–30.2
Nitrogen, ammonia plus organic (mg/L as N)	139	27	19	22	0.0000	–0.01652	0.38	(–)***	–63.8
Nitrogen, ammonia (mg/L as N)	53	37	70	11	A	A	A	A	A
Nitrite plus nitrate (mg/L as N)	128	59	46	22	0.0010	B	0.1	(–)***	B
Nitrogen, nitrite (mg/L as N)	55	49	89	11	A	A	A	A	A
Phosphorus, dissolved (mg/L as P)	54	40	74	11	A	A	A	A	A
Phophorus, ortho, dissolved (mg/L as P)	54	40	74	11	A	A	A	A	A
Phosphorus, total (mg/L as P)	134	31	23	22	0.0000	B	0.02	(–)***	B
Residue, dissolved at 180°C (mg/L)	55	0	0	11	0.0502	–0.4758	40	(–)*	–12.2
Dissolved solids, sum of constituents (mg/L)	55	0	0	11	0.0000	–0.745	38	(–)***	–19.3
Barium, dissolved (µg/L)	56	1	2	11	0.4783	0	7	0	0.0
Iron, dissolved (µg/L)	48	3	6	11	0.0032	B	23	(–)***	B
Manganese, dissolved (µg/L)	46	9	20	11	0.0000	B	4	(–)***	B
Strontium, dissolved (µg/L)	56	0	0	11	0.0000	–1.137	45	(–)***	–24.1
Zinc, dissolved (µg/L)	47	19	40	11	0.7031	B	5.5	0	B

Table 26. Trend analysis results for site 4, Shadow Mountain Reservoir, surface samples.

[0, no trend; (+), upward trend; (–), downward trend; significance: *, greater than 90 percent; **, greater than 95 percent; ***, greater than 99 percent; change is percent change in median since the first year of record; A, no trend computation because nondetects greater than 50 percent; B, no slope computation because nondetects greater than 20 percent; mg/L, milligrams per liter; µS/cm, microsiemens per centimeter at 25 degrees Celsius; °C, degree Celsius; in., inch; mL, milliliter; hplc, high-performance liquid chromatography; µg/L, micrograms per liter]

Seasonal Kendall season-edited data	Number	Nondetects	% nondetect	Period record (years)	*p*-value	Slope	Median	Significance	Change
Oxygen, dissolved (mg/L)	35	0	0	11	0.8687865534	0.01429	7.4	0	2.2
pH, field (standard units)	35	0	0	11	0.6171454802	–0.009913	7.6	0	–1.4
Specific conductance (µS/cm at 25°C)	36	0	0	11	0.119470507	–0.5274	49.6	0	–11.0
Water temperature (°C)	--	--	--	--	--	--	--	--	--
Hardness, total (mg/L as $CaCO_3$)	36	0	0	11	0.0898858202	–0.2003	22	(–)*	–9.5
Calcium, dissolved (mg/L)	36	0	0	11	0.0469222566	–0.09798	6.5	(–)**	–15.2
Magnesium, dissolved (mg/L)	36	0	0	11	0.6445834148	0	1.3	0	0.0
Potassium, dissolved (mg/L)	36	0	0	11	0.1453926983	0	0.7	0	0.0
Sodium adsorption (ratio)	36	0	0	11	0.8533074921	0	0.2	0	0.0
Sodium, dissolved (mg/L)	36	0	0	11	0.0005205513	–0.05838	1.9	(–)***	–28.5
Sodium (percent)	36	0	0	11	0.0000174818	–0.2501	16	(–)***	–15.7
Acid-neutralizing capacity (mg/L)	36	0	0	11	0.0690640193	–0.25	23.5	(–)*	–11.0
Chloride, dissolved (mg/L)	35	2	6	11	0.9999999996	B	0.4	0	B
Fluoride, dissolved (mg/L)	35	1	3	11	0.643221044	0	0.1	0	0.0
Silica, dissolved (mg/L)	36	0	0	11	0.0315551014	0.0991	5.55	(+)**	22.0
Sulfate, dissolved (mg/L)	35	0	0	11	0.0018395843	–0.05731	2.8	(–)***	–20.1
Nitrogen, ammonia plus organic (mg/L as N)	36	5	14	11	0.0016781137	B	0.3	(–)***	B
Nitrogen, ammonia (mg/L as N)	36	23	64	11	A	A	A	A	A
Nitrite plus nitrate (mg/L as N)	30	21	70	11	A	A	A	A	A
Nitrogen, nitrite (mg/L as N)	36	33	92	11	A	A	A	A	A
Phosphorus, dissolved (mg/L as P)	27	23	85	11	A	A	A	A	A
Phophorus, ortho, dissolved (mg/L as P)	36	35	97	11	A	A	A	A	A
Phosphorus, total (mg/L as P)	29	11	38	11	0.046261307	0	0.02	0	B
Residue, dissolved at 180°C (mg/L)	35	0	0	11	0.9670087749	0	38	0	0.0
Dissolved solids, sum of constituents (mg/L)	32	0	0	11	0.1267610508	–0.25	34	0	–7.7
Transparency, Secchi disk (in.)	36	1	3	11	0.3826629909	1.415	83	0	20.9
Coliform, fecal (colonies per 100 mL)	33	20	61	11	A	A	A	A	A
Chlorophyll-*a*, hplc (µg/L)	34	1	3	11	0.1967038082	–0.1129	2.25	0	–42.4
Chlorophyll-*b*, hplc (µg/L)	35	27	77	11	A	A	A	A	A
Barium, dissolved (µg/L)	36	1	3	11	0.899098618	0	7	0	0.0
Iron, dissolved (µg/L)	36	1	3	11	0.2332613662	–2.406	56	0	–37.6
Manganese, dissolved (µg/L)	36	6	17	11	0.0091607158	B	4	(–)***	B
Strontium, dissolved (µg/L)	36	1	3	11	0.038358664	–0.6355	38.685	(–)**	–16.5
Zinc, dissolved (µg/L)	27	11	41	11	0.0453922501	0	6	0	B

Table 27. Trend analysis results for site 4, Shadow Mountain Reservoir, bottom samples.

[0, no trend; (+), upward trend; (–), downward trend; significance: *, greater than 90 percent; **, greater than 95 percent; ***, greater than 99 percent; change is percent change in median since the first year of record; A, no trend computation because nondetects greater than 50 percent; B, no slope computation because nondetects greater than 20 percent; mg/L, milligrams per liter; µS/cm, microsiemens per centimeter at 25 degrees Celsius; °C, degree Celsius; µg/L, micrograms per liter]

Seasonal Kendall season-edited data	Number	Censored	Percentage censored	Period record (years)	*p*-value	Slope	Median	Significance	Change
Oxygen, dissolved (mg/L)	35	0	0	11	0.0044134641	0.2693	5.6	(+)***	74.4
pH, field (standard units)	35	0	0	11	0.254286403	0.01232	7.3	0	1.9
Specific conductance (µS/cm at 25°C)	36	0	0	11	0.0003232226	–0.9775	52	(–)***	–18.6
Water temperature (°C)	--	--	--	--	--	--	--	--	
Hardness, total (mg/L as $CaCO_3$)	36	0	0	11	0.0023115152	–0.3278	22	(–)***	–15.0
Calcium, dissolved (mg/L)	36	0	0	11	0.0009600972	–0.12	6.8	(–)***	–17.6
Magnesium, dissolved (mg/L)	36	0	0	11	0.2914253772	0	1.3	0	0.0
Potassium, dissolved (mg/L)	36	0	0	11	0.1815493972	0	0.7	0	0.0
Sodium adsorption (ratio)	36	0	0	11	0.8629658527	0	0.2	0	0.0
Sodium, dissolved (mg/L)	36	0	0	11	0.0000623096	–0.06004	1.9	(–)***	–29.2
Sodium (percent)	36	0	0	11	0.0003709347	–0.2003	16	(–)***	–12.8
Acid-neutralizing capacity (mg/L)	36	0	0	11	0.004847576	–0.2988	24	(–)***	–12.7
Chloride, dissolved (mg/L)	35	1	3	11	0.1113847049	–0.00999	0.4	0	–23.9
Fluoride, dissolved (mg/L)	35	2	6	11	0.9520599211	B	0.1	0	B
Silica, dissolved (mg/L)	36	0	0	11	0.6332197237	–0.01821	6.2	0	–3.2
Sulfate, dissolved (mg/L)	35	0	0	11	0.000936414	–0.07128	2.9	(–)***	–23.6
Nitrogen, ammonia plus organic (mg/L as N)	36	6	17	11	0.0300825763	0	0.25	0	B
Nitrogen, ammonia (mg/L as N)	36	17	47	11	0.1713121915	B	0.02	0	B
Nitrite plus nitrate (mg/L as N)	30	20	67	11	A	A	A	A	A
Nitrogen, nitrite (mg/L as N)	36	34	94	11	A	A	A	A	A
Phosphorus, dissolved (mg/L as P)	27	22	81	11	A	A	A	A	A
Phophorus, ortho, dissolved (mg/L as P)	36	33	92	11	A	A	A	A	A
Phosphorus, total (mg/L as P)	36	9	25	11	0.1247838628	B	0.02	0	B
Residue, dissolved at 180°C (mg/L)	35	0	0	11	0.0736147125	–0.4997	39	(–)*	–13.1
Dissolved solids, sum of constituents (mg/L)	32	0	0	11	0.028596739	–0.4938	34	(–)**	–14.7
Barium, dissolved (µg/L)	36	1	3	11	0.0465907953	0	7	0	0.0
Iron, dissolved (µg/L)	36	1	3	11	0.1891830763	–1.917	77	0	–23.8
Manganese, dissolved (µg/L)	36	3	8	11	0.0000252162	B	15	(–)***	B
Strontium, dissolved (µg/L)	36	1	3	11	0.0002823951	–0.993	39	(–)***	–24.3
Zinc, dissolved (µg/L)	27	15	56	11	A	A	A	A	A

Table 28. Trend analysis results for site 5, Adams Tunnel east portal.

[0, no trend; (+), upward trend; (–), downward trend; significance: *, greater than 90 percent; **, greater than 95 percent; ***, greater than 99 percent; change is percent change in median since the first year of record; A, no trend computation because nondetects greater than 50 percent; B, no slope computation because nondetects greater than 5 percent; ft^3/s, cubic feet per second; mg/L, milligrams per liter; µS/cm, microsiemens per centimeter at 25 degrees Celsius; °C, degree Celsius; µg/L, micrograms per liter]

Seasonal Kendall season-edited data	Number	Censored	Percentage censored	Period record (years)	*p*-value	Slope	Median	Significance	Change
Instantaneous discharge (ft^3/s)	175	0	0	30	0.2191	–0.997	455	0	–6.4
Oxygen, dissolved (mg/L)	176	0	0	30	0.3841	0	8.3	0	0.0
pH, field (standard units)	176	0	0	30	0.0000	0.02726	7.5	(+)***	11.6
Specific conductance (µS/cm at 25°C)	165	0	0	30	0.0025	–0.267	50	(–)***	–14.8
Water temperature (°C)	179	0	0	30	0.0022	0.02273	5	(+)***	14.7
Hardness, total (mg/L as $CaCO_3$)	141	0	0	24	0.1679	–0.05411	19	0	–6.6
Calcium, dissolved (mg/L)	141	0	0	24	0.2766	–0.01659	5.9	0	–6.5
Magnesium, dissolved (mg/L)	141	0	0	24	0.0078	–0.005393	1.1	(–)***	–11.1
Potassium, dissolved (mg/L)	139	0	0	24	0.0015	–0.005548	0.7	(–)***	–17.3
Sodium adsorption (ratio)	141	0	0	24	0.1300	0	0.2	0	0.0
Sodium, dissolved (mg/L)	141	0	0	24	0.0006	–0.01545	1.9	(–)***	–17.7
Sodium (percent)	139	0	0	24	0.0066	0	17	0	0.0
Acid-neutralizing capacity (mg/L)	141	0	0	24	0.2348	0.04984	21	0	5.9
Chloride, dissolved (mg/L)	139	1	1	24	0.0173	0	0.4	0	0.0
Fluoride, dissolved (mg/L)	140	14	10	24	0.1741	B	0.1	0	B
Silica, dissolved (mg/L)	139	0	0	24	0.0000	0.05004	4.4	(+)***	31.8
Sulfate, dissolved (mg/L)	138	0	0	24	0.0000	–0.1485	3.3	(–)***	–69.1
Nitrogen, ammonia plus organic (mg/L as N)	133	32	24	22	0.0000	B	0.3	(–)***	B
Nitrogen, ammonia (mg/L as N)	67	42	63	11	A	A	A	A	A
Nitrite plus nitrate (mg/L as N)	55	24	44	9	0.0030	0	0.1	0	B
Nitrogen, nitrite (mg/L as N)	67	60	90	11	A	A	A	A	A
Phosphorus, dissolved (mg/L as P)	116	58	50	20	0.0020	0	0.02	0	B
Phophorus, ortho, dissolved (mg/L as P)	67	51	76	11	A	A	A	A	A
Phosphorus, total (mg/L as P)	120	35	29	20	0.0057	0	0.02	0	B
Residue, dissolved at 180°C (mg/L)	66	0	0	11	0.7760	0	34	0	0.0
Dissolved solids, sum of constituents (mg/L)	131	0	0	24	0.3101	–0.04997	31	0	–3.8
Barium, dissolved (µg/L)	67	0	0	11	0.9159	0	6	0	0.0
Iron, dissolved (µg/L)	141	0	0	24	0.0000	–1.791	30	(–)***	–82.1
Strontium, dissolved (µg/L)	67	0	0	11	0.0000	–1.392	35	(–)***	–35.3
Zinc, dissolved (µg/L)	72	26	36	19	0.7935	B	8	0	B

Table 29. Trend analysis results for site 7, Olympus Tunnel, samples.

[0, no trend; (+), upward trend; (–), downward trend; significance: *, greater than 90 percent; **, greater than 95 percent; ***, greater than 99 percent; change is percent change in median since the first year of record; A, no trend computation because nondetects greater than 50 percent; B, no slope computation because nondetects greater than 20 percent; mg/L, milligrams per liter; µS/cm, microsiemens per centimeter at 25 degrees Celsius; °C, degree Celsius; µg/L, micrograms per liter]

Seasonal Kendall season-edited data	Number	Censored	Percentage censored	Period record (years)	*p*-value	Slope	Median	Significance	Change
Oxygen, dissolved (mg/L)	88	0	0	30	0.0402	0.02006	9.1	(+)**	6.8
pH, field (standard units)	88	0	0	30	0.0530	0.01051	7.6	(+)*	4.2
Specific conductance (µS/cm at 25°C)	81	0	0	30	0.0008	–0.3754	48	(–)***	–20.9
Water temperature (°C)	89	0	0	30	0.3111	0	4.5	0	0.0
Hardness, total (mg/L as $CaCO_3$)	72	0	0	25	0.0215	–0.1313	17.5	(–)**	–17.1
Calcium, dissolved (mg/L)	72	0	0	25	0.0271	–0.03847	5.15	(–)**	–17.0
Magnesium, dissolved (mg/L)	72	0	0	25	0.0100	–0.007212	1.1	(–)***	–15.1
Potassium, dissolved (mg/L)	71	0	0	25	0.0154	0	0.6	0	0.0
Sodium adsorption (ratio)	71	0	0	25	0.4704	0	0.2	0	0.0
Sodium, dissolved (mg/L)	71	0	0	25	0.3087	–0.00499	2	0	–6.0
Sodium (percent)	71	0	0	25	0.1399	0	19	0	0.0
Acid-neutralizing capacity (mg/L)	72	0	0	25	0.9084	0	18	0	0.0
Chloride, dissolved (mg/L)	72	0	0	25	0.4930	0	0.6	0	0.0
Fluoride, dissolved (mg/L)	70	5	7	25	0.4827	B	0.1	0	B
Silica, dissolved (mg/L)	72	0	0	25	0.0028	0.03356	4.6	(+)***	20.2
Sulfate, dissolved (mg/L)	71	0	0	25	0.0000	–0.1287	3.4	(–)***	–63.4
Nitrogen, ammonia plus organic (mg/L as N)	34	10	29	11	0.3054	B	0.3	0	B
Nitrogen, ammonia (mg/L as N)	69	15	22	25	0.9754	B	0.04	0	B
Nitrite plus nitrate (mg/L as N)	74	27	36	25	0.4603	B	0.089	0	B
Nitrogen, nitrite (mg/L as N)	71	69	97	25	A	A	A	A	A
Phosphorus, dissolved (mg/L as P)	60	29	48	22	0.0000	B	0.01	(–)***	B
Phophorus, ortho, dissolved (mg/L as P)	33	27	82	11	A	A	A	A	A
Phosphorus, total (mg/L as P)	68	10	15	25	0.0067	B	0.02	(–)***	B
Residue, dissolved at 180°C (mg/L)	31	0	0	11	0.6943	0.1778	33	0	6.1
Dissolved solids, sum of constituents (mg/L)	70	0	0	25	0.0137	–0.1671	30	(–)**	–13.0
Barium, dissolved (µg/L)	31	0	0	11	0.9577	0	6	0	0.0
Iron, dissolved (µg/L)	72	0	0	25	0.0050	–1.497	62.5	(–)***	–45.7
Manganese, dissolved (µg/L)	53	5	9	18	0.0413	B	4	(–)**	B
Strontium, dissolved (µg/L)	32	1	3	11	0.0478	–0.7347	28.5	(–)**	–24.6
Zinc, dissolved (µg/L)	25	10	40	11	0.0257	B	7	(–)**	B

Table 30. Trend analysis results for site 8, Carter Reservoir, surface samples.

[0, no trend; (+), upward trend; (–), downward trend; significance: *, greater than 90 percent; **, greater than 95 percent; ***, greater than 99 percent; change is percent change in median since the first year of record; A, no trend computation because nondetects greater than 50 percent; B, no slope computation because nondetects greater than 20 percent; mg/L, milligrams per liter; µS/cm, microsiemens per centimeter at 25 degrees Celsius; °C, degree Celsius; in., inch; mL, milliliter; hplc, high-performance liquid chromatography; µg/L, micrograms per liter]

Seasonal Kendall season-edited data	Number	Censored	Percentage censored	Period record (years)	*p*-value	Slope	Median	Significance	Change
Oxygen, dissolved (mg/L)	85	0	0	30	0.1114	–0.008112	7.6	0	–3.2
pH, field (standard units)	88	0	0	30	0.0121	0.01414	8	(+)**	5.5
Specific conductance (µS/cm at 25°C)	88	0	0	30	0.0000	–0.9957	80	(–)***	–31.3
Water temperature (°C)	88	0	0	30	0.9071	0	17	0	0.0
Hardness, total (mg/L as $CaCO_3$)	36	0	0	11	0.0002	–0.5723	30	(–)***	–18.8
Calcium, dissolved (mg/L)	36	0	0	11	0.0002	–0.1979	9.8	(–)***	–19.8
Magnesium, dissolved (mg/L)	36	0	0	11	0.0001	–0.01417	1.3	(–)***	–11.3
Potassium, dissolved (mg/L)	36	0	0	11	0.0370	0	0.7	0	0.0
Sodium adsorption (ratio)	36	0	0	11	1.0000	0	0.2	0	0.0
Sodium, dissolved (mg/L)	36	0	0	11	0.0000	–0.04227	2.2	(–)***	–19.0
Sodium (percent)	36	0	0	11	0.4848	0	13	0	0.0
Acid-neutralizing capacity (mg/L)	36	0	0	11	0.0009	–0.499	32	(–)***	–15.7
Chloride, dissolved (mg/L)	34	0	0	11	0.0063	0.03313	0.7	(+)***	72.7
Fluoride, dissolved (mg/L)	34	5	15	11	0.3807	B	0.1	0	B
Silica, dissolved (mg/L)	36	0	0	11	0.0005	0.1552	2.5	(+)***	108.8
Sulfate, dissolved (mg/L)	34	1	3	11	0.0004	–0.07395	2.9	(–)***	–24.3
Nitrogen, ammonia plus organic (mg/L as N)	35	14	40	11	0.0466	0	0.2	0	B
Nitrogen, ammonia (mg/L as N)	74	31	42	30	0.0215	0	0.03	0	B
Nitrite plus nitrate (mg/L as N)	77	51	66	29	A	A	A	A	A
Phosphorus, dissolved (mg/L as P)	29	25	86	11	A	A	A	A	A
Phophorus, ortho, dissolved (mg/L as P)	35	31	89	11	A	A	A	A	A
Phosphorus, total (mg/L as P)	72	28	39	29	0.0000	B	0.03	(–)***	B
Residue, dissolved at 180°C (mg/L)	79	0	0	30	0.0000	–0.4344	47	(–)***	–24.3
Dissolved solids, sum of constituents (mg/L)	33	0	0	11	0.0025	–0.4891	39.5	(–)***	–12.7
Transparency, Secchi disk (in.)	72	0	0	30	0.3452	0.4081	96	0	13.7
Coliform, fecal (colonies per 100 mL)	56	38	68	24	A	A	A	A	A
Chlorophyll-*a*, hplc (µg/L)	35	0	0	11	0.1413	0.04964	1.2	0	60.5
Barium, dissolved (µg/L)	36	0	0	11	0.0943	–0.2498	23	(–)*	–11.2
Iron, dissolved (µg/L)	27	8	30	11	0.0030	B	7	(–)***	B
Manganese, dissolved (µg/L)	27	19	70	11	A	A	A	A	A
Strontium, dissolved (µg/L)	36	0	0	11	0.0000	–1.116	41	(–)***	–25.7
Zinc, dissolved (µg/L)	27	11	41	11	0.6150	B	7.5	0	B

Table 31. Trend analysis results for site 8, Carter Reservoir, bottom samples.

[0, no trend; (+), upward trend; (–), downward trend; significance: *, greater than 90 percent; **, greater than 95 percent; ***, greater than 99 percent; change is percent change in median since the first year of record; A, no trend computation because nondetects greater than 50 percent; B, no slope computation because nondetects greater than 20 percent; mg/L, milligrams per liter; µS/cm, microsiemens per centimeter at 25 degrees Celsius; °C, degree Celsius; µg/L, micrograms per liter]

Seasonal Kendall season-edited data	Number	Censored	Percentage censored	Period record (years)	*p*-value	Slope	Median	Significance	Change
Oxygen, dissolved (mg/L)	79	0	0	30	<.00001	–0.08366	6.9	(–)***	–30.6
pH, field (standard units)	74	0	0	30	0.4324	0	7.4	0	0.0
Specific conductance (µS/cm at 25°C)	75	0	0	30	<.00001	–0.9488	71	(–)***	–33.2
Water temperature (°C)	87	0	0	30	0.0385	0.02798	6.5	(+)**	13.8
Hardness, total (mg/L as $CaCO_3$)	36	0	0	11	<.00001	–0.5897	28	(–)***	–20.6
Calcium, dissolved (mg/L)	36	0	0	11	<.00001	–0.2046	8.8	(–)***	–22.4
Magnesium, dissolved (mg/L)	36	0	0	11	<.00001	–0.0223	1.3	(–)***	–17.1
Potassium, dissolved (mg/L)	36	0	0	11	0.0016	0	0.6	0	0.0
Sodium adsorption (ratio)	36	0	0	11	1.0000	0	0.2	0	0.0
Sodium, dissolved (mg/L)	36	0	0	11	0.0001	–0.04681	2.2	(–)***	–20.8
Sodium (percent)	36	0	0	11	0.7898	0	14	0	0.0
Acid-neutralizing capacity (mg/L)	36	0	0	11	<.00001	–0.6231	30	(–)***	–20.3
Chloride, dissolved (mg/L)	34	0	0	11	0.0004	0.04391	0.6	(+)***	143.5
Fluoride, dissolved (mg/L)	34	4	12	11	0.8823	B	0.1	0	B
Silica, dissolved (mg/L)	36	0	0	11	0.0003	0.1573	3.8	(+)***	60.6
Sulfate, dissolved (mg/L)	33	0	0	11	<.00001	–0.06811	2.9	***	–22.6
Nitrogen, ammonia plus organic (mg/L as N)	35	18	51	11	A	A	A	A	A
Nitrogen, ammonia (mg/L as N)	64	16	25	30	0.6375	B	0.03	0	B
Nitrite plus nitrate (mg/L as N)	34	17	50	17	A	A	A	A	A
Phosphorus, dissolved (mg/L as P)	29	26	90	11	A	A	A	A	A
Phophorus, ortho, dissolved (mg/L as P)	35	32	91	11	A	A	A	A	A
Phosphorus, total (mg/L as P)	61	22	36	29	<.00001	B	0.02	(–)***	B
Residue, dissolved at 180°C (mg/L)	64	0	0	30	<.00001	–0.4577	43	(–)***	–27.4
Dissolved solids, sum of constituents (mg/L)	33	0	0	11	0.0003	–0.6581	38	(–)***	–17.3
Barium, dissolved (µg/L)	36	0	0	11	0.0612	–0.3049	9	(–)*	–31.0
Iron, dissolved (µg/L)	27	4	15	8	0.0296	B	4	(–)**	B
Manganese, dissolved (µg/L)	27	7	26	8	0.5328	B	9.95	0	B
Strontium, dissolved (µg/L)	36	0	0	11	<.00001	–1.161	39.5	(–)***	–27.5
Zinc, dissolved (µg/L)	27	10	37	8	0.3872	B	7	0	B

Table 32. Trend analysis results for site 9, Horsetooth Reservoir (Soldier Canyon Dam), surface samples.

[0, no trend; (+), upward trend; (–), downward trend; significance: *, greater than 90 percent; **, greater than 95 percent; ***, greater than 99 percent; change is percent change in median since the first year of record; A, no trend computation because nondetects greater than 50 percent; B, no slope computation because nondetects greater than 20 percent; mg/L, milligrams per liter; µS/cm, microsiemens per centimeter at 25 degrees Celsius; °C, degree Celsius; in., inch; mL, milliliter; hplc, high-performance liquid chromatography; µg/L, micrograms per liter]

Seasonal Kendall season-edited data	Number	Censored	Percentage censored	Period record (years)	*p*-value	Slope	Median	Significance	Change
Oxygen, dissolved (mg/L)	86	0	0	30	0.3364	–0.00384	7.8	0	–1.5
pH, field (standard units)	86	0	0	30	0.0002	0.02104	7.6	(+)***	8.7
Specific conductance (µS/cm at 25°C)	88	0	0	31	0.0000	–0.6607	75	(–)***	–23.9
Water temperature (°C)	88	0	0	31	0.8649	0	15.45	0	0.0
Hardness, total (mg/L as $CaCO_3$)	36	0	0	11	0.0100	–0.3969	28.5	(–)***	–14.1
Calcium, dissolved (mg/L)	36	0	0	11	0.0097	–0.1383	9.05	(–)***	–15.4
Magnesium, dissolved (mg/L)	36	0	0	11	0.0515	–0.01102	1.5	(–)*	–7.7
Potassium, dissolved (mg/L)	36	0	0	11	0.0432	0	0.7	0	0.0
Sodium adsorption (ratio)	36	0	0	11	1.0000	0	0.2	0	0.0
Sodium, dissolved (mg/L)	36	0	0	11	0.0396	–0.01973	2.4	(–)**	–8.6
Sodium (percent)	36	0	0	11	0.2232	0	15	0	0.0
Acid-neutralizing capacity (mg/L)	36	0	0	11	0.0025	–0.4926	29	(–)***	–17.0
Chloride, dissolved (mg/L)	34	0	0	11	0.0001	0.0642	0.7	(+)***	224.3
Fluoride, dissolved (mg/L)	34	5	15	11	0.5380	B	0.1	0	B
Silica, dissolved (mg/L)	36	0	0	11	0.0417	0.1041	2.75	(+)**	53.9
Sulfate, dissolved (mg/L)							3.4	--	
Nitrogen, ammonia plus organic (mg/L as N)	36	14	39	11	0.0338	0	0.3	0	B
Nitrogen, ammonia (mg/L as N)	82	39	48	31	0.0348	0	0.04	0	B
Nitrite plus nitrate (mg/L as N)	81	57	70	30	A	A	A	A	A
Nitrogen, nitrite (mg/L as N)	77	57	74	31	A	A	A	A	A
Phosphorus, dissolved (mg/L as P)	30	28	93	11	A	A	A	A	A
Phophorus, ortho, dissolved (mg/L as P)	36	32	89	11	A	A	A	A	A
Phosphorus, total (mg/L as P)	67	29	43	29	0.0000	B	0.04	(–)***	B
Residue, dissolved at 180°C (mg/L)	76	0	0	31	0.0000	–0.5625	50	(–)***	–29.6
Dissolved solids, sum of constituents (mg/L)	34	0	0	11	0.0350	–0.4937	39	(–)**	–12.9
Transparency, Secchi disk (in.)	68	0	0	30	0.0065	1.066	75	(+)***	54.7
Coliform, fecal (colonies per 100 mL)	52	31	60	23	A	A	A	A	A
Chlorophyll-*a*, hplc (µg/L)	35	0	0	11	0.1716	–0.0784	1.9	0	–36.4
Chlorophyll-*b*, hplc (µg/L)	35	28	80	11	A	A	A	A	A
Barium, dissolved (µg/L)	36	0	0	11	0.7456	0	18.5	0	0.0
Iron, dissolved (µg/L)	43	1	2	19	0.4434	–0.2706	13	0	–32.7
Manganese, dissolved (µg/L)	42	15	36	19	0.4685	B	3	0	B
Strontium, dissolved (µg/L)	36	0	0	11	0.0001	–1.229	37.5	(–)***	–30.1
Zinc, dissolved (µg/L)	27	11	41	8	0.5916	B	5.5	0	B

Table 33. Trend analysis results for site 9, Horsetooth Reservoir (Soldier Canyon Dam), bottom samples.

[0, no trend; (+), upward trend; (–), downward trend; significance: *, greater than 90 percent; **, greater than 95 percent; ***, greater than 99 percent; change is percent change in median since the first year of record; A, no trend computation because nondetects greater than 50 percent; B, no slope computation because nondetects greater than 20 percent; mg/L, milligrams per liter; µS/cm, microsiemens per centimeter at 25 degrees Celsius; °C, degree Celsius; µg/L, micrograms per liter]

Seasonal Kendall season-edited data	Number	Censored	Percentage censored	Period record (years)	*p*-value	Slope	Median	Significance	Change
Oxygen, dissolved (mg/L)	78	0	0	30	0.0010	–0.07019	7.5	(–)***	–24.5
pH, field (standard units)	49	0	0	17	0.6109	0	7.2	0	0.0
Specific conductance (µS/cm at 25°C)	73	0	0	30	0.0000	–0.4997	73	(–)***	–18.6
Water temperature (°C)	84	0	0	30	0.0806	0.0212	7.1	(+)*	9.4
Hardness, total (mg/L as $CaCO_3$)	36	0	0	11	0.0001	–0.5048	28.5	(–)***	–17.6
Calcium, dissolved (mg/L)	36	0	0	11	0.0001	–0.1742	8.95	(–)***	–19.2
Magnesium, dissolved (mg/L)	36	0	0	11	0.0033	–0.01957	1.5	(–)***	–13.3
Potassium, dissolved (mg/L)	36	0	0	11	0.0054	–0.009559	0.7	(–)***	–13.9
Sodium adsorption (ratio)	36	0	0	11	1.0000	0	0.2	0	0.0
Sodium, dissolved (mg/L)	36	0	0	11	0.0151	–0.02498	2.3	(–)**	–11.2
Sodium (percent)	36	0	0	11	0.0423	0	15	0	0.0
Acid-neutralizing capacity (mg/L)	36	0	0	11	0.0001	–0.6692	29	(–)***	–22.3
Chloride, dissolved (mg/L)	34	0	0	11	0.0000	0.07629	0.7	(+)***	346.4
Fluoride, dissolved (mg/L)	34	5	15	11	0.3881	B	0.1	0	B
Silica, dissolved (mg/L)	36	0	0	11	0.0876	0.1125	3.65	(+)*	41.6
Sulfate, dissolved (mg/L)	34	0	0	11	0.0019	–0.09884	3.2	0	–28.7
Nitrogen, ammonia plus organic (mg/L as N)	36	19	53	11	A	A	A	A	A
Nitrogen, ammonia (mg/L as N)	45	20	44	17	0.3865	B	0.04	0	B
Nitrite plus nitrate (mg/L as N)	39	10	26	17	0.4192	B	0.12	0	B
Nitrogen, nitrite (mg/L as N)	43	41	95	17	A	A	A	A	A
Phosphorus, dissolved (mg/L as P)	36	25	69	17	A	A	A	A	A
Phophorus, ortho, dissolved (mg/L as P)	36	25	69	11	A	A	A	A	A
Phosphorus, total (mg/L as P)	37	12	32	17	0.2979	B	0.03	0	B
Residue, dissolved at 180°C (mg/L)	64	0	0	31	0.0017	–0.2881	48	(–)***	–17.0
Dissolved solids, sum of constituents (mg/L)	34	0	0	11	0.0006	–0.4333	38.5	(–)***	–11.6
Barium, dissolved (µg/L)	36	0	0	11	0.0875	0.1098	17	(+)*	7.4
Iron, dissolved (µg/L)	33	2	6	11	0.4980	B	15	0	B
Manganese, dissolved (µg/L)	36	19	53	11	A	A	A	A	A
Strontium, dissolved (µg/L)	36	0	0	11	0.0000	–1.337	40	(–)***	–30.6
Zinc, dissolved (µg/L)	27	11	41	11	0.8970	B	6	0	B

Table 34. Trend analysis results for site 10, Horsetooth Reservoir (Spring Canyon Dam), surface samples.

[0, no trend; (+), upward trend; (–), downward trend; significance: *, greater than 90 percent; **, greater than 95 percent; ***, greater than 99 percent; change is percent change in median since the first year of record; A, no trend computation because nondetects greater than 50 percent; B, no slope computation because nondetects greater than 20 percent; mg/L, milligrams per liter; µS/cm, microsiemens per centimeter at 25 degrees Celsius; °C, degree Celsius; in., inch; mL, milliliter; hplc, high-performance liquid chromatography; µg/L, micrograms per liter]

Seasonal Kendall season-edited data	Number	Censored	Percentage censored	Period record (years)	*p*-value	Slope	Median	Significance	Change
Oxygen, dissolved (mg/L)	48	0	0	11	1.0620	0	7.6	0	0.0
pH, field (standard units)	50	0	0	11	1.8870	0.01251	7.65	0	1.8
Specific conductance (µS/cm at 25°C)	50	0	0	11	0.0043	–0.7928	66	(–)***	–12.3
Water temperature (°C)	48	0	0	11	0.0597	–0.158	16.65	(–)*	–9.9
Hardness, total (mg/L as $CaCO_3$)	36	0	0	11	0.0161	–0.3353	28	(–)**	–12.3
Calcium, dissolved (mg/L)	36	0	0	11	0.0234	–0.1126	8.95	(–)**	–12.9
Magnesium, dissolved (mg/L)	36	0	0	11	0.3846	0	1.4	0	0.0
Potassium, dissolved (mg/L)	36	0	0	11	0.1143	0	0.6	0	0.0
Sodium adsorption (ratio)	36	0	0	11	1.0000	0	0.2	0	0.0
Sodium, dissolved (mg/L)	36	0	0	11	0.0243	–0.03251	2.4	(–)**	–13.8
Sodium (percent)	36	0	0	11	1.1007	0	15	0	0.0
Acid-neutralizing capacity (mg/L)	36	0	0	11	0.0546	–0.3529	29	(–)*	–12.5
Chloride, dissolved (mg/L)	34	0	0	11	1.9996	0.06687	0.8	(+)***	184.5
Fluoride, dissolved (mg/L)	34	6	18	11	0.6458	B	0.1	0	B
Silica, dissolved (mg/L)	36	0	0	11	1.9483	0.1376	2.75	(+)*	78.7
Sulfate, dissolved (mg/L)	34	0	0	11	0.0688	–0.07948	3.2	(–)*	–23.8
Nitrogen, ammonia plus organic (mg/L as N)	36	16	44	11	0.0567	0	0.3	0	B
Nitrogen, ammonia (mg/L as N)	36	21	58	11	A	A	0.03	A	A
Nitrite plus nitrate (mg/L as N)	30	26	87	11	A	A	0.07	A	A
Nitrogen, nitrite (mg/L as N)	36	35	97	11	A	A	0.03	A	A
Phosphorus, dissolved (mg/L as P)	30	29	97	11	A	A	0.01	A	A
Phophorus, ortho, dissolved (mg/L as P)	36	34	94	11	A	A	0.02	A	A
Phosphorus, total (mg/L as P)	32	20	63	11	A	A	0.01	A	A
Residue, dissolved at 180°C (mg/L)	33	0	0	11	1.3793	0.2486	40	0	7.1
Dissolved solids, sum of constituents (mg/L)	34	0	0	11	0.1645	–0.2356	38	0	–6.6
Transparency, Secchi disk (in.)	46	0	0	11	1.9991	0	79.5	0	0.0
Coliform, fecal (colonies per 100 mL)	32	12	38	11	0.5629	B	2	0	B
Chlorophyll-*a*, hplc (µg/L)	35	0	0	11	0.2313	–0.07486	2.1	0	–32.3
Chlorophyll-*b*, hplc (µg/L)	35	24	69	11	A	A	0.1	A	A
Barium, dissolved (µg/L)	36	0	0	11	1.5075	0	18.5	0	0.0
Iron, dissolved (µg/L)	36	16	44	11	1.2370	B	21.5	0	B
Manganese, dissolved (µg/L)	32	11	34	11	1.8638	B	3	0	B
Strontium, dissolved (µg/L)	36	0	0	11	0.0000	–1.258	38	(–)***	–30.4
Zinc, dissolved (µg/L)	27	20	74	8	A	A	14	A	A

Table 35. Trend analysis results for site 10, Horsetooth Reservoir (Spring Canyon Dam), bottom samples.

[0, no trend; (+), upward trend; (–), downward trend; significance: *, greater than 90 percent; **, greater than 95 percent; ***, greater than 99 percent; change is percent change in median since the first year of record; A, no trend computation because nondetects greater than 50 percent; B, no slope computation because nondetects greater than 20 percent; mg/L, milligrams per liter; µS/cm, microsiemens per centimeter at 25 degrees Celsius; °C, degree Celsius; µg/L, micrograms per liter]

Seasonal Kendall season-edited data	Number	Censored	Percentage censored	Period record (years)	*p*-value	Slope	Median	Significance	Change
Oxygen, dissolved (mg/L)	48	0	0	11	0.0709	–0.09875	5.2	(–)*	–18.8
pH, field (standard units)	50	0	0	11	0.1716	–0.00826	7.3	0	–1.2
Specific conductance (µS/cm at 25°C)	50	0	0	11	0.0069	–0.8994	70	(–)***	–13.1
Water temperature (°C)	48	0	0	11	0.0134	0.06656	7.45	(+)**	10.4
Hardness, total (mg/L as $CaCO_3$)	36	0	0	11	0.0002	–0.4982	29	(–)***	–17.1
Calcium, dissolved (mg/L)	36	0	0	11	0.0001	–0.1634	9.1	(–)***	–17.8
Magnesium, dissolved (mg/L)	36	0	0	11	0.0070	–0.01736	1.5	(–)***	–11.9
Potassium, dissolved (mg/L)	36	0	0	11	0.0239	0	0.7	0	0.0
Sodium adsorption (ratio)	36	0	0	11	1.0000	0	0.2	0	0.0
Sodium, dissolved (mg/L)	36	0	0	11	0.0759	–0.01957	2.3	(–)*	–8.9
Sodium (percent)	36	0	0	11	1.9892	0.133	15	(+)**	10.3
Acid-neutralizing capacity (mg/L)	36	0	0	11	0.0020	–0.5249	30	(–)***	–17.4
Chloride, dissolved (mg/L)	34	0	0	11	0.0000	0.09665	0.7	(+)***	885.2
Fluoride, dissolved (mg/L)	34	4	12	11	0.9048	B	0.1	0	B
Silica, dissolved (mg/L)	36	0	0	11	0.0099	0.1971	3.85	(+)***	81.3
Sulfate, dissolved (mg/L)	34	0	0	11	0.0029	–0.09941	3.2	(–)***	–28.8
Nitrogen, ammonia plus organic (mg/L as N)	36	20	56	11	A	A	A	A	A
Nitrogen, ammonia (mg/L as N)	36	14	39	11	0.1157	B	0.04	0	B
Nitrite plus nitrate (mg/L as N)	31	11	35	11	0.0518	B	0.155	(+)*	B
Nitrogen, nitrite (mg/L as N)	36	34	94	11	A	A	A	A	A
Phosphorus, dissolved (mg/L as P)	32	21	66	11	A	A	A	A	A
Phophorus, ortho, dissolved (mg/L as P)	36	19	53	11	A	A	A	A	A
Phosphorus, total (mg/L as P)	34	11	32	11	1.0000	B	0.0295	0	B
Residue, dissolved at 180°C (mg/L)	33	0	0	11	0.2788	0.4263	42	0	11.9
Dissolved solids, sum of constituents (mg/L)	33	0	0	11	0.0568	–0.2659	40	(–)*	–7.0
Barium, dissolved (µg/L)	36	1	3	11	0.2815	0	17.5	0	0.0
Iron, dissolved (µg/L)	35	3	9	11	0.7407	B	21	0	B
Manganese, dissolved (µg/L)	35	3	9	11	0.1998	B	13	0	B
Strontium, dissolved (µg/L)	35	0	0	11	0.0001	–1.056	40.5	(–)***	–24.8
Zinc, dissolved (µg/L)	25	13	52	11	A	A	A	A	A