WATER-QUALITY VARIATIONS AND TRENDS IN MONUMENT AND FOUNTAIN CREEKS, EL PASO AND PUEBLO COUNTIES, COLORADO, WATER YEARS 1976-88

by Barbara C. Ruddy

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BRUCE BABBITT, Secretary
U.S. GEOLOGICAL SURVEY
Dallas L. Peck, Director

For additional information
write to:

District Chief
U.S. Geological Survey
Box 25046, Mail Stop 415
Federal Center
Denver, CO 80225-0046

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CONVERSION FACTORS AND RELATED INFORMATION

Multiply	*By*	*To obtain*
cubic foot per second (ft^3/s)	0.028317	cubic meter per second
foot (ft)	0.3048	meter
square mile (mi^2)	2.589	square kilometer

Degree Celsius (°C) may be converted to degree Fahrenheit (°F), by using the following formula:

$$°F = 9/5(°C) + 32.$$

The following water-quality terms and abbreviations also are used in this report:

colonies per 100 milliliters (/100 mL)
5-day biochemical oxygen demand (BOD)
degree Celsius (°C)
microgram per liter (µg/L)
microsiemens per centimeter at 25 degrees Celsius (µS/cm)
milligram per liter (mg/L)
milliliter (mL)

WATER-QUALITY VARIATIONS AND TRENDS IN MONUMENT AND FOUNTAIN CREEKS, EL PASO AND PUEBLO COUNTIES, COLORADO, WATER YEARS 1976-88

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ABSTRACT

Water-quality data were collected at four stations on Monument Creek and five stations on Fountain Creek during water years 1976 through 1988. These data were statistically analyzed to determine variations and trends in water-quality properties and constituents. A qualitative comparison using boxplots of water quality among all stations was done for the period of record. A spatial trend analysis was done to compare the water-quality changes among seven of the nine stations for water years 1980 through 1988. Analysis of time-series trends at each station was done to determine if changes in water-quality conditions occurred during the period of record.

Median values of the water-quality properties and constituents were compared to the appropriate State water-quality standards. Median values of the water-quality properties and constituents were within the State standards except for the following trace-metal concentrations: dissolved manganese at Monument Creek above North Gate Boulevard at U.S. Air Force Academy and Fountain Creek above Little Fountain Creek below Fountain; total recoverable copper at Monument Creek at Pikeview and Monument Creek at Bijou Street at Colorado Springs; and total selenium at Fountain Creek at Pueblo. Occasional violations of the State water-quality standards occurred at all stations.

Generally, median concentrations of most water-quality properties and constituents were larger downstream. Nutrient concentrations, except for nitrite plus nitrate as nitrogen, were largest at Fountain Creek below Janitell Road below Colorado Springs, which is downstream from the wastewater-treatment plant at Colorado Springs; the concentrations then were smaller downstream.

Statistical comparisons of median values of selected water-quality properties and constituents for determining trends among seven of the nine stations were made for water years 1980 through 1988. For Monument Creek, the comparisons indicated that median concentrations of most constituents at Monument Creek at Palmer Lake were significantly different from median concentrations of most constituents at Monument Creek at Pikeview and Monument Creek at Bijou Street at Colorado Springs, which are more similar to each other. Median concentrations of most constituents at Fountain Creek near Colorado Springs, upstream from the mouth of Monument Creek, were significantly different from the median concentrations of most constituents at downstream stations on Fountain Creek, with a few exceptions. Median concentrations of most constituents at Fountain Creek at Colorado Springs, downstream from the mouth of Monument Creek, were more similar to median concentrations at Monument Creek at Bijou Street at Colorado Springs than to median concentrations at Fountain Creek near Colorado Springs.

Water quality at Fountain Creek at Colorado Springs and at Fountain Creek below Janitell Road below Colorado Springs, upstream and downstream from the Colorado Springs Wastewater-Treatment Plant, were compared. The following property and constituents were not statistically different: water temperature, nitrite plus nitrate as nitrogen, and fecal coliform bacteria. The following properties and constituents had statistically significant increases downstream: instantaneous streamflow, specific conductance, total ammonia as nitrogen, un-ionized ammonia as nitrogen, total recoverable copper, total recoverable zinc, and 5-day biochemical oxygen demand. The following properties and constituents had statistically significant decreases downstream: pH, dissolved oxygen, suspended solids, and total recoverable iron.

Time-series trends in water quality were investigated at all stations for the period of record; the significant trends varied at each station. All stations on Monument and Fountain Creeks had significant temporal trends of at least one water-quality property or constituent.

INTRODUCTION

Rapid population growth occurred in Colorado Springs and the surrounding area from the mid-1970's to the mid-1980's. Although the projected accelerated growth did not continue during the late 1980's, future growth is anticipated. Water resources in this developing area are not abundant, and maintaining water quality is a concern. Development of land and ground water in the Colorado Springs area is likely to cause changes in the water quality of Monument and Fountain Creeks, the principal streams that drain the area (fig. 1) and which have relatively low flows during most of the year. Such changes could cause water quality to become a limiting factor for some stream uses, such as recreation, aquatic life, water supply, and agriculture.

In 1975, the U.S. Geological Survey (USGS), in cooperation with the Pikes Peak Area Council of Governments, began a study to monitor water quality and to compile a data base, for use by local agencies in the development of an areawide water-quality-management plan, and to characterize surface-water-quality conditions. General water-quality characteristics of Monument and Fountain Creeks, with emphasis on relation of water quality to stream classifications, for 1975-83, are reported by Edelmann (1990). Because the period of record was not adequate at most sites for many water-quality constituents, detection of water-quality trends was limited. In 1985, an additional study was begun by the USGS in cooperation with the Colorado Springs Department of Utilities, to evaluate water-quality variations and trends based on an extended period of record through 1988.

Purpose and Scope

This report describes water-quality variations and trends of Monument and Fountain Creeks. Data from nine water-quality stations that had periods of record ranging from 5 years (water years 1984-88) to 13 years (water years 1976-88) were used in the analysis. Spatial variations in streamflow and 30 individual water-quality properties and constituents were evaluated qualitatively using data from most stations in a graphical box-plot analysis. In

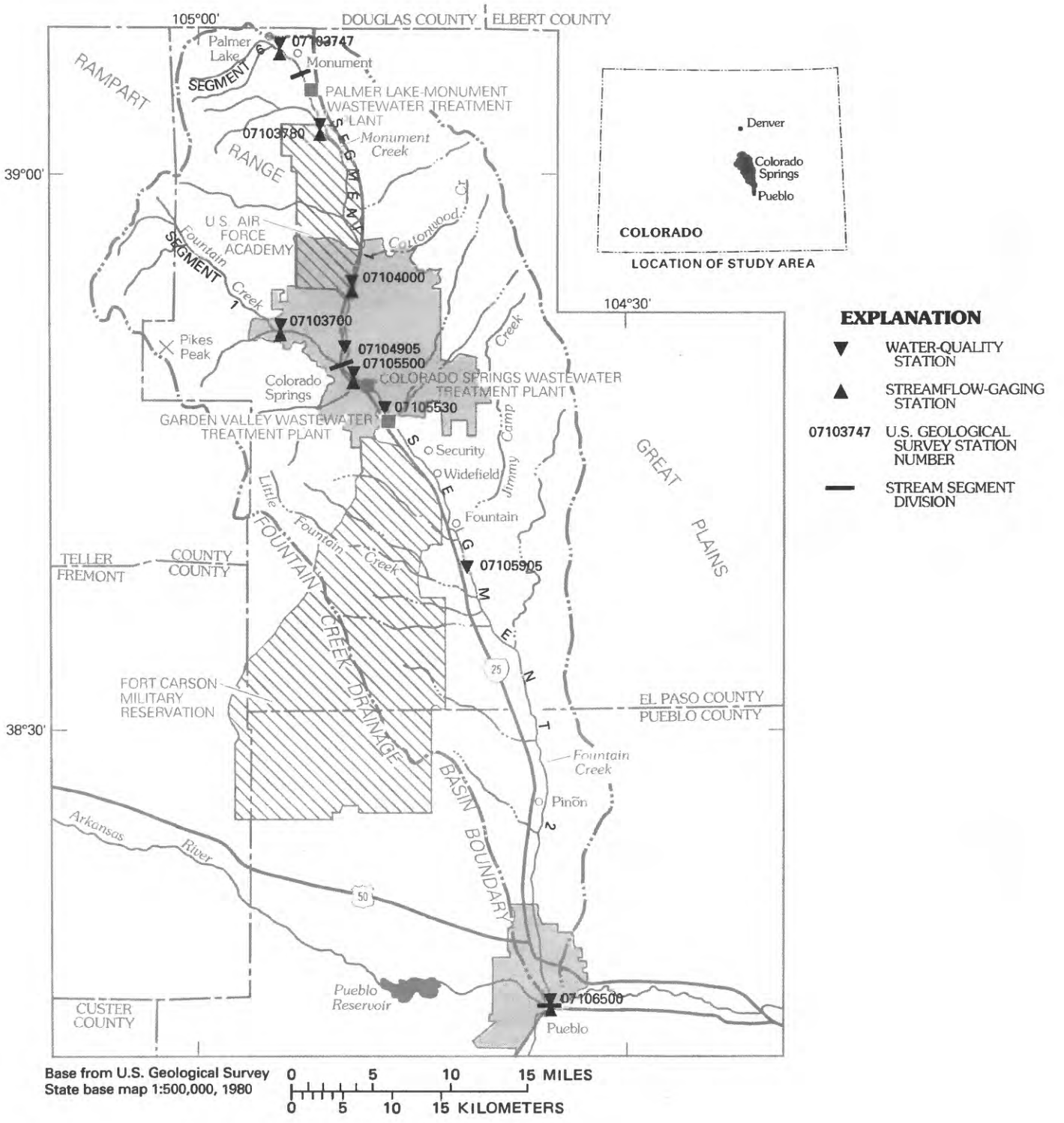

Figure 1.--Location of study area and water-quality stations.

addition, a statistical analysis of spatial trends of streamflow and selected water-quality properties and constituents among seven stations for a similar period of record (water years 1980-88) was performed. Finally, results of a seasonal Kendall test applied to identify trends in the time series of streamflow and each water-quality property and constituent that met specific criteria, for the period of record at each station, are presented.

Approach

Data from nine water-quality stations were used in the analysis of water-quality variations and trends (table 1). Streamflow and water-quality properties and constituents evaluated during the study were limited to the following: instantaneous streamflow, specific conductance, pH, water temperature, dissolved oxygen, hardness as calcium carbonate, dissolved calcium, dissolved magnesium, dissolved chloride, dissolved sulfate, suspended solids, nitrite plus nitrate as nitrogen, total ammonia as nitrogen, un-ionized ammonia as nitrogen, total ammonia plus organic nitrogen, total organic nitrogen as nitrogen, total phosphorus, total cadmium, total recoverable copper, dissolved iron, total recoverable iron, total recoverable lead, dissolved manganese, total recoverable manganese, total recoverable nickel, total selenium, total recoverable zinc, 5-day biochemical oxygen demand (BOD), total coliform bacteria, fecal coliform bacteria, and fecal streptococcus bacteria. Although data for instantaneous streamflow, water temperature, and dissolved-oxygen concentrations are included in the analyses, these measurements are time dependent, and substantial daily variations generally occur. The data are presented for comparative purposes and to provide background information for future uses. Un-ionized ammonia as nitrogen was estimated using the method of Thurston and others reported in Willingham (1976). The method uses water temperature, pH, and ammonia-nitrogen concentration data. Summary statistics were compiled for streamflow and the water-quality properties and constituents based on data available for each station. Comparison of streamflow and each water-quality property and constituent was made among stations that had available data. Box plots were used to display the variability of data at each station and to qualitatively compare data among stations. Statistical comparisons also were made on the data from stations 07103747 Monument Creek at Palmer Lake; 07104000 Monument Creek at Pikeview; 07104905 Monument Creek at Bijou Street at Colorado Springs, hereinafter referred to as Monument Creek at Bijou; 07103700 Fountain Creek near Colorado Springs; 07105500 Fountain Creek at Colorado Springs; 07105530 Fountain Creek below Janitell Road below Colorado Springs, hereinafter referred to as Fountain Creek below CSWWTP (Colorado Springs Wastewater Treatment Plant); and 07105905 Fountain Creek above Little Fountain Creek below Fountain, hereinafter referred to as Fountain Creek below Fountain, for water years 1980 through 1988 to determine the existence and significance of trends among the stations. The comparisons were made using the stations where sufficient data had been collected during a common period of record. Time-series trends in streamflow, water-quality properties, and concentrations of constituents were computed for all stations.

Table 1.--*Water-quality stations on Monument and Fountain Creeks used in this study*

Station number	Stream segment number[1]	U.S. Geological Survey station name	Period of data collection (water year)[2]
07103747	6	Monument Creek at Palmer Lake	1977-88
07103780	7	Monument Creek above North Gate Boulevard at U.S. Air Force Academy	1984-88
07104000	7	Monument Creek at Pikeview	1976-88
07104905	7	Monument Creek at Bijou Street at Colorado Springs	1980-88
07103700	1	Fountain Creek near Colorado Springs	1976-88
07105500	2	Fountain Creek at Colorado Springs	1976-88
07105530	2	Fountain Creek below Janitell Road below Colorado Springs	1976-88
07105905	2	Fountain Creek above Little Fountain Creek below Fountain	1976-88
07106500	2	Fountain Creek at Pueblo	1976-88

[1]Colorado Department of Health (1989).
[2]Data collected at each site varied during the period of record.

DESCRIPTION OF STUDY AREA

Monument and Fountain Creeks are the two main drainages northwest, west, and south of Colorado Springs (fig. 1). Monument Creek, which originates in the Rampart Range at an elevation of about 9,200 ft, generally flows northeast towards the town of Palmer Lake, where it changes direction and flows southeast to Colorado Springs. Monument Creek flows into Fountain Creek within the city limits of Colorado Springs. Fountain Creek, which originates on the slopes of Pikes Peak at an elevation of over 14,000 ft, generally flows southeast to Colorado Springs. From Colorado Springs, Fountain Creek continues to flow southeast to Pueblo, where it flows into the Arkansas River. Fountain Creek drains an area of 926 mi^2. The main sources of streamflow in both creeks are snowmelt, runoff from thunderstorms, and return flows from municipal, agricultural, and industrial water use. Along Fountain Creek, groundwater discharge also is a source.

Flow in Monument Creek is perennial. Flow from the Palmer Lake-Monument Wastewater Treatment Plant, flow from Cottonwood Creek, and miscellaneous inflows from urban areas are the main sources of flow for Monument Creek. Mean annual streamflow increases downstream and ranges from 7.52 to 28.8 ft^3/s for the period of record at three continuous streamflow-gaging stations: Monument Creek at Palmer Lake; Monument Creek above North Gate Boulevard at U.S. Air Force Academy, hereinafter referred to as Monument Creek at USAFA; and Monument Creek at Pikeview.

Flow in Fountain Creek is perennial from Colorado Springs to Fountain. In this reach, the streamflow is augmented by discharge of wastewater effluent from Colorado Springs, Garden Valley, Security, Fort Carson, Widefield, and Fountain (Edelmann and Cain, 1985). The percentage of annual flow contributed by wastewater effluent does not clearly explain the effects of wastewater effluent on the flows in Fountain Creek (Edelmann and Cain, 1985). Short periods of heavy runoff in Fountain Creek contribute a large volume to its annual flow, while flows of wastewater effluent are more constant. Downstream from Fountain, no-flow periods may occur during the summer because of agricultural diversions. Most of the land use between Colorado Springs and Pueblo is agricultural. Mean annual streamflow increases downstream and ranges from 14.6 to 72.1 ft^3/s for the period of record at three continuous streamflow-gaging stations: Fountain Creek near Colorado Springs, Fountain Creek at Colorado Springs, and Fountain Creek at Pueblo.

SUMMARY STATISTICS

For the nine stations where water-quality data were collected for this study, seven statistical parameters that define the distribution of the data were determined for streamflow and all water-quality properties and constituents that had a sufficient number of values. These parameters were the mean, standard deviation, minimum, lower quartile (25th percentile), median (50th percentile), upper quartile (75th percentile), and maximum. The criteria for a sufficient number of values were defined as follows: (1) At least 10 values equal to or exceeding the detection limit, and (2) no more than 75 percent of the values less than the detection limit (censored values). If either criterion was not satisfied, only the minimum and maximum values were reported to indicate the range of measured values.

Because the data for many properties and constituents included censored (less-than) values (because of improvement in analytical methods over time, resulting in a lowering of the detection limits), the methods used to compute the summary statistics were selected based on their accuracy for estimating specific distributional parameters for data sets containing censored values. Gilliom and Helsel (1986) determined that the log probability regression was the best method to estimate the mean and standard deviation of such data sets and that a lognormal maximum-likelihood method was best for estimating the median and quartile values. The software used in this study to compute the summary statistics incorporated these two methods, modified to accept data sets that had more than one detection limit (censored values) (Helsel and Cohn, 1988).

Summary statistics for the data compiled for the nine stations in this study are listed in tables 4 through 12 in the "Hydrologic Data" section at the back of the report. Also included in the tables are the applicable State water-quality standards that were in effect in 1989 (Colorado Department of Health, 1989). The standards vary in different stream segments. The standards are maximum allowable concentrations, except for the pH standard, which is an allowable range, and the dissolved-oxygen standard, which is a minimum allowable concentration. Where two values are listed for the dissolved-oxygen standard, the larger value applies during periods of spawning of cold-water fish. The standards for most trace metals were based on total recoverable concentration except for iron and manganese, which have standards for dissolved and total recoverable concentrations.

Exceedances of the State water-quality standards can be observed in the summaries listed in tables 4 through 12. Median pH values at all stations were always within the water-quality-standard allowance range. The maximum water-quality standard for pH was exceeded once at station 07103780 Monument Creek at USAFA (table 5) in August 1985 and once at station 07105530 Fountain Creek below CSWWTP (table 10) in September 1984.

Median dissolved-oxygen concentrations always exceeded the water-quality standard. At station 07105905 Fountain Creek below Fountain (table 11) in July 1988 and at station 07106500 Fountain Creek at Pueblo (table 12) in August 1981, the dissolved-oxygen concentrations did not meet the water-quality standard. At station 07103700 Fountain Creek near Colorado Springs (table 8) in August 1980, the dissolved-oxygen concentrations did not meet the standard for spawning of cold-water fish.

At station 07106500 Fountain Creek at Pueblo (table 12), the standard for nitrite plus nitrate as nitrogen was exceeded once in July 1982. Median concentrations of total phosphorus were larger than 0.1 mg/L except at station 07103747 Monument Creek at Palmer Lake (table 4) and 07103700 Fountain Creek near Colorado Springs (table 8). Data for total phosphorus were not collected at station 07103780 Monument Creek at USAFA. For the stations with median values larger than 0.1 mg/L, the median concentrations ranged from 0.16 mg/L at station 07104000 Monument Creek at Pikeview (table 6) to 4.4 mg/L at station 07105530 Fountain Creek below CSWWTP (table 10). There is no State water-quality standard or Federal criterion for phosphorus; however, the U.S. Environmental Protection Agency (1986) has stated that in order to prevent nuisance algal growth associated with accelerated eutrophication, total phosphorus concentrations should not exceed 0.1 mg/L in streams. This concentration is associated with eutrophication-related water-quality problems in reservoirs. Currently (1988), there are off-stream but no on-stream reservoirs on these two creeks.

Median trace-metal concentrations were less than the State standards at all the stations except the following: stations 07103780 Monument Creek at USAFA (table 5) and 07105905 Fountain Creek below Fountain (table 11), dissolved manganese; stations 07104000 Monument Creek at Pikeview (table 6) and 07104905 Monument Creek at Bijou (table 7), total recoverable copper; and station 07106500 Fountain Creek at Pueblo (table 12), total selenium. The State water-quality standard for fecal coliform was exceeded at least once at each station except stations 07103747 Monument Creek at Palmer Lake (table 4) and 07103780 Monument Creek at USAFA (table 5).

WATER-QUALITY VARIATIONS AND TREND ANALYSIS

Variations and trends in water-quality properties and constituents were investigated during this study. Water-quality variations among stations were evaluated qualitatively using box plots. Variability of water-quality data at each station and among stations was compared for the period of record. Because the period of record is not the same for all stations, the statistical determination of water-quality trends among seven of the nine stations was done for a common period of record: water years 1980 through 1988. Time-series trends at all nine stations were determined for the period of record.

Water-quality variations and trends are affected by the water uses in the basin. Wastewater-treatment plants downstream from Monument and Colorado Springs affect the water quality in the two creeks (Edelmann and Cain, 1985). Urbanization has increased throughout the northern part of the basin. Cottonwood Creek flows through a developing urban area into Monument Creek upstream from station 07104000 Monument Creek at Pikeview. Cottonwood Creek contributes large volumes of suspended sediment to Monument Creek (von Guerard, 1989) and has a larger specific conductance than Monument Creek. Downstream from station 07104905 Monument Creek at Bijou, more storm drains in Colorado Springs flow into Monument Creek. The area along Fountain Creek between Colorado Springs and Fountain generally is more urbanized than the area along Fountain Creek between Fountain and Pueblo, which generally is agricultural. Water use and reuse and tributary ground-water inflows downstream from station 07105530 Fountain Creek below CSWWTP probably cause the increased concentrations in many constituents (Cain and Edelmann, 1986). Jimmy Camp Creek, a tributary that has large specific-conductance values, flows into Fountain Creek between stations 07105530 Fountain Creek below CSWWTP and 07105905 Fountain Creek below Fountain.

Water-Quality Variations

Comparisons of water-quality properties and constituents were made among stations. Box plots were constructed to graphically display the constituent variability at each station and to qualitatively compare data among stations. Only qualitative comparisons and not trend analysis can be made because the number of values and period of record were different at each station. Box plots are useful because variability between data sets and unusual values can easily be seen. Box plots contain the following information (fig. 2). The horizontal line and diamond inside the box represent the median value (50 percent of the data are greater than this value and 50 percent of the data are less than this value). The lower line of the box is the 25th percentile or lower quartile (25 percent of the data are less than this value). The upper line of the box is the 75th percentile or upper quartile (75 percent of the data are less than this value). The interquartile range (IQR) contains the values between the 25th and 75th percentile and is the difference between the 25th and 75th percentile. The bottom of the vertical line on the box plot is the smallest value within 1.5 times the IQR of the box. The top of the vertical line is the largest value within 1.5 times the IQR of the box. Outside values, shown as □, are greater than 1.5 times the IQR from the box. The far out values, shown as o, are greater than 3 times the IQR from the box. The number at the top of the box plot is the number of data values used to construct the box plot. The period of record, in years, is listed above the number of data values. The number of data values and the period of record are important and need to be considered by the reader before conclusions are made about reasons for differences in water quality among stations.

Generally, concentrations of most of the water-quality properties and constituents were larger downstream, based on comparison of the box plots in figures 3 through 32 in the "Hydrologic Data" section. Box plots for cadmium are not included because it is the only constituent that for all stations either had more than 75 percent of the values less than the detection limit, or most of the summary statistics were estimated using methods described by Helsel and Conn (1988).

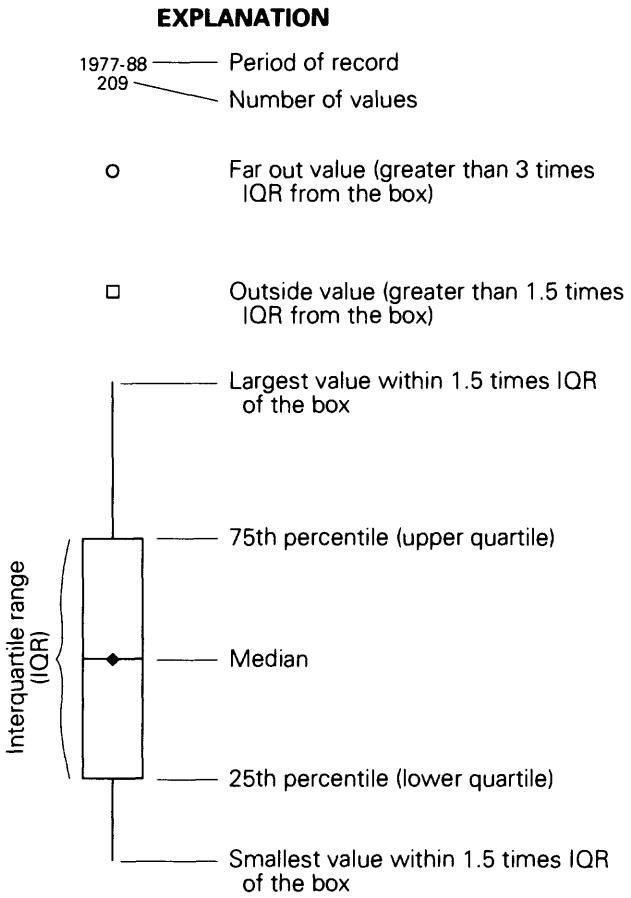

Figure 2.--Example diagram of a box plot.

Median values of instantaneous streamflow (fig. 3) were larger downstream on Monument Creek, and were larger downstream on Fountain Creek to Fountain Creek below CSWWTP. Streamflow was smaller at downstream stations on Fountain Creek because of irrigation withdrawals in this reach (Edelmann and Cain, 1985).

Median values of specific conductance (fig. 4) and median concentrations of dissolved chloride (fig. 11) and dissolved sulfate (fig. 12) were larger downstream on both creeks probably because of increasing urbanization, which increased wastewater effluent and urban runoff along Monument Creek (Edelmann, 1990, p. 15) and ground-water inflow and irrigation-return flow along Fountain Creek (Cain and Edelmann, 1986, p. 8). Median pH values (fig. 5) were smaller at station 07105530 Fountain Creek below CSWWTP. Median values of temperature (fig. 6) generally were higher downstream, and median dissolved-oxygen concentrations (fig. 7) generally were smaller downstream because of warmer stream temperatures. Median dissolved-oxygen concentrations were smaller downstream from the wastewater-treatment plant at Colorado Springs probably because of the smaller dissolved-oxygen concentrations in the effluent.

Median values of hardness, as calcium carbonate (fig. 8), and median concentrations of dissolved calcium (fig. 9), dissolved magnesium (fig. 10), and suspended solids (fig. 13) were larger downstream except at station 07105530 Fountain Creek below CSWWTP. Larger median concentations occurred downstream on Monument Creek probably because of wastewater effluent, tributary inflow from basins that drain sedimentary formations and erosive soils, and urbanization (Edelmann 1990). Larger median concentrations occurred downstream on Fountain Creek because of inflow from Monument Creek. The median concentrations are smaller at station 07105530 Fountain Creek below CSWWTP because of dilution, but the resulting streamflow increase from the effluent re-suspends sediments in the stream channel (Edelmann, 1990).

Median nutrient concentrations (figs. 14-19), except for nitrite plus nitrate as nitrogen, were largest at station 07105530 Fountain Creek below CSWWTP downstream from the wastewater-treatment plant at Colorado Springs because of the large volume of discharge from the wastewater-treatment plant (Kuhn, 1991). Median concentrations of nitrite plus nitrate as nitrogen (fig. 14) were larger downstream except at station 07105530 Fountain Creek below CSWWTP. The smaller concentration probably was due to the CSWWTP effluent containing small concentrations of nitrite plus nitrate as nitrogen, which resulted in dilution. Larger concentrations of nitrite plus nitrate downstream probably result primarily from nitrification of ammonia.

Median concentrations of most trace elements are larger downstream, probably because of water reuse. Median concentrations of total recoverable copper (fig. 20) and total recoverable zinc (fig. 28) were larger downstream except at station 07105905 Fountain Creek below Fountain. Median concentrations of total recoverable lead (fig. 23) were larger downstream except at station 07103780 Monument Creek at USAFA and at station 07105905 Fountain Creek below Fountain. Median concentrations of dissolved iron (fig. 21) were smaller downstream and concentrations of total recoverable iron (fig. 22) were larger downstream except at station 07105530 Fountain Creek below CSWWTP and then were larger again at station 07105905 Fountain Creek below Fountain. Median concentrations of dissolved manganese (fig. 24) were smaller downstream in Monument Creek except at station 07103780 Monument Creek at USAFA. Median concentrations of dissolved manganese (fig. 24) were larger downstream in Fountain Creek except at station 07106500 Fountain Creek at Pueblo. Median concentrations of total recoverable manganese (fig. 25) were larger downstream in both streams except at stations 07105530 Fountain Creek below CSWWTP and 07106500 Fountain Creek at Pueblo. Median concentrations of total recoverable nickel (fig. 26) were larger downstream except at station 07105905 Fountain Creek below Fountain and then were larger again at station 07106500 Fountain Creek at Pueblo. Median concentrations of total selenium (fig. 27) were substantially larger downstream from station 07105905 Fountain Creek below Fountain, possibly because of seleniferous beds in the shale bedrock (Cain and Edelmann, 1986).

Values of median 5-day biochemical oxygen demand (fig. 29) on Monument Creek were largest at station 07103780 Monument Creek at USAFA, which is downstream from the Palmer Lake Monument wastewater-treatment plant and were larger downstream on Fountain Creek except at station 07106500 Fountain Creek at Pueblo. Median bacterial counts (figs. 30-32) generally were larger downstream in Monument Creek. Median counts of fecal coliform bacteria (fig. 31)

were larger downstream to station 07105530 Fountain Creek below CSWWTP and then were smaller. Median counts of fecal streptococcus bacteria (fig. 32) were larger downstream except at station 07105905 Fountain Creek below Fountain and then were slightly larger at station 07105600 Fountain Creek at Pueblo.

Water-Quality Trends

Quantitative comparisons of median values of selected water-quality properties and concentrations of constituents were made among seven of the stations for water years 1980 through 1988. The stations analyzed were divided into two groups; the first group included three stations on Monument Creek: 07103747 Monument Creek at Palmer Lake, 07104000 Monument Creek at Pikeview, and 07104905 Monument Creek at Bijou. The second group included the most downstream station on Monument Creek, 07104905 Monument Creek at Bijou, and four stations on Fountain Creek: 07103700 Fountain Creek near Colorado Springs, 07105500 Fountain Creek at Colorado Springs, 07105530 Fountain Creek below CSWWTP, and 07105905 Fountain Creek below Fountain. Station 07104905 Monument Creek at Bijou was included in the second group of stations on Fountain Creek in order to compare the water-quality properties and concentrations of constituents of Monument Creek to the water-quality properties and concentrations of constituents of Fountain Creek because generally more than 50 percent of the streamflow in Fountain Creek is from Monument Creek (Doug Cain, U.S. Geological Survey, oral commun., 1990). Stations 07103780 Monument Creek at USAFA and 07106500 Fountain Creek at Pueblo were not included in the analysis because of insufficient data.

The comparisons were made using Tukey's studentized range test (SAS Institute Inc., 1985). Tukey's test was used to compare the median value of a water-quality property or constituent for all stations in a group. An alpha level of 0.05 was used to determine whether the median values were significantly different. The results are presented in table 2. Stations with the same letter or number are not significantly different. A, B, and C are used for the first group of stations; 1, 2, 3, 4, and 5 are used for the second group of stations. The lower the letter in the alphabet or the smaller the number, the smaller the median value. For example, the median water temperature at station 07104000 Monument Creek at Pikeview is not significantly different from the median water temperatures at stations 07103747 Monument Creek at Palmer Lake or 07104905 Monument Creek at Bijou, but the median water temperatures at 07103747 and 07104905 are significantly different from each other. The median values listed in this table may be different from the median values listed in tables 4 and 6-11 because of the period of record used.

Results of Tukey's test generally indicate that for Monument Creek, the median concentration of most constituents at station 07103747 Monument Creek at Palmer Lake is significantly different from stations 07104000 Monument Creek at Pikeview and 07104905 Monument Creek at Bijou, which are more similar to each other. The median concentration of most constituents at station 07103700 Fountain Creek near Colorado Springs, upstream from the mouth of Monument Creek, is significantly different from the median concentration of most constitiuents at downstream stations on Fountain Creek except for pH at station 07105500 Fountain Creek at Colorado Springs and for fecal coliform at

Table 2.--*Tukey's grouping and median values for streamflow and selected water-quality properties and constituents at selected water-quality stations, water years 1980 through 1988*

[07103747 Monument Creek at Palmer Lake; 07104000 Monument Creek at Pikeview; 07104905 Monument Creek at Bijou Street at Colorado Springs; 07103700 Fountain Creek near Colorado Springs; 07105500 Fountain Creek at Colorado Springs; 07105530 Fountain Creek below Janitell Road below Colorado Springs; 07105905 Fountain Creek above Little Fountain Creek below Fountain; ft^3/s, cubic feet per second; µS/cm, microsiemens per centimeter at 25 degrees Celsius; °C, degree Celsius; mg/L, milligrams per liter; µg/L, micrograms per liter; /100mL, colonies per 100 milliliters]

Property or constituent	Units	Monument Creek						Fountain Creek							
		Station 07103747		Station 07104000		Station 07104905		Station 07103700		Station 07105500		Station 07105530		Station 07105905	
		Tukey's grouping	Median	Tukey's grouping	Median	Tukey's grouping	Median	Tukey's grouping	Median	Tukey's grouping	Median	Tukey's grouping	Median	Tukey's grouping	Median
Instantaneous streamflow	ft^3/s	[1]A	3.1	B	23	B,2	25	1	13	3	40	5	93	4	82
Specific conductance	µS/cm	A	160	B	345	C,2	480	1	290	2	514	3	730	4	1,050
pH	standard	A	7.95	A	7.95	A,1	8.1	1	7.9	1	8.0	2	7.6	3	7.8
Water temperature	°C	A	8.0	A,B	11	B,2	13	1	7.5	2	13.5	2	13	2	14
Dissolved oxygen	mg/L	A	9.9	A	9.0	A,2,3	8.95	1	10.2	2	9.15	3,4	8.4	4	8.0
Suspended solids	mg/L	A	7	B	156	C,4	282	1	22	3	162	2	84	2,3	110
Nitrite plus nitrate as nitrogen	mg/L	A	[2].1	B	1.4	C,3	1.8	1	.8	2,3	1.6	2	1.3	4	3.7
Total ammonia as nitrogen	mg/L	A	.02	B	.13	B,2	.07	1	.035	2	.07	4	7.45	3	1.2
Un-ionized ammonia as nitrogen	mg/L	A	.00001	B	.0014	B,2	.0018	1	.0005	2	.001	4	.06	3	.012
Total recoverable copper	µg/L	A	3	B	8	C,3	11	1	4.5	2	10	3	15.5	3	13
Total recoverable iron	µg/L	A	575	B	4,400	C,4	6,800	1	905	3,4	4,550	2	2,150	3	3,400
Total recoverable zinc	µg/L	A	20	B	40	B	50	1	91	2	193	3	275	2	209
5-day biochemical oxygen demand	mg/L	A	.7	B	2.55	B,2	2.7	1	1.0	2	2.4	3	14	3	15
Fecal coliform bacteria	/100mL	A	5	B	58	B,1,2	175	1	90	1,2	180	2	375	1,2	150

[1]Median values at stations with the same letter or number are not significantly different at the alpha = 0.05 level. Tukey's test was run on two station groups; group one: 07103747, 07104000, and 07104905; group 2: 07104905, 07103700, 07105500, 07105530, and 07105905.

[2]The median value is 0.1, the detection limit.

stations 07105500 Fountain Creek at Colorado Springs and 07105905 Fountain Creek below Fountain. The median concentration of most constituents at station 07105500 Fountain Creek at Colorado Springs, downstream from the mouth of Monument Creek, is more similar to the median concentration of most constituents at station 07104905 Monument Creek at Bijou than to the median concentration of most constituents at station 07103700 Fountain Creek near Colorado Springs, indicating that the water quality of Monument Creek has a large effect on the water quality of Fountain Creek.

To determine the effect of the Colorado Springs Wastewater-Treatment Plant on the water quality of Fountain Creek, station 07105500 Fountain Creek at Colorado Springs, upstream from the wastewater-treatment plant, and station 07105530 Fountain Creek below CSWWTP were compared. Tukey's test results indicated that there were no statistically significant differences in the water quality between the two stations for the following property and constituents: water temperature, nitrite plus nitrate as nitrogen, and fecal coliform bacteria. The following properties and constituents had statistically significant increases downstream: instantaneous streamflow, specific conductance, total ammonia as nitrogen, un-ionized ammonia as nitrogen, total recoverable copper, total recoverable zinc, and 5-day BOD. The following properties and constituents had statistically significant decreases downstream: pH, dissolved oxygen, suspended solids, and total recoverable iron.

Time-Series Trends

Time-series trends at each station were analyzed to determine if changes in the values of water-quality properties and concentrations of constituents had occurred over time. Factors such as land use, water use, and climate in the basin can affect water quality. Detection of temporal trends in water quality can indicate changes in the factors that affect water quality.

Trend analysis of time-series data for water-quality properties and constituents is complicated by several common characteristics of the data: nonnormality, seasonality, serial dependence, and censoring. Nonnormal data cannot be described by a symmetrical, unimodal, bell-shaped distribution. Seasonal data have a natural sequential order over time and vary, depending on the time of year. Water-quality data often are serially dependent; the constituent concentration at one point in time is dependent upon and related to prior data. Censored data contain less-than values due to the detection limits of the analytical methods.

The seasonal Kendall test, which was used in this study to detect temporal trends in water quality, is based on methods developed by the U.S. Geological Survey (Hirsch and Slack, 1984). The seasonal Kendall test is a statistical technique unaffected by the problem characteristics described above (Hirsch and others, 1982; Hirsch and Slack, 1984). This technique is used to identify statistically significant monotonic changes (only increasing or only decreasing trends) in data over time. The technique also provides an estimate of the magnitude and direction of the change, which can be used to calculate the percent change in the median constituent concentration for the period of record. The seasonal Kendall test is a nonparametric statistical technique; the test statistic is determined by using ranks of the data rather than the actual data. Nonnormality of the data set and censored values are

not problems in a nonparametric approach because they do not affect the rank of the data. Trends are evaluated separately for each specified season (months were used in this study), and results are combined into a single test statistic (tau). The significance level (p-value) of tau then is adjusted to account for serial correlation.

In addition to testing the original data, the seasonal Kendall test can be used to identify trends in the time series of flow-adjusted concentrations. Flow adjustment would be used to eliminate the effect of correlation between streamflow and values of water-quality properties and constituent concentrations. This adjustment would decrease the possibility of erroneously concluding that the concentrations of a particular constituent have increased or decreased as a result of some change in land or water use in the basin when the change in concentration is a result of a change in flow conditions during the period of record. For this study, flow adjustments were not made to the concentration data because the changes in streamflow and the water-quality properties and constituents have probably resulted, at least in part, from human activity in the basin (for example, increases in discharge of wastewater effluent and urban runoff). Flow adjustment should not be used where human activity has altered the probability distribution of streamflow (Hirsch and others, 1991). Flow adjustments could erroneously remove the changes in values of water-quality properties and concentrations of constituents. Flow adjustment is not appropriate when the purpose of the study is to assess the effect of trends on the suitability of water for use by humans or aquatic organisms rather than to investigate the cause of the trend (Hirsch and others, 1991).

The seasonal Kendall test was applied to identify trends in the time series of each water-quality property and constituent at each station. For this study, the seasonal division was defined to be monthly because the water-quality sampling usually was done monthly. Results of the trend analyses are summarized in tables 13 through 21 in the "Hydrologic Data" section at the back of the report. The properties or constituents were included in these tables only if the data had the following characteristics:

1. At least 3 years of record.
2. At least 20 values were larger than or equal to the detection limit at stations 07104000 Monument Creek at Pikeview, 07104905 Monument Creek at Bijou, 07105500 Fountain Creek at Colorado Springs, and 07106500 Fountain Creek at Pueblo; or at least 30 values were larger than or equal to the detection limit at stations 07103747 Monument Creek at Palmer Lake, 07103780 Monument Creek at USAFA, 07103700 Fountain Creek near Colorado Springs, 07105530 Fountain Creek below CSWWTP, and 07105905 Fountain Creek below Fountain.
3. No more than 10 percent of the values were less than the detection limit (censored values).

Several significance levels are reported in the tables. The significance level of the trend test is the maximum probability of erroneously identifying a trend that does not actually exist. The significance level unadjusted for serial correlation is reported for all trends. If the period of record is 10 years or longer, the significance level adjusted for serial correlation also is reported. Generally, the adjusted significance level will be larger;

the trend is less significant because there is less information in serially correlated data. The difference between the unadjusted and adjusted significance levels increases as the strength of the serial correlation increases.

The trend slope listed in tables 13 through 21 is the seasonal Kendall slope estimator, as defined by Hirsch and others (1982). A negative trend slope indicates a decrease in the property or concentration of the constituent with time; a positive trend slope indicates an increase in the property or concentration of the constituent with time. The seasonal Kendall slope estimator, the trend slope, is the median of all possible differences in the time-series data within the same month and provides an estimate of the median annual change in the data.

In instances where the distribution of the data was highly skewed (the data distribution is asymmetrical; the mean is different from the median), a trend is unlikely to be linear; therefore, the trend-slope estimator computed from actual data values is not appropriate. Transforming the data to logarithms will linearize the trend if the annual changes are proportional to each other. The significance of the trend, which is based on the ranks of the data, is not affected by this transformation. Most of the trend analyses in this study were made on the actual data values; however, the logarithms of the number of colonies per 100 mL was used for trend analyses of all bacterial data. The trend slope for the bacterial data in tables 13 through 21 is the multiplicative change in median value each year because of the logarithm conversion. The change is not constant with time but increases or decreases with time. The change in median has been detransformed and is the overall change as a percentage of the estimated median for the first year of record in the original data units.

Significant trend slopes are identified in tables 13 through 21 by using the following criteria:

1. Moderately significant (*), if the significance level is less than or equal to 0.1 and greater than 0.05.
2. Significant (**), if the significance level is less than or equal to 0.05 and greater than 0.01.
3. Very significant (***), if the significance level is less than or equal to 0.01.

If the significance level (p-value) is greater than 0.1, there is a greater than 10-percent chance that there is no real trend. Selection of the significance level used in the above identification, if more than one significance level was reported for a property or constituent, was based on the order: (1) Significance level adjusted for serial correlation; and (2) unadjusted significance level, if there was no adjusted significance level reported.

For example, in table 13, the trend slope for water temperature is not significant. In table 13, the trend slope for pH was determined to be significant because the adjusted significance level (greater than 10 years of record) 0.0497 is less than or equal to 0.05 and greater than 0.01. Also in table 13, the trend slope for fecal streptococcus is very significant because the unadjusted significance level is 0.0100.

A summary of significant trends for all stations is listed in table 3. Several general observations about trends in the study area can be made from the results in this table. Instantaneous streamflow had positive trends except at station 07103780 Monument Creek at USAFA. Streamflow may have substantial daily variation but the instantaneous streamflows at time of sampling were characteristic of the mean daily streamflows (Edelmann, 1990). The frequency curves of the instantaneous measured streamflows from 1975 through 1983 were nearly identical to the mean daily streamflow-duration curves except for the extremely large and small streamflows. Specific conductance had variable trends. Stations 07103780 Monument Creek at USAFA and 07104905 Monument Creek at Bijou had positive trends, whereas stations 07103747 Monument Creek at Palmer Lake, 07103700 Fountain Creek near Colorado Springs, 07105500 Fountain Creek at Colorado Springs, 07105905 Fountain Creek below Fountain, and 07106500 Fountain Creek at Pueblo had negative trends. pH and concentrations of dissolved sulfate, nitrite plus nitrate as nitrogen, and un-ionized ammonia as nitrogen had positive trends at stations that had a significant trend. Concentrations of total ammonia as nitrogen, total ammonia plus organic nitrogen, total recoverable copper, dissolved manganese, and total recoverable nickel had negative trends at stations that had a significant trend. The other metals had variable trends at stations that had a significant trend. Concentrations of 5-day BOD had positive trends at two of three upstream stations on Monument Creek and negative trends at some of the downstream stations. Fecal coliform and fecal streptococcus had negative trends at all stations that had a significant trend except for fecal coliform at station 07105530 Fountain Creek below CSWWTP, which had a positive trend.

The trends considered to be very significant are plotted in figures 33 through 55 in the "Hydrologic Data" section. The trend plots include the data, the smooth line, and the trend line. The smooth line, or lowess curve, is an estimate of the weighted moving average of the water-quality property or constituent with time (Chambers and others, 1983). The trend line describes the linear change in the water-quality property or constituent for the period of record. Because of the variability in the data, the smooth line and the trend line help show the trend in the data. Many of the plotted trends are probably related to changes in pH and increases in wastewater discharge from treatment plants.

SUMMARY

Water-quality data were collected at four stations on Monument Creek and five stations on Fountain Creek during water years 1976 through 1988. These data were used to determine variations and trends in water-quality properties and constituents. A comparison of water quality among all stations was made qualitatively using box plots. Only qualitative comparisons could be made because the number of data values and period of record were different for each station. Water-quality trends for Monument Creek at Palmer Lake, Monument Creek at Pikeview, Monument Creek at Bijou Street at Colorado Springs, Fountain Creek near Colorado Springs, Fountain Creek at Colorado Springs, Fountain Creek below Janitell Road below Colorado Springs, and Fountain Creek above Little Fountain Creek below Fountain, for water years 1980 through 1988, also were evaluated. Time-series trends at each station were done to determine if changes in water-quality conditions occurred during the period of record at each station.

Table 3.--*Summary of significant trends for selected water-quality properties and constituents*

[07103747 Monument Creek at Palmer Lake; 07103780 Monument Creek above North Gate Boulevard at U.S. Air Force Academy; 07104000 Monument Creek at Pikeview; 07104905 Monument Creek at Bijou Street at Colorado Springs; 07103700 Fountain Creek near Colorado Springs; 07105500 Fountain Creek at Colorado Springs; 07105530 Fountain Creek below Janitell Road below Colorado Springs; 07105905 Fountain Creek above Little Fountain Creek below Fountain; 07106500 Fountain Creek at Pueblo; (+), significant positive trend; (-), significant negative trend; *, moderately significant trend, the significance level is less than or equal to 0.1 and greater than 0.05; **, significant trend, the significance level is less than or equal to 0.05 and greater than 0.01; ***, very significant trend, the significance level is less than or equal to 0.01; o, trend not significant; --, insufficient data]

Property or constituent	Significant trends by station								
	07103747	07103780	07104000	07104905	07103700	07105500	07105530	07105905	07106500
Instantaneous streamflow	(+),*	(-),***	(+),***	(+),**	(+),**	(+),**	(+),*	(+),**	(+),**
Specific conductance	(-),**	(+),***	o	(+),*	(-),*	(-),**	o	(-),**	(-),**
pH	(+),**	(+),***	(+),**	(+),***	o	(+),**	(+),**	(+),*	(+),***
Water temperature	o	(+),*	o	o	(-),*	o	o	o	o
Dissolved oxygen	o	(-),*	o	o	(+),*	o	o	o	(+),***
Hardness as calcium carbonate	--	--	--	--	--	--	o	--	--
Dissolved calcium	--	--	--	--	--	--	o	--	--
Dissolved magnesium	--	--	--	--	--	--	o	--	--
Dissolved chloride	o	(+),***	o	(+),***	o	o	(-),*	o	--
Dissolved sulfate	o	(+),**	o	(+),***	o	o	--	o	--
Suspended solids	--	(-),***	(+),**	o	o	o	o	o	(-),**
Nitrite plus nitrate as nitrogen	--	(+),**	(+),***	(+),***	o	o	o	(+),**	(+),***
Total ammonia as nitrogen	--	o	--	--	--	--	o	(-),*	o
Un-ionized ammonia as nitrogen	o	(+),***	(+),***	(+),**	o	o	(+),**	o	(+),*
Total ammonia plus organic nitrogen	--	o	o	(-),***	(-),*	(-),**	o	(-),*	(-),*
Total organic nitrogen as nitrogen	o	(+),**	o	(-),**	o	o	(-),*	o	o
Total phosphorus	--	--	o	o	o	o	o	o	--
Total recoverable copper	o	o	o	(-),***	(-),*	(-),**	o	o	o
Dissolved iron	o	o	--	--	o	--	o	--	--
Total recoverable iron	o	(-),**	(+),**	o	o	o	o	o	o
Total recoverable lead	--	--	--	o	--	--	--	--	o
Dissolved manganese	o	o	--	--	o	(-),*	o	--	--
Total recoverable manganese	o	o	(+),*	o	o	(-),***	(-),*	o	(+),*
Total recoverable nickel	--	--	o	o	--	o	(-),**	(-),*	o
Total selenium	--	--	o	o	--	o	o	o	o
Total recoverable zinc	--	--	o	o	(-),*	(-),***	(-),**	o	(+),*
5-day biochemical oxygen demand	o	(+),*	(+),*	(-),**	o	(-),**	o	o	(-),***
Fecal coliform	--	o	--	o	(-),**	o	(+),*	(-),***	o
Fecal streptococcus	(-),***	o	(-),*	o	o	(-),**	o	(-),*	o

Median values of the water-quality properties and constituents were compared to the appropriate State water-quality standards. Median values of the water-quality properties and constituents were within the State standards except for the following trace-metal concentrations: dissolved manganese at Monument Creek above North Gate Boulevard at U.S. Air Force Academy and Fountain Creek above Little Fountain Creek below Fountain; total recoverable copper at Monument Creek at Pikeview and Monument Creek at Bijou Street at Colorado Springs; and total selenium at Fountain Creek at Pueblo. Occasional violations of the State water-quality standards occurred at all stations.

Generally, concentrations of most water-quality properties and constituents were larger downstream. Nutrient concentrations, except for nitrite plus nitrate as nitrogen, were largest at Fountain Creek below Janitell Road below Colorado Springs, which is downstream from the wastewater-treatment plant at Colorado Springs; the concentrations then were smaller downstream.

Statistical comparisons of median values of selected water-quality properties and constituents for determining spatial trends were made among seven of the nine stations for water years 1980 through 1988. For Monument Creek, the comparisons indicated that the median concentrations of most constituents at Monument Creek at Palmer Lake were significantly different from the median concentrations at Monument Creek at Pikeview and Monument Creek at Bijou Street at Colorado Springs, which are more similar to each other. The median concentrations of most constituents at Fountain Creek near Colorado Springs, upstream from the mouth of Monument Creek, were significantly different from the median concentrations of most constituents at downstream stations on Fountain Creek, except for a few constituents. The median concentrations of most constituents at Fountain Creek at Colorado Springs, downstream from the mouth of Monument Creek, were more similar to the median concentrations of most constituents at Monument Creek at Bijou Street at Colorado Springs than to the median concentrations of most constituents at Fountain Creek near Colorado Springs; the water quality of Monument Creek has a large effect on the water quality of Fountain Creek.

Water quality at Fountain Creek at Colorado Springs and Fountain Creek below Janitell Road below Colorado Springs, upstream and downstream from the Colorado Springs Wastewater-Treatment Plant, were compared. The following property and constituents were not statistically different: water temperature, nitrite plus nitrate as nitrogen, and fecal coliform bacteria. The following properties and constituents had statistically significant increases downstream: instantaneous streamflow, specific conductance, total ammonia as nitrogen, un-ionized ammonia as nitrogen, total recoverable copper, total recoverable zinc, and 5-day biochemical oxygen demand. The following properties and constituents had statistically significant decreases downstream: pH, dissolved oxygen, suspended solids, and total recoverable iron.

Time-series trends in water quality were investigated at all stations for the period of record. The significant trends varied at each station. All stations except Monument Creek above North Gate Boulevard at U.S. Air Force Academy had positive trends in instantaneous streamflow. pH, and concentrations of dissolved sulfate, nitrite plus nitrate as nitrogen, and un-ionized ammonia as nitrogen had positive trends at all stations that had a significant trend. Concentrations of total ammonia plus organic nitrogen, total recoverable copper, dissolved manganese, and total recoverable nickel had negative trends at stations that had a significant trend. All stations on Monument and Fountain Creeks had significant temporal trends of at least one water-quality property or constituent.

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HYDROLOGIC DATA

Table 4.--*Summary statistics for streamflow and selected water-quality properties and constituents at water-quality station 07103747 Monument Creek at Palmer Lake*

[ft^3/s, cubic feet per second; µS/cm, microsiemens per centimeter at 25 degrees Celsius; °C, degree Celsius; mg/L, milligrams per liter; µg/L, micrograms per liter; /100 mL, colonies per 100 milliliters; ---, no stream standard; E, estimated using methods described by Helsel and Cohn (1988); <, less than; --, insufficient data]

Property or constituent	Units	Number of values	Number of censored values	Period of record (water year)	Mean	Standard deviation	Minimum	Lower quartile	Median	Upper quartile	Maximum	Water-quality standard[1]
Instantaneous streamflow	ft^3/s	209	0	1977-88	8.9	22	0.1	0.9	1.9	6.8	168	---
Specific conductance	µS/cm	206	0	1977-88	162	45	55	130	164	198	250	---
pH	standard	95	0	1977-88	7.8	0.5	6.5	7.5	7.9	8.1	9.0	6.5-9.0
Water temperature	°C	209	0	1977-88	9.6	7.0	0.0	3.0	9.0	15.0	25.0	---
Dissolved oxygen	mg/L	94	0	1977-88	9.6	1.9	6.1	8.1	9.7	11.0	13.6	5.0
Dissolved chloride	mg/L	83	0	1977-88	3.3	1.4	0.2	2.1	3.3	4.3	7.3	250
Dissolved sulfate	mg/L	78	0	1977-88	11	2.3	6.6	10	11	13	18	250
Suspended solids	mg/L	93	11	1977-88	17 E	35 E	<1	2	6	14	270	---
Nitrite plus nitrate as nitrogen	mg/L	97	39	1977-88	0.09 E	0.08 E	0.01	0.03 E	0.06	0.10	0.33	10
Total ammonia as nitrogen	mg/L	98	36	1977-88	0.02 E	0.04 E	<0.01	0.01 E	0.01	0.03	0.23	---
Un-ionized ammonia as nitrogen	mg/L	59	0	1977-88	0.00049	0.00058	0.00010	0.00011	0.00029	0.00068	0.0028	0.1
Total ammonia plus organic nitrogen	mg/L	56	10	1984-88	0.35 E	0.19 E	<0.20	0.20	0.30	0.40	0.90	---
Total organic nitrogen as nitrogen	mg/L	32	0	1984-88	0.34	0.17	0.16	0.25	0.28	0.40	0.84	---
Total phosphorus	mg/L	37	7	1977-80	0.03 E	0.04 E	<0.01	0.01	0.01	0.03	0.19	---
Total cadmium	µg/L	64	55	1977-88	--	--	<1	--	--	--	2 1	0.4
Total recoverable copper	µg/L	65	5	1978-88	3 E	2 E	<1	2	3	5	13	7
Dissolved iron	µg/L	54	0	1984-88	110	60	20	70	100	140	280	300
Total recoverable iron	µg/L	68	0	1977-88	1,100	1,400	40	350	520	1,100	7,800	4,400
Total recoverable lead	µg/L	65	27	1977-88	4 E	5 E	<1	1 E	2	5	35	6
Dissolved manganese	µg/L	56	3	1984-88	46 E	28 E	<10	20	40	60	130	50
Total recoverable manganese	µg/L	68	0	1977-88	68	38	30	40	70	90	230	1,000
Total recoverable zinc	µg/L	66	28	1977-88	20 E	30 E	2	6 E	10	30	180	50
5-day biochemical oxygen demand	mg/L	79	0	1977-88	0.8	0.7	0.1	0.4	0.6	0.8	5.0	---
Total coliform bacteria	/100 mL	7	0	1985	--	--	80	--	--	--	720	---
Fecal coliform bacteria	/100 mL	82	9	1977-88	77 E	280 E	<1	3	10	42	1,800	2,000
Fecal streptococcus bacteria	/100 mL	47	0	1985-88	110	150	2	10	40	170	620	---

[1]For stream segment 6 (Colorado Department of Health, 1989).
[2]Detection limit of analyzing equipment; may not be an exceedance of standard.

Table 5.--*Summary statistics for streamflow and selected water-quality properties and constituents at water-quality station 07103780 Monument Creek above North Gate Boulevard at U.S. Air Force Academy*

[ft^3/s, cubic feet per second; µS/cm, microsiemens per centimeter at 25 degrees Celsius; °C, degree Celsius; mg/L, milligrams per liter; µg/L, micrograms per liter; /100 mL, colonies per 100 milliliters; ---, no stream standard; E, estimated using methods described by Helsel and Cohn (1988); <, less than; --, insufficient data]

Property or constituent	Units	Number of values	Number of censored values	Period of record (water year)	Mean	Standard deviation	Minimum	Lower quartile	Median	Upper quartile	Maximum	Water-quality standard[1]
Instantaneous streamflow	ft^3/s	93	0	1984-88	24	40	1.4	4.8	11	22	261	---
Specific conductance	µS/cm	87	0	1984-88	223	74	100	158	228	262	501	---
pH	standard	58	0	1984-88	8.0	0.4	7.1	7.7	7.9	8.2	9.3	6.5-9.0
Water temperature	°C	88	0	1984-88	10.3	8.1	0.0	2.0	10.5	16.5	29.0	---
Dissolved oxygen	mg/L	59	0	1984-88	9.9	1.7	6.7	8.6	9.9	11.2	14.2	5.0
Dissolved chloride	mg/L	61	0	1984-88	10	5.0	3.2	6.2	9.0	13	28	250
Dissolved sulfate	mg/L	56	0	1984-88	22	14	11	15	19	25	110	250
Suspended solids	mg/L	56	1	1984-88	44 E	61 E	<1	8.2	20	64	376	---
Nitrite plus nitrate as nitrogen	mg/L	61	0	1984-88	0.60	0.36	0.10	0.30	0.50	0.80	1.4	10
Total ammonia as nitrogen	mg/L	61	3	1984-88	0.85 E	1.2 E	<0.01	0.15	0.40	1.05	7.1	---
Un-ionized ammonia as nitrogen	mg/L	55	0	1984-88	0.011	0.012	0.00035	0.0028	0.0082	0.013	0.06	0.1
Total ammonia plus organic nitrogen	mg/L	56	0	1984-88	1.7	1.4	0.40	0.82	1.3	2.0	8.1	---
Total organic nitrogen as nitrogen	mg/L	54	0	1984-88	0.87	0.51	0.10	0.57	0.78	1.1	3.4	---
Total cadmium	µg/L	55	45	1984-88	--	--	<1	--	--	--	3	2
Total recoverable copper	µg/L	56	0	1984-88	5	2	1	3	4	6	11	7
Dissolved iron	µg/L	56	1	1984-88	120 E	100 E	<10	50	90	160	580	300
Total recoverable iron	µg/L	56	0	1984-88	1,400	1,400	310	620	920	2,000	6,400	8,200
Total recoverable lead	µg/L	56	29	1984-88	5 E	14 E	<1	1 E	2 E	5	100	30
Dissolved manganese	µg/L	56	0	1984-88	73	41	10	40	70	90	250	50
Total recoverable manganese	µg/L	56	0	1984-88	160	280	50	90	110	160	2,200	1,000
Total recoverable zinc	µg/L	56	16	1984-88	21 E	21 E	<10	10 E	20	30	130	60
5-day biochemical oxygen demand	mg/L	44	0	1984-88	4.3	1.8	1.1	2.7	4.0	5.9	8.4	---
Total coliform bacteria	/100 mL	7	0	1985-88	--	--	13	--	--	--	470	---
Fecal coliform bacteria	/100 mL	44	3	1985-88	51 E	73 E	<2	8	24	68	400	2,000
Fecal streptococcus bacteria	/100 mL	47	0	1985-88	150	200	2	35	64	160	790	---

[1]For stream segment 7 (Colorado Department of Health, 1989).

Table 6.--*Summary statistics for streamflow and selected water-quality properties and constituents at water-quality station 07104000 Monument Creek at Pikeview*

[ft^3/s, cubic feet per second; µS/cm, microsiemens per centimeter at 25 degrees Celsius; °C, degree Celsius; mg/L, milligrams per liter; µg/L, micrograms per liter; /100 mL, colonies per 100 milliliters; ---, no stream standard; E, estimated using methods described by Helsel and Cohn (1988); <, less than; --, insufficient data]

Property or constituent	Units	Number of values	Number of censored values	Period of record (water year)	Mean	Standard deviation	Minimum	Lower quartile	Median	Upper quartile	Maximum	Water-quality standard[1]
Instantaneous streamflow	ft^3/s	249	0	1976-88	33	52	1.1	8.8	17	35	410	---
Specific conductance	µS/cm	243	0	1976-88	335	88	105	285	340	398	690	---
pH	standard	147	0	1976-88	7.8	0.4	6.8	7.6	7.9	8.1	8.7	6.5-9.0
Water temperature	°C	244	0	1976-88	12.2	8.6	0.0	5.0	12.0	19.0	30.0	---
Dissolved oxygen	mg/L	146	0	1976-88	9.2	2.0	5.6	7.5	8.8	10.9	15.0	5.0
Hardness as calcium carbonate	mg/L	15	0	1976-82	130	31	81	93	120	160	170	---
Dissolved calcium	mg/L	15	0	1976-82	40	10	25	30	40	50	55	---
Dissolved magnesium	mg/L	15	0	1976-82	6.1	1.3	4.1	4.5	6.3	7.3	8.0	---
Dissolved chloride	mg/L	104	0	1977-88	13	7.2	0.20	9.6	12	15	69	250
Dissolved sulfate	mg/L	99	0	1977-88	55	19	18	41	56	67	100	250
Suspended solids	mg/L	136	3	1977-88	271 E	466 E	<1	54	131	257	3,980	---
Nitrite plus nitrate as nitrogen	mg/L	150	0	1976-88	1.3	0.67	0.18	0.70	1.3	1.8	2.9	10
Total ammonia as nitrogen	mg/L	150	23	1976-88	0.26 E	0.50 E	<0.01	0.02	0.08	0.23	3.3	---
Un-ionized ammonia as nitrogen	mg/L	124	0	1976-88	0.0039	0.0071	0.000020	0.00057	0.0013	0.0036	0.036	0.1
Total ammonia plus organic nitrogen	mg/L	99	0	1976-88	1.2	0.95	0.20	0.60	1.0	1.5	6.6	---
Total organic nitrogen as nitrogen	mg/L	95	0	1976-88	0.96	0.76	0.19	0.56	0.80	1.10	6.40	---
Total phosphorus	mg/L	65	1	1976-82	0.24 E	0.19 E	<0.01	0.11	0.16	0.31	0.86	---
Total cadmium	µg/L	102	74	1976-88	0.72 E	1.2 E	<1	0.3 E	0.5 E	1	7	2
Total recoverable copper	µg/L	103	2	1976-88	11 E	10 E	<1	5	8	13	79	7
Dissolved iron	µg/L	81	10	1976-88	81 E	380 E	<10	20	30	50	3,400	300
Total recoverable iron	µg/L	110	0	1976-88	6,500	9,700	150	2,400	3,600	7,000	86,000	8,200
Total recoverable lead	µg/L	102	16	1976-88	13 E	19 E	<1	3	8	14	140	30
Dissolved manganese	µg/L	84	14	1981-88	24 E	21 E	6	10	20	30	160	50
Total recoverable manganese	µg/L	110	0	1976-88	190	230	20	80	130	200	1,900	1,000
Total recoverable nickel	µg/L	23	2	1981-83	4 E	3 E	<1	3	4	6	15	100
Total selenium	µg/L	26	2	1976-83	2 E	1 E	<1	1	2	2	3	10
Total recoverable zinc	µg/L	107	4	1976-88	60 E	70 E	2	30	40	70	520	60
5-day biochemical oxygen demand	mg/L	127	0	1976-88	2.8	2.8	0.1	0.9	1.9	4.0	15	---
Total coliform bacteria	/100 mL	9	0	1985	--	--	60	--	--	--	1,600	---
Fecal coliform bacteria	/100 mL	94	10	1976-88	370 E	1,100 E	<1	8	35	170	7,900	2,000
Fecal streptococcus bacteria	/100 mL	48	0	1985-88	400	370	43	100	230	630	1,800	---

[1]For stream segment 7 (Colorado Department of Health, 1989).

Table 7.--*Summary statistics for streamflow and selected water-quality properties and constituents at water-quality station 07104905 Monument Creek at Bijou Street at Colorado Springs*

[ft^3/s, cubic feet per second; µS/cm, microsiemens per centimeter at 25 degrees Celsius; °C, degree Celsius; mg/L, milligrams per liter; µg/L, micrograms per liter; /100 mL, colonies per 100 milliliters; ---, no stream standard; E, estimated using methods described by Helsel and Cohn (1988); <, less than]

Property or constituent	Units	Number of values	Number of censored values	Period of record (water year)	Mean	Standard deviation	Minimum	Lower quartile	Median	Upper quartile	Maximum	Water-quality standard[1]
Instantaneous streamflow	ft^3/s	100	0	1980-88	47	87	7.5	16	25	46	800	---
Specific conductance	µS/cm	100	0	1980-88	478	141	130	380	480	587	755	---
pH	standard	95	0	1980-88	8.0	0.3	7.2	7.8	8.1	8.2	8.5	6.5-9.0
Water temperature	°C	100	0	1980-88	12.6	8.8	0.0	5.1	13.0	19.2	31.5	---
Dissolved oxygen	mg/L	98	0	1980-88	9.2	2.0	5.3	7.6	9.0	11.0	13.2	5.0
Hardness as calcium carbonate	mg/L	12	0	1981-82	190	50	120	137	210	240	260	---
Dissolved calcium	mg/L	12	0	1981-82	58	15	37	42	64	72	75	---
Dissolved magnesium	mg/L	12	0	1981-82	12	3.4	6.8	8.0	14	14	17	---
Dissolved chloride	mg/L	69	0	1983-88	16	8.4	3.7	12	15	18	61	250
Dissolved sulfate	mg/L	69	0	1983-88	95	40	22	64	99	120	180	250
Suspended solids	mg/L	99	1	1980-88	463 E	613 E	<1	146	282	516	3,460	---
Nitrite plus nitrate as nitrogen	mg/L	100	0	1980-88	1.9	1.06	0.12	1.0	1.8	2.5	5.8	10
Total ammonia as nitrogen	mg/L	99	10	1980-88	0.15 E	0.19 E	<0.01	0.03	0.07	0.18	1.1	---
Un-ionized ammonia as nitrogen	mg/L	84	0	1980-88	0.0034	0.0038	0.000050	0.00088	0.0024	0.0042	0.023	0.1
Total ammonia plus organic nitrogen	mg/L	90	1	1981-88	1.2 E	0.72 E	<0.20	0.70	1.0	1.5	4.2	---
Total organic nitrogen as nitrogen	mg/L	81	0	1981-88	1.0	0.62	0.01	0.61	0.85	1.2	3.8	---
Total phosphorus	mg/L	20	0	1980-82	0.28	0.17	0.07	0.16	0.23	0.39	0.65	---
Total cadmium	µg/L	94	65	1980-88	0.7 E	0.7 E	<1	0.49 E	0.71 E	1	6	2
Total recoverable copper	µg/L	95	0	1980-88	18	23	4	9	11	18	150	7
Dissolved iron	µg/L	78	13	1981-88	40 E	60 E	<10	10	20	40	530	300
Total recoverable iron	µg/L	95	1	1980-88	11,000	14,000	<10	3,900	6,800	12,000	86,000	8,200
Total recoverable lead	µg/L	95	9	1980-88	18 E	19 E	<1	6	12	22	110	30
Dissolved manganese	µg/L	81	37	1981-88	11 E	7 E	5	6 E	9	10	30	50
Total recoverable manganese	µg/L	95	0	1980-88	270	310	10	120	170	280	2,200	1,000
Total recoverable nickel	µg/L	23	0	1981-83	8	4	3	5	8	10	21	100
Total selenium	µg/L	23	0	1981-83	3	1	1	2	3	4	6	10
Total recoverable zinc	µg/L	94	1	1980-88	80 E	80 E	<10	40	50	80	500	60
5-day biochemical oxygen demand	mg/L	81	0	1980-88	3.8	3.2	0.5	1.5	2.7	5.0	19	---
Total coliform bacteria	/100 mL	16	0	1984-85	6,100	20,000	130	440	1,200	1,600	80,000	---
Fecal coliform bacteria	/100 mL	53	4	1980-88	920 E	2,400 E	<4	28	170	640	16,000	2,000
Fecal streptococcus bacteria	/100 mL	49	1	1984-88	1,800 E	5,200 E	38	190	500	1,350	35,000	---

[1]For stream segment 7 (Colorado Department of Health, 1989).

Table 8.--*Summary statistics for streamflow and selected water-quality properties and constituents at water-quality station 07103700 Fountain Creek near Colorado Springs*

[ft^3/s, cubic feet per second; µS/cm, microsiemens per centimeter at 25 degrees Celsius; °C, degree Celsius; mg/L, milligrams per liter; µg/L, micrograms per liter; /100 mL, colonies per 100 milliliters; ---, no stream standard; E, estimated using methods described by Helsel and Cohn (1988); <, less than; --, insufficient data]

Property or constituent	Units	Number of values	Number of censored values	Period of record (water year)	Mean	Standard deviation	Minimum	Lower quartile	Median	Upper quartile	Maximum	Water-quality standard[1]
Instantaneous streamflow	ft^3/s	267	0	1976-88	17	20	3.8	7.8	10	16	172	---
Specific conductance	µS/cm	259	0	1976-88	313	92	100	258	315	360	750	---
pH	standard	140	0	1976-88	7.9	0.3	7.1	7.7	7.9	8.2	8.5	6.5-9.0
Water temperature	°C	262	0	1976-88	8.6	5.7	0.0	4.0	8.5	13.5	22.0	---
Dissolved oxygen	mg/L	145	0	1976-88	10.0	1.6	6.2	8.9	10.0	11.2	15.3	[2]6.0-(7.0)
Hardness as calcium carbonate	mg/L	15	0	1976, 1981	110	27	54	96	120	130	160	---
Dissolved calcium	mg/L	15	0	1976, 1981	35	8.2	17	29	37	39	50	---
Dissolved magnesium	mg/L	15	0	1976, 1981	6.8	1.7	2.9	5.8	7.4	7.7	9.1	---
Dissolved chloride	mg/L	103	0	1977-88	14	8.6	2.6	9.9	13	17	77	250
Dissolved sulfate	mg/L	98	0	1977-88	17	3.9	5.8	15	17	20	26	250
Suspended solids	mg/L	134	7	1977-88	61 E	129 E	<1	7	21	49	780	---
Nitrite plus nitrate as nitrogen	mg/L	148	0	1976-88	0.81	0.27	0.20	0.61	0.80	1.0	1.7	10
Total ammonia as nitrogen	mg/L	147	38	1976-88	0.05 E	0.06 E	<0.01	0.01	0.02	0.05	0.45	---
Un-ionized ammonia as nitrogen	mg/L	104	0	1976-88	0.00091	0.0012	0.000020	0.00028	0.00057	0.0011	0.0096	20
Total ammonia plus organic nitrogen	mg/L	100	9	1976-88	0.81 E	1.83 E	0.14	0.30	0.50	0.74	17	---
Total organic nitrogen as nitrogen	mg/L	74	0	1976-88	0.87	2.10	0.11	0.32	0.47	0.74	17	---
Total phosphorus	mg/L	63	6	1976-82	0.05 E	0.05 E	<0.01	0.02	0.04	0.07	0.31	---
Total cadmium	µg/L	100	78	1976-88	--	--	<1	--	--	--	17	1.4
Total recoverable copper	µg/L	102	3	1976-88	6 E	6 E	<1	3	4	7	39	10
Dissolved iron	µg/L	82	5	1976-88	77 E	110 E	<10	40	57	72	790	300
Total recoverable iron	µg/L	109	0	1976-88	2,400	6,200	140	510	870	2,000	58,000	1,350
Total recoverable lead	µg/L	102	30	1976-88	7 E	8 E	<1	2 E	4	8	53	25
Dissolved manganese	µg/L	85	0	1976-88	48	23	10	30	45	60	160	50
Total recoverable manganese	µg/L	109	0	1976-88	150	280	40	80	100	140	2,900	1,000
Total recoverable nickel	µg/L	24	4	1981-82	4	4	<1	2	3	4	22	100
Total selenium	µg/L	27	24	1976-82	--	--	<1	--	--	--	3	10
Total recoverable zinc	µg/L	102	7	1976-88	40 E	30 E	<10	20	30	40	240	50
5-day biochemical oxygen demand	mg/L	123	0	1976-88	1.3	1.4	0.1	0.7	0.9	1.4	11	---
Total coliform bacteria	/100 mL	16	0	1984-85	2,000	5,600	25	140	500	1,300	23,000	---
Fecal coliform bacteria	/100 mL	105	1	1976-88	930 E	4,800 E	2	24	140	420	46,000	2,000
Fecal streptococcus bacteria	/100 mL	54	0	1984-88	380	420	7	52	220	470	1,600	---

[1]For stream segment 1 (Colorado Department of Health, 1989).
[2]The larger value applies during periods of spawning of cold-water fish.

Table 9.--*Summary statistics for streamflow and selected water-quality properties and constituents at water-quality station 07105500 Fountain Creek at Colorado Springs*

[ft^3/s, cubic feet per second; µS/cm, microsiemens per centimeter at 25 degrees Celsius; °C, degree Celsius; mg/L, milligrams per liter; µg/L, micrograms per liter; /100 mL, colonies per 100 milliliters; ---, no stream standard; E, estimated using methods described by Helsel and Cohn (1988); <, less than]

Property or constituent	Units	Number of values	Number of censored values	Period of record (water year)	Mean	Standard deviation	Minimum	Lower quartile	Median	Upper quartile	Maximum	Water-quality standard[1]
Instantaneous streamflow	ft^3/s	306	0	1976-88	70	150	3.0	18	33	63	1,630	---
Specific conductance	µS/cm	283	0	1976-88	583	208	152	435	592	700	1,280	---
pH	standard	139	0	1976-88	7.9	0.3	6.7	7.7	7.9	8.1	8.6	6.5-9.0
Water temperature	°C	285	0	1976-88	13.0	8.1	0.0	5.0	13	20.0	28.5	---
Dissolved oxygen	mg/L	141	0	1976-88	9.3	1.7	6.2	8.0	9.1	10.6	13.5	5.0
Hardness as calcium carbonate	mg/L	15	0	1976-84	200	64	98	152	210	260	290	---
Dissolved calcium	mg/L	15	0	1976-84	56	17	29	43	59	72	80	---
Dissolved magnesium	mg/L	15	0	1976-84	14	5.5	6.3	10	15	19	22	---
Dissolved chloride	mg/L	110	0	1977-88	20	11	4.1	13	19	24	100	250
Dissolved sulfate	mg/L	98	0	1977-88	130	71	14	68	120	160	390	600
Suspended solids	mg/L	133	0	1977-88	266	353	1	62	149	316	2,210	---
Nitrite plus nitrate as nitrogen	mg/L	139	0	1976-88	1.6	0.76	0.30	1.0	1.4	2.1	3.9	10
Total ammonia as nitrogen	mg/L	139	15	1976-88	0.42 E	1.33 E	<0.01	0.03	0.08	0.27	14	---
Un-ionized ammonia as nitrogen	mg/L	119	0	1976-88	0.0065	0.015	0.000020	0.00067	0.0017	0.0044	0.13	---
Total ammonia plus organic nitrogen	mg/L	97	1	1976-88	1.1 E	0.74 E	<0.20	0.60	0.90	1.4	3.8	---
Total organic nitrogen as nitrogen	mg/L	86	1	1976-88	0.87 E	0.53 E	<0.01	0.54	0.76	1.0	3.4	---
Total phosphorus	mg/L	64	0	1976-82	0.50	0.66	0.02	0.13	0.33	0.58	4.6	---
Total cadmium	µg/L	99	72	1976-88	0.67 E	0.55 E	<1	0.53 E	0.71 E	0.97 E	4	10
Total recoverable copper	µg/L	100	1	1977-88	12 E	10 E	<1	6	10	14	83	200
Dissolved iron	µg/L	79	11	1976-88	160 E	390 E	<10	17	30	70	2,500	300
Total recoverable iron	µg/L	105	0	1976-88	6,300	8,400	200	2,000	4,300	6,900	69,000	---
Total recoverable lead	µg/L	100	12	1976-88	16 E	29 E	<1	4	8	19	250	50
Dissolved manganese	µg/L	81	4	1976-88	64 E	52 E	<10	30	50	80	290	150
Total recoverable manganese	µg/L	104	0	1976-88	250	240	70	150	200	260	2,300	---
Total recoverable nickel	µg/L	23	1	1981-83	6 E	3 E	<1	4	6	8	16	200
Total selenium	µg/L	24	1	1976-83	3 E	1 E	<1	2	3	4	7	10
Total recoverable zinc	µg/L	103	0	1976-88	70	60	10	40	60	80	460	2,000
5-day biochemical oxygen demand	mg/L	125	0	1976-88	4.2	4.5	0.20	1.5	3.0	5.6	29	---
Total coliform bacteria	/100 mL	15	0	1984-85	6,900	20,000	230	310	1,400	2,400	80,000	---
Fecal coliform bacteria	/100 mL	99	3	1976-88	470 E	730 E	<4	50	180	520	3,600	2,000
Fecal streptococcus bacteria	/100 mL	48	0	1984-88	900	1,200	50	180	400	980	5,500	---

[1]For stream segment 2 (Colorado Department of Health, 1989).

Table 10.--*Summary statistics for streamflow and selected water-quality properties and constituents at water-quality station 07105530 Fountain Creek below Janitell Road below Colorado Springs*

[ft^3/s, cubic feet per second; µS/cm, microsiemens per centimeter at 25 degrees Celsius; °C, degree Celsius; mg/L, milligrams per liter; µg/L, micrograms per liter; /100 mL, colonies per 100 milliliters; ---, no stream standard; E, estimated using methods described by Helsel and Cohn (1988); <, less than]

Property or constituent	Units	Number of values	Number of censored values	Period of record (water year)	Mean	Standard deviation	Minimum	Lower quartile	Median	Upper quartile	Maximum	Water-quality standard[1]
Instantaneous streamflow	ft^3/s	116	0	1976-88	109	71	20	67	86	130	415	---
Specific conductance	µS/cm	116	0	1976-88	711	151	240	622	746	820	950	---
pH	standard	112	0	1976-88	7.6	0.3	6.8	7.3	7.6	7.8	9.3	6.5-9.0
Water temperature	°C	116	0	1976-88	13.5	5.7	0.5	9.0	13.0	18.0	25.0	---
Dissolved oxygen	mg/L	115	0	1976-88	8.4	1.4	5.9	7.2	8.3	9.1	12.4	5.0
Hardness as calcium carbonate	mg/L	40	0	1976-85	170	33	73	160	180	196	210	---
Dissolved calcium	mg/L	40	0	1976-85	45	8.4	21	42	47	51	59	---
Dissolved magnesium	mg/L	40	0	1976-85	14	3	5	13	15	17	19	---
Dissolved chloride	mg/L	37	0	1981-85	33	13	8	24	33	40	84	250
Dissolved sulfate	mg/L	25	0	1982-85	130	37	44	120	140	170	180	600
Suspended solids	mg/L	103	1	1979-88	171 E	222 E	<1	46	86	196	1,120	---
Nitrite plus nitrate as nitrogen	mg/L	114	0	1976-88	1.5	0.90	0.40	0.94	1.3	1.8	5.2	10
Total ammonia as nitrogen	mg/L	108	2	1976-88	7.8 E	3.8 E	<0.01	5.1	7.5	11	20	---
Un-ionized ammonia as nitrogen	mg/L	103	0	1976-88	0.11	0.24	0.00037	0.035	0.062	0.12	2.4	---
Total ammonia plus organic nitrogen	mg/L	99	0	1976-88	12	6.1	2.4	8.8	11	15	37	---
Total organic nitrogen as nitrogen	mg/L	92	6	1976-88	4.0 E	5.0 E	<0.01	1.3	2.4	4.2	30	---
Total phosphorus	mg/L	32	0	1976-82	4.6	1.9	0.54	3.2	4.4	5.6	9.7	---
Total cadmium	µg/L	35	21	1976-88	0.88 E	0.24 E	<1.0	0.80 E	0.91 E	1.0 E	2.0	10
Total recoverable copper	µg/L	39	0	1976-88	18	12	5	11	16	20	80	200
Dissolved iron	µg/L	40	0	1976-85	52	33	9	34	46	55	160	300
Total recoverable iron	µg/L	39	0	1976-88	3,500	4,400	360	1,000	2,000	3,200	21,000	---
Total recoverable lead	µg/L	36	5	1976-85	14 E	11 E	<1	5	12	21	46	50
Dissolved manganese	µg/L	40	0	1976-85	100	56	6	62	100	120	290	150
Total recoverable manganese	µg/L	31	0	1976-87	240	160	1	160	180	260	780	---
Total recoverable nickel	µg/L	32	0	1981-88	19	13	5	11	16	25	76	200
Total selenium	µg/L	32	3	1976-88	5 E	2 E	<1	3	5	6	7	10
Total recoverable zinc	µg/L	39	0	1976-88	120	70	30	80	100	130	420	2,000
5-day biochemical oxygen demand	mg/L	97	0	1976-88	15	7.7	2.0	9.0	14.0	19	38	---
Total coliform bacteria	/100 mL	16	0	1984-85	10,300	20,000	700	1,500	3,200	9,500	80,000	---
Fecal coliform bacteria	/100 mL	67	3	1976-88	720 E	1,100 E	4	63	340	800	4,300	2,000
Fecal streptococcus bacteria	/100 mL	49	0	1984-88	1,900	2,300	110	305	1,000	2,200	8,300	---

[1]For stream segment 2 (Colorado Department of Health, 1989).

Table 11.--*Summary statistics for streamflow and selected water-quality properties and constituents at water-quality station 07105905 Fountain Creek above Little Fountain Creek below Fountain*

[ft^3/s, cubic feet per second; µS/cm, microsiemens per centimeter at 25 degrees Celsius; °C, degree Celsius; mg/L, milligrams per liter; µg/L, micrograms per liter; /100 mL, colonies per 100 milliliters; ---, no stream standard; E, estimated using methods described by Helsel and Cohn (1988); <, less than]

Property or constituent	Units	Number of values	Number of censored values	Period of record (water year)	Mean	Standard deviation	Minimum	Lower quartile	Median	Upper quartile	Maximum	Water-quality standard[1]
Instantaneous streamflow	ft^3/s	142	0	1976-88	106	257	9.1	35	61	101	3,000	---
Specific conductance	µS/cm	141	0	1976-88	1,110	309	353	950	1,100	1,290	2,120	---
pH	standard	135	0	1976-88	7.7	0.3	6.6	7.5	7.8	7.9	8.2	6.5-9.0
Water temperature	°C	140	0	1976-88	13.6	7.7	0.0	8.0	13.0	19.4	30.0	---
Dissolved oxygen	mg/L	135	0	1976-88	8.2	1.6	4.9	6.8	8.1	9.5	13.2	5.0
Hardness as calcium carbonate	mg/L	17	0	1976-84	390	130	210	290	390	430	710	---
Dissolved calcium	mg/L	17	0	1976-84	100	38	27	75	100	110	190	---
Dissolved magnesium	mg/L	17	0	1976-84	34	10	19	28	35	40	58	---
Dissolved chloride	mg/L	32	0	1977-85	60	13	26	53	61	69	87	250
Dissolved sulfate	mg/L	32	0	1977-85	370	96	190	310	345	420	590	600
Suspended solids	mg/L	130	0	1977-88	216	399	1	54	105	210	3,960	---
Nitrite plus nitrate as nitrogen	mg/L	139	0	1976-88	3.6	1.0	0.26	3.1	3.7	4.2	7.7	10
Total ammonia as nitrogen	mg/L	138	3	1976-88	2.5 E	2.5 E	<0.01	0.36	1.5	3.9	10	---
Un-ionized ammonia as nitrogen	mg/L	130	0	1976-88	0.029	0.32	0.00019	0.0050	0.017	0.047	0.15	---
Total ammonia plus organic nitrogen	mg/L	99	0	1976-88	4.8	4.0	0.50	1.8	3.9	6.3	20	---
Total organic nitrogen as nitrogen	mg/L	96	1	1976-88	2.5 E	3.1 E	<0.01	1.0	1.5	2.5	20	---
Total phosphorus	mg/L	59	0	1976-82	2.6	1.6	0.04	1.4	2.3	3.3	9.3	---
Total cadmium	µg/L	40	24	1976-88	0.90 E	0.82 E	<1	0.53 E	0.82 E	1.27	3	10
Total recoverable copper	µg/L	43	0	1976-88	21	30	4	9	13	20	150	200
Dissolved iron	µg/L	17	4	1976-88	30	39	<3	9	20	30	170	300
Total recoverable iron	µg/L	48	0	1976-88	6,600	14,000	210	1,300	3,000	6,600	97,000	---
Total recoverable lead	µg/L	40	7	1976-88	15 E	32 E	<1	3	6	16	200	50
Dissolved manganese	µg/L	17	0	1976-85	240	110	24	170	270	320	350	150
Total recoverable manganese	µg/L	39	0	1976-83	430	420	120	280	350	430	2,800	---
Total recoverable nickel	µg/L	32	0	1981-88	16	9	6	10	14	21	47	200
Total selenium	µg/L	32	0	1976-88	6	2	3	5	6	7	13	10
Total recoverable zinc	µg/L	48	0	1976-88	90	120	20	32	60	90	650	2,000
5-day biochemical oxygen demand	mg/L	128	0	1976-88	17	12	1	7.8	16	25	62	---
Total coliform bacteria	/100 mL	18	0	1984-85	10,000	18,000	420	1,300	3,900	14,000	80,000	---
Fecal coliform bacteria	/100 mL	97	2	1976-88	1,100 E	2,400 E	<10	80	320	1,100	17,000	2,000
Fecal streptococcus bacteria	/100 mL	51	0	1984-88	980	1,900	50	120	340	840	10,000	---

[1]For stream segment 2 (Colorado Department of Health, 1989).

Table 12.--*Summary statistics for streamflow and selected water-quality properties and constituents at water-quality station 07106500 Fountain Creek at Pueblo*

[ft^3/s, cubic feet per second; µS/cm, microsiemens per centimeter at 25 degrees Celsius; °C, degree Celsius; mg/L, milligrams per liter; µg/L, micrograms per liter; /100 mL, colonies per 100 milliliters; ---, no stream standard; E, estimated using methods described by Helsel and Cohn (1988); <, less than]

Property or constituent	Units	Number of values	Number of censored values	Period of record (water year)	Mean	Standard deviation	Minimum	Lower quartile	Median	Upper quartile	Maximum	Water-quality standard[1]
Instantaneous streamflow	ft^3/s	266	0	1976-88	125	162	0.1	24	74	149	1,100	---
Specific conductance	µS/cm	265	0	1976-88	1,590	796	566	1,180	1,410	1,800	6,000	---
pH	standard	89	0	1981-88	8.1	0.3	7.3	8.0	8.2	8.3	8.7	6.5-9.0
Water temperature	°C	225	0	1976-88	15.6	8.5	0.0	8.5	16.0	22.5	33.0	---
Dissolved oxygen	mg/L	92	0	1981-88	9.2	2.1	4.5	7.8	9.0	11.0	15.2	5.0
Hardness as calcium carbonate	mg/L	11	0	1981-82	520	140	320	400	520	610	770	---
Dissolved calcium	mg/L	11	0	1981-82	130	31	83	100	130	150	180	---
Dissolved magnesium	mg/L	11	0	1981-82	48	17	28	36	47	58	78	---
Suspended solids	mg/L	88	0	1981-88	576	1,060	6	124	264	486	6,760	---
Nitrite plus nitrate as nitrogen	mg/L	90	1	1981-88	4.7 E	1.5 E	<0.10	3.6	4.6	5.4	11	10
Total ammonia as nitrogen	mg/L	88	1	1981-88	0.41 E	0.77 E	<0.01	0.06	0.08	0.32	4.1	---
Un-ionized ammonia as nitrogen	mg/L	84	0	1981-88	0.0089	0.012	0.00050	0.00240	0.0040	0.0090	0.070	---
Total ammonia plus organic nitrogen	mg/L	87	1	1981-88	2.3 E	1.8 E	0.20	1.1	1.8	3.0	12	---
Total organic nitrogen as nitrogen	mg/L	86	0	1981-88	1.9	1.5	0.13	0.92	1.5	2.1	8.5	---
Total phosphorus	mg/L	10	0	1981-83	1.0	0.66	0.24	0.43	0.93	1.8	2.0	---
Total cadmium	µg/L	20	13	1981-83	0.75 E	0.90 E	<1	0.47 E	0.74 E	1.2	4	10
Total recoverable copper	µg/L	20	0	1981-83	23	19	4.00	12	19	24	80	200
Dissolved iron	µg/L	11	4	1981-82	17 E	14 E	<3	6	15	23	50	300
Total recoverable iron	µg/L	20	0	1981-83	15,000	16,000	80	3,900	9,800	21,800	55,000	---
Total recoverable lead	µg/L	20	1	1981-83	14 E	15 E	<1	6	12	18	69	50
Dissolved manganese	µg/L	11	0	1981-82	24	43	3	6	9	20	150	150
Total recoverable manganese	µg/L	20	0	1981-83	450	460	30	140	315	610	1,700	---
Total recoverable nickel	µg/L	20	0	1981-83	20	15	2	10	14	24	60	200
Total selenium	µg/L	20	0	1981-83	32	45	1	14	18	27	200	10
Total recoverable zinc	µg/L	20	0	1981-83	120	90	10	60	100	140	370	2,000
5-day biochemical oxygen demand	mg/L	75	0	1981-88	9.0	7.3	1.0	3.8	6.6	12	34	---
Total coliform bacteria	/100mL	12	0	1985	4,800	5,100	540	1,200	2,200	7,900	15,000	---
Fecal coliform bacteria	/100mL	43	4	1985-88	670 E	2,100 E	<4	37	130	320	13,000	2,000
Fecal streptococcus bacteria	/100mL	43	1	1985-88	1,700 E	4,200 E	29	210	390	1,000	24,000	---

[1]For stream segment 2 (Colorado Department of Health, 1989).

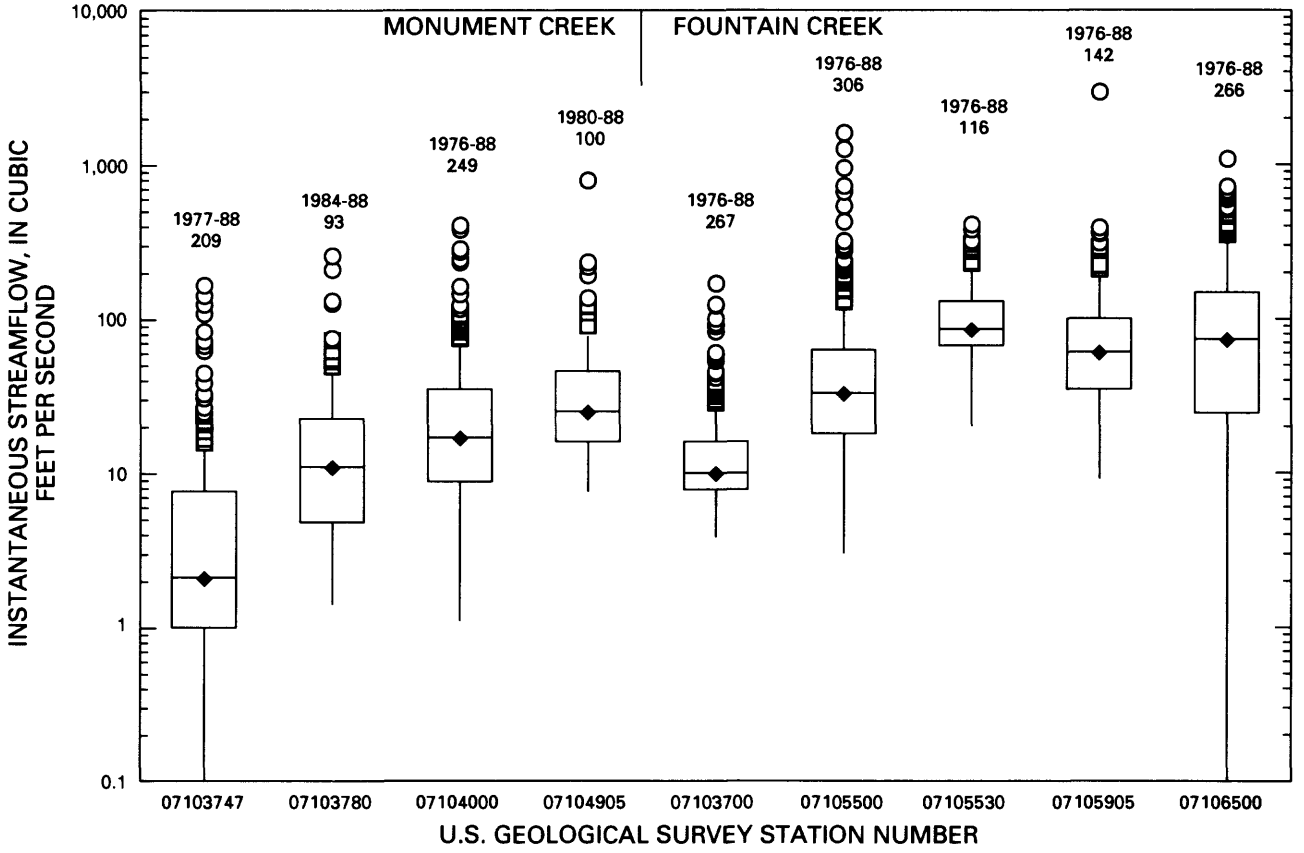

Figure 3.--Variations in instantaneous streamflow.

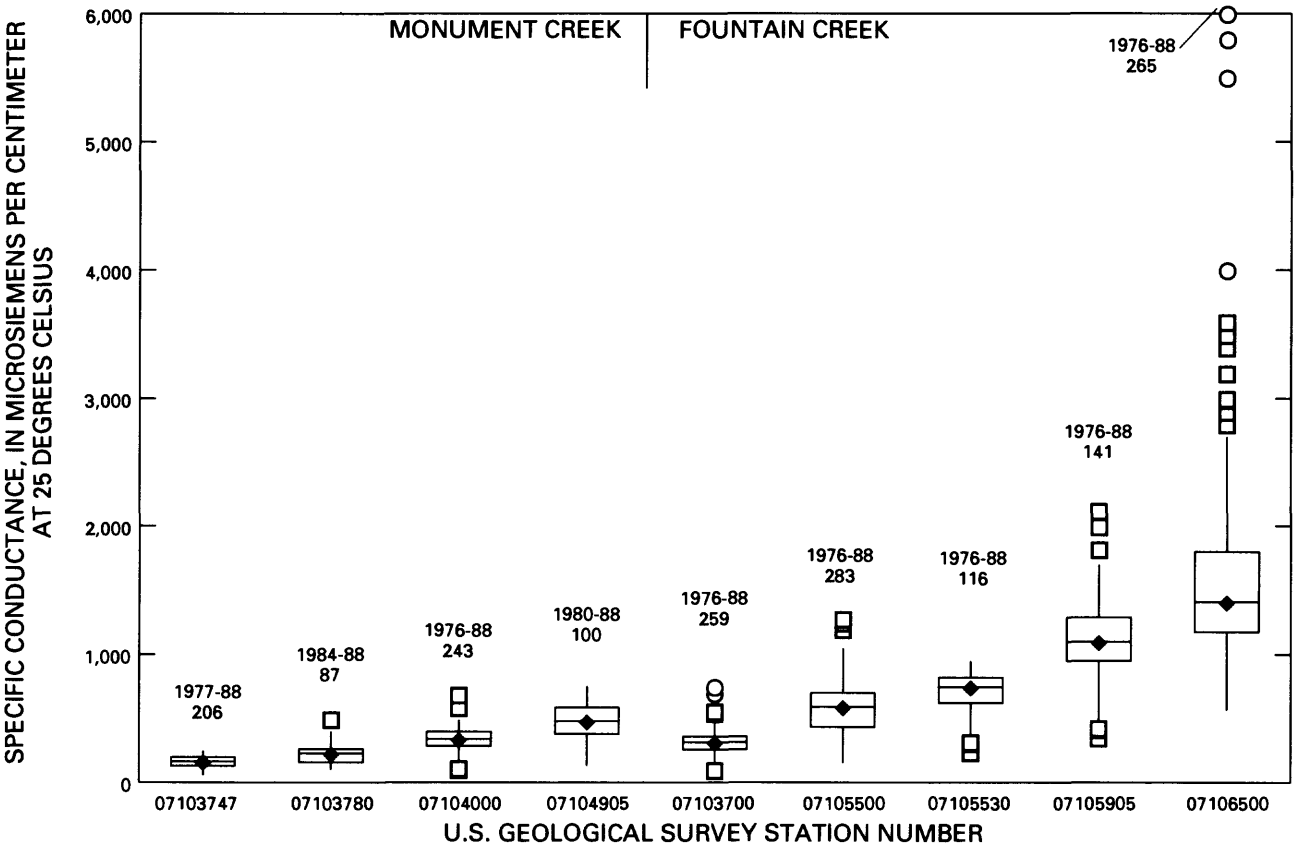

Figure 4.--Variations in specific conductance.

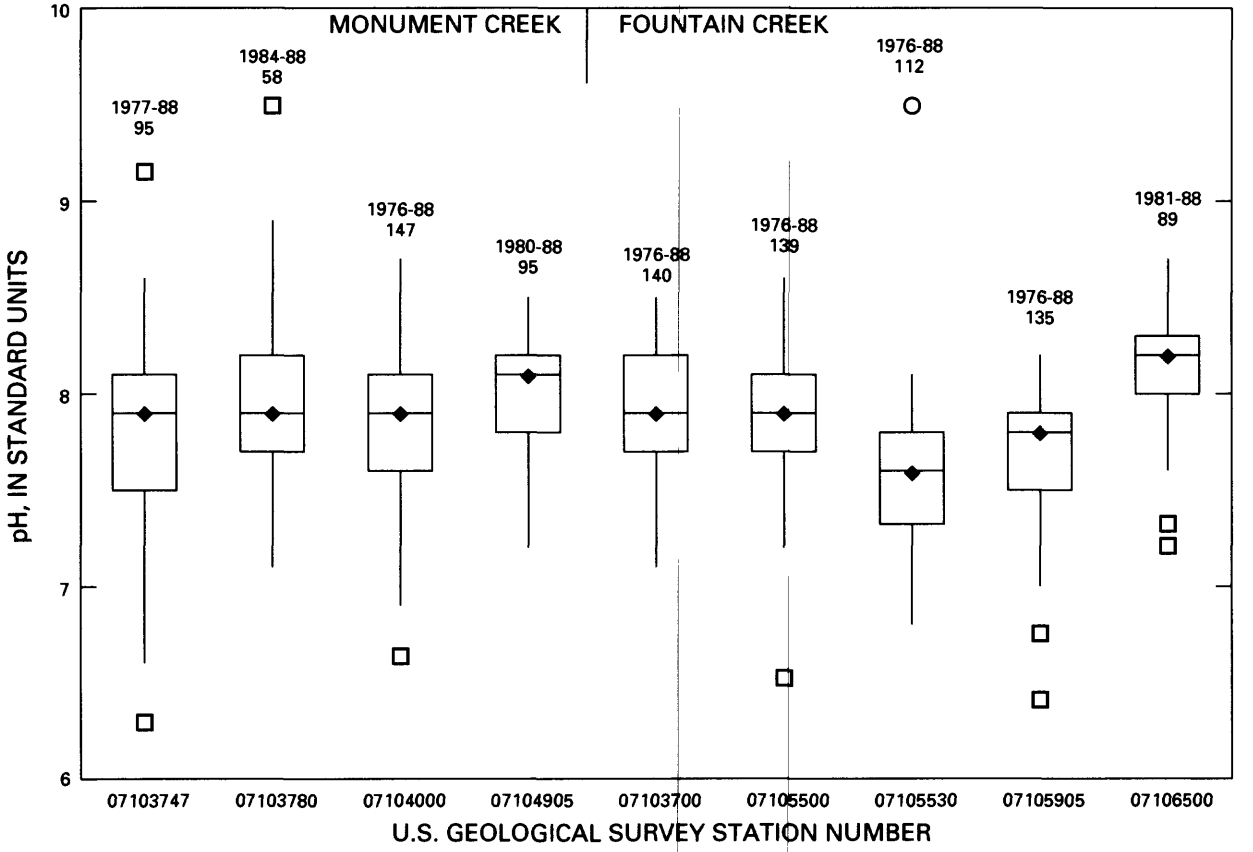

Figure 5.--Variations in pH.

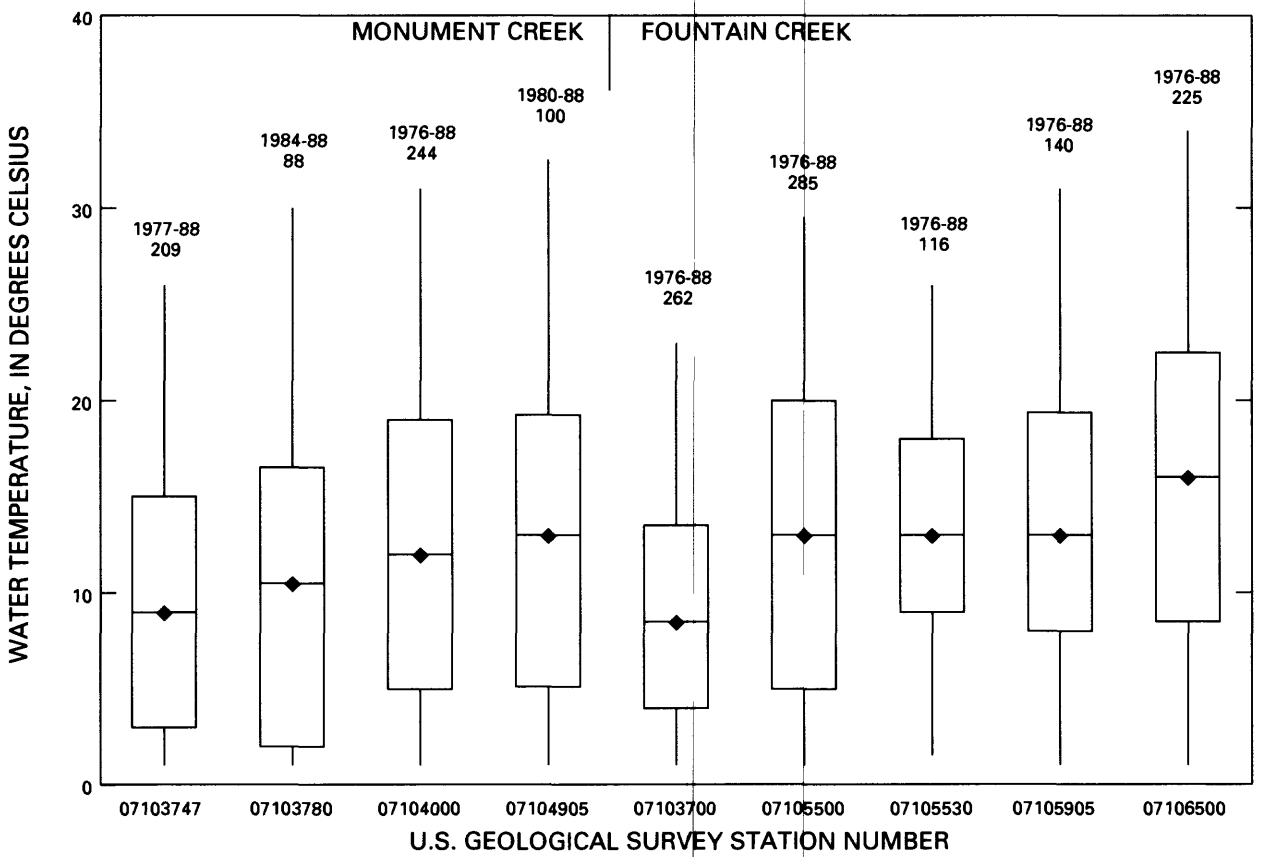

Figure 6.--Variations in water temperature.

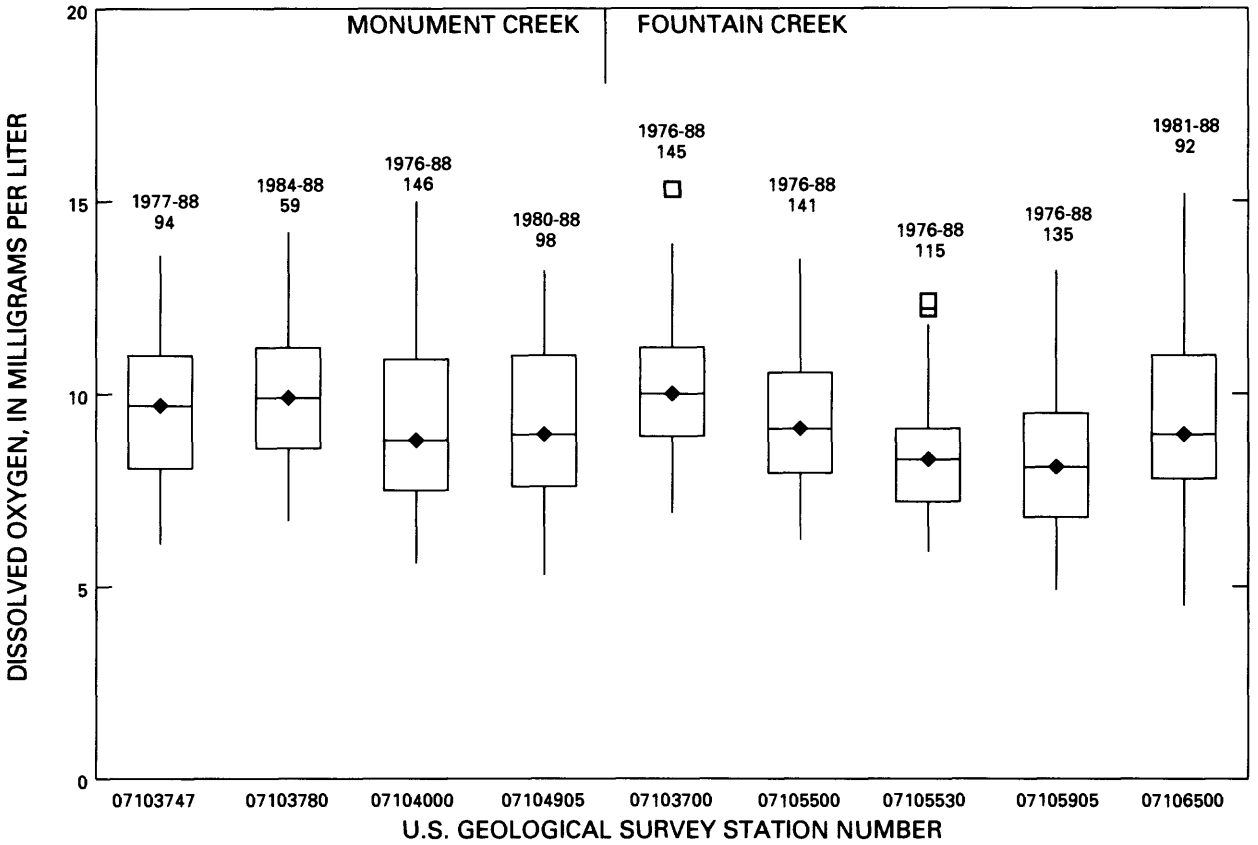

Figure 7.--Variations in concentrations of dissolved oxygen.

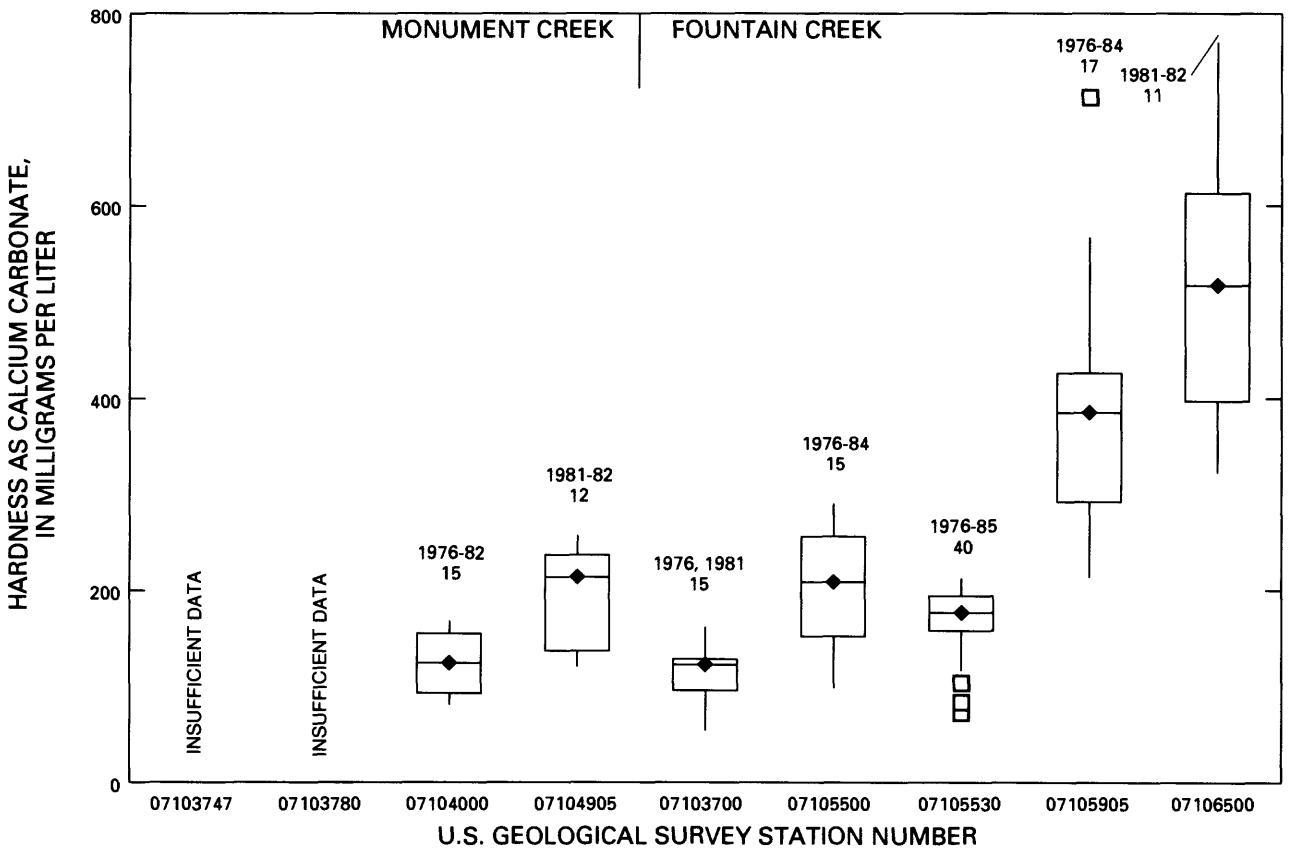

Figure 8.--Variations in hardness as calcium carbonate.

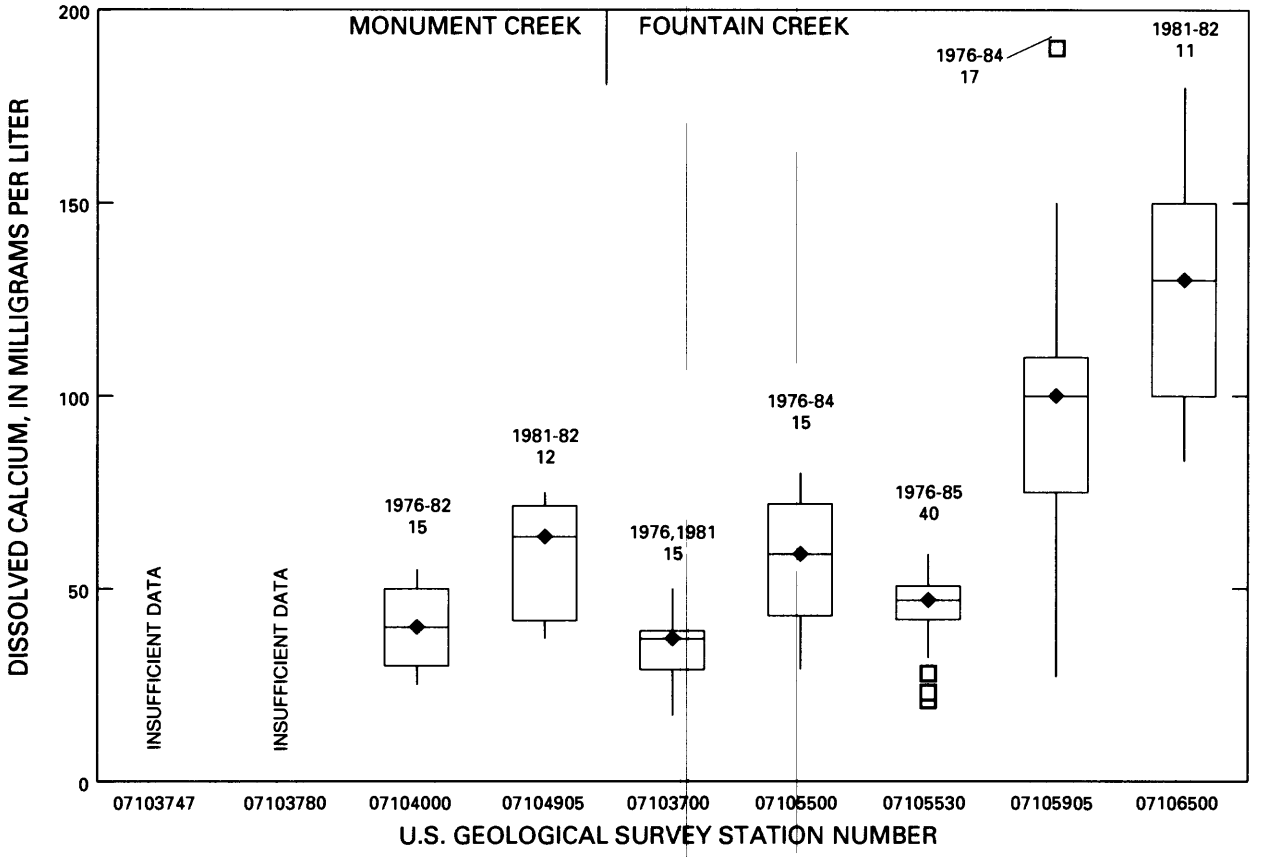

Figure 9.--Variations in concentrations of dissolved calcium.

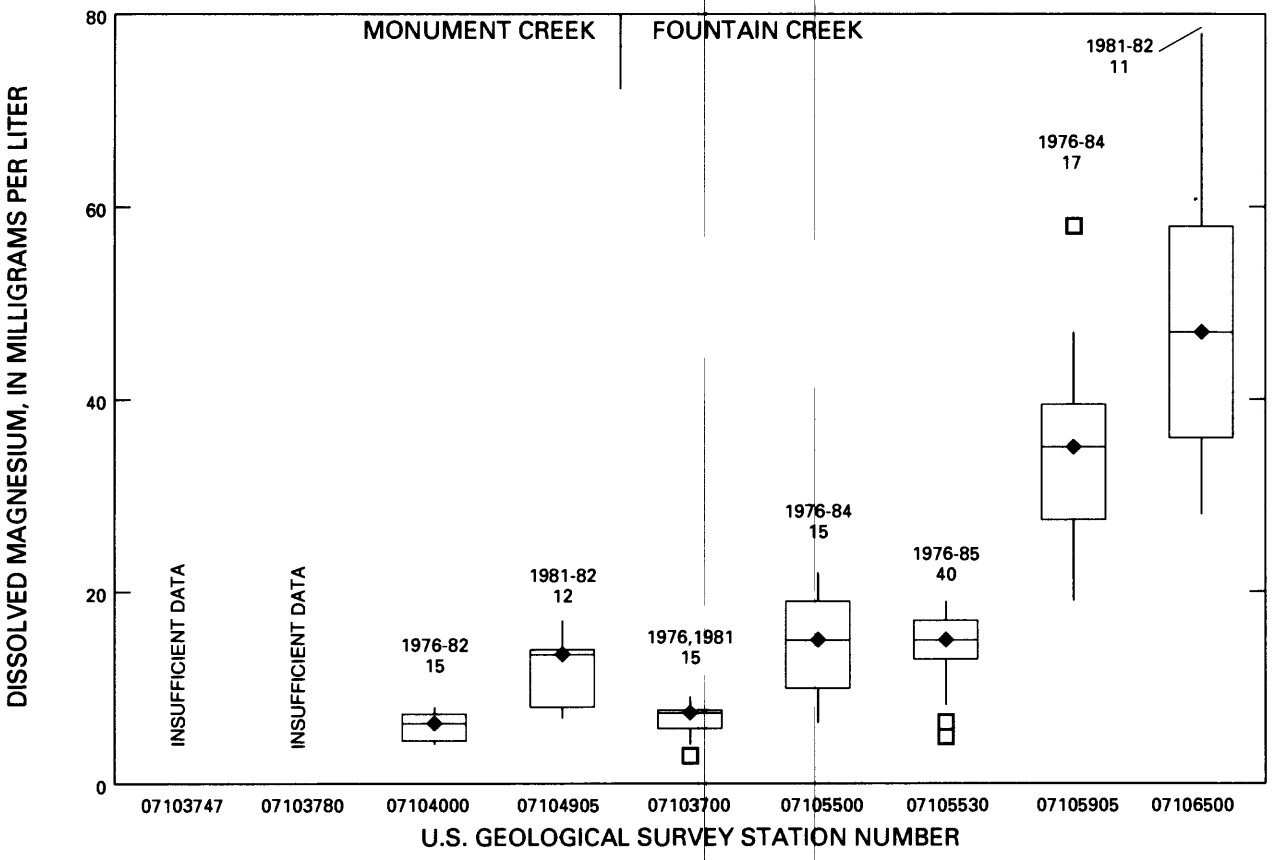

Figure 10.--Variations in concentrations of dissolved magnesium.

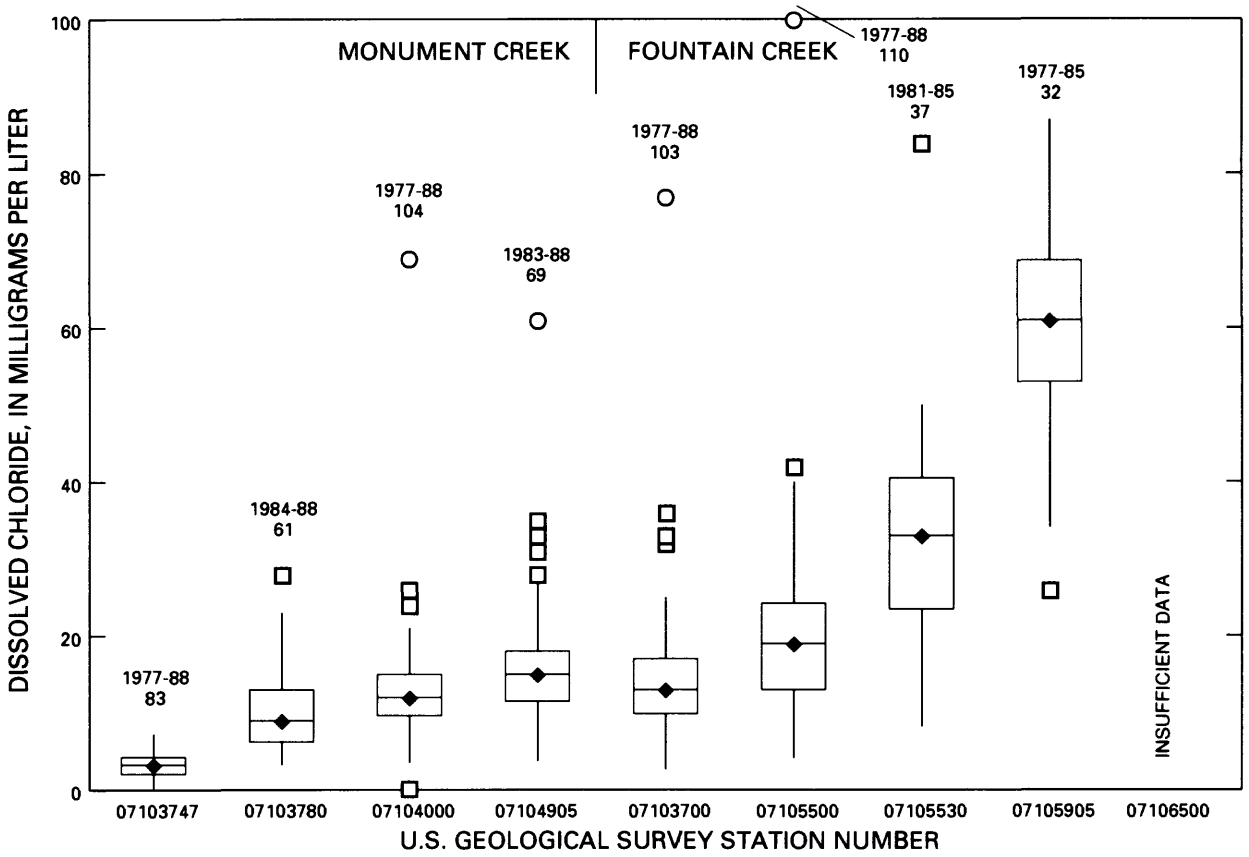

Figure 11.--Variations in concentrations of dissolved chloride.

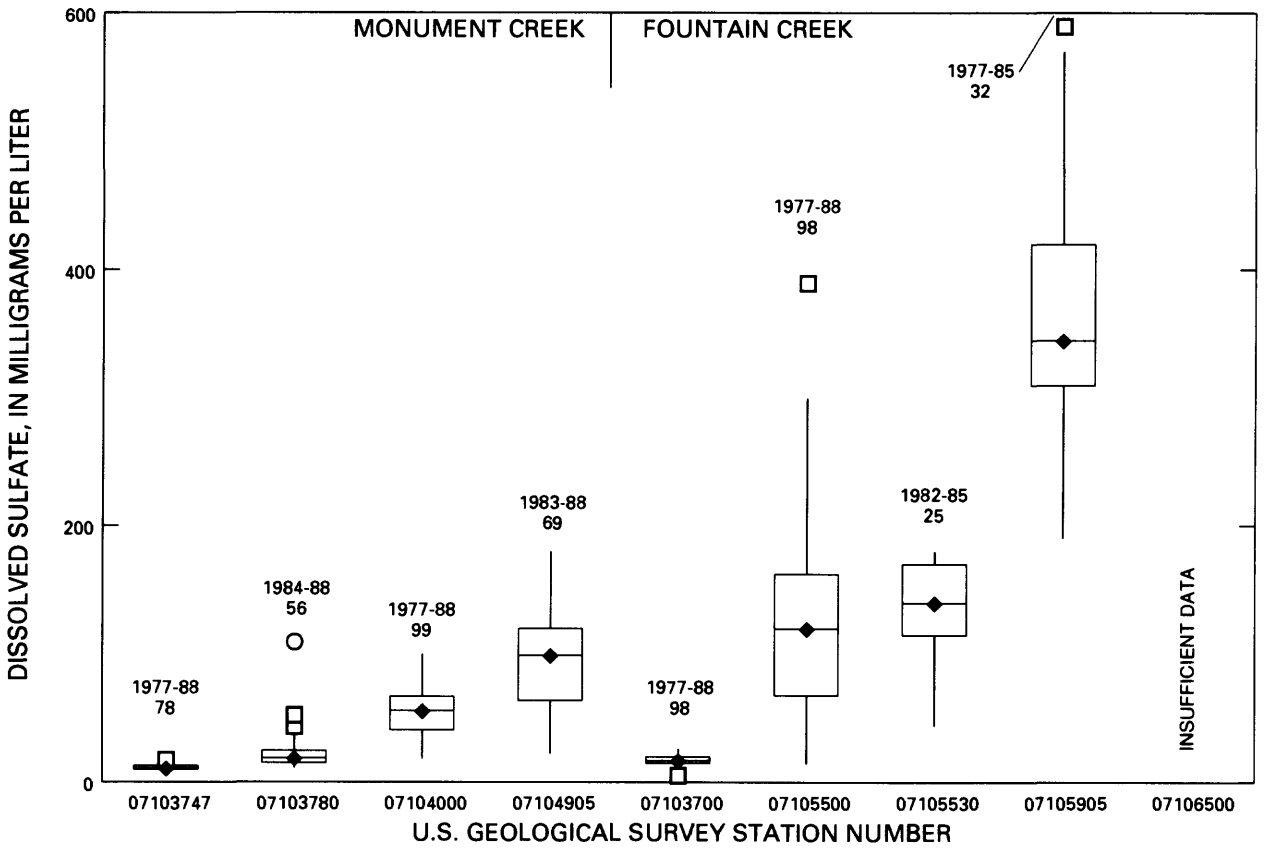

Figure 12.--Variations in concentrations of dissolved sulfate.

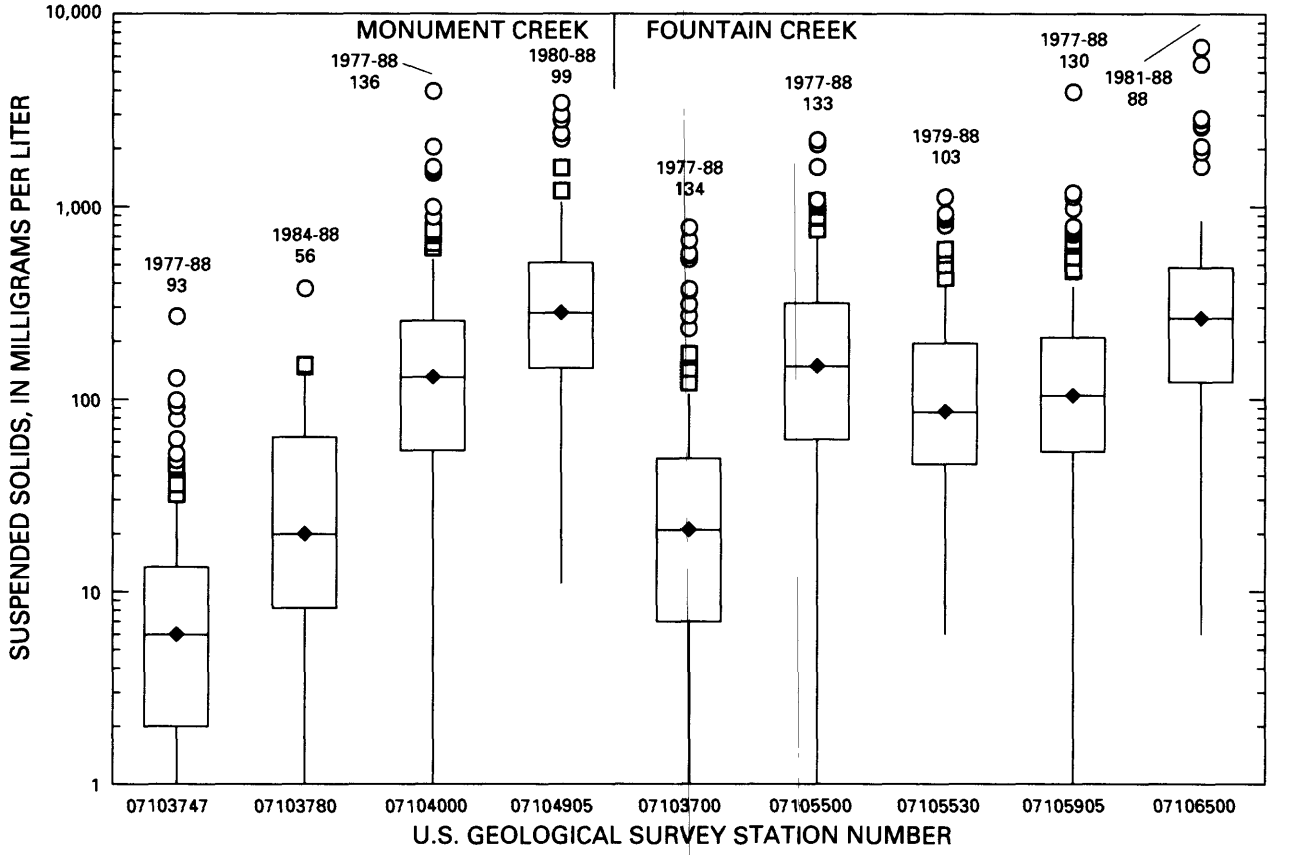

Figure 13.--Variations in concentrations of suspended solids.

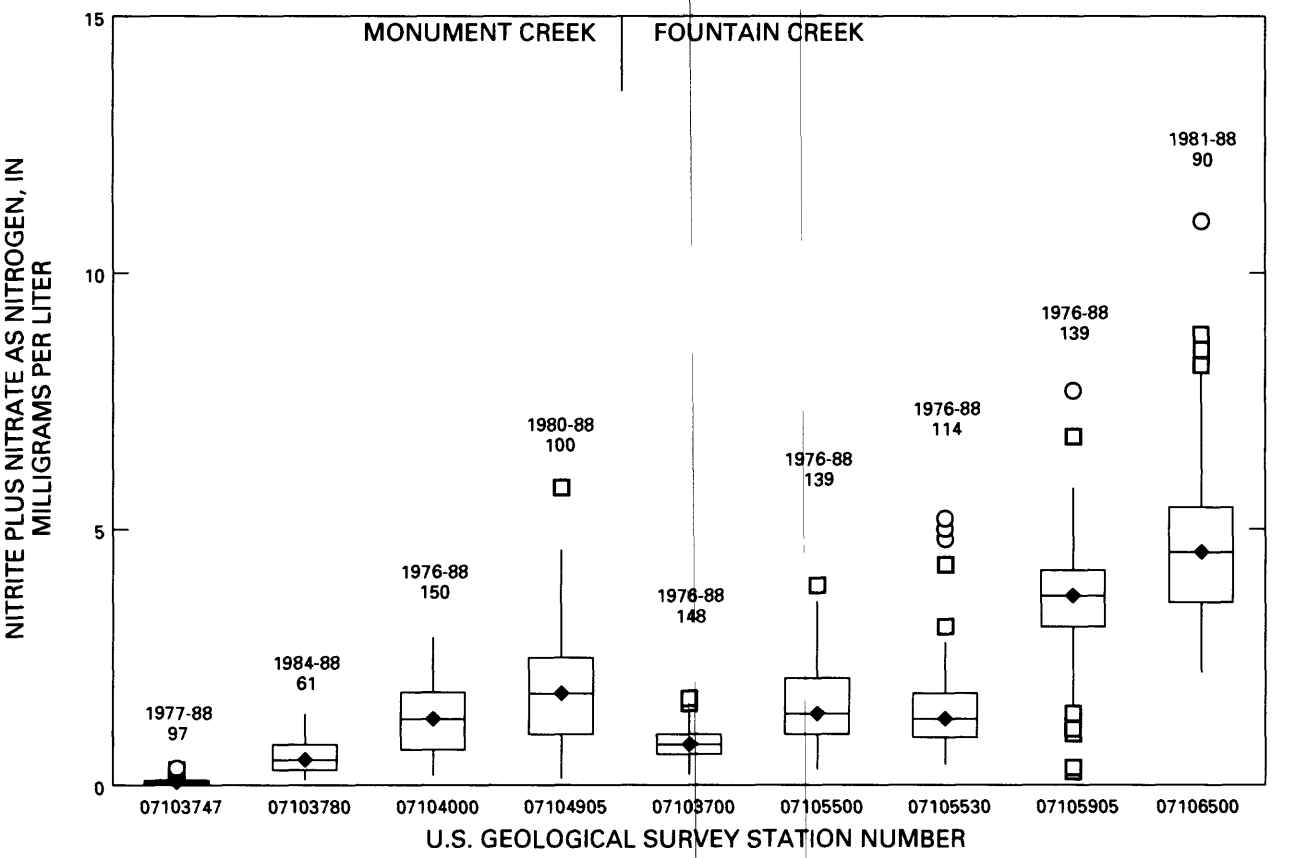

Figure 14.--Variations in concentrations of nitrite plus nitrate as nitrogen.

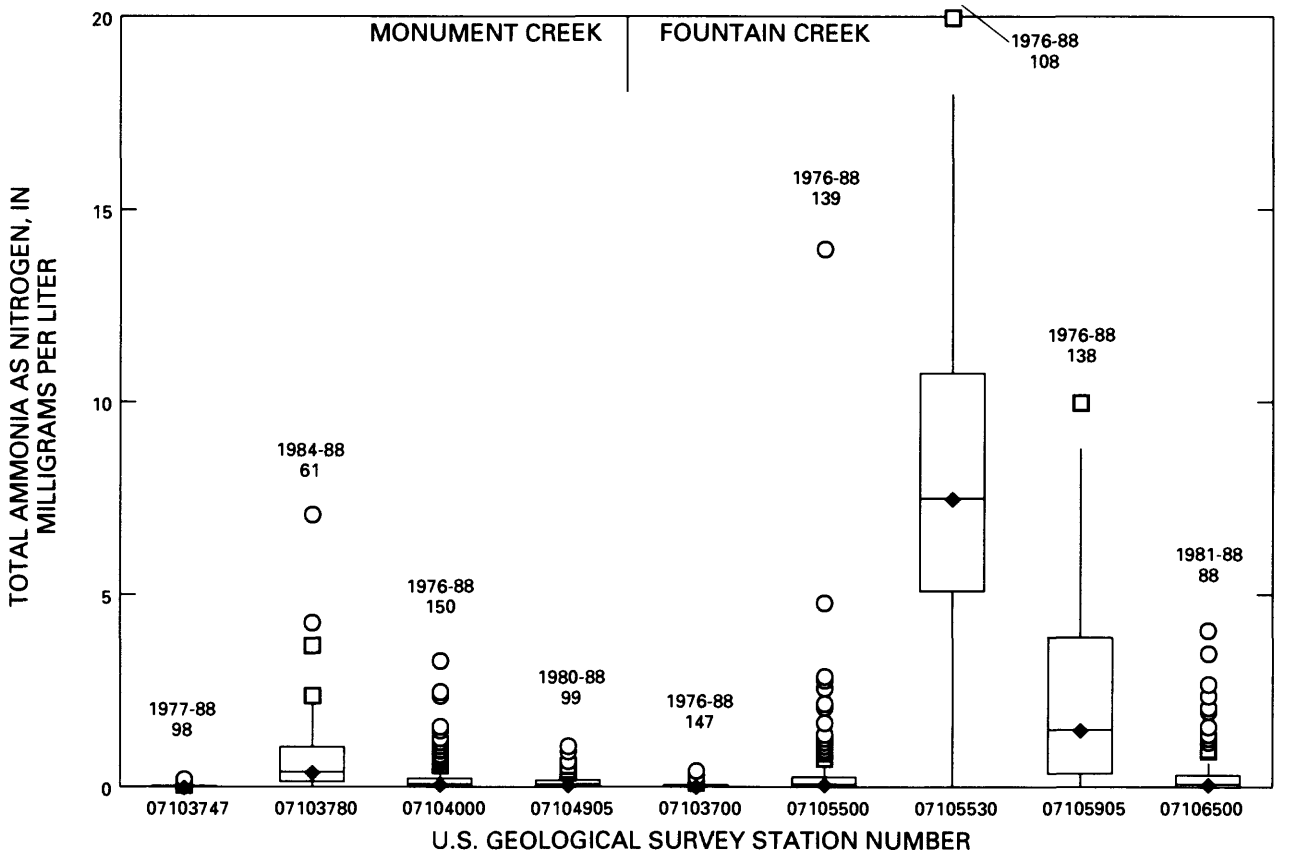

Figure 15.--Variations in concentrations of total ammonia as nitrogen.

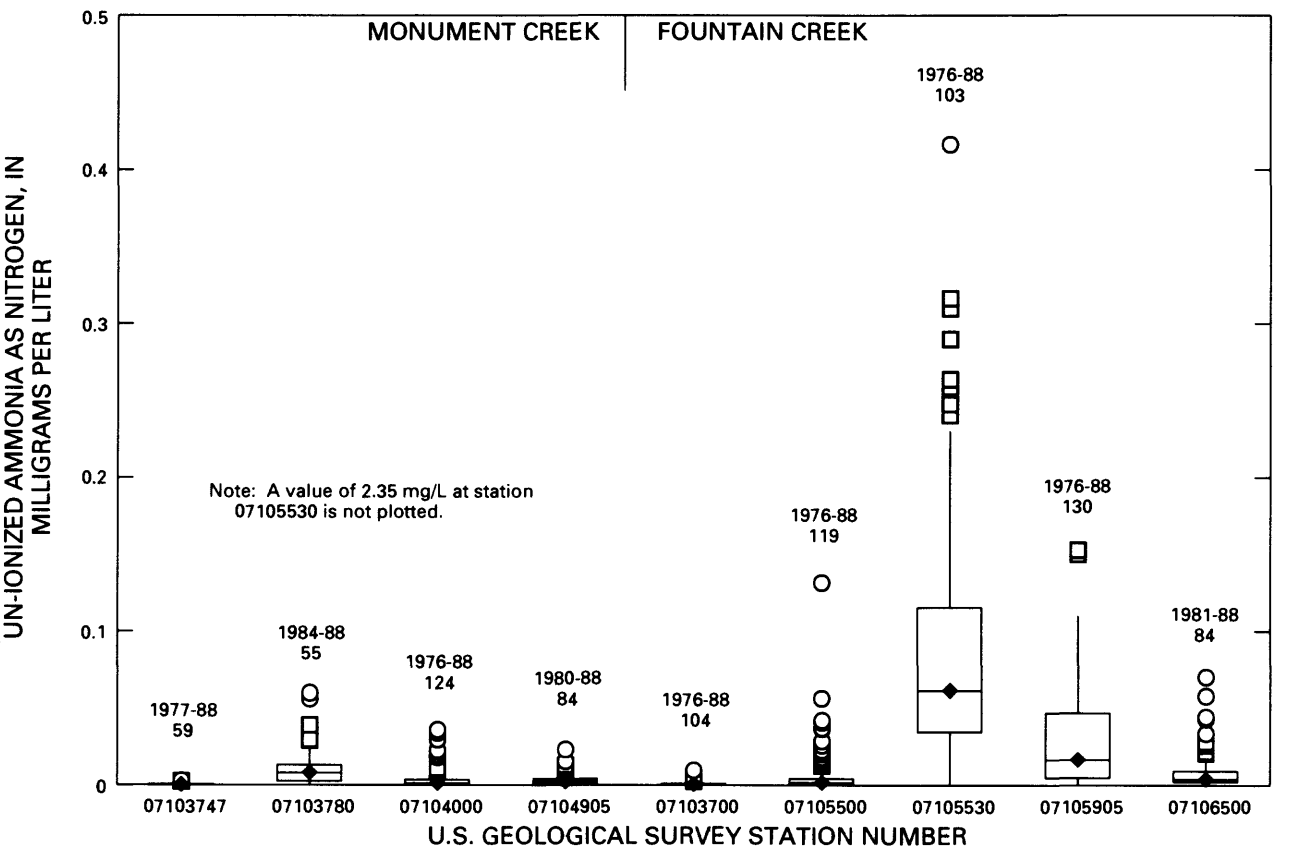

Figure 16.--Variations in concentrations of un-ionized ammonia as nitrogen.

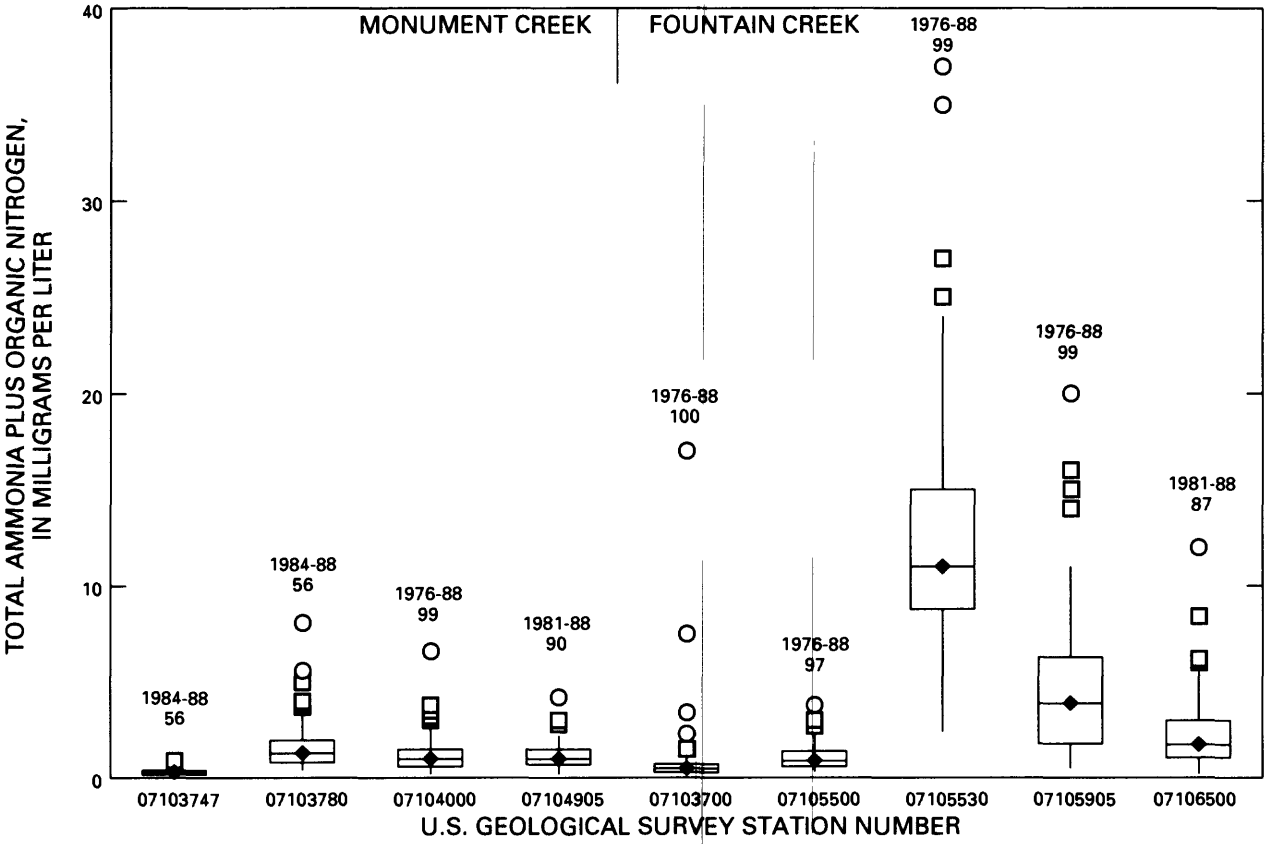

Figure 17.--Variations in concentrations of total ammonia plus organic nitrogen.

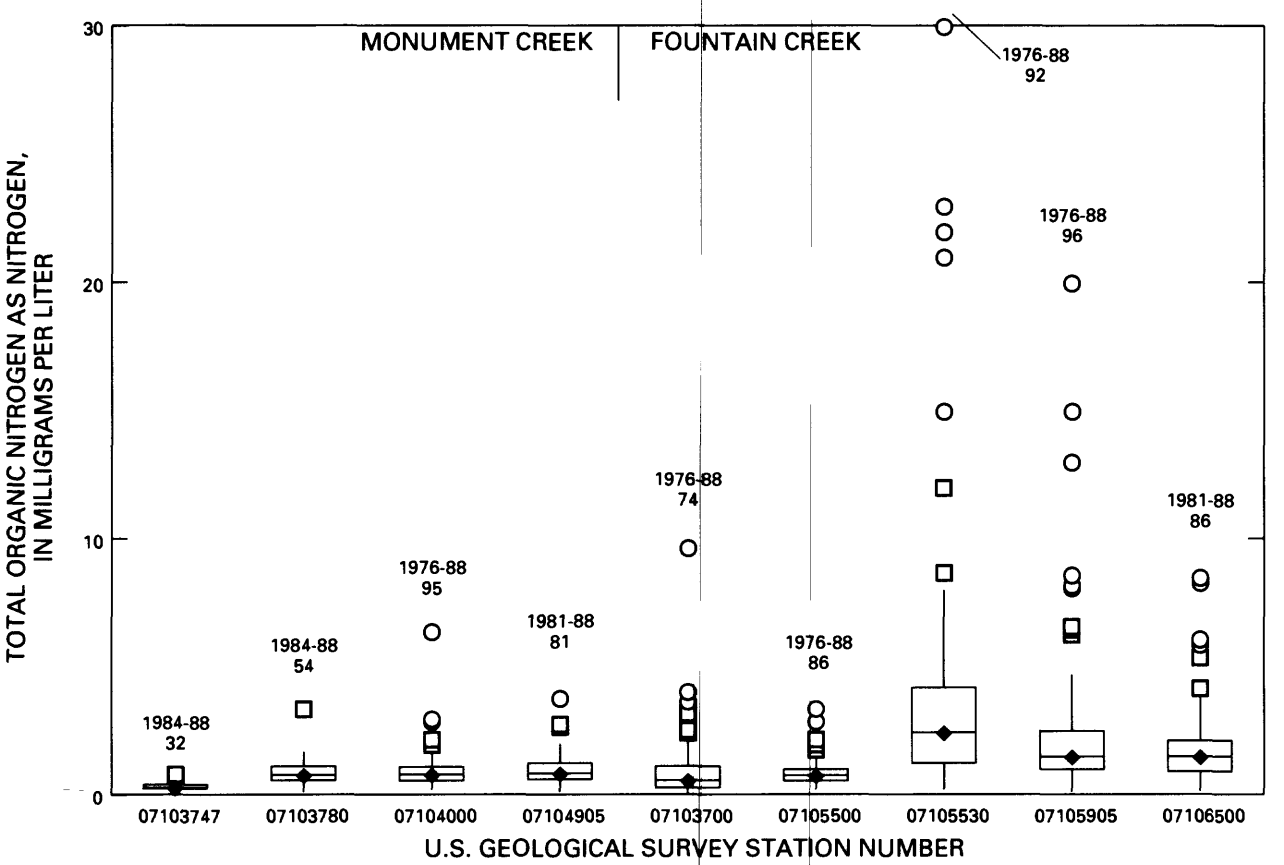

Figure 18.--Variations in concentrations of total organic nitrogen as nitrogen.

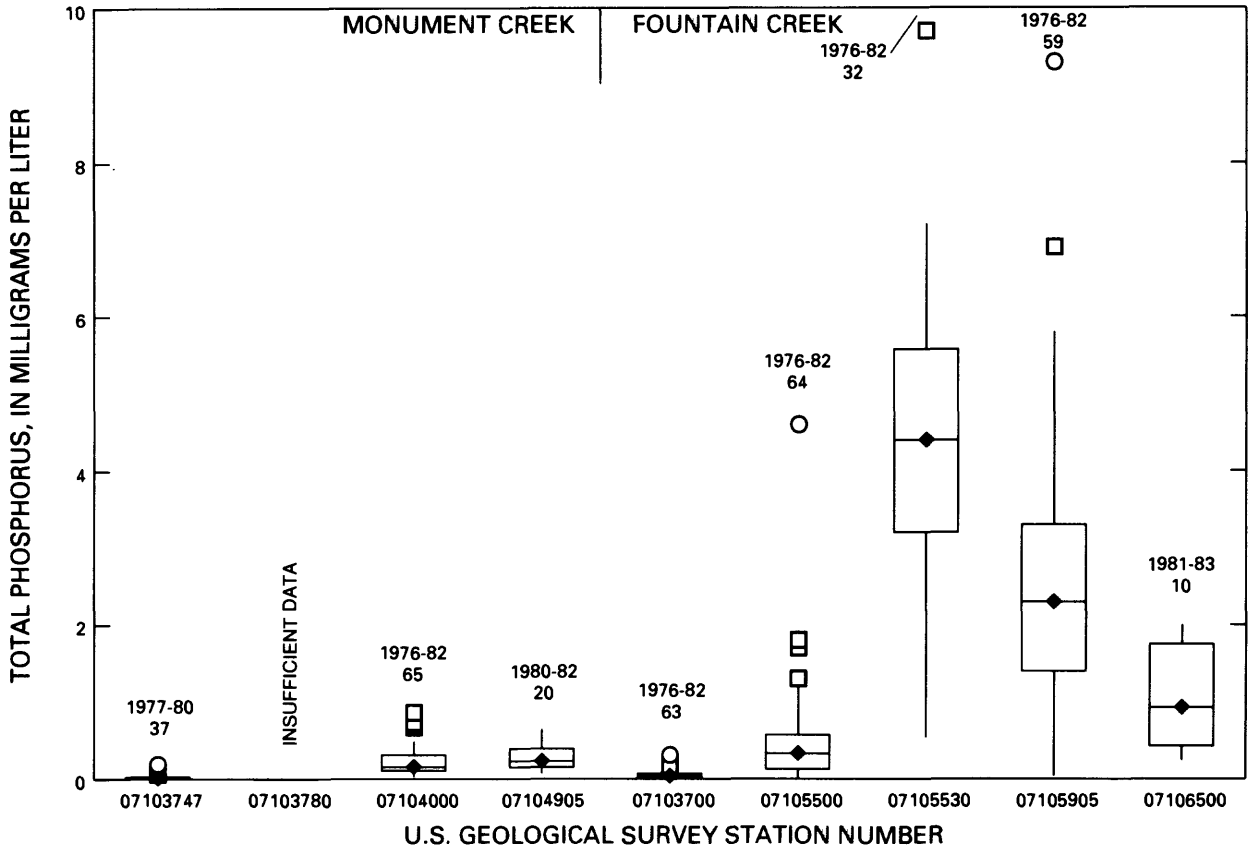

Figure 19.--Variations in concentrations of total phosphorus.

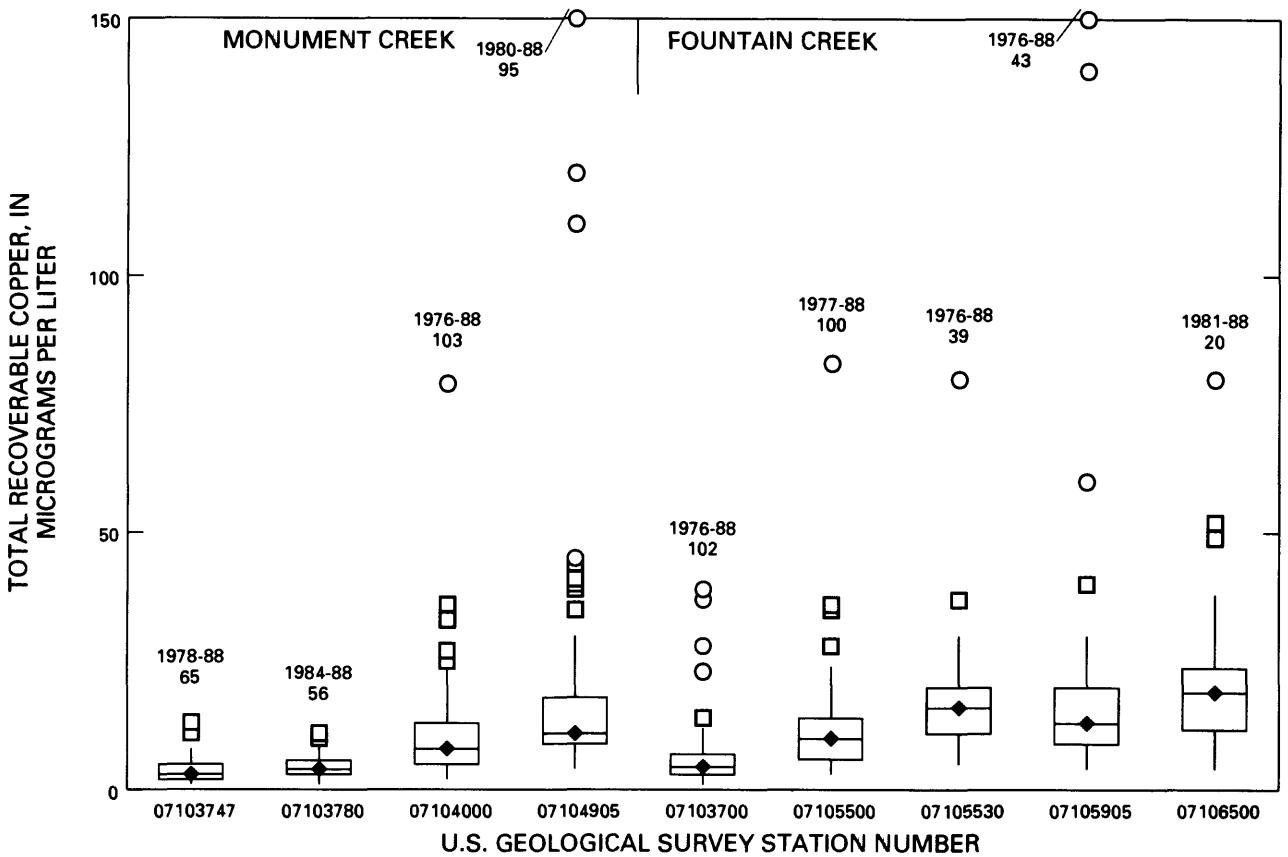

Figure 20.--Variations in concentrations of total recoverable copper.

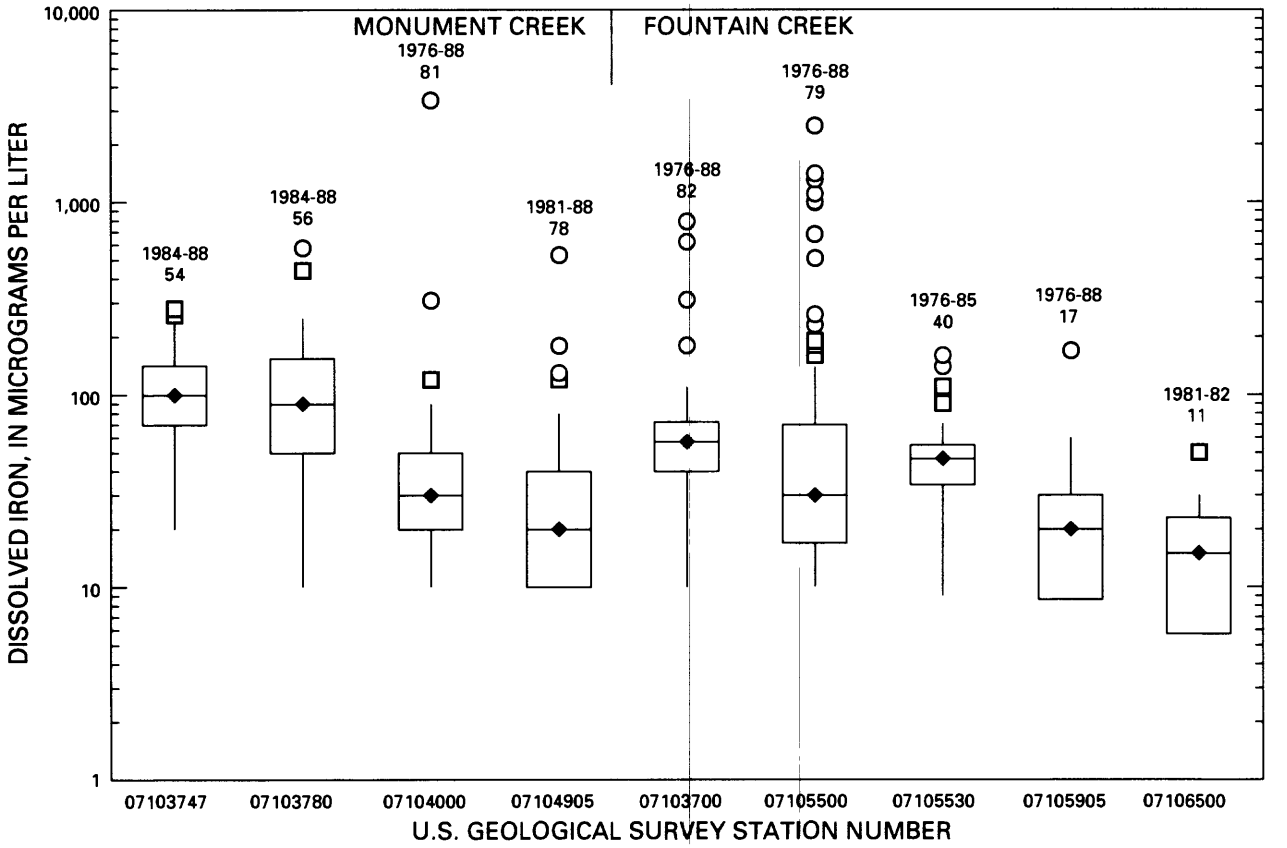

Figure 21.--Variations in concentrations of dissolved iron.

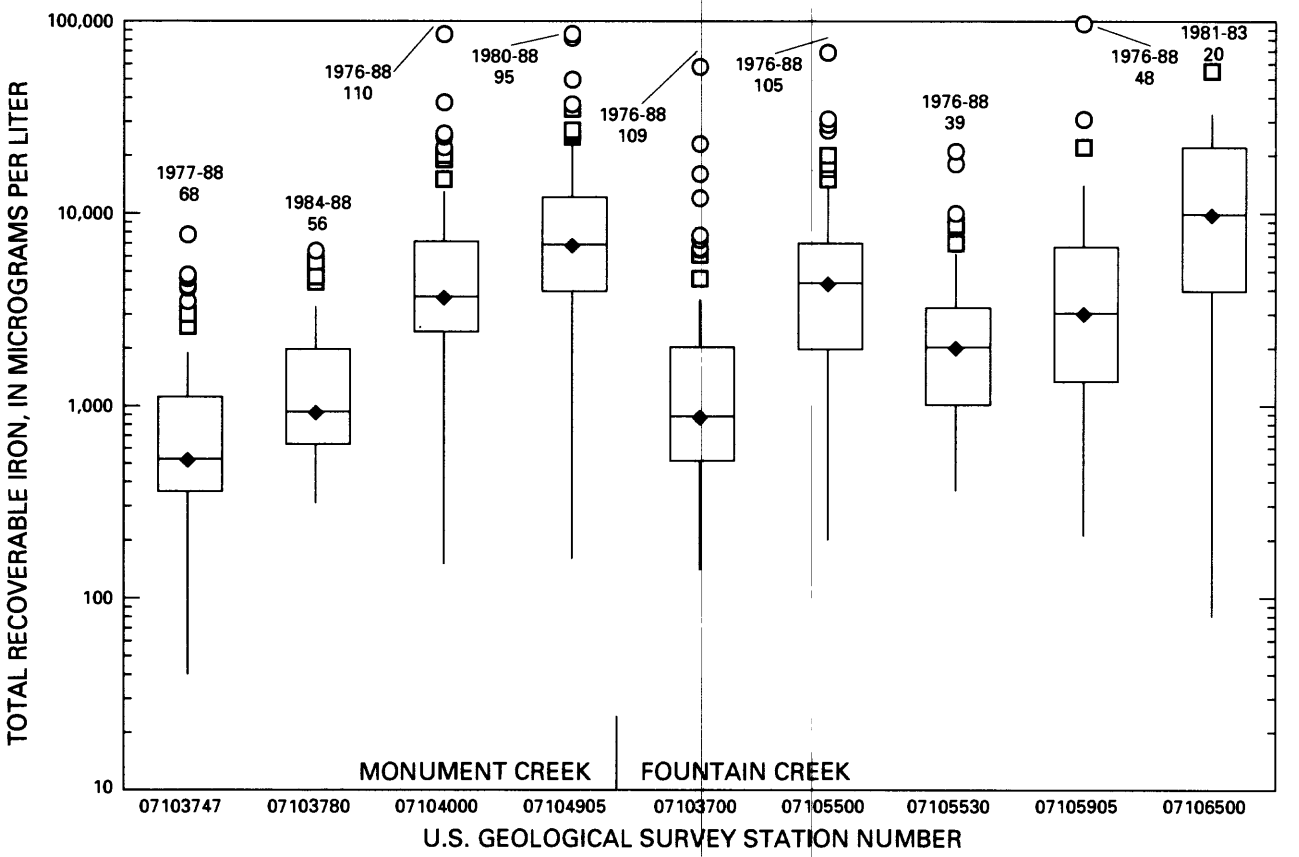

Figure 22.--Variations in concentrations of total recoverable iron.

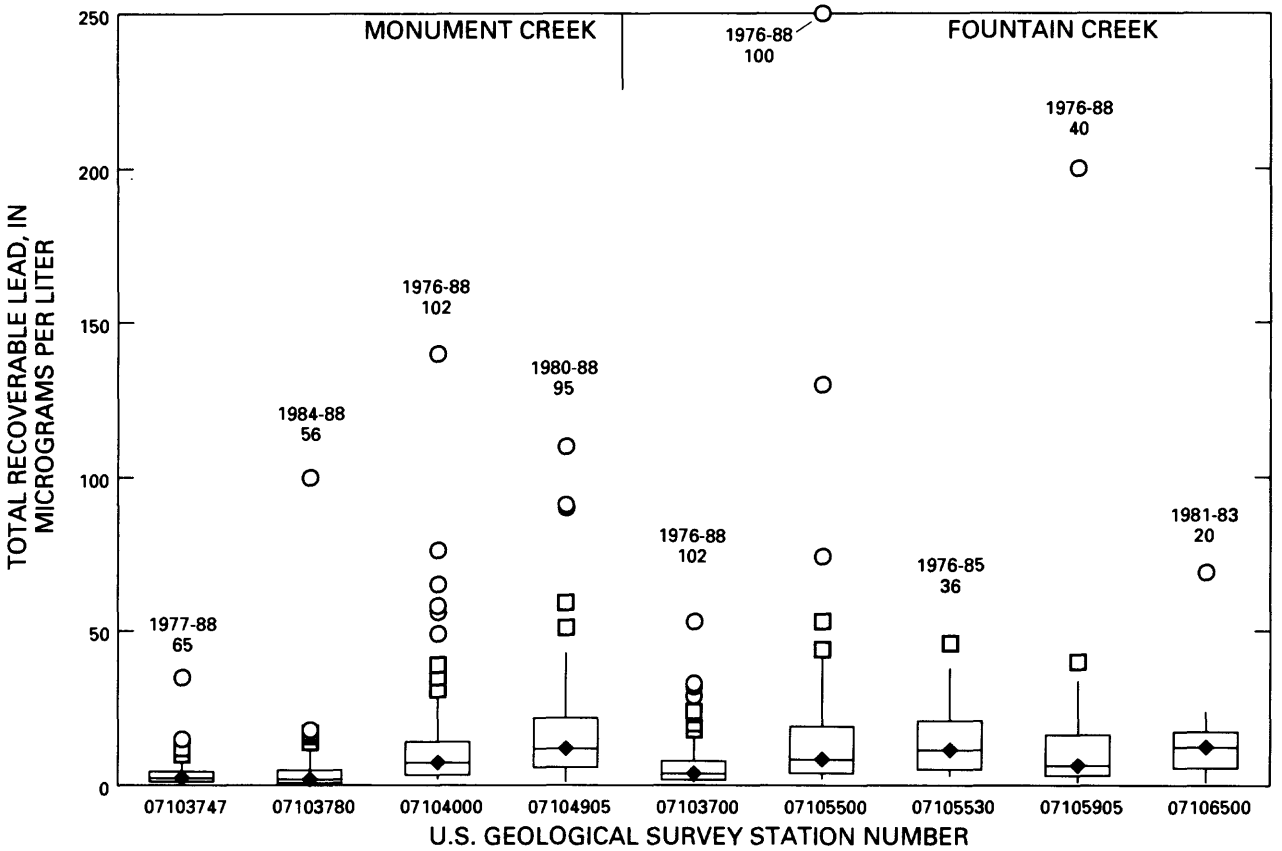

Figure 23.--Variations in concentrations of total recoverable lead.

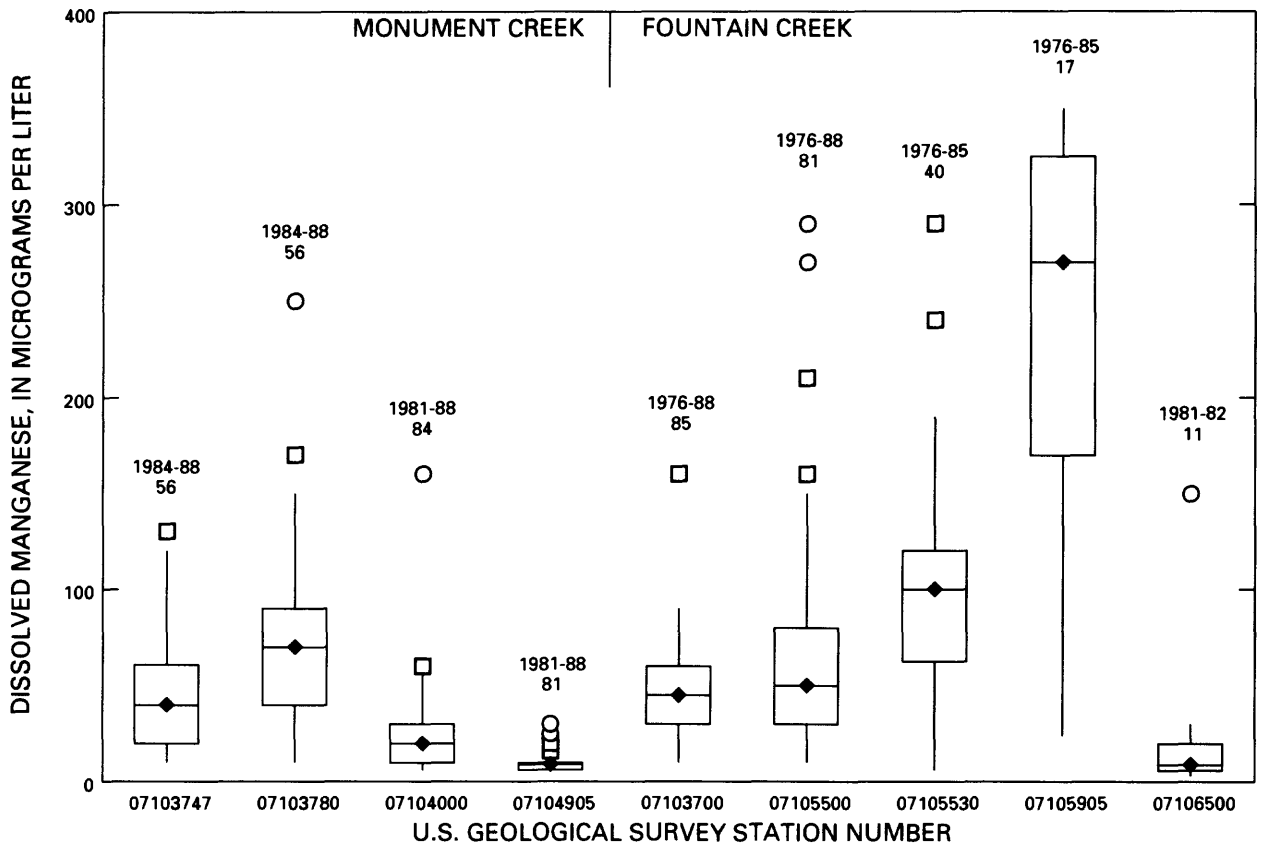

Figure 24.--Variations in concentrations of dissolved manganese.

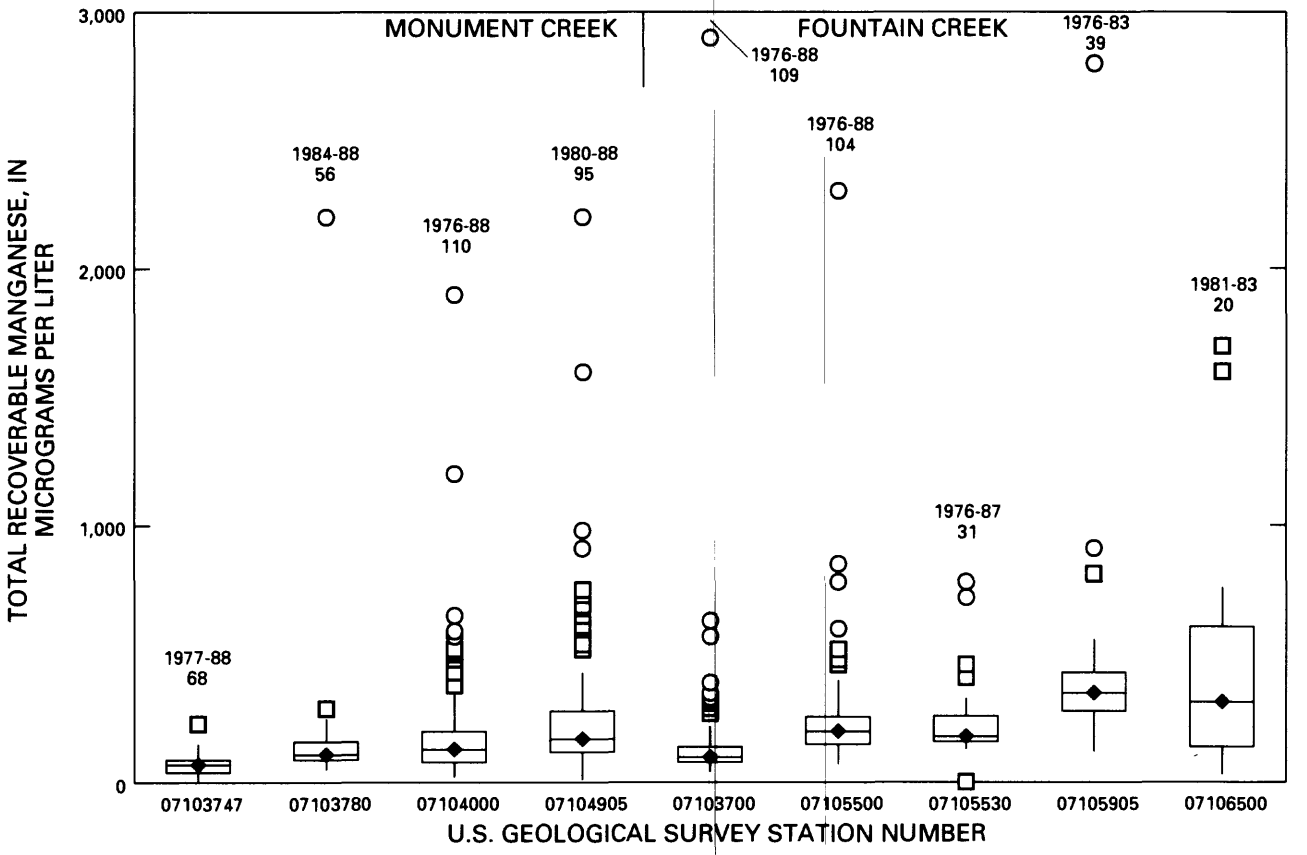

Figure 25.--Variations in concentrations of total recoverable manganese.

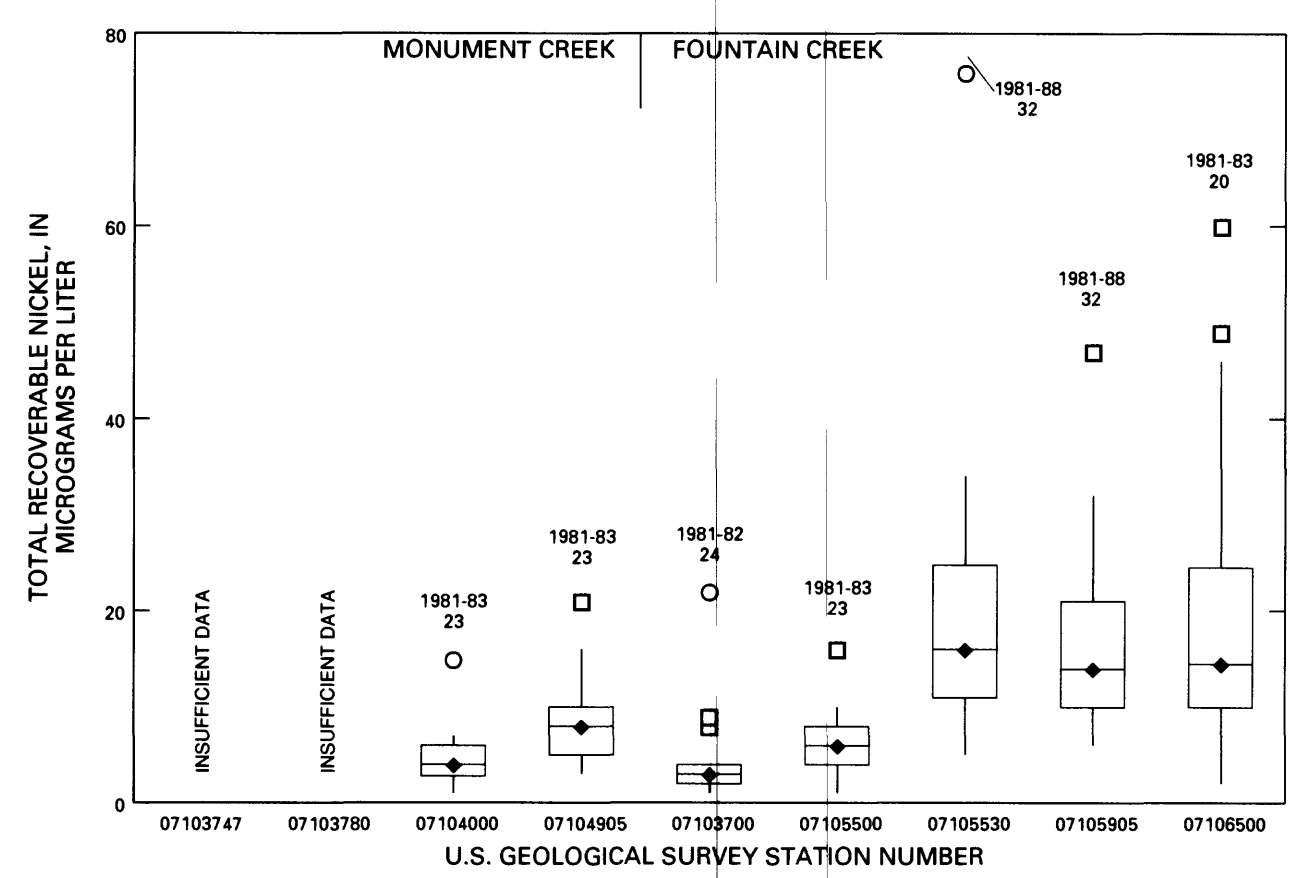

Figure 26.--Variations in concentrations of total recoverable nickel.

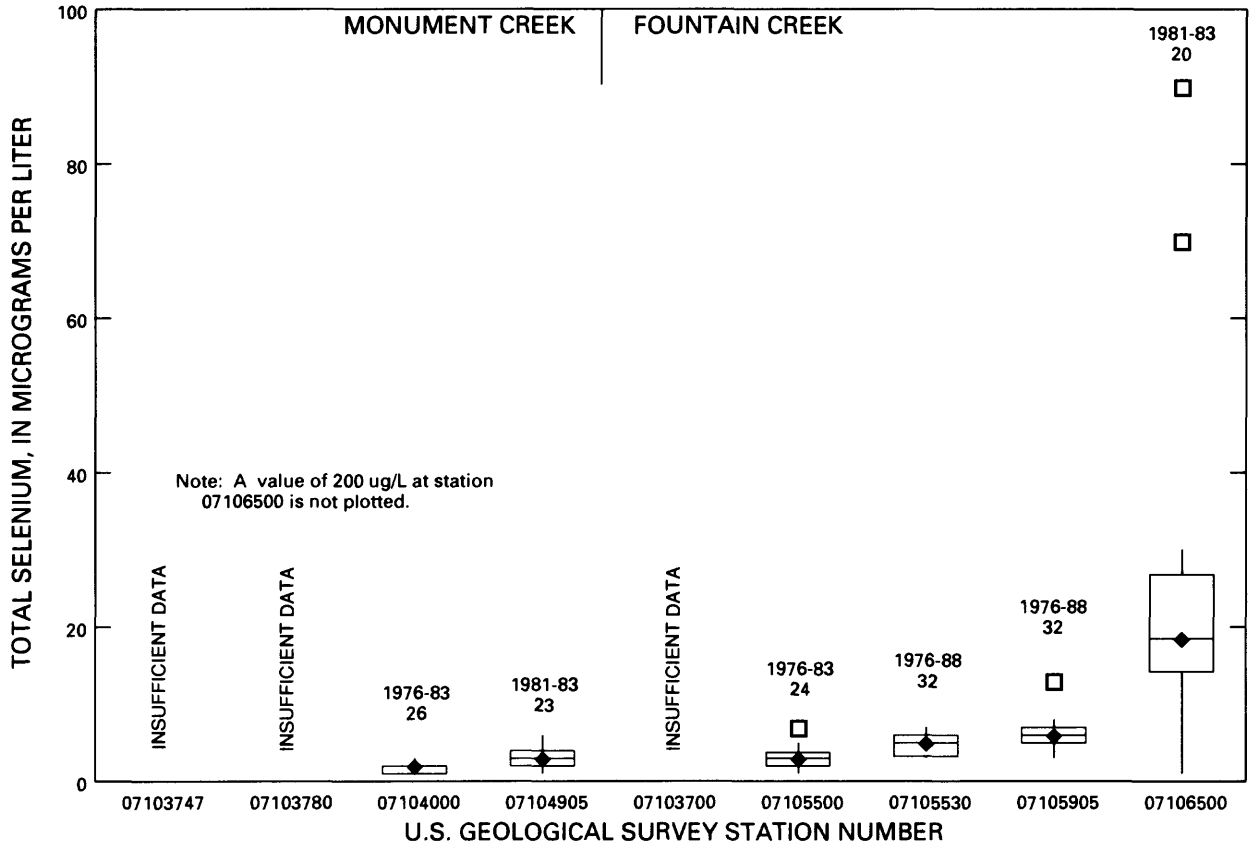

Figure 27.--Variations in concentrations of total selenium.

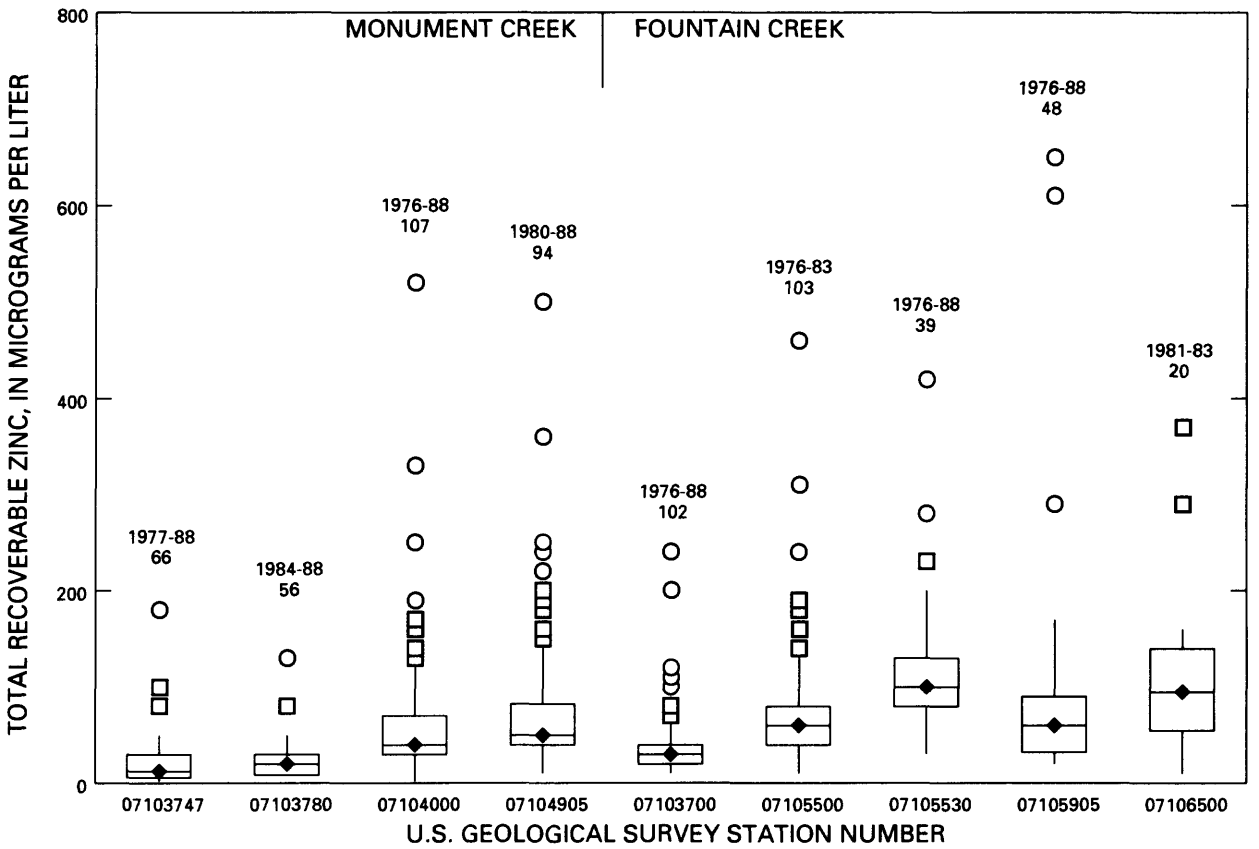

Figure 28.--Variations in concentrations of total recoverable zinc.

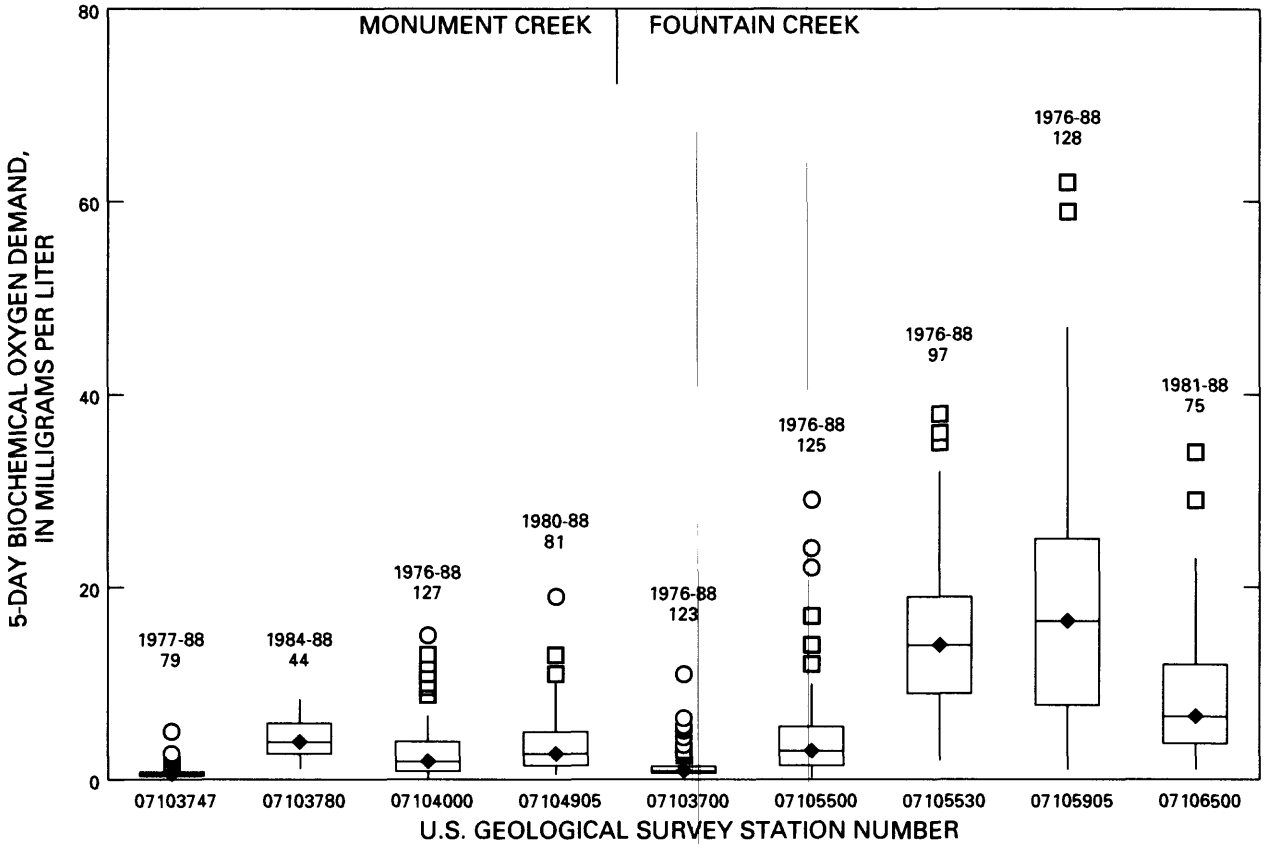

Figure 29.--Variations in 5-day biochemical oxygen demand.

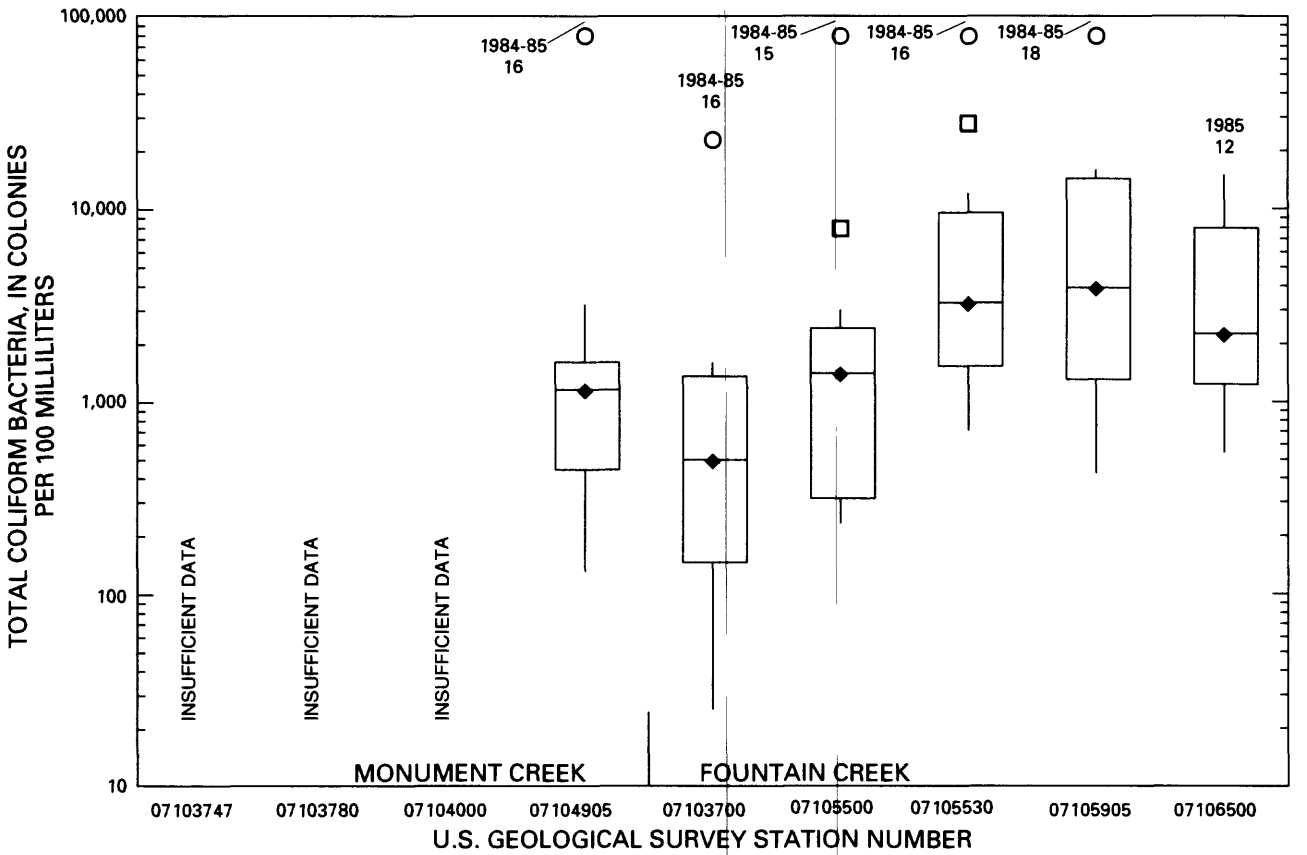

Figure 30.--Variations in counts of total coliform bacteria.

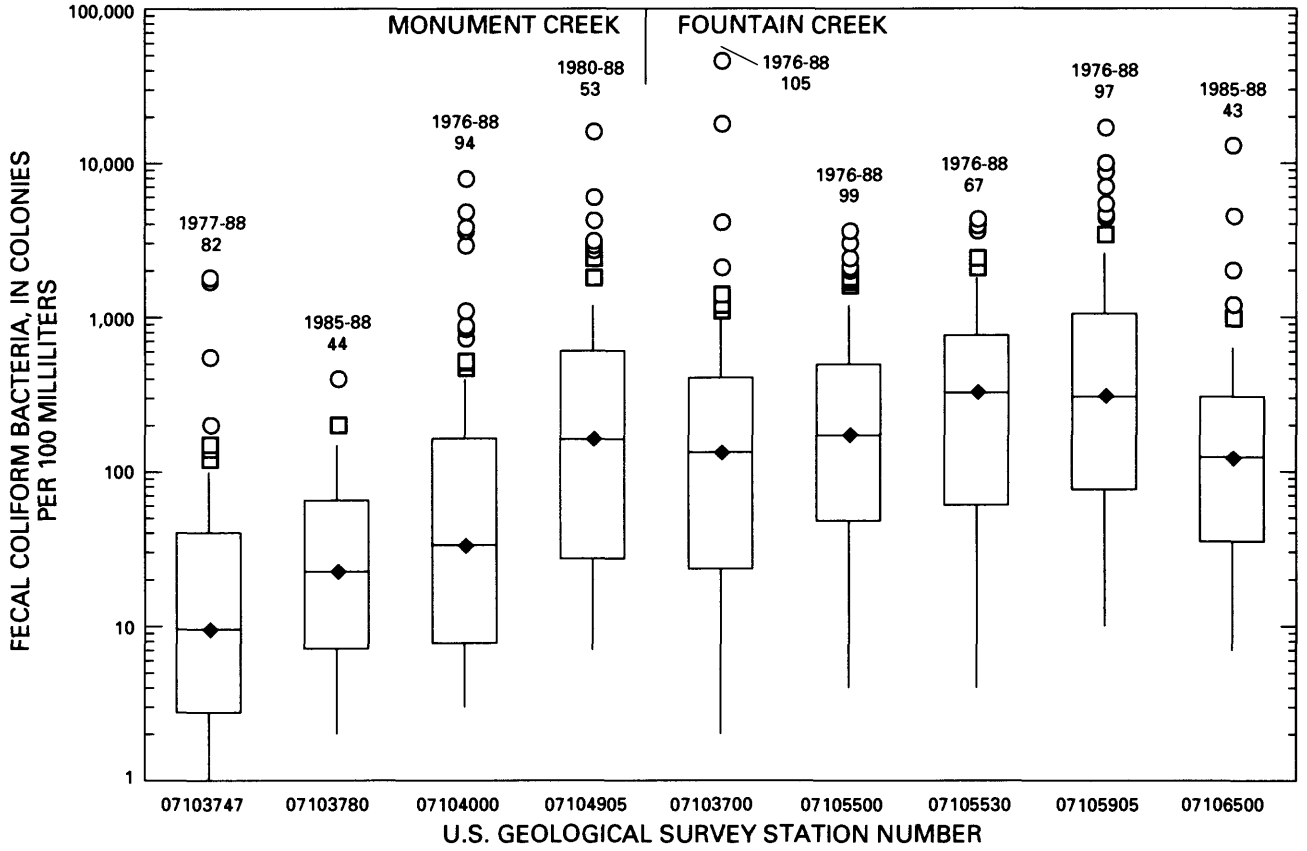

Figure 31.--Variations in counts of fecal coliform bacteria.

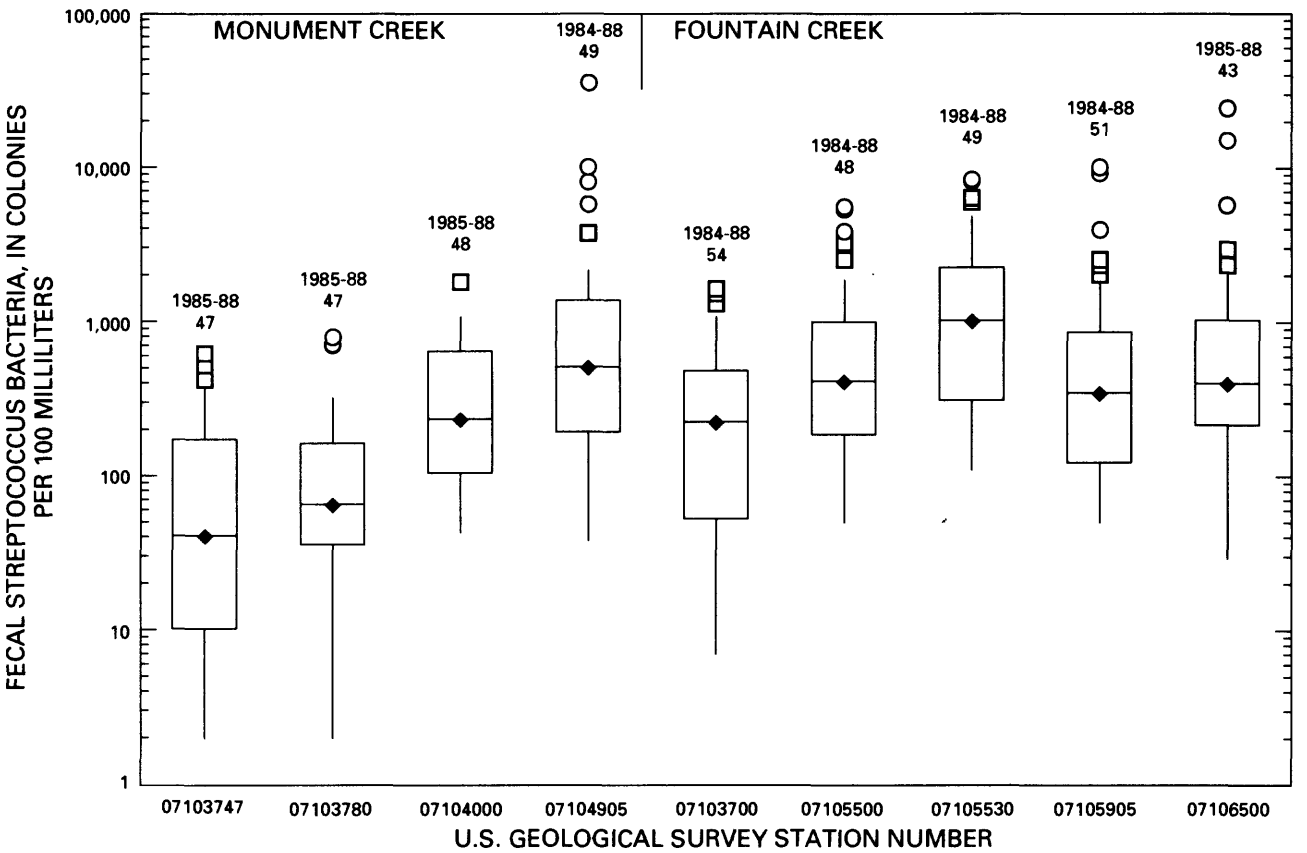

Figure 32.--Variations in counts of fecal streptococcus bacteria.

Table 13.--*Trend-analysis results of selected water-quality properties and constituents for water-quality station 07103747 Monument Creek at Palmer Lake*

[ft^3/s, cubic feet per second; µS/cm, microsiemens per centimeter at 25 degrees Celsius; °C, degree Celsius; mg/L, milligrams per liter; µg/L, micrograms per liter; /100 mL, colonies per 100 milliliters; --, insufficient data; *, moderately significant trend, the significance level is less than or equal to 0.1 and greater than 0.05; **, significant trend, the significance level is less than or equal to 0.05 and greater than 0.01; ***, very significant trend, the significance level is less than or equal to 0.01]

Property or constituent	Units	Number of values	Number of censored values	Period of record (water year)	Number of years	Significance level		Trend slope (units per year)
						Unadjusted	Adjusted for serial correlation	
Instantaneous streamflow	ft^3/s	209	0	1977-88	12	0.0000	0.0829	0.1*
Specific conductance	µS/cm	206	0	1977-88	12	0.0000	0.0244	-3**
pH	standard	95	0	1977-88	12	0.0000	0.0497	0.05**
Water temperature	°C	209	0	1977-88	12	0.4036	0.4884	-0.03
Dissolved oxygen	mg/L	94	0	1977-88	12	0.3072	0.5638	0.04
Dissolved chloride	mg/L	83	0	1977-88	12	0.1541	0.4035	-0.056
Dissolved sulfate	mg/L	78	0	1977-88	12	0.0103	0.1377	-0.1
Un-ionized ammonia as nitrogen	mg/L	59	0	1977-88	12	0.2896	0.5018	0.00010
Total organic nitrogen as nitrogen	mg/L	32	0	1984-88	5	0.1614	--	-0.032
Total recoverable copper	µg/L	65	5	1978-88	11	[1]0.12-0.25	[1]0.14-0.30	-0.1
Dissolved iron	µg/L	54	0	1984-88	5	0.9340	--	0.0
Total recoverable iron	µg/L	68	0	1977-88	12	0.5874	0.7331	10
Dissolved manganese	µg/L	56	3	1984-88	5	1.00	--	0.0
Total recoverable manganese	µg/L	68	0	1977-88	12	0.0626	0.0258	1
5-day biochemical oxygen demand	mg/L	79	0	1977-88	12	0.9623	0.9787	0.0
Fecal streptococcus[2]	/100 mL	47	0	1985-88	4	0.0100	--	-0.3***

[1]The significance level range results from treating the censored values differently: equal to the detection limit, equal to one-half the detection limit, and equal to zero. Changing the treatment of the censored values does not change the trend significance.

[2]Trend slope is slope of logarithms.

Table 14.--*Trend-analysis results of selected water-quality properties and constituents for water-quality station 07103780 Monument Creek above North Gate Boulevard at U.S. Air Force Academy*

[ft^3/s, cubic feet per second; µS/cm, microsiemens per centimeter at 25 degrees Celsius; °C, degree Celsius; mg/L, milligrams per liter; µg/L, micrograms per liter; /100 mL, colonies per 100 milliliters; --, insufficient data; *, moderately significant trend, the significance level is less than or equal to 0.1 and greater than 0.05; **, significant trend, the significance level is less than or equal to 0.05 and greater than 0.01; ***, very significant trend, the significance level is less than or equal to 0.01]

Property or constituent	Units	Number of values	Number of censored values	Period of record (water year)	Number of years	Significance level		Trend slope (units per year)
						Unadjusted	Adjusted for serial correlation	
Instantaneous streamflow	ft^3/s	93	0	1984-88	5	0.0002	--	-3***
Specific conductance	µS/cm	87	0	1984-88	5	0.0002	--	11***
pH	standard	58	0	1984-88	5	0.0015	--	0.1***
Water temperature	°C	88	0	1984-88	5	0.0708	--	0.5*
Dissolved oxygen	mg/L	59	0	1984-88	5	0.0906	--	-0.2*
Dissolved chloride	mg/L	61	0	1984-88	5	0.0002	--	1.2***
Dissolved sulfate	mg/L	56	0	1984-88	5	0.0430	--	1.0**
Suspended solids	mg/L	56	1	1984-88	5	0.0053	--	-7***
Nitrite plus nitrate as nitrogen	mg/L	61	0	1984-88	5	0.0137	--	0.058**
Total ammonia as nitrogen	mg/L	61	3	1984-88	5	0.5869	--	0.014
Un-ionized ammonia as nitrogen	mg/L	55	0	1984-88	5	0.0025	--	0.0022***
Total ammonia plus organic nitrogen	mg/L	56	0	1984-88	5	0.1347	--	0.10
Total organic nitrogen as nitrogen	mg/L	54	0	1984-88	5	0.0296	--	0.11**
Total recoverable copper	µg/L	56	0	1984-88	5	0.5676	--	0.0
Dissolved iron	µg/L	56	1	1984-88	5	0.4306	--	-3
Total recoverable iron	µg/L	56	0	1984-88	5	0.0303	--	-180**
Dissolved manganese	µg/L	56	0	1984-88	5	0.5223	--	0.0
Total recoverable manganese	µg/L	56	0	1984-88	5	0.8735	--	0.0
5-day biochemical oxygen demand	mg/L	44	0	1984-88	5	0.0959	--	0.3*
Fecal coliform[1]	/100 mL	44	3	1985-88	4	0.7173	--	-0.06
Fecal streptococcus[1]	/100 mL	47	0	1985-88	4	0.6397	--	-0.09

[1]Trend slope is slope of logarithms.

Table 15.--*Trend-analysis results of selected water-quality properties and constituents for water-quality station 07104000 Monument Creek at Pikeview*

[ft^3/s, cubic feet per second; µS/cm, microsiemens per centimeter at 25 degrees Celsius; °C, degree Celsius; mg/L, milligrams per liter; µg/L, micrograms per liter; /100 mL, colonies per 100 milliliters; --, insufficient data; *, moderately significant trend, the significance level is less than or equal to 0.1 and greater than 0.05; **, significant trend, the significance level is less than or equal to 0.05 and greater than 0.01; ***, very significant trend, the significance level is less than or equal to 0.01]

Property or constituent	Units	Number of values	Number of censored values	Period of record (water year)	Number of years	Significance level		Trend slope (units per year)
						Unadjusted	Adjusted for serial correlation	
Instantaneous streamflow	ft^3/s	249	0	1976-88	13	0.0000	0.0063	1.9***
Specific conductance	µS/cm	243	0	1976-88	13	0.0194	0.2986	4
pH	standard	147	0	1976-88	13	0.0000	0.0236	0.05**
Water temperature	°C	244	0	1976-88	13	0.2148	0.4495	0.04
Dissolved oxygen	mg/L	146	0	1976-88	13	0.0312	0.2536	0.05
Dissolved chloride	mg/L	104	0	1977-88	12	0.0005	0.1280	0.4
Dissolved sulfate	mg/L	99	0	1977-88	12	0.1322	0.4830	0.6
Suspended solids	mg/L	136	3	1977-88	12	0.0001	0.0201	13**
Nitrite plus nitrate as nitrogen	mg/L	150	0	1976-88	13	0.0000	0.0022	0.081***
Un-ionized ammonia as nitrogen	mg/L	124	0	1976-88	13	0.0000	0.0035	0.00020***
Total ammonia plus organic nitrogen	mg/L	99	0	1976-88	13	0.5618	0.7311	0.0018
Total organic nitrogen as nitrogen	mg/L	95	0	1976-88	13	0.7256	0.8339	-0.0029
Total phosphorus	mg/L	65	1	1976-82	7	0.7292	--	0.0025
Total recoverable copper	µg/L	103	2	1976-88	13	1.00	1.00	0.0
Total recoverable iron	µg/L	110	0	1976-88	13	0.0000	0.0123	270**
Total recoverable manganese	µg/L	110	0	1976-88	13	0.0071	0.0780	5*
Total recoverable nickel	µg/L	23	2	1981-83	3	0.1138	--	2
Total selenium	µg/L	26	2	1976-83	8	[1]0.24-0.31	--	0.0
Total recoverable zinc	µg/L	107	4	1976-88	13	[1]0.51-0.72	[1]0.69-0.83	0.0
5-day biochemical oxygen demand	mg/L	127	0	1976-88	13	0.0002	0.0638	0.1*
Fecal streptococcus[2]	/100 mL	48	0	1985-88	4	0.0682	--	-0.07*

[1]The significance level range results from treating the censored values differently: equal to the detection limit, equal to one-half the detection limit, and equal to zero. Changing the treatment of the censored values does not change the trend significance.

[2]Trend slope is slope of logarithms.

Table 16.--*Trend-analysis results of selected water-quality properties and constituents for water-quality station 07104905 Monument Creek at Bijou Street at Colorado Springs*

[ft^3/s, cubic feet per second; µS/cm, microsiemens per centimeter at 25 degrees Celsius; °C, degree Celsius; mg/L, milligrams per liter; µg/L, micrograms per liter; /100 mL, colonies per 100 milliliters; --, insufficient data; *, moderately significant trend, the significance level is less than or equal to 0.1 and greater than 0.05; **, significant trend, the significance level is less than or equal to 0.05 and greater than 0.01; ***, very significant trend, the significance level is less than or equal to 0.01]

Property or constituent	Units	Number of values	Number of censored values	Period of record (water year)	Number of years	Significance level		Trend slope (units per year)
						Unadjusted	Adjusted for serial correlation	
Instantaneous streamflow	ft^3/s	100	0	1980-88	9	0.0465	--	1.4**
Specific conductance	µS/cm	100	0	1980-88	9	0.0547	--	11*
pH	standard	95	0	1980-88	9	0.0000	--	0.05***
Water temperature	°C	100	0	1980-88	9	0.3492	--	0.00
Dissolved oxygen	mg/L	98	0	1980-88	9	0.1971	--	-0.08
Dissolved chloride	mg/L	69	0	1983-88	6	0.0000	--	1.6***
Dissolved sulfate	mg/L	69	0	1983-88	6	0.0000	--	10***
Suspended solids	mg/L	99	1	1980-88	9	0.1605	--	-12
Nitrite plus nitrate as nitrogen	mg/L	100	0	1980-88	9	0.0000	--	0.19***
Un-ionized ammonia as nitrogen	mg/L	84	0	1980-88	9	0.0305	--	0.00025**
Total ammonia plus organic nitrogen	mg/L	90	1	1981-88	8	0.0075	--	-0.075***
Total organic nitrogen as nitrogen	mg/L	81	0	1981-88	8	0.0141	--	-0.067**
Total phosphorus	mg/L	20	0	1980-82	3	1.0000	--	0.02
Total recoverable copper	µg/L	95	0	1980-88	9	0.0080	--	-0.6***
Total recoverable iron	µg/L	95	1	1980-88	9	0.2818	--	-180
Total recoverable lead	µg/L	95	9	1980-88	9	[1]0.33-0.74	--	0.0--0.3
Total recoverable manganese	µg/L	95	0	1980-88	9	0.7733	--	-0.7
Total recoverable nickel	µg/L	23	0	1981-83	3	0.1138	--	2
Total selenium	µg/L	23	0	1981-83	3	0.7518	--	-1
Total recoverable zinc	µg/L	94	1	1980-88	9	0.1142	--	-2
5-day biochemical oxygen demand	mg/L	81	0	1980-88	9	0.0223	--	-0.26**
Fecal coliform[2]	/100 mL	53	4	1980-88	9	0.3637	--	0.04
Fecal streptococcus[2]	/100 mL	49	1	1984-88	5	0.1839	--	-0.08

[1]The significance level range results from treating the censored values differently: equal to the detection limit, equal to one-half the detection limit, and equal to zero. Changing the treatment of the censored values does not change the trend significance.

[2]Trend slope is slope of logarithms.

Table 17.--*Trend-analysis results of selected water-quality properties and constituents for water-quality station 07103700 Fountain Creek near Colorado Springs*

[ft^3/s, cubic feet per second; µS/cm, microsiemens per centimeter at 25 degrees Celsius; °C, degree Celsius; mg/L, milligrams per liter; µg/L, micrograms per liter; /100 mL, colonies per 100 milliliters; --, insufficient data; *, moderately significant trend, the significance level is less than or equal to 0.1 and greater than 0.05; **, significant trend, the significance level is less than or equal to 0.05 and greater than 0.01; ***, very significant trend, the significance level is less than or equal to 0.01]

Property or constituent	Units	Number of values	Number of censored values	Period of record (water year)	Number of years	Significance level		Trend slope (units per year)
						Unadjusted	Adjusted for serial correlation	
Instantaneous streamflow	ft^3/s	267	0	1976-88	13	0.0000	0.0484	0.5**
Specific conductance	µS/cm	259	0	1976-88	13	0.0000	0.0578	-7*
pH	standard	140	0	1976-88	13	0.0047	0.1645	0.02
Water temperature	°C	262	0	1976-88	13	0.0029	0.0635	-0.2*
Dissolved oxygen	mg/L	145	0	1976-88	13	0.0008	0.0898	0.08*
Dissolved chloride	mg/L	103	0	1977-88	12	0.7221	0.8579	0.00
Dissolved sulfate	mg/L	98	0	1977-88	12	0.1433	0.4479	-0.22
Suspended solids	mg/L	134	7	1977-88	12	0.54	0.66	0.33
Nitrite plus nitrate as nitrogen	mg/L	148	0	1976-88	13	0.1474	0.4554	0.0040
Un-ionized ammonia as nitrogen	mg/L	104	0	1976-88	13	0.0730	0.1806	0.000021
Total ammonia plus organic nitrogen	mg/L	100	9	1976-88	13	0.0004	0.08	-0.05*
Total organic nitrogen as nitrogen	mg/L	74	0	1976-88	13	0.3875	0.5242	-0.018
Total phosphorus	mg/L	63	6	1976-82	7	[1]0.38-0.42	--	[1]0.0010-0.0030
Total recoverable copper	µg/L	102	3	1976-88	13	0.0038	0.0672	-0.3*
Dissolved iron	µg/L	82	5	1976-88	13	0.7499	0.7903	0.0
Total recoverable iron	µg/L	109	0	1976-88	13	0.6926	0.8061	13
Dissolved manganese	µg/L	85	0	1976-88	13	0.9646	0.9726	0.0
Total recoverable manganese	µg/L	109	0	1976-88	13	0.4737	0.6686	0.0
Total recoverable zinc	µg/L	102	7	1976-88	13	0.0005	0.053	[1]-2.0--2.5*
5-day biochemical oxygen demand	mg/L	123	0	1976-88	13	0.5222	0.6958	-0.009
Fecal coliform[2]	/100 mL	105	1	1976-88	13	[1]0.007-0.008	0.06	-0.04**
Fecal streptococcus[2]	/100 mL	54	0	1984-88	5	0.2193	--	-0.08

[1]The significance level range results from treating the censored values differently: equal to the detection limit, equal to one-half the detection limit, and equal to zero. Changing the treatment of the censored values does not change the trend significance.

[2]Trend slope is slope of logarithms.

Table 18.--*Trend-analysis results of selected water-quality properties and constituents for water-quality station 07105500 Fountain Creek at Colorado Springs*

[ft^3/s, cubic feet per second; µS/cm, microsiemens per centimeter at 25 degrees Celsius; °C, degree Celsius; mg/L, milligrams per liter; µg/L, micrograms per liter; /100 mL, colonies per 100 milliliters; --, insufficient data; *, moderately significant trend, the significance level is less than or equal to 0.1 and greater than 0.05; **, significant trend, the significance level is less than or equal to 0.05 and greater than 0.01; ***, very significant trend, the significance level is less than or equal to 0.01]

Property or constituent	Units	Number of values	Number of censored values	Period of record (water year)	Number of years	Significance level		Trend slope (units per year)
						Unadjusted	Adjusted for serial correlation	
Instantaneous streamflow	ft^3/s	306	0	1976-88	13	0.0000	0.0209	2.3**
Specific conductance	µS/cm	283	0	1976-88	13	0.0000	0.0413	-20**
pH	standard	139	0	1976-88	13	0.0000	0.0248	0.04**
Water temperature	°C	285	0	1976-88	13	0.4004	0.6668	-0.06
Dissolved oxygen	mg/L	141	0	1976-88	13	0.1040	0.4473	0.04
Dissolved chloride	mg/L	110	0	1977-88	12	0.1482	0.5249	-0.42
Dissolved sulfate	mg/L	98	0	1977-88	12	0.4859	0.7667	-1.9
Suspended solids	mg/L	133	0	1977-88	12	0.9263	0.9285	0.5
Nitrite plus nitrate as nitrogen	mg/L	139	0	1976-88	13	0.0024	0.2278	0.042
Un-ionized ammonia as nitrogen	mg/L	119	0	1976-88	13	0.0222	0.2590	-0.00014
Total ammonia plus organic nitrogen	mg/L	97	1	1976-88	13	0.0001	0.0162	-0.083**
Total organic nitrogen as nitrogen	mg/L	86	1	1976-88	13	0.1694	0.2373	-0.040
Total phosphorus	mg/L	64	0	1976-82	7	0.1232	--	-0.050
Total recoverable copper	µg/L	100	1	1977-88	12	0.0016	0.0453	-0.5**
Total recoverable iron	µg/L	105	0	1976-88	13	0.8803	0.8880	0.9
Dissolved manganese	µg/L	81	4	1976-88	13	0.0019	0.0556	-5*
Total recoverable manganese	µg/L	104	0	1976-88	13	0.0000	0.0039	-10***
Total recoverable nickel	µg/L	23	1	1981-83	3	1.0000	--	0.0
Total selenium	µg/L	24	1	1976-83	8	1.0000	--	0.0
Total recoverable zinc	µg/L	103	0	1976-88	13	0.0000	0.0070	-5***
5-day biochemical oxygen demand	mg/L	125	0	1976-88	13	0.0000	0.0256	-0.2**
Fecal coliform[1]	/100 mL	99	3	1976-88	13	0.9708	0.9780	-0.002
Fecal streptococcus[1]	/100 mL	48	0	1984-88	5	0.0395	--	-0.1**

[1]Trend slope is slope of logarithms.

Table 19.--*Trend-analysis results of selected water-quality properties and constituents for water-quality station 07105530 Fountain Creek below Janitell Road below Colorado Springs*

[ft^3/s, cubic feet per second; µS/cm, microsiemens per centimeter at 25 degrees Celsius; °C, degree Celsius; mg/L, milligrams per liter; µg/L, micrograms per liter; /100 mL, colonies per 100 milliliters; --, insufficient data; *, moderately significant trend, the significance level is less than or equal to 0.1 and greater than 0.05; **, significant trend, the significance level is less than or equal to 0.05 and greater than 0.01; ***, very significant trend, the significance level is less than or equal to 0.01]

Property or constituent	Units	Number of values	Number of censored values	Period of record (water year)	Number of years	Significance level		Trend slope (units per year)
						Unadjusted	Adjusted for serial correlation	
Instantaneous streamflow	ft^3/s	116	0	1976-88	13	0.0004	0.0832	4.5*
Specific conductance	µS/cm	116	0	1976-88	13	0.6520	0.8321	2
pH	standard	112	0	1976-88	13	0.0000	0.0207	0.05**
Water temperature	°C	116	0	1976-88	13	0.2801	0.5791	-0.1
Dissolved oxygen	mg/L	115	0	1976-88	13	0.1014	0.3838	0.06
Hardness as calcium carbonate	mg/L	40	0	1976-85	10	0.0778	0.2362	-5
Dissolved calcium	mg/L	40	0	1976-85	10	0.2004	0.3497	-0.5
Dissolved magnesium	mg/L	40	0	1976-85	10	0.0339	0.1745	-0.6
Dissolved chloride	mg/L	37	0	1981-85	5	0.0642	--	-5.0*
Suspended solids	mg/L	103	1	1979-88	10	0.9481	0.9616	-0.1
Nitrite plus nitrate as nitrogen	mg/L	114	0	1976-88	13	0.0003	0.1001	0.068
Total ammonia as nitrogen	mg/L	108	2	1976-88	13	0.4104	0.6749	0.10
Un-ionized ammonia as nitrogen	mg/L	103	0	1976-88	13	0.0000	0.0162	0.0090**
Total ammonia plus organic nitrogen	mg/L	99	0	1976-88	13	0.0447	0.4075	-0.50
Total organic nitrogen as nitrogen	mg/L	92	6	1976-88	13	0.0068	0.0970	-0.17*
Total phosphorus	mg/L	32	0	1976-82	7	0.3768	--	-0.24
Total recoverable copper	µg/L	39	0	1976-88	13	0.0564	0.1809	-0.9
Dissolved iron	µg/L	40	0	1976-85	10	0.5254	0.4253	-1
Total recoverable iron	µg/L	39	0	1976-88	13	0.0187	0.1006	-250
Dissolved manganese	µg/L	40	0	1976-85	10	0.0212	0.2239	-23
Total recoverable manganese	µg/L	31	0	1976-87	12	0.0756	0.0910	-14*
Total recoverable nickel	µg/L	32	0	1981-88	8	0.0293	--	-1**
Total selenium	µg/L	32	3	1976-88	13	0.4772	0.3320	0.1
Total recoverable zinc	µg/L	39	0	1976-88	13	0.1131	0.0382	-3**
5-day biochemical oxygen demand	mg/L	97	0	1976-88	13	0.4075	0.6198	-0.2
Fecal coliform[1]	/100 mL	67	3	1976-88	13	[2]0.03-0.05	0.10	0.08*
Fecal streptococcus[1]	/100 mL	49	0	1984-88	5	0.2631	--	-0.1

[1]Trend slope is slope of logarithms.

[2]The significance level range results from treating the censored values differently: equal to the detection limit, equal to one-half the detection limit, and equal to zero. Changing the treatment of the censored values does not change the trend significance.

Table 20.--*Trend-analysis results of selected water-quality properties and constituents for water-quality station 07105905 Fountain Creek above Little Fountain Creek below Fountain*

[ft^3/s, cubic feet per second; µS/cm, microsiemens per centimeter at 25 degrees Celsius; °C, degree Celsius; mg/L, milligrams per liter; µg/L, micrograms per liter; /100 mL, colonies per 100 milliliters; --, insufficient data; *, moderately significant trend, the significance level is less than or equal to 0.1 and greater than 0.05; **, significant trend, the significance level is less than or equal to 0.05 and greater than 0.01; ***, very significant trend, the significance level is less than or equal to 0.01]

Property or constituent	Units	Number of values	Number of censored values	Period of record (water year)	Number of years	Significance level		Trend slope (units per year)
						Unadjusted	Adjusted for serial correlation	
Instantaneous streamflow	ft^3/s	142	0	1976-88	13	0.0000	0.0103	5.2**
Specific conductance	µS/cm	141	0	1976-88	13	0.0000	0.0340	-30**
pH	standard	135	0	1976-88	13	0.0000	0.0735	0.03*
Water temperature	°C	140	0	1976-88	13	0.0518	0.1103	0.2
Dissolved oxygen	mg/L	135	0	1976-88	13	0.4236	0.6351	-0.02
Dissolved chloride	mg/L	32	0	1977-85	9	0.8597	--	4.5
Dissolved sulfate	mg/L	32	0	1977-85	9	1.0000	--	5.0
Suspended solids	mg/L	130	0	1977-88	12	0.7941	0.8294	-0.5
Nitrite plus nitrate as nitrogen	mg/L	139	0	1976-88	13	0.0001	0.0234	0.083**
Total ammonia as nitrogen	mg/L	138	3	1976-88	13	0.0039	0.0791	-0.052*
Un-ionized ammonia as nitrogen	mg/L	130	0	1976-88	13	0.2856	0.5830	0.00033
Total ammonia plus organic nitrogen	mg/L	99	0	1976-88	13	0.0011	0.0666	-0.20*
Total organic nitrogen as nitrogen	mg/L	96	1	1976-88	13	0.1494	0.2907	-0.06
Total phosphorus	mg/L	59	0	1976-82	7	0.1870	--	-0.15
Total recoverable copper	µg/L	43	0	1976-88	13	0.0817	0.1092	-0.8
Total recoverable iron	µg/L	48	0	1976-88	13	1.0000	1.0000	40
Total recoverable manganese	µg/L	39	0	1976-83	8	0.8351	--	-1
Total recoverable nickel	µg/L	32	0	1981-88	8	0.0786	--	-1*
Total selenium	µg/L	32	0	1976-88	13	0.4772	0.6180	-0.08
Total recoverable zinc	µg/L	48	0	1976-88	13	1.0000	1.0000	0.0
5-day biochemical oxygen demand	mg/L	128	0	1976-88	13	0.2185	0.2845	-0.3
Fecal coliform[1]	/100 mL	97	2	1976-88	13	0.0000	0.0106	-0.09***
Fecal streptococcus[1]	/100 mL	51	0	1984-88	5	0.0634	--	-0.1*

[1]Trend slope is slope of logarithms.

Table 21.--*Trend-analysis results of selected water-quality properties and constituents for water-quality station 07106500 Fountain Creek at Pueblo*

[ft^3/s, cubic feet per second; µS/cm, microsiemens per centimeter at 25 degrees Celsius; °C, degree Celsius; mg/L, milligrams per liter; µg/L, micrograms per liter; /100 mL, colonies per 100 milliliters; --, insufficient data; *, moderately significant trend, the significance level is less than or equal to 0.1 and greater than 0.05; **, significant trend, the significance level is less than or equal to 0.05 and greater than 0.01; ***, very significant trend, the significance level is less than or equal to 0.01]

Property or constituent	Units	Number of values	Number of censored values	Period of record (water year)	Number of years	Significance level		Trend slope (units per year)
						Unadjusted	Adjusted for serial correlation	
Instantaneous streamflow	ft^3/s	266	0	1976-88	13	0.0000	0.0216	6.0**
Specific conductance	µS/cm	265	0	1976-88	13	0.0000	0.0119	-61**
pH	standard	89	0	1981-88	8	0.0000	--	0.07***
Water temperature	°C	225	0	1976-88	13	0.1555	0.1739	-0.2
Dissolved oxygen	mg/L	92	0	1981-88	8	0.0012	--	0.2***
Suspended solids	mg/L	88	0	1981-88	8	0.0221	--	-26**
Nitrite plus nitrate as nitrogen	mg/L	90	1	1981-88	8	0.0002	--	0.22***
Total ammonia as nitrogen	mg/L	88	1	1981-88	8	0.1127	--	-0.0050
Un-ionized ammonia as nitrogen	mg/L	84	0	1981-88	8	0.0553	--	0.00020*
Total ammonia plus organic nitrogen	mg/L	87	1	1981-88	8	0.0929	--	-0.075*
Total organic nitrogen as nitrogen	mg/L	86	0	1981-88	8	0.1351	--	-0.057
Total recoverable copper	µg/L	20	0	1981-83	3	0.2888	--	10
Total recoverable iron	µg/L	20	0	1981-83	3	0.2888	--	7,800
Total recoverable lead	µg/L	20	1	1981-83	3	0.1306	--	5
Total recoverable manganese	µg/L	20	0	1981-83	3	0.0771	--	180*
Total recoverable nickel	µg/L	20	0	1981-83	3	0.2888	--	6
Total selenium	µg/L	20	0	1981-83	3	0.4497	--	-6
Total recoverable zinc	µg/L	20	0	1981-83	3	0.0771	--	35*
5-day biochemical oxygen demand	mg/L	75	0	1981-88	8	0.0004	--	-0.6***
Fecal coliform[1]	/100 mL	43	4	1985-88	4	0.7394	--	-0.1
Fecal streptococcus[1]	/100 mL	43	1	1985-88	4	0.4996	--	-0.06

[1]Trend slope is slope of logarithms.

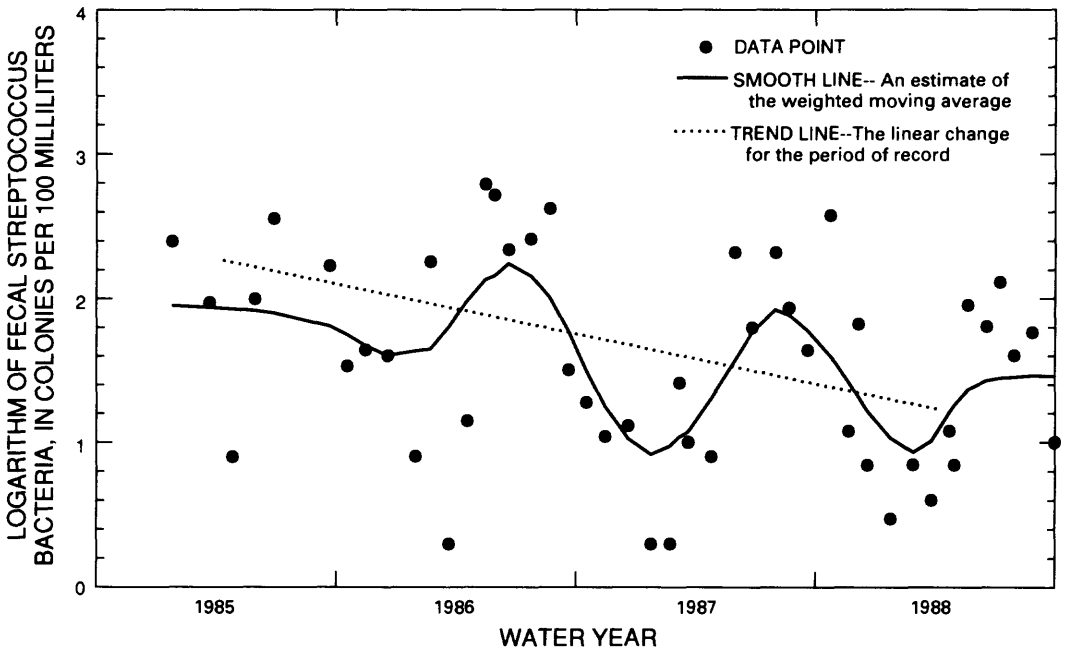

Figure 33.--Fecal streptococcus bacteria at water-quality station 07103747 Monument Creek at Palmer Lake.

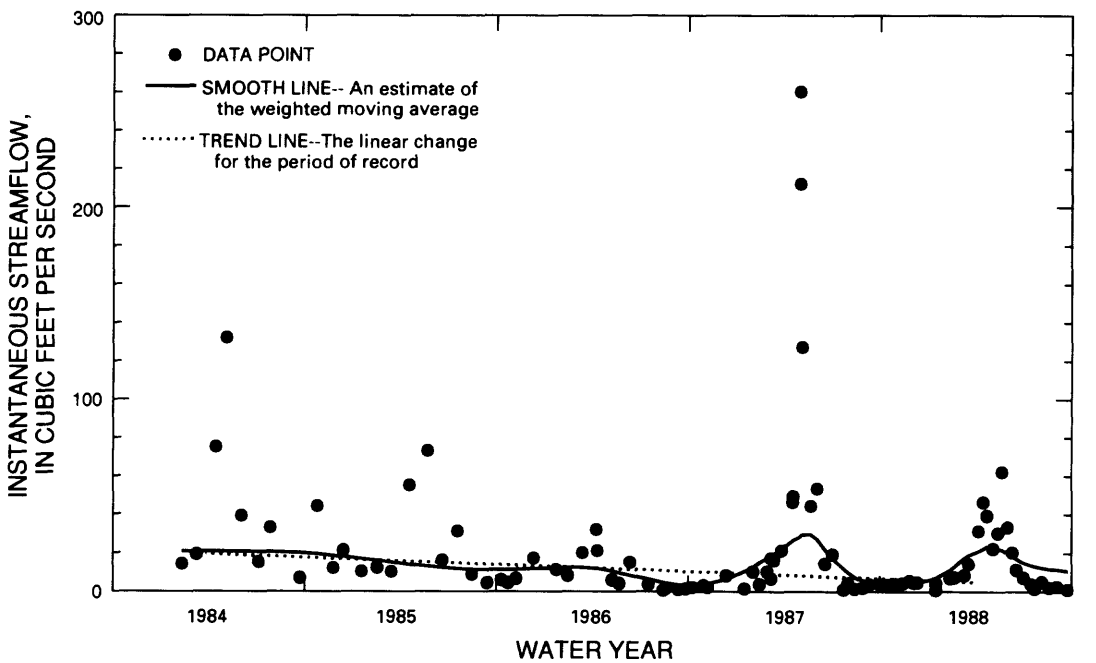

Figure 34.--Trend of instantaneous streamflow at water-quality station 07103780 Monument Creek above North Gate Boulevard at U.S. Air Force Academy.

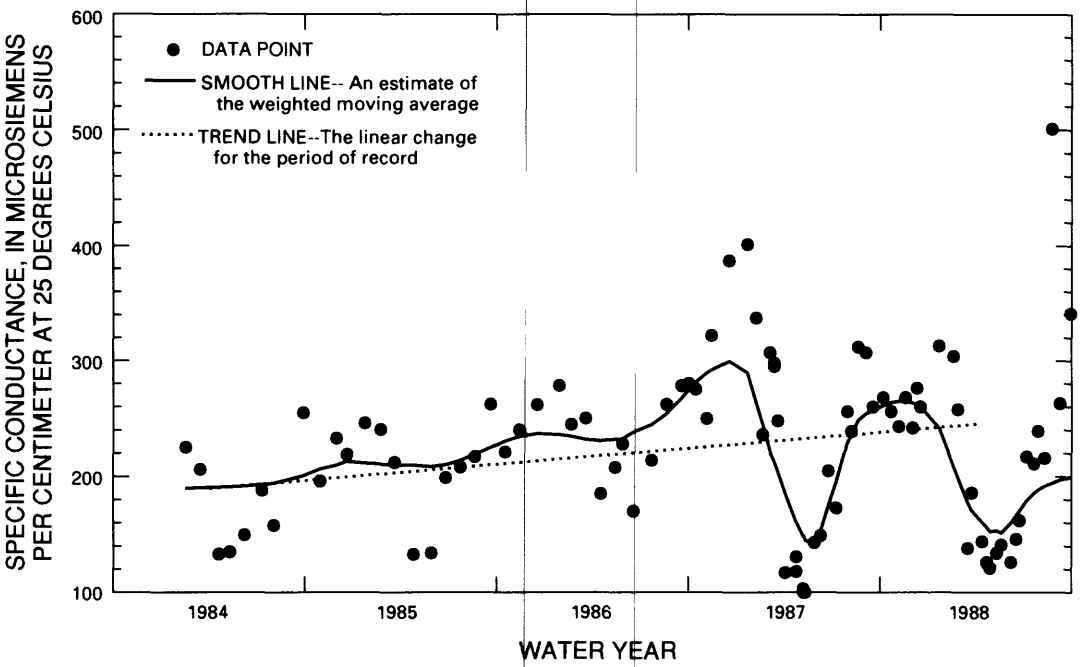

Figure 35.--Trend of specific conductance at water-quality station 07103780 Monument Creek above North Gate Boulevard at U.S. Air Force Academy.

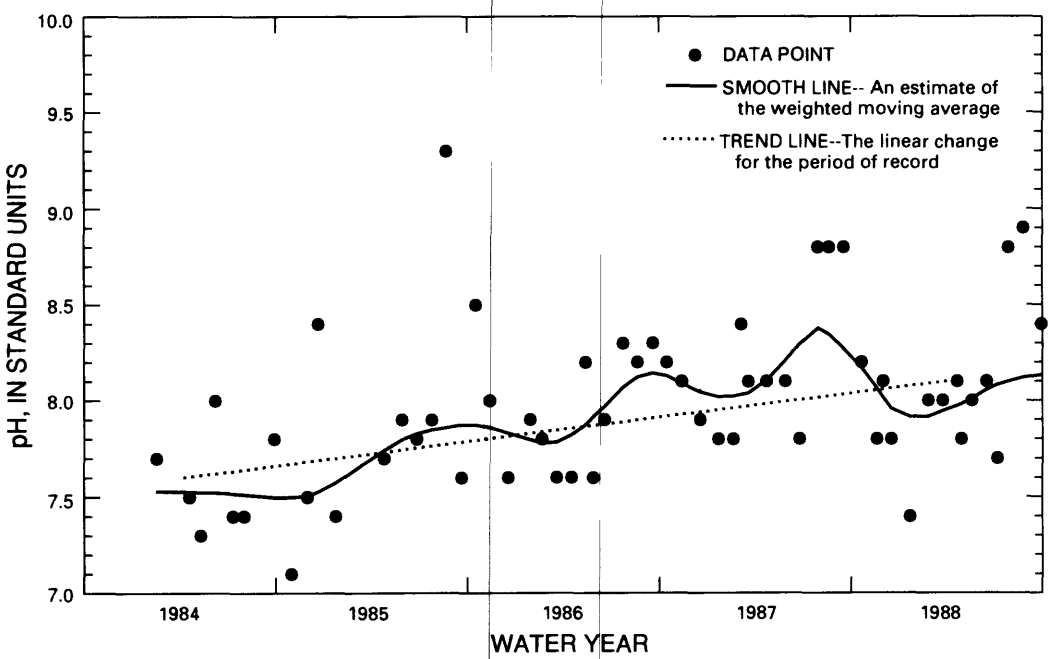

Figure 36.--Trend of pH at water-quality station 07103780 Monument Creek above North Gate Boulevard at U.S. Air Force Academy.

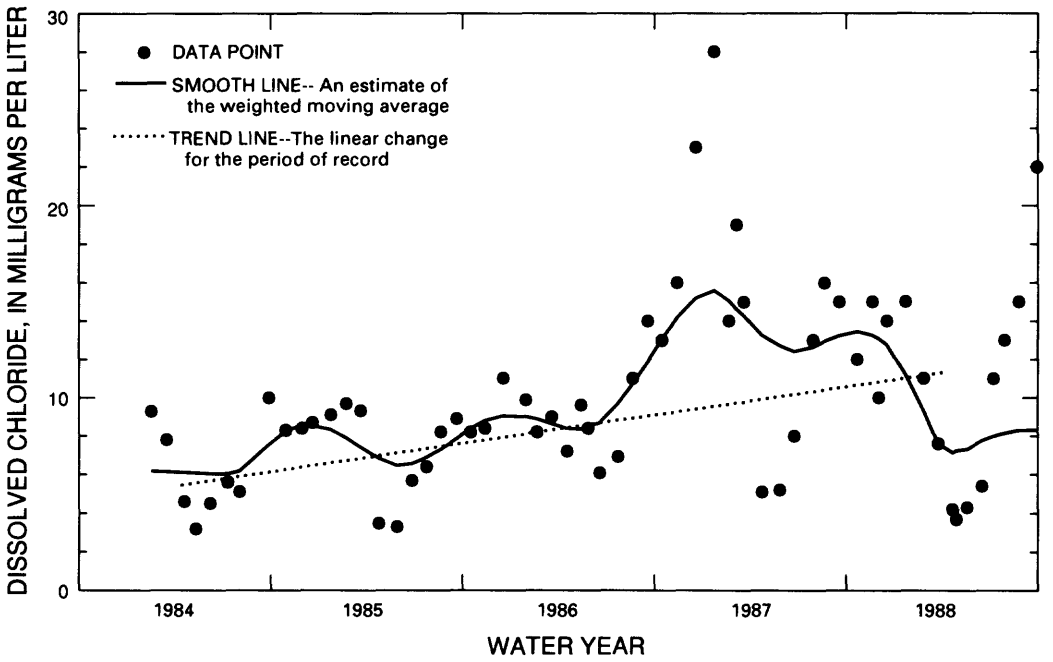

Figure 37.--Trend of dissolved chloride at water-quality station 07103780 Monument Creek above North Gate Boulevard at U.S. Air Force Academy.

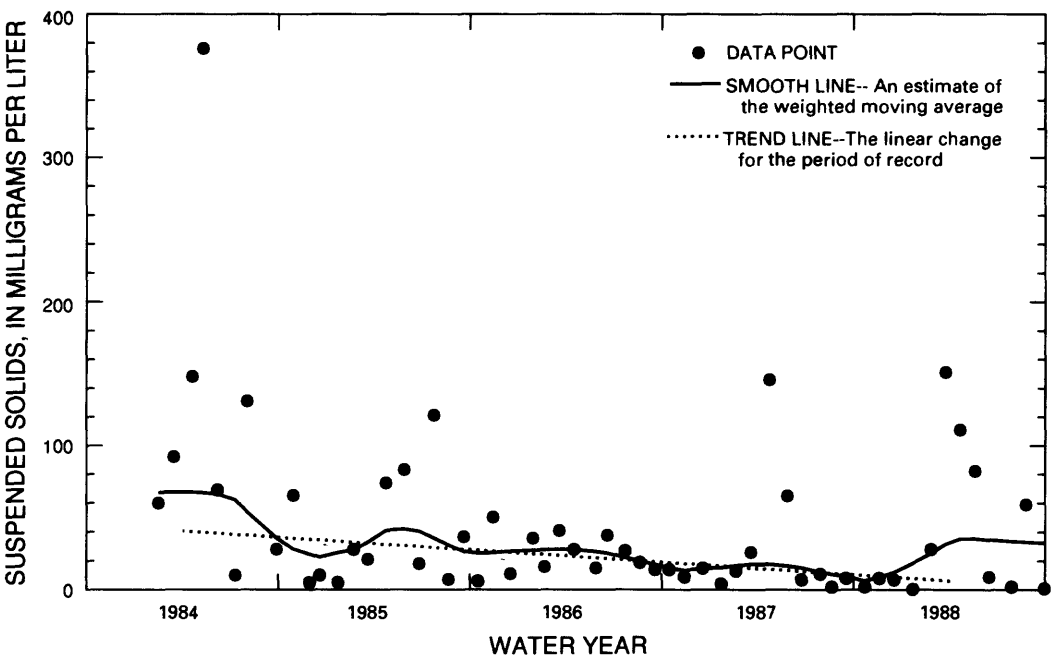

Figure 38.--Trend of suspended solids at water-quality station 07103780 Monument Creek above North Gate Boulevard at U.S. Air Force Academy.

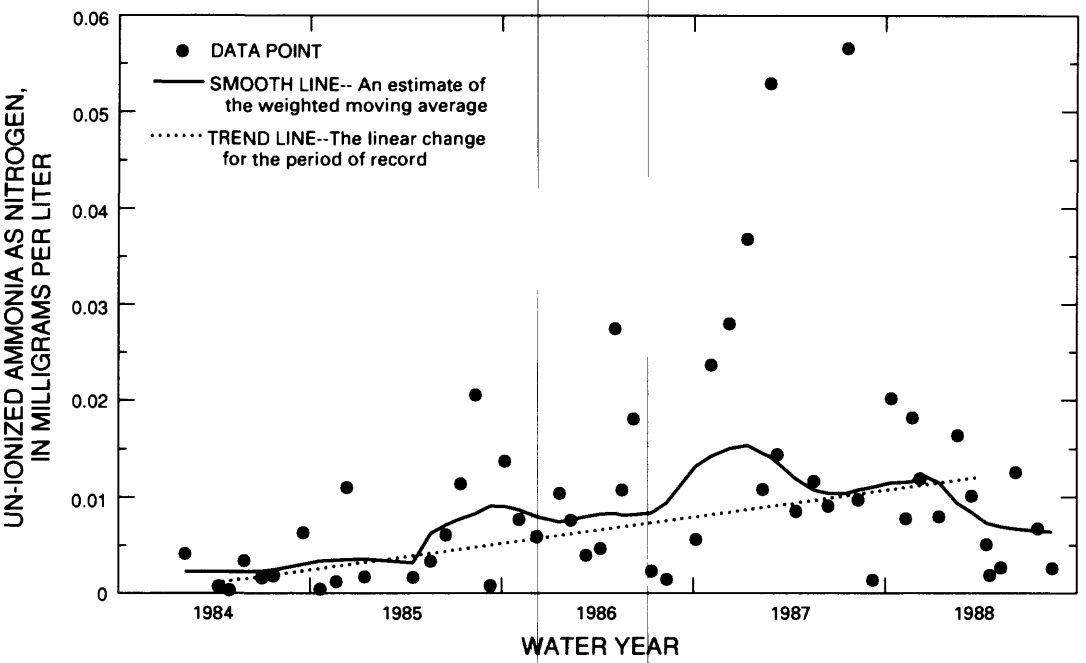

Figure 39.--Trend of un-ionized ammonia as nitrogen at water-quality station 07103780 Monument Creek above North Gate Boulevard at U.S. Air Force Academy.

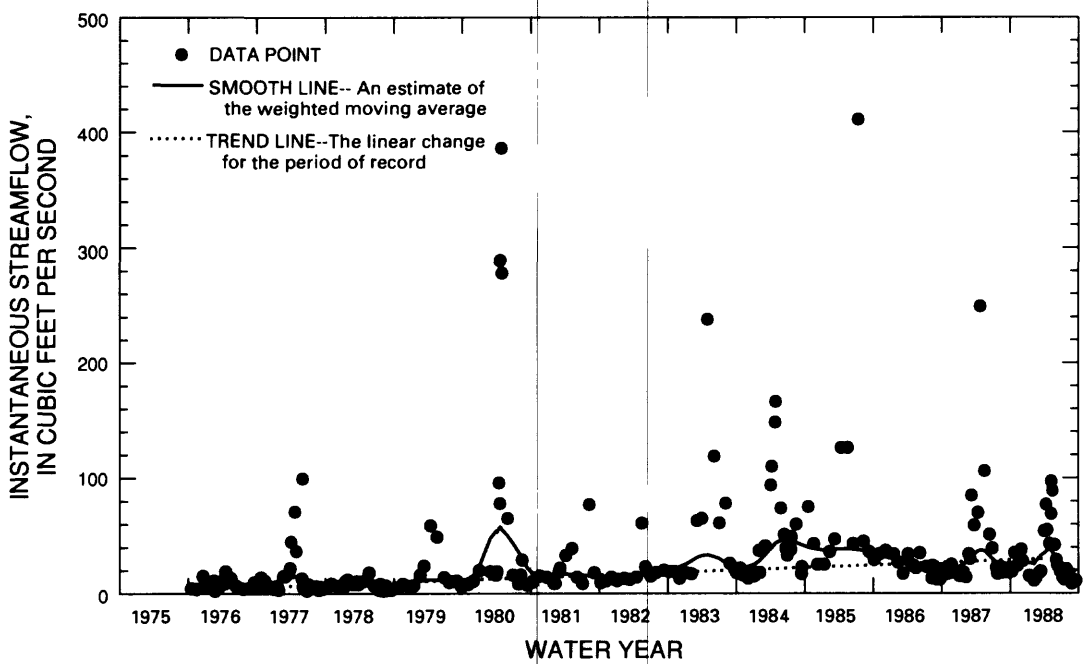

Figure 40.--Trend of instantaneous streamflow at water-quality station 07104000 Monument Creek at Pikeview.

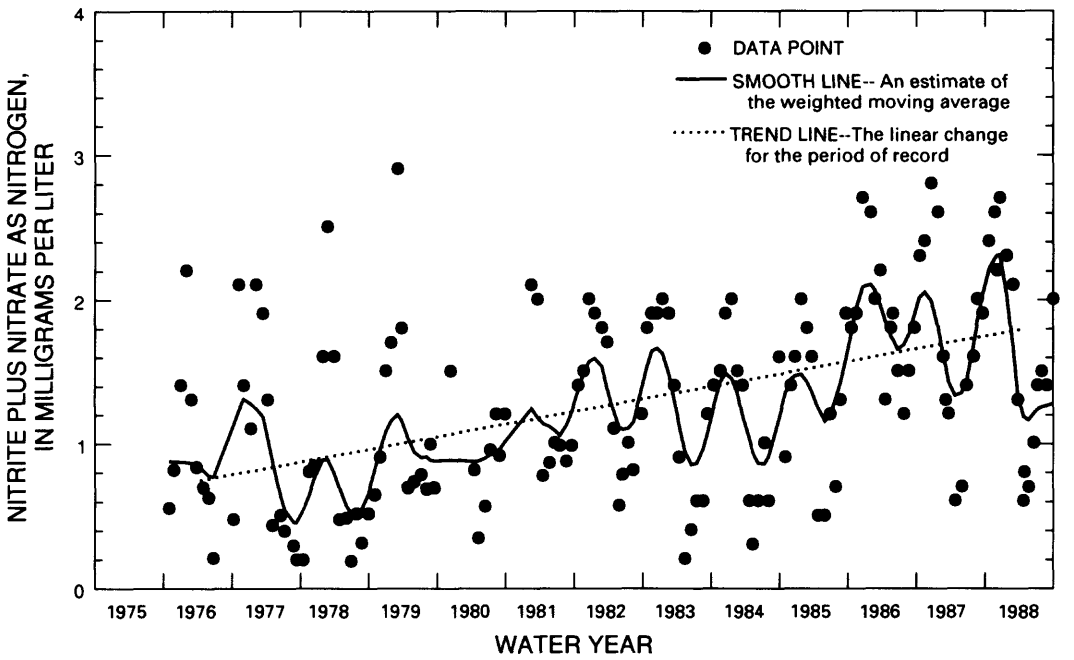

Figure 41.--Trend of nitrite plus nitrate as nitrogen at water-quality station 07104000 Monument Creek at Pikeview.

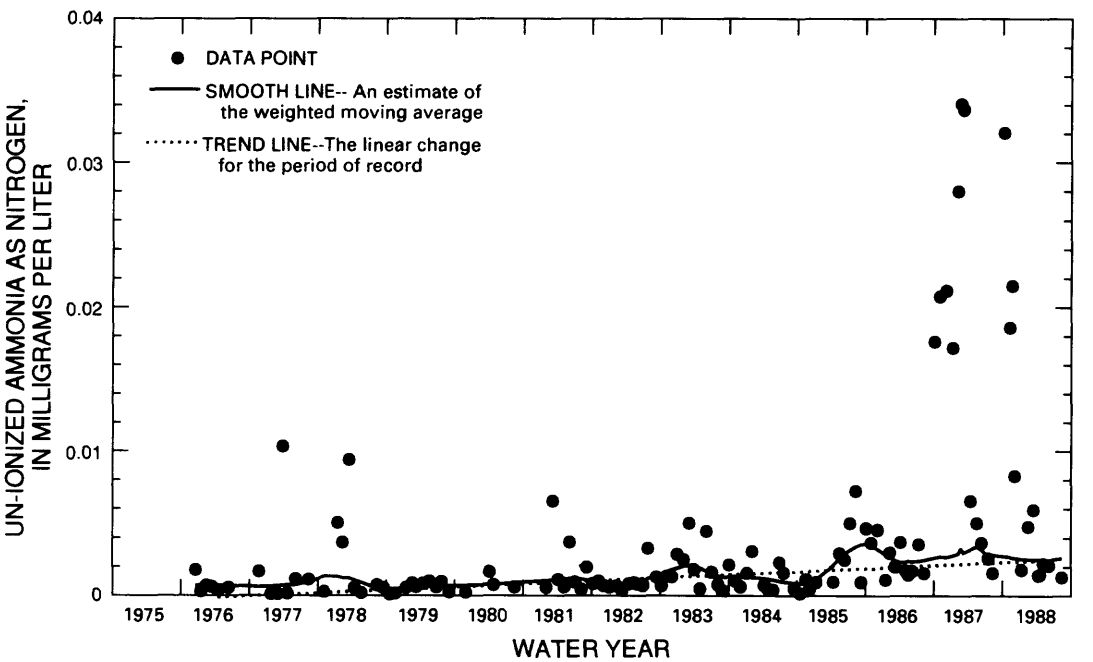

Figure 42.--Trend of un-ionized ammonia as nitrogen at water-quality station 07104000 Monument Creek at Pikeview.

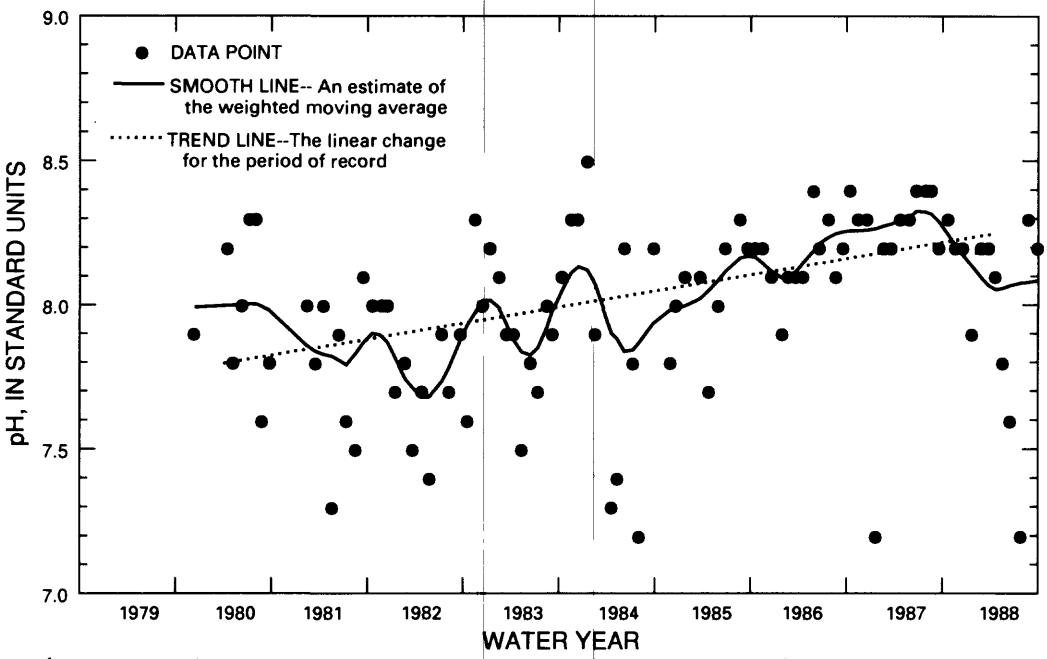

Figure 43.--Trend of pH at water-quality station 07104905 Monument Creek at Bijou Street at Colorado Springs.

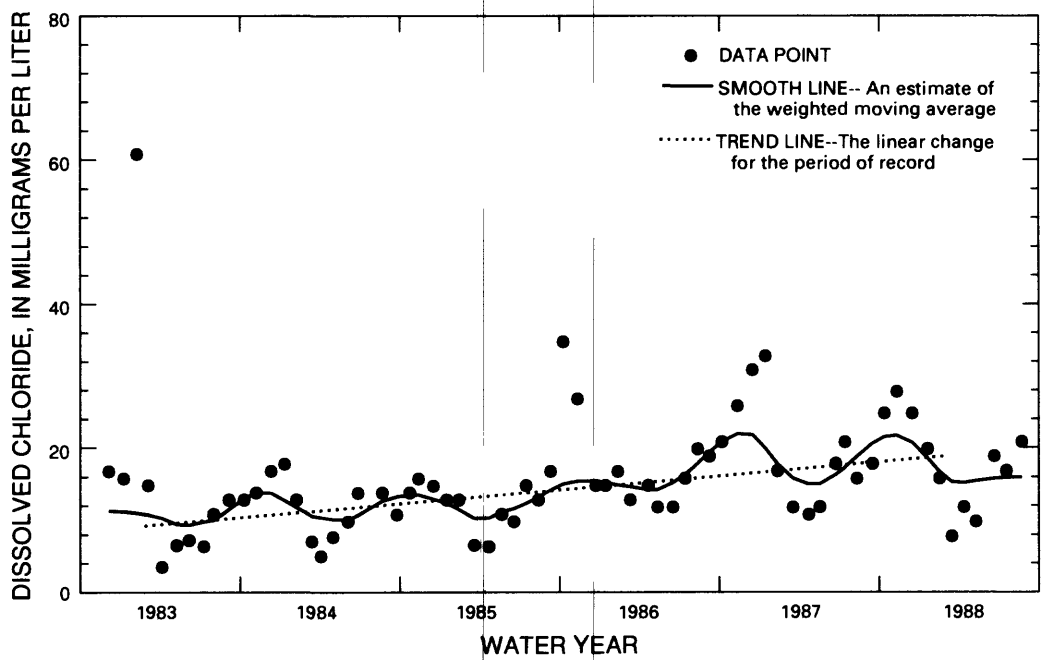

Figure 44.--Trend of dissolved chloride at water-quality station 07104905 Monument Creek at Bijou Street at Colorado Springs.

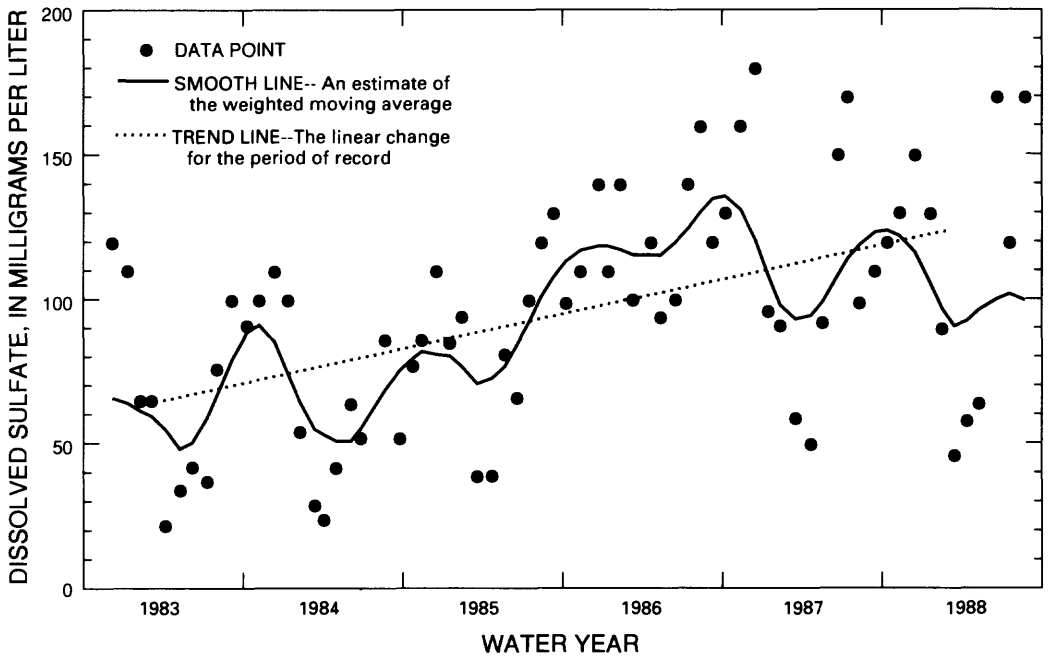

Figure 45.--Trend of dissolved sulfate at water-quality station 07104905 Monument Creek at Bijou Street at Colorado Springs.

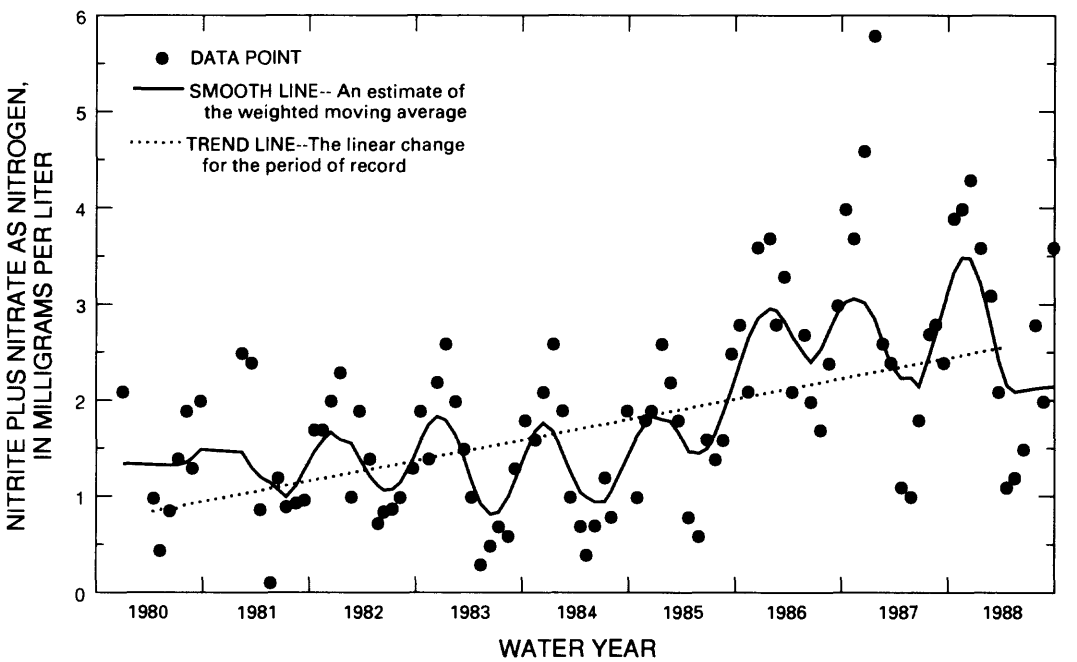

Figure 46.--Trend of nitrite plus nitrate as nitrogen at water-quality station 07104905 Monument Creek at Bijou Street at Colorado Springs.

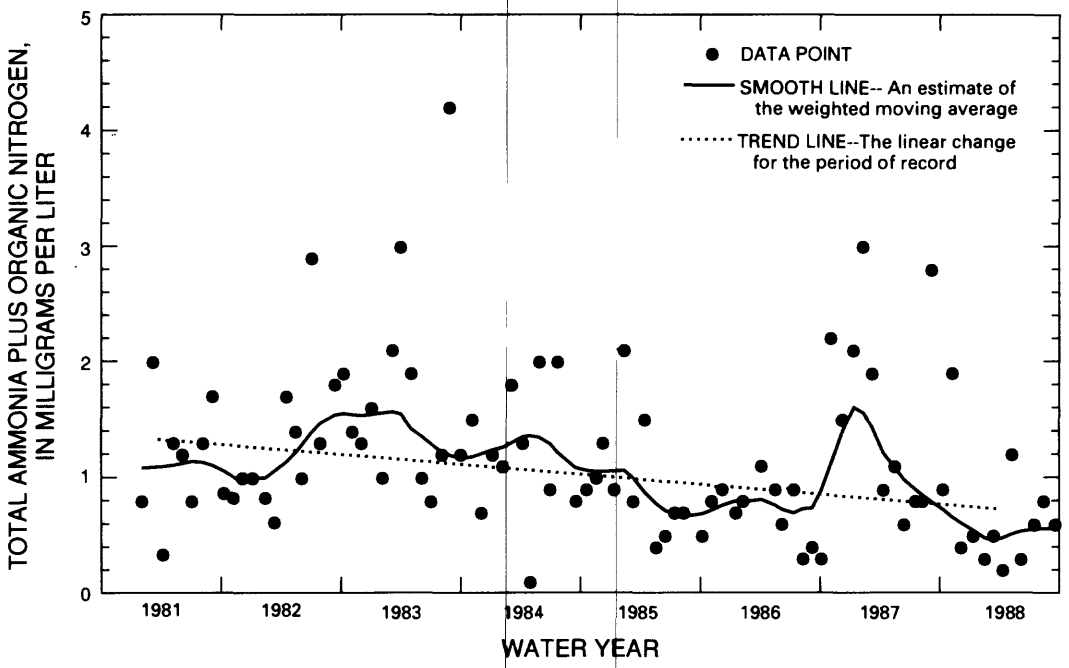

Figure 47.--Trend of total ammonia plus organic nitrogen at water-quality station 07104905 Monument Creek at Bijou Street at Colorado Springs.

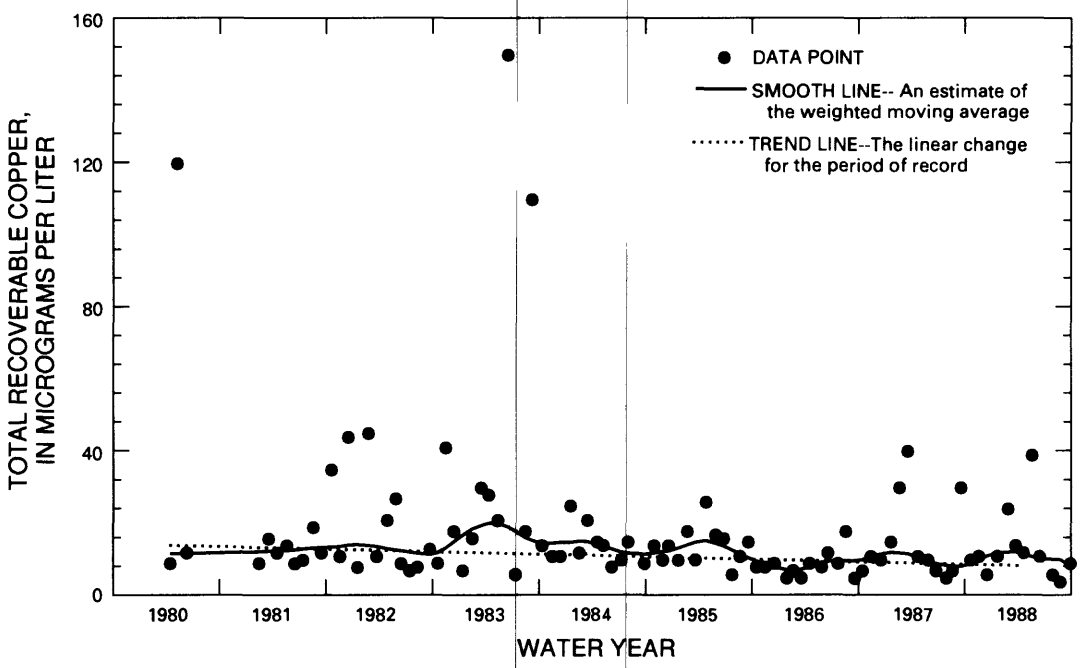

Figure 48.--Trend of total recoverable copper at water-quality station 07104905 Monument Creek at Bijou Street at Colorado Springs.

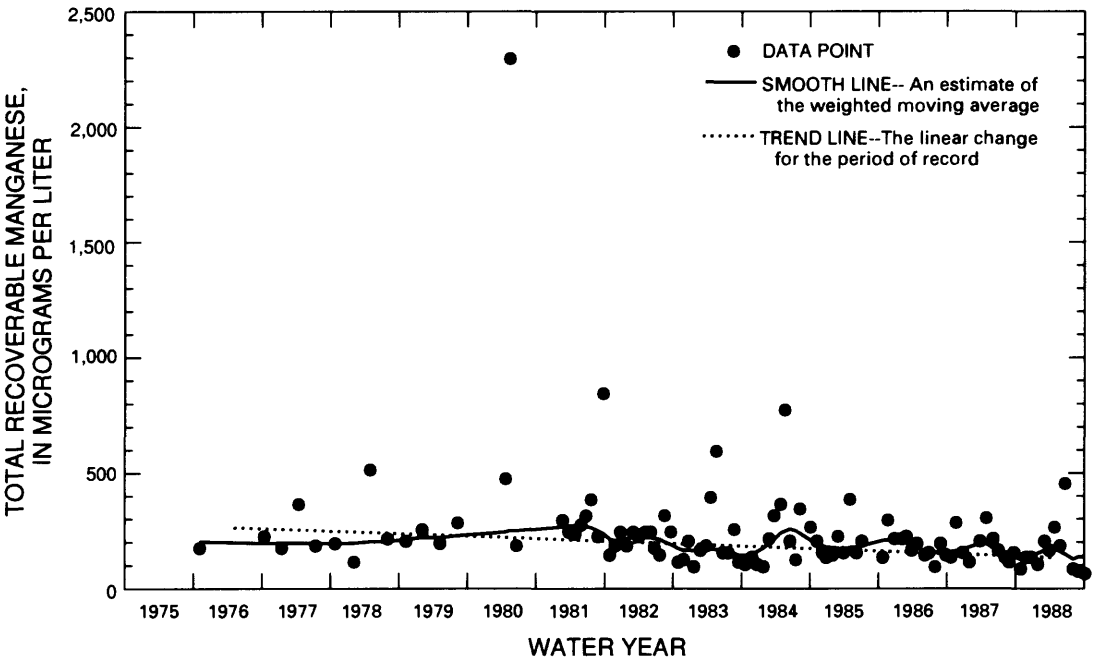

Figure 49.--Trend of total recoverable manganese at water-quality station 07105500 Fountain Creek at Colorado Springs.

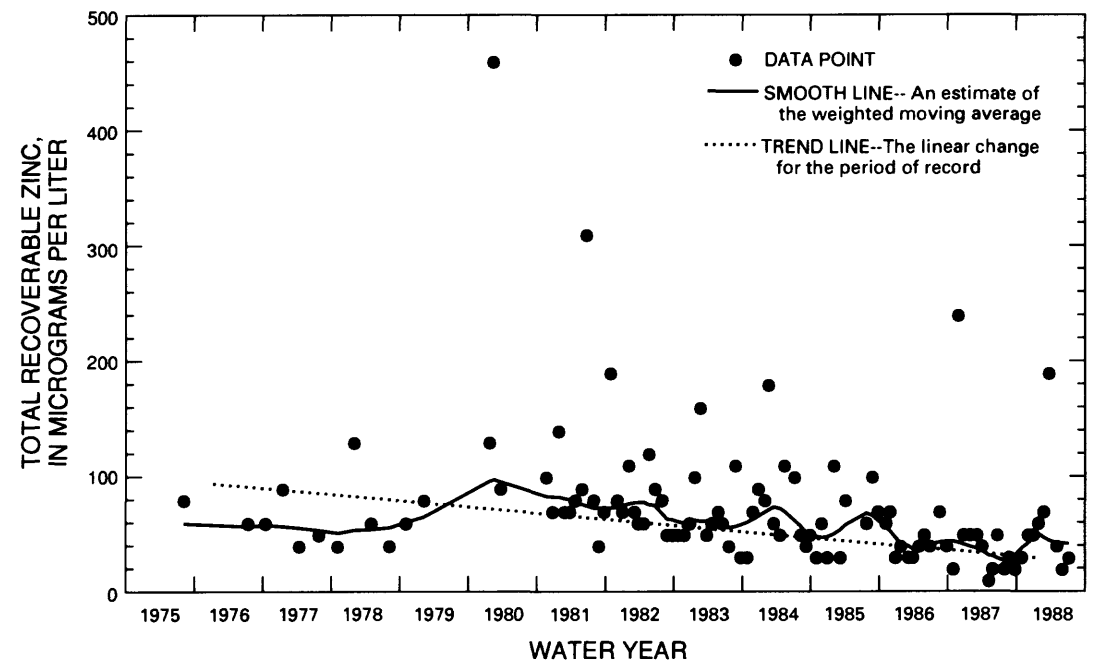

Figure 50.--Trend of total recoverable zinc at water-quality station 07105500 Fountain Creek at Colorado Springs.

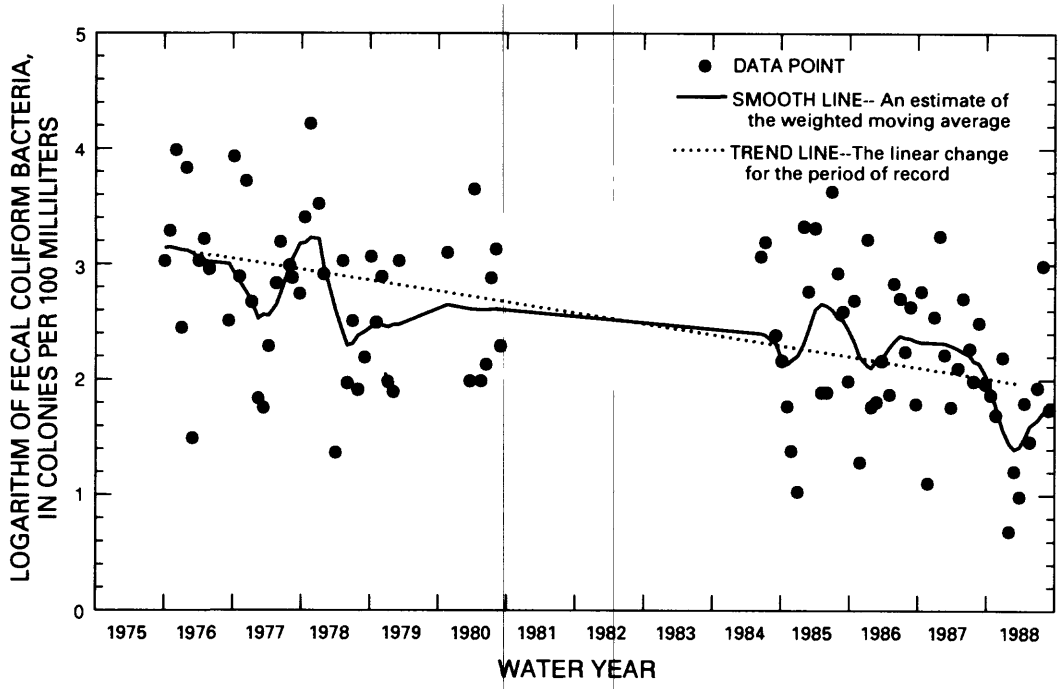

Figure 51.--Trend of fecal coliform bacteria at water-quality station 07105905 Fountain Creek above Little Fountain Creek below Fountain.

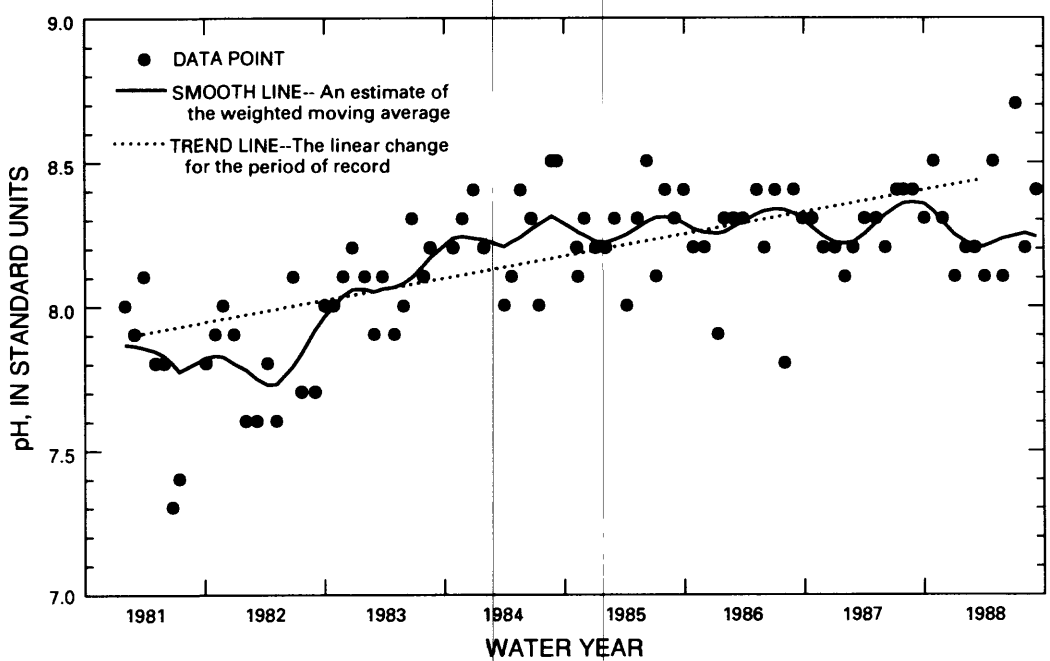

Figure 52.--Trend of pH at water-quality station 07106500 Fountain Creek at Pueblo.

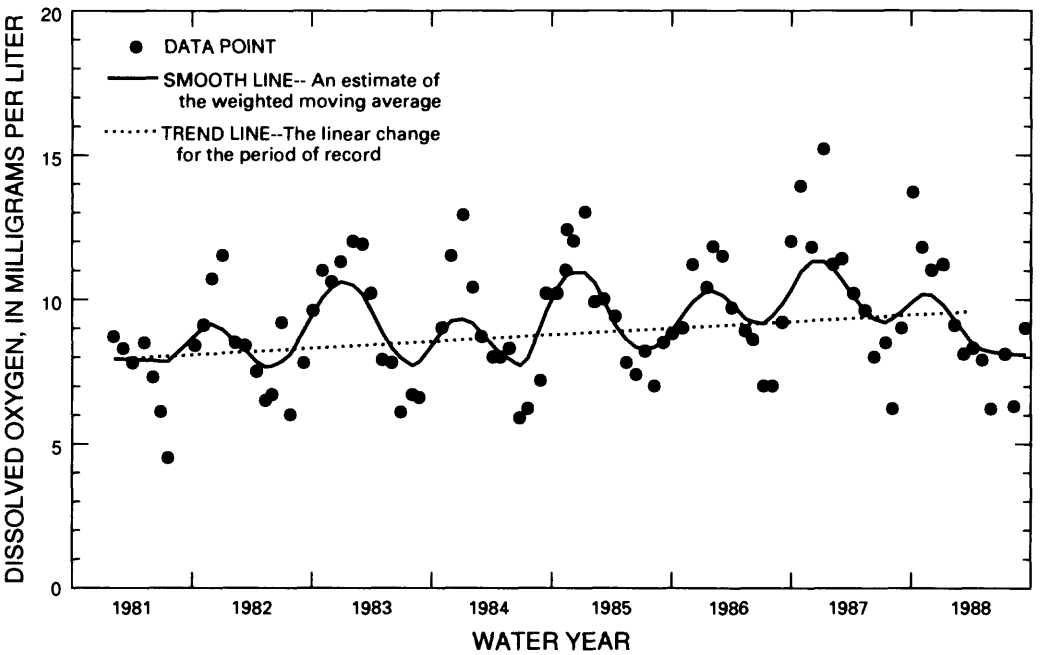

Figure 53.--Trend of dissolved oxygen at water-quality station 07106500 Fountain Creek at Pueblo.

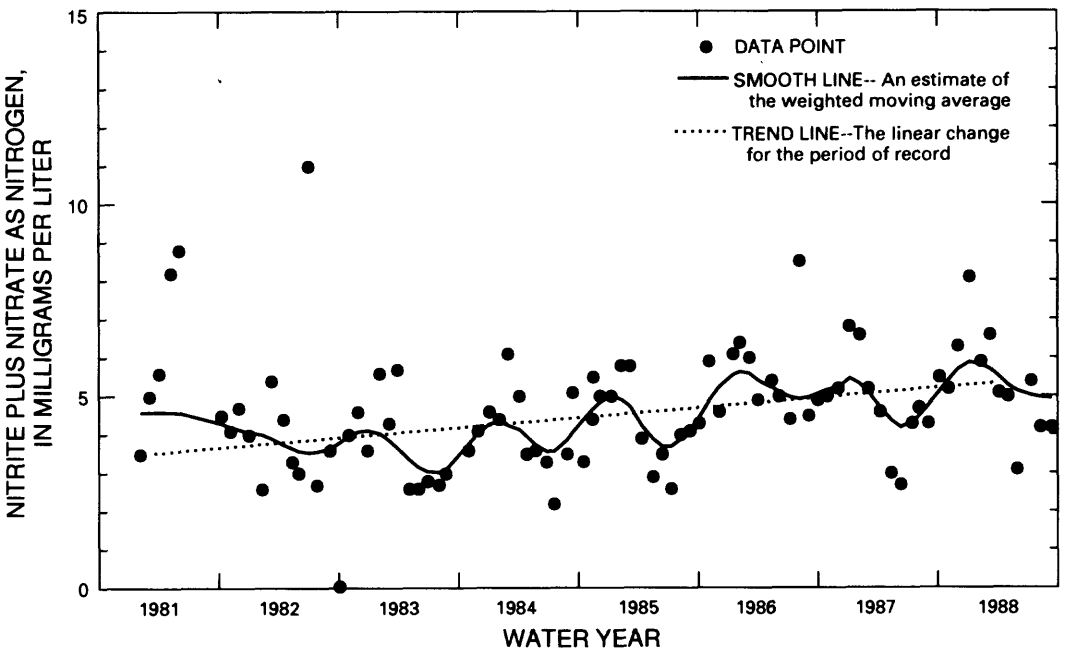

Figure 54.--Trend of nitrite plus nitrate as nitrogen at water-quality station 07106500 Fountain Creek at Pueblo.

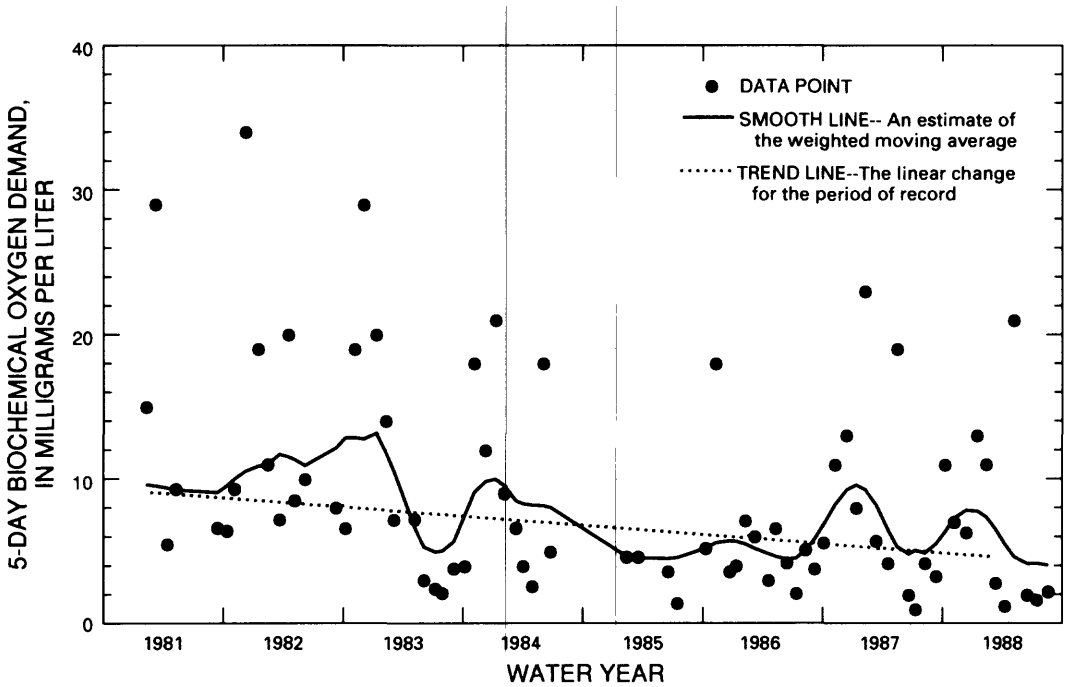

Figure 55.--Trend of 5-day biochemical oxygen demand at water-quality station 07106500 Fountain Creek at Pueblo.

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