WATER QUALITY OF FOUNTAIN AND MONUMENT CREEKS, SOUTH-CENTRAL COLORADO, WITH EMPHASIS ON RELATION OF WATER QUALITY TO STREAM CLASSIFICATIONS

By Patrick Edelmann

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Multiply	*By*	*To obtain*
cubic foot per second (ft^3/s)	0.028317	cubic meter per second
mile (mi)	1.609	kilometer

Temperature in degree Celsius (°C) may be converted to degree Fahrenheit (°F) by using the following equation:

$$°F = 9/5(°C)+32$$

Water-quality terms and abbreviations used in this report are:

5-day biochemical oxygen demand (BOD_5)
microgram per liter (µg/L)
microsiemens per centimeter at 25 degrees Celsius (µS/cm)
milligram per liter (mg/L)
milliliter (mL)

WATER QUALITY OF FOUNTAIN AND MONUMENT CREEKS, SOUTH-CENTRAL COLORADO, WITH EMPHASIS ON RELATION OF WATER QUALITY TO STREAM CLASSIFICATIONS

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ABSTRACT

The quality of water of Fountain and Monument Creeks was monitored from 1975 through 1983. The purpose of the monitoring program was to provide the necessary data to describe the general water-quality characteristics of Fountain and Monument Creeks and to evaluate the water quality of each stream segment based on classifications established by the Colorado Department of Health in 1982. Most of the water-quality constituents monitored during the investigation have numeric water-quality standards and were evaluated according to those standards. Selected water-quality data also were evaluated for seasonal, temporal, and spatial variations.

The quality of water of Fountain and Monument Creeks changes as the water leaves the mountains and flows along the Rampart Range. Concentrations of dissolved solids, as represented by specific conductance, increased downstream in Fountain and Monument Creeks. During the period of record, 1975 through 1983, the median specific conductance of Fountain Creek increased from 341 microsiemens per centimeter at site F12 near Manitou Springs to 1,750 microsiemens per centimeter at site F66 at Pueblo, probably because of discharge from wastewater-treatment plants and irrigation-return flows. Specific conductance also increased downstream in Monument Creek, probably as a result of discharge from wastewater-treatment plants, ground-water discharge, and inflow from tributaries that drain densely urbanized areas.

Five-day biochemical oxygen demand increased downstream in Fountain and Monument Creeks during 1975 through 1983. The median 5-day biochemical oxygen demand of Fountain Creek increased downstream from 1 to 28 milligrams per liter primarily because of discharge from wastewater-treatment plants. Five-day biochemical oxygen demand increased downstream in Monument Creek as a result of discharge from wastewater-treatment plants and from nonpoint sources.

Measurements of pH and dissolved oxygen and analyses of concentrations of dissolved chloride, dissolved sulfate, and total nitrite plus nitrate as nitrogen made on Upper Fountain Creek were within the values established as the water-quality standards for the stream segment. Concentrations of dissolved manganese and total-recoverable copper, iron, lead, silver, and zinc exceeded water-quality standards established for Upper Fountain Creek. Concentrations of dissolved manganese, total selenium, and total-recoverable iron, lead, manganese, silver, and zinc increased downstream within a 3-mile stream length of Upper Fountain Creek.

Measurements of pH, dissolved oxygen, dissolved chloride, dissolved sulfate, and total nitrite plus nitrate as nitrogen made on Lower Fountain Creek nearly always were within the values established as the water-quality

standards for the stream. Concentrations of dissolved manganese and total-recoverable nickel and silver increased just downstream from the Colorado Springs Wastewater Treatment Plant effluent. Of these trace elements, only dissolved-manganese concentrations exceeded the water-quality standard for Lower Fountain Creek. Concentrations of dissolved iron, total selenium, and total-recoverable copper and lead exceeded the water-quality standards for Lower Fountain Creek at the downstream sites.

Water-quality data collected on Upper Monument Creek from 1977 through 1980 indicate that Upper Monument Creek is a well-oxygenated stream and has a small 5-day biochemical oxygen demand, small concentrations of dissolved and suspended solids, total ammonia, total nitrite plus nitrate, and trace elements.

Five-day biochemical oxygen demand and concentrations of fecal coliform bacteria, dissolved chloride, dissolved sulfate, and total nitrite plus nitrate as nitrogen frequently increased downstream but generally remained less than the water-quality standards. Concentrations of total-recoverable copper, iron, lead, manganese, and zinc frequently increased downstream and, with the exception of manganese, frequently exceeded the water-quality standards.

INTRODUCTION

Fountain and Monument Creeks originate in the Rampart Range northwest of Colorado Springs (fig. 1). As the streams flow from the mountains, the flows are affected by storage reservoirs, power developments, diversions for irrigation, municipal use, irrigation-return flows, discharge from wastewater-treatment plants, and ground-water discharge. These activities also may affect water quality. The water quality of Fountain and Monument Creeks has been monitored since 1975 by the U.S. Geological Survey in cooperation with the Colorado Springs Department of Utilities and the Lower Fountain Water-Quality Management Association. This monitoring was part of a study to develop a water-quality data base for use by local agencies in the development of an areawide water-quality management plan.

During 1982, the State of Colorado adopted regulations that established basic standards, an antidegradation standard, and a system for classifying and assigning numeric water-quality standards to State waters, including Fountain and Monument Creeks (Colorado Department of Health, 1982). As a result of the stream-classification process, Fountain and Monument Creeks were divided into stream segments based on beneficial-use categories. Most of the water-quality constituents monitored during the study have numeric water-quality standards and were evaluated according to those standards.

Purpose and Scope

The purpose of this report is to describe the general water-quality characteristics of Fountain and Monument Creeks (fig. 1) and to evaluate the water quality of each stream segment, with emphasis on evaluating the quality of water as it pertains to the numeric water-quality standards established by the Colorado Department of Health (1982) for the stream segments. Selected

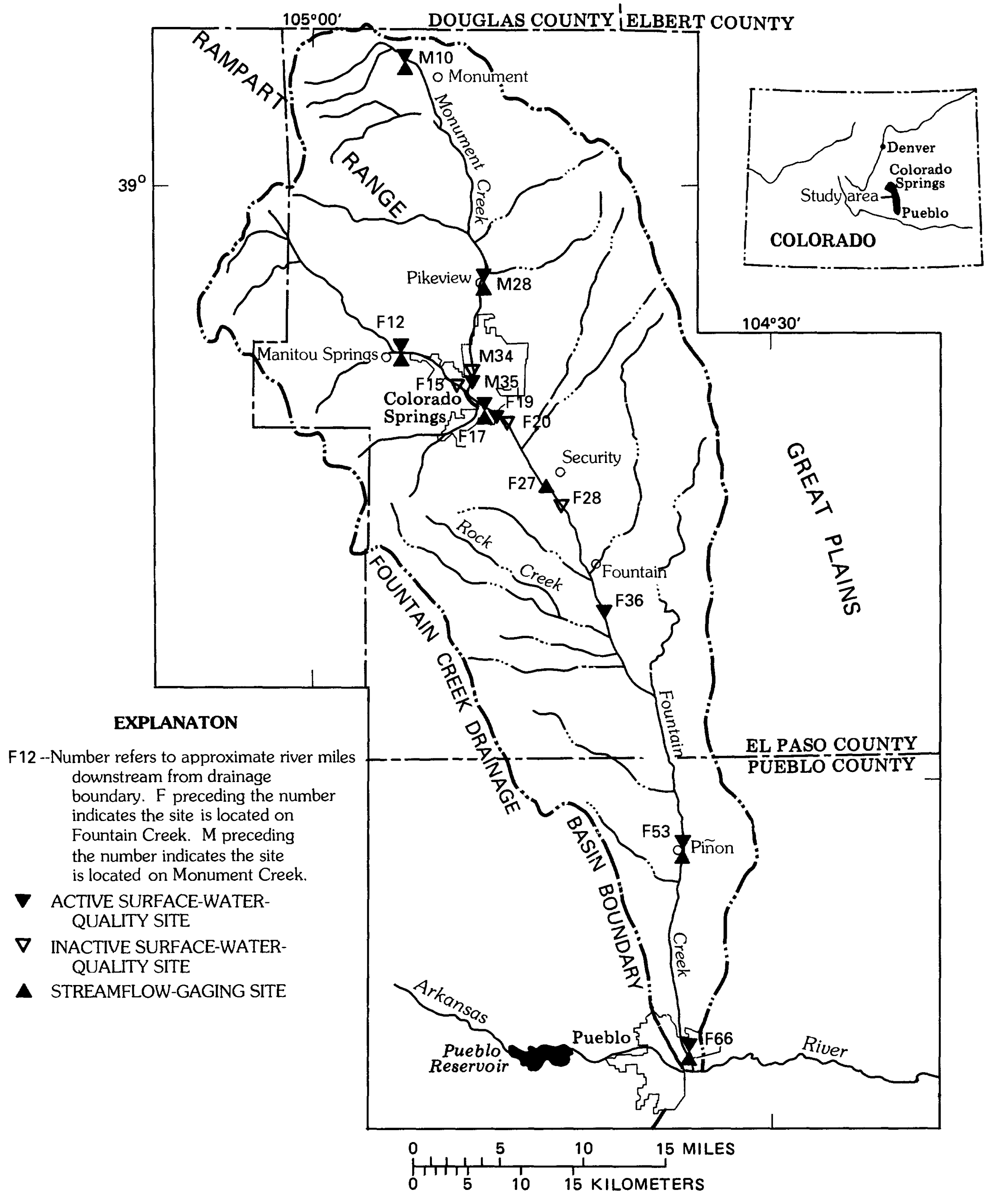


Figure 1.--Location of surface-water-quality sites and streamflow-gaging sites on Fountain and Monument Creeks.

water-quality data also were evaluated for seasonal, temporal, and spatial variations. The scope of the report included reviewing previous reports on the two basins and assembling and evaluating streamflow and surface-water-quality data collected from 1975 through 1983. Previous reports of surface water and surface-water quality of Fountain Creek basin, including Monument Creek basin, that were reviewed and are pertinent to this report include: Klein and Bingham (1975) and Livingston and others (1975, 1976a, 1976b).

Water-quality constituents monitored during 1975 through 1983 included: (1) Water temperature, specific conductance, pH, and dissolved oxygen (by personnel onsite); (2) 5-day biochemical oxygen demand (BOD_5) and fecal coliform bacteria (by U.S. Geological Survey personnel in the Pueblo sub-district office); and (3) suspended solids, dissolved chloride, dissolved sulfate, total ammonia, total nitrite plus nitrate, total-recoverable cadmium, dissolved chromium, dissolved-hexavalent chromium, total-recoverable copper, total-recoverable iron, dissolved iron, total-recoverable lead, total-recoverable manganese, dissolved manganese, total-recoverable nickel, total selenium, total-recoverable silver, and total-recoverable zinc (by the U.S. Geological Survey Denver Analytical Laboratory).

Acknowledgments

The author appreciates the time, information, and suggestions provided by Gene Y. Michael and Dennis T. Cafaro, Colorado Springs Department of Utilities; Robert T. Schrader, Security Water and Sanitation District; Donald C. Lohrmeyer, Widefield Homes Incorporated; Edmond W. Hakes and Elmer J. Wahlborg, Stratmoor Hills Water and Sanitation District; F. Stuart Loosley, Cherokee Water District; and Mary Barber, U.S. Department of the Army.

STREAM CLASSIFICATIONS AND WATER-QUALITY STANDARDS

Stream classifications in Colorado are based on categories of beneficial use which include class 1 recreation, class 2 recreation, class 1 cold- or warm-water aquatic life, class 2 cold- or warm-water aquatic life, domestic water supply, and agricultural categories. Streams categorized for recreational use are intended for human uses such as swimming, wading, or boating. Class 1 recreation streams are suitable for prolonged full-body contact sports such as swimming. Class 2 recreation streams are suitable for wading and fishing but not for full-body contact sports. Streams categorized for class 1 aquatic-life use either provide or could provide a habitat sufficient to protect and maintain a wide variety of biota, including sensitive species. Streams categorized for class 2 aquatic-life use are primarily limited by flow and streambed characteristics in their ability to maintain a variety of biota. Because temperature affects the aquatic community, cold- and warm-water aquatic-life classifications were established. Streams that have a cold-water aquatic-life classification have temperatures that rarely exceed 20 °C; whereas, streams that have a warm-water aquatic life classification frequently have temperatures that exceed 20 °C. Streams categorized for domestic water-supply use are suitable or intended to be suitable as potable water supplies. The agricultural-use category is for streams that are suitable for irrigation of crops usually grown in Colorado and for streams that are not detrimental to livestock that drink the water. Beneficial-use categories were assigned to stream segments based on actual uses and on potential uses as determined by water quality and geomorphology. Water-quality standards then were established for specific constituents to protect the categorized uses. The criteria for selecting numeric standards were based on current scientific evidence of effects of pollutants on domestic water supply, recreation, agriculture, and class 1 aquatic-life classifications. For class 2 aquatic-life classification, the water-quality standards were based on natural or background levels and were defined as the arithmetic mean of historic water-quality data plus one standard deviation. For streams that have a multiple-use classification, the most restrictive set of water-quality standards were applied. However, water-quality standards assigned to a particular stream segment may be exceeded during temporary natural conditions, such as storm or spring runoff, drought, or when the flow is less than the annual average 7-consecutive-day flow that is expected to occur once in 10 years (Colorado Department of Health, 1982).

DESCRIPTION OF STREAM-CLASSIFICATION SEGMENTS AND STREAMFLOW

During the stream-classification process, Fountain and Monument Creeks were divided into five stream segments based on differences in water quality and different uses of the stream's water. For the purposes of this report, the two Fountain Creek stream segments are referred to as Upper Fountain Creek and Lower Fountain Creek (fig. 2). Monument Creek was divided into three stream segments. However, the stream segment upstream from Palmer Lake is located on U.S. Defense Department property and was not studied during this investigation. The other two stream segments are referred to in this report as Upper Monument Creek and Lower Monument Creek (fig. 2).

Upper Fountain Creek

Upper Fountain Creek comprises a 15-mi stream segment upstream from the confluence with Monument Creek (fig. 2) and has been classified by the Colorado Department of Health (1982) for class 2 recreation, class 1 cold-water aquatic life, domestic water supply, and agricultural uses. Associated with these classifications are numerical water-quality standards for specific water-quality constituents (table 1).

Flow in Upper Fountain Creek originates near Woodland Park (fig. 2) where it is initially comprised of effluent from the Woodland Park Wastewater Treatment Plant. As the stream flows southeastward from Woodland Park through a steep-sloping canyon to Manitou Springs, it receives most of its streamflow from tributaries and reservoirs that drain a part of the surrounding Rampart Range and the national forest. With the exception of a few small communities located along the stream, the drainage area upstream from Manitou Springs is undeveloped. From Manitou Springs to the confluence with Monument Creek, Upper Fountain Creek flows through and drains residential, commercial, and industrial areas of Manitou Springs and a part of Colorado Springs. In addition to surface-water drainage, the stream in this reach receives some ground-water discharge from the alluvium (Livingston and others, 1976a, p. 65). The streamflow decreases in this reach due to diversion for the city of Colorado Springs.

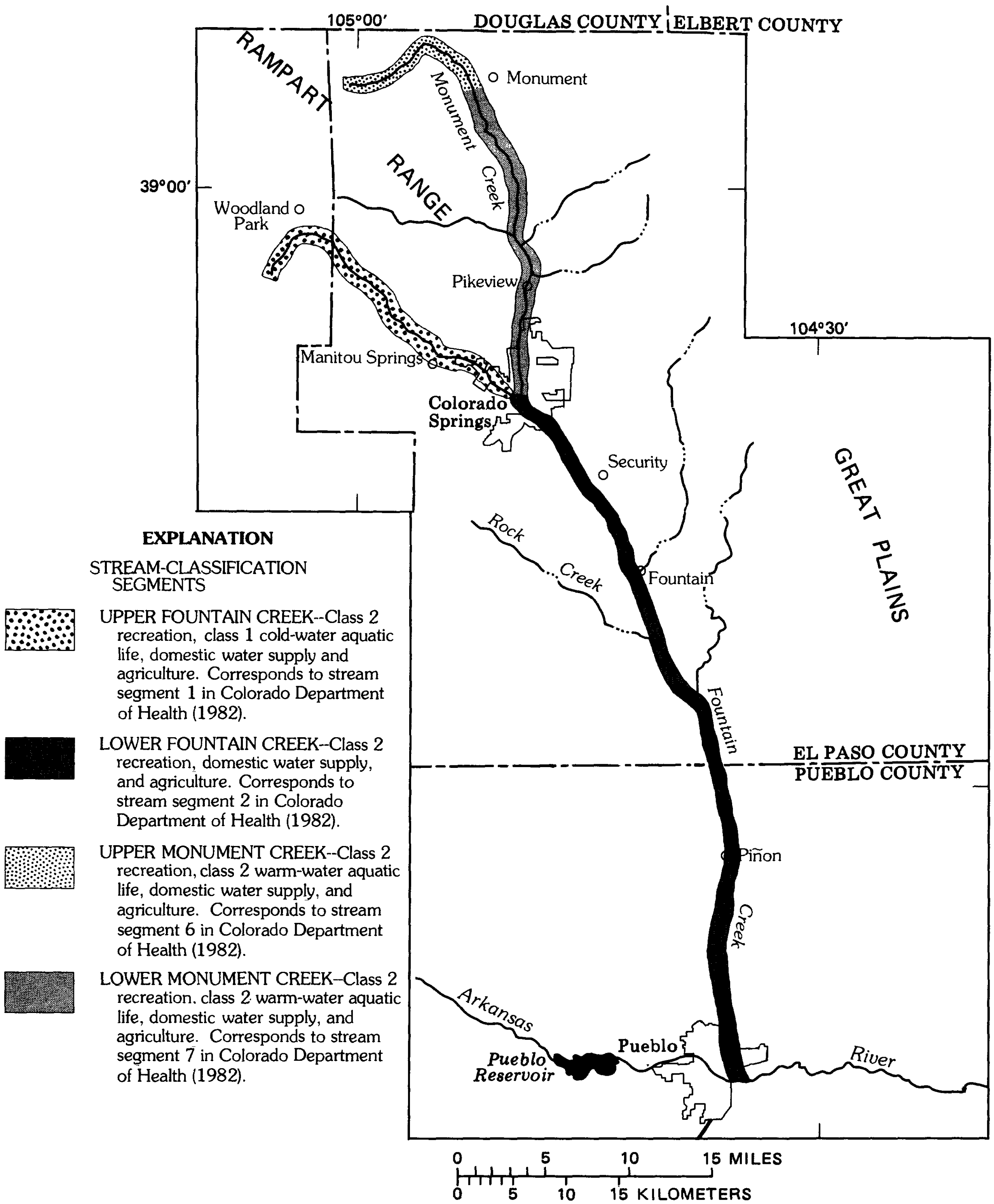


Figure 2.--Location of stream-classification segments and description of stream-use classification.

Table 1.--*Numeric water-quality standards for the stream-classification segments of Fountain and Monument Creeks*

[mg/L, milligrams per liter; µg/L, micrograms per liter; --, not applicable]

Water-quality constituent	Numeric water-quality standards[1]			
	Upper Fountain Creek	Lower Fountain Creek	Upper Monument Creek	Lower Monument Creek
pH (standard units)	6.5 to 9.0	6.5 to 9.0	6.5 to 9.0	6.5 to 9.0
Oxygen, dissolved (mg/L)	6.0 (7.0 during spawning)	5.0	5.0	5.0
Nitrogen, nitrite, total (mg/L, as nitrogen)	.05	1.0	.5	.5
Nitrogen, nitrate, total (mg/L, as nitrogen)	10	10	10	10
Chloride, dissolved (mg/L)	250	250	250	250
Sulfate, dissolved (mg/L)	250	600	250	250
Cadmium, total (µg/L)	1.4	10	.4	2
Chromium, trivalent (µg/L)	50	50	50	50
Chromium, hexavalent (µg/L)	25	50	25	25
Copper, total (µg/L)	10	200	7	1
Lead, total (µg/L)	25	50	6	30
Iron, total (µg/L)	1,350	--	4,400	8,200
Iron, dissolved (µg/L)	300	300	300	300
Manganese, total (µg/L)	1,000	--	1,000	1,000
Manganese, dissolved (µg/L)	50	150	50	50
Nickel, total (µg/L)	100	200	50	100
Selenium, total (µg/L)	10	10	10	10
Silver, total (µg/L)	.1	50	.1	.1
Zinc, total (µg/L)	50	2,000	50	60

[1]Numeric water-quality standards were established by the Colorado Department of Health (1982). The standards for State waters were reviewed and amended by the Colorado Water Quality Control Commission during 1983, 1985, 1986, and 1987. However, no modifications were made to the numeric water-quality standards for the Fountain and Monument Creek stream segments.

The streamflow of Upper Fountain Creek has been gaged from 1959 through 1983 at site F12 (station 07103700, Fountain Creek near Colorado Springs) (fig. 1) located upstream from the city of Colorado Springs diversion. The streamflow has been smallest during winter; it is largest during the spring from snowmelt runoff and during the summer from thunderstorms (fig. 3*A*).

Variability in streamflows also can be illustrated by the streamflow-duration curve for site F12 (fig. 3*B*). Streamflow-duration curves are useful for evaluating the flow characteristics of a basin (Searcy, 1959). The relatively steeper slopes at the upper end of the curves in figure 3*B* indicate that larger streamflows vary substantially and result from direct runoff such as that produced by intense thunderstorms. The relatively flatter slopes, especially at the lower end of the curves (fig. 3*B*), are indicative of perennial storage in the basin (Searcy, 1959, p. 22). The perennial storage tends to sustain streamflow during periods of little or no precipitation or direct runoff (October through April, fig. 3*A*); in Upper Fountain Creek, streamflows probably are sustained primarily by releases from reservoirs in the basin and ground-water discharge to Upper Fountain Creek and its tributaries. The frequency curve of instantaneous streamflows, made in conjunction with water-quality samples collected from 1975 through 1983 at site F12, is nearly identical to the mean daily streamflow-duration curve (fig. 3*B*). Therefore, water-quality samples collected at site F12 should characterize the water-quality conditions that occur approximately 98 percent of the time.

Lower Fountain Creek

Lower Fountain Creek has a stream length of approximately 52 mi, which extends from a point immediately upstream from the confluence with Monument Creek to the confluence with the Arkansas River at Pueblo (fig. 2). This stream segment has been classified for class 2 recreation, domestic water supply, and agricultural uses. Numeric water-quality standards associated with these classifications for specific water-quality constituents are listed in table 1.

The northern part of Lower Fountain Creek is perennial and receives flow from a variety of sources including Upper Fountain Creek, Monument Creek, tributaries that drain the Colorado Springs area and Fort Carson, effluent from five wastewater-treatment plants, and the alluvial aquifer. The stream traverses residential, commercial, industrial, and agricultural areas and consists primarily of sewage effluent (Edelmann and Cain, 1985), most of which is discharged to Fountain Creek by the Colorado Springs Wastewater Treatment Plant located about 0.5 mi downstream from site F17 (station 07105500 Fountain Creek at Colorado Springs) (fig. 1). The streamflow in the northern part of Lower Fountain Creek is the primary source of recharge to the alluvial aquifer, which serves as the water supply for the communities south of Colorado Springs and which supplements the Colorado Springs water supply. A portion of the streamflow in the northern part of Lower Fountain Creek is diverted and used for agricultural purposes.

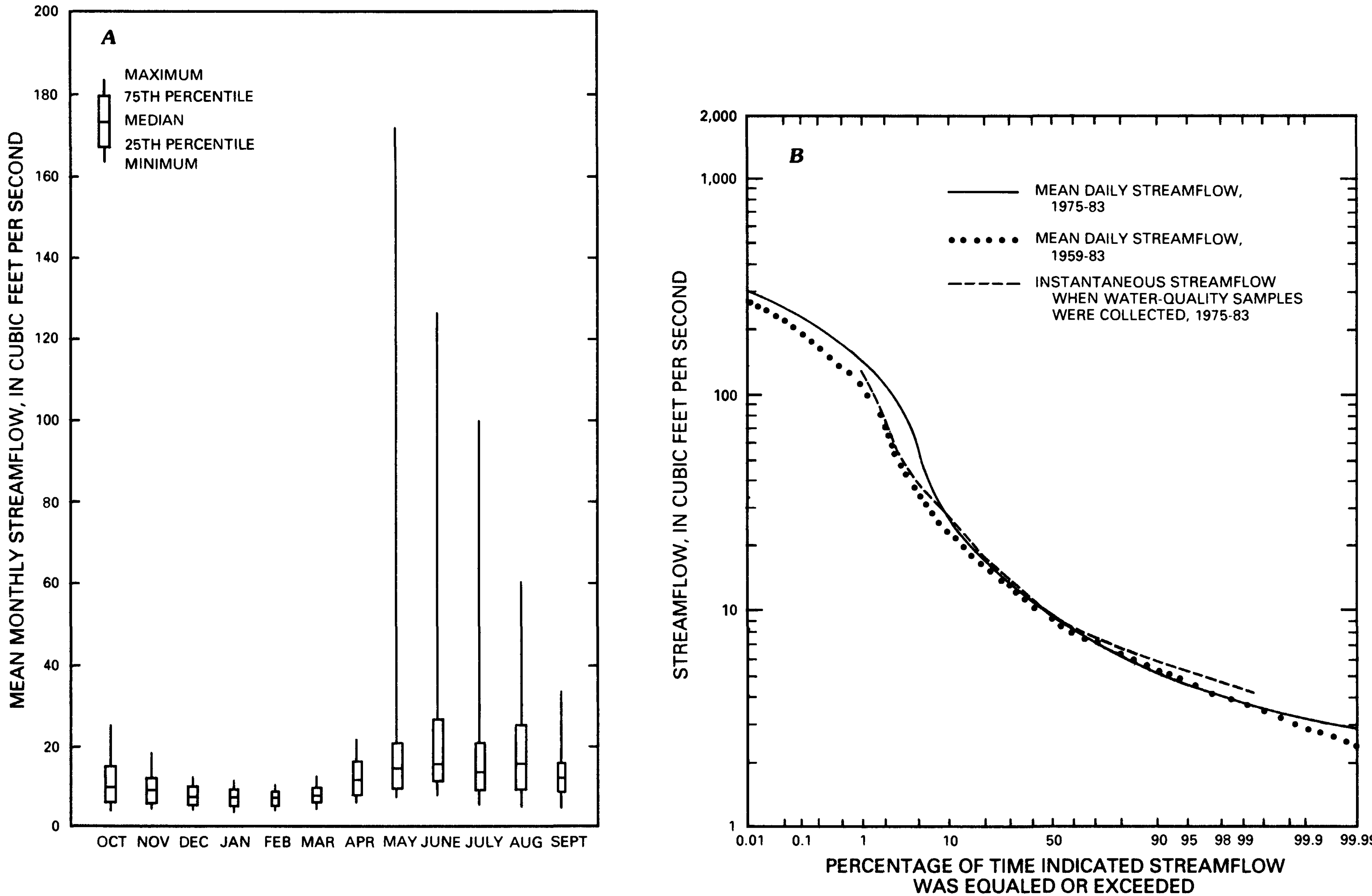


Figure 3.--(*A*) Statistical summary of mean monthly streamflows, 1959-83, and (*B*) streamflow-duration curves for site F12.

The streamflow of the northern part of Lower Fountain Creek has been gaged at sites F17 and F27 (station 07105800 Fountain Creek at Security) (fig. 1) and is summarized in figures 4 and 5. Generally, streamflows at sites F17 and F27 are smallest during fall and winter (fig. 4); larger streamflows occur during spring from snowmelt runoff and during summer from thunderstorms. The streamflow-duration curves shown in figure 5 indicate that mean daily streamflow has been less than 28 ft^3/s at site F17 and has been less than 45 ft^3/s at site F27 about 50 percent of the time. The slope of the curves indicates that the streamflow varies substantially, and flow is largely from runoff. Except at extreme streamflows, figure 5 also indicates that instantaneous streamflow measured when water-quality samples were collected compares favorably with the frequency distribution of mean daily streamflow at site F17. Therefore, water-quality samples collected at site F17 should characterize the water-quality conditions that occur approximately 98 percent of the time.

Downstream from the town of Fountain, streamflows vary considerably from the northern part of Lower Fountain Creek due to numerous diversions for agricultural use. Except for Pueblo, the remaining 30 mi of stream traverse irrigated agricultural lands. Periods of no streamflow have occurred during the summer months of many years. Water enters the stream as irrigation-return flow, ground-water discharge, and from ephemeral tributaries that predominately drain rangelands.

Streamflow downstream from Fountain has been gaged at site F53 (station 07106300 Fountain Creek near Pinon) (fig. 1) and site F66 (station 07106500 Fountain Creek at Pueblo); streamflow at these sites is summarized in figures 6 and 7. Streamflows are much larger during the winter at sites F53 and F66 than in the northern part of Lower Fountain Creek due to lack of winter diversions for irrigation. The largest flows in the southern part of Lower Fountain Creek occur during the summer as a result of thunderstorms. However, during dry summers when irrigation demands are large and runoff is small, Fountain Creek may be dry at sites F53 and F66. The streamflow-duration curves shown in figure 7 indicate that streamflows vary substantially and are greatly affected by direct runoff and upstream diversions. The mean daily streamflows are less than 41 ft^3/s at site F53 and less than 17 ft^3/s at site F66 about 50 percent of the time. Frequency curves of instantaneous streamflows made when water-quality samples were collected at sites F53 and F66 are considerably different than the mean daily streamflow-duration curves (fig. 7). Therefore, the summary statistics of water-quality constituents measured at sites F53 and F66 that are affected by streamflow may be somewhat biased toward larger streamflows.

Upper Monument Creek

Upper Monument Creek comprises approximately a 3-mi stream segment downstream from the national forest boundary and U.S. Defense Department property to the outlet of Monument Lake, which is located at Monument (fig. 2). This stream segment has been classified for class 2 recreation, class 2 warm-water aquatic life, domestic water supply, and agricultural uses. Numeric water-quality standards associated with these classifications are listed in table 1.

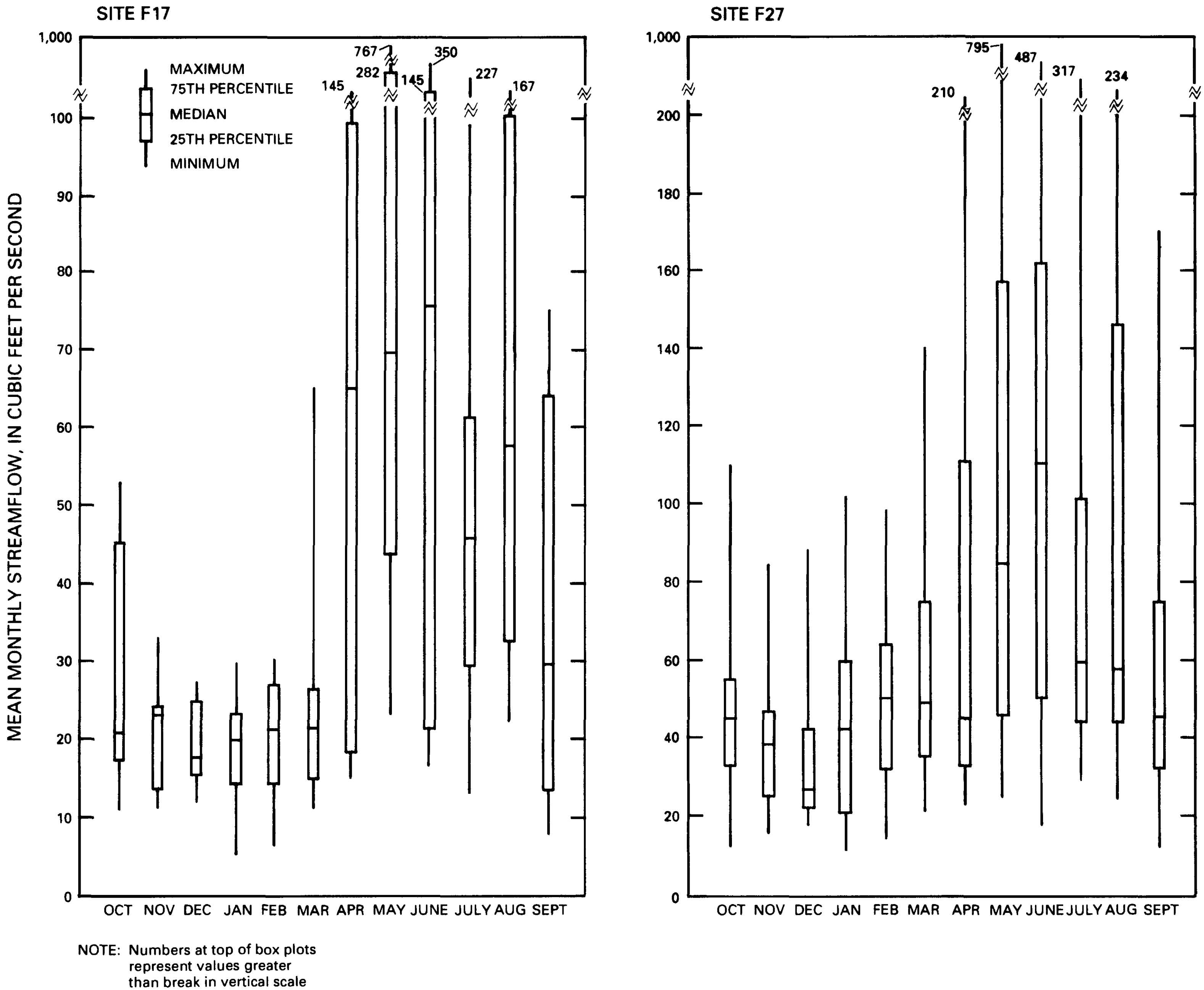


Figure 4.--Statistical summary of mean monthly streamflows for site F17, 1977-83, and site F27, 1965-83.

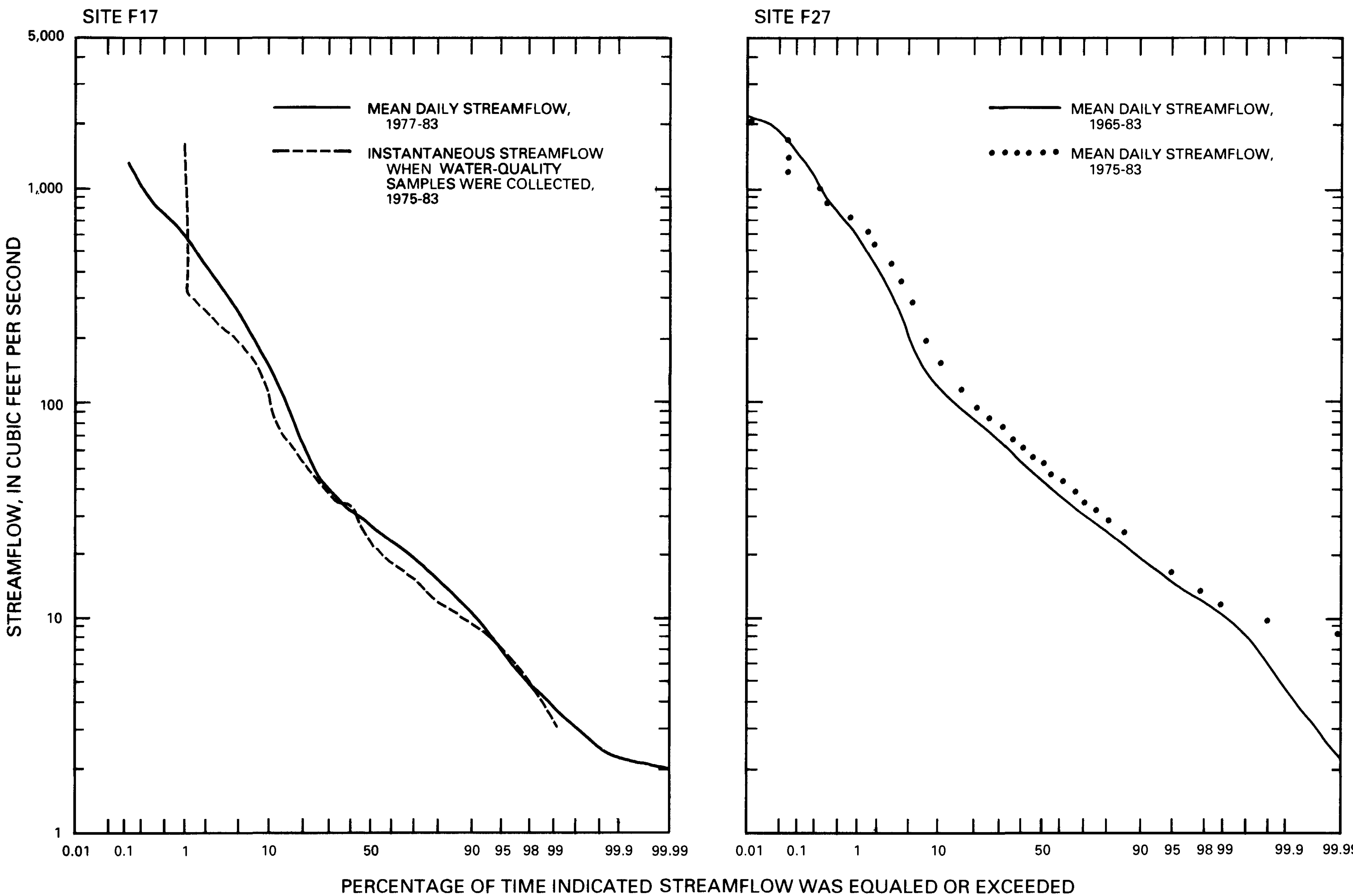
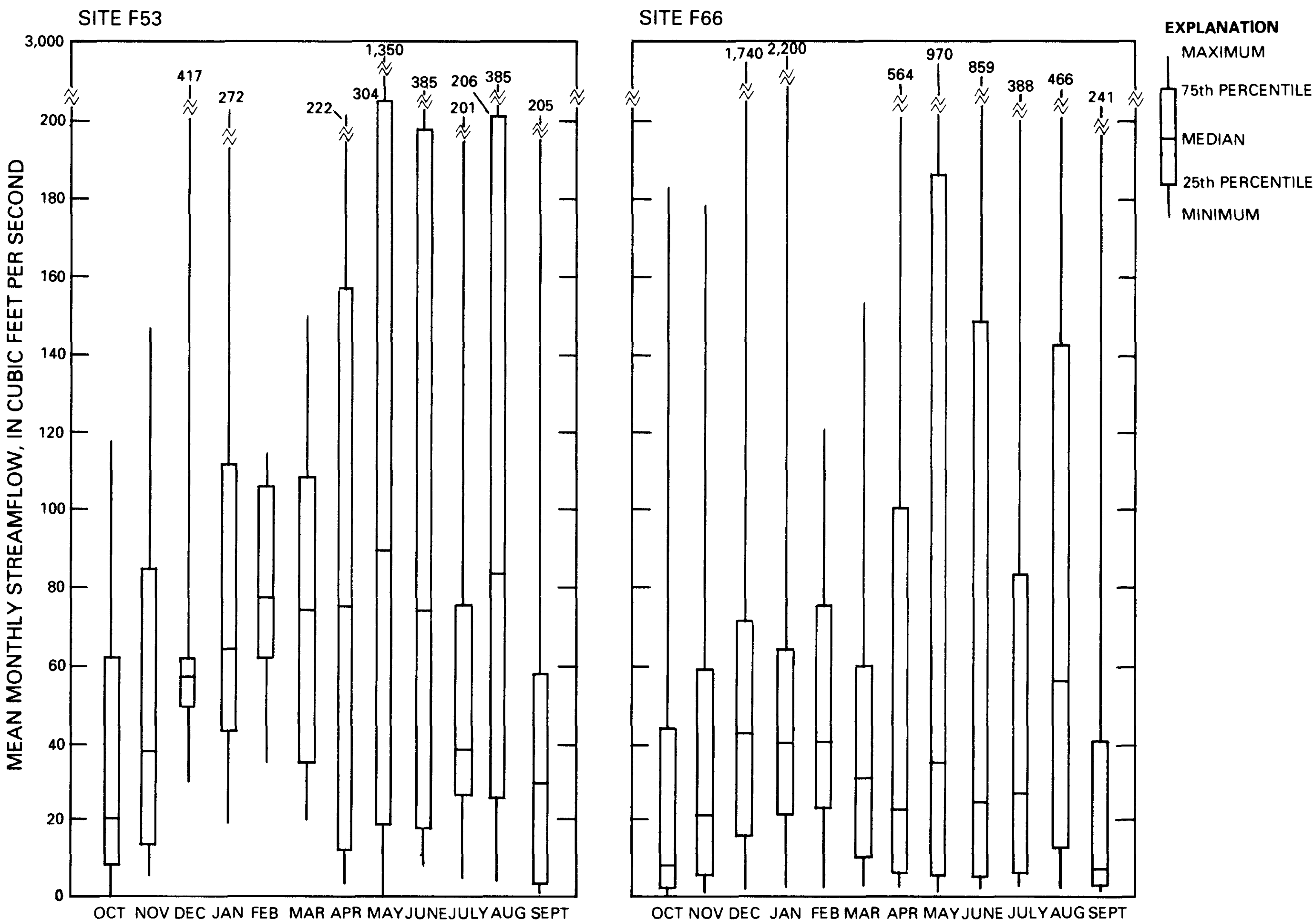


Figure 5.--Streamflow-duration curves for sites F17 and F27.



NOTE: Numbers at top of box plots represent values greater than break in vertical scale

Figure 6.--Statistical summary of mean monthly streamflows for site F53, 1974-83, and site F66, 1923-83.

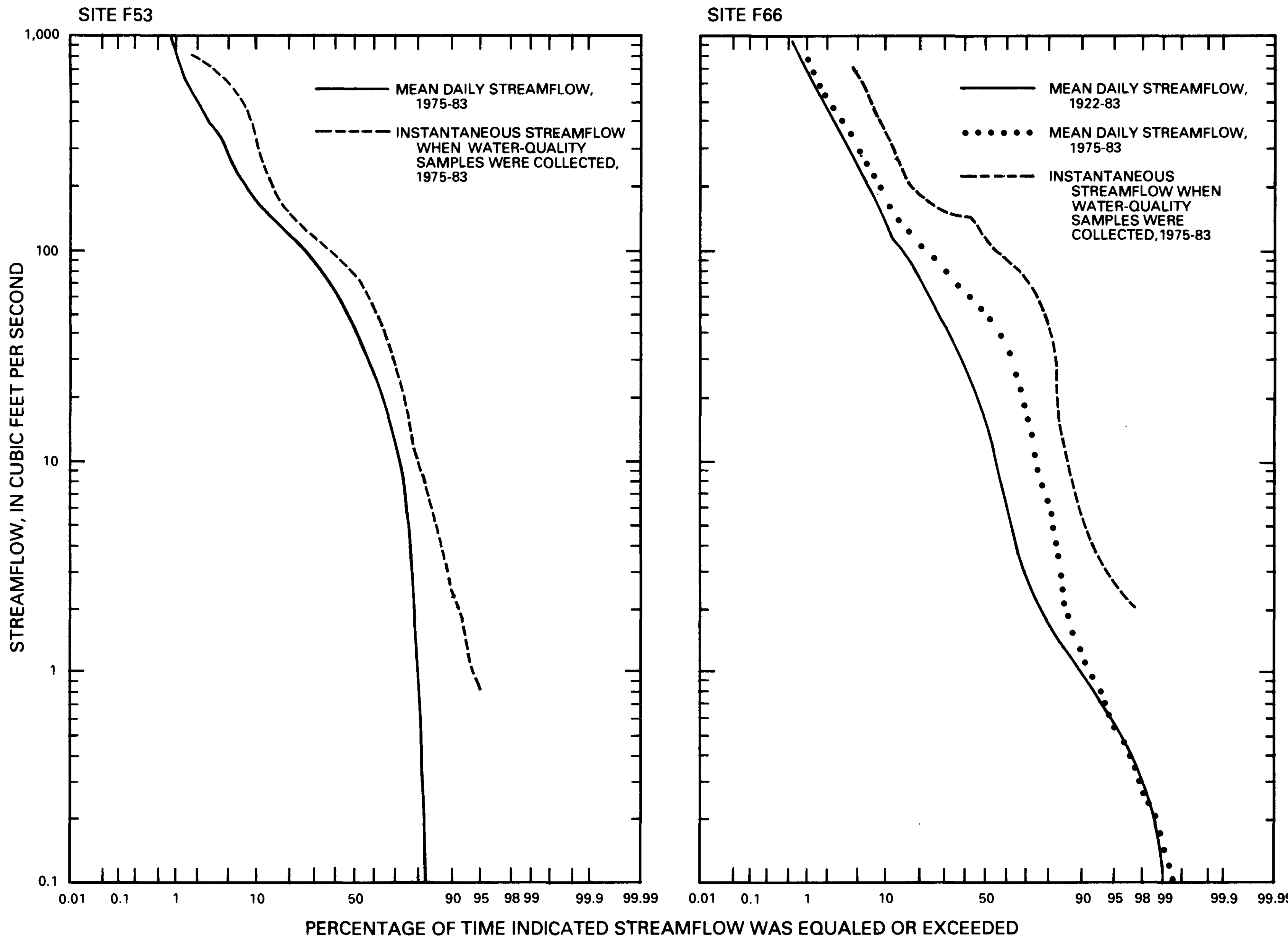


Figure 7.--Streamflow-duration curves for sites F53 and F66.

Most of the streamflow in Upper Monument Creek is derived from tributaries and reservoirs that drain a part of the surrounding Rampart Range and the national forest. As the stream flows southeastward toward Monument, it flows through and drains a few small communities and pastures. Water is diverted in this reach primarily for use as a municipal water supply. Some water also is diverted to ponds and to irrigate pastures.

The streamflow of Upper Monument Creek has been gaged since 1977 at site M10 (station 07103747 Monument Creek at Palmer Lake) (fig. 1) located downstream from the Palmer Lake water-supply diversion. Generally, streamflow has been smallest during the fall and winter (fig. 8*A*); larger and more variable streamflows occurred during the spring from snowmelt runoff and during the summer from thunderstorms. The mean daily streamflow-duration curve (fig. 8*B*) indicates that streamflows have been less than 2 ft^3/s about 50 percent of the time, and streamflows varied substantially as a result of minimal contribution from ground water in storage or from upstream diversions. The frequency curve of instantaneous streamflows made when water-quality samples were collected differs greatly from the mean daily streamflow-duration curve. Therefore, the summary statistics of water-quality constituents affected by streamflow may be somewhat biased toward the larger streamflows.

Lower Monument Creek

Lower Monument Creek comprises the stream segment from Monument to the confluence with Fountain Creek (fig. 2) and has been classified for class 2 recreation, class 2 warm-water aquatic life, domestic water supply, and for agricultural uses. Numeric water-quality standards associated with these classifications are listed in table 1.

As Lower Monument Creek flows south toward Colorado Springs, the streamflow is affected by storage reservoirs, tributaries that drain a part of the Rampart Range and a part of the Colorado Springs area, sewage effluent, ground-water discharge, and diversions. Much of the stream traverses and drains densely developed commercial and industrial areas. Because of urbanization, much of the drainage area is covered by impervious material, which increases the volume and peaks of direct runoff.

The streamflow of Lower Monument Creek has been gaged at site M28 (station 07104000 Monument Creek at Pikeview) (fig. 1) and is summarized in figure 9. The streamflow is smallest during the fall and winter (fig. 9*A*); larger and more variable streamflows occur during the spring from snowmelt runoff and during the summer from thunderstorms. The mean daily streamflow has ranged from 0 to 1,140 ft^3/s and usually has been less than 13 ft^3/s. The steep slope of the duration curves in figure 9*B* indicates that streamflows vary substantially. The streamflow-duration curve for instantaneous streamflow made when water-quality samples were collected is almost identical to the mean daily streamflow-duration curve (fig. 9*B*), except for extreme streamflows. Therefore, the water-quality samples collected at the site should characterize the water-quality conditions that occur approximately 96 percent of the time.

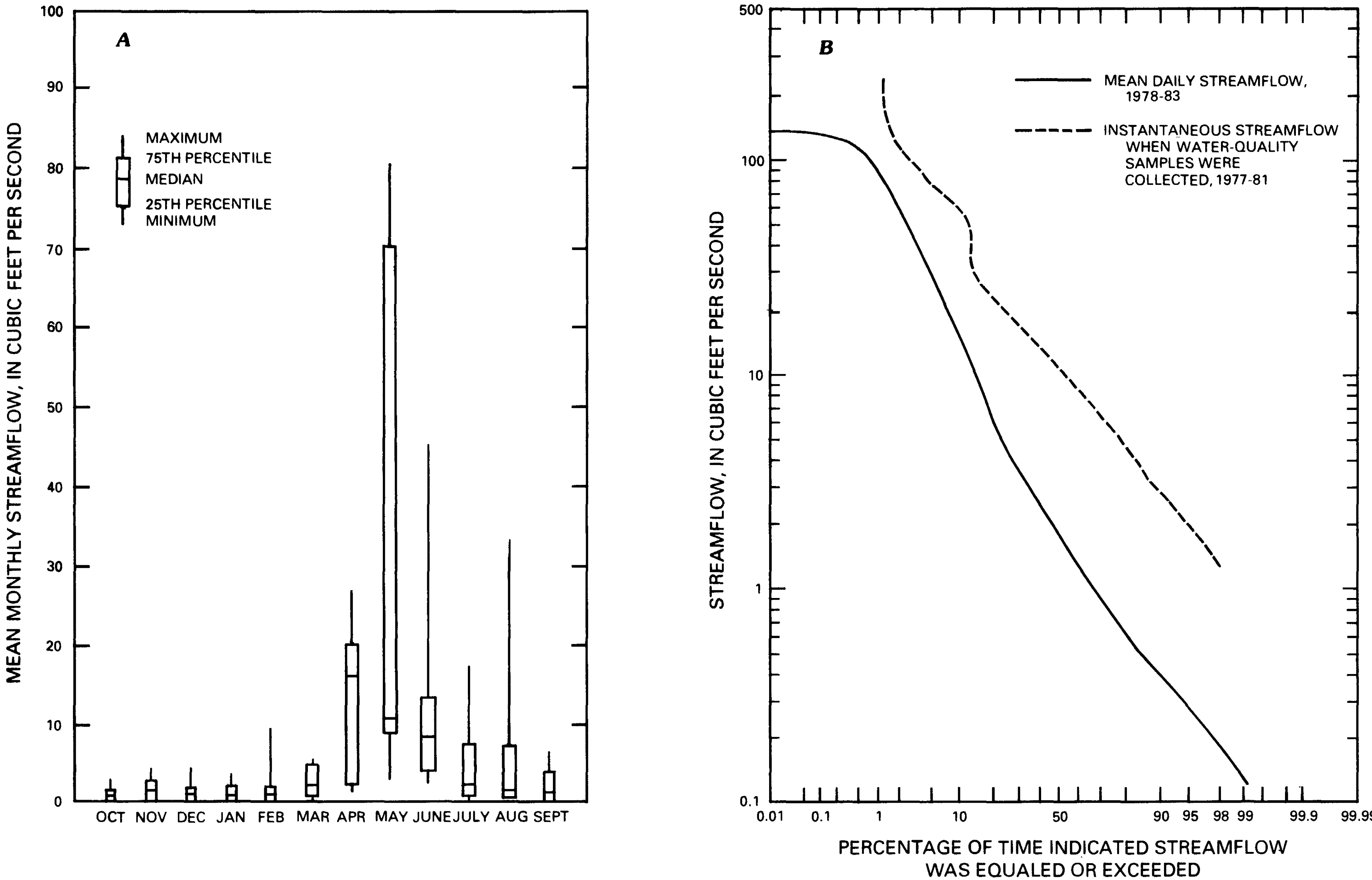


Figure 8.--(*A*) Statistical summary of mean monthly streamflows, 1977-83, and (*B*) streamflow-duration curves for site M10.

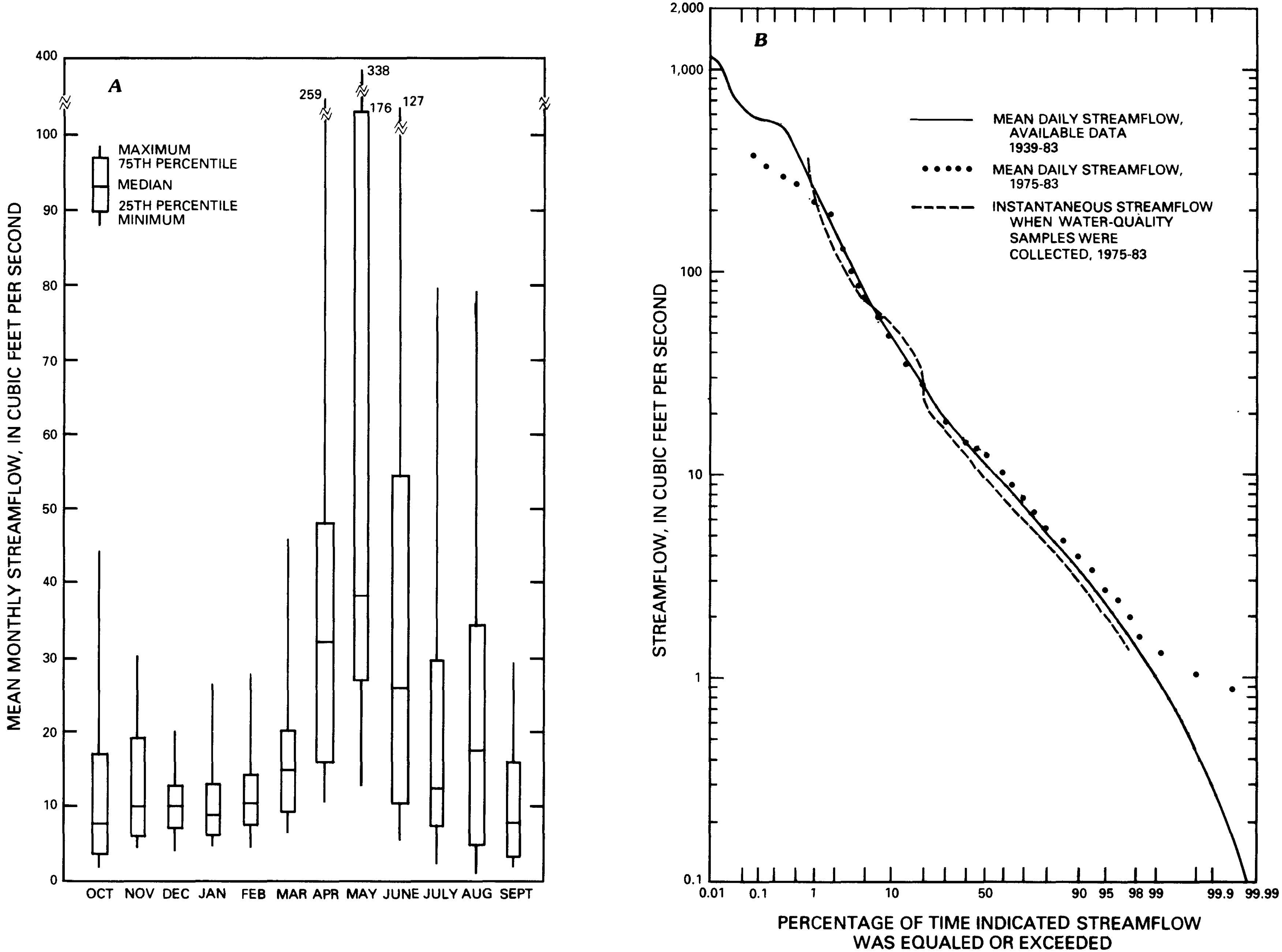


Figure 9.--(*A*) Statistical summary of mean monthly streamflows, available data, 1939-83, and (*B*) streamflow-duration curves for site M28.

GENERAL WATER-QUALITY CHARACTERISTICS OF STREAMS

Water quality of Fountain and Monument Creeks is affected by many natural and manmade factors. Some of the general water-quality characteristics of the streams can be described using information about water temperature, specific conductance, pH, BOD_5, dissolved oxygen, and suspended solids.

Water temperature is important because it affects the usefulness of water for many purposes and partially controls physical, chemical, and biological processes. Temperature affects the waste-assimilation capacity and, therefore, the aesthetic and sanitary qualities of water. Increased temperature accelerates the biodegradation of organic material in overlying water and in bottom deposits, thus increasing dissolved-oxygen demand (U.S. Environmental Protection Agency, 1976, p. 220).

Specific conductance is an indicator of general water quality because it is directly related to the concentration of dissolved solids in the water; as dissolved solids increase, specific conductance increases. In the study area, mountain streams have relatively small specific conductance because the streams are in contact with igneous and metamorphic rocks that resist chemical weathering. In contrast, streams of the plains are in contact with sedimentary rocks that frequently contain soluble minerals, thereby resulting in relatively large specific conductance. Specific conductance of streams also is affected by man-related activities, such as irrigation and wastewater treatment, as well as by soluble substances that enter the stream from runoff.

The pH is a measure of the hydrogen-ion activity and is important in water-quality investigations because solubility of many chemical constituents, including trace elements, and the biological activity of many organisms in water are pH dependent. Thus, pH is an important factor in controlling concentrations of chemical constituents and populations of organisms in the water. The pH also may affect the suitability of water for various uses. A pH range of 6.5 to 9.0 is the numeric standard set by the Colorado Department of Health (1982) for Fountain and Monument Creeks.

The BOD_5 represents the quantity of dissolved oxygen required by organisms in the stream for aerobic biochemical digestion of organic matter in water (Klein and Bingham, 1975, p. 5) and is a useful way of expressing stream-pollution loads. The rate of biochemical-oxidation reactions are dependent on water temperature, microbial population, and waste type. The BOD_5 analysis is performed in a laboratory at a constant temperature of 20 °C. The BOD_5 is calculated from the dissolved-oxygen depletion that occurs over a 5-day incubation period.

Dissolved oxygen is another constituent of interest in water-quality investigations. The dissolved-oxygen concentration in water is inversely related to water temperature and is affected by photosynthesis, respiration, physical interaction of the water with the atmosphere (aeration), and waste loads. It generally has been considered significant in evaluating the aesthetic qualities of water as well as for maintaining fish and other aquatic life. Therefore, the Colorado Department of Health (1982) established a minimum standard of 6.0 mg/L for Upper Fountain Creek and 5.0 mg/L for Lower Fountain Creek, Upper Monument Creek, and Lower Monument Creek.

Suspended solids are the organic and inorganic particulate matter in water and are an important transportation mechanism for micro-organisms and suspended chemical constituents such as trace elements. Suspended solids also interfere with recreational use, aesthetic enjoyment, biological activity, and water treatment. Large concentrations of suspended solids can impair the use of water for irrigation because of formation of crusts on top of the soil, which can inhibit water infiltration, plant emergence, and soil aeration (U.S. Environmental Protection Agency, 1976, p. 212).

Water-quality data in this report are summarized in illustrations that use minimum, 25th-percentile, median, mean, 75th-percentile, and maximum values. Water-quality data for the period of record are summarized in the "Supplemental Data" section in the back of this report using the mean, standard deviation, median, and interquartile range (75th percentile-25th percentile). Water-quality data collected on Fountain and Monument Creeks were not normally distributed. Therefore, the significance in differences of water-quality data that occurred between sites was tested, unless otherwise noted, using the Wilcoxon rank-sum nonparametric test (SAS Institute, Inc., 1982). Because the water-quality data are not normally distributed, the mean and standard deviation do not accurately represent the variation in the data. However, the mean and standard deviation are included in tables 3 through 6 in the "Supplemental Data" section at the back of this report; this information provides the reader a means of comparing water-quality data to the mean plus one standard deviation water-quality criteria established by the Colorado Department of Health (1982) for numeric water-quality standards.

Fountain Creek

Water temperature, specific conductance, pH, BOD_5, dissolved oxygen, and suspended solids were measured at nine sites on Fountain Creek between 1975 and 1983. The period of record for the collection of water-quality data at the sites varies (table 2). Water temperature, specific conductance, pH, and dissolved oxygen were measured monthly at each site when water-quality samples were collected. Additional measurements of water temperature and specific conductance were made in conjunction with streamflow measurements at those sites that had streamflow gages (fig. 1).

Water Temperature

Measurements of instantaneous water temperature were made during daylight hours, and they indicate that substantial variations occur at every site on Fountain Creek (fig. 10). Water temperature generally undergoes a diel fluctuation, especially during the warmer months. Therefore, water-temperature measurements probably are somewhat warmer than the true mean daily water temperature.

Table 2.--*Summary of selected water-quality data for Fountain and Monument Creeks, 1975-83*

[--, data not collected]

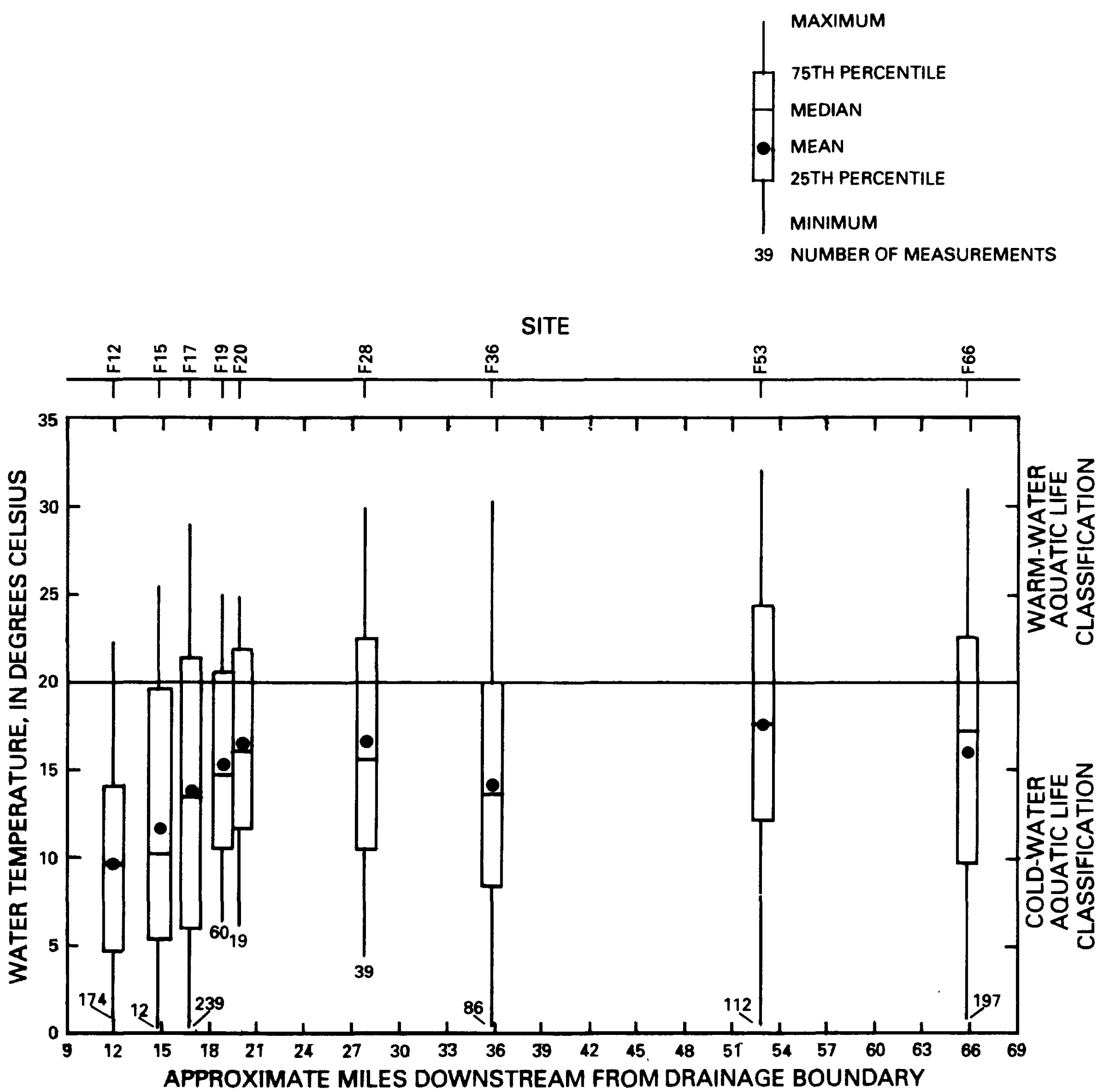
Site number in figure 1[a]	Station number	Station name	Period of selected water-quality data			
			Onsite measurements[b]	Major ions	Nutrients	Trace elements
		FOUNTAIN CREEK				
F12	07103700	Fountain Creek near Colorado Springs	1975-83	1975-79, 1982-83	1975-83	1975-83
F15	07103707	Fountain Creek below 8th Street at Colorado Springs	1981-82	--	1981-82	1981
F17	07105500	Fountain Creek at Colorado Springs	1975-83	1976-79, 1981, 1983	1975-83	1975-83
F19	07105530	Fountain Creek below Janitell Road below Colorado Springs	1975-76, 1979-83	1980-83	1975-76, 1979-83	1975-77 1979-83
F20	07105535	Fountain Creek below Circle Drive below Colorado Springs	1980-82	1981-82	1980-82	1980-82
F28	07105825	Fountain Creek below Widefield	1979-83	1981-83	1979-83	1980-83
F36	07105905	Fountain Creek above Little Fountain Creek below Fountain	1975-79, 1980-83	1976-79	1975-83	1975-82

Table 2.--*Summary of selected water-quality data for Fountain and Monument Creeks, 1975-83*--Continued

			Period of selected water-quality data			
Site number in figure 1[a]	Station number	Station name	Onsite measurements[b]	Major ions	Nutrients	Trace elements
		FOUNTAIN CREEK--Continued				
F53	07106300	Fountain Creek near Pinon	1975-83	1975-76, 1979	1976-77, 1979-83	1975, 1976, 1977, 1979-82
F66	07106500	Fountain Creek at Pueblo	1975-83	1975	1981-83	1981-82
		MONUMENT CREEK				
M10	07103747	Monument Creek at Palmer Lake	1976-83	1976-79	1977-80	1976-80
M28	07104000	Monument Creek at Pikeview	1975-83	1976-79, 1982-83	1975-83	1975-83
M34	07104900	Monument Creek at Cache La Poudre Street	1976-79	1976-79	1976-79	1976-79
M35	07104905	Monument Creek at Bijou Street	1979-83	1982-83	1979-83	1980-83

[a]Site number represents approximate river miles downstream from drainage boundary. An "F" preceding the number indicates the site is located on Fountain Creek. An "M" preceding the number indicates the site is on Monument Creek.

[b]Onsite measurements are made at the site and include water temperature, specific conductance, pH, and dissolved oxygen.



Note: Period of record for individual sites is variable. See tables 3 and 4.

Figure 10.--Statistical summary of downstream variations in water temperature for Fountain Creek, available data, 1975-83.

Upstream from the confluence with Monument Creek, measurements of water temperature at sites F12 and F15 ranged from 0 to about 25 °C (fig. 10). Monthly variations in water temperature measured at site F12 are shown in figure 11. Coldest temperatures measured at this site have occurred during December and January; the median temperature was about 1.5 °C. Warmest temperatures have occurred during July; the median temperature was about 18 °C. These data indicate that water temperatures of Upper Fountain Creek rarely exceed 20 °C. Water temperatures frequently exceed 20 °C during the summer throughout Lower Fountain Creek as shown in figure 11 for sites F17 and F36. At least 25 percent of the instantaneous water-temperature measurements at each site on Lower Fountain Creek exceeds 20 °C (fig. 10). The water temperatures are warmer in Lower Fountain Creek because of warmer climate, inflow

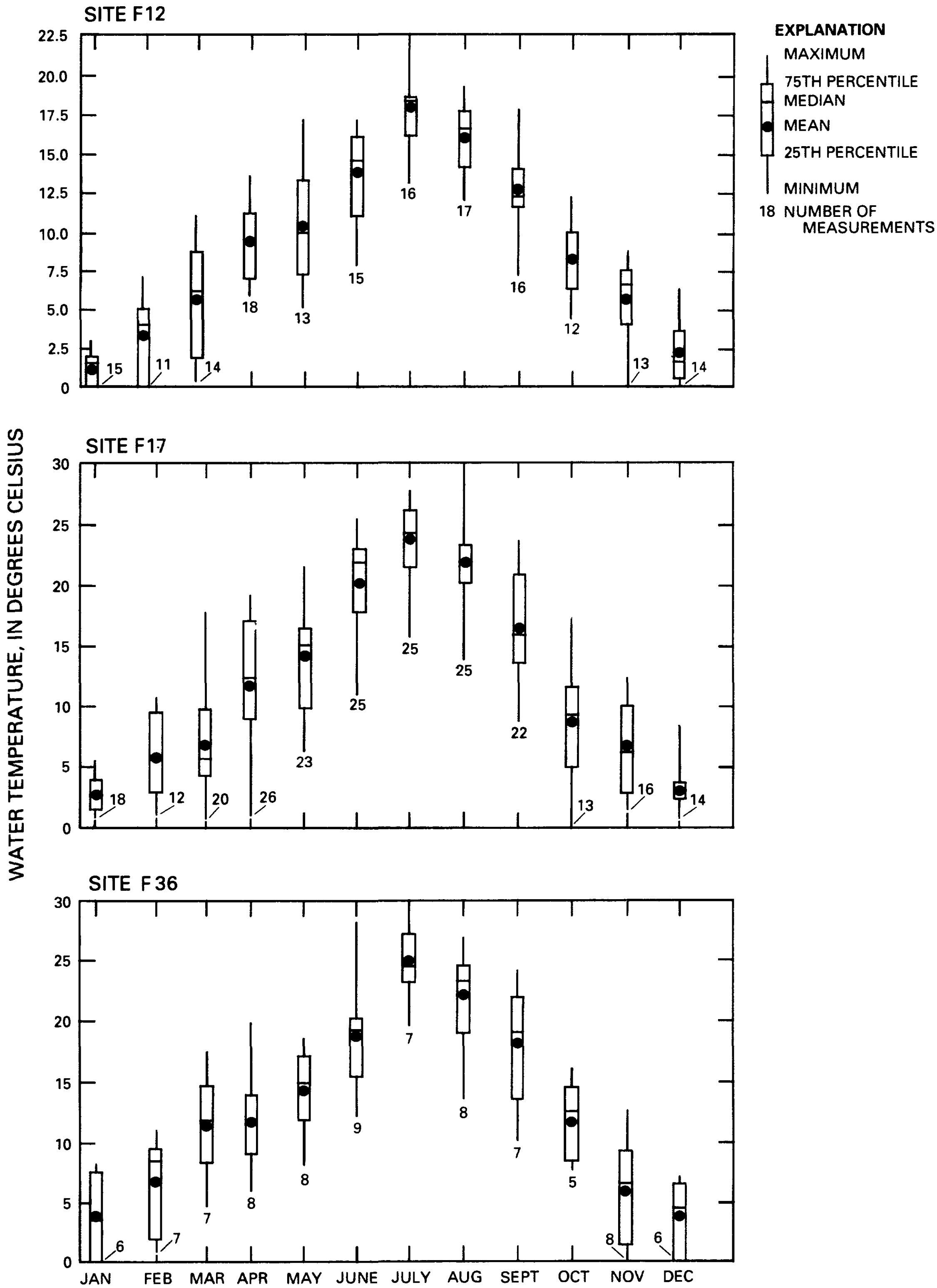


Figure 11.--Statistical summary of monthly variations in water temperature for sites F12, F17, and F36, 1975-83.

from Monument Creek, and effluent from wastewater-treatment plants. The effect of effluent from wastewater-treatment plants on water temperatures of Lower Fountain Creek is shown in figure 10. The minimum water temperature measured at all sites was 0 °C except for three sites located between river miles 18 and 30. These sites are located in the stream reach in which the water consists mostly of wastewater discharged to Fountain Creek by five wastewater-treatment plants. The minimum water temperature measured in this reach was 4 °C at F28 and 6 °C at F19 and F20. As water temperature increases during the summer (fig. 11), the stream may become odoriferous because of increased volatility of odor-causing compounds, especially in the stream reach that is laden with wastewater. Warmer temperatures also aid in waste assimilation, thus increasing demands on the dissolved-oxygen resources of the stream.

Specific Conductance

Specific conductance of Fountain Creek generally increases downstream as the stream flows from the mountains through residential, commercial, industrial, and agricultural areas (fig. 12). Dissolved-solids concentrations, as represented by specific conductance, at site F12 usually are small because the streamflow consists mostly of water that drains a part of the Rampart Range, which generally is unaffected by man and is composed mostly of igneous and metamorphic rocks that resist chemical weathering. Median specific conductance of Fountain Creek increases by a factor of about 2 from site F12 (341 μS/cm) to site F17 (658 μS/cm), probably because of urbanization, ground-water discharge, the city of Colorado Springs diversion that decreases dilution, inflow from Monument Creek, and mine tailings located adjacent to the stream and upstream from the confluence with Monument Creek. Between sites F17 and F66, the median specific conductance increased from 658 to 1,750 μS/cm, probably as the result of discharge from wastewater-treatment plants and irrigation-return flows and, probably to a lesser extent, from tributary inflow. The variations in specific conductance of Fountain Creek increase downstream as a result of greater variations in flow and differences in sources of flow.

Monthly variations in the specific conductance of Fountain Creek at sites F12, F17, and F36 are summarized in figure 13. Specific-conductance measurements made at site F12 indicate that dissolved-solids concentrations are smallest during the summer when streamflow is large and that dissolved-solids concentrations are largest during the winter when streamflow is small. The seasonal variations in specific conductance at sites F17 and F36 are dissimilar from those at site F12. At sites F17 and F36, the smallest specific conductance occurs during summer; however, the largest specific conductance may occur during any season, depending on flow and sources of flow.

pH

The median pH of Fountain Creek ranges from 7.4 at sites F19 and F20, which are located about 2 mi downstream from the Colorado Springs Wastewater Treatment Plant, to 7.9 at site F66 located at Pueblo (fig. 14). All pH measurements made on Fountain Creek have been within the acceptable range of 6.5 to 9.0 established by the Colorado Department of Health (1982), which

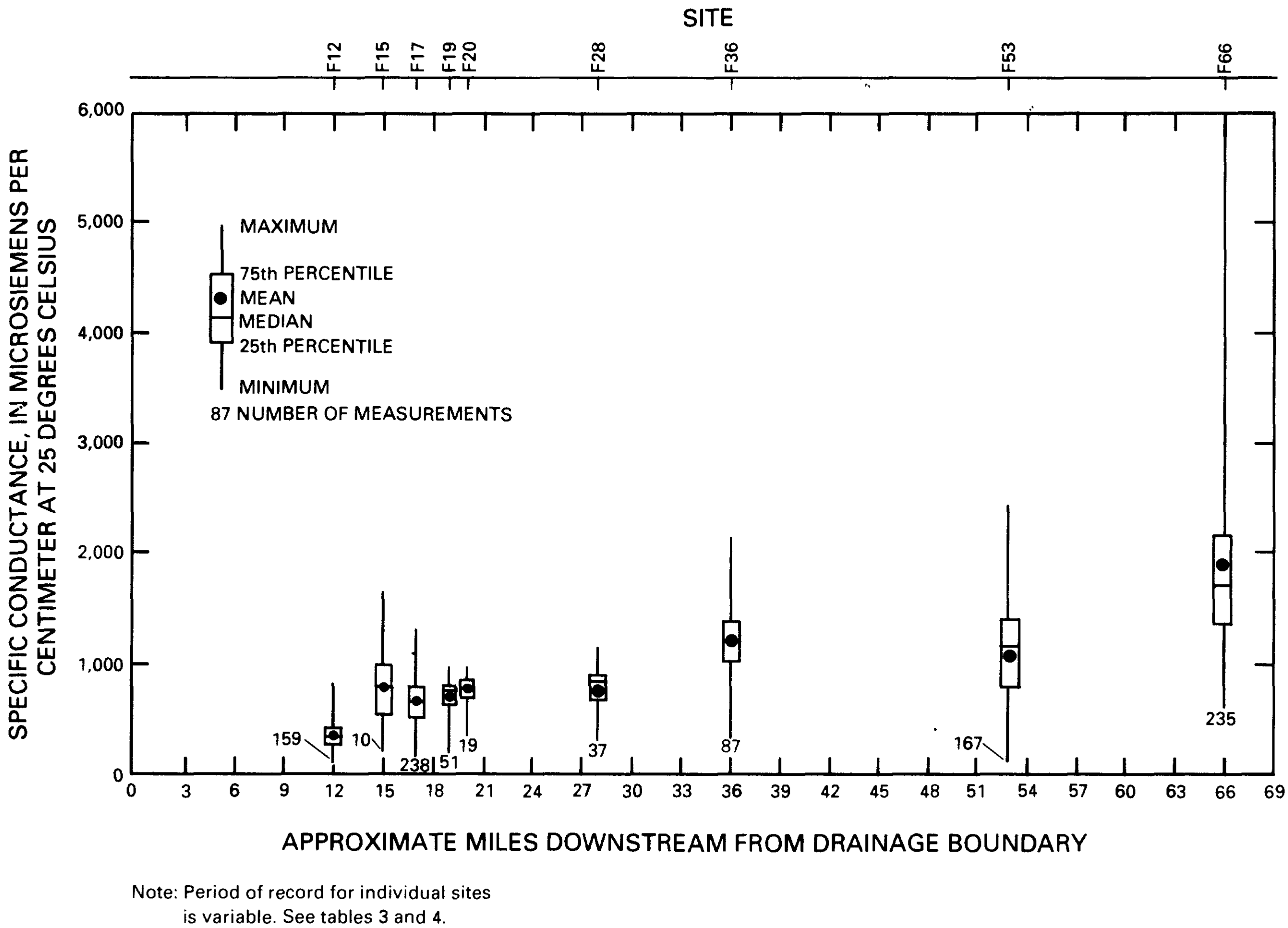


Figure 12.--Statistical summary of downstream variations in specific conductance for Fountain Creek, available data, 1975-83.

indicates that pH does not adversely affect the intended beneficial uses of the stream. As an indication of the near-neutral pH measurements, the solubility of most trace elements can be expected to be relatively small in this well-oxygenated stream. However, some trace elements, such as manganese, selenium, and zinc, are fairly soluble at the pH levels measured on Fountain Creek.

During 1981, when pH was measured at site F12 and site F15, there was a small but significant (95 percent level of confidence) decrease in pH. This decrease in pH, which occurred between sites F12 and F15, possibly was the result of drainage from mine tailings. The pH increases downstream from site F15 for a short distance as the result of inflow from Monument Creek. Downstream from site F17, the pH decreases, probably as the result of effluent from the Colorado Springs Wastewater Treatment Plant and, then, gradually increases throughout the remaining 47 mi of Fountain Creek.

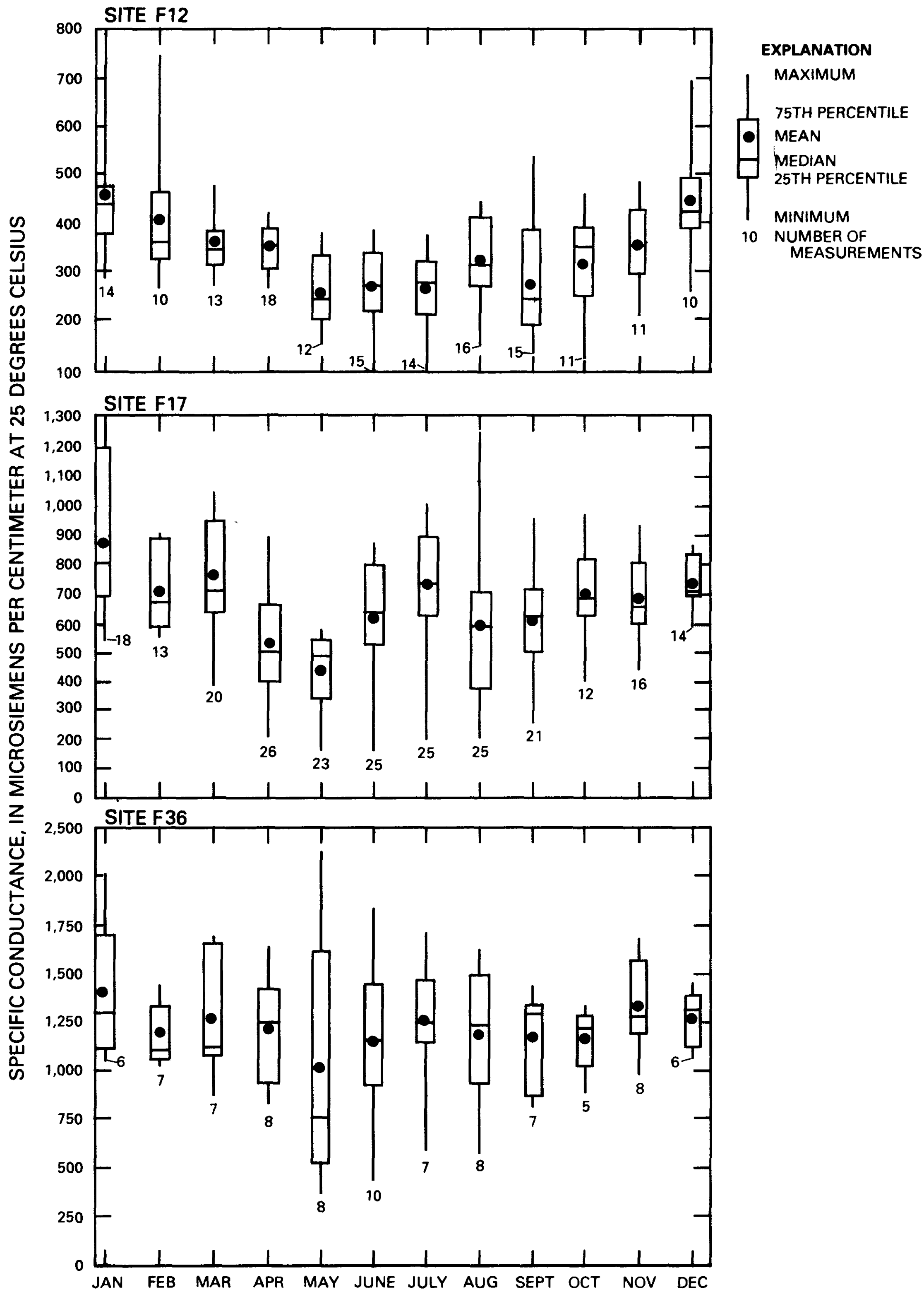


Figure 13.--Statistical summary of monthly variations in specific conductance for sites F12, F17, and F36, 1975-83.

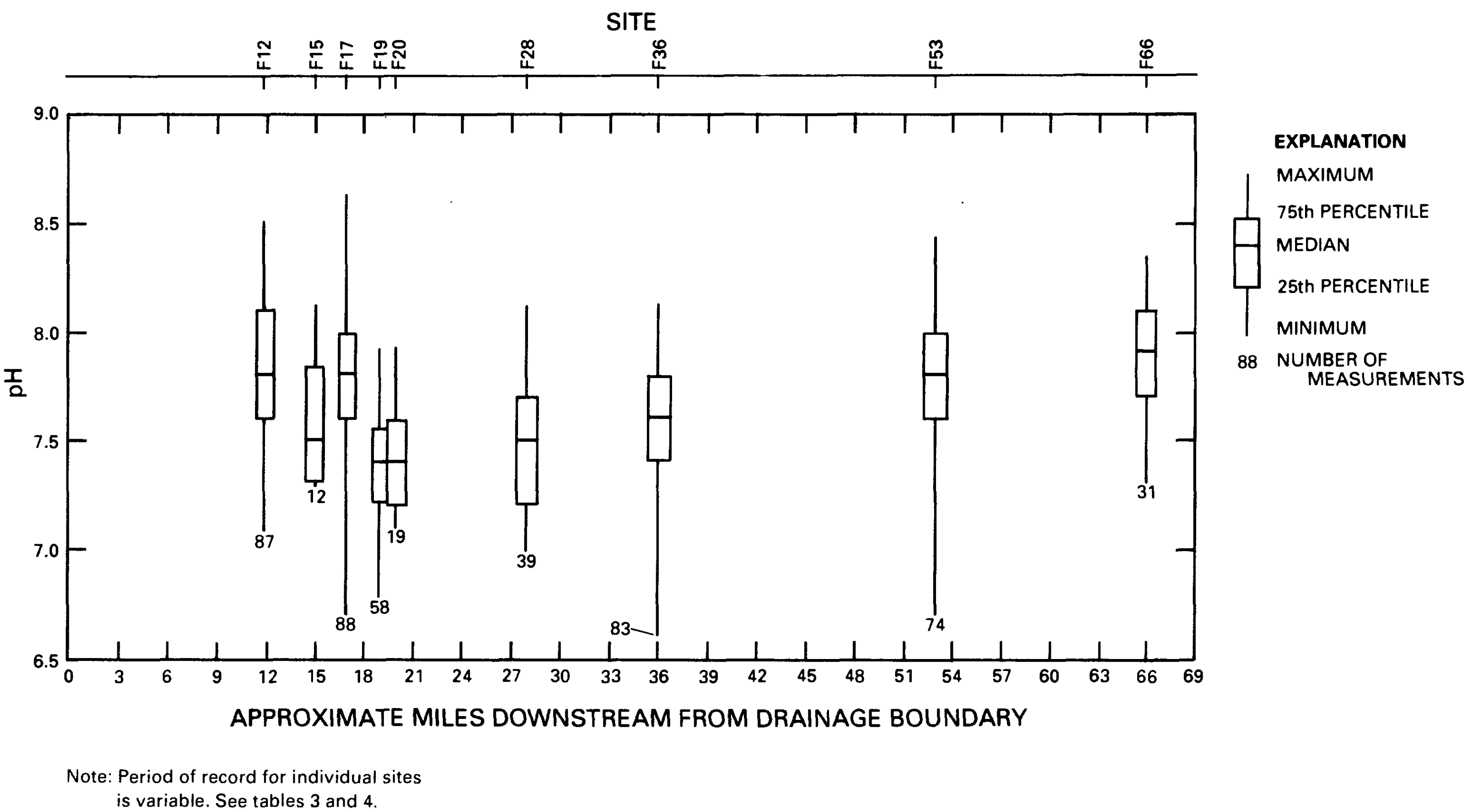


Figure 14.--Statistical summary of downstream variations in pH for Fountain Creek, available data, 1975-83.

Five-Day Biochemical Oxygen Demand

The BOD_5 measurements made on Fountain Creek from 1975 through 1983 are summarized in figure 15*A* and the measurements made from 1980 through 1983 are summarized in figure 15*B*. Although the two figures are similar, downstream variations in BOD_5 are better represented in figure 15*B* because the period of record and the number of measurements are more similar between the sites.

The median BOD_5 (1980-83) of Upper Fountain Creek (sites F12 and F15, fig. 15*B*) was about 1 mg/L. These data indicate that small quantities of biochemically oxidizable material were present in this stream reach. The median BOD_5 increased from about 1 mg/L in Upper Fountain Creek to almost 4 mg/L at site F17 primarily as the result of inflow from Monument Creek. About 0.5 mi downstream from site F17, the outfall from the Colorado Springs Wastewater Treatment Plant enters Fountain Creek. Downstream from this outfall, the streamflow in Fountain Creek consists largely of sewage effluent (Edelmann and Cain, 1985), and BOD_5 increases rapidly as a result of effluent from the Colorado Springs Wastewater Treatment Plant and from four smaller wastewater-treatment plants that enter Fountain Creek within a 10-mi stream reach, as evidenced by the concentrations of BOD_5 measured at sites F19, F20, and F28. The median BOD_5 measured at site F28, which is located downstream from Security, Colo., was 28 mg/L, indicating that a considerable quantity of biochemically oxygen-demanding material is present. Downstream from site F28, the BOD_5 decreases.

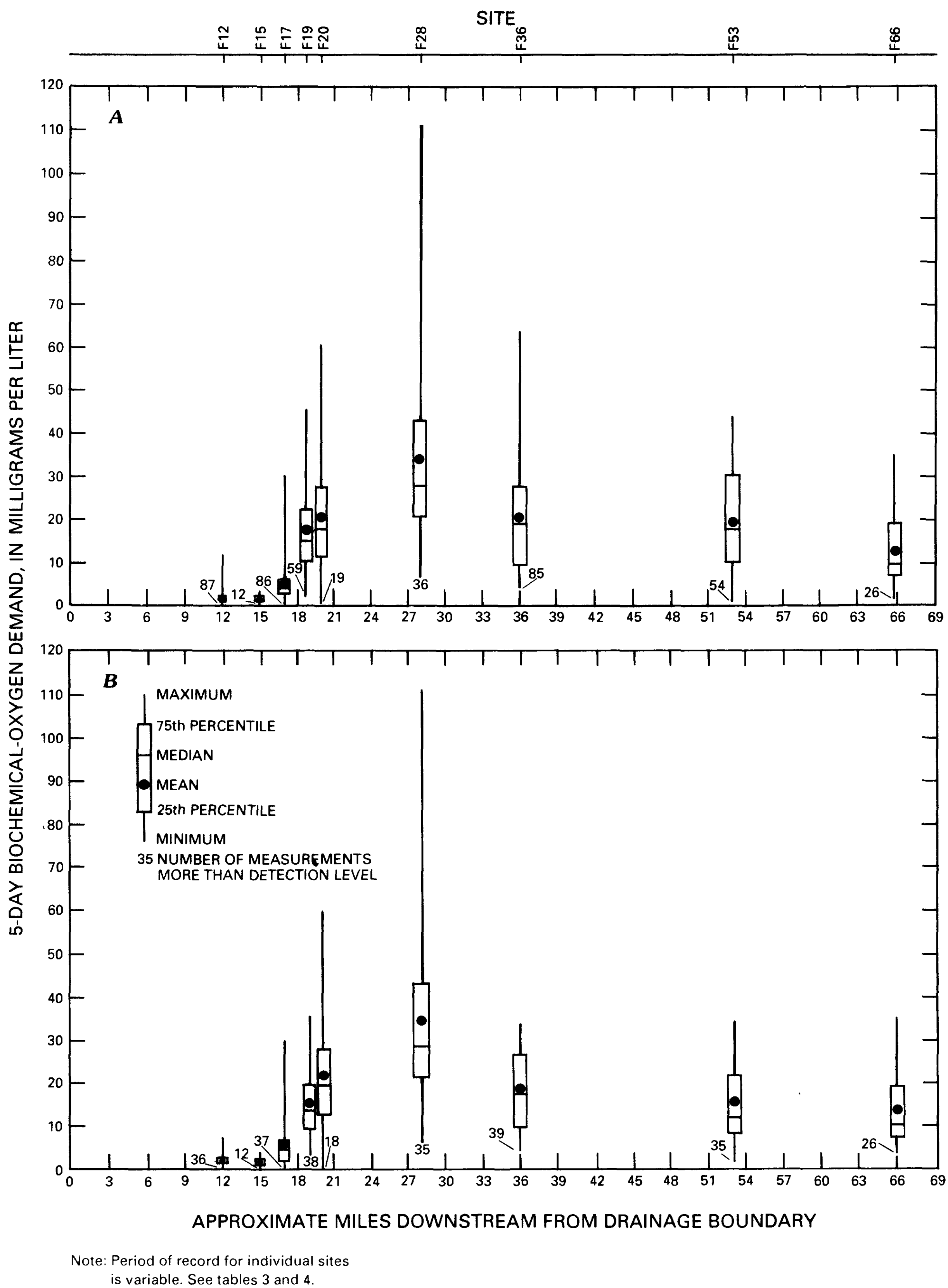


Figure 15.--Statistical summary of downstream variations in 5-day biochemical oxygen demand for Fountain Creek, available data, (*A*) 1975-83, and (*B*) 1980-83.

Dissolved Oxygen

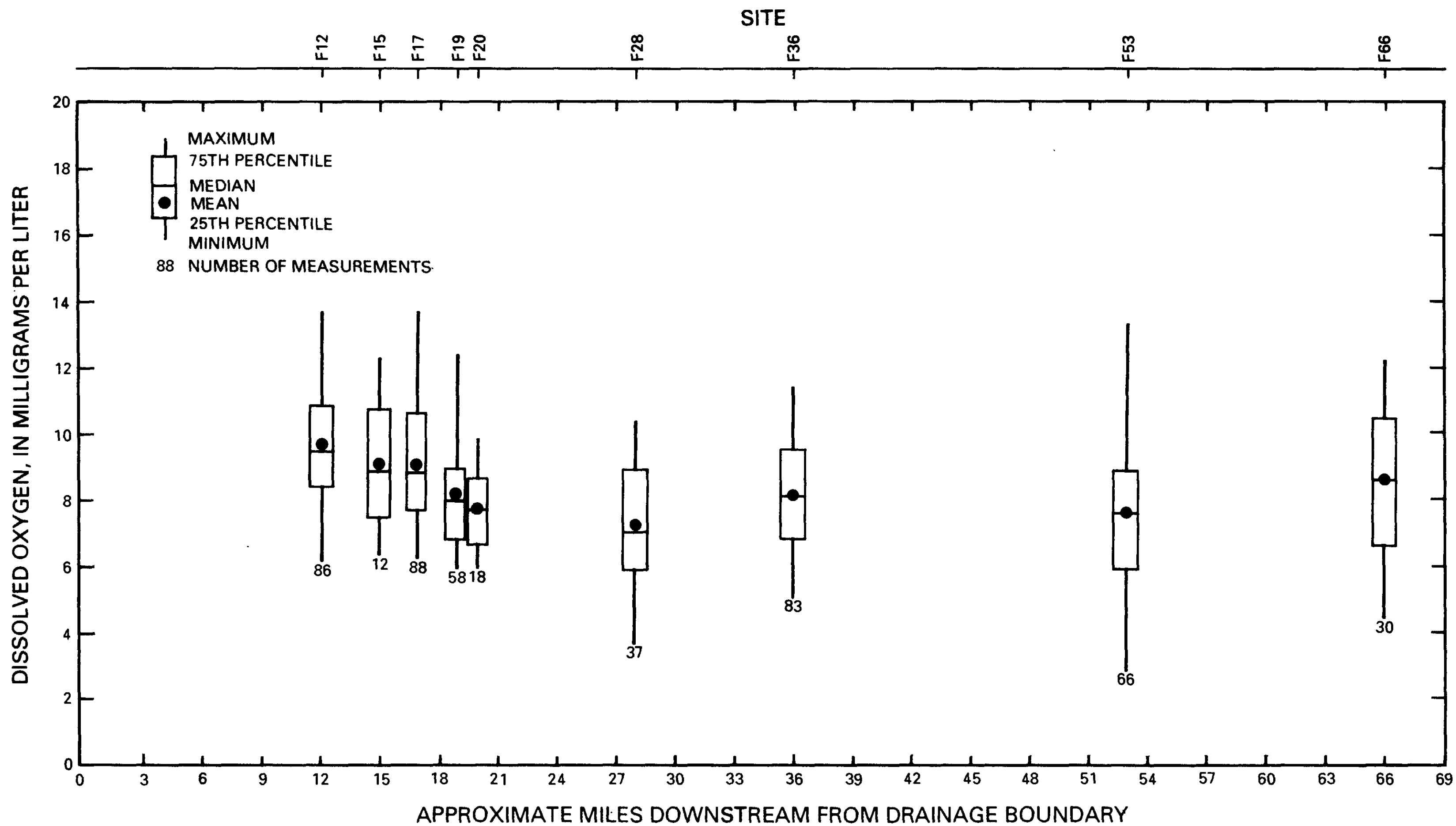
When considerable oxygen demand is present in a stream such as Fountain Creek, dissolved oxygen may be substantially depleted while digestive processes are occurring. However, the dissolved-oxygen concentrations, which were measured in Fountain Creek during the daylight hours and, therefore, are likely to be somewhat larger than the minimum daily dissolved-oxygen concentration, indicate that the stream generally is well oxygenated (fig. 16). Since 1975, only four dissolved-oxygen measurements were less than the recommended standard of 5.0 mg/L for Lower Fountain Creek. The stream remains well oxygenated probably because of large reaeration rates that result from large velocities and shallow depths in Fountain Creek.

Monthly variations in dissolved-oxygen concentrations of Fountain Creek at sites F12, F17, and F36 are summarized in figure 17. Because dissolved-oxygen concentration is inversely related to water temperature, the smallest dissolved-oxygen concentrations of Fountain Creek occur during July and August when water temperatures are warmest and biological decomposition is greatest (fig. 11); the largest dissolved-oxygen concentrations occur during December and January when water temperatures are coldest and biological decomposition is least.

Suspended Solids

The suspended-solids concentrations at nine sites along Fountain Creek from 1975 through 1983 are summarized in figure 18*A*, and suspended-solids concentrations from 1980 through 1983 are summarized in figure 18*B*. Downstream variations in suspended-solids concentrations are better represented in figure 18*B* because the period of record and the number of measurements are more similar between sites.

The suspended-solids concentrations measured on Fountain Creek upstream from the confluence with Monument Creek have been small because of the presence of nonerosive igneous and metamorphic rocks, the cobbled-bed channel, and the shallow soils in the Upper Fountain Creek basin. The small concentrations of suspended solids result in a clear stream, which adds to the aesthetic quality. However, suspended-solids concentrations rapidly increase downstream from the confluence with Monument Creek primarily as the result of Monument Creek inflow, as indicated by data collected at site F17. Suspended-solids concentrations decreased from site F17 to site F19 because of dilution from the Colorado Springs Wastewater Treatement Plant effluent. The median suspended-solids concentration (1980-83) decreased from 156 mg/L at site F17 to 89 mg/L at site F19 (fig. 18*B*), which is located about 2 mi downstream from the wastewater-treatment plant outfall. However, the resulting increase in streamflow from the effluent re-entrains sediments that have been deposited in the stream channel downstream as the result of tributary inflows, which increases the suspended-solids concentrations downstream from site F20 (fig. 18*B*).



Note: Period of record for individual sites is variable. See tables 3 and 4.

Figure 16.--Statistical summary of downstream variations in concentrations of dissolved oxygen for Fountain Creek, available data, 1975-83.

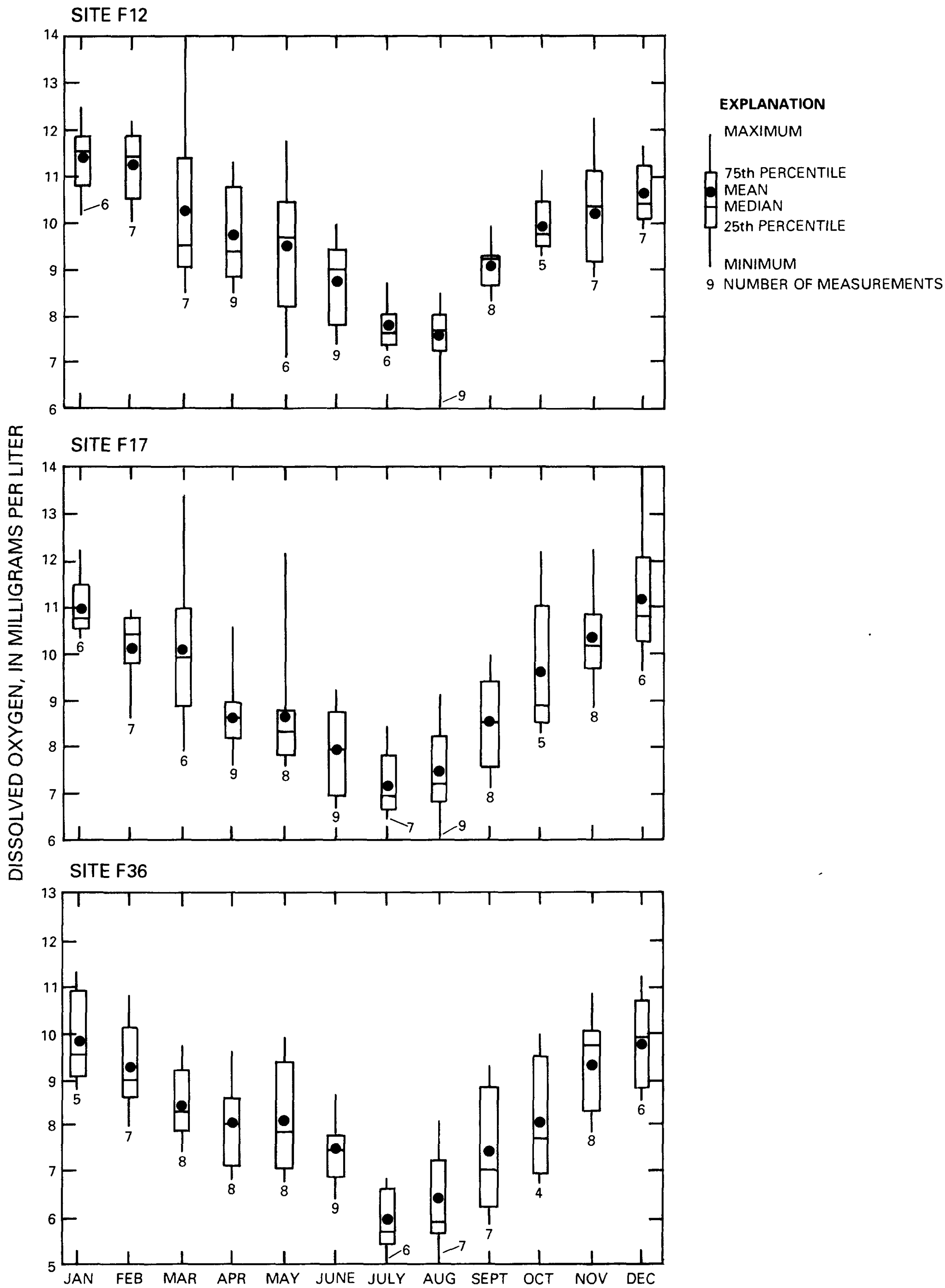


Figure 17.--Statistical summary of monthly variations in concentrations of dissolved oxygen for sites F12, F17, and F36, 1975-83.

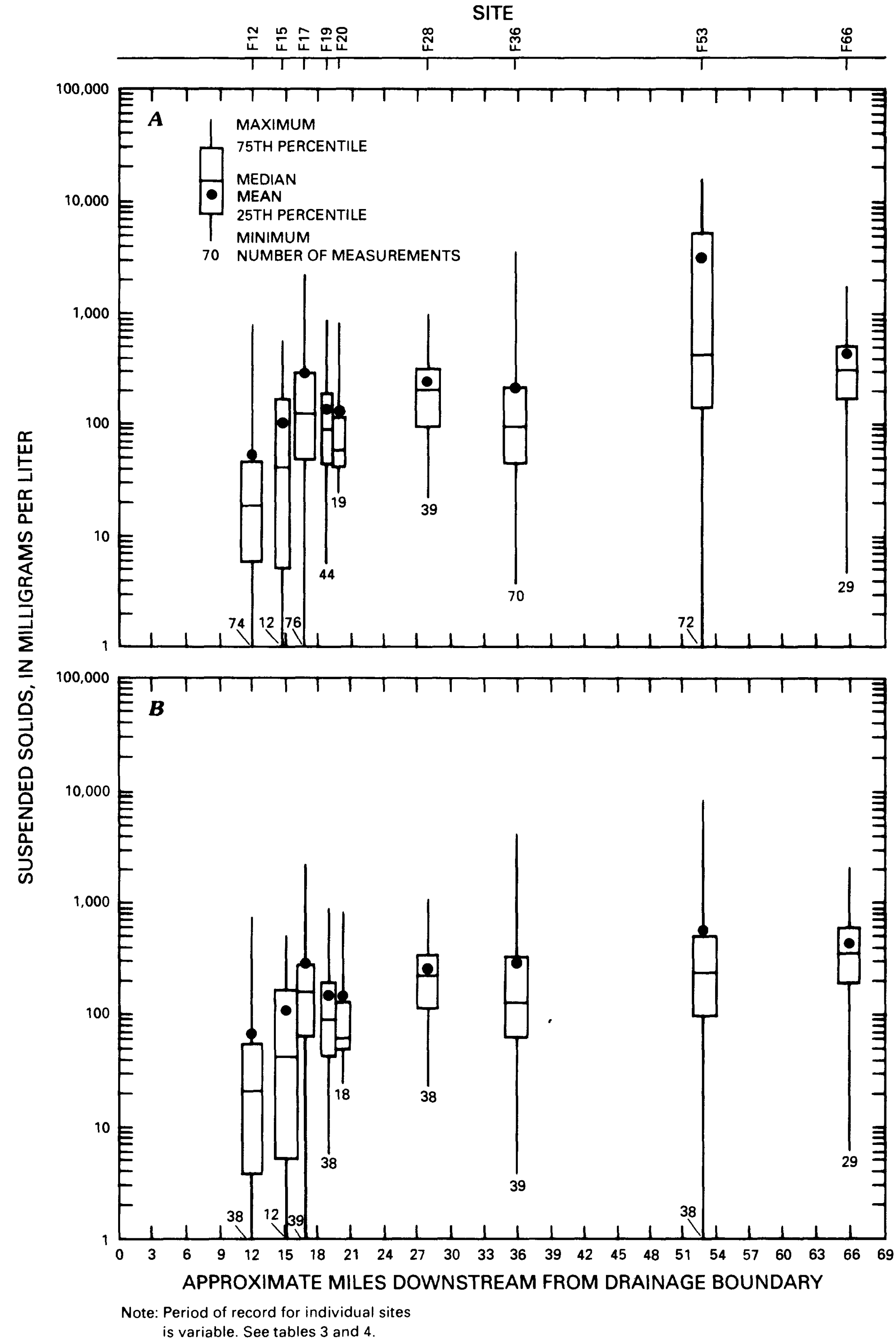


Figure 18.--Statistical summary of downstream variations in concentrations of suspended solids for Fountain Creek, available data, (*A*) 1975-83, and (*B*) 1980-83.

Monument Creek

Between 1975 and 1983, water temperature, specific conductance, pH, BOD_5, dissolved oxygen, and suspended solids were measured at four sites on Monument Creek. The period of record of water-quality data varies at each of the four sites (table 2). Water temperature, specific conductance, pH, and dissolved oxygen were measured monthly at each site when water-quality samples were collected. Additional measurements of water temperature and specific conductance were made at sites M10 and M28 (fig. 1) when streamflow measurements were made.

Water Temperature

Measurements of instantaneous water temperature in Monument Creek are summarized in figure 19. At site M10, water temperatures have ranged from 0 to about 25 °C, and more than 75 percent of the measurements were less than 20 °C. Coldest water temperatures measured at site M10 (fig. 20) have occurred during the winter; median temperatures measured during December, January, and February have been 1.5, 1.0, and 1.5 °C. Warmest temperatures have occurred during July; median water temperature was 19.5 °C. Downstream from site M28 (fig. 19), instantaneous water temperatures ranged from 0 to 30.5 °C. Coldest temperatures measured at site M28 (fig. 20) occurred during the winter; median temperatures measured during December, January, and February have been 0, 0, and 1.5 °C. Warmest temperatures occurred during July; median water temperature was 23 °C.

Specific Conductance

Specific conductance of Monument Creek increases downstream as the stream flows from the mountains through residential, commercial, and industrial areas (fig. 21). Measurements of specific conductance at site M10 have been small because the streamflow consists of water that largely is unaffected by man and drains a part of the Rampart Range, which is composed mostly of igneous and metamorphic rocks that resist chemical weathering. Measurements of specific conductance made at site M10 have ranged from 50 to 250 µS/cm; median specific conductance was 180 µS/cm. Downstream from Monument, the stream is in contact with sedimentary rocks that contain soluble minerals and receives water from wastewater-treatment plants, ground-water discharge, and tributaries that drain densely urbanized areas. As these waters enter Monument Creek, specific conductance increases. The increase in specific conductance that occurs between site M28 and the mouth of Monument Creek probably results from drainage of the commercial and industrial areas of Colorado Springs. The apparent decrease in specific conductance between site M34 and site M35 probably is the result of different periods of records having different sources of flow (fig. 21). The range of specific-conductance measurements at the four sites on Monument Creek increases downstream because of greater variations in flow and differences in sources of flow.

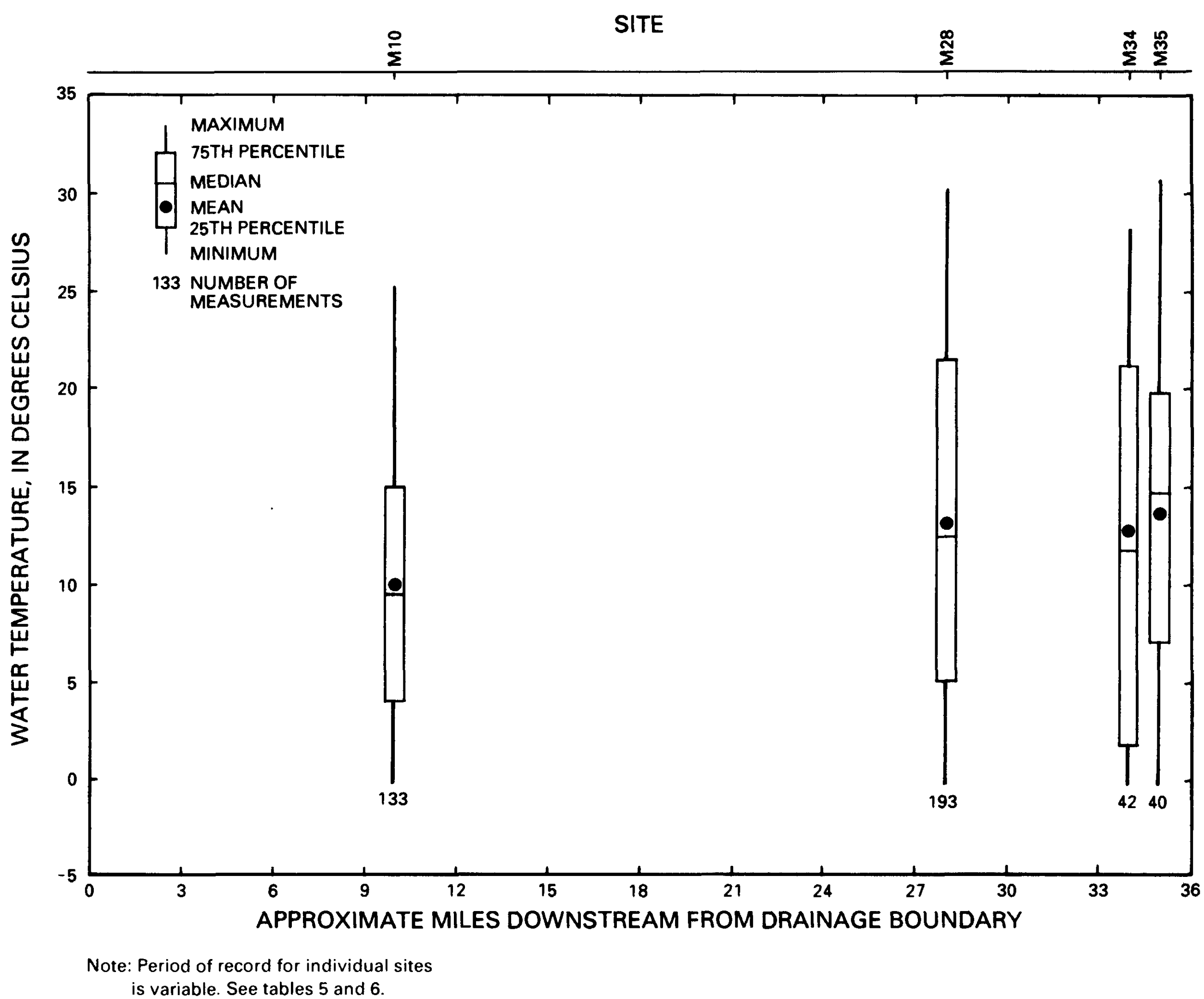


Figure 19.--Statistical summary of downstream variations in water temperature for Monument Creek, available data, 1975-83.

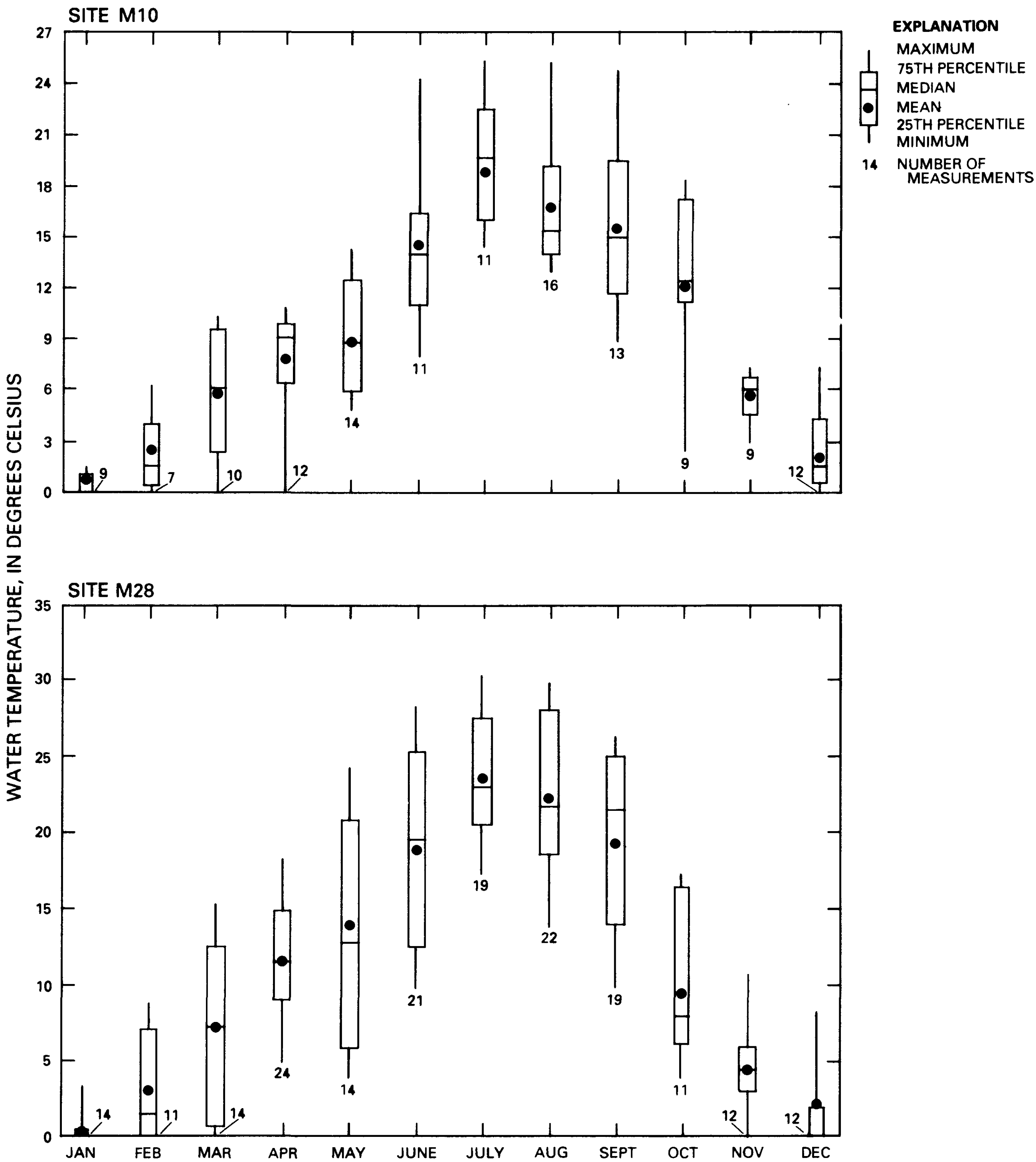
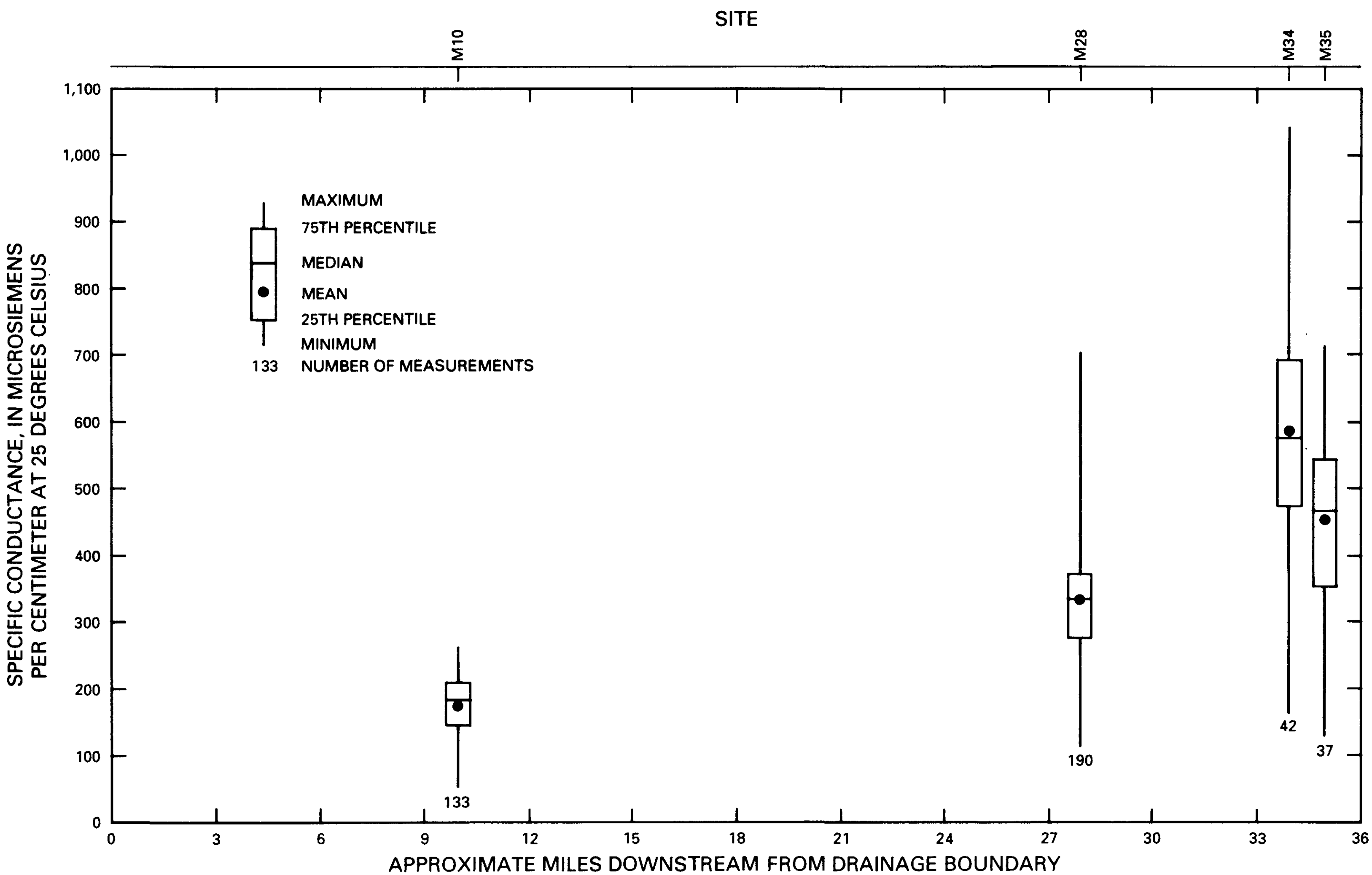


Figure 20.--Statistical summary of monthly variations in water temperature for sites M10 and M28, available data, 1975-83.



Note: Period of record for individual sites is variable. See tables 5 and 6.

Figure 21.--Statistical summary of downstream variations in specific conductance for Monument Creek, available data, 1975-83.

Monthly variations in the specific conductance of Monument Creek at sites M10 and M28 are summarized in figure 22. Median specific conductance is smaller during April, May, and June. The largest median specific conductance occurs during August and September at site M10 and in August at site M28; however, the largest specific conductance may occur during any season depending on the sources of flow.

pH

The pH of Monument Creek varies considerably at each of the four sites where measurements have been made; however, all measurements were within the acceptable range of 6.5 to 9.0 (fig. 23). The median pH increased from 7.5 at site M10 to 8.0 at site M34, which is located about 2 mi upstream from the confluence with Fountain Creek. The increase may result from ground-water discharge or drainage of alkaline materials that enter the stream from urbanized areas. At the measured levels of pH, most trace elements are relatively insoluble in this well-oxygenated stream. However, manganese, selenium, and zinc are fairly soluble at the pH levels measured on Monument Creek.

Five-Day Biochemical Oxygen Demand

Except for site M35, the BOD_5 measured on Monument Creek was less than 4 mg/L for more than 50 percent of the time samples were collected, indicating that small quantities of biochemically oxidizable material were present in the stream. The BOD_5 measured on Monument Creek is summarized in figures 24 and 25. Between 1975 and 1983, BOD_5 generally increased downstream (fig. 24) because more oxidizable material was present in the stream, probably because of discharge from wastewater-treatment plants and from nonpoint sources transported to the stream by runoff.

A slight increase in median BOD_5 occurred from 1975 through 1979, between sites M28 and M34 and, from 1980 through 1983, between sites M28 and M35 (fig. 25). In addition, the BOD_5 measured from 1980 through 1983 was considerably larger than concentrations measured from 1975 through 1979, indicating there was more biochemically oxidizable material in the stream from 1980 through 1983 than from 1975 through 1979 (fig. 25).

Dissolved Oxygen

Dissolved-oxygen concentrations were measured in Monument Creek during the daylight hours. Dissolved-oxygen concentrations frequently exhibit diel variations, and the largest concentrations occur during daylight as a result of photosynthesis. Thus, the dissolved-oxygen concentrations measured in Monument Creek are likely to be greater than the minimum daily dissolved-oxygen concentration (fig. 26). Since 1975, all dissolved-oxygen measurements made on Monument Creek, except for one measurement at site M34, have been greater than the recommended standard of 5.0 mg/L. The large velocities and shallow depths keep the stream well oxygenated.

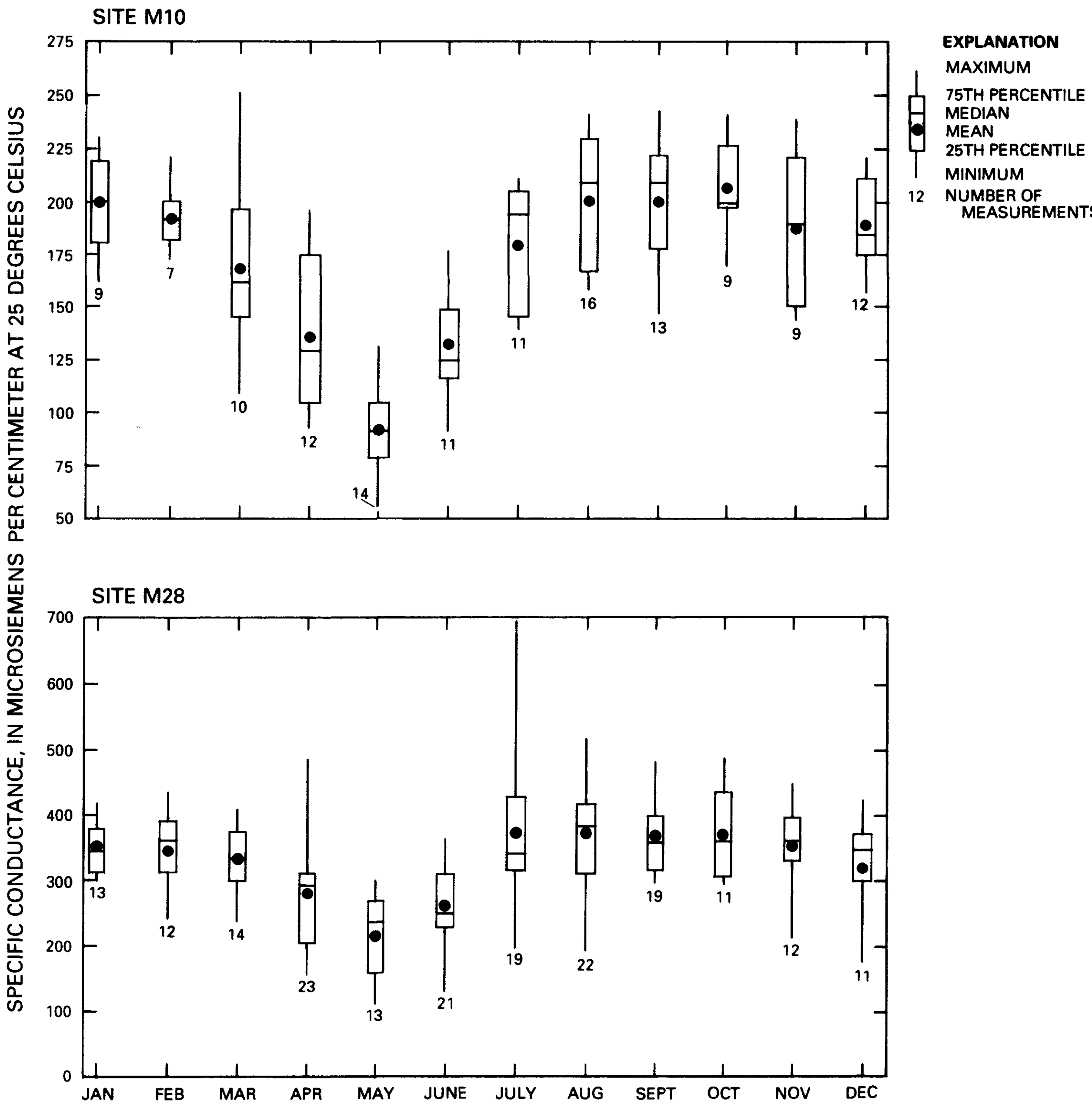
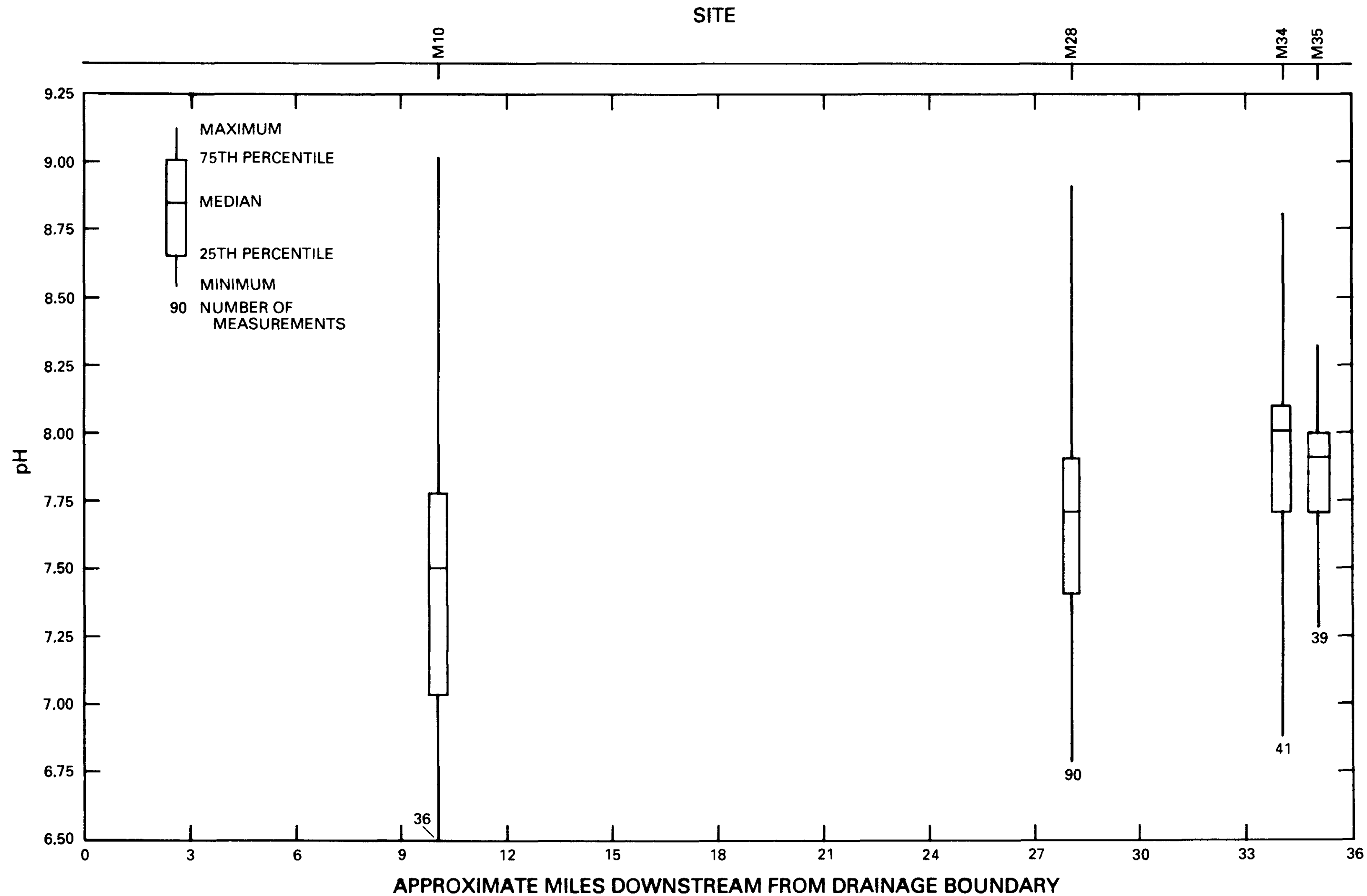
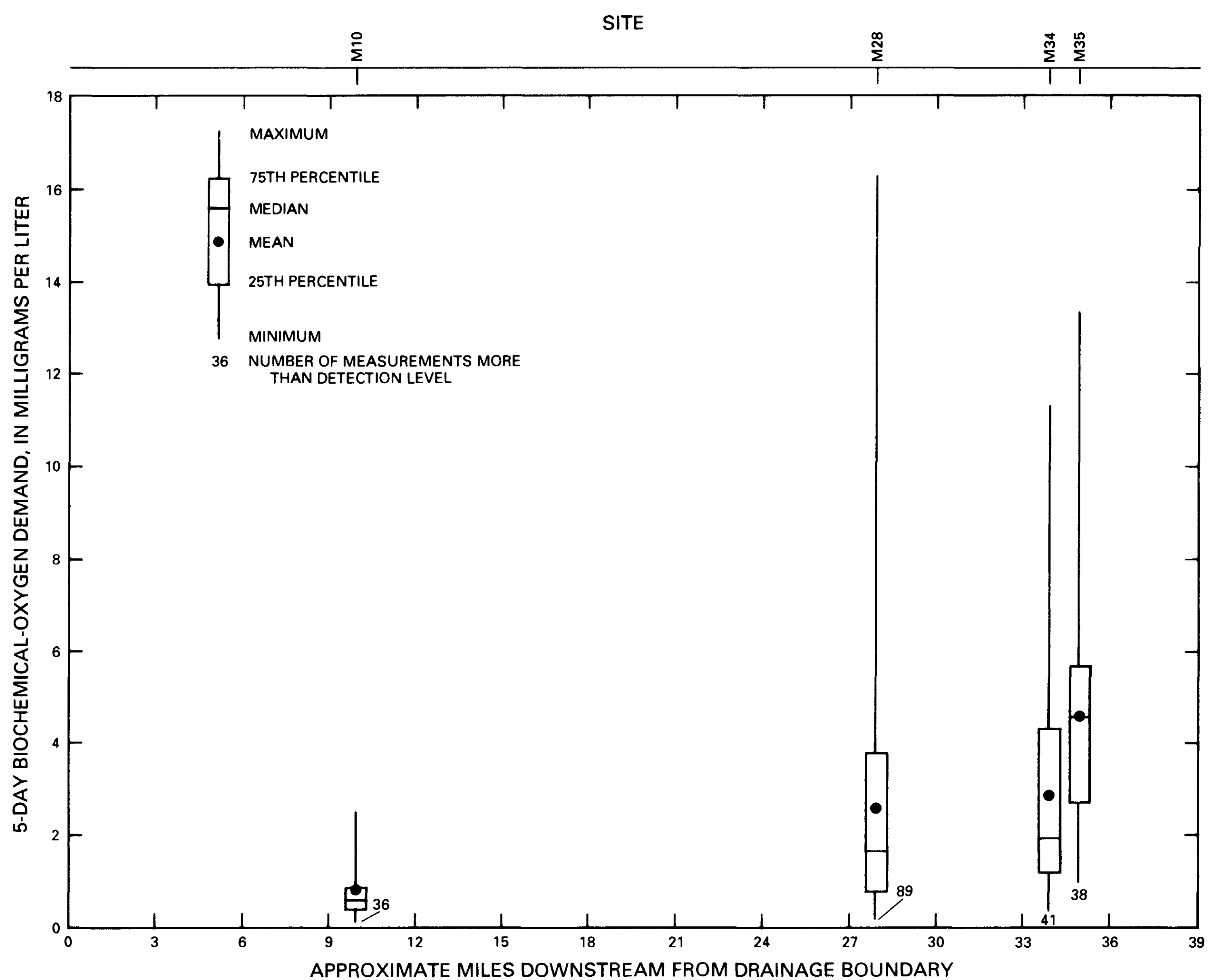


Figure 22.--Statistical summary of monthly variations in specific conductance for sites M10 and M28, available data, 1975-83.



Note: Period of record for individual sites is variable. See tables 5 and 6.

Figure 23.--Statistical summary of downstream variations in pH for Monument Creek, available data, 1975-83.



Note: Period of record for individual sites is variable. See tables 5 and 6.

Figure 24.--Statistical summary of downstream variations in 5-day biochemical oxygen demand for Monument Creek, available data, 1975-83.

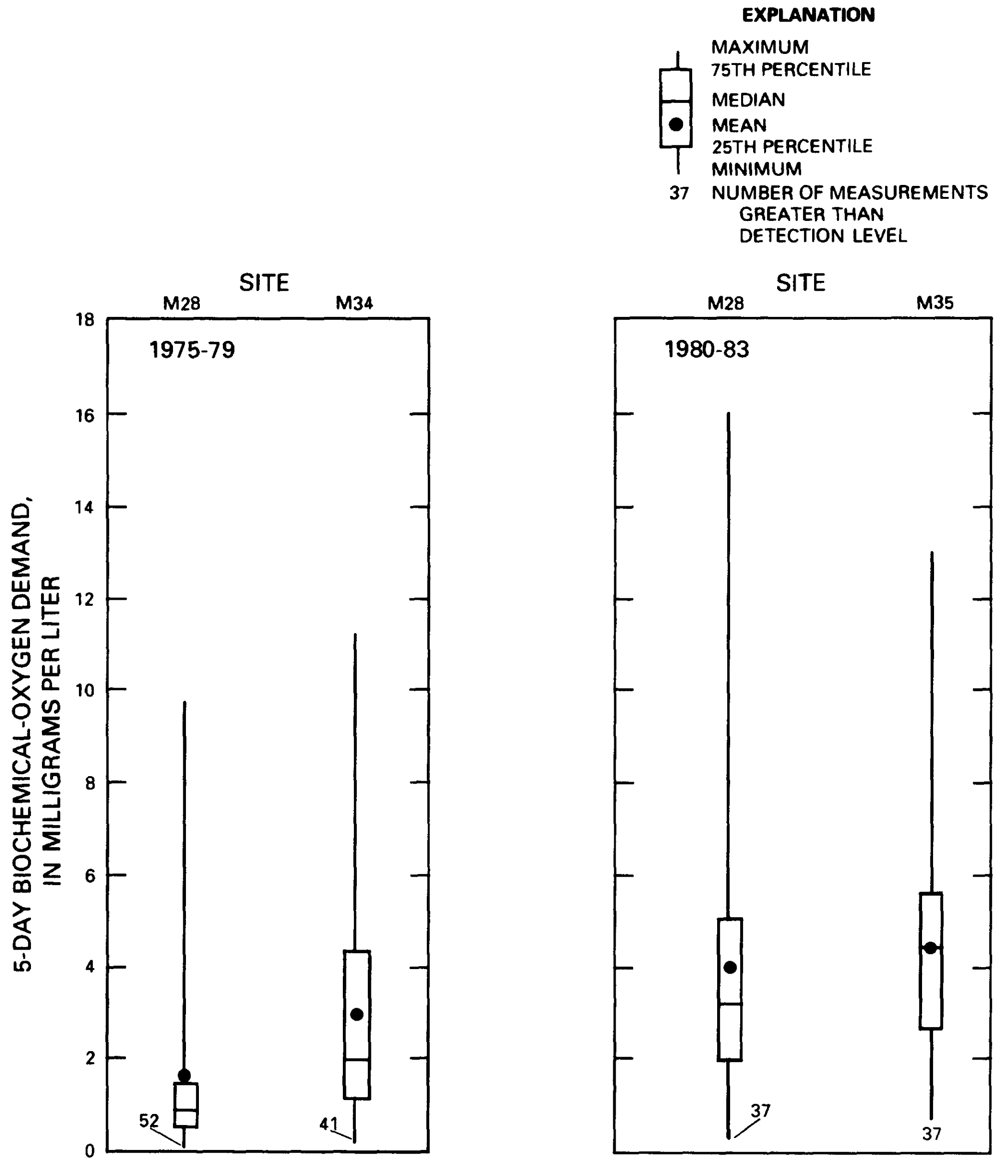
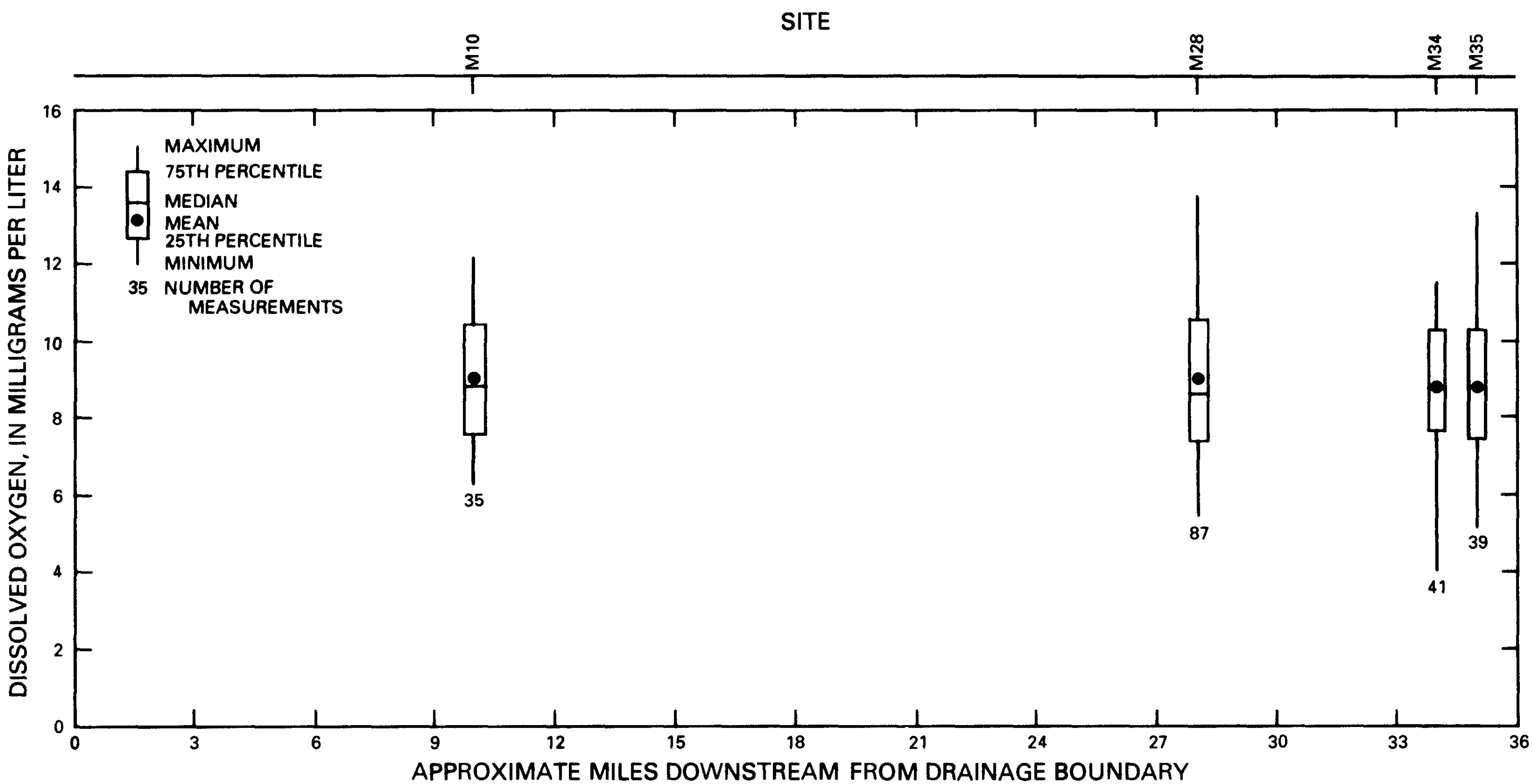


Figure 25.--Statistical summary of 5-day biochemical oxygen demand for sites M28 and M34, 1975-79, and for sites M28 and M35, 1980-83.

Monthly variations in dissolved-oxygen concentrations measured at site M28 are summarized in figure 27. The smallest median dissolved-oxygen concentrations occur during July and August when water temperatures are warmest, which results in lessened oxygen solubility; largest dissolved-oxygen concentrations occur during December, January, and February when water temperatures are coldest, which results in greater oxygen solubility.



Note: Period of record for individual sites is variable. See tables 5 and 6.

Figure 26.--Statistical summary of downstream variations in concentrations of dissolved oxygen for Monument Creek, available data, 1975-83.

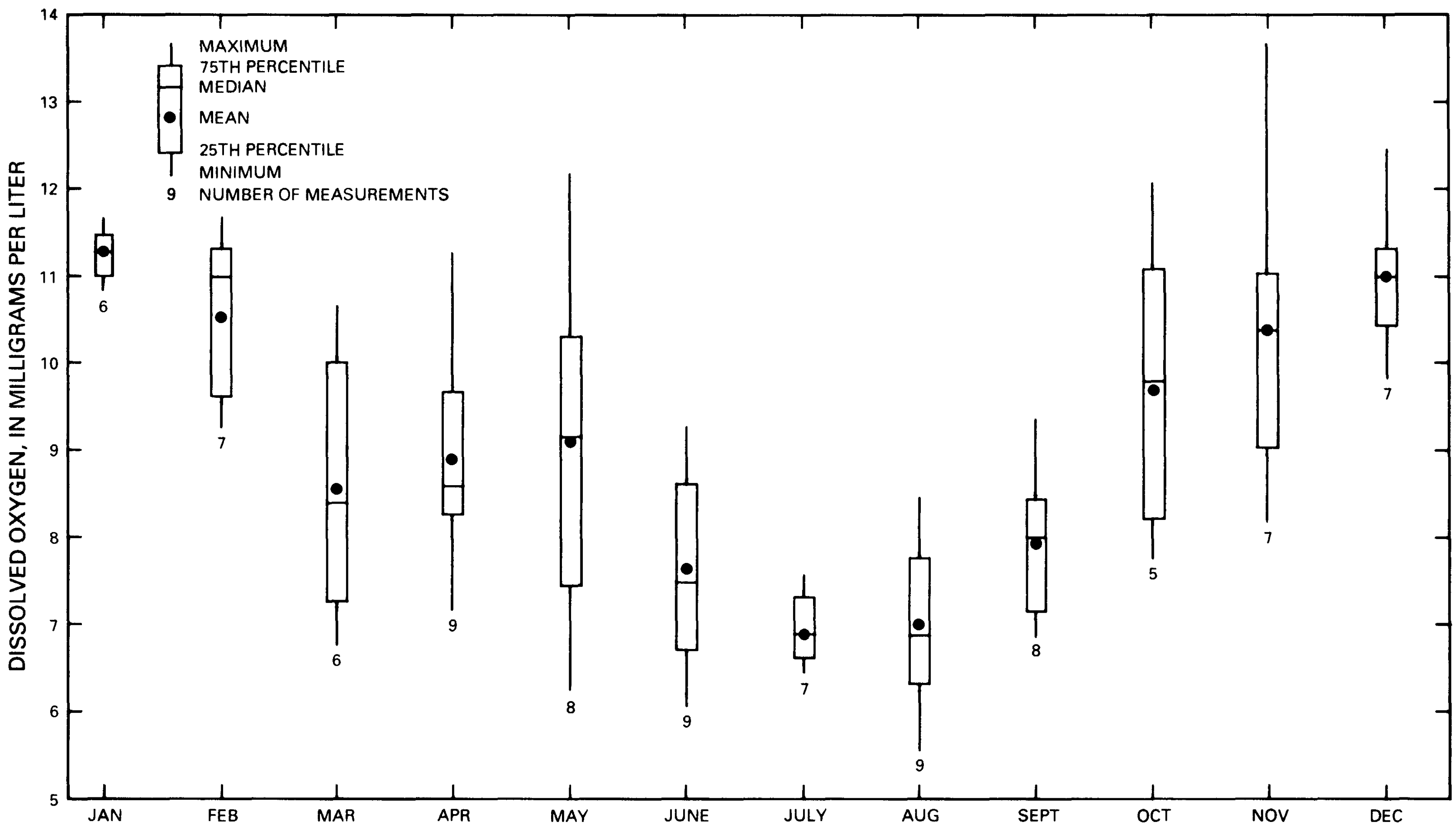


Figure 27.--Statistical summary of monthly variations in concentrations of dissolved oxygen for site M28, 1975-83.

Suspended Solids

Measurements of suspended solids on Monument Creek have indicated the occurrence of large variations in concentrations and downstream and temporal increases in concentrations (fig. 28). Suspended-solids concentrations measured from 1977 to 1981 at site M10 have been small because of the cobbled-bed stream channel and the presence of nonerosive igneous and metamorphic formations in the upper part of Monument Creek basin. The increase in suspended-solids concentration that occurs downstream from site M10 probably results from discharge from wastewater-treatment plants and tributary inflow from basins that drain sedimentary formations and erosive soils. During 1975 through 1979, the median suspended-solids concentration increased in a 6-mi reach from 38 mg/L at site M28 to 223 mg/L at site M34 (fig. 28*B*). Suspended-solids concentrations of Lower Monument Creek increased during 1980 through 1983. The median suspended-solids concentration at site M28 increased from 38 mg/L during 1975 through 1979 (fig. 28*B*) to 132 mg/L during 1980 through 1983 (fig. 28*C*). The median suspended-solids concentration at site M34 was 223 mg/L during 1975 through 1979 (fig. 28*B*); the median suspended-solids concentration at site M35 (site M34 was discontinued in 1980) was 336 mg/L during 1980 through 1983 (fig. 28*C*). These increases probably have occurred because of encroachment of urbanization on previously undeveloped lands and increases in streamflow that occurred during 1980 through 1983. Urbanization results in land disturbances and a more impervious land cover, which increases direct runoff and the suspended-solids concentrations.

WATER QUALITY OF THE STREAM-CLASSIFICATION SEGMENTS

Upper Fountain Creek

The quality of water of Upper Fountain Creek was monitored at two sites between 1975 and 1983. Water-quality data were collected monthly from 1975 through 1983 at site F12. Water quality at this site represents an integration of the quality of water upstream from Manitou Springs and is not necessarily representative of the quality of water at any particular point farther upstream. During 1981 and 1982, water-quality samples were collected monthly at site F15, which is located approximately 0.5 mi upstream from the confluence with Monument Creek. Water-quality samples were collected at both sites on the same day.

Water quality of Upper Fountain Creek was evaluated with respect to instream water-quality standards, for variations in water quality between the two sites, and for seasonal variations of selected constituents.

Fecal Coliform Bacteria and Major Inorganic Constituents

Fecal coliform concentrations were analyzed monthly at site F12 from 1975 through 1980 and are summarized statistically in table 3. Fecal coliform bacteria were not analyzed at site F15. Fecal coliform bacteria concentrations ranged from 4 to 46,000 colonies per 100 mL; the median fecal coliform bacteria concentration was 255 colonies per 100 mL.

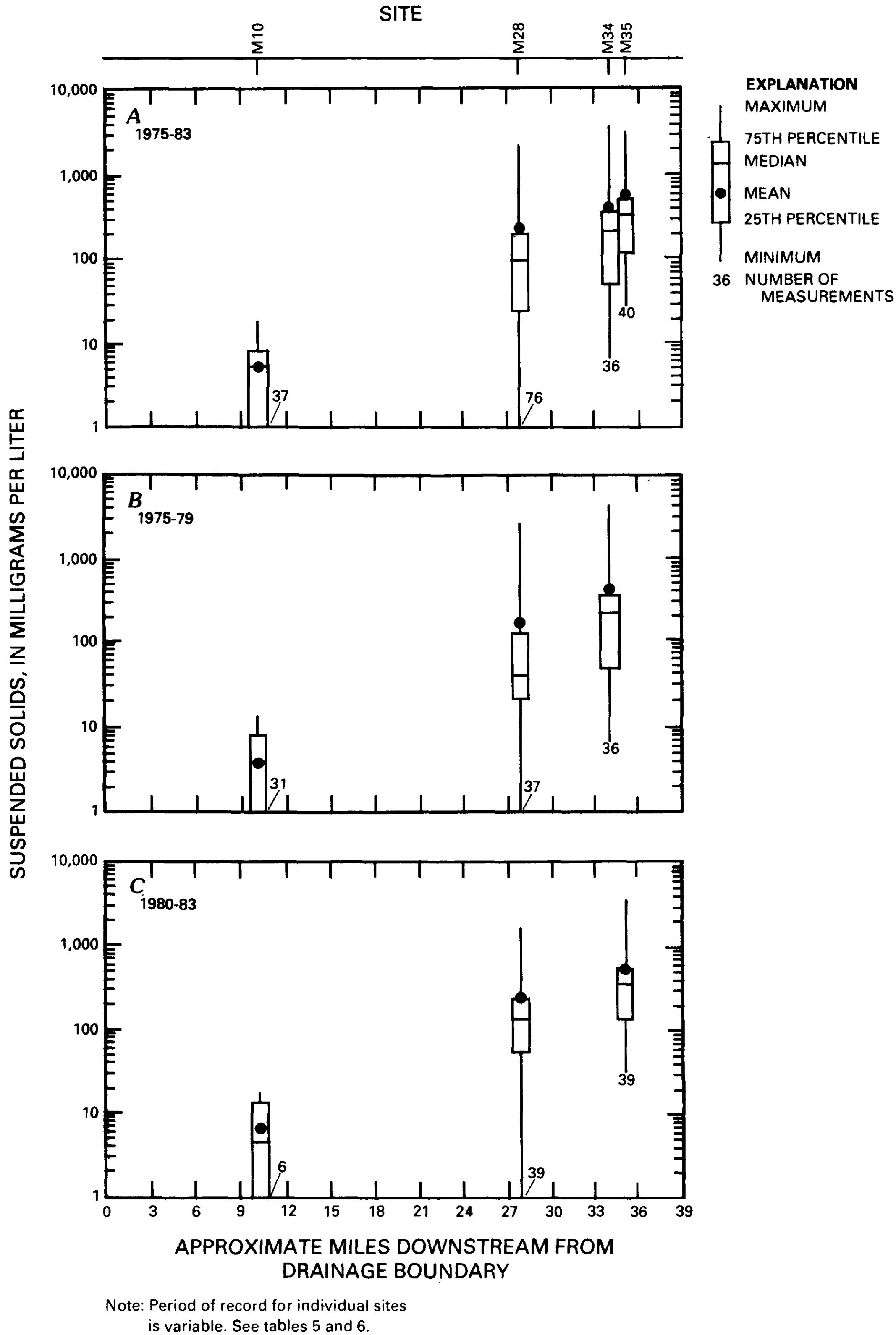


Figure 28.--Statistical summary of downstream variations in concentrations of suspended solids for Monument Creek, available data, (*A*) 1975-83, (*B*) 1975-79, and (*C*) 1980-83.

Major inorganic constituents monitored from 1975 through 1983 include dissolved chloride, dissolved sulfate, total ammonia as nitrogen, and total nitrite plus nitrate as nitrogen. Information for these constituents is summarized in table 3. Dissolved-chloride and dissolved-sulfate concentrations have been a factor of 10 less than the instream water-quality standard of 250 mg/L (each) at site F12. Dissolved-chloride concentrations ranged from 2.6 to 36 mg/L; the median concentration was 15 mg/L (fig. 29). Dissolved-sulfate concentrations ranged from 8.9 to 26 mg/L; the median concentration

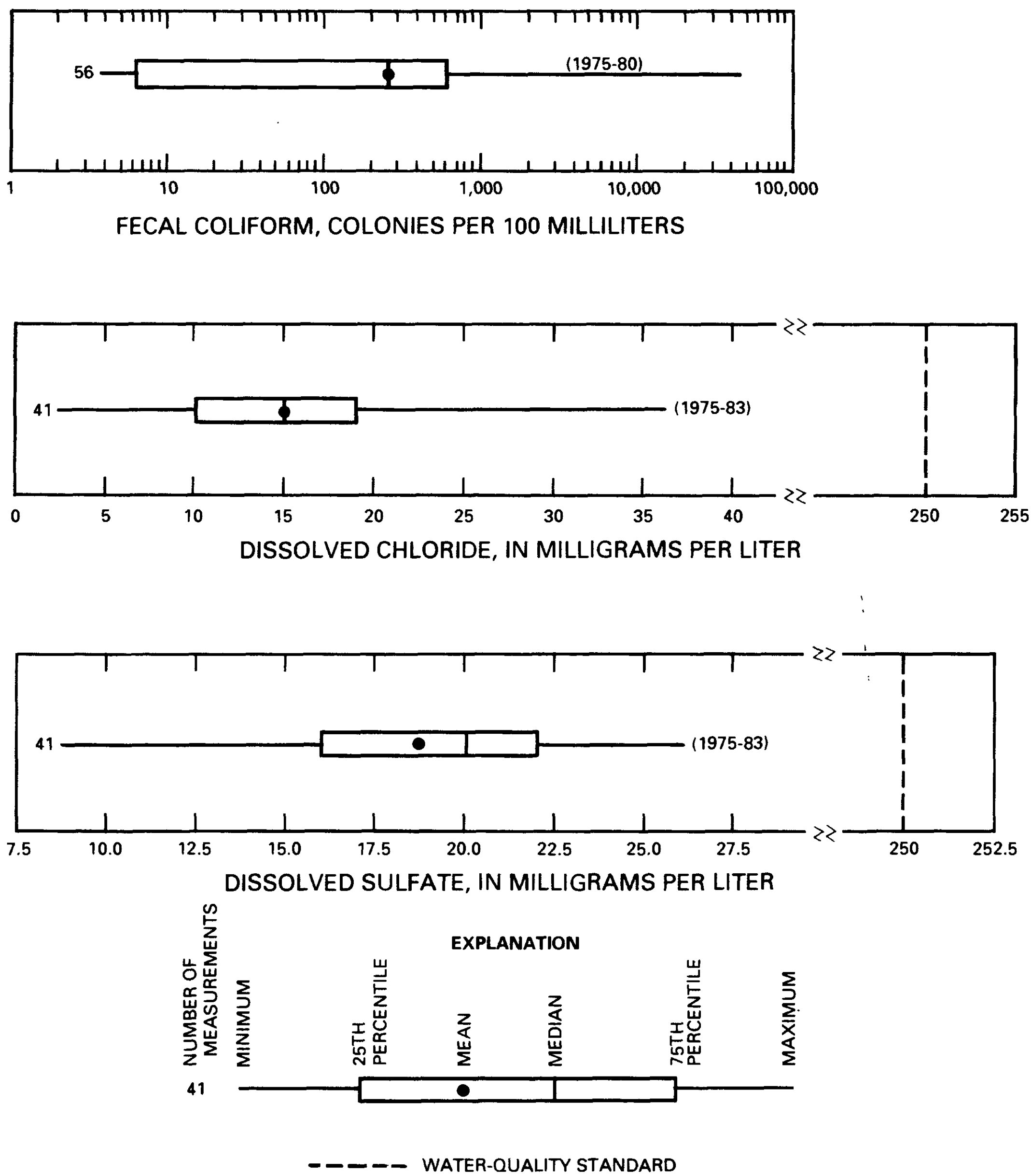


Figure 29.--Statistical summary of concentrations of fecal coliform bacteria, dissolved chloride, and dissolved sulfate for site F12, available data, 1975-83.

was 20 mg/L (fig. 29). The small concentrations of dissolved chloride and dissolved sulfate in water samples collected at site F12 occur because the streamflow consists mostly of water that drains from a part of the Rampart Range, which largely is unaffected by man and which is composed mostly of igneous and metamorphic rocks. Because specific conductance increases downstream from site F12 (fig. 12), the dissolved-chloride and dissolved-sulfate concentrations probably are larger downstream from site F12. However, water samples collected at site F15 during 1981 and 1982 were not analyzed for dissolved chloride and dissolved sulfate, and a trend could not be ascertained.

Concentrations of total nitrite plus nitrate as nitrogen at sites F12 and F15 are summarized in figure 30. Temporal variations in total nitrite plus nitrate as nitrogen indicate that small concentrations have occurred at sites F12 and F15 (fig. 30*A*). The median concentration of total nitrite plus nitrate as nitrogen at site F12 was 0.8 mg/L (table 3) or more than 10 times less than the water-quality standard of 10 mg/L. A comparison of the concentrations of total nitrite plus nitrate as nitrogen at sites F12 and F15 for 1981 (fig. 30*B*) indicates that median concentrations increased downstream by a factor of 2 within a 3-mi reach; the increase was significant at the 99-percent confidence level using a nonparametric signed-rank test (SAS Institute, Inc., 1982). A comparison of concentrations of total ammonia as nitrogen also indicates that an increase occurred downstream (table 3). Although there is only 1 year of data at both sites, the data indicate that a downstream increase in nitrogen concentrations is occurring. Because there are no known point sources of nitrogen downstream from site F12, the measured increase probably is from activities associated with urbanization, such as lawn fertilization, which could contribute nitrogen to the stream in runoff. Median concentrations of total nitrite plus nitrate as nitrogen have been largest during the winter and generally have been smallest during the fall (fig. 31).

Trace Elements

Trace elements analyzed from water samples collected at sites F12 and F15 are summarized statistically in table 3. If an element had values less than the detection level, the statistic listed in table 3 was estimated using the method developed by Helsel and Gilliom (1985). Concentrations of selected trace elements also are summarized in figures 32 and 33 and include total-recoverable copper, total-recoverable iron, dissolved iron, total-recoverable lead, total-recoverable manganese, dissolved manganese, total-recoverable nickel, and total-recoverable zinc. These elements were selected for graphical presentation because concentrations either exceeded the instream water-quality standard or because concentrations increased downstream. Statistical summaries of concentrations of total-recoverable silver are not graphically presented because numerous concentrations were less than the detection limit. Concentrations of total-recoverable copper, total-recoverable iron, total-recoverable lead, dissolved manganese, total-recoverable silver, and total-recoverable zinc have exceeded the instream water-quality standards at both sites (figs. 32 and 33; table 3).

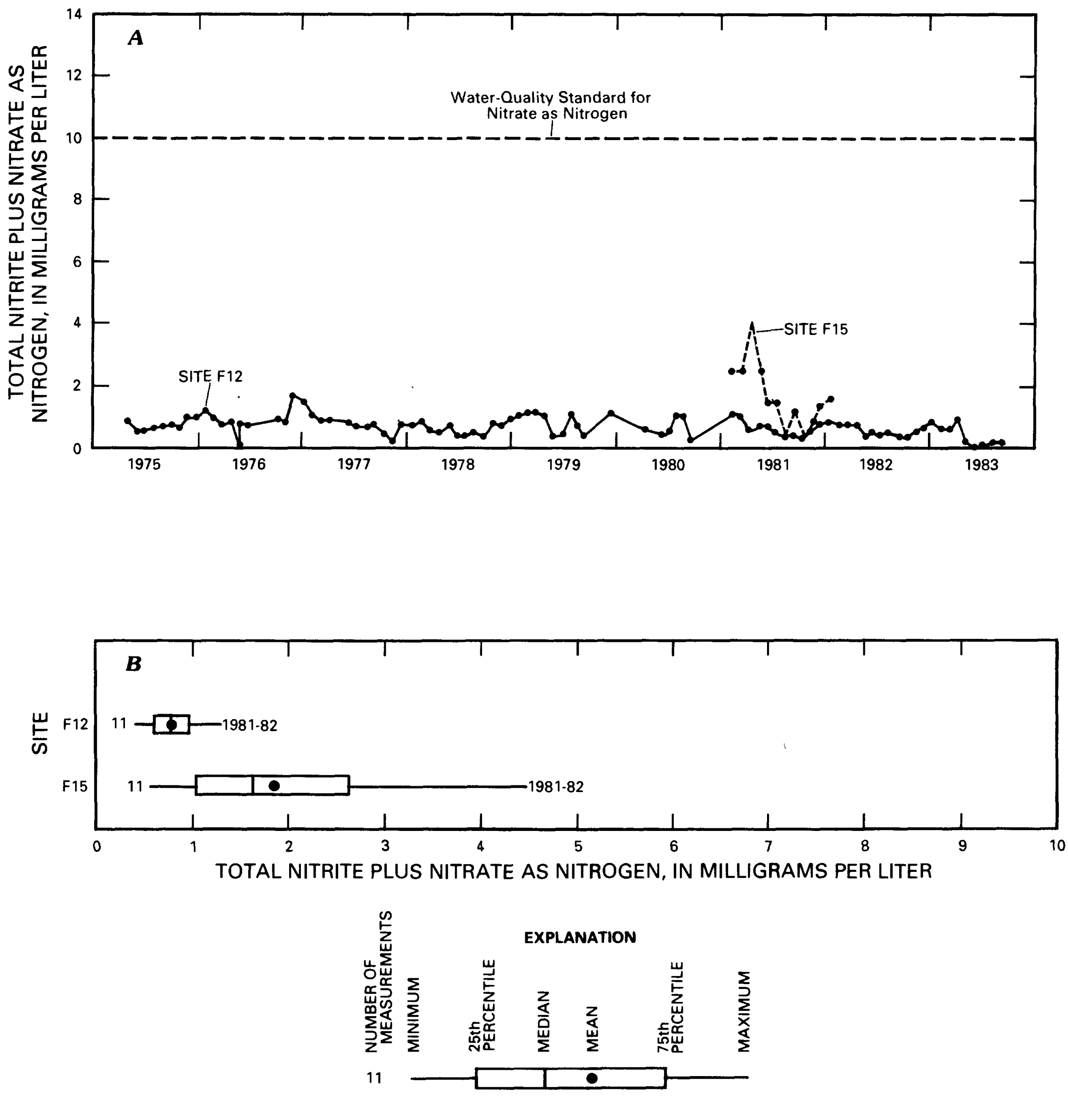


Figure 30.--(*A*) Temporal variations and (*B*) statistical summary of concentrations of total nitrite plus nitrate as nitrogen for sites F12 and F15.

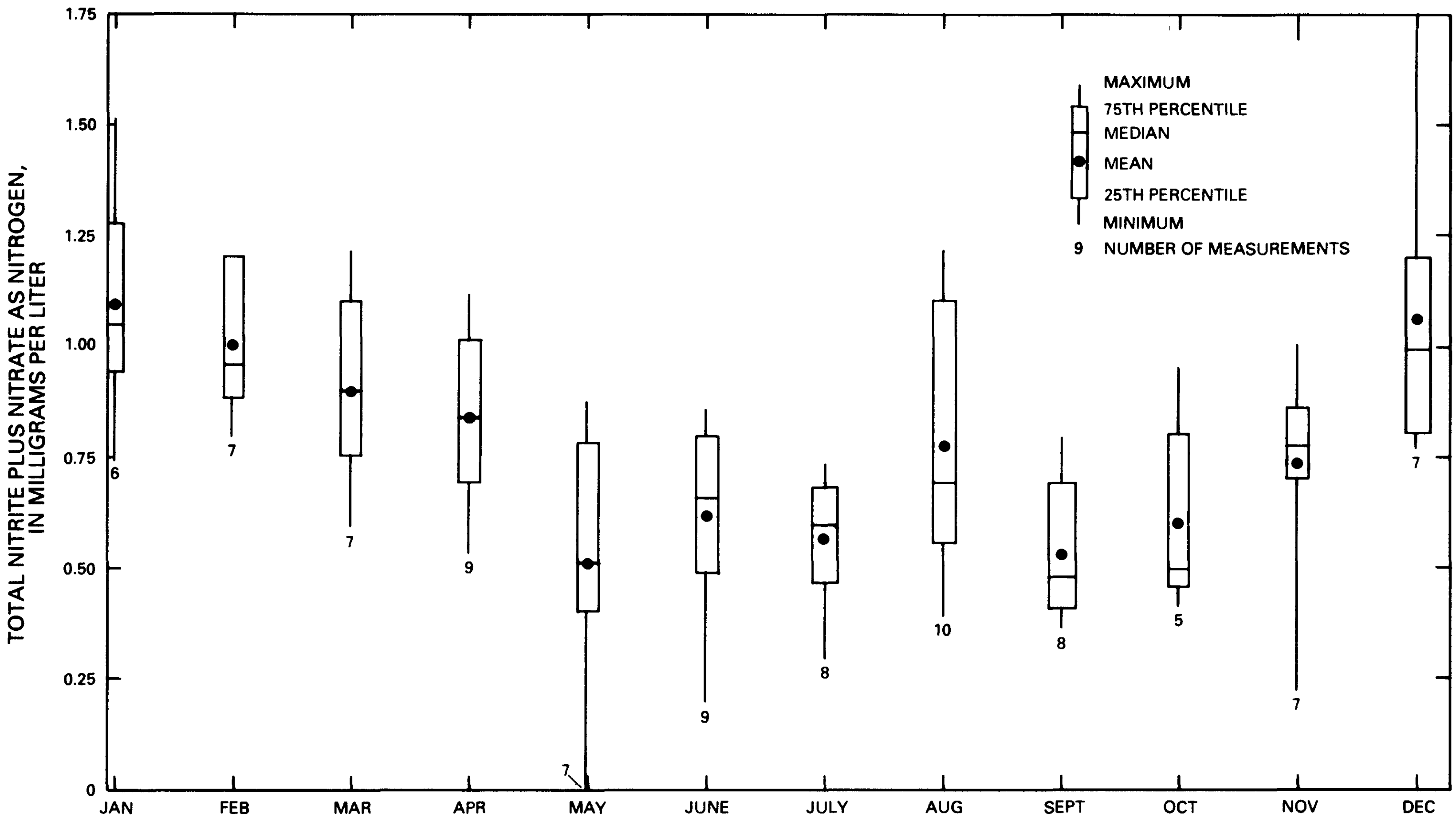


Figure 31.--Statistical summary of monthly variations in concentrations of total nitrite plus nitrate as nitrogen for site F12, 1975-83.

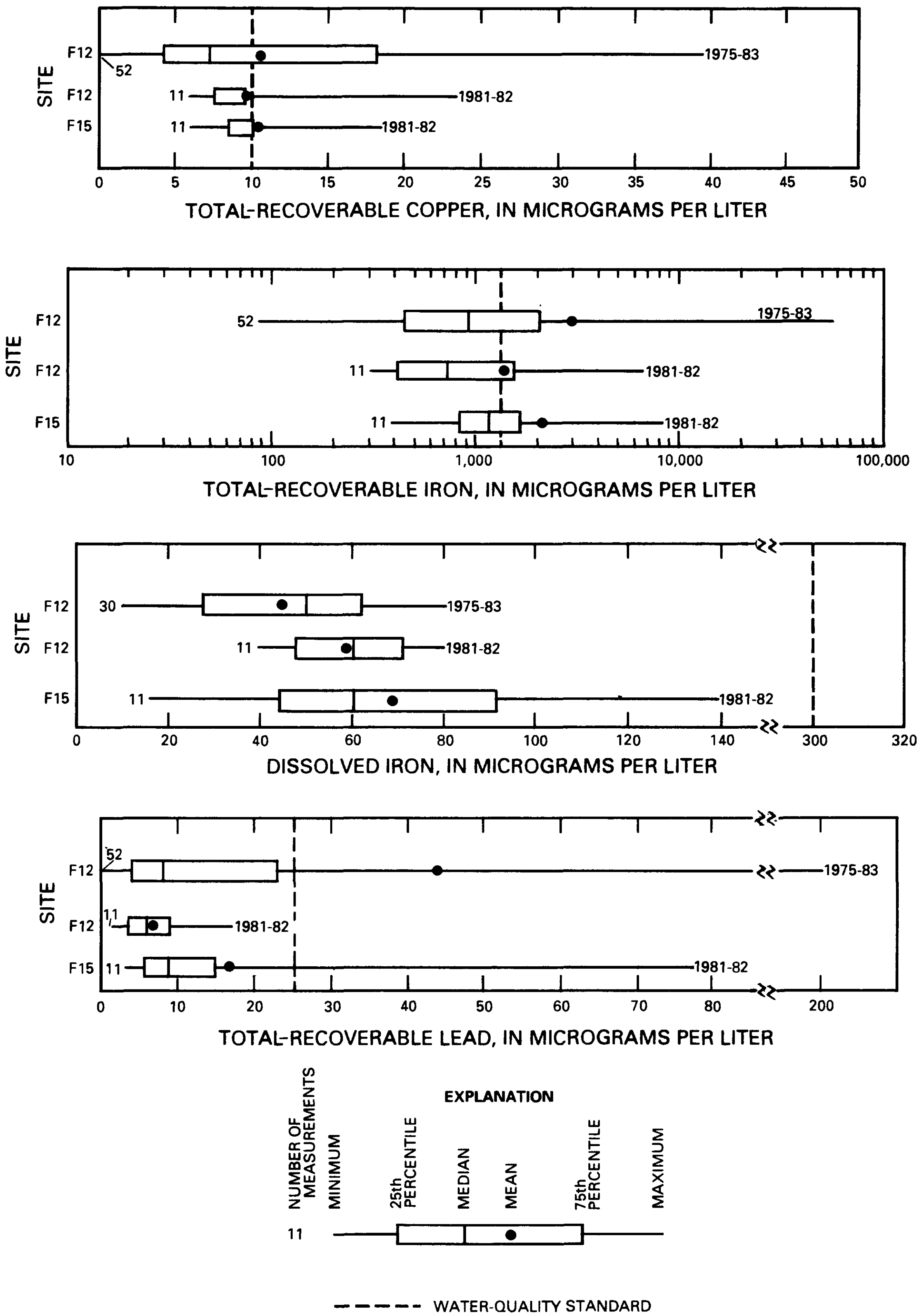


Figure 32.--Statistical summary of concentrations of total-recoverable copper, total-recoverable iron, dissolved iron, and total-recoverable lead for sites F12 and F15.

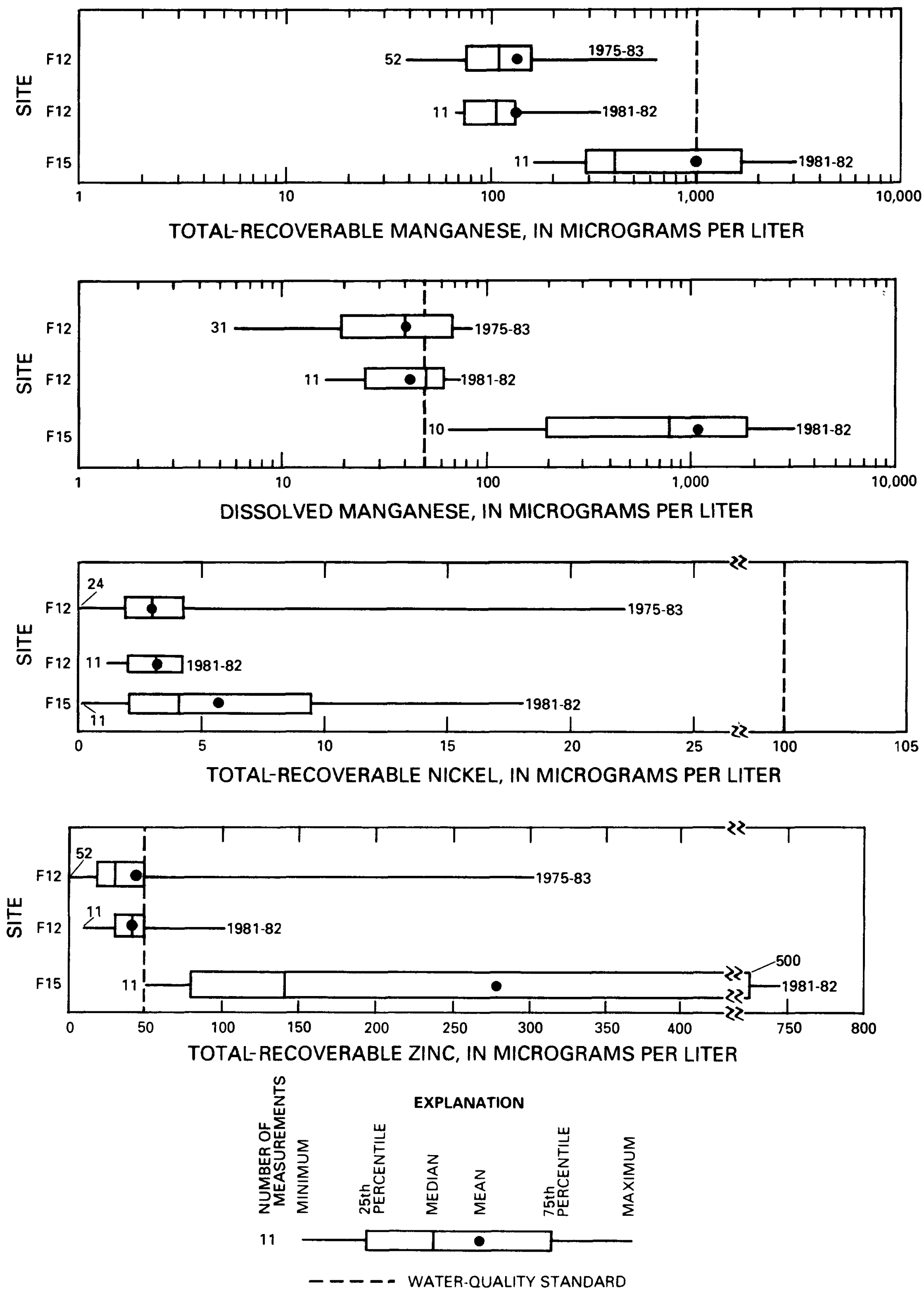


Figure 33.--Statistical summary of concentrations of total-recoverable manganese, dissolved manganese, total-recoverable nickel, and total-recoverable zinc for sites F12 and F15.

The principal source of the trace elements in Upper Fountain Creek probably was the sedimentary formations in the basin. The source for total-recoverable copper at sites F12 and F15 was the same, as evidenced by the similarity of total-recoverable copper concentrations analyzed during 1981 through 1982. However, as indicated by analyses of water samples collected at the two sites during 1981, there are additional sources of total-recoverable iron, total-recoverable lead, total-recoverable manganese, dissolved manganese, total-recoverable zinc (figs. 32 and 33), total-recoverable silver, and total selenium (table 3) downstream from Manitou Springs (site F12). The concentrations of these trace elements were considerably larger at site F15 than at site F12 located 3 mi upstream. Additional sources of the trace elements probably are nonpoint sources such as runoff from mine tailings that extend approximately 1 mi upstream from site F15 along the southern stream bank. Furthermore, a comparison of concentrations of total-recoverable manganese and dissolved manganese at site F15 (fig. 33) indicates that most of the manganese in the stream at this site is in solution.

Lower Fountain Creek

Between 1975 and 1983, water quality of Lower Fountain Creek was monitored at seven sites for varying periods of time (table 2). The seven sites are: (1) Site F17, at Colorado Springs; (2) site F19, downstream from the Colorado Springs Wastewater Treatment Plant outfall; (3) site F20, downstream from the Garden Valley Wastewater Treatment Plant outfall; (4) site F28, downstream from the Security and Widefield Wastewater Treatment Plant outfalls and Clover Ditch, which is the effluent ditch for the Fort Carson Wastewater Treatment Plant; (5) site F36, downstream from Fountain; (6) site F53, at Pinon; and (7) site F66, at Pueblo.

The data for the period of record for each water-quality constituent at each site were summarized (table 4) for the purposes of making downstream comparisons; data collected from 1980 to 1983 also were summarized in figures presented in the following sections. The water quality of Lower Fountain Creek was evaluated with respect to water-quality standards.

Fecal Coliform Bacteria and Major Inorganic Constituents

Concentrations of fecal coliform bacteria analyzed from water samples collected from Lower Fountain Creek indicate that large variations in concentrations occur at each site (fig. 34). A comparison of fecal coliform bacteria concentrations analyzed during 1980 indicated that the smallest median concentration occurred at site F19 (fig. 34*B*), which is located downstream from the Colorado Springs Wastewater Treatment Plant outfall, and that the largest median concentration occurred at site F28 (fig. 34*B*), which is located at the southern end of a 10-mi reach of stream that receives effluent from four small municipal wastewater-treatment plants.

Concentrations of the major inorganic constituents that were monitored between 1975 and 1983 probably have been affected by municipal wastewater. Concentrations of total ammonia as nitrogen and total nitrite plus nitrate as nitrogen are the best indicators of the effect of municipal wastewater on

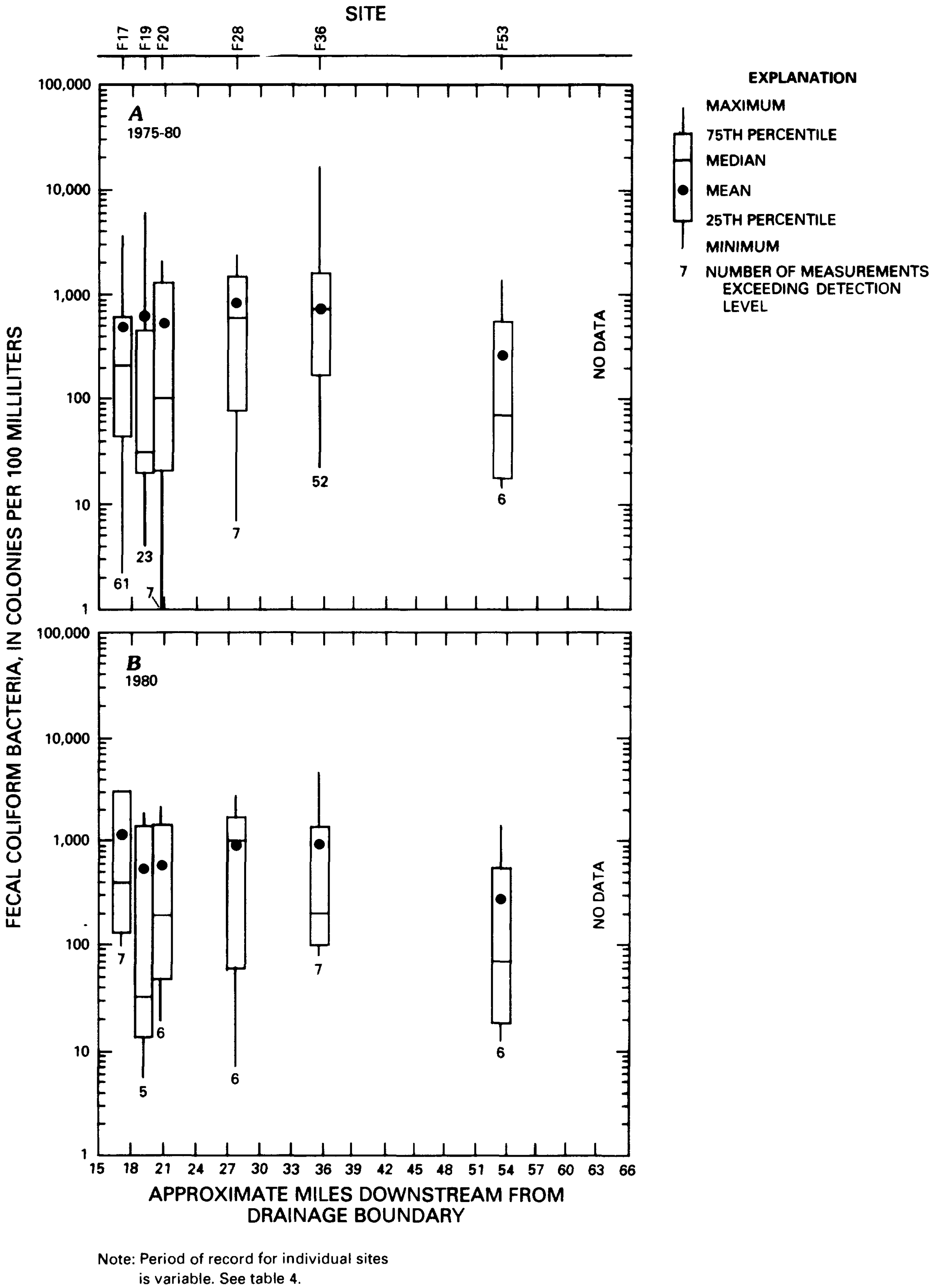


Figure 34.--Statistical summary of downstream variations in concentrations of fecal coliform bacteria for Lower Fountain Creek (*A*) 1975-80, and (*B*) 1980.

water quality. Concentrations of total ammonia as nitrogen, which is discharged by wastewater-treatment plants, are largest between Colorado Springs and Fountain (F19, F20, and F28) (fig. 35*A*). Farther downstream, biological processes convert ammonia to nitrite and nitrate, which decreases the concentrations of total ammonia as nitrogen and increases the concentrations of total nitrite plus nitrate as nitrogen (figs. 35*A* and 35*B*). Although large increases in the concentrations of total nitrite plus nitrate as nitrogen have occurred in Lower Fountain Creek, only one analysis (at site F66) exceeded the instream standard (fig. 35*B*; table 4).

Concentrations of dissolved chloride and, to a lesser extent, dissolved sulfate have increased, probably as a result of municipal wastewater effluent (fig. 36), but most of the increase results from irrigation-return flows that occur in the southern part of Lower Fountain Creek. The maximum dissolved-chloride concentration was 87 mg/L at site F36 (fig. 36*A*), which is approximately one-third the instream water-quality standard. The only dissolved-sulfate concentration measured that exceeded the instream standard of 600 mg/L occurred at site F66 (fig. 36*B*) where two of the six analyses exceeded the standard. The largest concentration was 710 mg/L.

Trace Elements

A statistical summary of the concentrations of trace elements for Lower Fountain Creek is presented in table 4. The limited data for concentrations of dissolved trace elements indicate that the trace elements primarily occur as suspended material. Concentrations of total-recoverable cadmium, dissolved chromium, and dissolved-hexavalent chromium usually were less than the analytical detection limit. When the concentrations of these elements were detectable, they were less than the water-quality standards except for one analysis for total-recoverable cadmium at site F53. Concentrations of total-recoverable nickel, total-recoverable silver, and total-recoverable zinc never exceeded the water-quality standards. Concentrations of total-recoverable copper, dissolved iron, and total-recoverable lead occasionally exceeded the water-quality standards. Total-selenium concentrations frequently exceeded the water-quality standard at site F66 and occasionally at sites F36 and F53. Dissolved-manganese concentrations exceeded the water-quality standard at sites F17, F19, F28, and F36. Even though there are no designated water-quality standards for total-recoverable iron and total-recoverable manganese for Lower Fountain Creek, large concentrations of these trace elements occurred at most of the sites.

A comparison of the concentrations of total-recoverable copper, total-recoverable lead, and total-recoverable zinc, using data collected from 1980 through 1983, indicates that large variations do not occur downstream (fig. 37). However, concentrations of other trace elements, such as total-recoverable manganese and total selenium (fig. 38), increased downstream. The median concentration of total-recoverable manganese increased from 180 μg/L at site F19 to 390 μg/L at site F28 (fig. 38*A*). An increase in concentrations of total selenium occurred between site F53 and F66 (fig. 38*B*). The median selenium concentration increased from 4 μg/L at site F53 to 18 μg/L at site F66, which indicates that either seleniferous soils or seleniferous beds in the Cretaceous Pierre Shale are present in the southern part of Lower

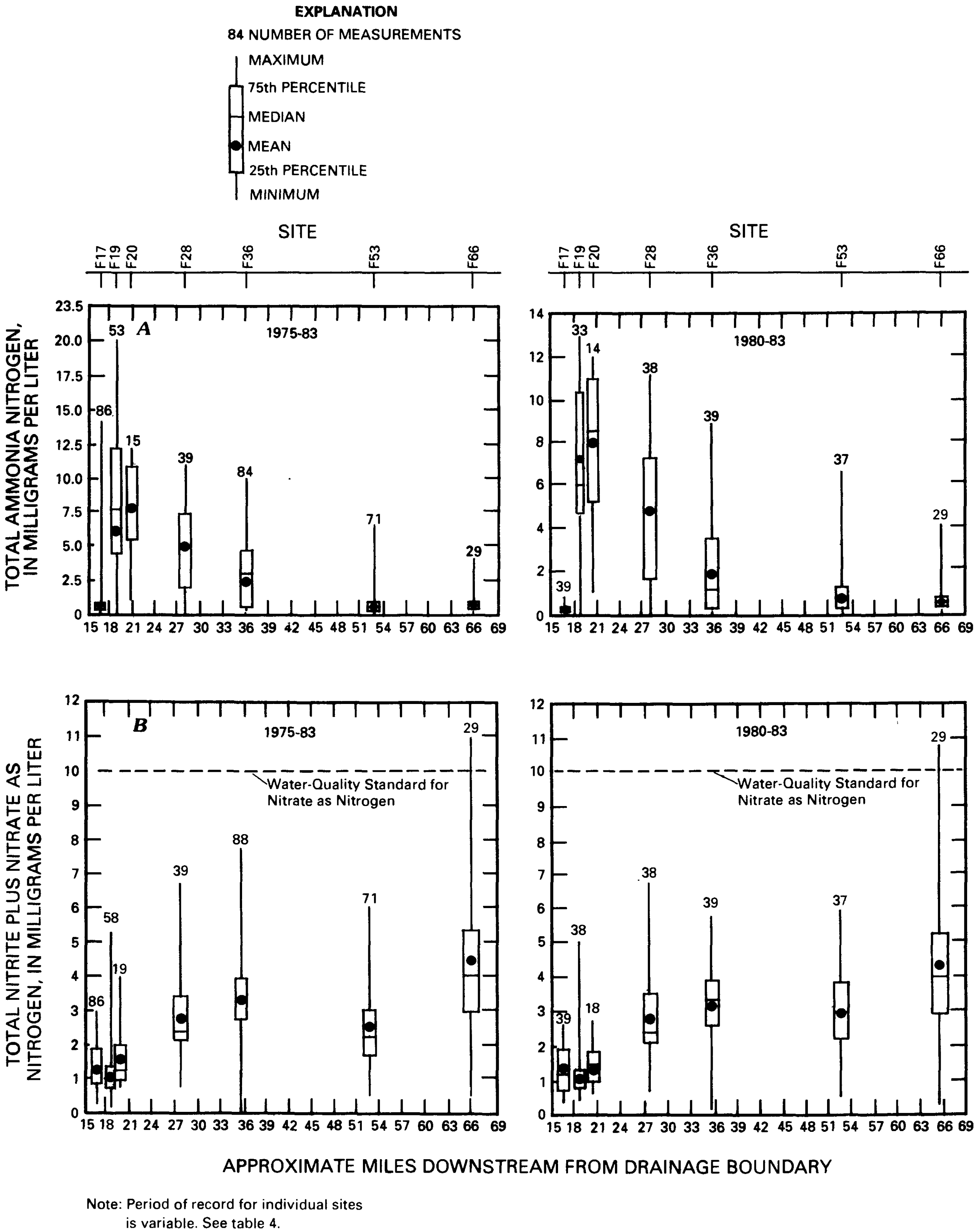


Figure 35.--Statistical summary of downstream variations in concentrations of (*A*) total ammonia as nitrogen, and (*B*) total nitrite plus nitrate as nitrogen for Lower Fountain Creek.

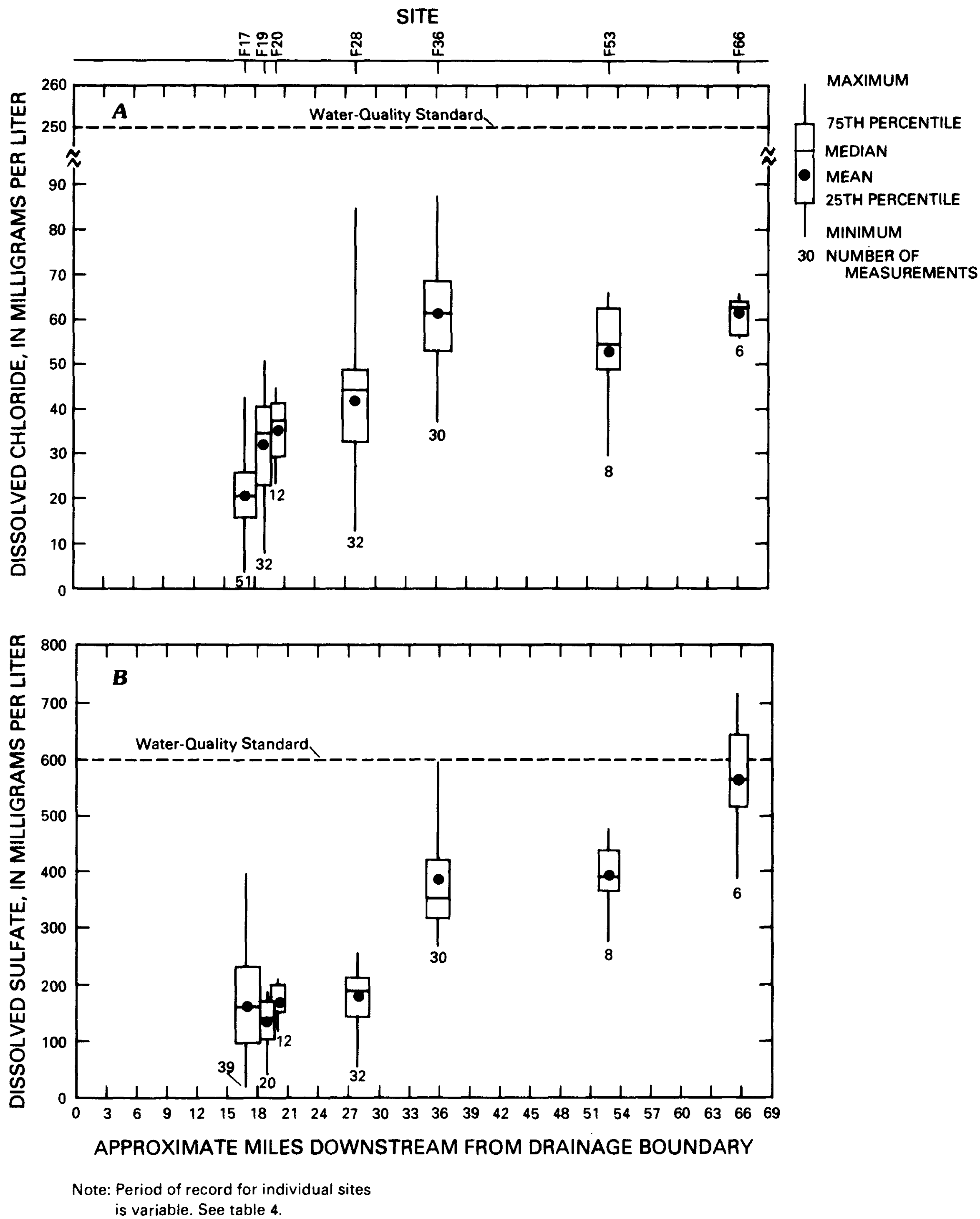


Figure 36.--Statistical summary of downstream variations in concentrations of (*A*) dissolved chloride, and (*B*) dissolved sulfate for Lower Fountain Creek, available data, 1975-83.

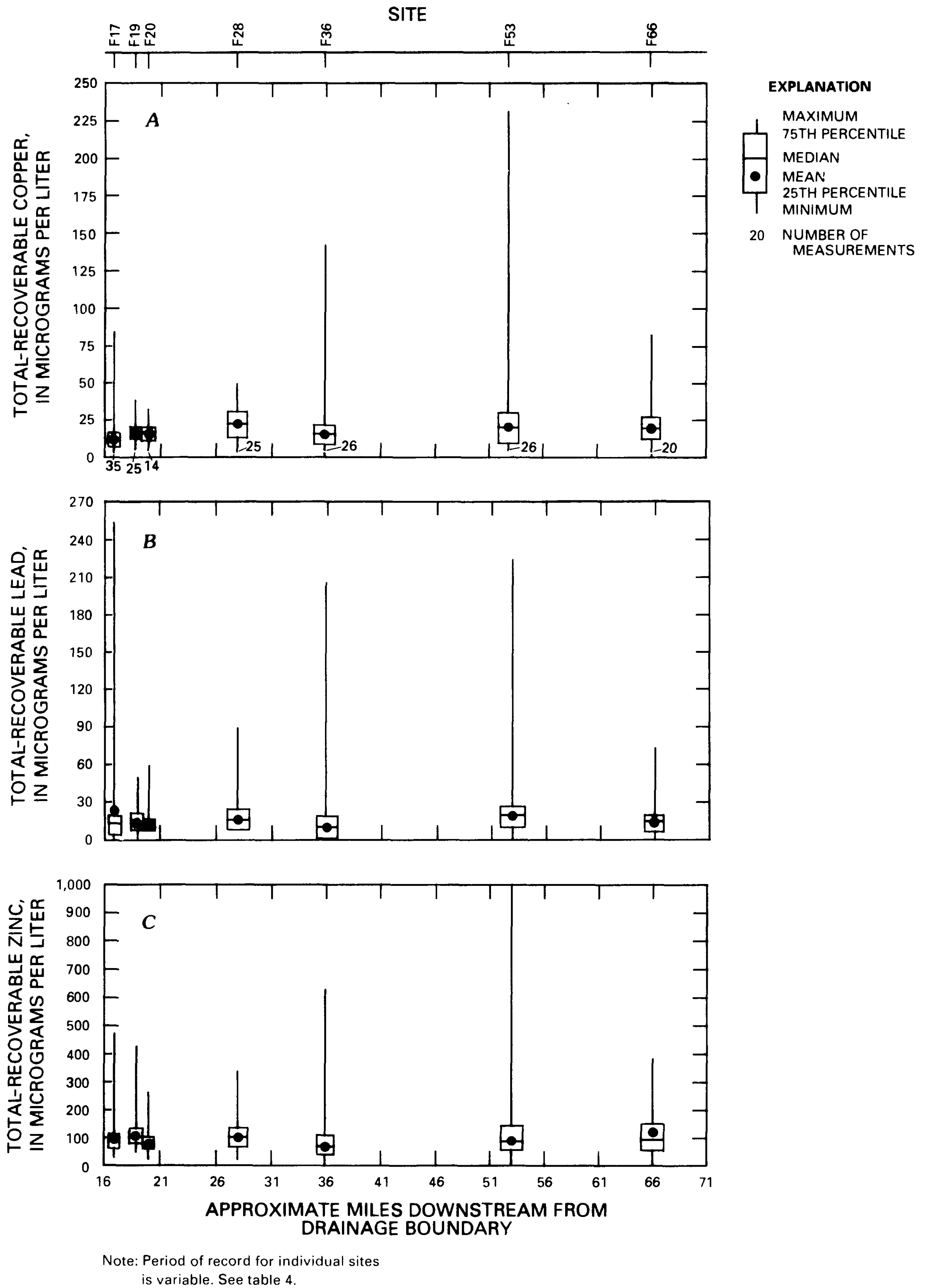


Figure 37.--Statistical summary of downstream variations in concentrations of total-recoverable (*A*) copper, (*B*) lead, and (*C*) zinc for Lower Fountain Creek, 1980-83.

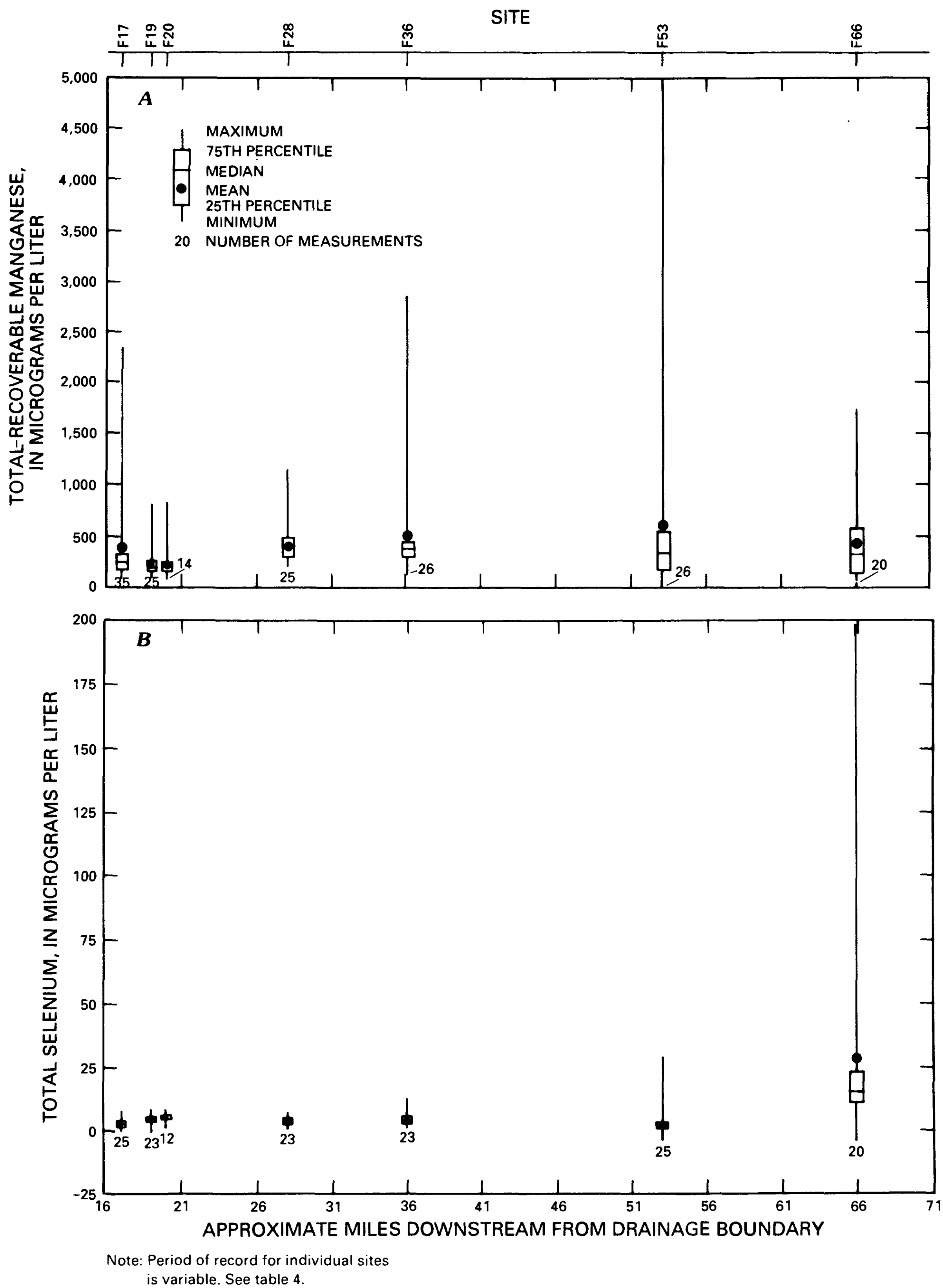


Figure 38.--Statistical summary of downstream variations in concentrations of (*A*) total-recoverable manganese, and (*B*) total selenium for Lower Fountain Creek, 1980-83.

Fountain Creek. The median concentrations of dissolved manganese, total-recoverable nickel, and total-recoverable silver increased just downstream from the outfall of the Colorado Springs Wastewater Treatment Plant as indicated by data collected at sites F19 and F20 (fig. 39). Concentrations of dissolved manganese increased from site F17 to downstream from site F36 and then decreased throughout the remaining stream reach. Concentrations of total-recoverable nickel continued to increase downstream to site F28, which is located downstream from other wastewater-treatment plants.

Upper Monument Creek

The quality of water of Upper Monument Creek was monitored monthly from 1977 through 1980 at site M10, which is located at Palmer Lake and near the middle of Upper Monument Creek. Water quality at this site represents an integration of the quality of water upstream. Water quality of Upper Monument Creek was evaluated with respect to instream water-quality standards.

Fecal Coliform Bacteria and Major Inorganic Constituents

Fecal coliform bacteria were monitored at site M10 from 1977 through 1980. Concentrations of fecal coliform bacteria and major inorganic constituents are summarized statistically in table 5. Fecal coliform bacteria concentrations ranged from 3 to 1,800 colonies per 100 mL; the median concentration was 29 colonies per 100 mL (fig. 40; table 5), indicating that large variations in fecal coliform bacteria concentrations occurred from 1977 through 1980.

Major inorganic constituents monitored at site M10 include dissolved chloride, dissolved sulfate, total ammonia as nitrogen, and total nitrite plus nitrate as nitrogen. The concentrations of these constituents were small. Concentrations of dissolved chloride were less than 10 mg/L, and concentrations of dissolved sulfate were less than 20 mg/L (fig. 40). The largest measured dissolved-chloride concentration was 6.6 mg/L, which is about 38 times less than the instream water-quality standard of 250 mg/L; the largest measured dissolved-sulfate concentration was 18 mg/L or about 14 times less than the instream dissolved sulfate water-quality standard of 250 mg/L. Concentrations of total ammonia as nitrogen and total nitrite plus nitrate as nitrogen were less than the detection level about 97 and 69 percent of the time (table 5). The largest concentration of total ammonia as nitrogen was 0.23 mg/L. The largest concentration of total nitrite plus nitrate as nitrogen was 0.33 mg/L (fig. 40) or 30 times less than the instream standard of 10 mg/L. These data indicate that from 1977 through 1980 the water quality of Upper Monument Creek upstream from site M10 largely was unaffected by man-related activities.

Trace Elements

Concentrations of trace elements that were analyzed at site M10 are summarized in table 5. No more than 12 analyses were made of any trace element, but the limited data indicate that the concentrations of the trace elements

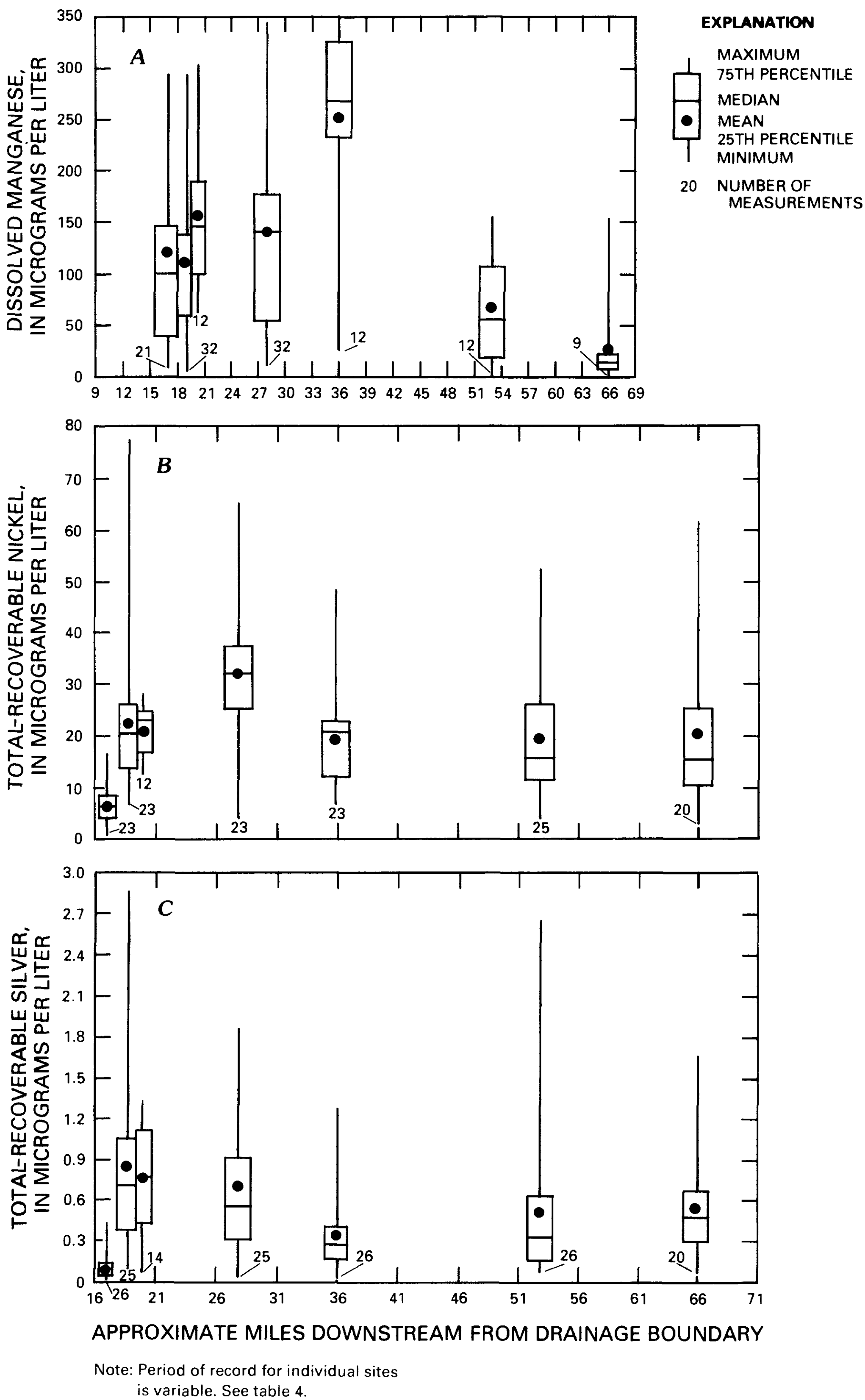


Figure 39.--Statistical summary of downstream variations in concentrations of (*A*) dissolved manganese, (*B*) total-recoverable nickel, and (*C*) total-recoverable silver for Lower Fountain Creek, 1980-83.

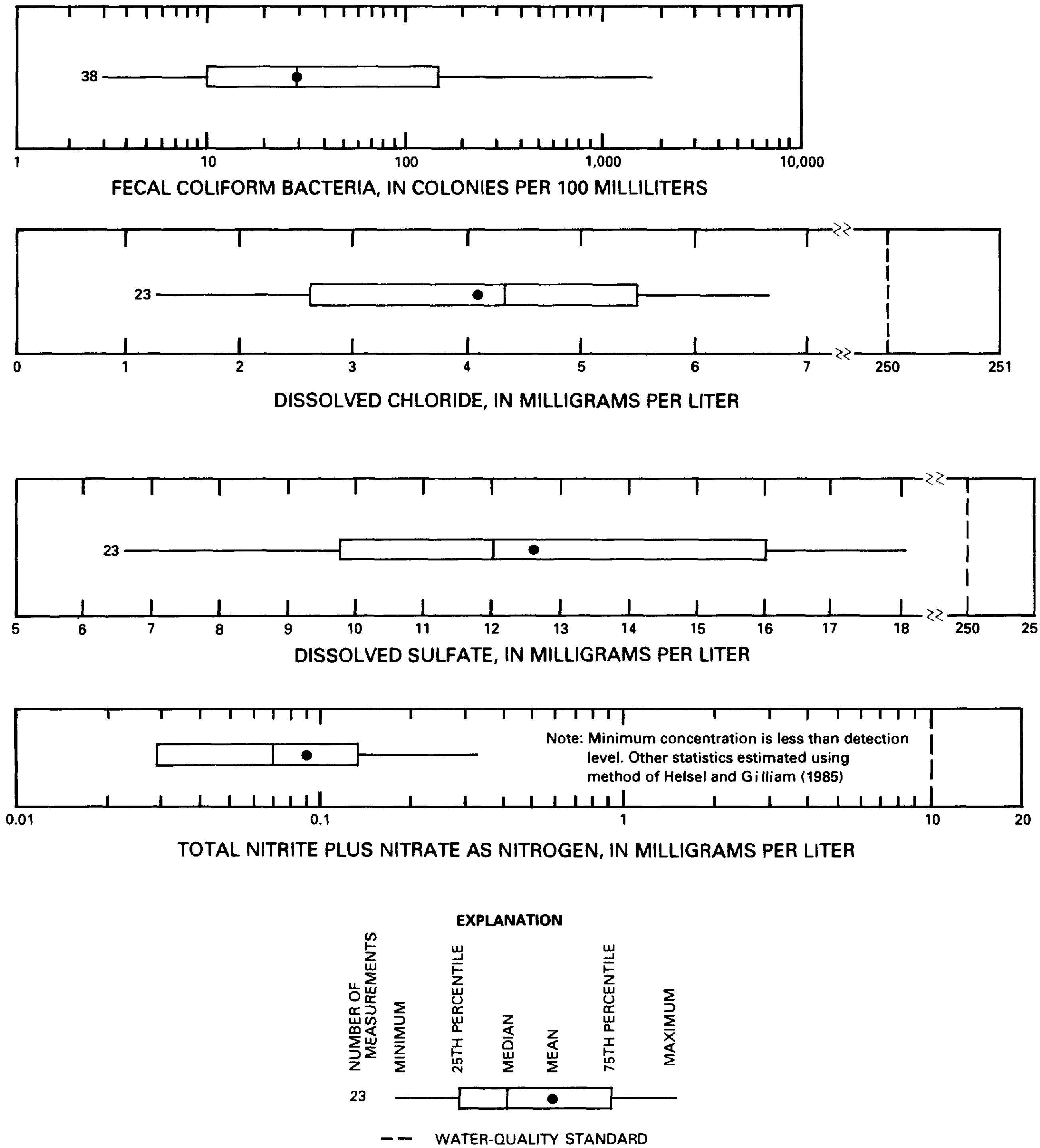


Figure 40.--Statistical summary of concentrations of fecal coliform bacteria, dissolved chloride, dissolved sulfate, and total nitrite plus nitrate as nitrogen for site M10, 1977-80.

were small. Several of the concentrations of the trace elements analyzed were frequently less than the detection level. Total-recoverable cadmium, dissolved-hexavalent chromium, and total-recoverable silver were never detected (table 5). Total-recoverable copper was less than detection level in 44 percent of the samples analyzed, and total-recoverable zinc was less than detection level in 67 percent of the samples. Concentrations of total-recoverable iron, total-recoverable lead, and total-recoverable manganese were detected in all the samples analyzed and are summarized in figure 41. One analysis for total-recoverable copper (table 5) and one analysis for total-recoverable lead (fig. 41; table 5) exceeded the instream water-quality standard.

Lower Monument Creek

The quality of water of Lower Monument Creek has been monitored at three sites, which have varying periods of water-quality data collection (table 2). Water-quality data were collected at site M28 located at Pikeview from 1975 through 1983. Water-quality data were collected at two sites located near the confluence with Fountain Creek; at site M34, water-quality data were collected from 1976 through 1979, and at site M35, water-quality data were collected from 1980 through 1983. The quality of water of Lower Monument Creek was evaluated for monthly variations at site M28. Downstream variations in water quality generally are described using data collected from 1980 through 1983 at site M28 and near the Fountain Creek confluence at site M35. A few downstream comparisons were made using data collected at sites M28 and M34 from 1976 through 1979. In addition, water-quality constituents are evaluated with respect to instream water-quality standards.

Fecal Coliform Bacteria and Major Inorganic Constituents

Fecal coliform bacteria concentrations that were analyzed at the sites on Lower Monument Creek are summarized statistically in figure 42 and in table 6. The data (fig. 42) indicate that large variations in fecal coliform bacteria concentrations occurred at each site, and that an increase in median fecal coliform bacteria concentrations occurred downstream from site M28. The median fecal coliform bacteria concentration increased from 16 colonies per 100 mL at site M28 to 140 colonies per 100 mL at site M34. Because there are no known point sources downstream from site M28, the increase probably is due to tributary inflow and nonpoint sources.

The only major inorganic constituent that exceeded the instream water-quality standard was dissolved sulfate and that occurred only twice at site M34. The remainder of the analyzed concentrations of dissolved chloride, dissolved sulfate, and total nitrite plus nitrate as nitrogen was small and considerably less than the water-quality standards (figs. 42 and 43). A comparison of concentrations of dissolved chloride, dissolved sulfate, and total nitrite plus nitrate as nitrogen between sites M28 and M34 indicates that increases occurred downstream from site M28 (fig. 42). From 1976 through 1979, the largest variations in concentrations of dissolved chloride and dissolved sulfate occurred upstream from the confluence of Fountain Creek at site M34 because of the greater variations in sources of flow that occur

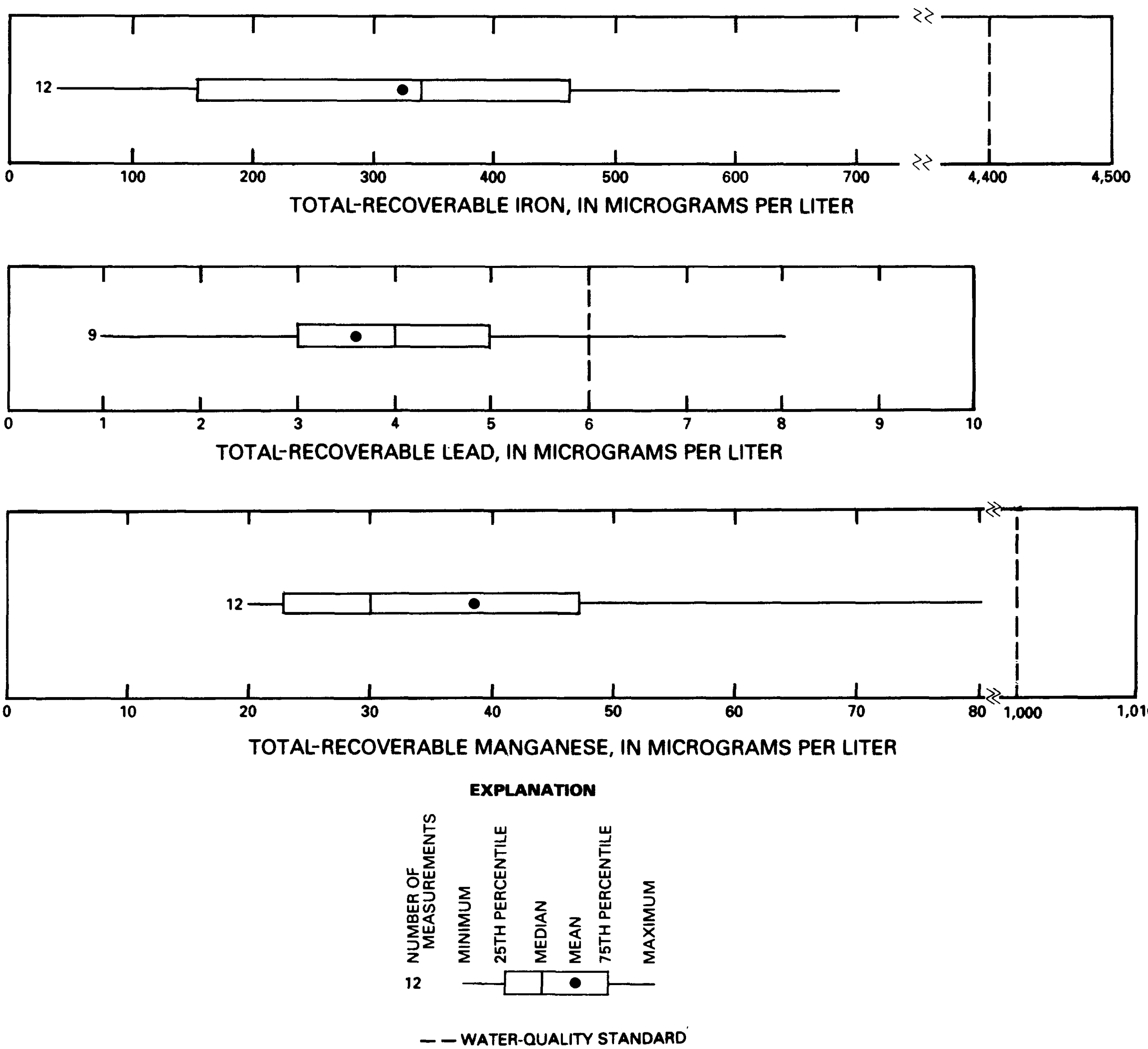


Figure 41.--Statistical summary of concentrations of total-recoverable iron, lead, and manganese for site M10, 1977-80.

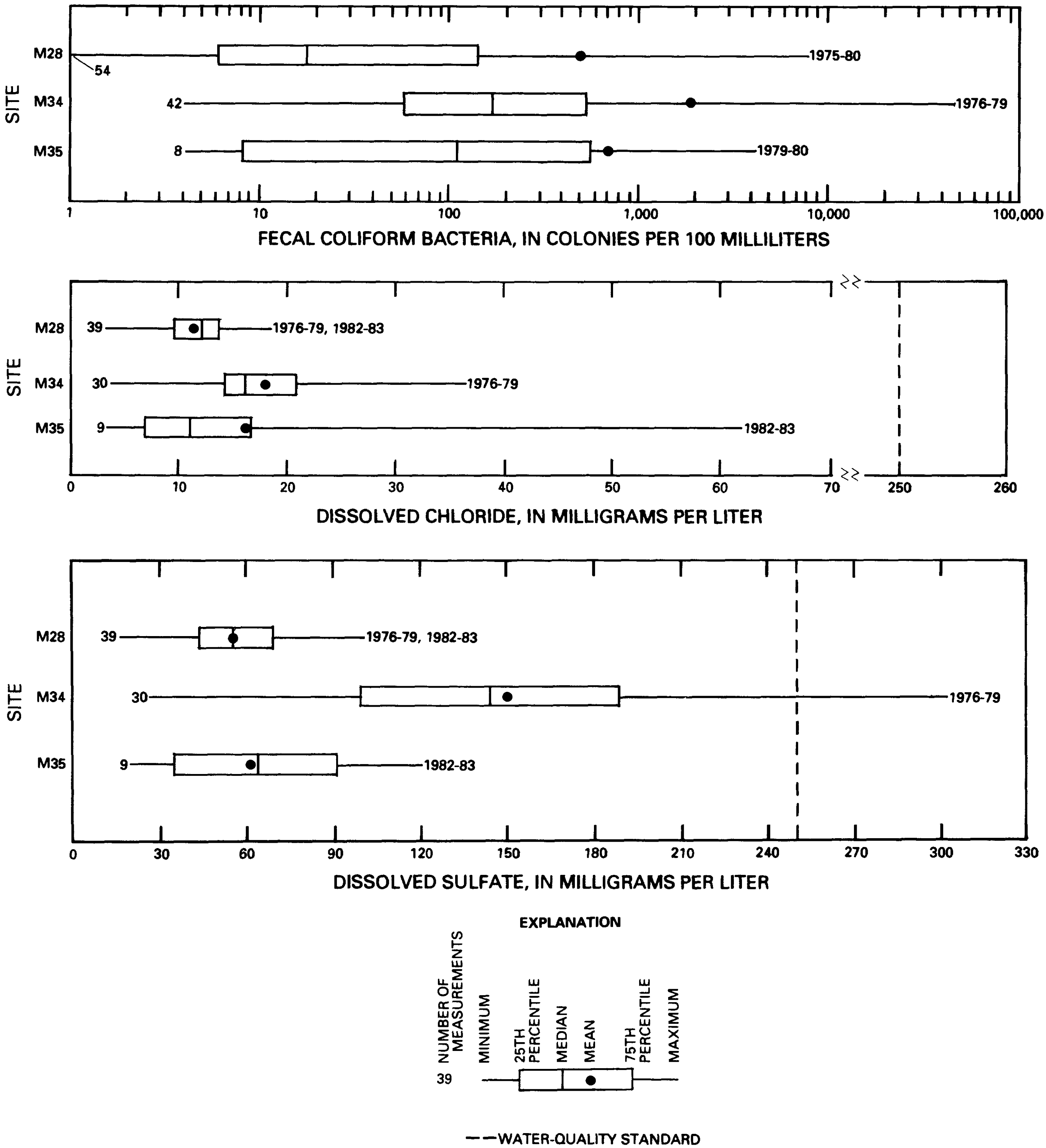


Figure 42.--Statistical summary of concentrations of fecal coliform bacteria, dissolved chloride, and dissolved sulfate for Lower Monument Creek.

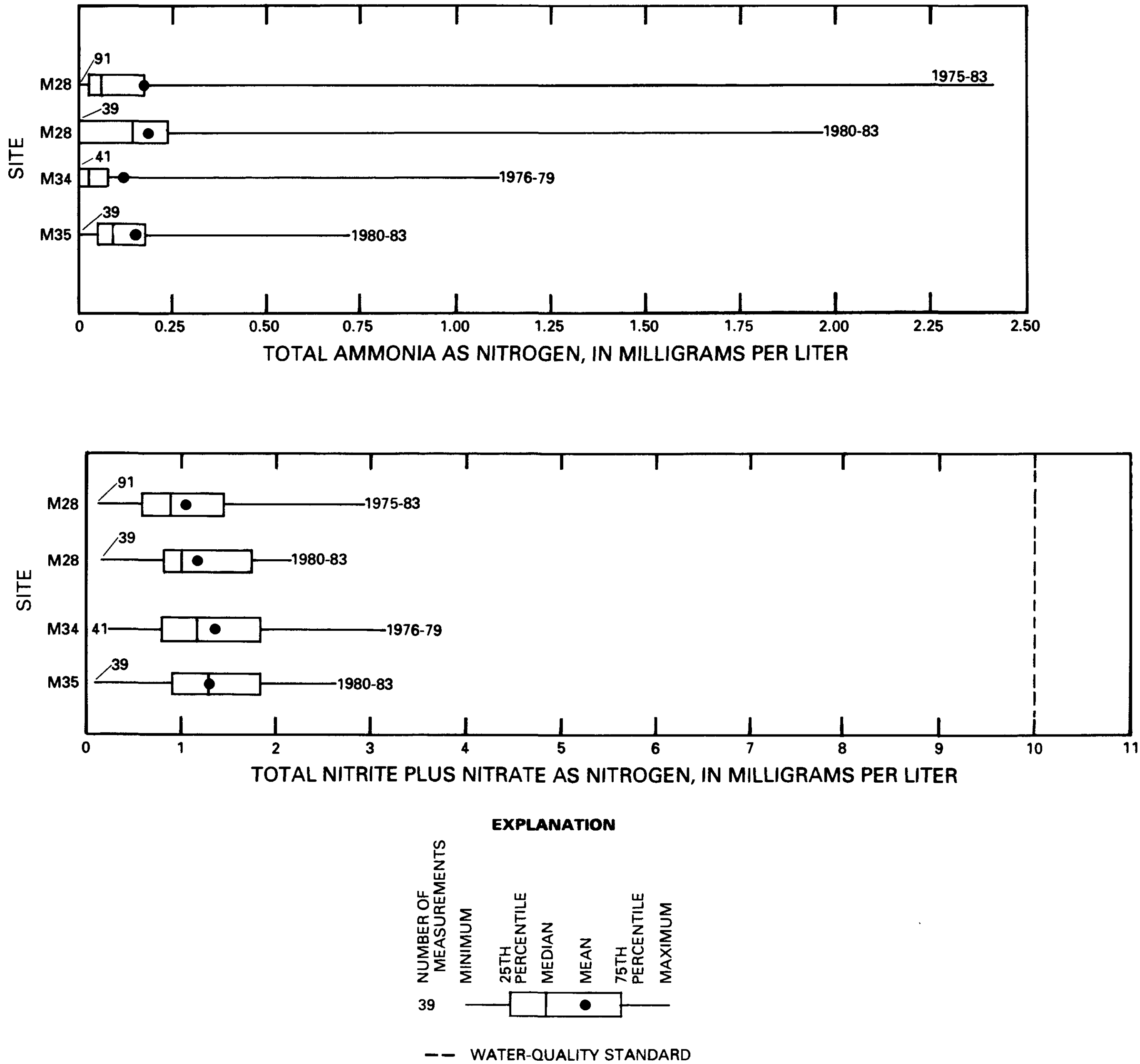


Figure 43.--Statistical summary of concentrations of total ammonia as nitrogen and total nitrite plus nitrate as nitrogen for Lower Monument Creek.

between sites M28 and M34. Median concentrations of total nitrite plus nitrate as nitrogen increased slightly downstream in relation to decreases in concentrations of total ammonia as nitrogen, which was nitrified to nitrite and then to nitrate. Concentrations of total ammonia as nitrogen and total nitrite plus nitrate as nitrogen (fig. 44) were largest during the winter, probably as the result of less dilution due to smaller streamflows and colder water temperatures, which inhibit biological uptake.

Trace Elements

Concentrations of trace elements analyzed from samples collected from Lower Monument Creek are summarized in table 6. The few dissolved trace elements monitored indicate that the largest concentrations of trace elements are suspended rather than in solution, as would be expected from the measured pH values and from the large concentrations of suspended solids that occur. Concentrations of total-recoverable cadmium, dissolved chromium, and dissolved-hexavalent chromium often were less than the detection level. Concentrations of dissolved iron and dissolved manganese were detectable but were only a small fraction of the concentrations of total-recoverable iron and total-recoverable manganese. Concentrations of dissolved chromium, dissolved-hexavalent chromium, total-recoverable copper, total-recoverable iron, total-recoverable lead, total-recoverable manganese, dissolved manganese, and total-recoverable zinc (figs. 45 and 46; table 6) exceeded the instream water-quality standards. Every water sample collected on Lower Monument Creek that was analyzed for total-recoverable copper exceeded the instream water-quality standard of 1 μg/L. A comparison of total-recoverable copper concentrations measured from 1980 through 1983 indicated there was an increase from site M28 to site M35 (fig. 45). Most of the concentrations that exceeded the instream standards for total-recoverable iron (fig. 46A) and total-recoverable lead (fig. 45) occurred at site M35, 7 mi downstream from site M28. Concentrations of total-recoverable lead (fig. 45), total-recoverable nickel (fig. 45), total-recoverable manganese (fig. 46), and total selenium (fig. 45) also increased within the 7-mi stream reach between sites M28 and M35. These data indicate there are additional sources of several trace elements downstream from Pikeview (site M28) that contribute substantial quantities of trace elements to Lower Monument Creek. In addition, concentrations of total-recoverable iron, total-recoverable manganese, and total-recoverable zinc were larger from 1980 through 1983 than from 1975 through 1979 (fig. 46).

CONCLUSIONS

During the stream-classification process, Fountain and Monument Creeks were divided into stream segments based on differences in water quality and uses of the water. Fountain Creek was divided into Upper Fountain Creek and Lower Fountain Creek, and Monument Creek was divided into Upper Monument Creek and Lower Monument Creek. Each stream segment was assigned a specific stream classification and specific water-quality standards by the Colorado Department of Health (1982). The general water-quality characteristics of Fountain and Monument Creeks were evaluated using data collected from 1975 through 1983. The water quality of each stream segment was evaluated in relation to the State's numeric water-quality standards.

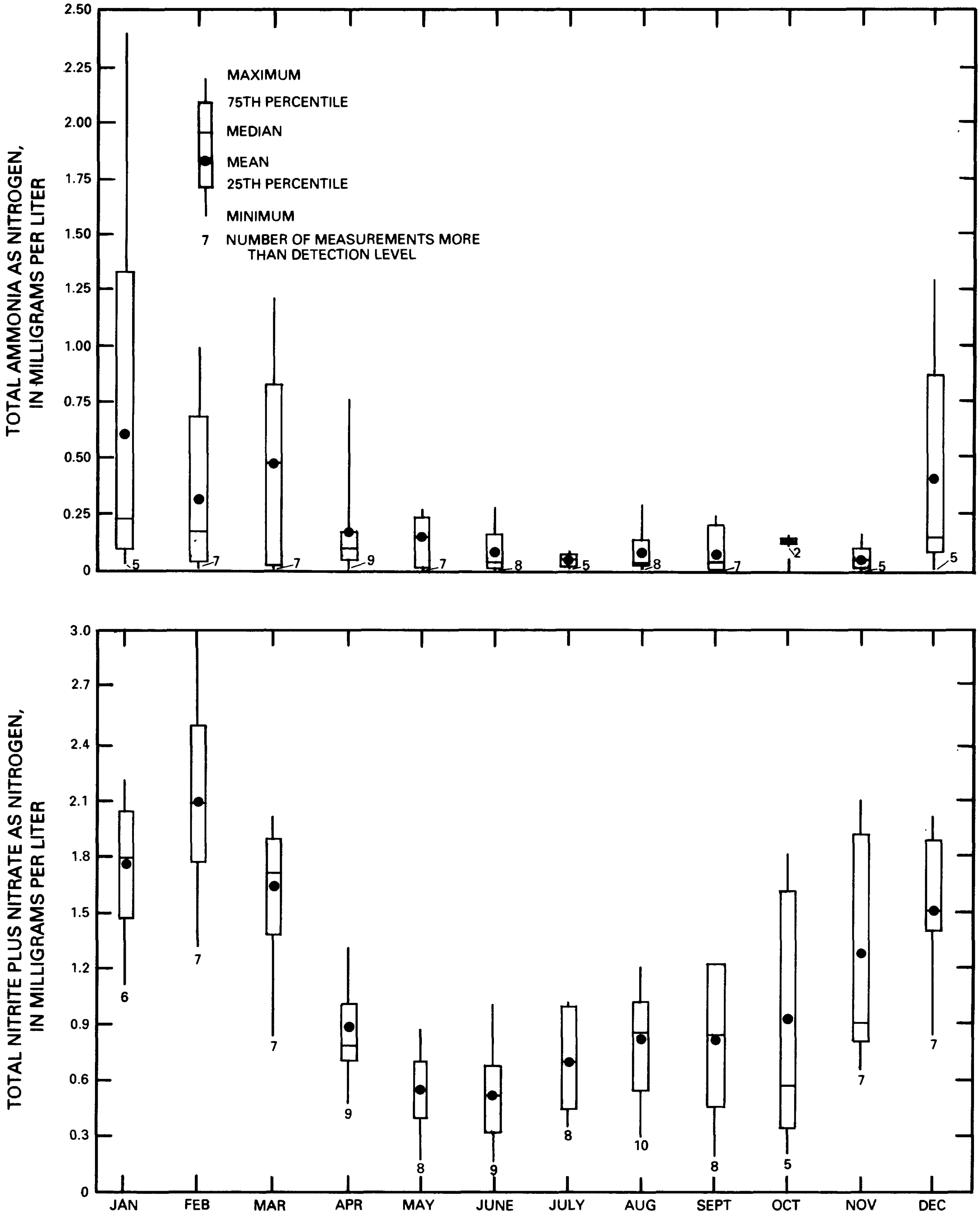


Figure 44.--Statistical summary of monthly variations in concentrations of total ammonia as nitrogen and total nitrite plus nitrate as nitrogen for site M28, 1975-83.

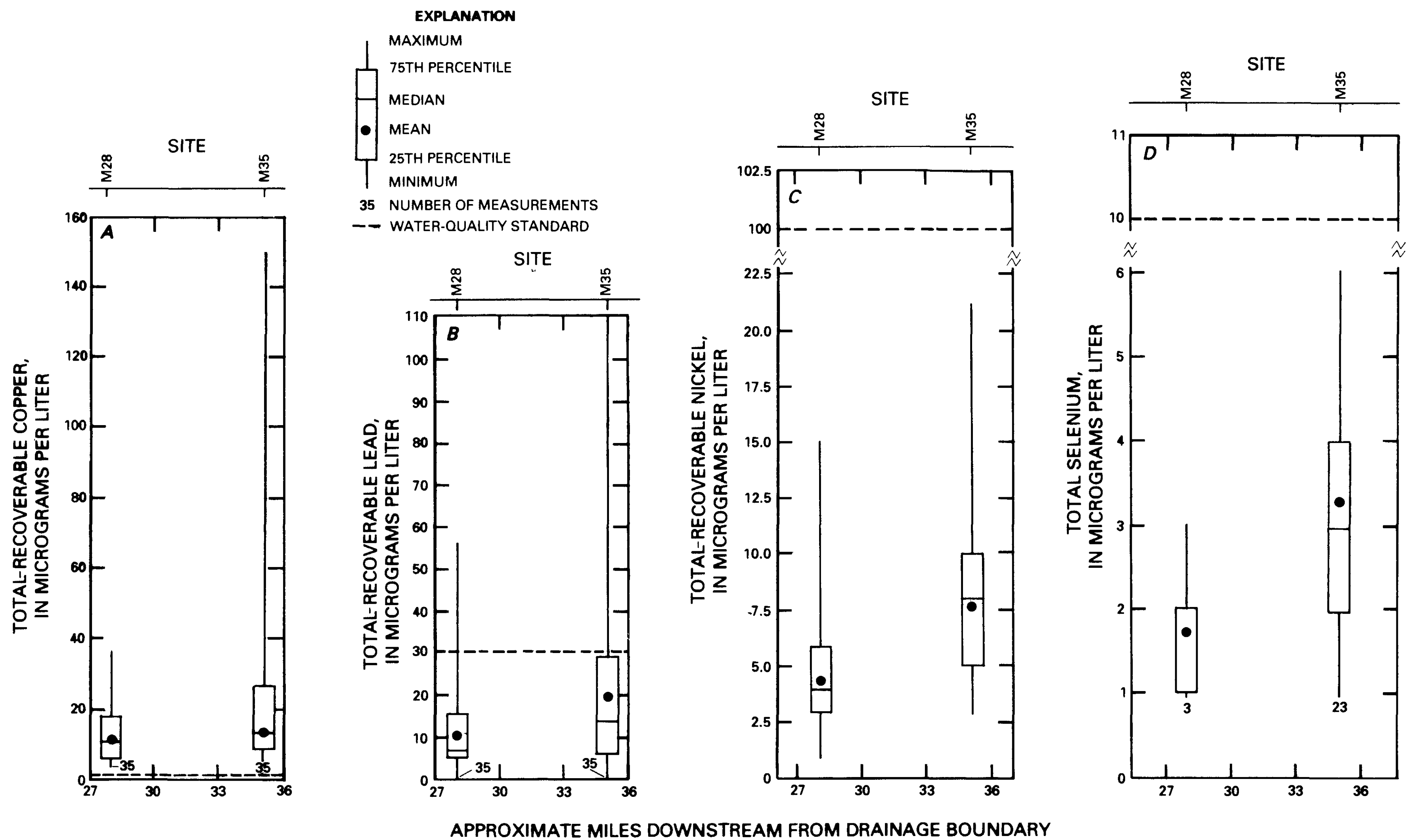


Figure 45.--Statistical summary of downstream variations in concentrations of (*A*) total-recoverable copper, (*B*) total-recoverable lead, (*C*) total-recoverable nickel, and (*D*) total selenium for sites M28 and M35, 1980-83.

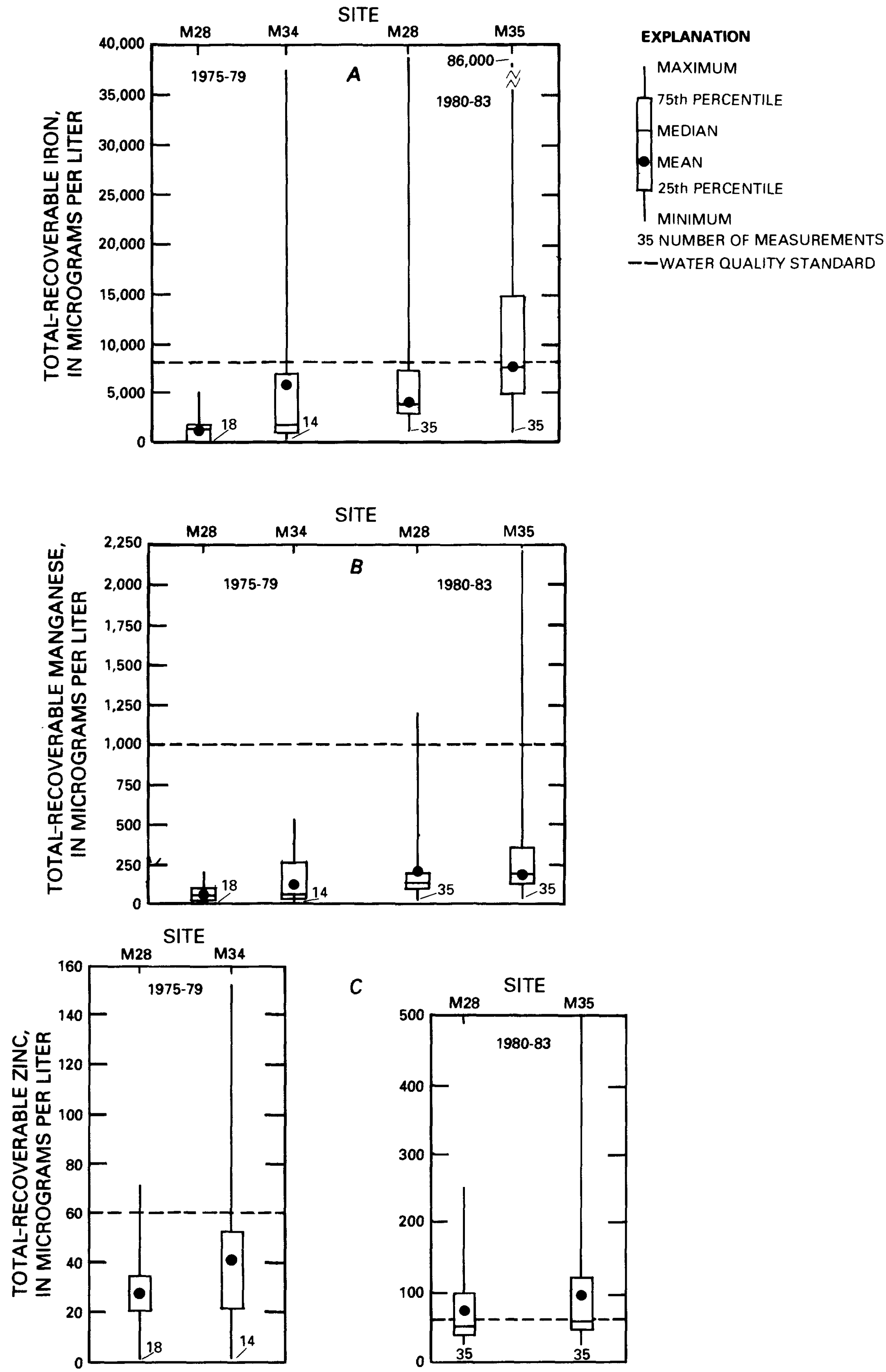


Figure 46.--Statistical summary of concentrations of total-recoverable (*A*) iron, (*B*) manganese, and (*C*) zinc for sites M28 and M34, 1975-79, and for sites M28 and M35, 1980-83.

The quality of water of Fountain and Monument Creeks changes as the water leaves the mountains and flows along the Rampart Range. Concentrations of dissolved solids, as represented by specific conductance, increased downstream in Fountain and Monument Creeks. During the period of record, 1975 through 1983, the median specific conductance of Fountain Creek increased from 341 µS/cm at site F12 near Manitou Springs to 1,750 µS/cm at site F66 at Pueblo, probably because of discharge from wastewater-treatment plants and irrigation-return flows and, to a lesser extent, from tributary inflow. Specific conductance also increased downstream in Monument Creek, probably as a result of wastewater-treatment plants, ground-water discharge, and inflows that drain densely urbanized areas.

BOD_5 increased downstream in Fountain and Monument Creeks during 1975 through 1983. The median BOD_5 concentration of Fountain Creek increased from 1 mg/L at site F12 to 28 mg/L at site F28 downstream from Security, primarily because of discharge from wastewater-treatment plants. Downstream from site F28, the BOD_5 decreases. BOD_5 increased downstream in Monument Creek, probably as a result of discharge from wastewater-treatment plants and from nonpoint sources.

The quality of water of Upper Fountain Creek was monitored from 1975 through 1983. As indicated by the physical properties and major inorganic constituents that were measured, the quality of water of Upper Fountain Creek was suitable for its intended uses. All values of pH and concentrations of dissolved oxygen, dissolved chloride, dissolved sulfate, and total nitrite plus nitrate as nitrogen were within the acceptable water-quality standards established by the State for the stream. However, concentrations of several trace elements exceeded the water-quality standards. Concentrations of total-recoverable copper, total-recoverable iron, total-recoverable lead, dissolved manganese, total-recoverable silver, and total-recoverable zinc have exceeded the water-quality standards at sites F12 and F15. Water-quality data also indicate there are additional sources of total-recoverable iron, total-recoverable lead, total-recoverable manganese, dissolved manganese, total selenium, total-recoverable silver, and total-recoverable zinc between sites F12 and F15 located 3 mi downstream. The additional sources of these trace elements probably are nonpoint sources such as runoff from mine tailings that are in the area.

Quality of water of Lower Fountain Creek was monitored from 1975 through 1983. Values of pH and concentrations of dissolved oxygen, dissolved chloride, dissolved sulfate, and total nitrite plus nitrate as nitrogen usually were within the values established as instream water-quality standards. Concentrations of dissolved manganese, total-recoverable nickel, and total-recoverable silver increased just downstream from the Colorado Springs Wastewater Treatment Plant. Of these trace elements, only dissolved-manganese concentrations exceeded the State water-quality standard for Lower Fountain Creek. Concentrations of other trace elements including total-recoverable copper, total-recoverable lead, dissolved iron, and total selenium exceeded the water-quality standards at the downstream sites.

The quality of water of Upper Monument Creek was monitored from 1977 through 1980 and can be characterized as being within State standards for physical properties, major inorganic constituents, and trace elements. Upper

Monument Creek is a well-oxygenated stream and has a small BOD_5 and small concentrations of dissolved and suspended solids, total ammonia, nitrite plus nitrate, and trace elements.

Quality of water of Lower Monument Creek was monitored from 1975 through 1983. BOD_5, fecal coliform bacteria, concentrations of dissolved chloride and sulfate, and total nitrite plus nitrate as nitrogen frequently increased downstream but generally remained within the State water-quality standards. Concentrations of total-recoverable copper, total-recoverable iron, total-recoverable lead, total-recoverable manganese, and total-recoverable zinc frequently increased downstream and, with the exception of total-recoverable manganese, frequently exceeded the water-quality standards.

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SUPPLEMENTAL DATA

Table 3.--*Statistical summary of water-quality data for Upper Fountain Creek*

[°C, degrees Celsius; μS/cm, microsiemens per centimeter at 25 degrees Celsius; mg/L, milligrams per liter; mL, milliliters; μg/L, micrograms per liter; NA, not applicable; --, insufficient data to calculate statistic]

Property or constituent	Number of measurements	Number of measurements less than detection level	Percentage of measurements less than detection level	Mean	Standard deviation	Median	Interquartile range	Water-quality standard[1]	Number of measurements greater than water-quality standard	Percentage of measurements greater than water-quality standard	Period of years summarized
SITE F12 (STATION 07103700 FOUNTAIN CREEK NEAR COLORADO SPRINGS)											
Water temperature, °C	174	0	0	9.2	5.8	9.3	9.5	NA	NA	NA	1975-83
Specific conductance, μS/cm	159	0	0	341	113	341	131	NA	NA	NA	1975-83
pH (standard units)	87	0	0	NA	NA	7.8	.5	6.5 to 9.0	[3]0	[3]0	1975-83
Oxygen, dissolved, mg/L	85	0	0	9.6	1.5	9.4	2.0	[4]6.0	85	100	1975-83
Fecal coliform bacteria, colonies per 100 mL	56	0	0	1,508	6,523	255	550	NA	NA	NA	1975-80
Chloride, dissolved, mg/L	41	0	0	15	7.2	15	9.0	250	0	0	1975-79; 1982-83
Sulfate, dissolved, mg/L	41	0	0	19	4.4	20	6.0	250	0	0	1975-79; 1982-83
Nitrogen, ammonia, total, mg/L	89	64	72	[2].06	[2].07	[2].04	[2].05	NA	NA	NA	1975-83
Nitrogen, nitrite plus nitrate, total, mg/L	90	0	0	.8	.3	.8	.4	10	0	0	1975-83
Cadmium, total recoverable, μg/L	41	39	95	--	--	--	--	1.4	1	2	1978-79; 1981-83

Table 3.--*Statistical summary of water-quality data for Upper Fountain Creek*--Continued

Property or constituent	Number of measurements	Number of measurements less than detection level	Percentage of measurements less than detection level	Mean	Standard deviation	Median	Interquartile range	Water-quality standard[1]	Number of measurements greater than water-quality standard	Percentage of measurements greater than water-quality standard	Period of years summarized
SITE F12 (STATION 07103700 FOUNTAIN CREEK NEAR COLORADO SPRINGS)--Continued											
Chromium, dissolved, µg/L	38	36	95	--	--	--	--	50	0	0	1975-76; 1981-83
Chromium, hexavalent, dissolved, µg/L	39	37	95	--	--	--	--	25	0	0	1976-79 1980-83
Copper, total recoverable, µg/L	41	0	0	8.2	7.9	6	5	10	8	20	1978-83
Iron, total recoverable, µg/L	52	0	0	3,000	8,300	920	1,500	1,350	21	40	1975-79; 1981-83
Iron, dissolved, µg/L	21	0	0	56	14	60	20	300	0	0	1981-83
Lead, total recoverable, µg/L	41	4	10	[2]8.1	[2]7.4	6	7	25	2	5	1978-83
Manganese, total recoverable, µg/L	52	0	0	140	102	110	60	1,000	0	0	1975-83
Manganese, dissolved, µg/L	31	0	0	42	20	40	40	50	10	32	1975-77; 1981-83
Nickel, total recoverable, µg/L	24	4	17	[2]3.9	[2]4.4	3	2	100	0	0	1981-82
Selenium, total, µg/L	30	26	87	--	--	--	--	10	0	0	1975-76; 1981-83
Silver, total recoverable, µg/L	26	18	69	[2].05	[2].11	[2].01	[2].03	.1	4	15	1981-83
Zinc, total recoverable, µg/L	52	7	14	[2]42	[2]44	30	30	50	8	15	1975-83

Table 3.--*Statistical summary of water-quality data for Upper Fountain Creek*--Continued

Property or constituent	Number of measurements	Number of measurements less than detection level	Percentage of measurements less than detection level	Mean	Standard deviation	Median	Interquartile range	Water-quality standard[1]	Number of measurements greater than water-quality standard	Percentage of measurements greater than water-quality standard	Period of years summarized
SITE F15 (STATION 07103707 FOUNTAIN CREEK BELOW 8TH STREET AT COLORADO SPRINGS)											
Water temperature, °C	12	0	0	12	8.3	9.8	13	NA	NA	NA	1981-82
Specific conductance, µS/cm	10	0	0	806	408	804	355	NA	NA	NA	1981
pH (standard units)	12	0	0	NA	NA	7.5	.5	6.5 to 9.0	[3]0	[3]0	1981-82
Oxygen, dissolved, mg/L	12	0	0	9.0	1.8	8.9	2.8	[4]6.0	12	100	1981-82
Fecal coliform bacteria, colonies per 100 mL				No data							
Chloride, dissolved, mg/L				No data							
Sulfate, dissolved, mg/L				No data							
Nitrogen, ammonia, total, mg/L	12	0	0	.12	.04	.12	.05	NA	NA	NA	1981-82
Nitrogen, nitrite plus nitrate, total, mg/L	12	0	0	1.8	1.1	1.6	1.4	10	0	0	1981-82
Cadmium, total recoverable, µg/L	12	10	83	--	--	--	--	1.4	2	17	1981
Chromium, dissolved, µg/L	12	7	58	--	--	--	--	50	0	0	1981
Chromium, hexavalent, dissolved, µg/L	12	11	92	--	--	--	--	25	0	0	1981

Table 3.--*Statistical summary of water-quality data for Upper Fountain Creek*--Continued

Property or constituent	Number of measurements	Number of measurements less than detection level	Percentage of measurements less than detection level	Mean	Standard deviation	Median	Interquartile range	Water-quality standard[1]	Number of measurements greater than water-quality standard	Percentage of measurements greater than water-quality standard	Period of years summarized
SITE F15 (STATION 07103707 FOUNTAIN CREEK BELOW 8TH STREET AT COLORADO SPRINGS)--Continued											
Copper, total recoverable, µg/L	12	0	0	10	3.5	10	3.0	10	3	25	1981
Iron, total recoverable, µg/L	12	0	0	2,230	2,510	1,250	1,450	1,350	5	42	1981
Iron, dissolved, µg/L	12	0	0	66	39	56	52	300	0	0	1981
Lead, total recoverable, µg/L	12	0	0	16	20	9	8	25	2	17	1981
Manganese, total recoverable, µg/L	12	0	0	955	889	430	1,170	1,000	5	42	1981
Manganese, dissolved, µg/L	11	0	0	951	950	380	1,180	50	11	100	1981
Nickel, total recoverable, µg/L	12	2	17	[2]5.4	[2]4.8	4	5	100	0	0	1981
Selenium, total, µg/L	12	0	0	5.7	4.3	5	7	10	2	17	1981
Silver, total recoverable, µg/L	12	2	17	[2].16	[2].19	.10	.16	.1	5	42	1981
Zinc, total recoverable, µg/L	12	0	0	269	224	175	355	50	10	83	1981

[1]Water-quality standard established by the Colorado Department of Health (1982).
[2]The statistic was estimated using the method developed by Helsel and Gilliom (1985).
[3]Number or percentage of measurements outside range established by water-quality standard.
[4]Water-quality standard for dissolved oxygen is a minimum value.

Table 4.--*Statistical summary of water-quality data for Lower Fountain Creek*

[°C, degrees Celsius; µS/cm, microsiemens per centimeter at 25 degrees Celsius; mg/L, milligrams per liter; mL, milliliters; µg/L, micrograms per liter; NA, not applicable; --, insufficient data to calculate statistic]

Property or constituent	Number of measurements	Number of measurements less than detection level	Percentage of measurements less than detection level	Mean	Standard deviation	Median	Interquartile range	Water-quality standard[1]	Number of measurements greater than water-quality standard	Percentage of measurements greater than water-quality standard	Period of years summarized
SITE F17 (STATION 07105500 FOUNTAIN CREEK AT COLORADO SPRINGS)											
Water temperature, °C	239	0	0	13	8.1	13	16	NA	NA	NA	1975-83
Specific conductance, µS/cm	238	0	0	653	217	658	286	NA	NA	NA	1975-83
pH (standard units)	88	0	0	NA	NA	7.8	.40	6.5 to 9.0	[3]0	[3]0	1975-83
Oxygen, dissolved, mg/L	86	0	0	9.0	1.7	8.8	2.6	[4]5.0	86	100	1975-83
Fecal coliform bacteria, colonies per 100 mL	61	16	26	[2]534	[2]828	220	[2]463	NA	NA	NA	1975-81
Chloride, dissolved, mg/L	51	0	0	20	7.9	21	10	250	0	0	1976-79; 1981,83
Sulfate, dissolved, mg/L	39	0	0	160	86	160	126	600	0	0	1976-79; 1983
Nitrogen, ammonia, total, mg/L	86	26	30	[2].5	[2]1.6	.12	[2].46	NA	NA	NA	1975-83
Nitrogen, nitrite plus nitrate, total, mg/L	86	0	0	1.3	.58	1.2	.96	10	0	0	1975-83
Cadmium, total recoverable, µg/L	42	39	93	--	--	--	--	10	0	0	1978-83

Table 4.--*Statistical summary of water-quality data for Lower Fountain Creek*--Continued

Property or constituent	Number of measurements	Number of measurements less than detection level	Percentage of measurements less than detection level	Mean	Standard deviation	Median	Interquartile range	Water-quality standard[1]	Number of measurements greater than water-quality standard	Percentage of measurements greater than water-quality standard	Period of years summarized
SITE F17 (STATION 07105500 FOUNTAIN CREEK AT COLORADO SPRINGS)--Continued											
Chromium, dissolved, µg/L	36	29	81	--	--	--	--	50	0	0	1975-76; 1981-83
Chromium, hexavalent, dissolved, µg/L	38	32	84	--	--	--	--	50	0	0	1977-82
Copper, total recoverable, µg/L	42	0	0	14	14	10	11	200	0	0	1975-76; 1977-83
Iron, total recoverable, µg/L	51	0	0	6,850	11,000	3,700	5,150	NA	NA	NA	1975; 1977-83
Iron, dissolved, µg/L	25	2	8	[2]158	[2]499	30	20	300	2	8	1975; 1981; 1983
Lead, total recoverable, µg/L	42	2	5	[2]22	[2]43	10	17	50	3	7	1978-83
Manganese, total recoverable, µg/L	51	0	0	292	315	230	90	NA	NA	NA	1975-83
Manganese, dissolved, µg/L	25	0	0	109	78	100	90	150	5	20	1975; 1980-83
Nickel, total recoverable, µg/L	23	1	4	[2]6.2	[2]3.5	6	4	200	0	0	1980-82
Selenium, total, µg/L	27	2	7	[2]2.9	[2]1.4	3	2	10	0	0	1975; 1980-82
Silver, total recoverable, µg/L	26	7	27	[2].08	[2].08	.06	[2].09	50	0	0	1980-83
Zinc, total recoverable, µg/L	50	0	0	94	73	70	40	2,000	0	0	1975; 1977-79; 1981-83

Table 4.--*Statistical summary of water-quality data for Lower Fountain Creek*--Continued

Property or constituent	Number of measurements	Number of measurements less than detection level	Percentage of measurements less than detection level	Mean	Standard deviation	Median	Interquartile range	Water-quality standard[1]	Number of measurements greater than water-quality standard	Percentage of measurements greater than water-quality standard	Period of years summarized
SITE F19 (STATION 07105530 FOUNTAIN CREEK BELOW JANITELL ROAD BELOW COLORADO SPRINGS)											
Water temperature, °C	60	0	0	15	5.0	14	9.8	NA	NA	NA	1975-76; 1979-83
Specific conductance, µS/cm	51	0	0	712	163	760	169	NA	NA	NA	1975-76; 1979-83
pH (standard units)	58	0	0	NA	NA	7.4	.35	6.5 to 9.0	[3]0	[3]0	1975-76; 1979-83
Oxygen, dissolved, mg/L	58	0	0	8.0	1.3	8.0	1.8	[4]5.0	58	100	1975-76; 1979-83
Fecal coliform bacteria, colonies per 100 mL	22	14	64	[2]423	[2]785	[2]20	[2]408	NA	NA	NA	1975-76; 1979-81
Chloride, dissolved, mg/L	32	0	0	32	11	35	17	250	0	0	1980-83
Sulfate, dissolved, mg/L	20	0	0	132	41	140	65	600	0	0	1981-83
Nitrogen, ammonia, total, mg/L	53	3	6	7.9	4.7	6.2	7.4	NA	NA	NA	1975-76; 1979-83
Nitrogen, nitrite plus nitrate, total, mg/L	58	0	0	1.3	1.1	.98	.57	10	0	0	1975-76 1979-83
Cadmium, total recoverable, µg/L	27	26	96	--	--	--	--	10	0	0	1979-82
Chromium, dissolved, µg/L	29	14	48	[2]14	[2]14	[2]10	[2]15	50	0	0	1975-77; 1980-82

Table 4.--*Statistical summary of water-quality data for Lower Fountain Creek*--Continued

Property or constituent	Number of measurements	Number of measurements less than detection level	Percentage of measurements less than detection level	Mean	Standard deviation	Median	Interquartile range	Water-quality standard[1]	Number of measurements greater than water-quality standard	Percentage of measurements greater than water-quality standard	Period of years summarized
SITE F19 (STATION 07105530 FOUNTAIN CREEK BELOW JANITELL ROAD BELOW COLORADO SPRINGS)--Continued											
Chromium, hexavalent, dissolved, µg/L	30	27	90	--	--	--	--	50	0	0	1975-76; 1979-82
Copper, total recoverable, µg/L	27	0	0	17	6.9	16	7	200	0	0	1978-82
Iron, total recoverable, µg/L	33	0	0	3,890	4,670	2,400	2,500	NA	NA	NA	1978-82
Iron, dissolved, µg/L	38	1	3	[2]56	[2]33	48	20	300	0	0	1975-76; 1980-83
Lead, total recoverable, µg/L	27	1	4	[2]15	[2]11	13	14	50	0	0	1978-82
Manganese, total recoverable, µg/L	33	0	0	243	151	180	90	NA	NA	NA	1978-83
Manganese, dissolved, µg/L	38	1	3	[2]108	[2]57	110	70	150	6	16	1975-76; 1980-83
Nickel, total recoverable, µg/L	23	0	0	22	14	20	11	200	0	0	1980-82
Selenium, total, µg/L	29	3	10	[2]4.4	[2]1.5	5	2	10	0	0	1975-76; 1980-82
Silver, total recoverable, µg/L	25	0	0	.84	.64	.70	.55	50	0	0	1975-82
Zinc, total recoverable, µg/L	33	0	0	121	72	100	50	2,000	0	0	1975-76; 1978-80

Table 4.--*Statistical summary of water-quality data for Lower Fountain Creek*--Continued

Property or constituent	Number of measurements	Number of measurements less than detection level	Percentage of measurements less than detection level	Mean	Standard deviation	Median	Interquartile range	Water-quality standard[1]	Number of measurements greater than water-quality standard	Percentage of measurements greater than water-quality standard	Period of years summarized
SITE F20 (STATION 07105535 FOUNTAIN CREEK BELOW CIRCLE DRIVE BELOW COLORADO SPRINGS)											
Water temperature, °C	19	0	0	16	5.5	16	9.0	NA	NA	NA	1980-82
Specific conductance, µS/cm	19	0	0	766	133	798	150	NA	NA	NA	1980-82
pH (standard units)	19	0	0	NA	NA	7.4	.35	6.5 to 9.0	[3]0	[3]0	1980-82
Oxygen, dissolved, mg/L	18	0	0	7.7	1.0	7.7	1.6	[4]5.0	18	100	1980-82
Fecal coliform bacteria, colonies per 100 mL	7	2	29	[2]523	[2]776	100	[2]702	NA	NA	NA	1980
Chloride, dissolved, mg/L	12	0	0	36	6.8	38	11	250	0	0	1981-82
Sulfate, dissolved, mg/L	12	0	0	168	28	165	45	600	0	0	1981-82
Nitrogen, ammonia, total, mg/L	15	0	0	7.7	3.2	7.9	4.7	10	0	0	1980-82
Nitrogen, nitrite plus nitrate, total, mg/L	19	0	0	1.5	.81	1.2	.91	10	0	0	1980-82
Cadmium, total recoverable, µg/L	14	13	93	--	--	--	--	10	0	0	1980-82
Chromium, dissolved, µg/L	12	2	17	[2]14	[2]14	10	15	50	0	0	1980-82
Chromium, hexavalent, dissolved, µg/L	14	13	93	--	--	--	--	50	0	0	1980-82

Table 4.--*Statistical summary of water-quality data for Lower Fountain Creek*--Continued

Property or constituent	Number of measurements	Number of measurements less than detection level	Percentage of measurements less than detection level	Mean	Standard deviation	Median	Interquartile range	Water-quality standard[1]	Number of measurements greater than water-quality standard	Percentage of measurements greater than water-quality standard	Period of years summarized
SITE F20 (STATION 07105535 FOUNTAIN CREEK BELOW CIRCLE DRIVE BELOW COLORADO SPRINGS)--Continued											
Copper, total recoverable, µg/L	14	0	0	17	6.4	16	8	200	0	0	1980-82
Iron, total recoverable, µg/L	14	0	0	3,530	4,900	2,100	2,200	NA	NA	NA	1980-82
Iron, dissolved, µg/L	12	0	0	41	11	40	12	300	0	0	1980-82
Lead, total recoverable, µg/L	14	0	0	13	14	9	9	50	1	7	1980-82
Manganese, total recoverable, µg/L	14	0	0	243	168	205	60	NA	NA	NA	1980-82
Manganese, dissolved, µg/L	12	0	0	154	69	145	85	150	0	0	1980-82
Nickel, total recoverable, µg/L	12	0	0	21	4.9	23	7.5	200	0	0	1980-82
Selenium, total, µg/L	12	0	0	5.4	1.2	5	1.5	10	0	0	1980-82
Silver, total recoverable, µg/L	14	0	0	.74	.38	.76	.63	50	0	0	1980-82
Zinc, total recoverable, µg/L	14	0	0	89	52	75	20	2,000	0	0	1980-82

Table 4.--*Statistical summary of water-quality data for Lower Fountain Creek*--Continued

Property or constituent	Number of measurements	Number of measurements less than detection level	Percentage of measurements less than detection level	Mean	Standard deviation	Median	Interquartile range	Water-quality standard[1]	Number of measurements greater than water-quality standard	Percentage of measurements greater than water-quality standard	Period of years summarized
SITE F28 (STATION 07105825 FOUNTAIN CREEK BELOW WIDEFIELD)											
Water temperature, °C	39	0	0	16	6.9	15	11	NA	NA	NA	1979-83
Specific conductance, µS/cm	37	0	0	796	189	850	212	NA	NA	NA	1979-83
pH (standard units)	39	0	0	NA	NA	7.5	0.45	6.5 to 9.0	[3]0	[3]0	1979-83
Oxygen, dissolved, mg/L	37	0	0	7.2	1.6	6.9	2.6	[4]5.0	34	92	1979-83
Fecal coliform bacteria, colonies per 100 mL	7	1	14	[2]933	[2]964	600	1,210	NA	NA	NA	1979-81
Chloride, dissolved, mg/L	32	0	0	43	14	44	16	250	0	0	1981-83
Sulfate, dissolved, mg/L	32	0	0	178	47	190	65	600	0	0	1981-83
Nitrogen, ammonia, total, mg/L	39	0	0	4.9	3.2	4.8	5.4	NA	NA	NA	1979-83
Nitrogen, nitrite plus nitrate, total, mg/L	39	0	0	2.8	1.1	2.4	1.3	10	0	0	1979-83
Cadmium, total recoverable, µg/L	25	23	92	--	--	--	--	10	0	0	1980-82
Chromium, dissolved, µg/L	23	15	65	[2]6.5	[2]4.3	[2]8.6	[2]2.9	50	0	0	1981-82

Table 4.--*Statistical summary of water-quality data for Lower Fountain Creek*--Continued

Property or constituent	Number of measurements	Number of measurements less than detection level	Percentage of measurements less than detection level	Mean	Standard deviation	Median	Interquartile range	Water-quality standard[1]	Number of measurements greater than water-quality standard	Percentage of measurements greater than water-quality standard	Period of years summarized
SITE F28 (STATION 07105825 FOUNTAIN CREEK BELOW WIDEFIELD)--Continued											
Copper, total recoverable, µg/L	25	0	0	22	10	21	15	200	0	0	1980-82
Iron, total recoverable, µg/L	25	0	0	9,350	8,300	7,900	7,700	NA	NA	NA	1980-82
Iron, dissolved, µg/L	32	2	6	[2]36	[2]34	31	16	300	0	0	1981-83
Lead, total recoverable, µg/L	25	0	0	20	19	15	15	50	2	8	1980-82
Manganese, total recoverable, µg/L	25	0	0	415	183	390	170	NA	NA	NA	1980-82
Manganese, dissolved, µg/L	32	0	0	137	91	140	113	150	13	41	1981-83
Nickel, total recoverable, µg/L	23	0	0	32	12	32	11	200	0	0	1981-82
Selenium, total, µg/L	23	0	0	4.7	1.2	5	1.5	10	0	0	1981-82
Silver, total recoverable, µg/L	25	6	24	[2].78	[2].42	.63	.49	50	0	0	1980-82
Zinc, total recoverable, µg/L	25	0	0	112	60	100	60	2,000	0	0	1980-82

Table 4.--*Statistical summary of water-quality data for Lower Fountain Creek*--Continued

Property or constituent	Number of measurements	Number of measurements less than detection level	Percentage of measurements less than detection level	Mean	Standard deviation	Median	Interquartile range	Water-quality standard[1]	Number of measurements greater than water-quality standard	Percentage of measurements greater than water-quality standard	Period of years summarized
SITE F36 (STATION 07105905 FOUNTAIN CREEK ABOVE LITTLE FOUNTAIN CREEK BELOW FOUNTAIN)											
Water temperature, °C	86	0	0	13	7.7	13	12	NA	NA	NA	1975-79 1980-83
Specific conductance, μS/cm	87	0	0	1,210	335	1,230	340	NA	NA	NA	1975-79 1980-83
pH (standard units)	83	0	0	NA	NA	7.6	.40	6.5 to 9.0	[3]0	[3]0	1975-79; 1980-83
Oxygen, dissolved, mg/L	82	0	0	8.1	1.5	8.0	2.4	[4]5.0	82	100	1975-79; 1980-83
Fecal coliform bacteria, colonies per 100 mL	51	8	16	[2]1,700	[2]3,060	780	1,170	NA	NA	NA	1975-81
Chloride, dissolved, mg/L	30	0	0	62	11	62	15	250	0	0	1976-79
Sulfate, dissolved, mg/L	30	0	0	383	89	355	100	600	0	0	1976-79
Nitrogen, ammonia, total, mg/L	84	7	8	[2]2.9	[2]2.7	2.2	4.2	NA	NA	NA	1975-83
Nitrogen, nitrite plus nitrate, total, mg/L	88	2	2	3.2	1.3	3.3	1.2	10	0	0	1975-83
Cadmium, total recoverable, μg/L	31	26	84	--	--	--	--	10	0	0	1978; 1980-82
Chromium, dissolved, μg/L	29	22	76	[2]6.5	[2]4.3	[2]8.6	[2]2.9	50	0	0	1975-76; 1981-82

Table 4.--*Statistical summary of water-quality data for Lower Fountain Creek*--Continued

Property or constituent	Number of measurements	Number of measurements less than detection level	Percentage of measurements less than detection level	Mean	Standard deviation	Median	Interquartile range	Water-quality standard[1]	Number of measurements greater than water-quality standard	Percentage of measurements greater than water-quality standard	Period of years summarized
SITE F36 (STATION 07105905 FOUNTAIN CREEK ABOVE LITTLE FOUNTAIN CREEK BELOW FOUNTAIN)--Continued											
Chromium, hexavalent, dissolved, µg/L	38	35	92	--	--	--	--	50	0	0	1976-79; 1980-82
Copper, total recoverable, µg/L	31	0	0	19	25	13	10	200	0	0	1978; 1980-82
Iron, total recoverable, µg/L	42	0	0	6,940	15,200	3,050	5,500	NA	NA	NA	1975-80; 1981-82
Iron, dissolved, µg/L	18	4	22	[2]22	[2]13	20	20	300	0	0	1975-76; 1981-82
Lead, total recoverable, µg/L	31	3	10	[2]17	[2]35	7	12	50	1	3	1978; 1980-82
Manganese, total recoverable, µg/L	42	0	0	436	404	365	160	NA	NA	NA	1975-78; 1980-82
Manganese, dissolved, µg/L	18	0	0	275	86	300	80	150	16	89	1975-76; 1980-82
Nickel, total recoverable, µg/L	23	0	0	19	9.0	20	9.5	200	0	0	1980-82
Selenium, total, µg/L	29	0	0	6.0	1.9	6	2	10	1	3	1975-76; 1980-82
Silver, total recoverable, µg/L	26	25	96	--	--	--	--	50	0	0	1980-82
Zinc, total recoverable, µg/L	42	0	0	86	98	65	60	2,000	0	0	1975-78; 1980-82

Table 4.--*Statistical summary of water-quality data for Lower Fountain Creek*--Continued

Property or constituent	Number of measurements	Number of measurements less than detection level	Percentage of measurements less than detection level	Mean	Standard deviation	Median	Interquartile range	Water-quality standard[1]	Number of measurements greater than water-quality standard	Percentage of measurements greater than water-quality standard	Period of years summarized
SITE F53 (STATION 07106300 FOUNTAIN CREEK NEAR PINON)											
Water temperature, °C	112	0	0	17	8.2	17	12	NA	NA	NA	1975-77; 1979-83
Specific conductance, µS/cm	167	0	0	1,150	398	1,180	612	NA	NA	NA	1975-83
pH (standard units)	74	0	0	NA	NA	7.8	.40	6.5 to 9.0	[3]0	[3]0	1976; 1979-83
Oxygen, dissolved, mg/L	66	0	0	7.4	1.9	7.4	2.5	[4]5.0	65	98	1976; 1979-83
Fecal coliform bacteria, colonies per 100 mL	6	0	0	309	543	70	580	NA	NA	NA	1980
Chloride, dissolved, mg/L	39	0	0	34	18	36	29	250	0	0	1975; 1976; 1979
Sulfate, dissolved, mg/L	39	0	0	285	109	290	160	600	0	0	1975-76; 1979
Nitrogen, ammonia, total, mg/L	71	3	4	.61	1.1	.16	.65	NA	NA	NA	1976-77; 1979-83
Nitrogen, nitrite plus nitrate, total, mg/L	71	0	0	2.5	1.1	2.3	1.2	10	0	0	1976-77; 1979-83
Cadmium, total recoverable, µg/L	28	28	100	--	--	--	--	10	1	4	1979; 1980-82
Chromium, dissolved, µg/L	26	16	61	[2]4.2	[2]4.7	[2]10	--	50	0	0	1980-82

Table 4.--*Statistical summary of water-quality data for Lower Fountain Creek*--Continued

Property or constituent	Number of measurements	Number of measurements less than detection level	Percentage of measurements less than detection level	Mean	Standard deviation	Median	Interquartile range	Water-quality standard[1]	Number of measurements greater than water-quality standard	Percentage of measurements greater than water-quality standard	Period of years summarized
SITE F53 (STATION 07106300 FOUNTAIN CREEK NEAR PINON)--Continued											
Chromium, hexavalent, dissolved, µg/L	59	56	95	--	--	--	--	50	0	0	1976-77; 1979-82
Copper, total recoverable, µg/L	28	0	0	33	46	20	22	200	1	4	1979-82
Iron, total recoverable, µg/L	28	0	0	20,500	37,600	8,100	14,800	NA	NA	NA	1979-82
Iron, dissolved, µg/L	47	15	32	[2]34	[2]50	20	[2]31	300	1	2	1976-77; 1981-82
Lead, total recoverable, µg/L	28	2	7	[2]23	[2]40	17	13	50	0	0	1979-82
Manganese, total recoverable, µg/L	28	0	0	632	1,000	315	390	NA	NA	NA	1979-82
Manganese, dissolved, µg/L	49	29	59	[2]25	[2]36	[2]7.4	[2]18	150	0	0	1975; 1977; 1979; 1981-82
Nickel, total recoverable, µg/L	27	0	0	21	19	15	14	200	0	0	1979-82
Selenium, total, µg/L	44	7	16	[2]5.1	[2]4.8	4	4	10	4	9	1976-77; 1979-82
Silver, total recoverable, µg/L	28	25	89	--	--	--	--	50	0	0	1979-82
Zinc, total recoverable, µg/L	28	1	4	[2]146	[2]197	80	90	2,000	0	0	1979-82

Table 4.--*Statistical summary of water-quality data for Lower Fountain Creek*--Continued

Property or constituent	Number of measurements	Number of measurements less than detection level	Percentage of measurements less than detection level	Mean	Standard deviation	Median	Interquartile range	Water-quality standard[1]	Number of measurements greater than water-quality standard	Percentage of measurements greater than water-quality standard	Period of years summarized
SITE F66 (STATION 07106500 FOUNTAIN CREEK AT PUEBLO)											
Water temperature, °C	197	0	0	16	8.1	16	13	NA	NA	NA	1975-83
Specific conductance, µS/cm	235	0	0	1,910	835	1,750	800	NA	NA	NA	1975-83
pH (standard units)	31	0	0	NA	NA	7.9	.35	6.5 to 9.0	[3]0	[3]0	1981-83
Oxygen, dissolved, mg/L	30	0	0	8.4	1.9	8.4	2.9	[4]5.0	29	97	1981-83
Fecal coliform bacteria, colonies per 100 mL				No data							
Chloride, dissolved, mg/L	6	0	0	62	3.5	64	7.0	250	0	0	1975
Sulfate, dissolved, mg/L	6	0	0	570	105	570	60	600	2	33	1975
Nitrogen, ammonia, total, mg/L	29	1	3	[2].54	[2]1.0	.11	.17	NA	NA	NA	1981-83
Nitrogen, nitrite plus nitrate, total, mg/L	29	1	3	[2]4.4	[2]2.0	4.0	2.0	10	1	3	1981-83
Cadmium, total recoverable, µg/L	20	20	100	--	--	--	--	10	0	0	1981-82
Chromium, dissolved, µg/L	20	15	75	--	--	--	--	50	0	0	1981-82

Table 4.--*Statistical summary of water-quality data for Lower Fountain Creek*--Continued

Property or constituent	Number of measurements	Number of measurements less than detection level	Percentage of measurements less than detection level	Mean	Standard deviation	Median	Interquartile range	Water-quality standard[1]	Number of measurements greater than water-quality standard	Percentage of measurements greater than water-quality standard	Period of years summarized
SITE F66 (STATION 07106500 FOUNTAIN CREEK AT PUEBLO)--Continued											
Chromium, hexavalent, dissolved, μg/L	20	18	90	--	--	--	--	50	0	0	1981-82
Copper, total recoverable, μg/L	20	0	0	23	19	19	11	200	0	0	1981-82
Iron, total recoverable, μg/L	20	0	0	15,200	16,200	9,750	15,200	NA	NA	NA	1981-82
Iron, dissolved, μg/L	15	4	27	[2]25	[2]14	20	[2]29	300	0	0	1981-82
Lead, total recoverable, μg/L	20	2	10	[2]14	[2]15	12	10	50	1	5	1981-82
Manganese, total recoverable, μg/L	20	0	0	446	465	315	455	NA	NA	NA	1981-82
Manganese, dissolved, μg/L	15	5	33	[2]29	[2]41	17	[2]18	150	0	0	1975; 1981-82
Nickel, total recoverable, μg/L	20	0	0	20	15	14	14	200	0	0	1981-82
Selenium, total, μg/L	20	0	0	32	45	18	12	10	16	80	1981-82
Silver, total recoverable, μg/L	20	19	95	--	--	--	--	50	0	0	1981-82
Zinc, total recoverable, μg/L	20	1	5	[2]118	[2]85	95	80	2,000	0	0	1981-82

[1]Water-quality standard established by the Colorado Department of Health (1982).
[2]The statistic was estimated using the method developed by Helsel and Gilliom (1985).
[3]Number or percentage of measurements outside range established by water-quality standard.
[4]Water-quality standard for dissolved oxygen is a minimum value.

Table 5.--*Statistical summary of water-quality data for Upper Monument Creek*

[°C, degrees Celsius; µS/cm, microsiemens per centimeter at 25 degrees Celsius; mg/L, milligrams per liter; mL, milliliters; µg/L, micrograms per liter; NA, not applicable; --, insufficient data to calculate statistic]

Property or constituent	Number of measurements	Number of measurements less than detection level	Percentage of measurements less than detection level	Mean	Standard deviation	Median	Interquartile range	Water-quality standard[1]	Number of measurements greater than water-quality standard	Percentage of measurements greater than water-quality standard	Period of years summarized
SITE M10 (STATION 07103747 MONUMENT CREEK AT PALMER LAKE)											
Water temperature, °C	133	0	0	10	6.8	9.5	11	NA	NA	NA	1976-83
Specific conductance, µS/cm	133	0	0	173	45	180	60	NA	NA	NA	1976-83
pH (standard units)	36	0	0	NA	NA	7.5	.7	6.5 to 9.0	[3]0	[3]0	1976-80
Oxygen, dissolved, mg/L	35	0	0	9.0	1.5	8.8	2.7	[4]5.0	35	100	1976-80
Fecal coliform bacteria, colonies per 100 mL	38	2	5	[2]143	[2]395	29	60	NA	NA	NA	1977-80
Chloride, dissolved, mg/L	23	0	0	4.1	1.6	4.3	2.7	250	0	0	1977-79
Sulfate, dissolved, mg/L	23	0	0	12	3.2	12	5.7	250	0	0	1976-79
Nitrogen, ammonia, total, mg/L	37	36	97	--	--	--	--	--	--	--	1977-80
Nitrogen, nitrite plus nitrate, total, mg/L	36	25	69	[2].09	[2].07	[2].07	[2].08	10	0	0	1977-80
Cadmium, total recoverable, µg/L	9	9	100	--	--	--	--	.4	0	0	1978-80
Chromium, dissolved, µg/L					No data						
Chromium, hexavalent, dissolved, µg/L	12	12	100	--	--	--	--	25	0	0	1977-80

Table 5.--*Statistical summary of water-quality data for Upper Monument Creek*--Continued

Property or constituent	Number of measurements	Number of measurements less than detection level	Percentage of measurements less than detection level	Mean	Standard deviation	Median	Interquartile range	Water-quality standard[1]	Number of measurements greater than water-quality standard	Percentage of measurements greater than water-quality standard	Period of years summarized
SITE M10 (STATION 07103747 MONUMENT CREEK AT PALMER LAKE)--Continued											
Copper, total recoverable, µg/L	9	4	44	[2]3.0	[2]4.0	2	[2]2	7	1	11	1978-80
Iron, total recoverable, µg/L	12	0	0	323	192	340	295	4,400	0	0	1976-80
Iron, dissolved, µg/L					No data						
Lead, total recoverable, µg/L	9	0	0	3.6	2.1	4	2	6	1	11	1978-80
Manganese, total recoverable, µg/L	12	0	0	38	19	30	20	1,000	0	0	1977-80
Manganese, dissolved, µg/L					No data						
Nickel, total recoverable, µg/L					No data						
Selenium, total, µg/L					No data						
Silver, total recoverable, µg/L	2	2	100	--	--	--	--	.1	0	0	1980
Zinc, total recoverable, µg/L	12	8	67	[2]15	[2]8.5	[2]17	[2]6	50	0	0	1977-80

[1]Water-quality standard established by the Colorado Department of Health (1982).
[2]The statistic was estimated using the method developed by Helsel and Gilliom (1985).
[3]Number or percentage of measurements outside range established by water-quality standard.
[4]Water-quality standard for dissolved oxygen is a minimum value.

Table 6.--*Statistical summary of water-quality data for Lower Monument Creek*

[°C, degrees Celsius; µS/cm, microsiemens per centimeter at 25 degrees Celsius; mg/L, milligrams per liter; mL, milliliters; µg/L, micrograms per liter; NA, not applicable; --, insufficient data to calculate statistic]

Property or constituent	Number of measurements	Number of measurements less than detection level	Percentage of measurements less than detection level	Mean	Standard deviation	Median	Interquartile range	Water-quality standard[1]	Number of measurements greater than water-quality standard	Percentage of measurements greater than water-quality standard	Period of years summarized
SITE M28 (STATION 07104000 MONUMENT CREEK AT PIKEVIEW)											
Water temperature, °C	193	0	0	13	9.1	12	16	NA	NA	NA	1975-83
Specific conductance, µS/cm	190	0	0	327	88	330	96	NA	NA	NA	1975-83
pH (standard units)	90	0	0	NA	NA	7.7	.5	6.5 to 9.0	[3]0	[3]0	1975-83
Oxygen, dissolved, mg/L	87	0	0	8.9	1.8	8.6	3.1	[4]5.0	87	100	1975-83
Fecal coliform bacteria, colonies per 100 mL	54	29	54	[2]494	[2]1,437	[2]16	[2]128	NA	NA	NA	1975-80
Chloride, dissolved, mg/L	39	0	0	11	3.8	12	4.7	250	0	0	1976-79; 1982-83
Sulfate, dissolved, mg/L	39	0	0	57	21	56	28	250	0	0	1976-79; 1982-83
Nitrogen, ammonia, total, mg/L	91	20	22	[2].18	[2].35	.06	.16	NA	NA	NA	1975-83
Nitrogen, nitrite plus nitrate, total, mg/L	91	0	0	1.1	.6	.9	.9	10	0	0	1975-83
Cadmium, total recoverable, µg/L	42	35	83	--	--	--	--	2	4	10	1978-79; 1981-83

Table 6.--*Statistical summary of water-quality data for Lower Monument Creek*--Continued

Property or constituent	Number of measurements	Number of measurements less than detection level	Percentage of measurements less than detection level	Mean	Standard deviation	Median	Interquartile range	Water-quality standard[1]	Number of measurements greater than water-quality standard	Percentage of measurements greater than water-quality standard	Period of years summarized
SITE M28 (STATION 07104000 MONUMENT CREEK AT PIKEVIEW--Continued											
Chromium, dissolved, μg/L	38	34	90	--	--	--	--	50	0	0	1975-76; 1981-83
Chromium, hexavalent, dissolved, μg/L	40	39	98	--	--	--	--	25	0	0	1976-82
Copper, total recoverable, μg/L	42	1	2	[2]11	[2]8.5	7	10	1	42	100	1978-83
Iron, total recoverable, μg/L	53	0	0	4,650	6,170	2,800	3,300	8,200	6	11	1975-83
Iron, dissolved, μg/L	27	3	11	[2]38	[2]28	30	20	300	0	0	1981; 1983
Lead, total recoverable, μg/L	42	2	5	[2]12	[2]11	7	11	30	3	7	1978-83
Manganese, total recoverable, μg/L	53	0	0	164	189	110	100	1,000	1	2	1975-83
Manganese, dissolved, μg/L	21	0	0	22	14	20	16	50	2	10	1981-83
Nickel, total recoverable, μg/L	23	2	9	[2]4.3	[2]3.1	4	3	100	0	0	1981-82
Selenium, total, μg/L	29	2	7	[2]1.6	[2].66	2	1	10	0	0	1975-76; 1981-82
Silver, total recoverable, μg/L	26	11	42	[2].07	[2].10	.04	[2].05	.1	0	0	1980; 1981-82
Zinc, total recoverable, μg/L	53	6	11	[2]54	[2]45	40	40	60	14	26	1975-83

Table 6.--*Statistical summary of water-quality data for Lower Monument Creek*--Continued

Property or constituent	Number of measurements	Number of measurements less than detection level	Percentage of measurements less than detection level	Mean	Standard deviation	Median	Interquartile range	Water-quality standard[1]	Number of measurements greater than water-quality standard	Percentage of measurements greater than water-quality standard	Period of years summarized
SITE M34 (STATION 07104900 MONUMENT CREEK AT CACHE LA POUDRE STREET)											
Water temperature, °C	42	0	0	13	9.5	12	19	NA	NA	NA	1976-79
Specific conductance, µS/cm	42	0	0	583	178	578	210	NA	NA	NA	1976-79
pH (standard units)	41	0	0	NA	NA	8.0	.4	6.5 to 9.0	[3]0	[3]0	1976-79
Oxygen, dissolved, mg/L	41	0	0	8.9	1.6	8.8	2.5	[4]5.0	40	98	1976-79
Fecal coliform bacteria, colonies per 100 mL	41	14	34	[2]1,814	[2]7,389	140	[2]451	NA	NA	NA	1976-79
Chloride, dissolved, mg/L	30	0	0	18	7.1	16.0	7.0	250	0	0	1976-79
Sulfate, dissolved, mg/L	30	0	0	150	67	145	90	250	2	7	1976-79
Nitrogen, ammonia, total, mg/L	41	9	22	[2].12	[2].24	.03	.07	NA	NA	NA	1976-79
Nitrogen, nitrite plus nitrate, total, mg/L	41	0	0	1.4	.7	1.2	.9	10	0	0	1976-79
Cadmium, total recoverable, µg/L	7	7	100	--	--	--	--	2	0	0	1978-79
Chromium, dissolved, µg/L	2	2	100	--	--	--	--	50	0	0	1976

Table 6.--*Statistical summary of water-quality data for Lower Monument Creek*--Continued

Property or constituent	Number of measurements	Number of measurements less than detection level	Percentage of measurements less than detection level	Mean	Standard deviation	Median	Interquartile range	Water-quality standard[1]	Number of measurements greater than water-quality standard	Percentage of measurements greater than water-quality standard	Period of years summarized
SITE M34 (STATION 07104900 MONUMENT CREEK AT CACHE LA POUDRE STREET)--Continued											
Chromium, hexavalent, dissolved, µg/L	14	13	93	--	--	--	--	25	0	0	1976-79
Copper, total recoverable, µg/L	7	0	0	10	10	7	2	1	7	100	1978-79
Iron, total recoverable, µg/L	14	0	0	5,720	9,630	1,550	6,430	8,200	2	14	1976-79
Iron, dissolved, µg/L	2	1	50	--	--	--	--	300	0	0	1976
Lead, total recoverable, µg/L	7	1	14	[2]12	[2]12	7	12	30	1	14	1978-80
Manganese, total recoverable, µg/L	14	0	0	136	148	55	200	1,000	0	0	1976-79
Manganese, dissolved, µg/L	1	0	0	--	--	--	--	50	0	0	1979
Nickel, total recoverable, µg/L	1	0	0	--	--	--	--	100	0	0	1979
Selenium, total, µg/L	3	0	0	4.0	2.0	4	2	10	0	0	1976; 1979
Silver, total recoverable, µg/L	1	1	100	--	--	--	--	.1	0	0	1979
Zinc, total recoverable, µg/L	14	4	29	[2]38	[2]39	20	[2]34	60	2	14	1976-79

Table 6.--*Statistical summary of water-quality data for Lower Monument Creek*--Continued

Property or constituent	Number of measurements	Number of measurements less than detection level	Percentage of measurements less than detection level	Mean	Standard deviation	Median	Interquartile range	Water-quality standard[1]	Number of measurements greater than water-quality standard	Percentage of measurements greater than water-quality standard	Period of years summarized
SITE M35 (STATION 07104905 MONUMENT CREEK AT BIJOU STREET)											
Water temperature, °C	40	0	0	14	8.8	15	13	NA	NA	NA	1979-83
Specific conductance, µS/cm	37	0	0	452	134	465	185	NA	NA	NA	1979-83
pH (standard units)	39	0	0	NA	NA	7.9	.3	6.5 to 9.0	[3]0	[3]0	1979-83
Oxygen, dissolved, mg/L	39	0	0	8.9	2.1	8.8	2.8	[4]5.0	39	100	1979-83
Fecal coliform bacteria, colonies per 100 mL	8	3	38	[2]692	[2]1,440	110	[2]530	NA	NA	NA	1979-80
Chloride, dissolved, mg/L	9	0	0	16	18	11	9.3	250	0	0	1982-83
Sulfate, dissolved, mg/L	9	0	0	63	34	65	39	250	0	0	1982-83
Nitrogen, ammonia, total, mg/L	40	14	35	[2].15	[2].15	.10	[2].15	NA	NA	NA	1979-83
Nitrogen, nitrite plus nitrate, total, mg/L	40	0	0	1.3	.64	1.3	1.0	10	0	0	1979-83
Cadmium, total recoverable, µg/L	35	31	89	--	--	--	--	2	0	0	1979-83
Chromium, dissolved, µg/L	32	26	81	--	--	--	--	50	1	3	1981-83
Chromium, hexavalent, dissolved, µg/L	25	22	88	--	--	--	--	25	1	4	1980-82

Table 6.--*Statistical summary of water-quality data for Lower Monument Creek*--Continued

Property or constituent	Number of measurements	Number of measurements less than detection level	Percentage of measurements less than detection level	Mean	Standard deviation	Median	Interquartile range	Water-quality standard[1]	Number of measurements greater than water-quality standard	Percentage of measurements greater than water-quality standard	Period of years summarized
SITE M35 (STATION 07104905 MONUMENT CREEK AT BIJOU STREET)--Continued											
Copper, total recoverable, µg/L	35	0	0	27	33	14	18	1	35	100	1980-83
Iron, total recoverable, µg/L	35	0	0	13,700	19,300	7,300	9,700	8,200	12	34	1980-83
Iron, dissolved, µg/L	21	2	10	[2]29	[2]24	20	30	300	0	0	1981-82; 1983
Lead, total recoverable, µg/L	35	1	3	[2]20	[2]23	15	20	30	8	23	1980-83
Manganese, total recoverable, µg/L	35	0	0	337	440	190	190	1,000	2	6	1980-83
Manganese, dissolved, µg/L	21	8	38	[2]12	[2]7.6	10	[2]12	50	0	0	1981-82; 1983
Nickel, total recoverable, µg/L	23	0	0	7.7	4.2	8	4	100	0	0	1981-82
Selenium, total, µg/L	23	0	0	3.3	1.3	3	2	10	0	0	1981-82
Silver, total recoverable, µg/L	26	11	42	[2].06	[2].10	.03	[2].05	.1	0	0	1980-82
Zinc, total recoverable, µg/L	35	0	0	103	112	60	60	60	17	49	1980-83

[1]Water-quality standard established by the Colorado Department of Health (1982).
[2]The statistic was estimated using the method developed by Helsel and Gilliom (1985).
[3]Number or percentage of measurements outside range established by water-quality standard.
[4]Water-quality standard for dissolved oxygen is a minimum value.

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