SEDIMENT-TRANSPORT CHARACTERISTICS AND EFFECTS OF SEDIMENT TRANSPORT ON BENTHIC INVERTEBRATES IN THE FOUNTAIN CREEK DRAINAGE BASIN UPSTREAM FROM WIDEFIELD, SOUTHEASTERN COLORADO, 1985-88

By Paul von Guerard

U.S. GEOLOGICAL SURVEY

Water-Resources Investigations Report 89-4161

Prepared in cooperation with the

CITY OF COLORADO SPRINGS DEPARTMENT OF UTILITIES

Denver, Colorado
1989

DEPARTMENT OF THE INTERIOR

MANUEL LUJAN, JR., Secretary

U.S. GEOLOGICAL SURVEY

Dallas L. Peck, Director

For additional information
write to:

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

Copies of this report can
be purchased from:

U.S. Geological Survey
Books and Open-File Reports Section
Box 25425
Federal Center
Denver, CO 80225-0425

CONTENTS

FIGURES

TABLES

CONVERSION FACTORS

Inch-pound units used in this report may be converted to metric (International System) units by using the following conversion factors:

Multiply inch-pound unit	*By*	*To obtain metric unit*
acre-foot per square mile	0.000476	cubic hectometer per square kilometer
cubic foot per second (ft^3/s)	0.028317	cubic meter per second
foot (ft)	0.3048	meter
inch (in.)	25.4	millimeter (mm)
mile (mi)	1.609	kilometer
square foot (ft^2)	0.09290	square meter
square mile (mi^2)	2.590	square kilometer
ton (short)	0.9072	megagram
ton per day (ton/d)	0.9072	megagram per day ton per
day per foot (ton/d/ft)	0.9072	megagram per day per meter
ton per square mile (ton/mi^2)	0.3503	megagram per square kilometer

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

$$°C = 5/9(°F-32).$$

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

microsiemens per centimeter at 25 degrees Celsius (µS/cm at 25°C).
milligram per liter (mg/L)
millimeter (mm)

Suspended-sediment concentrations are reported only in milligrams per liter (mg/L) because these values are (within the range of values presented) numerically equal to concentrations expressed in parts per million.

Sea level: In this report "sea level" refers to the National Geodetic Vertical Datum of 1929 (NGVD of 1929)--a geodetic datum derived from a general adjustment of the first-order level nets of both the United States and Canada, formerly called Sea Level Datum of 1929.

SEDIMENT-TRANSPORT CHARACTERISTICS AND EFFECTS OF SEDIMENT TRANSPORT ON BENTHIC INVERTEBRATES IN THE FOUNTAIN CREEK DRAINAGE BASIN UPSTREAM FROM WIDEFIELD, SOUTHEASTERN COLORADO, 1985-88

By Paul von Guerard

ABSTRACT

Sediment and benthic-invertebrate data were collected during water years 1985 through 1988 in the Fountain Creek drainage basin upstream from Widefield, Colorado. Sediment data collected include suspended-sediment concentrations and particle-size analysis of suspended sediment, bedload, and bed material. The smallest median suspended-sediment concentrations were determined for suspended-sediment samples collected at Monument Creek at Palmer Lake and Monument Creek above North Gate Boulevard, at U.S. Air Force Academy. Maximum and median suspended-sediment concentrations were largest at Fountain Creek near Colorado Springs and Monument Creek at Bijou Street at Colorado Springs. Sediment-transport equations were derived for total suspended-sediment discharge and suspended-sand discharge at seven periodic sampling sites. Annual suspended-sediment loads for water years 1985 through 1988 and mean annual suspended-sediment yields were computed for the seven periodic sampling sites. Mean annual suspended-sediment yield for 1985 through 1988 increased about 73 percent downstream in the Fountain Creek drainage basin primarily as a result of sediment discharging from Monument Creek. Mean annual suspended-sediment yields decreased about 30 percent in the lower part of the Fountain Creek drainage basin. In the downstream parts of the Monument Creek drainage basin, mean annual suspended-sediment yield increased about 608 percent.

The median grain size of all bed-material samples was very coarse sand to small cobbles, and the median grain size of all bedload samples was coarse sand to very fine gravel. Bedload discharge was computed at six of the periodic sampling sites. Measured bedload discharge ranged from 2.6 to 3,570 tons per day. Bedload discharge, as a percentage of total sediment discharge, ranged from 6 to 92 percent, and the smaller values occurred during rainfall runoff.

Except for 1988, benthic invertebrates were collected four times annually at five of the periodic sampling sites. Number of taxa, species density, and similarity indices were determined for the five sites. At the five benthic-invertebrate sampling sites, 138 taxa were identified; however only 24 were common to all sites. At the benthic-invertebrate sampling sites, changes in streambed elevation was measured periodically during stream-channel cross-section surveys. The more habitat-sensitive benthic invertebrates--Ephemeroptera, Plecoptera, and Trichoptera were most abundant and were most frequently collected at sites where there was little to no change in streambed elevation.

Multiple comparison tests were used to test for similarity of benthic invertebrates between the five sites. Multiple-regression analysis was done to determine the effects of sediment transport on benthic-invertebrate densities. Median grain size of bed material collected in conjunction with benthic-invertebrate samples and flooding during the 30 days prior to sampling consistently accounted for the most variation in mean densities of total organisms for major taxa groups sampled. Benthic-invertebrate densities were largest at sites with larger median grain size of bed material and that had the fewest periods of flooding during the 30 days prior to sample collection.

INTRODUCTION

The Fountain Creek drainage basin in southeastern Colorado (fig. 1) has been affected by extensive erosion for more than a century. Chapman (1933) used Fountain Creek as an example of a stream that has been affected by greater than normal erosion rates, which he believed began in the late 1870's as a result of agricultural development. Since 1950, much agricultural area in the basin has been replaced by urban development. Attention of local and state governments has been focused on the effects of changing land use on streams and rivers in the area.

In 1985, the U.S. Geological Survey, in cooperation with the City of Colorado Springs Department of Utilities, began a study to determine the sediment-transport characteristics and the effects of sediment transport on benthic invertebrates in the Fountain Creek drainage basin upstream from Widefield. The study area, hereinafter referred to as the basin, is in eastern Teller County and northwestern El Paso County upstream from Widefield. The basin includes 495 mi^2 (square miles) of the Fountain Creek drainage, which also includes the City of Colorado Springs.

Purpose and Scope

This report defines the sediment-transport characteristics in Fountain and Monument Creeks and describes the effects of sediment transport on benthic invertebrates in Fountain and Monument Creeks. Sediment and benthic-invertebrate data collection began in 1985 and continued through water year 1988. Suspended-sediment data were collected periodically at seven sites; periodic sampling of bedload and collection of bed material occurred at six of the seven sites, and periodic sampling of benthic invertebrates was done four times annually at five sites, except for water year 1988, when only three samples were collected (figs. 1 and 2; table 1). Suspended-sediment data were used to develop suspended-sediment-transport equations that were used to determine suspended-sediment discharge and yields in Fountain Creek and its main tributary, Monument Creek.

Bedload and bed-material data and periodic measurements of stream-channel cross sections were used to describe streambed stability at benthic-invertebrate sampling sites. The number of organisms, number of taxa, and similarity indices were determined from benthic-invertebrate data collected at five sites (fig. 1; table 1). Multiple-comparison tests were used to test for similarity of the number of benthic invertebrates among the five sites sampled. Multiple-regression analyses were done to determine the effects of selected water-quality properties and constituents, size distribution of bed material, and frequency of flooding on benthic-invertebrate densities. In this report, the term flooding or flood refers to streamflow resulting from snowmelt or rainfall runoff.

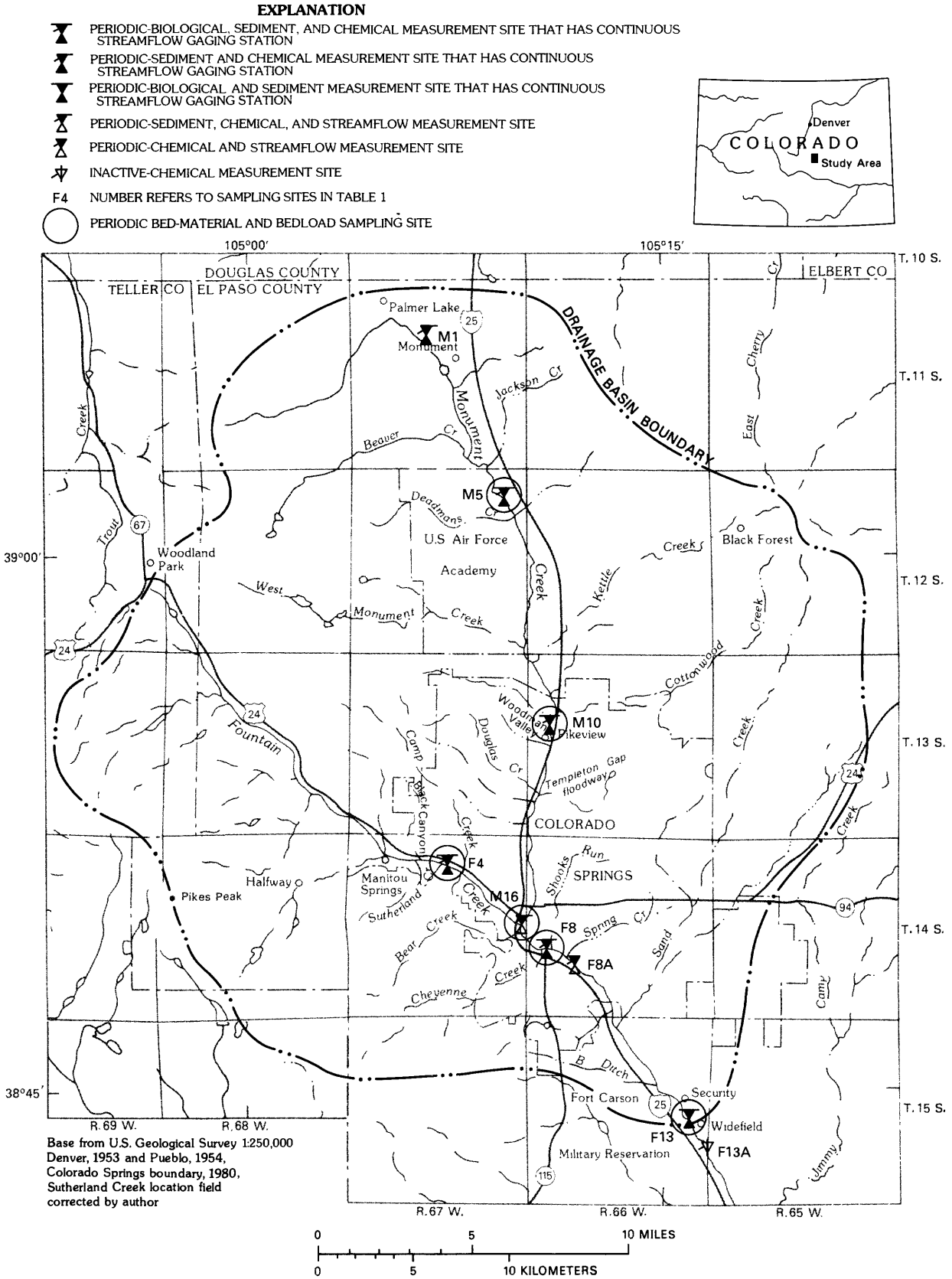

Figure 1.--Location of Fountain Creek drainage basin upstream from Widefield and location of sampling sites.

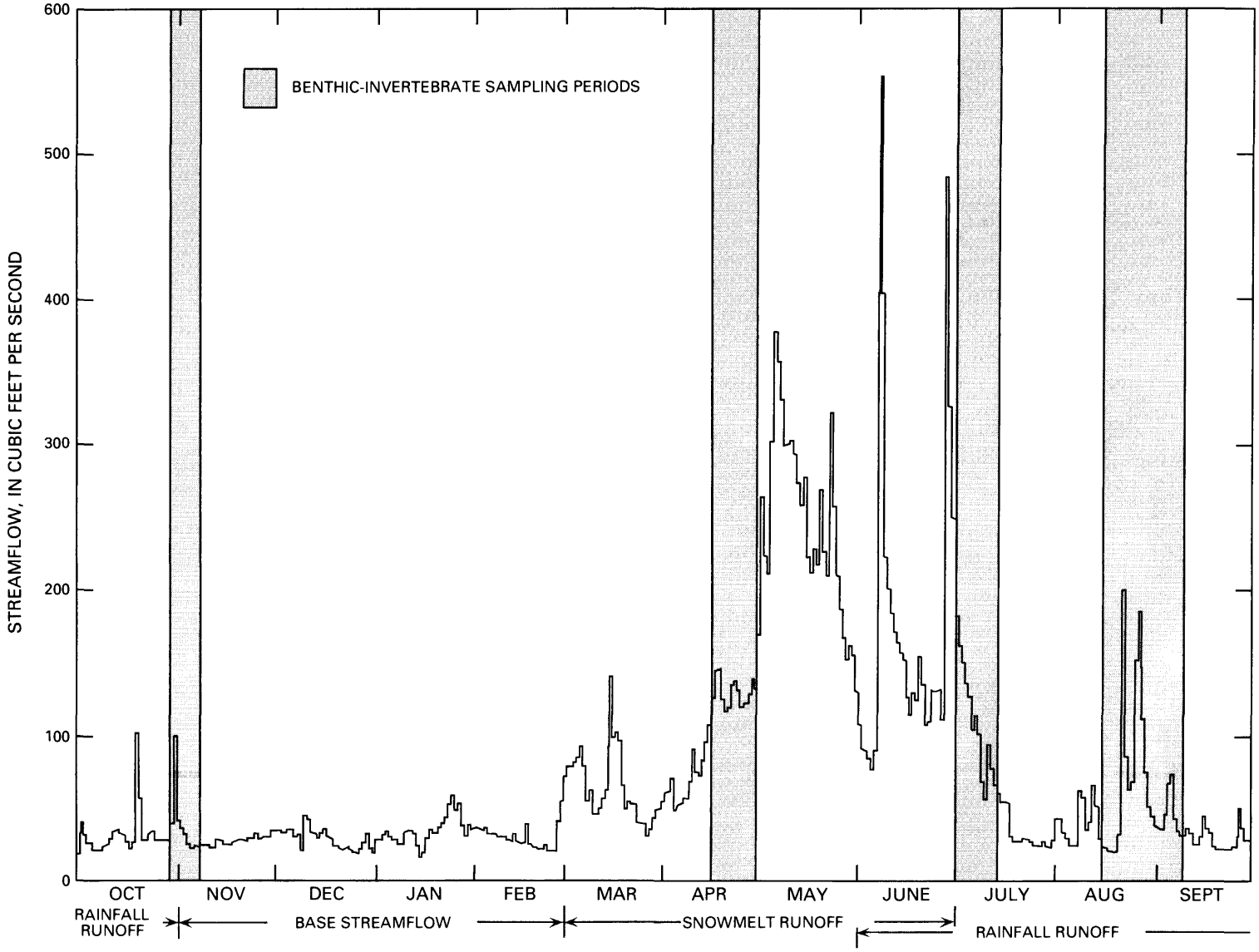

Figure 2.--Example of streamflow hydrograph and benthic-invertebrate sampling periods for Fountain and Monument Creeks.

Table 1.--*Chemical quality, sediment, and benthic-invertebrate sampling sites*
[--, Not applicable]

Site number in figure 1	U.S. Geological Survey station number	U.S. Geological Survey station name	Approximate distance from drainage divide (miles)	Drainage-basin area (square miles)	Data collection				
					Bedload and bed material	Suspended sediment	Benthic invertebrates and bed material	Channel cross section	Periodic chemical quality
[1]F4	07103700	Fountain Creek near Colorado Springs	12	103	Yes	Yes	Yes	Yes	Yes
[1]F8	07105500	Fountain Creek at Colorado Springs	17	392	Yes	Yes	Yes	Yes	Yes
[2]F8A	07105530	Fountain Creek below Janitell road below Colorado Springs	18.8	--	No	No	No	No	Yes
[1]F13	07105800	Fountain Creek at Security	26	495	Yes	Yes	Yes	Yes	No
[2]F13A	07105825	Fountain Creek at Widefield	27.5	--	No	No	No	No	Yes
[1]M1	07103747	Monument Creek at Palmer Lake	10	25.9	No	Yes	No	No	Yes
[1]M5	07103780	Monument Creek above North Gate Boulevard at U.S. Air Force Academy	20	81.9	Yes	Yes	Yes	Yes	Yes
[1]M10	07104000	Monument Creek at Pikeview	28	204	Yes	Yes	Yes	Yes	Yes
[1]M16	07104905	Monument Creek at Bijou Street at Colorado Springs	35	236	Yes	Yes	No	No	Yes

[1]Site numbers used in von Guerard (1989).
[2]Data from these sites were used to estimate unionized ammonia concentrations for site F13.

Description of Study Area

The basin is located in and along the eastern slope of the Front Range section of the southern Rocky Mountains. Elevations in the basin range from 5,640 ft (feet) at the outflow of the basin upstream from Widefield to 14,109 ft at the summit of Pikes Peak. Climatic conditions range from semiarid in areas below 6,500 ft to alpine in areas above 11,500 ft. Precipitation within the basin is distributed seasonally as rain and snow. As elevation increases, precipitation as snowfall increases as a part of the total precipitation. Annual precipitation for 1948-87 at the Colorado Springs airport ranged from 8.6 to 25.4 in. (inches). The mean annual precipitation at this location is 15.2 in. Mean annual precipitation from 1951 to 1981 for the entire basin is 18.2 in. (Colorado Climate Center, 1984). Convective thunderstorms contribute most of the rainfall that occurs during May through September. Thunderstorms occur an average of 70 days each year (U.S. Geological Survey 1970, p. 116).

The western one-third of the basin is underlain by granite of Precambrian age, and the remainder of the basin is underlain by sandstone and shale of Cretaceous age and alluvial and windlain deposits of Quaternary age. Soils in the basin tend to be sandy, moderately deep to deep, and well drained to excessively well drained. A more detailed description of the study area is discussed in von Guerard (1989).

Acknowledgments

The author thanks Steven P. Canton of Chadwick & Associates, Inc., for his review of this report and for providing insight into the complexities of the benthic-invertebrate communities of Fountain and Monument Creeks. The author also thanks Peter C. McCarville, a streamflow observer in Colorado Springs, for his untiring efforts in collecting suspended-sediment samples. His data collection and information concerning the occurrence of floods was invaluable to the success of this project.

SEDIMENT-TRANSPORT CHARACTERISTICS

The instream physical habitat available for benthic invertebrates is dependent upon the prevailing flow regime and the sediment transport. Streamflow in the basin is characterized by base streamflow during November through February, snowmelt runoff during March through June, and rainfall runoff during May through October (fig. 2). During most years, there is some overlap of the snowmelt and rainfall-runoff periods. Sewage-treatment-plant effluent affects streamflow at Fountain Creek at Security (site F13) year round (fig 1; table 1) (Kuhn, 1988). Instantaneous minimum, maximum, and mean annual streamflow for selected sites on Fountain and Monument Creeks are listed in table 2. The following is a discussion of the characteristics of suspended sediment and bedload sediment transported in Fountain and Monument Creeks.

Table 2.--*Summary of streamflow for selected sites on Fountain and Monument Creeks*

Site number in figure 1	U.S. Geological Survey station number	Period of record (water year)	Streamflow (cubic feet per second)					
			For period of record			For period of study (water years 1985-88)		
			Instantaneous Minimum	Instantaneous Maximum	Mean annual	Instantaneous Minimum	Instantaneous Maximum	Mean annual
F4	07103700	1958-88	2.0	2,630	14.6	2.0	229	18.7
F8	07105500	1922-24; 1977-88	2.0	6,000	63.4	11	4,450	74.8
F13	07105800	1964-88	1.9	25,000	84.5	51	3,800	137
M1	07103747	February 1977-88	.10	216	7.5	.50	204	7.3
M5	07103780	April 19, 1985-88	1.1	372	17.5	1.1	372	17.5
M10	07104000	1939-49; January 1976-88	0.0	3,750	28.8	7.1	3,020	39.5
M16	07104905	(1)	(1)	(1)	(1)	(1)	(1)	[2]45.8

[1]No continuous streamflow data are collected.
[2]Mean annual streamflow was computed from streamflow derived by methods described in von Guerard (1989).

Suspended Sediment

Suspended sediment is the sediment transported in suspension by the turbulent forces of streamflow or by Brownian movement. Suspended sediment can be described as either fine (silt and clay) or coarse (usually sand). Fine sediments, sediments with particle diameters finer than 0.062 mm (millimeter), once suspended in the water column will stay in suspension for long periods of time and are transported by most streamflow discharges. The occurrence of suspended sands, sediments with particle diameters that range from 0.062 mm through 2.0 mm, is dependent on streamflow. Suspended-sediment samples were collected periodically at seven sites in the basin during water years 1985-88 (fig. 1; table 1). The samples were collected monthly, with increased sampling frequency during periods of snowmelt and rainfall runoff, by using a DH-48 or a D-74 depth-integrating sampler and the equal-width-increment (equal-transit rate) method described by Guy and Norman (1970). All sediment samples were analyzed for suspended-sediment concentration. Selected samples specifically were analyzed for the percentage of suspended sediment finer than sand size (less than 0.062 mm) and for complete particle-size analysis of suspended sediments, including percentage of suspended sediment finer than coarse clay (in the range of 0.002 to 0.004 mm), very fine to coarse silt (in the range of 0.004 to 0.062 mm), and very fine to coarse sand (in the range of 0.062 to 1.0 mm) (Guy, 1969).

A statistical summary of suspended-sediment concentrations and percentage of suspended sediment finer than 0.062 mm is listed in table 3. The smallest median suspended-sediment concentrations were determined for suspended-sediment samples collected at Monument Creek at Palmer Lake (site M1) and Monument Creek above North Gate Boulevard, at U.S. Air Force Academy (site M5) (hereinafter referred to as Monument Creek at USAFA) (table 3). These sites are located in the headwater parts of Monument Creek. Maximum and median suspended-sediment concentrations were largest at Fountain Creek near Colorado Springs (site F4) and Monument Creek at Bijou Street at Colorado Springs (site M16) (table 3). For the seven sites sampled, median values for suspended sediment finer than 0.062 mm ranged from 55 to 69 percent (table 3).

Except for site M1, suspended-sediment samples were collected for complete particle-size analysis at all suspended-sediment sampling sites during periods of snowmelt or rainfall runoff. These data are summarized in table 15 in the "Supplemental Information" section at the back of this report. Silt (in the range of 0.004 to 0.062 mm) composed 23 to 61 percent of the suspended sediment. Coarse clay (in the range of 0.002 to 0.004 mm) and suspended sediments finer than 0.002 mm composed 11 to 62 percent of the suspended sediment. Most of the suspended sand in transport in Fountain and Monument Creeks is very fine (in the range of 0.062 to 0.125 mm) to fine (in the range of 0.125 to 0.25 mm) sand. Medium (in the range of 0.25 to 0.50 mm) to coarse sands (in the range of 0.50 to 1.0 mm) usually composed less than 10 percent of the suspended sand.

Table 3.--*Summary of suspended-sediment concentration and percentage of suspended sediment finer than 0.062 millimeters at selected sites on Fountain and Monument Creeks, water years 1985-88*

Site number in figure 1	U.S. Geological Survey station number	Number of samples	Suspended-sediment concentration, in milligrams per liter			Number of samples	Percentage of suspended sediment finer than 0.062 millimeters		
			Minimum	Maximum	Median		Minimum	Maximum	Median
F4	07103700	161	1	41,000	174	141	18	99	69
F8	07105500	194	38	27,100	1,300	187	28	92	59
F13	07105800	163	39	25,900	925	161	10	95	64
M1	07103747	50	1	3,610	21	28	35	97	58
M5	07103780	125	4	7,220	54	100	23	96	55
M10	07104000	146	19	26,200	685	139	20	89	60
M16	07104905	151	53	22,200	1,820	149	28	96	59

Suspended-Sediment Discharge

Suspended-sediment and streamflow relations were developed using ordinary least-squares regression (Glysson, 1987). Total suspended-sediment discharge (suspended clay, silt, and sand), hereinafter referred to as suspended-sediment discharge, and suspended-sand discharge, were computed for each sediment-sampling site by applying suspended-sediment-transport equations to the daily mean streamflow for each day at each site.

The regression equation estimates the mean response of the dependent variable (suspended-sediment discharge) given known values of the independent variable (streamflow). The form of the regression equation is a linear function of the logarithmic-transformed (natural log) variable:

$$\ln Y = \ln B_0 + B_1 \ln X. \quad (1)$$

Taking the antilogs, the form of the regression equation becomes:

$$Y = B_0 X^{B_1}, \quad (2)$$

where Y = suspended-sediment (or suspended-sand) discharge, in tons per day;
B_0 = regression constant;
B_1 = regression coefficient; and
X = streamflow, in cubic feet per second.

A transformation bias is produced when the logarithms of the estimated mean response (log of suspended-sediment discharge) is retransformed (eq. 2) (Miller, 1984; Cohn and others, 1989). This tranformation bias usually results in underestimation of the retransformed mean response (suspended-sediment discharge). It is possible, however, to eliminate the major part of this transformation bias by multiplying the estimated annual suspended-sediment load by a correction factor (Miller, 1984):

$$Cb = e^{0.5MSE}, \quad (3)$$

where Cb = transformation bias-correction factor;
e = base of the natural logarithm; and
MSE = mean square error of estimate.

Cohn and others (1989) reported that transformation bias-correction factors, such as the one described by Miller (1984), may produce unsatisfactory results when sample sizes (n) are small ($n<50$) and when mean square error of estimate is large ($MSE>1.0$). Annual suspended-sediment and suspended-sand loads computed using the equations in table 4 were adjusted using transformation bias-correction factors described by Miller (1984) and Cohn and others (1989). Use of the transformation bias-correction factor proposed by Cohn and others (1989) resulted in annual suspended-sediment and suspended-sand loads that were from 0 to 3 and -1 to 6 percent different than loads obtained using the transformation bias-correction factor described by Miller (1984). A possible explanation of the small differences in results obtained using the two transformation bias-correction factors is that annual suspended-sediment and suspended-sand loads were determined for streamflows within the range of streamflows used to define the regression relations listed in table 4.

Table 4.--*Suspended-sediment-transport equations derived from measurements of suspended-sediment discharge for Fountain and Monument Creeks during water years 1985-88*

[n, sample size; Cb, transformation bias-correction factor; R^2, coefficient of multiple determination; MSE, mean square error of estimate, in log of tons; Qs, total suspended-sediment discharge, in tons per day; Qsa, suspended-sand discharge, in tons per day; Q, streamflow, in cubic feet per second]

Site number in figure 1	U.S. Geological Survey station number	Regression equation	n	C_b	R^2	MSE
[1]F4	07103700	$Qs = 0.009Q^{2.42}$	161	2.65	0.64	1.95
		$Qsa = 0.009Q^{2.14}$	141	1.80	.71	1.18
[1]F8	07105500	$Qs = 0.01Q^{2.20}$	194	1.50	.89	.81
		$Qsa = 0.003Q^{2.26}$	187	1.66	.86	1.01
F13	07105800	$Qs = 0.001Q^{2.45}$	163	1.24	.91	.58
		$Qsa = 0.0004Q^{2.44}$	161	1.41	.89	.69
M1	07103747	$Qs = 0.35Q^{0.99}$	50	1.45	.68	.75
		$Qsa = 0.28Q^{0.94}$	28	1.85	.60	1.23
M5	07103780	$Qs = 0.078Q^{1.53}$	125	1.36	.84	.62
		$Qsa = 0.057Q^{1.46}$	100	1.51	.79	.83
M10	07104000	$Qs = 0.057Q^{1.96}$	146	1.60	.79	.94
		$Qsa = 0.025Q^{1.93}$	139	1.51	.80	.83
M16	07104905	$Qs = 0.026Q^{2.20}$	151	1.32	.89	.56
		$Qsa = 0.007Q^{2.27}$	149	1.38	.88	.64

[1]Regression equations significantly different ($p<0.05$) than equations used in von Guerard (1989).

Because there is a negligible difference in results obtained using the two transformation bias-correction factors, and because Miller's correction factor is more convenient to use because it is applied equally to all streamflows, Miller's transformation bias-correction factor was used to correct for transformation bias in the equations in table 4. The effects of transformation bias-correction factors for a regression relation of selected suspended-sediment discharge to streamflow (table 4) is shown in figure 3.

The reliability of the regression equations in table 4 can be evaluated by examining the values of the coefficient of multiple determination (R^2) and the mean square error of estimate (MSE) for each regression (table 4). The coefficient of multiple determination is a measure of proportion of total variation in the dependent variable (suspended-sediment discharge) explained by the independent variable (streamflow). Mean square error is a measure of the difference between the predicted and observed values of the dependent variable. The larger the MSE, the greater the variance about the regression line.

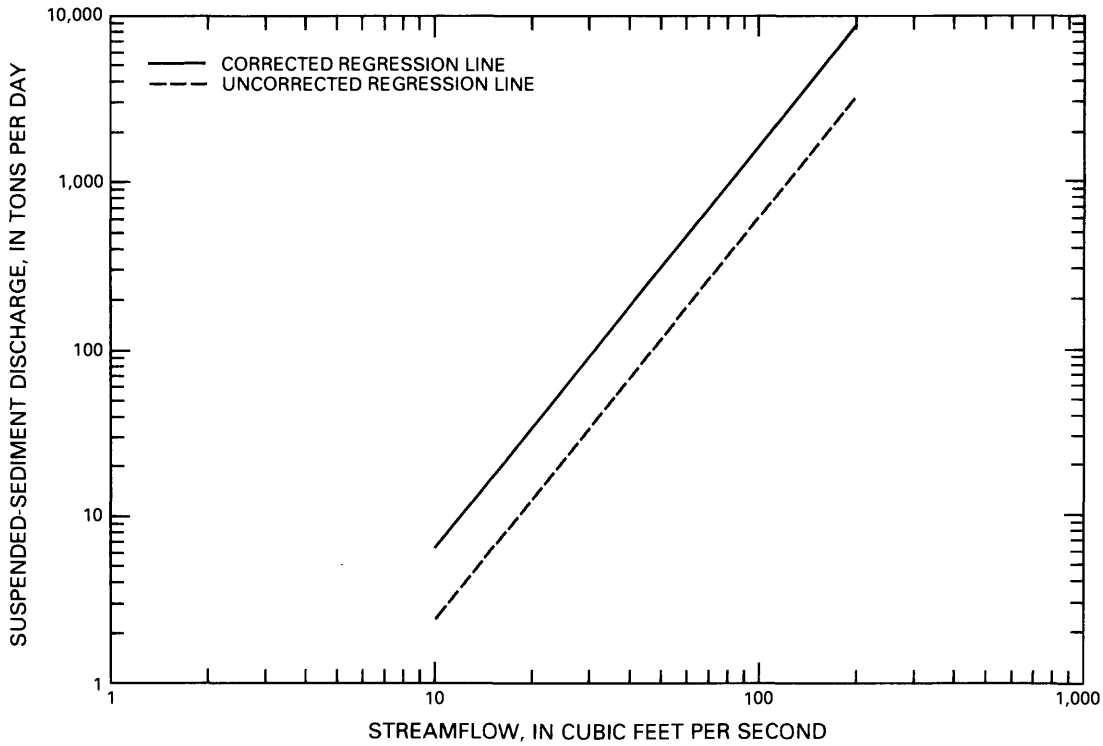

Figure 3.--Uncorrected regression line and the regression line corrected for transformation bias for relation of suspended-sediment discharge to streamflow for Fountain Creek near Colorado Springs (site F4).

Continuous streamflow records are available from six of the periodic suspended-sediment sampling sites. The continuous streamflow record available at Monument Creek at USAFA (site M5), however, began on April 19, 1985 (table 2). Daily mean streamflow at site M5 was estimated for the first 6 months of water year 1985 by comparing the partial record at site M5 with the corresponding record for Monument Creek at Palmer Lake (site M1). These data were compared using ordinary least-squares regression and were determined to be quite similar. The missing record for water year 1985 at site M5 was estimated using the following equation:

$$Q_{M5} = 6.02 + (2.06\ Q_{M1}), \quad (4)$$

where Q_{M5} = daily mean streamflow at Monument Creek at USAFA (site M5), in cubic feet per second; and
Q_{M1} = daily mean streamflow at Monument Creek at Palmer Lake (site M1), in cubic feet per second.

For this equation, the coefficient of multiple determination (R^2) is 0.95.

Daily mean streamflow at Monument Creek at Bijou Street at Colorado Springs (site M16) was estimated from daily streamflow records from nearby sites using techniques described by von Guerard (1989). By use of the

equations in table 4 for water year 1985, Fountain Creek near Colorado Springs (site F4), Fountain Creek at Colorado Springs (site F8) and Monument Creek at Pikeview (site M10) had substantially larger annual suspended-sediment and suspended-sand loads than were reported in von Guerard (1989). Regression equations derived by von Guerard (1989) from data collected in 1985 were compared to the regression equations listed in table 4 by using analysis of covariance using dummy variables. All regression equations were determined to be not significantly different ($p>0.05$), except for those derived for sites F4 and F8 ($p<0.05$). Larger suspended-sediment concentrations were determined, and higher streamflows occurred during water years 1986-88 than during water year 1985. Regression equations developed by von Guerard (1989), based only on data collected during water year 1985, did not include the larger suspended-sediment concentrations at sites F4 and F8 and higher streamflows at site F8 that occurred during water year 1985. This may account for the difference in regression equations derived using data collected during water year 1985 and those derived using data collected during water years 1985-88 for sites F4 and F8.

Annual suspended-sediment and suspended-sand loads and mean annual suspended-sediment yields for water years 1985-88 at the seven suspended-sediment sampling sites are summarized in table 5. There is an apparent decrease in mean annual suspended-sediment load between sites F8 and F13. However, the difference in suspended-sediment load, about -11 percent, between sites F8 and F13 is less than the streamflow measurement and suspended-sediment-sampling error at these sites. Mean annual suspended-sediment yield increased about 73 percent between Fountain Creek near Colorado Springs (site F4) and Fountain Creek at Colorado Springs (site F8) (fig. 4, table 5). Suspended-sediment yield at site F8 is affected greatly by Monument Creek. Mean annual suspended-sediment yields decreased about 30 percent between sites F8 and F13. Mean annual suspended-sand load, as a percent of mean annual suspended-sediment load, was about 21 percent at site F4, about 47 percent at site F8, and about 40 percent at site F13.

Mean annual suspended-sediment load for Monument Creek at Bijou Street at Colorado Springs (site M16), about 0.75 mi upstream from the confluence of Fountain Creek and Monument Creek, was about 74 percent of the mean annual suspended-sediment load at site F8 (table 5). Mean annual suspended-sediment yield increased about 20 percent between Monument Creek at Palmer Lake (site M1) and Monument Creek at USAFA (site M5). Between site M5 and Monument Creek at Pikeview (site M10), mean annual suspended-sediment yield increased about 608 percent (fig. 5, table 5). Mean annual suspended-sediment yield increased about 61 percent between site M10 and Monument Creek at Bijou Street at Colorado Springs (site M16) (fig. 5, table 5). Mean annual suspended-sand load, as a percent of mean annual suspended-sediment load, was about 88 percent at site M1, 61 percent at site M5, about 36 percent at site M10, and about 40 percent at site M16.

Suspended-sediment transport occurs in Fountain and Monument Creeks at all rates of streamflow. However, the majority of suspended sediment is transported by streamflows (floods) in excess of mean annual streamflows for the period of record (figs. 6*A-B*; table 2). Floods transport the larger part of the annual suspended-sediment load. For example at site M16, about 75 percent of the annual suspended-sediment load is transported by streamflows that exceed 100 ft^3/s, which occur about 9 percent of the time.

Table 5.--*Summary of annual suspended-sediment and suspended-sand loads and mean annual suspended-sediment yields at selected sites on Fountain and Monument Creeks, water years 1985-88*

Site number in figure 1	U.S. Geological Survey station number	Water year								Mean annual (water years 1985-88)		
		1985		1986		1987		1988				
		Suspended-sediment load (tons)	Suspended-sand load (tons)	Suspended-sediment load (tons)	Suspended-sand load (tons)	Suspended-sediment load (tons)	Suspended-sand load (tons)	Suspended-sediment load (tons)	Suspended-sand load (tons)	Suspended-sediment load (tons)	Suspended-sediment yield (tons per square mile)	Suspended-sand load (tons)
F4	07103700	107,000	21,400	4,630	1,490	19,900	4,800	2,790	920	33,600	326	7,150
F8	07105500	621,000	295,000	25,400	10,900	191,000	88,600	46,800	20,900	221,000	564	104,000
F13	07105800	474,000	188,000	52,700	21,100	181,000	71,800	76,700	30,600	196,000	396	77,900
M1	07103747	2,140	1,870	667	622	1,500	1,300	930	841	1,310	51	1,160
M5	07103780	10,300	6,200	1,490	998	5,720	3,450	2,440	1,580	4,990	61	3,060
M10	07104000	215,000	76,400	21,100	7,880	87,700	31,600	28,600	10,500	88,100	432	31,600
M16	07104905	439,000	180,000	21,700	7,920	157,000	62,500	37,800	14,400	164,000	695	66,200

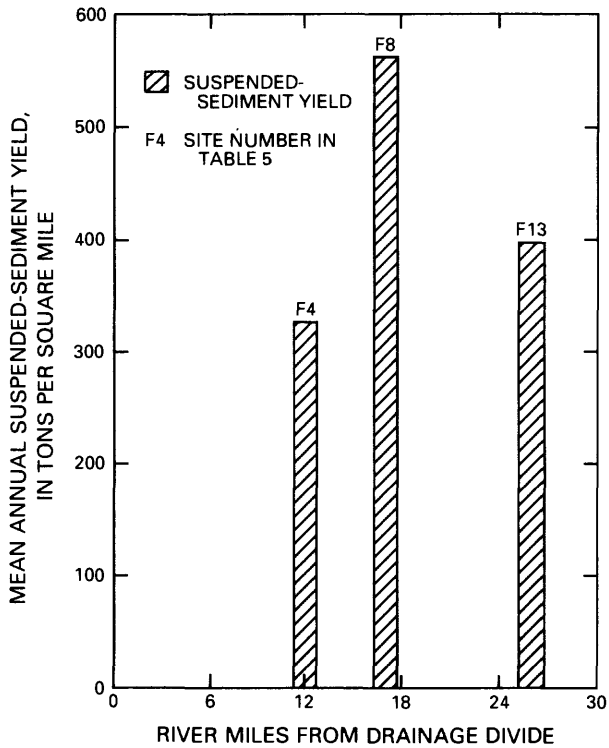

Figure 4.--Mean annual suspended-sediment yield for suspended-sediment sampling sites on Fountain Creek for water years 1985-88.

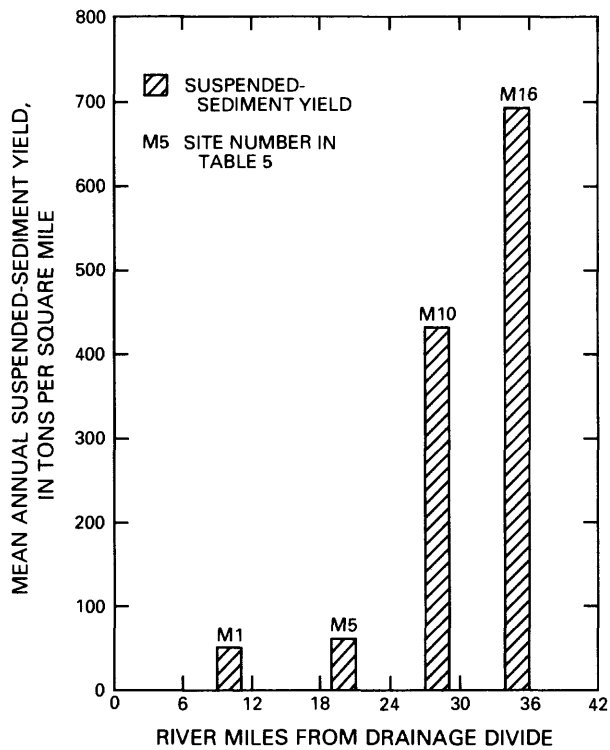

Figure 5.--Mean annual suspended-sediment yield for suspended-sediment sampling sites on Monument Creek for water years 1985-88.

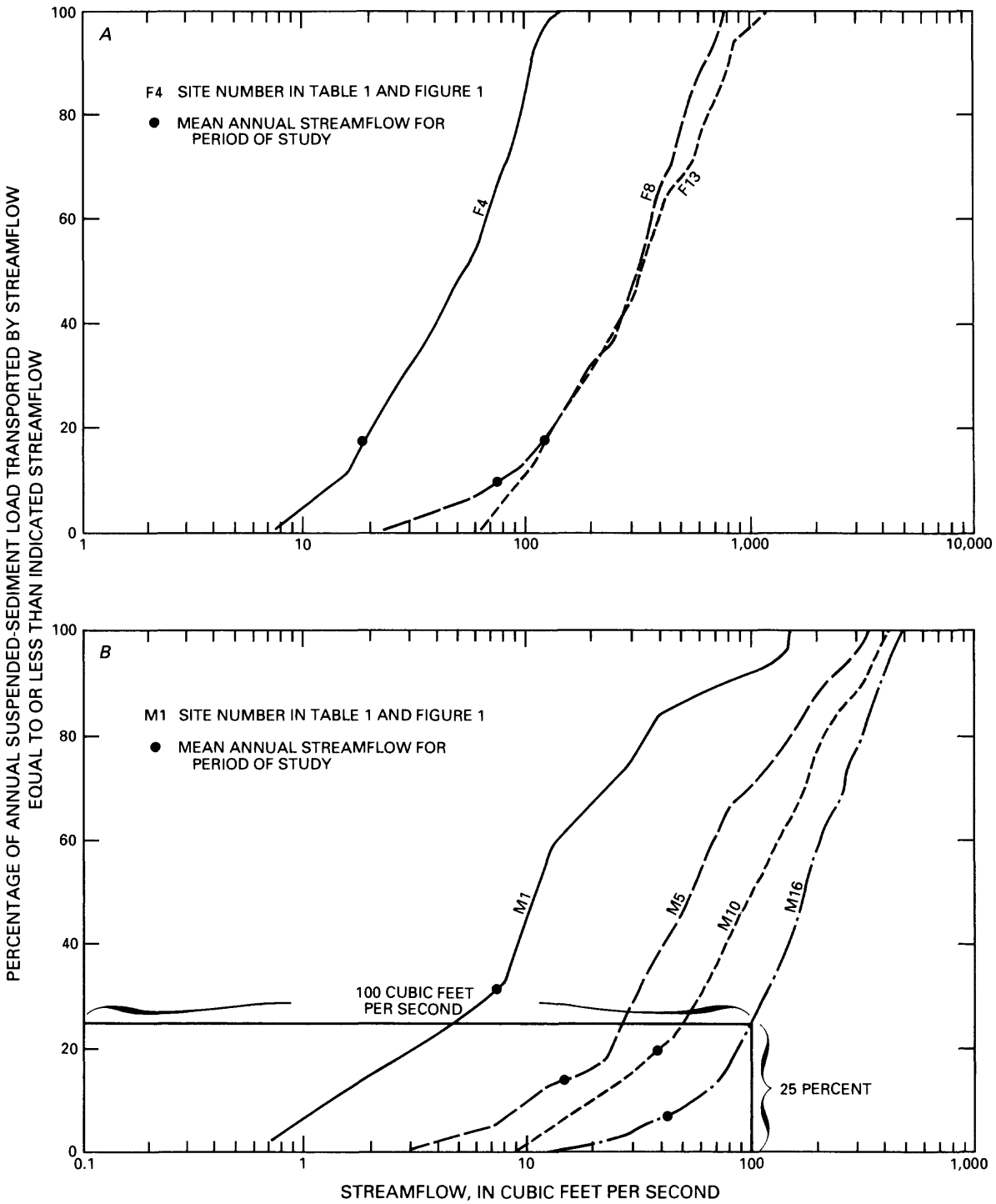

Figure 6.--Relation between percentage of annual suspended-sediment load and streamflow for suspended-sediment sampling sites on Fountain (A) and Monument (B) Creeks, water years 1985-88.

Comparison of Suspended-Sediment Yield in Fountain and Monument Creeks to Suspended-Sediment Yield of Other Streams in Colorado

To evaluate the relative magnitude of suspended-sediment yield in Fountain and Monument Creeks, mean annual suspended-sediment yield for selected sites in Fountain and Monument Creeks were compared with mean annual suspended-sediment yield from nine other streams in Colorado (fig. 7; table 6) (Elliott and DeFeyter, 1986). Sites were selected that have established relations of suspended-sediment discharge to streamflow and that have the same periods of streamflow record (water years 1977-82). Daily streamflow data for water years 1977-82 were available for Fountain Creek near Colorado Springs (site F4), Fountain Creek at Colorado Springs (F8), Fountain Creek at Security (site F13), Monument Creek at Palmer Lake (site M1), and Monument Creek at Pikeview (site M10) (table 1; fig. 1). Suspended-sediment discharge for water years 1977-82 at sites F4, F8, F13, M1, and M10 were calculated using the regression equations listed in table 4. These data were used to compute mean annual suspended-sediment yields in tons per square mile for each site (table 6). For the purposes of this analysis, it is assumed that the conditions that affect the relation of suspended-sediment discharge to streamflow developed for sites on Fountain and Monument Creeks for water years 1985-88 are representative of conditions during water years 1977-82. This comparison is only valid for the period of record and does not represent long-term average conditions.

The nine sites selected for comparison have drainage-basin areas that range in size from 22.1 to 550 mi^2, which are similar to those for sites on Fountain and Monument Creeks. General geologic, land use, and streamflow characteristics of the drainage basins for the nine comparison sites and the sites on Fountain and Monument Creeks also are listed in table 6.

For sites on Fountain and Monument Creeks, mean annual streamflow per unit area generally is less than the comparison sites (table 6). This difference may be attributed to climatic differences between the sites on Fountain and Monument Creeks and the comparison sites. There also may be larger volumes of streamflow associated with greater snowmelt runoff and transmountain diversions of streamflow in some of the drainage basins of the comparison sites.

Except for the Purgatoire River at Madrid (site 4; fig. 7; table 6), mean annual suspended-sediment yield at Fountain Creek near Colorado Springs (site F4), Fountain Creek at Colorado Springs (site F8), Fountain Creek at Security (site F13), and Monument Creek at Pikeview (site M10) were larger than the mean annual suspended-sediment yields for the comparison sites (table 6). Rainfall runoff in the study area may produce more frequent flooding than in the drainage basins upstream from the comparison sites. Rain-splash erosion, which is associated with rainfall, and greater streambank erosion in stream channels downstream from urban areas may account for the generally larger suspended-sediment yields for sites in the study area than for the comparison sites. Suspended-sediment yield at the Purgatoire River at Madrid (site 4; table 6) is affected by active streambank erosion, remnants of coal mining, and easily erodible sedimentary rocks in the drainage basin.

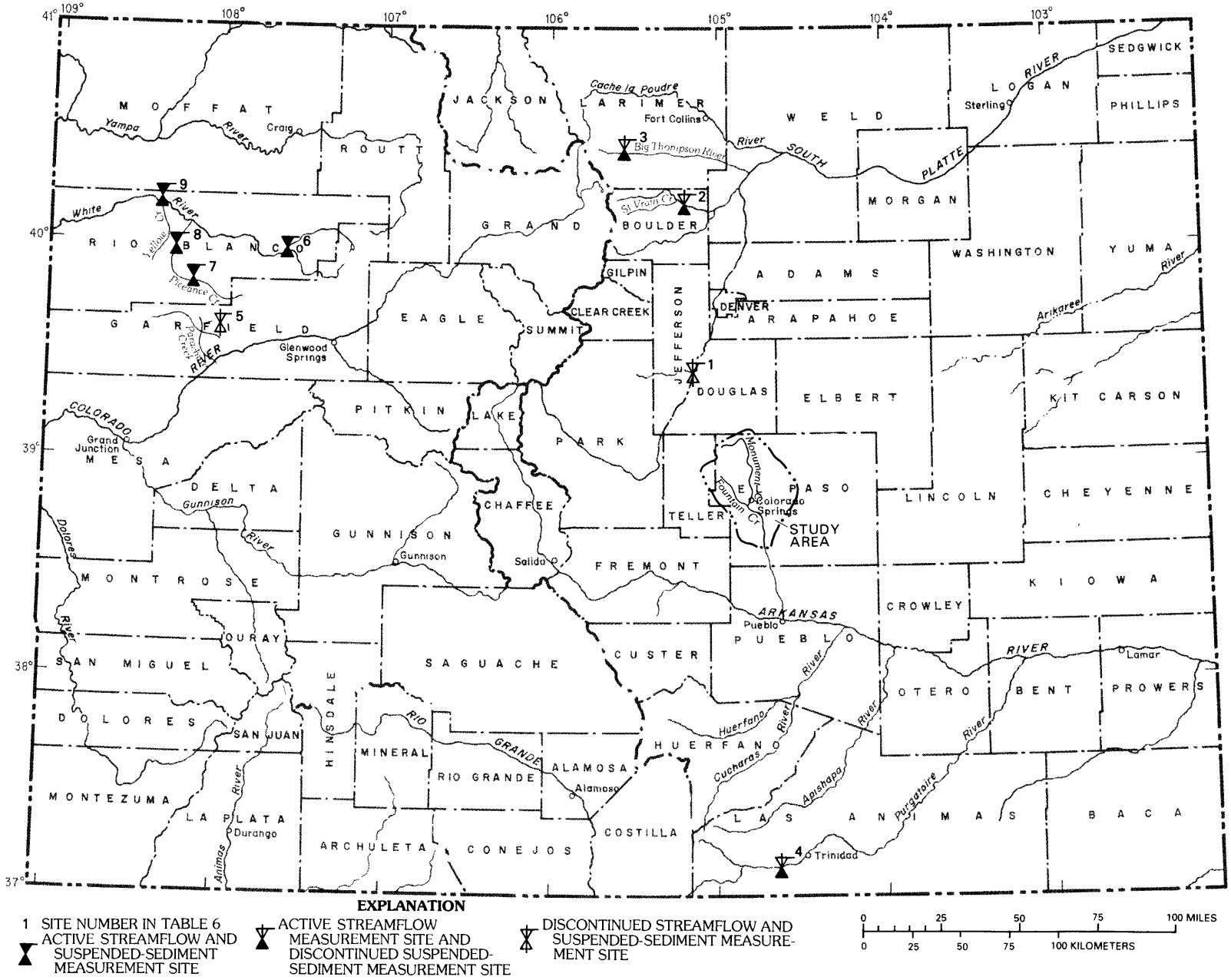

Figure 7.--Location of selected suspended-sediment sampling sites in Colorado used for comparison to sites on Fountain and Monument Creeks.

Table 6.--*General drainage-basin characteristics and summary of mean annual streamflow and mean annual suspended-sediment yield for selected streams in Colorado during water years 1977-82*

[R, Rural; M, mining; U, urbanized]

Site number[1]	U.S. Geological Survey station name and station number	Elevation (feet)	Drainage-basin area (square miles)	Generalized drainage-basin characteristics			Mean annual	
				Surface geology	Land use	Sources of peak streamflow	Streamflow (acre-feet per square mile)	Suspended-sediment yield (tons per square mile)
1	North Fork South Platte River at South Platte 06707000	6,090	479	Granite	R	Snowmelt	368	32.6
2	Saint Vrain Creek at Lyons 06724000	5,290	212	Granite	R	Snowmelt	421	9.6
3	Big Thompson River at Estes Park 0673300	7,490	137	Granite	R	Snowmelt, rainfall	654	21.5
4	Purgatoire River at Madrid 07124200	6,260	550	Sedimentary	R,M	Snowmelt, rainfall	92.9	747
5	East Middle Fork Parachute Creek near Rio Blanco 09092850	7,400	22.1	Sedimentary	R	Snowmelt	203	175
6	South Fork White River at Buford 09304000	6,970	170	Sedimentary	R	Snowmelt	987	173
7	Piceance Creek below Rio Blanco 09306007	6,370	177	Sedimentary	R	Snowmelt, rainfall	48.3	71.0
8	Piceance Creek below Ryan Gulch near Rio Blanco 09306200	6,070	506	Sedimentary	R	Snowmelt, rainfall	30.6	34.2
9	Yellow Creek near White River 09306255	5,540	262	Sedimentary	R	Rainfall	5.1	200
F4	Fountain Creek near Colorado Springs 07103700	6,110	103	Sedimentary, granite	U	Snowmelt, rainfall	102	446
F8	Fountain Creek at Colorado Springs, 07105500	5,900	392	Sedimentary, granite	U	Snowmelt, rainfall	89	690
F13	Fountain Creek at Security 07105800	5,640	495	Sedimentary, granite	U	Snowmelt, rainfall	119	429
M1	Monument Creek at Palmer Lake 07103747	6,950	25.9	Granite	R	Snowmelt	115	28.8
M10	Monument Creek at Pikeview 07104000	6,200	204	Sedimentary, granite	U	Snowmelt, rainfall	65.5	202

[1]Single numbers indicate site numbers in figure 7; letters and numbers indicate site numbers in figure 1.

Bed Material and Bedload

Information about the characterization of bed material and bedload can be used to determine the relative health of a stream habitat (Molles, 1985; Sagar, 1986). Generally, large-sized bed material and stable stream channels provide healthier environments for benthic invertebrates.

Bed material is sediment composing the streambed. Bed material may be mobile sediments, which are sampled as suspended load or bedload. Bed-material samples, collected in conjunction with bedload samples, were collected by using a hand-held, 4.6-in.-diameter scoop. The edges of the open end of the scoop were beveled. The scoop was about 10 in. long and was mounted on a 5-ft long handle. Samples were collected by scooping perpendicular to the direction of streamflow at five or more verticals. To avoid the loss of fine material, the top 2 in. of sample were discarded before the scoop was emptied.

Bed-material samples collected in conjunction with benthic-invertebrate samples were collected from three, 1-ft^2 areas defined by the Surber sampler. Size distribution of bed-material samples collected in Fountain and Monument Creeks are listed in table 16 in the "Supplemental Information" section at the back of this report.

Bedload is sediment moving on or near the streambed. Bedload was collected at six periodic sampling sites (fig. 1; table 1) by using the Helley-Smith sampler with a 3- by 3-in. orifice (Helley and Smith, 1971; Emmett, 1980). Bedload samples were collected using the single-equal-width increment method described in Edwards and Glysson (1988). At each bedload-measurement site, stream-channel cross sections were located as close as possible to the previously sampled cross section. Variation in the location of stream-channel cross sections was due to selection of cross sections that could be waded under existing streamflow conditions. Samples number 14 and 16 (table 7) were collected from a bridge about 0.25 mi downstream from site F13. Bedload samples were collected periodically during snowmelt and rainfall runoff. Size distribution of bedload samples collected in Fountain and Monument Creeks are summarized in table 17 (in the "Supplemental Information" section at the back of this report).

Bedload discharge was computed by using the following equation:

$$Q_{bl} = \frac{S_w}{S_t} \quad C_w \quad 380.95 \qquad (5)$$

where Q_{bl} = bedload discharge, in tons per day;

S_w = total sample weight, in kilograms;

S_t = total sample time, in seconds;

C_w = stream channel width, in feet; and

380.95 = a unit conversion constant.

Table 7.--*Results of bedload sampling for selected sediment-sampling sites on Fountain and Monument Creeks, water years 1985-88*

[S, snowmelt runoff; R, rainfall runoff; B, base streamflow plus sewage-treatment-plant effluent; --, no data]

Number of bedload sample in figure 8	Date	Source of streamflow	Streamflow (cubic feet per second)	Stream channel width (feet)	Duration of sample (seconds)	Sample weight (kilograms)	Average channel-wide bedload discharge (tons per day per foot)	Total-bedload discharge (tons per day)
			FOUNTAIN CREEK NEAR COLORADO SPRINGS (SITE F4)					
1	04-04-85	S	22	17.0	960	0.77	0.31	5.2
2	04-18-85	S	35	19.8	1,440	3.37	.89	17.6
3	04-30-85	R	122	22.6	1,220	12.8	4.00	90.3
4	04-29-87	S	24	17.5	1,020	1.80	.67	11.8
			FOUNTAIN CREEK AT COLORADO SPRINGS (SITE F8)					
5	04-04-85	S	115	57.5	1,260	13.3	4.02	231
6	05-03-85	S	526	119	1,500	43.3	11.0	1,310
7	05-01-87	S	131	57.0	1,560	30.8	7.52	429
8	06-23-88	R	115	26.0	900	19.7	8.34	217
9	06-23-88	R	90	25.0	900	21.1	8.93	223
			FOUNTAIN CREEK AT SECURITY (SITE F13)					
10	04-04-85	S	197	53.0	1,080	17.2	6.06	322
11	05-03-85	S	633	111	1,260	29.4	8.88	987
12	10-28-85	B	123	68.5	1,320	14.2	4.09	281
13	05-01-87	S	170	82.5	1,560	21.9	5.34	441
14	08-26-87	R	1,190	115	330	26.9	31.0	3,570
15	06-15-88	R	130	51.5	1,560	10.3	2.51	130
16	08-09-88	R	1,000	127	345	16.9	18.7	2,370
			MONUMENT CREEK ABOVE NORTH GATE BOULEVARD AT U.S. AIR FORCE ACADEMY (SITE M5)					
17	04-18-85	S	62	15.0	1,140	18.1	6.05	90.7
18	05-03-85	S	199	35.0	1,320	68.8	19.8	695
19	04-30-87	S	33	16.4	900	0.38	0.16	2.6
			MONUMENT CREEK AT PIKEVIEW (SITE M10)					
20	04-03-85	S	57	55.5	1,080	4.0	1.41	78.3
21	05-02-85	S	321	76.0	1,080	31.3	11.0	839
22	04-29-87	S	72	54.5	1,500	20.1	5.10	278
			MONUMENT CREEK AT BIJOU STREET AT COLORADO SPRINGS (SITE M16)					
23	04-03-85	S	58	32.0	900	15.4	6.52	209
24	05-02-85	S	346	70.0	1,380	41.6	11.5	804
25	04-30-87	S	77	35.5	960	13.7	5.44	193

Table 7.--*Results of bedload sampling for selected sediment-sampling sites on Fountain and Monument Creeks, water years 1985-88*--Continued

Number of bedload sample in figure 8	Suspended-sediment concentration (milligrams per liter)	Suspended-sediment discharge[1] (tons per day)	Total sediment discharge[2] (tons per day)	Total sediment discharge, Colby's method[3] (tons per day)	Bedload discharge as a percentage of total sediment discharge (percent)
		FOUNTAIN CREEK NEAR COLORADO SPRINGS (SITE F4)			
1	42	1.7	6.9	11.7	75
2	93	3.1	20.7	31.1	85
3	4,900	1,300	1,390	2,300	6
4	157	5.7	17.5	37.4	67
		FOUNTAIN CREEK AT COLORADO SPRINGS (SITE F8)			
5	1,130	256	487	762	47
6	2,210	2,760	4,070	6,030	32
7	434	119	548	515	78
8	[4]4,470	888	1,100	--	20
9	[4]3,300	514	737	--	30
		FOUNTAIN CREEK AT SECURITY (SITE F13)			
10	993	373	695	1,210	46
11	2,280	565	1,550	7,800	64
12	135	25.5	306	218	92
13	494	135	576	711	77
14	[4]5,940	16,100	19,700	33,300	18
15	2,150	535	665	1,310	20
16	[4]11,200	27,200	29,600	--	8
		MONUMENT CREEK ABOVE NORTHGATE BOULEVARD AT U.S. AIR FORCE ACADEMY (SITE M5)			
17	330	46.7	137	164	66
18	1,060	495	1,190	1,250	58
19	151	14	16.6	18	16
		MONUMENT CREEK AT PIKEVIEW (SITE M10)			
20	1,030	54.1	132	415	59
21	2,720	1,880	2,720	4,930	31
22	449	30.8	309	352	90
		MONUMENT CREEK AT BIJOU STREET AT COLORADO SPRINGS (SITE M16)			
23	1,270	109	318	463	66
24	3,450	2,770	3,570	6,890	22
25	482	63.5	256	346	75

[1]Suspended-sediment discharge adjusted by computing percentage of streamflow sampled using methods described in Colby and Hubbell (1961).

[2]Total sediment discharge based on the sum of the measured bedload discharge and adjusted suspended-sediment discharge.

[3]Colby, 1957.

[4]The bedload sample was collected during a period of rapidly falling streamflow. Suspended-sediment concentration is a mean of suspended-sediment concentrations collected before and after the bedload sample was collected.

Definitions of grain-size classifications used for bed-material and bedload samples are discussed in Guy (1969). The median grain size of bed-material samples collected in conjunction with bedload samples was very coarse sand (in the range of 1.0 to 2.0 mm) to very coarse gravel (in the range of 32.0 to 64.0 mm). Median grain size of bed material sampled in conjunction with benthic-invertebrate samples was very coarse sand (in the range of 1.0 to 2.0 mm) to small cobbles (in the range of 64 to 128 mm) (table 16 in the "Supplemental Information" section at the back of this report). The median grain size of all bedload samples was coarse sand (in the range of 0.50 to 1.0 mm) to very fine gravel (in the range of 2.0 to 4.0 mm) (table 17, in the "Supplemental Information" section at the back of this report).

The median d_{50} of bed-material and bedload samples is summarized in table 8. The difference in median d_{50} between the two sets of bed-material samples is a result of the collection of bed-material samples at bedload and benthic-invertebrate sampling sites. The most desirable site for collecting bedload samples is at uniform stream cross sections that have bed material with a uniform distribution of sediment grain sizes. When bed material is homogeneous, "perching" of the bedload sampler on large gravel and cobbles is avoided, and the loss of bedload sample transported under the sampler is minimized. Benthic-invertebrate sampling sites were selected to represent the variation in benthic invertebrates associated with existing bed-material conditions, which at most sites tended to include coarse gravel to cobbles. Size distribution of bed material is determined by calculating the percent of the total sample weight for each size class represented. Collection of only one or two grains of coarser bed material may skew the size distribution of samples collected in heterogenous bed material. Bed-material samples collected in conjunction with benthic invertebrates were collected where bed material was heterogenous, unlike the homogenous bed-material conditions desired for bedload sampling. Because of these sampling-site selection criteria, with the exception of Monument Creek at Pikeview (site M10), where bed material is mostly sand to very fine gravel (table 16 in the "Supplemental Information" section at the back of this report), bed-material samples collected in conjunction with benthic-invertebrate samples included a larger percentage of coarse grain sizes than those collected in conjunction with bedload samples (table 16).

Table 8.--*Median grain-size statistics for bed-material and bedload samples for selected sites on Fountain and Monument Creeks, water years 1985-88*

[d_{50}, median grain size; --, not applicable]

Site number in figure 1	U.S. Geological Survey station number	Median d_{50}, in millimeters		
		Bed-material samples		Bedload samples
		Sampled in conjunction with bedload samples	Sampled in conjunction with benthic-invertebrate samples	
F4	07103700	3.29	51.0	1.71
F8	07105500	2.57	40.0	1.52
F13	07105800	2.33	12.0	1.35
M5	07103780	6.23	60.0	3.05
M10	07104000	1.93	1.83	1.43
M16	07104905	1.96	--	1.76

Results of bedload sampling listed in table 17 (in the "Supplemental Information" section at the back of this report) are summarized in table 7. To evaluate the relative magnitude of bedload discharge measured at sites on Fountain and Monument Creeks, bedload discharge was calculated as a percentage of total sediment discharge for all bedload samples collected (table 7).

Total sediment discharge was determined by using two methods. The first method is the sum of measured bedload discharge and adjusted suspended-sediment discharge. Computations of suspended-sediment discharge account for some of the suspended-sediment discharge in the unsampled zone. The unsampled zone can be described as follows:

> Sampling the entire depth of the water column is not possible because the location of the suspended-sediment sampler nozzle relative to the bottom of the sampler prevents the nozzle from passing through the zone (unsampled zone) close to the streambed (Edwards and Glysson, 1988, p. 3).

In order to avoid the inherent bias that suspended-sediment discharge computations would contribute to the calculation of total sediment discharge, adjusted suspended-sediment discharges were computed based on the percentage of streamflow sampled. Percentage of streamflow sampled was determined using methods described in Colby and Hubbell (1961).

The second method for determining total sediment discharge was developed by Colby (1957). Colby's method is used to calculate total sediment discharge by relating unmeasured sediment discharge to mean velocity and to concentration of measured suspended sediment. Total sediment discharge calculated using Colby's method usually was larger than measured total sediment discharge. Results from the two methods are compared in table 7 for sites where bedload discharge was measured.

Studies of sediment transport in the Big Lost River, Idaho, Big Sandy River, Wyoming, and the Yampa River, Colorado, have indicated that bedload discharge as a percentage of total sediment discharge ranged from about 1.0 to about 83 percent (Kircher, 1982; Elliott and others, 1984; Williams and Krupin, 1984). A similar range in percentage (6 to 92) occurs at bedload sampling sites on Fountain and Monument Creeks.

Except for one bedload measurement sample (number 12, table 7), bedload discharge measurements represent snowmelt or rainfall-runoff conditions. Bedload sample number 12 (table 7) represents streamflow conditions where about one-half of the streamflow discharge was base streamflow and the remainder was sewage-treatment-plant effluent. Bedload discharge as a percentage of total sediment discharge usually was smallest during rainfall runoff and ranged from 6 to 30 percent (fig. 8; table 7). During rainfall runoff, fine sediments are introduced into streams by erosion resulting from rain splash and surface runoff; fine sediments also are suspended from the streambed. When supply of fine sediments is limited, bedload discharge increases as a percentage of total sediment discharge. Bedload discharge, as a percentage of total sediment discharge during snowmelt runoff, ranged from 16 to 90 percent (fig. 8; table 7). This variation is a result of the natural variability of bedload transport and the variability of the supply of fine sediments for transport as suspended sediment. Bedload samples 6, 19, 21, and 24 have the smallest bedload discharge as a percentage of total sediment

discharge for samples collected during snowmelt runoff (fig. 8; table 7). The small total bedload discharge for sample 19 (2.6 tons/d) may be a result of a lack of sand-sized particles available for transport (table 16 in the "Supplemental Information" section at the back of this report). Bedload-sample numbers 6, 21, and 24 were collected near the peak discharge of the snowmelt runoff when fine sediments from the stream channel were readily available for transport as suspended sediment. The remaining samples that have a larger bedload discharge as a percentage of total sediment discharge were collected after the snowmelt-runoff peak and represent sediment-transport conditions where fine sediments have been flushed out of the stream channel and where there is no contribution of fine sediments from streams tributary to Fountain Creek.

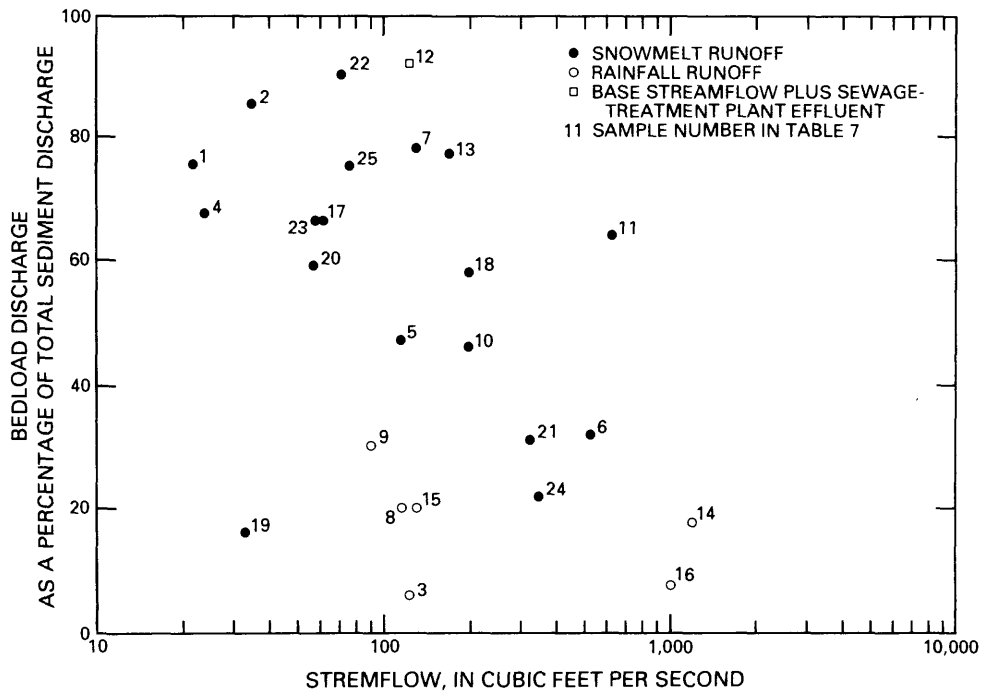

Figure 8.--Relation of streamflow and bedload discharge as a percentage of total sediment discharge for bedload-sampling sites on Fountain and Monument Creeks.

The competence of streamflow can be described by using the Shields (1936) dimensionless shear-stress relation for estimating the particle size of bed material at the threshold of movement. Maximum particle size of bed material transportable for various streamflows was estimated by using the following equation (Elliott and others, 1984):

$$d_c = \frac{\overline{D}\, S}{(\gamma_s/\gamma - 1)\, \tau^*_c}(304.8) \qquad (6)$$

where d_c = particle size of bed material, in millimeters, at threshold of movement;

$\bar{D}$ = mean channel depth, in feet;
S = water-surface slope;
γ_s/γ = ratio of specific weights of sediment and water (2.65);
τ^*_c = dimensionless critical shear stress--the critical shear stress necessary for movement of bed material; and
304.8 = a unit conversion constant, in millimeters per feet.

The large quantities of bedload transported by Fountain and Monument Creeks (table 7) are indicative of streamflow conditions during which the critical shear stress necessary for bed-material movement (competence) is normally met or exceeded. Entrainment of gravel and cobbles in natural streams usually is estimated by using values of τ^*_c that range from 0.045 to 0.060 (Andrews, 1983). Ranges of sediment-particle sizes at threshold of movement, computed by using τ^*_c of 0.045 and 0.060, for selected sediment-sampling sites on Fountain and Monument Creeks are summarized in table 9. The particle size of bed material at the threshold of movement, d_c, is much larger than the d_{50} of most of the bed-material samples collected in conjunction with stream channel depth and water-surface slope measurements (these samples were collected at cross sections where bedload discharge was measured) (table 9). Comparison of d_c with the median d_{50} of bed-material samples collected in conjunction with benthic-invertebrate samples (table 8) indicates that d_c usually is much larger than d_{50} at Fountain Creek at Security (site F13) and Monument Creek at Pikeview (site M10). The median d_{50} of bed-material samples collected in conjunction with benthic-invertebrate samples at Fountain Creek near Colorado Springs (site F4), Fountain Creek at Colorado Springs (site F8), and Monument Creek at USAFA (site M5) usually were larger than d_c.

The range of particle sizes at threshold of movement listed in table 9 represent conditions associated with small to moderate streamflows. The upper limit of particle sizes at threshold of movement would be larger for higher streamflows. For example, a peak streamflow of 2,400 ft^3/s and a mean channel depth of 2.52 ft and a water-surface slope of 0.006 was recorded for a flood that occurred June 1, 1977, at Fountain Creek at Colorado Springs (site F8). Particle sizes at threshold of movement (d_c) for dimensionless critical shear stresses (τ^*_c) of 0.45 and 0.60 were 62.1 and 46.5 mm. These values of d_c exceed the median d_{50} of bed-material samples collected at site F8 in conjunction with bedload and benthic-invertebrate samples (table 8). This analysis indicates that Fountain and Monument Creeks are capable of transporting most of the bed-material grain sizes sampled (table 9, and table 16 in the "Supplemental Information" section at the back of this report).

Stream-Channel Cross Sections

Changes in streambed elevation in Fountain and Monument Creeks were determined semiquantitatively by monitoring a network of stream-channel cross sections. Stream-channel cross sections, hereinafter referred to as cross sections, were located at Fountain Creek near Colorado Springs (site F4), Fountain Creek at Colorado Springs (site F8), Fountain Creek at Security (site F13), Monument Creek at USAFA (site M5), and Monument Creek at Pikeview (site M10) (fig. 1; table 1).

Table 9.--*Summary of calculations for sediment-particle sizes at threshold of movement*

[--, indicates no data]

Date	Streamflow (cubic feet per second)	Mean channel depth (feet)	Water-surface slope[1] (feet per feet)	Bed material sampled in conjunction with stream channel depth and water-surface slope measurements[2]		Particle size of bed material (d_c) at threshold of movement for dimensionless critical shear stress (millimeters)	
				Grain size at 50th (d_{50}) percentile (millimeters)	Grain size at 95th (d_{95}) percentile (millimeters)	τ_{*c} =0.045	τ_{*c} =0.060
FOUNTAIN CREEK NEAR COLORADO SPRINGS (SITE F4)							
04-30-85	122	1.29	0.01	2.9	29.0	53.0	39.7
04-29-87	24	.61	.008	2.1	10.8	20.0	15.0
FOUNTAIN CREEK AT COLORADO SPRINGS (SITE F8)							
05-03-85	526	1.10	.003	3.4	34.0	13.5	10.2
05-01-87	131	.73	.006	2.6	107.0	18.0	13.5
06-23-88	[3]102	[4].60	.006	2.9	14.2	14.8	11.1
FOUNTAIN CREEK AT SECURITY (SITE F13)							
05-03-85	633	1.23	.011	2.1	24.8	55.5	41.6
10-28-85	123	.62	.010	2.5	35.7	25.4	19.1
05-01-87	170	.64	.007	1.8	8.2	18.4	13.8
06-15-88	150	.89	.003	--	--	11.0	8.2
MONUMENT CREEK ABOVE NORTH GATE BOULEVARD AT U.S. AIR FORCE ACADEMY (SITE M5)							
04-18-85	62	1.23	.005	6.2	29.5	25.2	18.9
05-03-85	199	1.40	.004	2.7	15.4	23.0	17.2
04-30-87	33	.91	.006	52.7	119.6	22.4	16.8
MONUMENT CREEK AT PIKEVIEW (SITE M10)							
10-28-85	24.3	0.25	0.020	1.5	6.0	20.5	15.4
04-29-87	72	.44	.015	2.5	13.0	27.1	20.3
MONUMENT CREEK AT BIJOU STREET AT COLORADO SPRINGS (SITE M16)							
05-02-85	346	1.12	.010	1.9	23.8	46.0	34.5
04-30-87	77	.64	.006	1.5	9.0	15.8	11.8

[1]Water-surface slope was measured by a transit survey of water-surface elevations.
[2]Bed-material samples were collected at cross sections where bedload discharge was measured.
[3]Average of two streamflow measurements made in conjunction with bedload sampling (table 7).
[4]Estimated.

Cross sections were established in the vicinity of streamflow-gaging stations and were referenced to the local stream-gage datum or an arbitrary datum. Surveys of the cross sections were done periodically, usually in conjunction with benthic-invertebrate sampling. Cross-section data are summarized in table 18 in the "Supplemental Information" section at the back of this report.

Fountain Creek

The cross section at site F4 was established about 200 ft upstream from the stream gage. Cross-section measurements made at site F4 indicate little or no measured change in streambed elevation (fig. 16 and table 18 in the "Supplemental Information" section at the back of this report).

Two cross sections were established at site F8, one about 200 ft upstream from the stream gage and the other about 300 ft downstream from the stream gage. The two cross sections at site F8 are depicted in figures 17 and 18 in the "Supplemental Information" section at the back of this report. Maximum measured changes in streambed elevation between consecutive cross-section surveys was -0.8 (October 29, 1985, to April 14, 1986, cross-section stations 34.0 and 40.0) and 1.9 ft (August 12, 1985, to October 29, 1985, cross-section station 105.0) at the upstream cross section and -1.4 (July 10, 1986, to August 25, 1986, cross-section station 20.0) and 1.4 ft (August 25, 1986, to November 7, 1986, cross section station 20.0) at the downstream cross section (table 18 in the "Supplemental Information" section at the back of this report). The streambed at site F8 is mobile, and bedload transport occurs during most streamflows (tables 7 and 9).

The cross section at site F13 is located about 200 ft upstream from the stream gage. Maximum measured changes in streambed elevation between consecutive cross-section surveys was -1.1 (July 11, 1985, to July 23, 1985, cross-section stations 40.0 and 100.0) and 1.4 ft (July 11, 1985, to July 23, 1985, cross-section station 25.5) (table 18 in the "Supplemental Information" section at the back of this report). The streambed at site F13 is mobile during most streamflow conditions. A series of cross-section surveys made at site F13 from January 11, 1985, through October 29, 1985, illustrates how streambed elevations may fluctuate in stream reaches that have a mobile streambed (fig. 9).

Monument Creek

The cross section at site M5 is located about 100 ft downstream from the stream gage. Cross-section measurements made at site M5 indicate little or no measured change in streambed elevation in the stream channel (fig. 19 in the "Supplemental Information" section at the back of this report; table 18).

The cross section at site M10 is located about 100 ft downstream from the stream gage. Examples of the cross section are shown in figure 20 in the "Supplemental Information" section at the back of this report. The cross sections depicted in figure 20 are for stations 92.0 through 172.0 ft (table 18). The entire cross section is about 172.0 ft wide; however, the active stream channel having perennial streamflow is only about 80.0 ft wide. Maximum measured changes in streambed elevation between consecutive cross-section surveys was -1.8 ft (April 29, 1987, to July 14, 1987, cross section station 66.0) and 1.2 ft (July 14, 1987, to August 27, 1987, cross section station 66.0) (table 18). The streambed is mobile, and changes in streambed elevation occur during most streamflows.

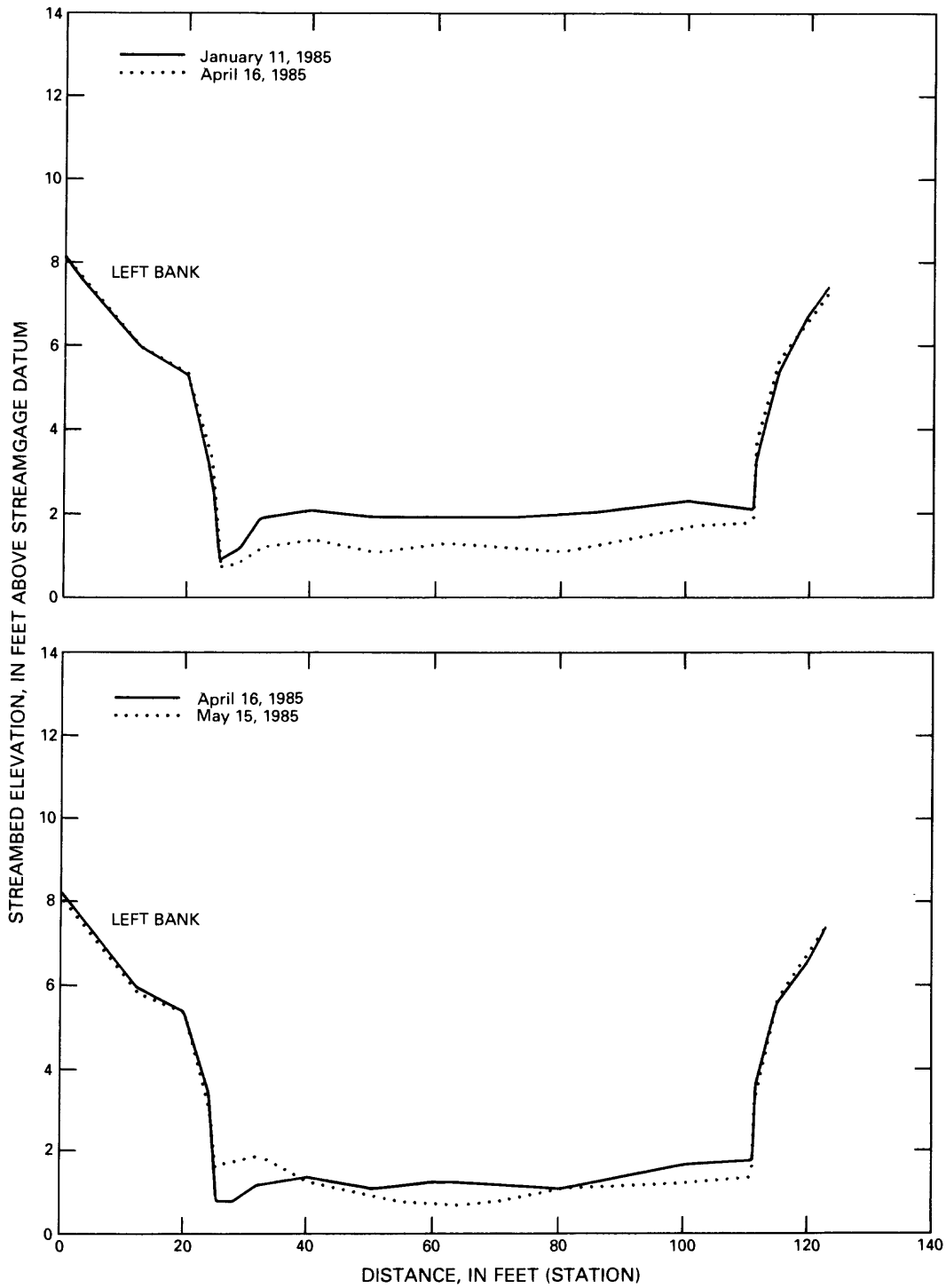

Figure 9.--Selected stream-channel cross-section surveys for Fountain Creek at Security (site F13).

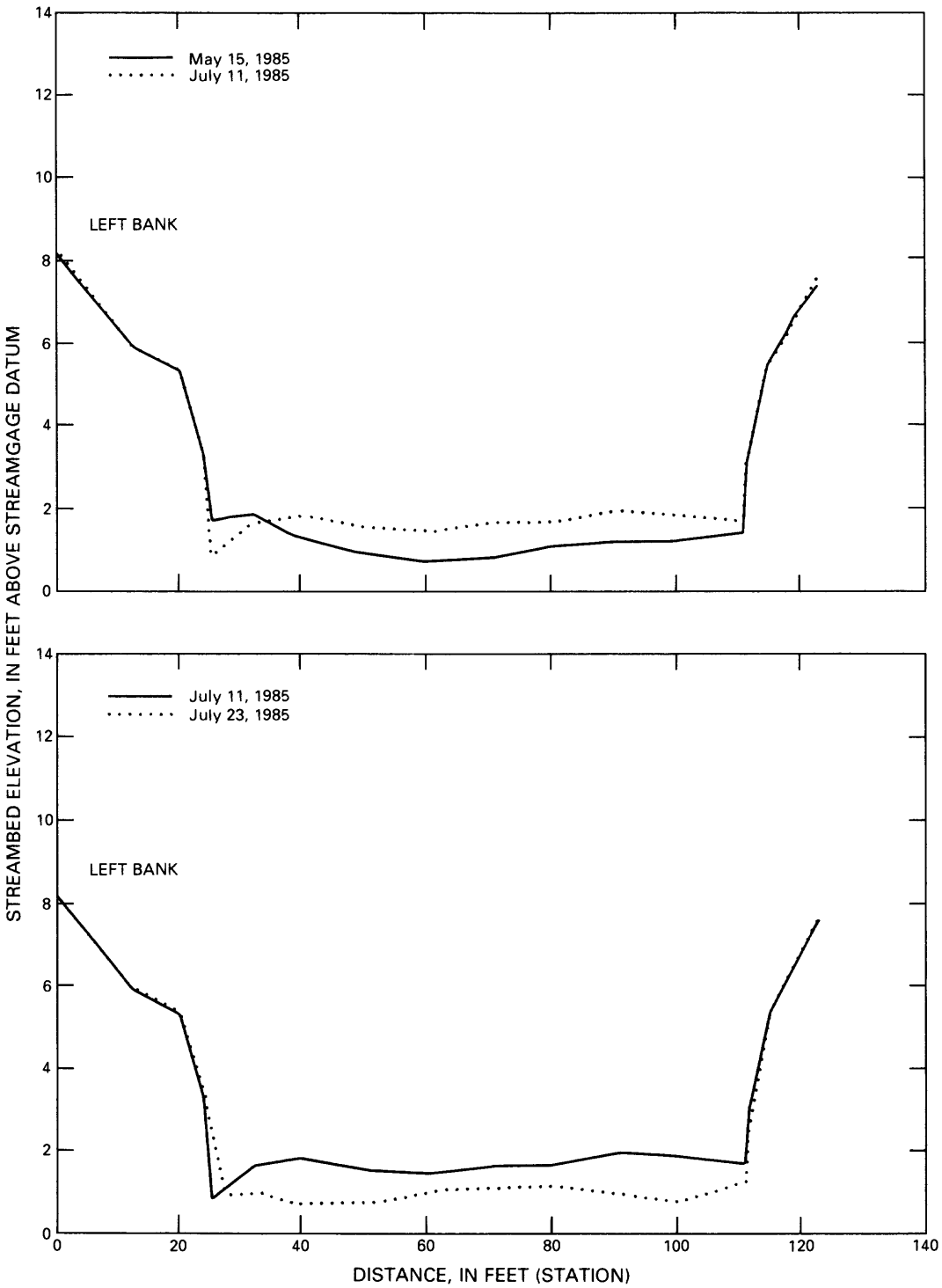

Figure 9.--Selected stream-channel cross-section surveys for Fountain Creek at Security (site F13)--Continued.

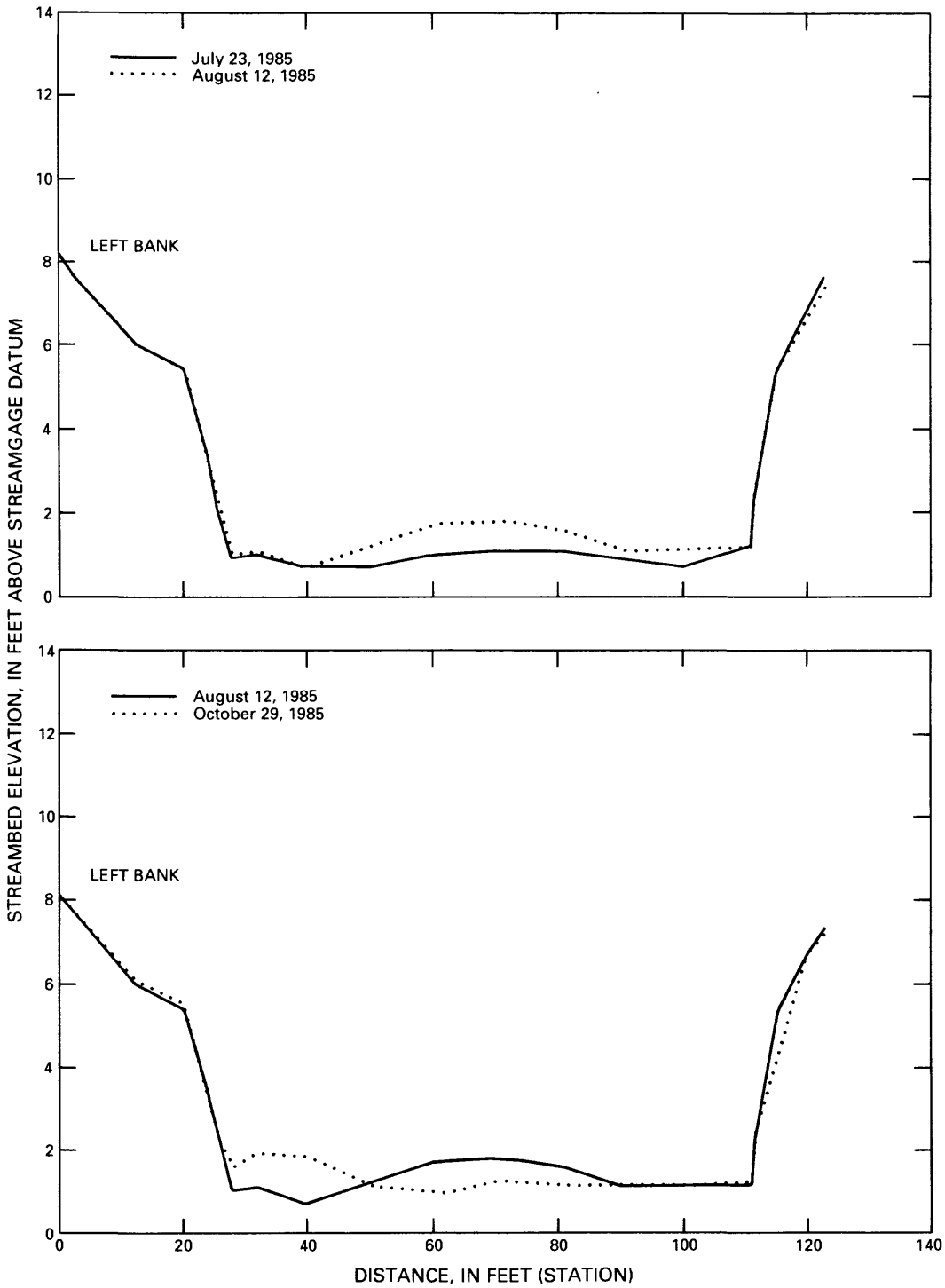

Figure 9.--Selected stream-channel cross-section surveys for Fountain Creek at Security (site F13)--Continued.

BENTHIC INVERTEBRATES

The annual streamflow regime and the transport of sediment in a stream environment can affect the occurrence and abundance of stream biota (Canton and others, 1984; Molles, 1985; Meffe and Minckley, 1986; Sagar, 1986). The following is a discussion of the temporal and spatial occurrence of benthic invertebrates at five selected sites on Fountain and Monument Creeks (fig. 1, table 1).

Sampling Methods and Sampling-Site Descriptions

Benthic-invertebrate samples were collected at sites that represent a variety of hydrologic, water quality, and stream-habitat conditions. All sampling sites were located at U.S. Geological Survey streamflow-gaging stations (fig. 1; table 1).

Collection

From April 1985 to September 1988, benthic-invertebrate samples were collected four times a year at five sites within the basin, except for 1988, when no samples were collected during the fall. Samples were collected in April prior to the majority of snowmelt runoff (spring), after snowmelt runoff in late June to early July (early summer), after periods of rainfall runoff in mid August to early September (late summer), and in late October to early November (fall) (fig. 2).

Benthic-invertebrate samples were collected by using a 1-ft^2 Surber sampler that has a 210-μm (micrometer) mesh net, and by using methods described by Britton and Greeson (1989). Three replicate samples were collected in riffle areas at each site. Where no riffles occurred, replicate samples were collected from bed material in a flowing part of the stream that was representative of the site. According to Canton and Chadwick (1988), three replicate samples can provide an acceptable estimate of total density of benthic invertebrates. Benthic-invertebrate samples were analyzed for total number of organisms and total number of taxa by a commercial laboratory. Onsite measurements of water temperature, specific conductance, pH, and dissolved oxygen were made during each sample collection. As noted earlier, bed-material samples were collected in conjunction with most of the benthic-invertebrate samples (table 16 in the "Supplemental Information" section at the back of this report). Summary data for water temperature, specific conductance, pH, and dissolved oxygen measured in Fountain Creek, in conjunction with benthic-invertebrate samples, are listed in table 10.

Fountain Creek

Fountain Creek near Colorado Springs (site F4) was the upstream sampling site on Fountain Creek (fig. 1). Elevation at the stream gage is 6,110 ft. Benthic-invertebrate samples were collected about 50 to 100 ft upstream from the stream gage. The stream channel at site F4 is about 15- to 30-ft wide and was completely shaded by mature cottonwood and willow trees. Bed material was sand, gravel, and small cobbles and had a median d_{50} of 51.0 mm (table 8).

Table 10.--*Summary of water-quality properties and constituents measured at sites on Fountain and Monument Creeks, water years 1985-88*

Site number in figure 1	Water temperature (degrees Celsius)		Specific conductance (microsiemens per centimeter at 25 degrees Celsius)		pH (standard units)		Dissolved oxygen (milligrams per liter)	
	Median	Range	Median	Range	Median	Range	Median	Range
F4	13.0	7.0-17.5	289	179-415	8.3	7.9-8.7	8.4	7.0-11.4
F8	18.0	7.5-27.0	495	290-953	8.3	7.8-8.6	7.5	6.5-11.8
F13	17.0	11.0-27.0	770	500-975	7.9	7.4-8.1	6.2	3.8-8.9
M5	11.5	4.0-24.0	210	122-365	8.4	7.5-9.4	8.3	6.0-11.6
M10	16.5	10.0-26.0	345	220-497	8.3	7.2-8.5	7.4	5.2-9.8

The sampling site at Fountain Creek at Colorado Springs (site F8) is located about 1.3 stream miles downstream from the confluence of Monument Creek (fig. 1). Streamflow and suspended-sediment transport at this site are affected greatly by inflows from Monument Creek (von Guerard, 1989). Benthic-invertebrate samples were collected 100 to 200 ft upstream from the stream gage, and upstream from the confluence of Cheyenne Creek, which flows into Fountain Creek immediately upstream from the stream gage. Stream-channel width ranges from about 60 to 100 ft. Riparian vegetation included mature willows and cottonwoods. However, the stream channel generally was not shaded by the vegetation. Streambanks, which are undercut in some areas, provide localized shade. Bed material was mostly sand, gravel, and small cobbles, and the median d_{50} was 40.0 mm (table 8). During periods of base streamflow, the stream channel was mostly sand and gravel. The interstices between cobbles and boulders in the stream channel usually are filled with sand and gravel.

The sampling site at Fountain Creek at Security (site F13) is located at the outflow of the basin (fig. 1). Benthic invertebrates were collected about 50 to 150 ft downstream from the stream gage. Stream-channel width was about 80 to 100 ft. The stream channel was intermittently shaded by high streambanks and mature cottonwood and willow trees. Bed material was mostly sand and gravel and had a median d_{50} of 12.0 mm (table 8). At times, the stream channel was eroded to shale bedrock.

Monument Creek

Monument Creek at USAFA (site M5) was the upstream sampling site on Monument Creek (fig. 1). Benthic invertebrates were collected in a riffle about 300 ft upstream from the stream gage. The stream channel in the vicinity of the gage was about 15- to 25-ft wide. Intermittent shade was provided by streambanks and riparian vegetation. Bed material was sand, gravel, and small to large cobbles that had a median d_{50} of 60.0 mm (table 8).

The furthermost downstream benthic-invertebrate sampling site on Monument Creek was Monument Creek at Pikeview (site M10) (fig. 1). Benthic-invertebrate samples were collected 50 to 100 ft downstream from the stream gage. The stream channel in the vicinity of the gage was bout 60 to 90 feet wide. Intermittent shade was provided by riparian vegetation. Bed material was sand and gravel that had a median d_{50} of 1.83 mm (table 8).

Benthic-Invertebrate Composition and Occurrence

Understanding the composition and occurrence of benthic-invertebrate communities is useful for identifying stream reaches that have healthy (large numbers of organisms and taxa) or unhealthy (small numbers of organisms and taxa) aquatic environments. The presence or absence of benthic-invertebrate taxa may determine the abundance of and occurrence of fish populations. Plecoptera (stoneflies), Diptera (true flies), and Trichoptera (caddisflies) larvae are an important part of the diet of certain fish, especially trout (Pennak, 1978). There were 138 taxa identified at the 5 sampling sites on Fountain and Monument Creeks; however, only 24 were common to all sites. For the purposes of this analysis, except for pupa, taxa include all organisms identified. Benthic-invertebrate data from five selected sites on Fountain and Monument Creeks are summarized in table 19 in the "Supplemental Information" section at the back of this report.

Fountain Creek

There were 81 taxa identified at Fountain Creek near Colorado Springs (site F4). Mean densities of total organisms collected ranged from 90 to 8,800 organisms/m^2 (table 11), and the median was 1,400/m^2. On all sampling dates, Ephemeroptera (mayflies), Diptera (true flies), and Oligochaeta (worms) comprised about 80 to about 100 percent of the mean density of organisms.

There were major changes in community structure at site F4 during the four sampling periods. Diptera (including *Cricotopus* sp., *Diamesa* sp., *Orthocladius* sp., and *Parametriocnemus* sp.), were the most abundant organisms collected during spring at site F4 (fig. 10; table 11; and table 19 in the "Supplemental Information" section at the back of this report). *Cricotopus* sp. and *Diamesa* sp. composed from 0 to about 34 percent and about 6 to about 20 percent of the mean total density of organisms collected during spring. Oligochaeta were the second most abundant groups of organisms collected at site F4 (fig. 10). *Limnodrilus* sp. composed 0 to about 50 percent of the mean total density of organisms collected during spring. Ephemeroptera and Trichoptera represented most of the remaining organisms collected during spring (fig. 10).

The most abundant groups of organisms collected during early summer were from the groups Oligochaeta and Ephemeroptera (fig. 11; table 11). *Limnodrilus* sp. was the worm most frequently collected and was the most abundant organism, comprising from 0 to about 73 percent of the mean total density of organisms collected during early summer sampling. *Baetis tricaudatus* was the most frequently collected and most abundant mayfly, comprising from about 9.0 to about 33 percent of the mean total density of organisms collected during early summer. Organisms from the groups Diptera and Trichoptera represented most of the remaining organisms collected during early summer (fig. 11).

Table 11.--*Summary of mean densities of organisms for major taxonomic groups and all taxa for benthic invertebrates collected at selected sites on Fountain and Monument Creeks, water years 1985-88*

[Densities are rounded to standard significant figures (Britton and Greeson, 1989); mean density of organisms including all taxa is sometimes less than the sum of mean densities of organisms of major taxa because of rounding to standard significant figures]

Date	Major taxa (mean density of organisms per square meter)					Mean density of organisms including all taxa (per square meter)
	Ephemeroptera (mayflies)	Plecoptera (stoneflies)	Trichoptera (caddisflies)	Diptera (true flies)	Oligochaeta (worms)	
07103700 FOUNTAIN CREEK NEAR COLORADO SPRINGS (SITE F4)						
04-16-85	39	7	0	590	600	1,200
07-11-85	930	110	11	1,300	6,400	8,800
08-12-85	520	22	7	170	100	840
10-28-85	1,900	33	450	170	110	2,600
04-14-86	1,200	23	630	5,400	850	8,200
07-10-86	1,100	21	120	400	1,800	3,500
08-25-86	180	0	0	90	40	310
11-05-86	800	11	120	320	100	1,400
04-27-87	320	8	0	900	140	1,400
07-15-87	470	11	0	320	460	1,300
08-26-87	1,100	68	65	290	36	1,600
11-04-87	1,200	47	190	160	150	1,700
04-25-88	47	11	7	450	74	630
06-30-88	160	4	32	120	120	490
09-07-88	7	0	18	58	7	90
07105500 FOUNTAIN CREEK AT COLORADO SPRINGS (SITE F8)						
04-16-85	18	26	0	330	97	470
07-11-85	440	11	18	3,500	480	4,400
08-12-85	0	0	4	48	47	120
10-28-85	15	0	7	180	220	430
04-14-86	7	0	0	220	110	340
07-10-86	54	0	4	270	39	380
08-25-86	36	4	4	160	51	260
11-05-86	11	0	0	420	640	1,100
04-27-87	54	4	0	730	950	1,700
07-15-87	93	4	7	530	120	760
09-01-87	47	4	0	230	50	330
11-04-87	120	0	0	570	90	780
04-25-88	0	0	0	95	43	140
06-30-88	11	7	4	36	51	120
09-07-88	68	0	0	590	14	680
07105800 FOUNTAIN CREEK AT SECURITY (SITE F13)						
04-16-85	0	4	0	90	190	280
07-11-85	54	0	0	2,300	9,300	12,000
08-12-85	0	0	0	51	110	160
10-28-85	4	0	0	32	1,700	1,700
04-14-86	0	0	0	470	1,900	2,400
07-10-86	57	0	0	360	2,400	2,800
08-25-86	0	0	0	160	120	280
11-05-86	4	4	0	81	3,800	3,900
04-27-87	11	0	0	1,800	16,000	18,000
07-15-87	29	0	0	360	6,200	6,600
09-01-87	43	0	0	200	1,100	1,300
11-04-87	0	0	0	140	4,100	4,300
04-25-88	7	0	4	560	2,500	3,000
06-30-88	15	4	0	200	76	290
09-07-88	29	0	0	11,000	13,000	24,000

Table 11.--*Summary of mean densities of organisms for major taxonomic groups and all taxa for benthic invertebrates collected at selected sites on Fountain and Monument Creeks, water years 1985-88*--Continued

Date	Major taxa (mean density of organisms per square meter)					Mean density of organisms including all taxa (per square meter)
	Ephemeroptera (mayflies)	Plecoptera (stoneflies)	Trichoptera (caddisflies)	Diptera (true flies)	Oligochaeta (worms)	
07103780 MONUMENT CREEK ABOVE NORTH GATE BOULEVARD AT U.S. AIR FORCE ACADEMY (SITE M5)						
04-16-85	22	4	0	180	250	460
07-11-85	8,300	93	320	5,600	3,900	18,000
08-12-85	5,200	57	780	3,400	29	9,500
10-29-85	7,000	770	2,900	2,200	5,000	18,000
04-14-86	720	25	220	2,000	3,500	6,400
07-10-86	4,300	0	730	1,700	6,200	13,000
08-25-86	7,200	270	6,300	1,800	1,600	17,000
11-05-86	4,800	170	4,900	6,800	2,800	20,000
04-27-87	350	8	100	1,400	6,100	8,000
07-14-87	3,000	0	1,000	2,000	580	6,600
08-26-87	4,300	110	2,700	2,300	620	10,000
11-04-87	940	78	920	2,400	6,100	10,000
04-25-88	25	4	25	290	330	680
06-30-88	3,200	14	590	1,700	310	5,900
09-07-88	2,100	44	2,200	830	130	5,300
07104000 MONUMENT CREEK AT PIKEVIEW (SITE M10)						
04-16-85	0	0	0	28	14	42
07-11-85	130	0	0	400	370	910
08-12-85	0	0	0	30	120	160
10-28-85	0	4	0	11	230	240
04-14-86	0	7	0	100	43	150
07-10-86	11	0	0	340	270	640
08-25-86	14	0	0	80	110	200
11-05-86	0	0	0	200	790	990
04-27-87	0	0	0	79	1,100	1,200
07-14-87	210	0	7	260	180	670
08-26-87	0	0	0	300	360	660
11-04-87	0	0	0	110	250	370
04-25-88	0	0	0	80	47	130
06-30-88	18	0	0	31	290	340
09-07-88	8	0	14	460	140	640

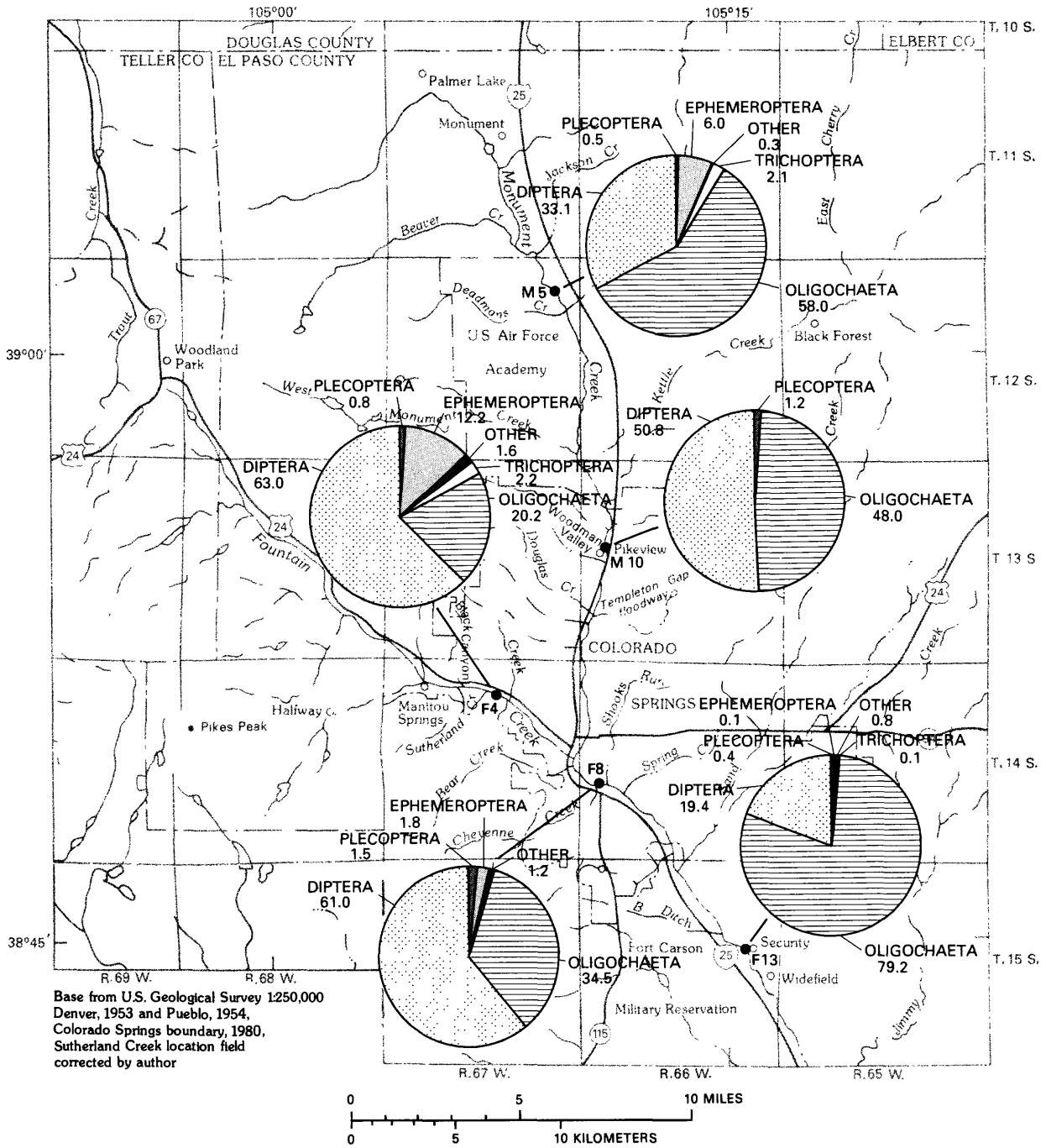

Figure 10.--Mean percentage composition of major taxonomic groups collected at selected sites on Fountain and Monument Creeks during spring (April).

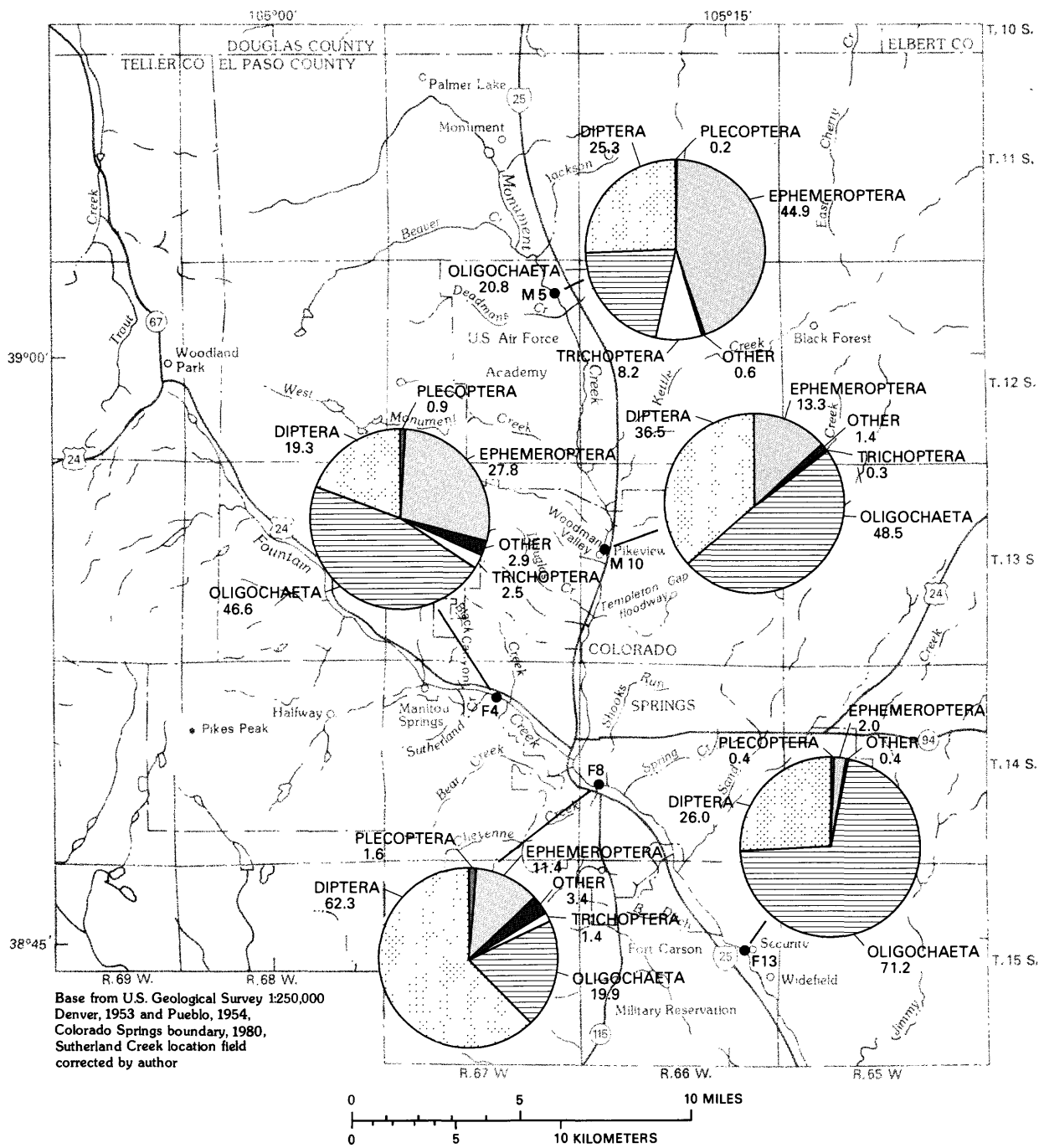

Figure 11.--Mean percentage composition of major taxonomic groups collected at selected sites on Fountain and Monument Creeks during early summer (late June to early July).

During late summer there was a decrease in the number of worms collected. Taxa from the groups Ephemeroptera and Diptera were the most abundant organisms collected during late summer (fig. 12). *Baetis tricaudatus* was the mayfly that occurred most frequently, comprising about 7.8 to about 61 percent of the mean total density of organisms collected. The true fly most frequently collected was *Parametriocnemus* sp., comprising from 0 to about 28 percent of the total organisms collected. Organisms from the groups Oligochaeta, Trichoptera, and Plecoptera represented most of the remaining organisms collected during late summer (fig. 12).

Mayflies were the most abundant organisms collected at site F4 during fall (fig. 13). *Baetis tricaudatus* comprised from about 34 to about 69 percent of the mean density of total organisms collected. Organisms from the groups Diptera, Trichoptera, and Oligochaeta represented the majority of the remaining organisms (fig. 13).

There were 63 taxa identified at Fountain Creek at Colorado Springs (site F8). Mean densities of total organisms ranged from 120 to 4,400 organisms/m^2 (table 11), and the median was 430 organisms/m^2. Seasonal changes in community structure were not apparent at this site; taxa from the groups Diptera and Oligochaeta were the most abundant organisms during all sampling periods. True flies were the most frequently collected organisms during all sampling periods (figs. 10-13). The true fly, *Parametriocnemus* sp. was collected during every sampling period and comprised about 2.7 to about 68 percent of the mean total density of organisms collected. *Limnodrilus* sp. was the most frequently collected worm, comprising from 0 to about 58 percent of the mean total density of organisms collected. Organisms from the groups Ephemeroptera, Plecoptera, and Trichoptera represented the majority of the remaining organisms (table 11). Caddisflies were not collected during spring but were collected during 7 of the remaining 11 sampling periods (table 11).

Fifty-five taxa were identified at Fountain Creek at Security (site F13). Mean density of total organisms ranged from 160 to 24,000 organisms/m^2 (table 11), and the median was 2,800 organisms/m^2. Worms were the most abundant and frequently collected organisms during all sampling periods (figs. 10-13). *Limnodrilus* sp. comprised from about 0 to about 97 percent of the mean total density of organisms collected. True flies, mainly *Parametriocnemus* sp., were the second most abundant group of organisms collected (figs. 10-13; table 11). Mayflies were present during 10 sampling periods. Stoneflies were only collected three times, once during spring, once during early summer, and once during fall. Caddisflies were present during only one sampling period (table 11).

Monument Creek

There were 78 taxa identified at Monument Creek at USAFA (site M5). Taxa from the groups Ephemeroptera, Diptera, Trichoptera, and Oligochaeta accounted for greater than 95 percent of total organisms sampled during all sampling periods. Plecoptera, although not present in large numbers, were collected during all but two sampling periods. Mean density of total organisms ranged from 460 to 20,000 organisms/m^2 (table 11), and the median was 9,500 organisms/m^2.

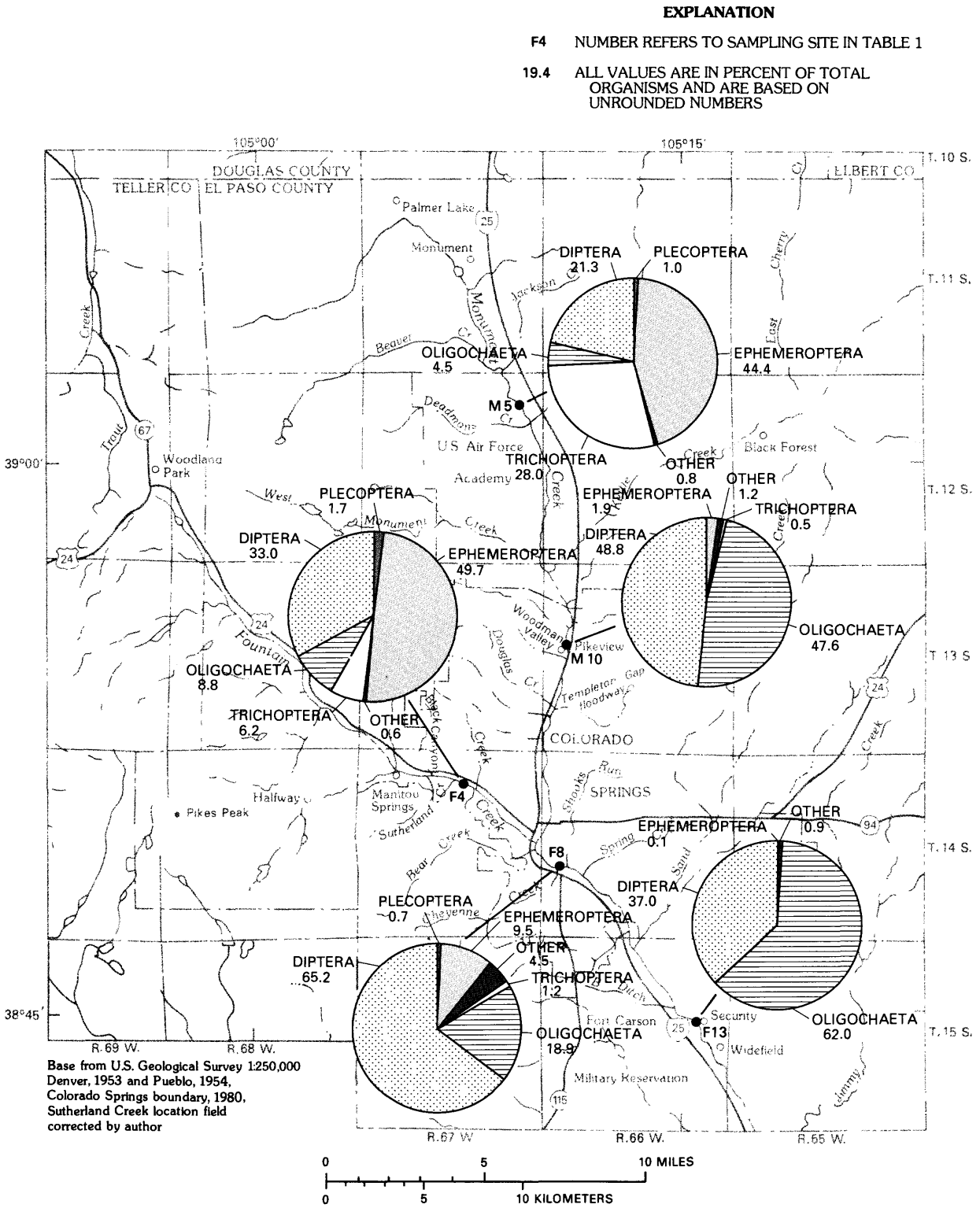

Figure 12.--Mean percentage composition of major taxonomic groups collected at selected sites on Fountain and Monument Creeks during late summer (mid-August to early September).

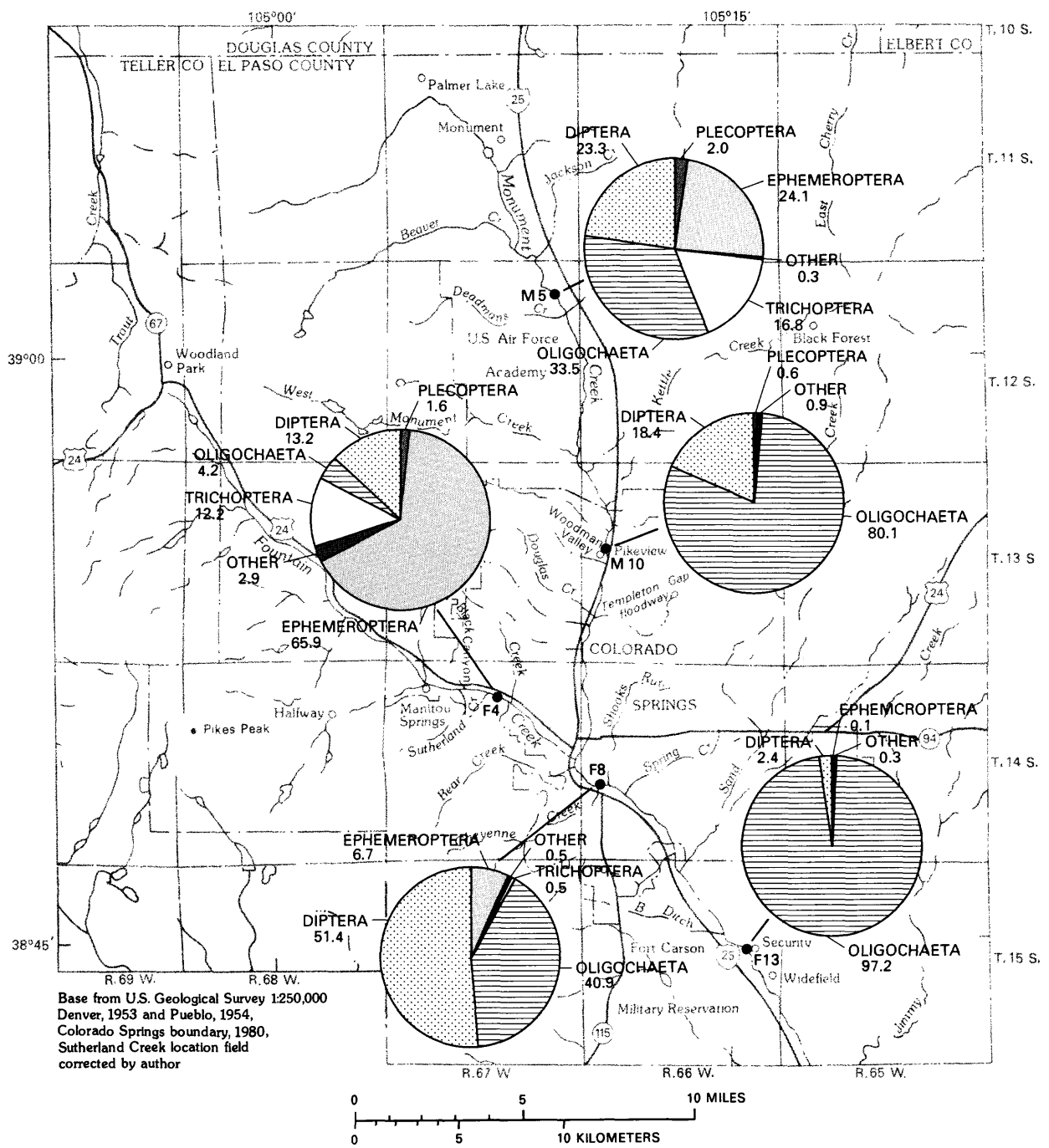

Figure 13.--Mean percentage composition of major taxonomic groups collected at selected sites on Fountain and Monument Creeks during fall (late October to early November).

There were large changes in community structure at site M5 during the four sampling periods. During spring sampling, Oligochaeta and Diptera comprised the majority of the total organisms collected (fig. 10). Of the worms collected, *Limnodrilus* sp. and Tubificidae accounted for about 49 to about 76 percent of the mean total density of organisms collected during spring. *Cricotopus* sp., *Diamesa* sp, *Orthocladius* sp., and *Parametriocnemus* sp. were the most abundant true flies collected during the spring sampling.

During early summer, Ephemeroptera replaced Oligochaeta as the most abundant group of organisms collected at site M5 (fig. 11). *Baetis bicaudatus* and *Baetis tricaudatus* were the most abundant mayflies collected, comprising about 29 to about 45 percent of the mean total density of organisms collected. Diptera were the second most abundant group of organisms collected. *Parametriocnemus* sp. and *Simulium* sp. were the most abundant among the Diptera group, comprising from 8.5 to about 22 percent of the mean total density of organisms collected.

Ephemeroptera and Trichoptera were the most abundant group of organisms collected during late summer (fig. 12). *Baetis bicaudatus and Baetis tricaudatus* were the most abundant mayflies collected, comprising about 30 to about 54 percent of the mean total density of organisms. *Hydropsyche* sp. was the most abundant caddisfly collected, comprising about 8.2 to about 38 percent of the mean total density of organisms. In addition, the abundance of the caddisfly, *Hydropsyche* sp., and the truefly, *Simulium* sp., is notable because they are characterized as clingers and require a stable habitat (such as cobbles) (Merritt and Cummins, 1984).

There was a change in dominant taxa from Ephemeroptera to Oligochaeta during the fall at site M5 (fig. 13). The worms, *Limnodrilus* sp., and immature Tubificidae, composed about 14 to about 61 percent of the mean total density of organisms collected. Ephemeroptera, Diptera, and Trichoptera composed about 43 to about 82 percent of the mean total density of organisms during fall (table 11).

There were 41 taxa identified at Monument Creek at Pikeview (site M10). Mean density of total organisms ranged from 42 to 1,200 organisms/m^2, and the median was 370 organisms/m^2 (table 11). Oligochaeta and Diptera were the most frequently collected and the most abundant groups of organisms collected during all sampling periods (figs. 10-13). *Limnodrilus* sp. was the most frequently occurring Oligochaeta, comprising from 0 to about 92 percent of the mean total density of organisms collected during all sampling periods. *Cricotopus* sp., *Diamesa* sp., *Micropsectra* sp., *Orthoclaudius* sp., *Parametriocnemus* sp., and *Phaenopsectra* sp. were the most abundant true flies collected during all sampling periods. Mayflies were collected during only six sampling periods, and stoneflies and caddisflies were collected during only two sampling periods (table 11).

Comparison of Sampling Results Between Sites

The following is a discussion of differences in species composition between sites as defined by the similarity index and by the percent similarity. Also discussed are the results of analysis of variance and multiple comparison tests on the ranks of mean densities of organisms for all taxa and mean densities of organisms for the major taxa occurring at all five sampling sites.

Similarity Indices

Evaluation of the similarity index and percent similarity can be useful in determining which sites are the most similar taxonomically. The similarity index provides a comparison of taxa between two sites. However, the index does not take into account the relative abundance of taxa. The similarity index is calculated by using the following formula (Odum, 1971):

$$S = \frac{2c}{a+b}, \qquad (7)$$

where S = similarity index;
c = number of taxa common to both samples or sites;
a = number of taxa in sample at site a; and
b = number of taxa in sample at site b.
The similarity index values range from 0 to 1; the closer the value to 1, the greater the similarity in taxonomic composition between samples or sites.

Percent similarity is a measure of the abundance of taxa common to two samples or sites. Percent similarity is calculated by summing the smallest percentage of total organisms for each taxa common to both samples or sites. Percent similarity ranges from 0 to 100 percent; the closer the value is to 100 percent, the greater the relative importance of similar taxa between samples or sites (Whittaker, 1975).

Evaluation of the similarity index and percent similarity together can be useful in understanding the vagaries of comparing taxonomic data between sites. For example, for the samples collected during November 1987 at Fountain Creek at Security (site F13) and Monument Creek at USAFA (site M5), the similarity index and percent similarity calculated were about 0.26 and about 63. The small similarity index indicates little similarity in taxonomic composition between sites F13 and M5. Only 5 taxa were collected at site F13, whereas 33 were collected at site M5 during November 1987 (table 19 in the "Supplemental Information" section at the back of this report). However, the percent similarity of about 63 indicates that the sites may be similar in terms of the relative abundance of taxa common to both sites. Further analysis indicates that Oligochaetes composed about 95 percent of the mean total density of organisms at site F13 and about 61 percent at site M5 during November 1987 (table 11). Thus, while during November 1987 there was little similarity between sites based on number of similar taxa, the density of similar taxa, Oligochaetes, results in greater percentage similarity between sites. In this instance, percent similarity helped to identify the large effect that Oligochaetes have on benthic-invertebrate densities at sites F13 and M5 for a specific sampling period.

Values for similarity indexes and percent similarities between all sites are summarized in table 12. The largest median values for similarity index calculated were between Fountain Creek at Colorado Springs (site F8) and Monument Creek at Pikeview (site M10), and between Fountain Creek near Colorado Springs (site F4) and Monument Creek at USAFA (site M5) (table 12).

Table 12.--*Summary of values of similarity index and percent similarity for benthic-invertebrate sampling sites on Fountain and Monument Creeks, water years 1985-88*

[Values for similarity index and percent similarity are calculated from unrounded numbers]

Site number in figure 1	Similarity index			Percent similarity		
	Maximum	Minimum	Median	Maximum	Minimum	Median
F4-F8	0.69	0.38	0.48	50.8	11.9	40.2
F4-F13	.64	.22	.40	83.4	5.1	28.0
F4-M5	.64	.33	.54	73.9	25.5	44.3
F4-M10	.54	.17	.32	59.7	2.8	36.4
F8-F13	.74	.30	.50	64.5	13.4	46.3
F8-M5	.78	.33	.50	72.1	15.6	37.9
F8-M10	.64	.36	.55	73.5	8.0	57.8
F13-M5	.62	.20	.41	69.8	9.4	29.4
F13-M10	.72	.12	.45	95.0	31.8	58.0
M5-M10	.67	.15	.41	80.7	8.4	40.5

Comparison of Densities of Organisms Between Sites

Average mean densities of organisms for all taxa and average mean densities of organisms of the major taxa, Ephemeroptera, Plecoptera, Trichoptera, Diptera, and Oligochaeta for the five benthic-intertebrate sampling sites (fig. 1; table 1) were compared using analysis of variance (ANOVA). For the purpose of this analysis, the data were ranked, and ANOVA was done on the ranks of the data (Conover and Iman, 1981). The group means of ranked data for total densities of organisms and densities of organisms of the major taxa groups between the five sites were significantly different ($p<0.05$). Because there is a difference in average mean densities of organisms between sites, it would be useful to determine which sites were different and which sites were similar. The difference in average mean densities of organisms between sites was determined using Tukeys studentized range test (Statistical Analysis System Institute, 1985). The Tukeys studentized range test is a multiple comparison test that sets the overall error rate to a stated alpha level, in this instance alpha = 0.05. The overall error rate is the overall probability of declaring at least one false difference between sites.

Box plots were used to compare mean densities of organisms for all taxa and mean densities of organisms for major taxa at the five sites. A box plot is a useful tool for visually examining the central tendency and dispersion of a group of data, and is useful for comparing two or more groups of data. An example of a box plot is shown in figure 14. To construct a box plot, the median value is plotted as a horizontal line. The 25th and 75th percentiles are used as the upper and lower ends of the box. The box represents the interquartile range. Vertical lines extend to within 1.5 times the interquartile range. Outliers within 1.5 to 3.0 times the interquartile range are shown as "*" and far out values greater or less than 3.0 times the interquartile range are shown as "•" (Martin and Crawford, 1987). Mean densities of organisms for all taxa and mean densities of organisms for major taxa collected at the five sites are summarized in box plots (figs. 15*A-F*).

The Tukeys test was applied to ranks of the data used in the ANOVA procedure. Results of multiple comparison tests between the five benthic-invertebrate sampling sites are included in figures 15*A-F*. Sampling sites where average mean densities are similar ($p>0.05$) have been assigned the same number. For example, average mean densities of organisms for all taxa between sites F13 and M5 are considered similar and are designated by the number 1 (fig. 15*A*). However, average mean densities of organisms for all taxa at site F13 also are similar to site F4, and this is designated by the number 2 (fig. 15*A*). In this instance, average mean densities of organisms for all taxa were similar between sites F13 and M5, sites F13 and F4, but not sites F4 and M5.

Average mean densities of organisms for all taxa for Fountain Creek near Colorado Springs (site F4) and Fountain Creek at Colorado Springs (site F8) were similar ($p>0.05$) (fig. 15*A*). The similarity of average mean densities of organisms for all taxa between sites F4 and F8 are a result of the occurrence of bottom sprawling Diptera (*Parametriocnemus* sp.) and organisms from the group Oligochaeta (figs. 15*E,F*). However, benthic-invertebrate habitat is less favorable at site F8 than at site F4. The effects of increased streamflow and sediment discharge from Monument Creek on stream habitat are evident at site F8; the more habitat-sensitive taxa, Ephemeroptera, Plecoptera, and Trichoptera are less abundant than at site F4 (figs. 15*B,C,D*).

Fountain Creek at Security (site F13) and Monument Creek at USAFA (site M5) had the largest densities of total organisms collected. The average mean densities of organisms for all taxa at sites F13 and M5 were similar ($p>0.05$) (fig. 15*A*). Sites F13 and M5 represent the extremes in instream-habitat conditions in the study area with respect to stability of streambed and variability of streamflow. Site F13 has a mobile streambed. Streamflow at site F13 is affected by urbanization in the basin and is especially variable during rainfall runoff. Site M5 has a stable streambed, drains a mostly rural part of the basin, and has a smaller range of streamflows (table 2). The similarity of average mean densities of total organisms is a result of the large densities of Oligochaetes collected at sites F13 and M5 (fig. 15*F*; table 11). Oligochaetes are able to exist in a wide range of habitats as opposed to the more habitat-sensitive taxa of Ephemeroptera, Plecoptera, and Trichoptera (Pennak, 1978). Oligochaeta is the only major taxa group for which average mean densities of organisms were similar between sites F13 and M5 (figs. 15*A-F*). The more habitat-sensitive taxa, Ephemeroptera, Plecoptera, and Trichoptera were substantially more abundant at site M5 than at site F13 (figs. 15*B,C,D*).

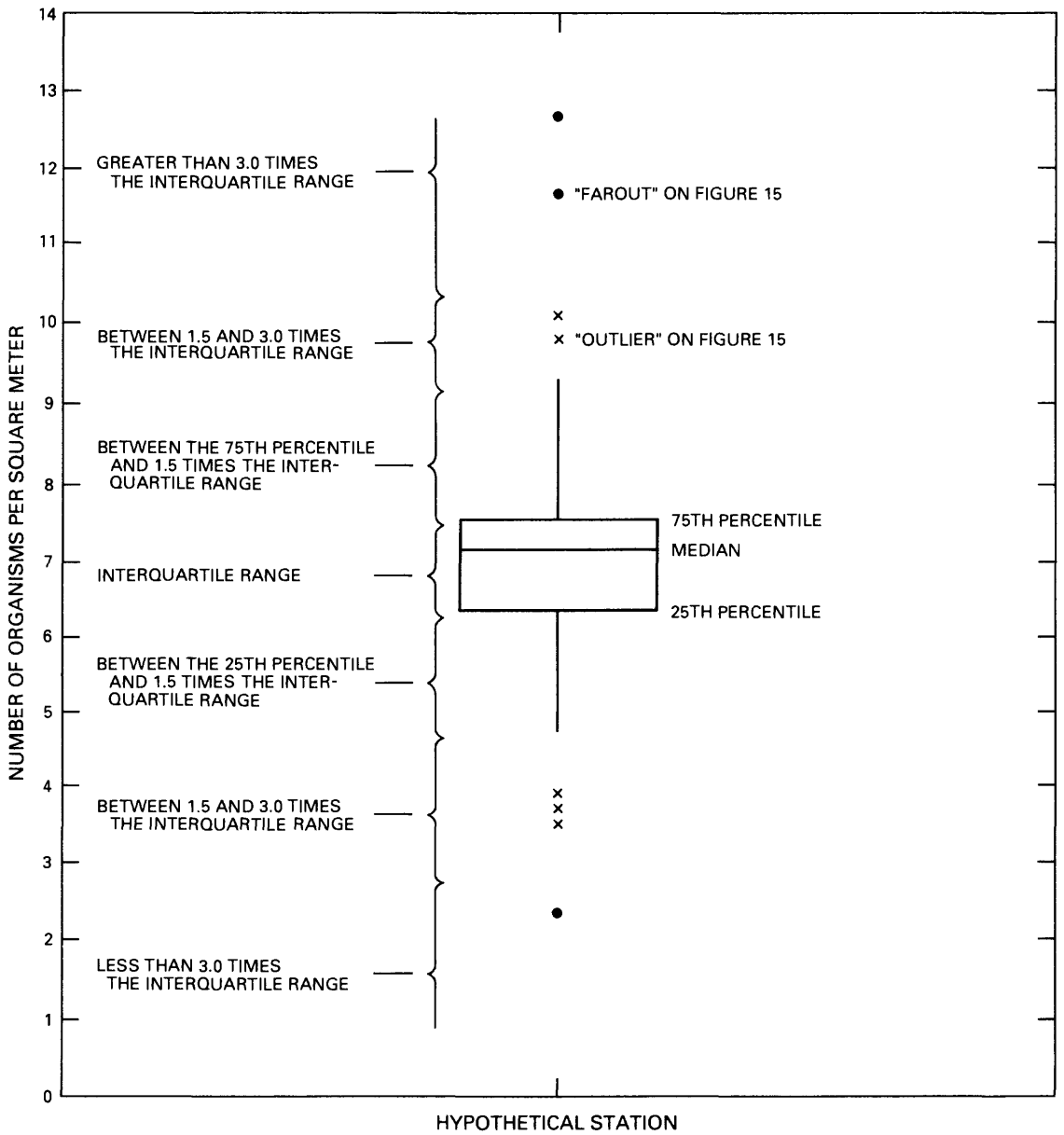

Figure 14.--Example of a box plot.

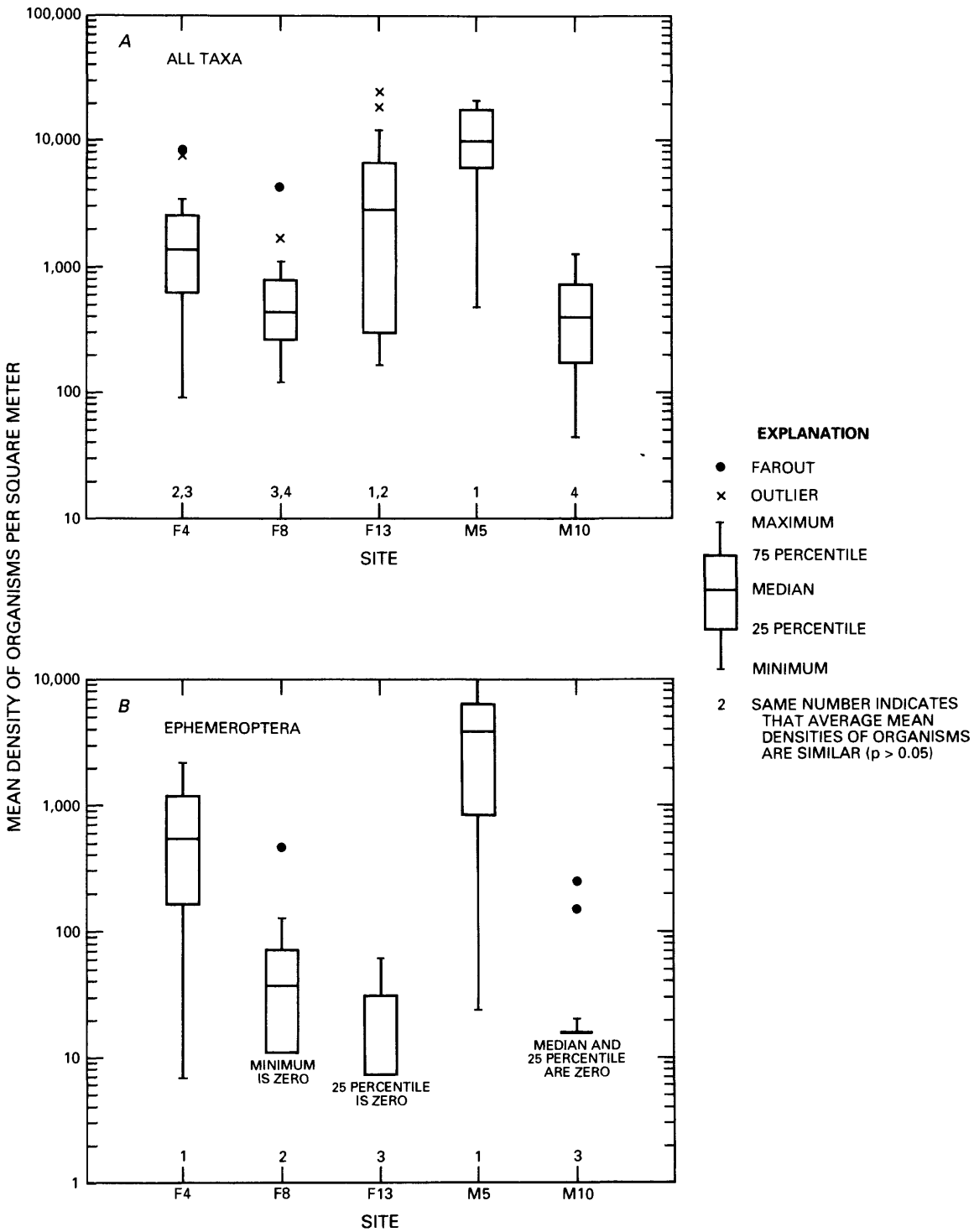

Figure 15.--Box plot of mean densities of organisms for all taxa and major taxonomic groups for benthic invertebrates collected on Fountain and Monument Creeks.

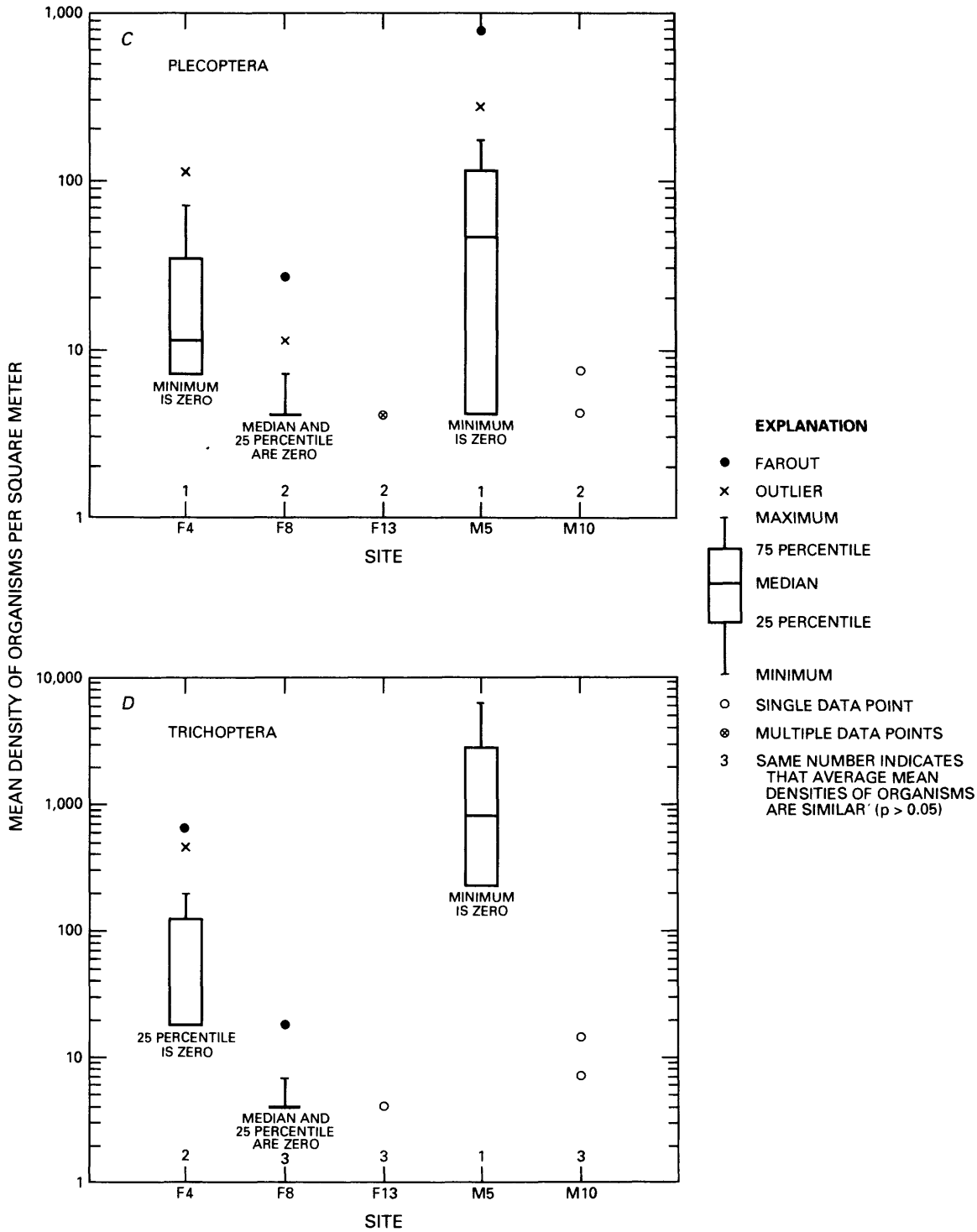

Figure 15.--Box plot of mean densities of organisms for all taxa and major taxonomic groups for benthic invertebrates collected on Fountain and Monument Creeks--Continued.

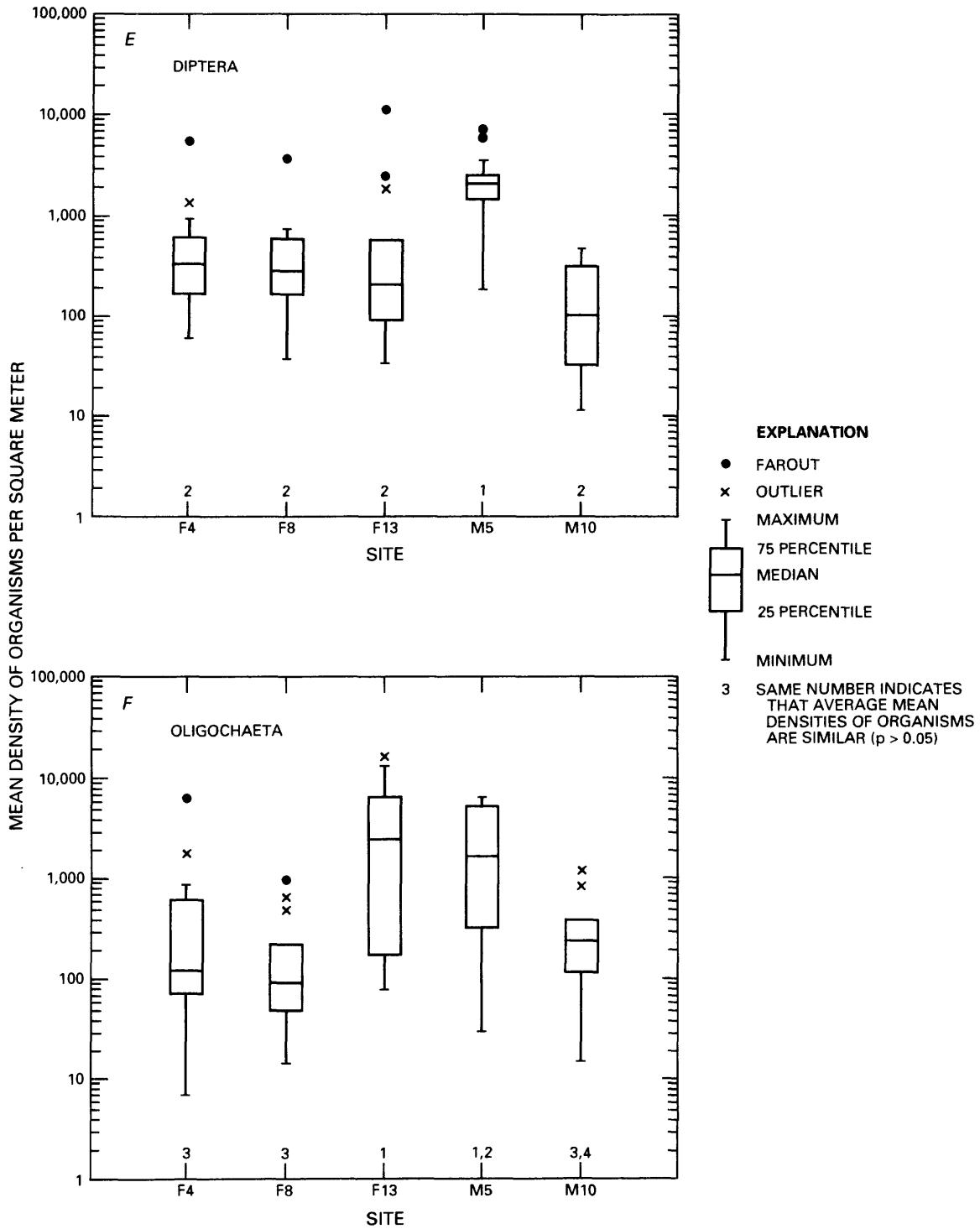

Figure 15.--Box plot of mean densities of organisms for all taxa and major taxonomic groups for benthic invertebrates collected on Fountain and Monument Creeks--Continued.

Mean densities of organisms for all taxa were smallest at sites F8 and M10 (fig. 15*A*). The average mean densities of organisms for all taxa and for the major taxa groups, Plecoptera, Trichoptera, Diptera, and Oligochaeta, at sites F8 and M10 are similar ($p>0.05$) (fig. 15*A,C-F*). At sites F8 and M10, streamflow is affected by urbanization, and bed material mostly is sand and gravel (table 16).

Sites F4 and M5 had the largest numbers of the more habitat-sensitive taxa, Ephemeroptera, Plecoptera, and Trichoptera (figs. 15*B,C,D*). Average mean densities of Ephemeroptera and Plecoptera at sites F4 and M5 were similar ($p>0.05$) (figs. 15*B,C*). Mean densities of Ephemeroptera, Plecoptera, and Trichoptera were smaller at sites F13 and M10 (figs. 15*B,C,D*). At sites F13 and M10, fluctuations in streambed elevations were more likely to occur (fig. 9, and fig. 20 in the "Supplemental Information" section at the back of this report), (table 8), and median d_{50} of bed material was smallest. Sites F8, F13, and M10 had average mean densities of Plecoptera, Trichoptera, and Diptera that were similar ($p>0.05$) (figs. 15*C,D,E*).

Comparison with Other Studies

Benthic-invertebrate samples were collected monthly from May 1979 through April 1980 at sites F4, F8, F13 and about 7 mi upstream from site M5 (Colorado Springs Wastewater Division, 1980). The composition of benthic-invertebrate samples collected at these sites during 1979 and 1980 were similar to the present study. Site F4 and the site upstream from site M5 had the greatest number of taxa and the most abundant populations of Ephemeroptera, Plecoptera, and Trichoptera. Diptera and Oligochaeta were the most abundant organisms collected at sites F8 and F13. Ephemeroptera, Plecoptera, and Trichoptera rarely were collected at sites F8 and F13 (Colorado Springs Wastewater Division, 1980).

EFFECTS OF SEDIMENT TRANSPORT ON BENTHIC INVERTEBRATES

Stream habitat can be described by the water quality and physical characteristics of a stream. The occurrence and abundance of benthic invertebrates may be limited by: (1) Water quality (Roback, 1974; Pennak, 1978); (2) availability of suitable physical habitat as a function of type of bed material (Bell, 1968-69; Ward, 1975); and (3) stability of physical habitat as a function of bed-material size distribution and the occurrence of streamflows that can transport the bed material, thus causing disruption of the physical habitat (Molles, 1985; Sagar, 1986; S.P. Canton, Chadwick and Associates, Littleton, Colo., written commun., 1989).

By determining how much variance in benthic-invertebrate densities can be explained by certain stream-habitat characteristics, it may be possible to identify those characteristics that have the largest effect on benthic-invertebrate densities. The percent total variation in benthic-invertebrate densities that can be explained by stream-habitat characteristics is represented by R^2 and is expressed as a percent. The RSQUARE procedure (Statistical Analysis System Institute, 1985, p. 711) was used to determine which stream-habitat characteristics explain the largest percent variation in benthic-invertebrate densities in Fountain and Monument Creeks. For a given

sample, the RSQUARE procedure performs all possible subset linear regressions and finds the subsets of independent variables that best predict the dependent variable (Statistical Analysis System Institute, 1985). The best regression model was selected based on R^2 and checked using other model-selection criteria (Statistical Analysis System Institute, 1985, p. 713). For the purposes of this analysis, only regression models that were significant (probability of a greater F<0.05) and had independent variables that were significant in the regression model (probability of a greater T<0.05) were used. Hydrologic data usually are skewed and do not have a normal distribution. Therefore, when using parametric statistical techniques, such as RSQUARE, data need to be transformed to approximate a normal distribution. Dependent and independent variables used in the RSQUARE procedure were log transformed (natural logarithm, base e).

Stream-habitat characteristics (independent variables) that were used as possible variables to explain variation in benthic-invertebrate populations were:

1. Water temperature, in degrees Celsius.
2. Specific conductance, in microsiemens per centimeter at 25 degrees Celsius.
3. pH, in standard units.
4. Dissolved oxygen, in milligrams per liter.
5. Ammonium nitrogen (NH_4), in milligrams per liter.
6. Unionized ammonia nitrogen (NH_3), in milligrams per liter.
7. Median grain size of bed material sampled in conjunction with benthic-invertebrate samples, in millimeters.
8. Peak streamflow (flooding) during the 30 days prior to collection of benthic invertebrates. This was defined by using a dummy variable. Peak streamflows were considered to be streamflows large enough to substantially affect existing benthic-invertebrate densities (table 13). In some instances, peak streamflows substantially larger than those listed in table 13 that occurred more than 30 days prior to collection of benthic invertebrates were included in this analysis (table 13).

Water temperature, specific conductance, pH, and dissolved oxygen were measured at the same time as benthic-invertebrate samples were collected. Ammonium nitrogen (NH_4) data were mean concentrations of samples collected periodically (monthly) at a sampling site prior to the collection of benthic-invertebrate samples. NH_4 data were unavailable at Fountain Creek at Security (site F13). During December 1979 through September 1982, NH_4 data were collected at Fountain Creek below Janitell road (site F8A) and Fountain Creek below Widefield (site F13A) (fig. 1). Site F8A is about 7.2 mi upstream from site F13, and site F13A is about 1.5 mi downstream from site F13. The ratio of NH_4 concentrations (site F13A/site F8A) was calculated for sites F8A and F13A. Water-quality samples, including analysis for NH_4, were available at site F8A for the period of benthic-invertebrate sampling at site F13. To estimate NH_4 concentrations at site F13 during benthic-invertebrate sampling, NH_4 data at site F8A that corresponds to the benthic-invertebrate sampling period were multiplied by the median ratio (0.67) of NH_4 concentrations determined between sites F8A and F13A. Unionized ammonia (NH_3) was calculated at each site by using methods described by Skarheim (1973). For the purposes of this analysis, data for independent variables not collected during benthic-invertebrate sampling were estimated based on values of predictor variables collected for similar streamflow and sampling conditions.

Table 13.--*Streamflows used to determine flooding during the 30 days prior to collection of benthic invertebrates*

U.S. Geological Survey station number and site number in figure 1 and table 1	Streamflows above which existing benthic-invertebrate densities were considered to be substantially disturbed (cubic feet per second)	Number of times streamflows were exceeded during the 30 days prior to benthic-invertebrate sampling
07103700, site F4	100	3
[1,2]07105500, site F8	90	15
[1]07105800, site F13	200	15
07103780, site M5	150	1
[1]07104000, site M10	50	14

[1]Peak streamflows of 4,450 ft^3/s at site F8, 3,630 ft^3/s at site F13, and 2,750 ft^3/s at site M10 occurred 45 days prior to collection of benthic invertebrates.

[2]Peak streamflow of 927 ft^3/s occurred 32 days prior to collection of benthic invertebrates.

Streamflows large enough to disturb benthic-invertebrate densities substantially (table 13) were determined for each site based on the following analysis:

Fountain Creek near Colorado Springs (site F4):

At a streamflow of 122 ft^3/s, particle size at threshold of movement (d_c in table 9) was near or exceeded the median d_{50} of bed-material samples collected in conjunction with benthic-invertebrate samples (table 8). Sand is readily transported at most streamflows; however, sand composes generally less than 10 percent of bed material collected in conjunction with benthic-invertebrate samples (table 16 in the "Supplemental Information" section at the back of this report), the effects of streamflows less than 100 ft^3/s on benthic-invertebrate densities were considered minimal.

Fountain Creek at Colorado Springs (site F8), Fountain Creek at Security (site F13), and Monument Creek at Pikeview (site M10):

Because sand is readily available in bed material (table 16) and readily transported by most streamflows (table 9), benthic invertebrates present at these sites were assumed to be adapted to a shifting substrate type of habitat. Because of this assumption, it was difficult to quantify the magnitude of streamflows that cause significant disturbance of benthic-invertebrate densities.

Substantial disturbance of benthic invertebrates was assumed to occur when changes in streambed elevation was greater than 0.4 ft. Changes of about 0.4 ft or more occurred between most of the cross-section surveys at these sites (table 18 in the "Supplemental Information" section at the back of this report). Examination of streamflow records indicated that these changes tended to occur when streamflows greater than twice the daily median streamflow occurred

between consecutive cross-section surveys. For the purposes of this analysis, streamflows about 2 times the daily median streamflow for the period of study were considered to substantially disrupt benthic-invertebrate densities.

Monument Creek at USAFA (site M5):

Particle size at threshold of movement (d_c in table 9) did not exceed the median d_{50} of bed material collected in conjunction with benthic-invertebrate samples (table 8). However, bedload discharge at a streamflow larger than 150 ft^3/s was substantial (table 7) and was assumed to causes substantial changes in benthic-invertebrate densities. Sand is readily transported at most streamflows; however, sand generally composes less than 5 percent of bed material collected in conjunction with benthic invertebrates (table 16). The effects of streamflows less than 150 ft^3/s on benthic-invertebrate densities were considered minimal.

Results of application of the RSQUARE procedure to the Fountain and Monument Creeks data are summarized in table 14. Median grain size of bed material collected in conjunction with benthic-invertebrate samples and flooding during the 30 days prior to sampling were the most frequently occurring independent variables explaining the most variation in benthic-invertebrate densities during all sampling periods (table 14). Concentration of ammonium nitrogen was the most frequently occurring independent variable explaining the most variation in densities of Oligochaetes during all sampling periods. Oligochaetes typically are bottom dwellers unaffected by size of bed material and are able to exist in a wide range of stream habitats (Pennak, 1978).

Median d_{50} of bed material collected in conjunction with benthic-invertebrate samples was largest at Fountain Creek near Colorado Springs (site F4) and Monument Creek at USAFA (site M5) (fig. 1; table 8). These sites consistently had the greatest number of taxa and, except for Oligochaetes at site F13, had the largest mean densities of benthic invertebrates (table 11 and table 19 in the "Supplemental Information" section at the back of this report). Sand is more common in bed material at Fountain Creek at Colorado Springs (site F8), Fountain Creek at Security (site F13), and Monument Creek at Pikeview (site M10) (table 16); these sites had less diverse taxa and, except for Oligochaetes at site F13, generally had small mean densities of benthic invertebrates (table 11). Sand affects the occurrence of benthic invertebrates by filling the interstices between the larger bed material, thus limiting available habitat. The filling of interstices may smother benthic invertebrates not adapted to a burrowing type of environment, such as most Ephemeroptera, Plecoptera, and Trichoptera. Also, the transport of sand abrades the coarser bed material and may cause increased mortality among benthic invertebrates. Bed-material conditions at Fountain Creek at Colorado Springs (site F8) may provide an example of how benthic invertebrates are affected by sand filling interstices and abrading coarser bed material. The median d_{50} of bed material sampled in conjunction with benthic invertebrates at site F8 is less than, but similar, to the median d_{50} at sites F4 and M5 (table 8). However, the median percentage of sand (in the range of 0.062 to 2.0 mm) determined in bed-material samples collected in conjunction with benthic-invertebrate samples is 13 at site F8 compared to 4 and 2 at sites F4 and M5. Benthic-invertebrate densities at site F8 usually were smaller than sites F4 and M5 (figs. 15*A-F*; table 11).

Table 14.--*Variation in total organisms and major taxa of benthic invertebrates accounted for by independent variables included in the best regression model for Fountain and Monument Creeks*

[R^2, coefficient of determination; °C, degrees Celsius; µS/cm, microsiemens per centimeter at 25 degrees Celsius; mg/L, milligrams per liter; mm, millimeters; +, significant in regression model, positive correlation; -, significant in regression model, negative correlation; *, not significant]

Taxa	R^2 (expressed as percent)	Water temperature (°C)	Specific conductance (µS/cm)	pH (standard units)	Dissolved oxygen (mg/L)	Ammonium nitrogen total (mg/L)	Un-ionized ammonia nitrogen total (mg/L)	Median grain size of bed material	Flooding during the 30 days prior to sampling
				ALL SAMPLING PERIODS					
Total	18	*	*	*	*	*	*	+	*
organisms	30	*	*	*	*	+	*	*	-
	35	*	*	*	*	+	*	+	-
Ephemeroptera	46	*	*	*	*	*	*	+	*
	55	*	*	*	*	*	*	+	-
	60	+	*	*	*	*	*	+	-
	62	+	+	*	*	*	*	+	-
Plecoptera	34	*	*	*	*	*	*	*	-
	37	*	-	*	*	*	*	*	-
Trichoptera	45	*	*	*	*	*	*	*	-
	52	*	*	*	*	*	*	+	-
	56	*	*	+	*	*	*	+	-
Diptera	22	*	*	*	*	*	*	+	*
Oligochaeta	25	*	*	*	*	+	*	*	*
				SPRING (APRIL)					
Total	27	*	*	*	*	*	*	+	*
organisms	48	*	*	*	*	*	+	*	-
Ephemeroptera	41	*	*	*	*	*	*	+	*
Plecoptera	43	*	*	*	*	*	*	*	-
Trichoptera	46	*	*	*	*	*	*	+	*
	61	*	*	*	+	*	*	+	*
	74	*	*	*	+	+	*	+	*
Diptera	40	*	*	*	*	*	*	+	*
	49	*	+	*	*	*	*	*	-
Oligochaeta	40	*	*	*	*	+	*	*	*
				EARLY SUMMER (LATE JUNE-EARLY JULY)					
Total	44	*	*	*	*	*	*	*	-
organisms	66	*	*	*	-	*	*	*	-
Ephemeroptera	71	*	*	*	*	*	*	*	-
Plecoptera	40	-	*	*	*	*	*	*	*
Trichoptera	70	*	*	*	*	*	*	*	-
	77	*	*	*	*	*	*	+	-
Diptera	32	*	*	*	*	*	*	*	-
	47	+	*	*	*	*	*	*	-
Oligochaeta	22	*	*	*	*	*	*	*	-
	52	*	*	*	*	*	+	*	-
				LATE SUMMER (LATE AUGUST-EARLY SEPTEMBER)					
Total organisms	*	*	*	*	*	*	*	*	*
Ephemeroptera	50	*	*	*	*	*	*	+	*
	68	*	-	*	*	*	*	+	*
Plecoptera	43	*	-	*	*	*	*	*	*
	65	*	-	*	*	*	*	+	*
Trichoptera	40	*	-	*	*	*	*	*	*
Diptera	*	*	*	*	*	*	*	*	*
Oligochaeta	30	*	*	*	*	+	*	*	*
				FALL (LATE OCTOBER-EARLY NOVEMBER					
Total	33	-	*	*	*	*	*	*	*
organisms	58	-	*	*	*	+	*	*	*
	71	-	*	+	*	+	*	*	*
Ephemeroptera	66	*	*	*	*	*	*	+	*
Plecoptera	64	*	-	*	*	*	*	*	*
Trichoptera	69	*	-	*	*	*	*	*	*
	82	-	-	*	*	*	*	*	*
Diptera	48	-	*	*	*	*	*	*	*
Oligochaeta	33	*	*	*	*	+	*	*	*

Flooding during the 30 days prior to sampling was the most frequently occurring independent variable explaining the most variation in benthic-invertebrate densities during early summer (table 14). Sagar (1986) reported that benthic-invertebrate abundance was inversely related to antecedent (30 days prior to sampling) streamflows. Molles (1985) reported that a single flood caused decreases in total densities of benthic invertebrates in a stream in northern New Mexico and that after 9 months, densities of benthic invertebrates were substantially smaller at the disturbed sites than at an undisturbed sampling site.

Streamflows large enough to substantially disturb benthic-invertebrate densities occurred most frequently at sites F8, F13, and M10 (table 13). During flooding, most of the bottom material at sites F13 and M10 is readily transported. Although the particle size at threshold of movement (table 9) is less than the median d_{50} of bed material collected in conjunction with benthic-invertebrate samples (table 8), the transport of sand during periods of flooding may affect benthic-invertebrate densities at site F8. The large changes in streambed elevation measured at these sites (table 18) indicate the habitat disruption that results from flooding.

During the late summer, no significant (probability of a greater $T<0.05$) independent variables were identified for total number of organisms or for total number of Diptera organisms. During the late summer and fall, there were no independent variables that consistently explained the variation in benthic-invertebrate densities. Disruption of benthic-invertebrate densities as a result of flooding during spring and early summer may explain the absence of any consistent independent variables during the late summer and fall.

This analysis did not include any study of toxic chemical constituents. How the presence or absence of such toxic substances affect benthic-invertebrate densities was not determined.

SUMMARY AND CONCLUSIONS

The smallest median suspended-sediment concentrations were determined for suspended-sediment samples collected at Monument Creek at Palmer Lake (site M1) and Monument Creek at U.S. Air Force Academy (site M5). These sites are located in the headwater parts of Monument Creek. Maximum and median suspended-sediment concentrations were largest at Fountain Creek near Colorado Springs (site F4) and Monument Creek at Bijou Street at Colorado Springs (site M16). Median values for percentage of suspended sediment finer than 0.062 mm ranged from 55 to 69 percent. Most of the suspended sand in transport during snowmelt and rainfall runoff is very fine to fine. Silt composed from 23 to 61 percent of suspended sediment. Coarse clay and suspended sediments finer than 0.002 mm composed 11 to 62 percent of the suspended sediment.

Mean annual suspended-sediment yield increased about 73 percent between Fountain Creek near Colorado Springs (site F4) and Fountain Creek at Colorado Springs (site F8). Suspended-sediment discharge at site F8 is affected greatly by suspended-sediment discharge from Monument Creek, the main tributary to Fountain Creek. Mean annual suspended-sediment yields decreased about 30 percent between sites F8 and F13.

Mean annual suspended-sediment yield increased about 20 percent between Monument Creek at Palmer Lake (site M1) and Monument Creek at USAFA (site M5). Between site M5 and Monument Creek at Pikeview (site M10), mean annual suspended-sediment yield increased about 608 percent.

The median grain size of all bed-material samples was very coarse sand to small cobbles. The median grain size of all bedload samples was coarse sand to very fine gravel.

Bedload discharge was computed at six of the periodic sampling sites. Measured bedload discharge ranged from 2.6 to 3,570 tons per day. Bedload discharge, as a percentage of total sediment discharge, is smallest during periods of rainfall runoff, ranging from 6 to 30 percent. During periods of rainfall runoff, fine sediments are introduced into streams by erosion resulting from rain splash and surface runoff. Bedload discharge, as a percentage of total sediment discharge during snowmelt runoff, ranged from 16 to 90 percent.

Fountain and Monument Creeks are capable of transporting most of the bed-material grain sizes sampled. The range of particle sizes at threshold of movement represented small to moderate streamflows. The upper limit of particle sizes at threshold of movement would be larger for higher streamflows.

Sites F4 and M5 have stable streambeds with little or no change in streambed elevation measured. Sites F8, F13, and M10 have mobile streambeds with changes in streambed elevation commonly measured between consecutive stream-channel cross-section surveys.

Benthic invertebrates were collected four times annually, except during 1988, when they were collected only three times. Number of taxa, species density, and similarity indices were determined at five of the periodic sampling sites. At the five benthic-invertebrate sampling sites, 138 taxa were identified; however, only 24 were common to all sites. Total number of taxa identified were 81 at site F4, 63 at site F8, 55 at site F13, 78 at site M5, and 41 at site M10. The more habitat-sensitive taxa, Ephemeroptera, Plecoptera, and Trichoptera were most abundant and were more frequently collected at sites F4 and M5. Evaluation of similarity indices and percent similarity between all sites indicated that sites F8 and M10 were most similar, and sites F4 and M5 were most similar.

The average mean densities of total number of organisms at sites F13 and M5 were similar ($p>0.05$). Sites F13 and M5 represented the extremes in instream-habitat conditions in the study area with respect to stability of streambed and variability of streamflow. The similarity of average mean densities of total number of organisms is a result of the large numbers of Oligochaetes collected at sites F13 and M5. Oligochaetes are able to exist in a wide range of habitats as opposed to the more habitat-sensitive taxa of Ephemeroptera, Plecoptera, and Trichoptera. Oligochaeta is the only major taxa group for which mean densities of organisms were similar between sites F13 and M5. The more habitat-sensitive-taxa Ephemeroptera, Plecoptera, and Trichoptera were substantially more abundant at site M5.

Mean densities of total number of organisms were smallest at sites F8 and M10. The average mean densities of total number of organisms at sites F8 and M10 were similar ($p>0.05$). Bed material at sites F8 and M10 is mostly sand and gravel.

Average mean densities of Ephemeroptera and Plecoptera at sites F4 and M5 were similar ($p>0.05$). Mean densities of Ephemeroptera, Plecoptera, and Trichoptera were smaller at sites F13 and M10 than at sites F4 and M5. At sites F13 and M10, fluctuations in streambed elevations were more likely to occur, and median d_{50} of bed material was smaller. Sites F8, F13, and M10 had average mean densities of Plecoptera, Trichoptera, and Diptera that were similar ($p>0.05$).

Median diameter of bed material that was collected in conjunction with benthic-invertebrate samples and flooding that occurred 30 days prior to sampling consistently explained the most variation in benthic-invertebrate densities during all sampling periods. Concentrations of ammonium nitrogen consistently explained the most variation in densities of Oligochaetes during all sampling periods. Oligochaetes typically are bottom dwellers unaffected by size of bed material and are able to exist in a wide range of stream habitats. Flooding during the 30 days prior to sampling consistently explained the most variation in benthic-invertebrate densities during early summer.

During late summer, no significant (probability of a greater $T<0.05$) independent variables were identified for total number of organisms or for total number of Diptera organisms. During late summer and fall, there were no independent variables that consistently explained the variation in benthic-invertebrate densities. Disruption of benthic-invertebrate densities, as a result of flooding (during spring and early summer), may explain the absence of any consistent predictor variables during late summer and fall.

This analysis did not include any study of toxic chemical constituents. How the presence or absence of such toxic substances affects benthic-invertebrate densities was not determined.

REFERENCES CITED

Andrews, E.D., 1983, Entrainment of gravel from naturally sorted riverbed material: Geological Society of America Bulletin, v. 94, p. 1225-1231.

Bell, H.L., 1968-69, Effect of substrate types on aquatic insect distribution: Journal of Minnesota Academy of Science, v. 35, p. 79-81.

Britton, L.J., and Greeson, P.E., editors, 1989, Methods for collection and analysis of biological and microbiological samples: U.S. Geological Survey Techniques of Water-Resources Investigations, bk. 5, chap. A4, 363 p.

Canton, S.P. and Chadwick, J.W., 1988, Variability in benthic invertebrate density estimates from stream samples: Journal of Freshwater Ecology, v. 4 no. 3. p. 291-298.

Canton, S.P., Cline, L.D., Short, R.A., and Ward, J.V., 1984, The macro-invertebrates of a Colorado stream during a period of fluctuating discharge: Freshwater Biology, v. 14, p. 311-316.

Chapman, H.H., 1933, Influence of overgrazing on erosion and watersheds: Civil Engineering, v. 3, no. 2, p. 74-78.
Cohn, T.A., Delong, L.L., Gilroy, E.J., Hirsch, R.M., and Wells, D.K., 1989, Estimating constituent loads: Water Resources Research, v. 25, no. 5, p. 937-942.
Colby, B.R., 1957, Relationship of unmeasured sediment discharge to mean velocity: American Geophysical Union Transactions, v. 38, no. 5, p. 708-717.
Colby, B.R., and Hubbell, D.W., 1961, Simplified methods for computing total sediment discharge with the modified Einstein procedure: U.S. Geological Survey Water-Supply Paper 1593, 17 p.
Colorado Climate Center, 1984, Colorado average precipitation map 1951-1980: Fort Collins, Colo., scale 1:500,000.
Colorado Springs Wastewater Division, 1980, Colorado Springs Wastewater division stream study: Colorado Springs, Colo., unpublished report, 129 p.
Conover, W.J. and Iman, R.L., 1981, Rank transformations as a bridge between parametric and non-parametric statistics: The American Statistician, v. 35, no. 3, p. 124-129.
Edwards, T.K., and Glysson, G.D., 1988, Field methods for measurement of fluvial sediment: U.S. Geological Survey Open-File Report 86-531, 118 p.
Elliott, J.G., and DeFeyter, K.L., 1986, Sediment-data sources and estimated annual suspended-sediment loads of rivers and streams in Colorado: U.S. Geological Survey Water-Resources Investigations Report 84-4141, 44 p.
Elliott, J.G., Kircher, J.E., and von Guerard, Paul, 1984, Sediment transport in the lower Yampa River, northwestern Colorado: U.S. Geological Survey Water-Resources Investigations Report 84-4141, 44 p.
Emmett, W.W., 1980, A field calibration of the sediment-trapping characteristics of the Helley-Smith bedload sampler: U.S. Geological Survey Professional Paper 1139, 44 p.
Glysson, G.D., 1987, Sediment transport curves: U.S. Geological Survey Open-File Report 87-218, 47 p.
Guy, H.P., 1969, Laboratory theory and methods for sediment analysis: U.S. Geological Survey Techniques of Water Resources Investigations, bk. 3 chap. C1, 58 p.
Guy, H.P., and Norman, V.W., 1970, Field methods for measurement of fluvial sediment: U.S. Geological Survey Techniques of Water-Resources Investigations, bk. 3, chap. C2, 59 p.
Helley, E.J., and Smith, Winchell, 1971, Development and calibration of a pressure-difference bedload sampler: U.S. Geological Survey Open-File Report 73-108, 38 p.
Kircher, J.E., 1982, Sediment transport and source areas of sediment and runoff, Big Sandy River basin, Wyoming: U.S. Geological Survey Water-Resources Investigations Report 81-72, 51 p. [Available only from National Technical Information Service, Springfield, Va., as PB-82 215 898].
Kuhn, Gerhard, 1988, Methods to determine transit losses for return flows of transmountain water in Fountain Creek between Colorado Springs and the Arkansas River, Colorado: U.S. Geological Survey Water-Resources Investigations Report 87-4119, 183 p.
Martin, J.D., and Crawford, C.G., 1987, Statistical analysis of surface-water-quality data in and near the coal-mining region of southwestern Indiana, 1957-80: U.S. Geological Survey Water-Supply Paper 2291, 92 p.

Meffe, G.K. and Minckley, W.L., 1986, Persistence and stability of fish and invertebrate assemblages in a repeatedly disturbed sonoran desert stream: The American Midland Naturalist, v. 117, no. 1, p. 177-191.
Merritt, R.W., and Cummins, K.W., 1984, An introduction to the aquatic insects of North America (2d ed.): Dubuque, Iowa, Kendall and Hunt, 722 p.
Miller, D.M., 1984, Reducing transformation bias in curve fitting: The American Statistician, v., 38, no. 2, p. 124-126.
Molles, M.C., 1985, Recovery of a stream invertebrate community from a flash flood in Tesuque Creek, New Mexico: The Southwestern Naturalist, v. 30 (2), p. 279-287.
Odum, E.P., 1971, Fundamentals of ecology (3d ed.): Philadelphia, W.B. Saunders Co., 574 p.
Pennak, R.W., 1978, Freshwater invertebrates of the United States (2d ed.): New York, John Wiley and Sons, 803 p.
Roback, S.S., 1974, Insects (Arthropoda: Insecta), *in* Hart, C.W., Jr., and Fuller, S.L.H., eds., Pollution ecology of fresh water invertebrates: New York, Academic Press, p. 313-376.
Sagar, P.M., 1986, The effects of floods on the invertebrate fauna of a large, unstable braided river: New Zealand Journal of Marine Research, v. 20, no. 1, p. 37-46.
Shields, A., 1936, "Anwendung der Achnlichkeitsmechanik und Turbulenz forschung auf die Geschiebewegung," Mitteilung Preussischen Versuchanstalt Wasser, Erd, Schiffbau, Berlin, No. 26 (in German).
Skarheim, H.P., 1973, Tables of the fraction of ammonia in the undissociated form for pH 6 to 9, temperature 0-30 degrees Celsius, total dissolved solids 0-3000 mg/L, and salinity 5-35 g/kg: Berkeley, University of California, Sanitary Engineering Research Laboratory, SERL Report No. 73-5, 33 p.
Statistical Analysis System Institute, 1985, SAS users guide--statistics (5th ed.): Carey, N.C., SAS Institute, Inc., 956 p.
U.S. Geological Survey, 1970, The National Atlas of the United States of America: Washington, D.C., 335 p.
Von Guerard, Paul, 1989, Suspended sediment and sediment-source areas in the Fountain Creek drainage basin upstream from Widefield, southeastern Colorado: U.S. Geological Survey Water-Resources Investigations Report 88-4136, 36 p.
Ward, J.V., 1975, Bottom fauna-substrate relationships in a northern Colorado trout stream: 1945 and 1974, Ecology, v. 56, no. 6, p. 1429-1434.
Whittaker, R.H., 1975, Communities and ecosystems (2d ed.): New York, MacMillan Publishing Co., Inc., 385 p.
Williams, R.P., and Krupin, P.J., 1984, Erosion, channel change, and sediment transport in the Big Lost River, Idaho: U.S. Geological Survey Water-Resources Investigations Report 84-4147, 87 p.

SUPPLEMENTAL INFORMATION

Table 15.--*Suspended-sediment size distribution for samples collected during snowmelt and rainfall runoff for selected sites on Fountain and Monument Creeks, water years 1985-88*

[mm, millimeters; mg/L, milligrams per liter; NA, not applicable; --, indicates no data]

Date	Percentage of suspended sediment smaller than indicated diameter									Suspended-sediment concentration (mg/L)	Steamflow (cubic feet per second)
	1.00 mm (percent)	0.50 mm (percent)	0.25 mm (percent)	0.125 mm (percent)	0.062 mm (percent)	0.016 mm (percent)	0.008 mm (percent)	0.004 mm (percent)	0.002 mm (percent)		
07103700 FOUNTAIN CREEK NEAR COLORADO SPRINGS (SITE F4)											
04-04-85	NA	NA	NA	100	94	--	--	--	--	42	22
04-18-85	99	99	94	85	73	41	--	26	25	93	35
04-30-85	NA	100	96	89	81	60	--	40	31	4,900	122
04-29-87	NA	100	98	85	67	--	--	--	--	157	24
07105500 FOUNTAIN CREEK AT COLORADO SPRINGS (SITE F8)											
04-04-85	NA	100	95	88	78	58	--	37	28	1,130	115
05-03-85	100	99	87	59	39	22	--	13	10	2,210	526
05-01-87	100	97	80	65	56	40	--	26	19	434	131
06-23-88	100	98	90	77	67	51	45	38	31	3,890	234
07105800 FOUNTAIN CREEK AT SECURITY (SITE F13)											
04-04-85	NA	100	92	83	74	55	--	42	28	993	197
05-03-85	NA	100	87	64	44	26	--	15	11	2,280	633
05-01-87	100	94	80	68	58	42	--	28	21	494	170
06-08-87	99	98	95	86	69	50	43	35	28	22,700	2,680
08-26-87	100	99	92	78	64	49	41	34	28	8,460	1,350
08-26-87	100	97	91	80	69	58	52	44	36	3,730	550
06-15-88	NA	100	99	94	89	80	73	62	50	2,150	150
08-09-88	100	99	96	82	67	49	42	35	28	16,800	3,000
08-09-88	NA	100	95	84	70	54	46	39	31	14,000	2,520
08-09-88	100	99	96	85	74	60	53	46	39	8,380	911
07103780 MONUMENT CREEK ABOVE NORTH GATE BOULEVARD AT U.S. AIR FORCE ACADEMY (SITE M5)											
04-18-85	NA	100	85	62	45	29	--	17	16	330	62
05-03-85	100	97	75	49	34	19	--	11	8	1,060	199
04-30-87	NA	--	100	98	93	60	--	32	20	151	33
07104000 MONUMENT CREEK AT PIKEVIEW (SITE M10)											
04-03-85	NA	100	97	88	73	49	--	32	28	1,030	57
05-02-85	100	98	90	65	40	22	--	13	10	2,720	321
04-29-87	NA	100	97	87	76	52	--	38	30	449	72
07104905 MONUMENT CREEK AT BIJOU STREET AT COLORADO SPRINGS (SITE M16)											
04-03-85	NA	100	95	87	79	61	--	40	34	1,270	58
05-02-85	100	99	91	69	45	25	--	16	13	3,450	346
04-30-87	NA	100	94	80	66	47	--	32	24	482	77

Table 16.--*Bed-material size distribution for selected sites on Fountain and Monument Creeks, water years 1985-88*

[mm, millimeters; --, not applicable]

Date	Percent of bed material smaller than indicated diameter												
	256.0 mm (percent)	128.0 mm (percent)	64.0 mm (percent)	32.0 mm (percent)	16.0 mm (percent)	8.0 mm (percent)	4.0 mm (percent)	2.0 mm (percent)	1.0 mm (percent)	0.50 mm (percent)	0.25 mm (percent)	0.125 mm (percent)	0.062 mm (percent)
			07103700 FOUNTAIN CREEK NEAR COLORADO SPRINGS (SITE F4)										
[1]04-04-85	--	100	--	94	86	72	56	40	26	16	8	4	2
[1]04-18-85	--	--	100	89	76	69	55	41	27	16	8	4	1
[1]04-30-85	--	--	100	96	89	77	60	43	25	9	1	0	0
[2]08-12-85	--	100	70	37	35	31	23	16	11	7	2	0	0
[2]10-29-85	--	100	72	49	38	28	21	16	11	6	1	0	0
[2]04-14-86	--	100	72	33	29	24	21	21	13	3	0	0	0
[2]07-10-86	--	100	48	30	21	14	9	6	3	2	0	0	0
[2]08-25-86	--	100	47	31	22	16	10	5	3	1	0	0	0
[2]11-05-86	--	100	35	15	5	2	1	0	0	0	0	0	0
[2]04-28-87	--	100	61	34	21	13	7	4	2	1	0	0	0
[1]04-29-87	--	--	--	--	100	92	74	48	26	13	4	2	0
[2]07-15-87	--	100	47	21	12	7	4	3	2	1	0	0	0
[2]08-26-87	--	100	68	33	16	8	4	2	1	1	0	0	0
[2]11-04-87	--	100	71	38	25	15	10	7	4	2	1	0	0
[2]04-25-88	--	100	64	16	9	6	4	3	2	1	0	0	0
[2]06-30-88	--	100	48	24	13	8	5	3	2	1	0	0	0
[2]09-07-88	--	100	82	39	23	12	7	4	2	1	0	0	0
			07105500 FOUNTAIN CREEK AT COLORADO SPRINGS (SITE F8)										
[1]04-04-85	--	--	--	--	100	89	73	46	22	8	2	0	0
[3]05-02-85	--	--	--	--	100	91	75	54	29	12	4	1	0
[1]05-03-85	--	--	100	95	88	76	57	32	17	9	3	0	0
[2]08-12-85	--	100	74	69	60	52	42	29	17	8	2	0	0
[1,4]10-28-85	--	100	85	77	72	67	59	44	25	11	3	0	0
[2]04-14-86	--	100	74	54	50	43	34	24	15	9	3	0	0
[2]07-10-86	--	100	70	40	34	25	18	12	7	3	1	0	0
[2]08-26-86	--	100	71	58	50	39	30	22	16	9	2	0	0
[2]11-06-86	--	100	25	13	12	10	7	4	2	1	0	0	0
[2]04-27-87	--	--	100	82	64	49	37	23	13	6	2	0	0
[1]05-01-87	--	100	85	85	83	76	65	44	22	8	1	0	0
[2]07-15-87	--	100	57	27	17	11	8	5	3	1	0	0	0
[2]09-07-87	--	100	42	33	27	22	17	10	4	2	0	0	0
[2]11-04-87	100	62	52	40	33	26	20	13	6	2	0	0	0
[2]04-25-88	--	100	72	44	38	31	28	18	10	4	1	0	0
[1]06-23-88	--	--	100	98	97	89	73	49	26	11	2	0	0
[2]06-30-88	--	--	100	95	88	78	65	45	24	10	1	0	0
[2]09-07-88	--	100	58	32	19	11	7	4	2	1	0	0	0
			07105800 FOUNTAIN CREEK AT SECURITY (SITE F13)										
[1]04-04-85	--	--	100	93	81	58	32	20	10	4	1	0	0
[1]05-03-85	--	--	--	100	90	81	68	49	30	14	2	0	0
[2]08-12-85	--	--	100	80	76	68	57	39	20	7	1	0	0
[1]10-28-85	--	--	100	94	92	82	66	44	23	9	2	0	0
[2]07-11-86	--	100	87	65	56	44	34	25	17	10	2	0	0
[2]08-26-86	100	84	75	60	50	41	32	23	16	9	2	0	0
[2]11-06-86	--	100	85	73	64	55	45	30	14	6	2	0	0
[2]04-28-87	--	100	84	62	37	24	16	10	6	3	1	0	0
[1]05-01-87	--	--	--	--	100	95	80	56	31	13	2	0	0
[2]07-15-87	--	100	91	66	45	33	24	17	10	4	1	0	0
[2]09-01-87	--	100	74	49	42	37	30	21	13	7	3	0	0
[2]11-04-87	--	--	100	97	94	87	73	50	26	10	2	0	0
[2]04-25-88	--	100	72	61	28	11	5	2	1	0	0	0	0
[2]07-01-88	--	--	100	99	95	84	67	41	7	2	1	0	0
[2]09-07-88	--	--	100	78	64	51	38	21	10	4	1	0	0

Table 16.--*Bed-material size distribution for selected sites on Fountain and Monument Creeks, water years 1985-88*--Continued

Date	Percent of bed material smaller than indicated diameter												
	256.0 mm (percent)	128.0 mm (percent)	64.0 mm (percent)	32.0 mm (percent)	16.0 mm (percent)	8.0 mm (percent)	4.0 mm (percent)	2.0 mm (percent)	1.0 mm (percent)	0.50 mm (percent)	0.25 mm (percent)	0.125 mm (percent)	0.062 mm (percent)
07103780 MONUMENT CREEK ABOVE NORTH GATE BOULEVARD AT U.S. AIR FORCE ACADEMY (SITE M5)													
[1]04-18-85	--	--	100	96	88	59	39	21	10	4	1	0	0
[1]05-03-85	--	--	--	100	96	81	63	42	26	16	6	1	0
[2]08-12-85	--	100	70	37	27	24	22	16	10	4	1	0	0
[2]10-29-85	--	100	59	41	26	17	14	11	7	3	1	0	0
[2]04-14-86	100	50	32	13	8	5	3	2	1	0	0	0	0
[2]07-10-86	--	100	40	21	14	8	5	2	1	0	0	0	0
[2]08-25-86	100	85	72	28	17	10	6	3	2	1	0	0	0
[2]11-05-86	--	100	68	27	18	15	10	8	6	4	1	0	0
[2]04-27-87	--	100	83	16	6	3	1	1	0	0	0	0	0
[1]04-30-87	--	100	62	28	11	6	3	2	1	0	0	0	0
[2]07-14-87	100	65	38	19	11	8	6	4	2	1	0	0	0
[2]08-26-87	--	100	54	19	10	6	4	2	1	0	0	0	0
[2]11-03-87	100	75	28	7	3	1	0	0	0	0	0	0	0
[2]04-25-88	100	56	28	18	10	6	4	2	1	0	0	0	0
[2]06-30-88	100	84	37	23	11	6	3	2	1	0	0	0	0
[2]09-07-88	100	72	60	18	7	4	2	1	0	0	0	0	0
07104000 MONUMENT CREEK AT PIKEVIEW (SITE M10)													
[1]04-03-85	--	--	--	100	99	92	80	57	32	14	3	0	0
[1]05-02-85	--	--	100	98	98	96	80	48	21	9	2	0	0
[2]08-12-85	--	--	--	100	100	94	81	56	30	15	4	1	0
[1]10-28-85	--	--	--	100	100	98	90	68	38	16	3	0	0
[2]04-14-86	--	--	--	100	98	94	81	58	33	16	3	0	0
[2]07-10-86	--	--	100	98	93	88	77	55	33	15	5	1	0
[2]08-25-86	--	--	100	98	97	94	85	67	42	22	6	1	0
[2]11-05-86	--	--	--	100	99	94	82	60	34	17	5	1	0
[2]04-27-87	--	--	--	100	99	92	75	48	25	10	2	0	0
[1]04-29-87	--	--	--	100	98	90	71	44	21	8	1	0	0
[2]07-14-87	--	--	--	100	98	91	73	44	22	9	2	0	0
[2]08-26-87	--	--	--	100	98	94	80	52	28	14	4	1	0
[2]11-04-87	--	--	--	100	99	97	88	60	33	15	4	1	0
[2]04-25-88	--	--	--	100	99	93	76	50	27	11	2	0	0
[2]06-30-88	--	--	--	100	98	90	74	50	28	15	5	1	0
[2]09-07-88	--	--	--	100	99	95	83	58	34	16	5	0	0
07104905 MONUMENT CREEK AT BIJOU STREET AT COLORADO SPRINGS (SITE M16)													
[1]04-03-85	--	--	--	100	93	82	68	48	27	11	2	1	0
[1]05-02-85	--	--	100	97	93	85	72	51	27	11	2	0	0
[1]04-30-87	--	--	--	100	99	94	83	62	38	18	2	0	0

[1]Samples collected in conjunction with bedload measurement.
[2]Samples collected in conjunction with benthic-invertebrate samples.
[3]Sample collected was not in conjunction with bedload measurement or benthic-invertebrate samples. Sample was collected with the 6-in. diameter scoop near the bedload measurement section.
[4]Sample was collected in conjunction with a bedload sample; however, the bedload sample was not used in any analysis due to problems with bedload sampling.

Table 17.--*Bedload size distribution for selected sites on Fountain and Monument Creeks, water years 1985-88*

[mm, millimeters; --, not applicable]

Date	Percent of bedload smaller than indicated diameter										
	64.0 mm (percent)	32.0 mm (percent)	16.00 mm (percent)	8.00 mm (percent)	4.00 mm (percent)	2.00 mm (percent)	1.00 mm (percent)	0.50 mm (percent)	0.25 mm (percent)	0.125 mm (percent)	0.062 mm (percent)
07103700 FOUNTAIN CREEK NEAR COLORADO SPRINGS (SITE F4)											
04-04-85	--	--	100	99	86	57	25	8	1	0	0
04-18-85	--	--	100	98	85	61	30	10	1	0	0
04-30-85	--	100	97	90	72	53	38	26	7	1	0
04-29-87	--	--	100	97	79	60	37	17	2	0	0
07105500 FOUNTAIN CREEK AT COLORADO SPRINGS (SITE F8)											
04-04-85	--	--	100	94	82	58	36	18	3	0	0
05-02-85	--	--	100	91	75	54	29	12	4	1	0
05-03-85	--	--	100	98	78	45	26	17	6	1	0
05-01-87	--	--	100	96	86	64	35	15	3	0	0
06-24-88	--	100	99	95	84	63	41	25	6	1	0
06-24-88	--	100	99	94	83	64	42	22	5	1	0
07105800 FOUNTAIN CREEK AT SECURITY (SITE F13)											
04-04-85	--	--	100	94	80	58	30	12	2	0	0
05-03-85	--	100	98	94	86	71	52	34	9	1	0
10-28-85	--	--	100	96	84	59	32	13	1	0	0
05-01-87	--	100	99	95	85	64	40	19	2	0	0
08-26-87	--	100	97	89	75	55	36	20	4	1	0
06-15-88	--	--	100	96	87	63	36	21	5	0	0
08-09-88	100	99	94	87	72	47	19	6	1	0	0
07103780 MONUMENT CREEK ABOVE NORTH GATE BOULEVARD AT U.S. AIR FORCE ACADEMY (SITE M5)											
04-18-85	--	100	95	78	60	39	22	12	2	0	0
05-03-85	--	100	95	81	58	34	17	9	2	0	0
04-30-87	--	100	98	95	86	67	45	21	3	0	0
07104000 MONUMENT CREEK AT PIKEVIEW (SITE M10)											
04-03-85	--	--	100	98	92	74	49	29	8	1	0
05-02-85	--	100	92	87	74	53	35	23	8	1	0
04-29-87	--	100	99	94	91	67	37	16	3	0	0
07104905 MONUMENT CREEK AT BIJOU STREET AT COLORADO SPRINGS (SITE M16)											
04-03-85	--	100	97	90	77	55	33	17	3	0	0
05-02-85	--	100	96	88	76	56	38	24	7	1	0
04-30-87	--	--	100	95	81	55	33	18	4	0	0

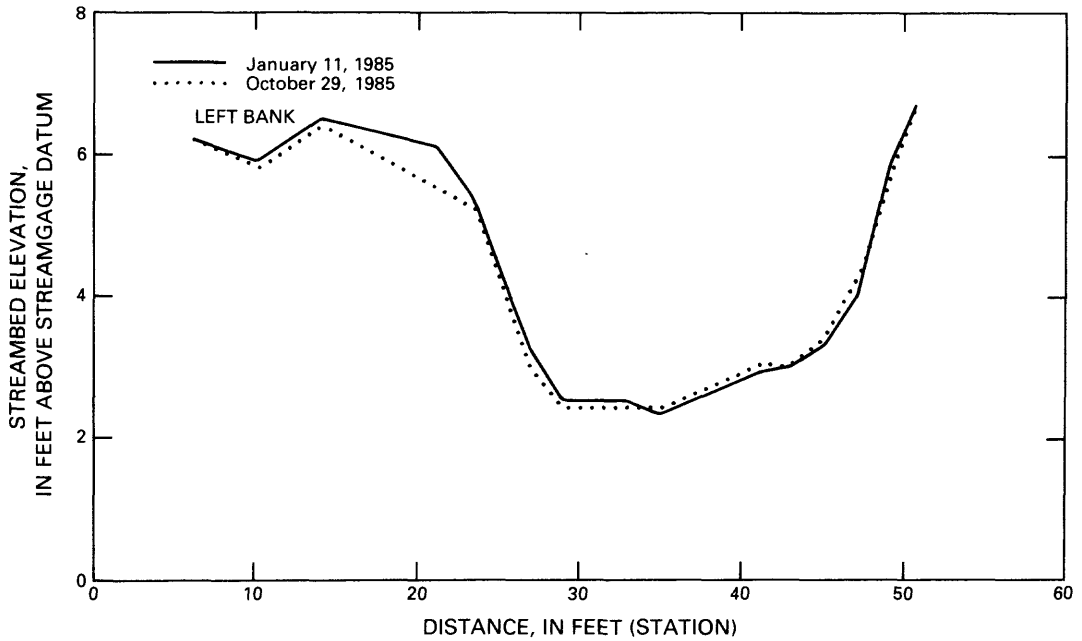

Figure 16.--Selected stream-channel cross-section surveys for Fountain Creek near Colorado Springs (site F4).

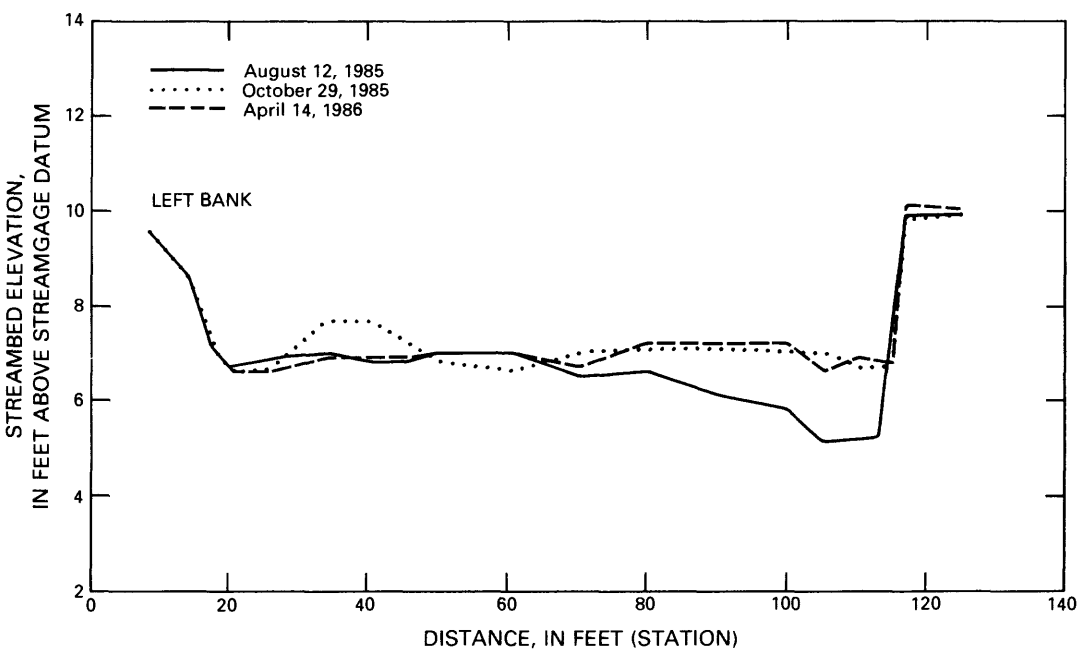

Figure 17.--Selected stream-channel cross-section surveys upstream from streamflow-gaging station Fountain Creek at Colorado Springs (site F8).

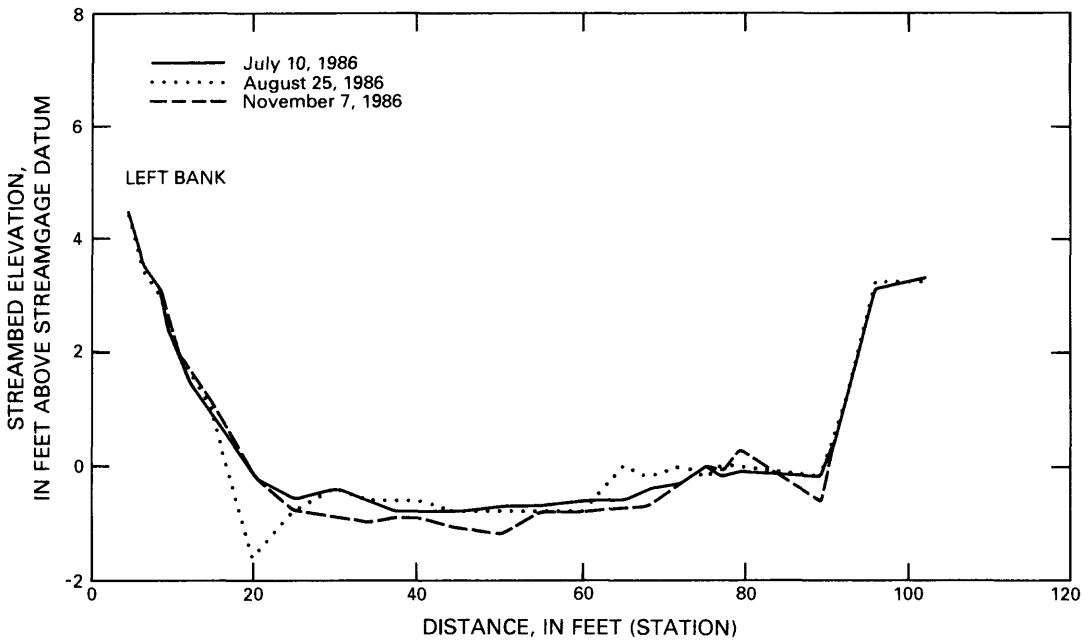

Figure 18.--Selected stream-channel cross-section surveys downstream from streamflow-gaging station Fountain Creek at Colorado Springs (site F8).

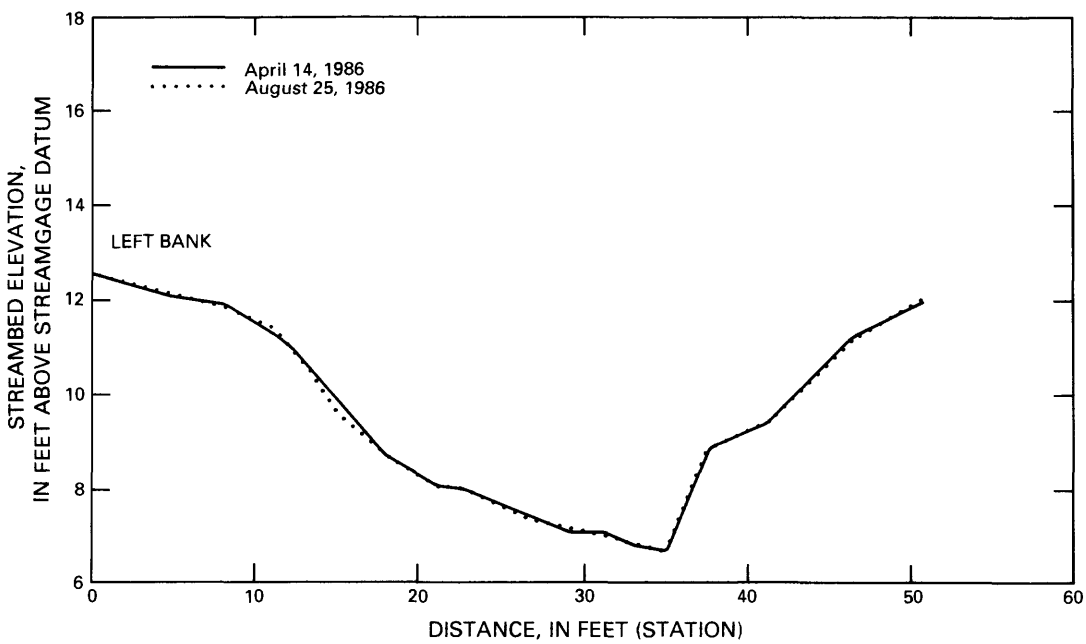

Figure 19.--Selected stream-channel cross-section surveys for Monument Creek above North Gate Boulevard at U.S. Air Force Academy (site M5).

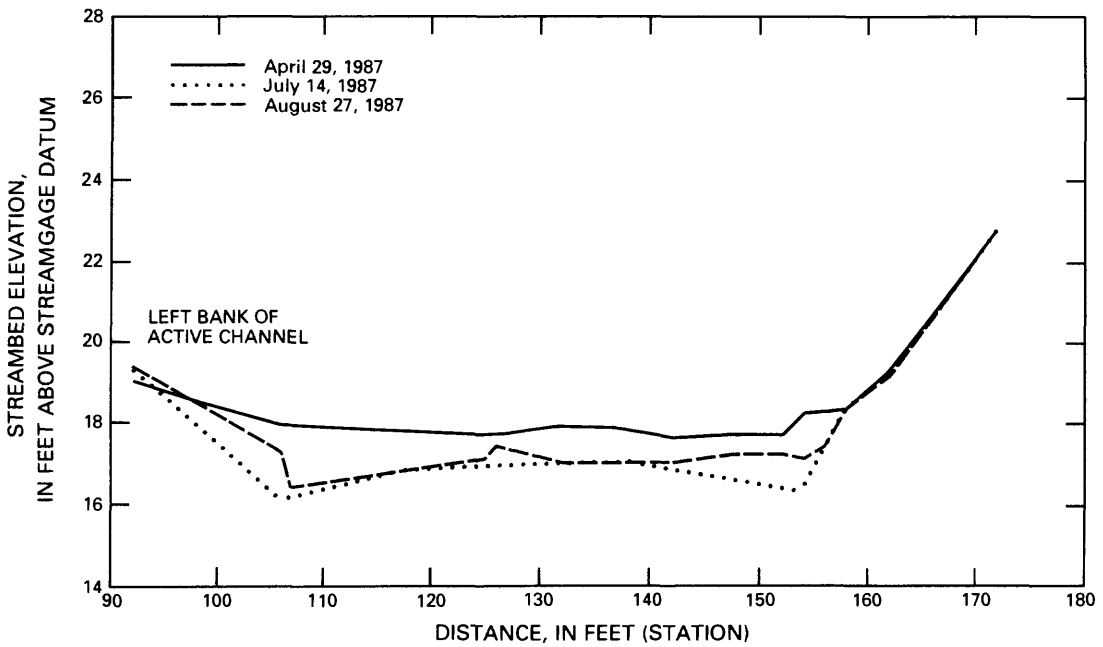

Figure 20.--Selected stream-channel cross-section surveys for Monument Creek at Pikeview (site M10). (Cross sections depicted are for stations 92.0 through 172.0 ft. The entire cross section is about 172.0 ft wide; however, the active stream channel having perennial streamflow is 80.0 ft wide.)

Table 18.--*Summary of stream-channel cross-section data for selected sites on Fountain and Monument Creeks, water years 1985-88*

Distance, in feet from left stream-bank (station)	Streambed elevation, in feet above streamgage datum															
	1985						1986			1987				1988		
	01-11	04-16	05-15	07-11	08-12	10-29	04-14	07-10	08-25	04-28	07-15	08-27	11-03	04-26	06-30	09-07
							07103700 FOUNTAIN CREEK NEAR COLORADO SPRINGS (SITE F4)									
5.0	--	--	--	--	--	--	--	--	--	--	--	--	--	--	6.4	--
6.0	6.2	6.3	6.3	6.3	6.3	6.2	6.3	6.3	6.4	6.4	6.4	6.3	6.3	6.4	--	5.5
10.0	5.9	5.8	5.8	5.8	5.8	5.8	5.8	5.8	5.8	5.8	5.8	5.8	5.8	5.8	5.8	5.8
14.0	6.5	6.4	6.4	6.4	6.4	6.4	6.4	--	--	--	--	--	--	--	6.7	6.7
20.0	--	--	--	--	--	--	--	--	--	--	--	--	--	--	6.4	--
21.0	6.1	6.1	6.1	6.1	6.0	--	--	--	--	--	--	--	--	--	--	--
23.5	5.3	5.2	5.2	5.3	5.2	5.2	5.3	5.3	5.4	5.4	5.4	5.4	5.6	5.4	--	5.6
24.0	--	--	--	--	--	--	--	--	--	--	--	--	--	--	5.4	--
26.0	--	--	--	--	--	--	--	--	--	--	--	--	--	--	3.8	--
26.5	--	--	--	--	--	--	--	--	--	--	--	--	--	--	3.2	--
27.0	3.2	3.2	2.9	2.9	2.9	3.0	3.1	3.2	3.0	3.0	3.0	3.1	2.9	3.1	--	3.6
29.0	2.5	2.8	2.6	2.6	2.5	2.4	2.4	2.8	2.5	2.7	2.9	2.8	2.7	2.7	3.1	3.0
30.0	--	--	--	--	--	--	--	--	--	--	--	--	--	--	2.7	2.9
31.0	2.5	2.4	2.7	2.6	2.3	2.4	2.3	2.7	2.4	2.4	2.7	2.6	2.6	2.6	--	2.7
33.0	2.5	2.4	2.5	2.4	2.4	2.4	2.5	2.6	2.4	2.4	2.4	2.4	2.4	2.4	2.4	2.4
35.0	2.3	2.4	2.3	2.3	2.3	2.4	2.5	2.5	2.4	2.5	2.3	2.4	2.5	2.6	--	2.5
36.0	--	--	--	--	--	--	--	--	--	--	--	--	--	--	2.4	--
37.0	2.5	2.5	2.5	2.5	2.5	2.6	2.5	2.6	2.6	2.5	2.0	2.6	2.5	2.5	--	2.6
39.0	2.7	2.7	2.7	2.7	2.6	2.8	2.7	2.9	2.6	2.6	2.4	2.5	2.4	2.4	2.7	2.5
41.0	2.9	2.9	2.9	2.9	2.8	3.0	2.9	2.9	2.9	2.9	2.8	2.9	2.7	2.8	--	2.7
43.0	3.0	3.0	3.1	3.0	3.0	3.0	3.0	3.2	3.0	3.0	2.8	2.9	2.8	2.8	2.8	2.7
45.0	3.3	3.1	3.2	3.2	3.2	3.4	3.3	3.1	3.1	3.2	3.1	3.1	2.9	3.1	--	3.3
45.5	--	--	--	--	--	--	--	--	--	--	--	--	--	--	3.0	--
47.0	4.0	3.9	3.9	3.9	3.9	4.2	4.0	3.9	4.0	4.0	4.0	4.0	3.8	3.8	--	4.1
48.0	--	--	--	--	--	--	--	--	--	--	--	--	--	--	4.5	--
49.0	5.8	5.6	5.7	5.7	5.6	5.6	5.8	5.7	5.8	5.8	5.5	5.8	5.7	5.7	--	5.8
50.7	6.7	6.4	6.7	6.6	6.6	6.6	6.6	6.6	6.6	6.7	6.6	6.6	6.6	6.7	--	6.6
50.8	--	--	--	--	--	--	--	--	--	--	--	--	--	--	6.6	--

Table 18.--*Summary of stream-channel cross-section data for selected sites on Fountain and Monument Creeks, water years 1985-88*--Continued

Distance, in feet from left stream-bank (station)	Streambed elevation, in feet above streamgage datum													
	1985			1986				1987				1988		
	07-23	08-12	10-29	04-14	07-10	08-25	11-07	04-27	07-14	09-01	11-03	04-26	07-01	09-07
	07105500 FOUNTAIN CREEK AT COLORADO SPRINGS (UPSTREAM FROM NEVADA STREET, SITE F8)													
0.0	--	--	--	--	--	--	--	--	--	--	--	--	9.6	10.0
8.0	9.1	9.6	9.6	9.6	9.6	9.6	9.6	9.6	9.6	9.7	9.6	9.7	--	9.6
10.0	--	--	--	--	--	--	--	--	--	--	--	--	9.4	--
14.0	8.4	8.6	8.6	8.6	8.6	8.6	8.7	8.6	8.8	8.9	8.8	8.9	--	9.0
16.0	--	--	--	--	--	--	--	--	--	--	--	--	8.3	--
17.0	7.1	7.2	7.4	7.3	7.8	7.9	7.8	7.9	8.1	8.1	8.0	8.0	--	8.2
20.0	6.2	6.7	6.6	6.6	7.0	7.0	6.6	6.6	6.5	6.7	6.5	6.9	6.8	7.2
22.0	--	--	--	--	--	--	--	--	--	--	--	--	6.4	6.6
25.0	--	--	--	--	--	--	--	--	--	--	--	--	6.4	--
26.0	6.3	6.9	6.7	6.6	7.0	6.9	6.5	6.5	6.3	6.5	6.4	6.8	--	6.4
30.0	--	--	--	--	--	--	--	--	--	--	--	--	6.5	--
31.0	--	--	--	--	--	--	--	--	--	--	--	--	--	6.6
34.0	6.6	7.0	7.7	6.9	6.8	6.6	6.6	6.6	6.3	6.4	6.4	6.5	--	6.8
35.0	--	--	--	--	--	--	--	--	--	--	--	--	6.5	--
40.0	6.8	6.8	7.7	6.9	6.6	6.6	6.7	6.5	6.4	6.3	6.3	6.4	6.7	6.6
45.0	7.1	6.8	7.3	6.9	6.6	6.7	6.9	6.5	6.4	6.1	6.3	6.3	6.6	6.2
50.0	7.1	7.0	6.8	7.0	6.6	6.9	6.9	6.5	6.3	6.2	6.3	6.4	6.5	6.2
55.0	--	--	--	--	--	--	--	--	--	--	--	--	6.6	--
60.0	6.7	7.0	6.6	7.0	7.2	6.7	6.6	6.6	6.2	6.2	6.3	6.4	6.3	6.6
65.0	--	--	--	--	--	--	--	--	--	--	--	--	6.4	--
70.0	6.9	6.5	7.0	6.7	6.4	6.6	6.5	6.5	6.3	6.7	6.5	6.7	6.4	6.8
72.0	--	--	--	--	--	--	--	--	--	--	--	--	--	6.8
75.0	--	--	--	--	--	--	--	--	--	--	--	--	6.6	--
76.0	--	--	--	--	--	--	--	--	--	--	--	--	6.8	--
80.0	6.3	6.6	7.1	7.2	6.8	7.0	6.8	6.9	6.8	6.7	6.6	6.9	6.9	7.0
85.0	--	--	--	--	--	--	--	--	--	--	--	--	6.8	--
90.0	6.0	6.1	7.1	7.2	7.0	6.9	7.0	5.9	6.6	6.6	6.7	6.7	6.7	7.0
95.0	--	--	--	--	--	--	--	--	--	--	--	--	6.5	--
100.0	5.4	5.8	7.0	7.2	6.6	6.6	6.7	6.7	6.6	6.7	6.8	6.6	6.7	7.2
102.0	--	--	--	--	--	--	--	--	--	--	--	--	6.8	--
104.0	--	--	--	--	--	--	--	--	--	--	--	--	6.9	--
105.0	4.3	5.1	7.0	6.6	6.8	6.9	6.5	6.8	6.7	6.7	6.8	6.8	6.6	7.2
110.0	4.4	5.2	6.7	6.9	7.0	7.0	7.0	7.0	6.9	6.8	6.8	6.8	6.9	7.0
113.0	5.4	5.2	6.7	6.8	7.0	6.9	6.9	6.8	6.8	6.7	--	6.8	--	7.2
114.0	--	--	--	--	--	--	--	--	--	--	--	--	6.8	--
115.0	6.6	7.4	6.7	6.8	6.9	7.0	6.9	7.1	6.9	7.0	7.1	7.0	7.3	7.2
116.0	--	--	--	--	--	--	--	--	--	--	--	--	9.7	--
117.0	9.9	9.9	9.8	10.1	10.0	9.8	9.9	10.0	10.0	9.8	9.9	10.0	--	9.6
120.0	--	--	--	--	--	--	--	--	--	--	--	--	10.4	--
125.0	9.9	9.9	10.0	10.0	10.0	10.1	10.1	10.0	10.0	10.0	10.0	10.0	--	10.2
132.8	--	--	--	--	--	--	--	--	--	9.7	10.2	9.8	--	9.9
133.0	--	--	--	--	--	--	--	--	--	--	--	--	10.2	--

Table 18.--*Summary of stream-channel cross-section data for selected sites on Fountain and Monument Creeks, water years 1985-88*--Continued

Distance, in feet from left stream-bank (station)	Streambed elevation, in feet above streamgage datum																	
	1985							1986				1987				1988		
	01-11	04-16	05-15	07-11	07-23	08-12	10-29	04-14	07-10	08-25	11-07	04-27	07-14	09-01	11-03	04-26	07-01	09-07
								07105500 FOUNTAIN CREEK AT COLORADO SPRINGS (DOWNSTREAM FROM NEVADA STREET, SITE F8)										
4.0	4.2	3.6	4.2	3.5	4.2	4.0	4.2	4.2	4.5	4.4	4.5	4.4	4.5	4.3	4.7	4.4	4.6	4.4
4.2	3.6	3.3	4.1	3.3	3.6	3.6	3.8	3.8	4.3	--	--	--	--	--	4.4	--	--	--
6.0	3.2	3.0	3.3	3.0	3.1	3.1	3.4	3.4	3.5	3.4	3.5	3.5	3.6	3.6	3.6	3.6	--	3.7
8.0	2.7	2.5	2.7	2.5	2.6	2.6	3.1	3.1	3.1	3.0	3.1	3.1	3.2	3.2	3.3	3.1	--	3.2
9.2	1.2	1.8	2.4	1.8	2.2	2.1	2.4	2.5	2.4	2.4	2.6	2.8	2.7	2.7	2.7	2.6	--	2.8
10.0	1.7	1.1	1.7	1.6	1.7	1.7	2.1	2.1	2.1	2.2	2.1	2.2	2.2	2.3	2.5	2.4	2.5	2.6
12.0	0.4	0.4	0.8	0.7	1.1	0.7	0.8	1.2	1.4	1.6	1.6	1.6	0.9	1.9	2.0	1.6	--	2.1
14.0	0.1	0.1	0.4	0.3	0.4	-0.3	0.4	0.4	1.0	1.2	1.2	1.2	1.4	1.4	1.5	1.4	1.4	2.1
17.0	--	--	--	--	--	--	--	--	--	--	--	--	--	1.0	1.0	--	--	--
18.0	--	--	--	--	--	--	--	--	--	--	--	--	0.2	0.4	--	0.6	--	--
19.0	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	0.8	--
19.5	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	0.1	--
20.0	-0.4	-0.4	-0.5	-0.7	-0.6	-0.8	-0.8	-0.9	-0.2	-1.6	-0.2	-0.2	--	-0.1	-0.5	-0.4	--	0.1
24.0	--	--	--	--	--	--	--	--	--	--	--	--	-0.4	-0.5	--	--	--	--
25.0	-0.8	-0.8	-0.7	-0.8	-1.2	-1.0	-0.9	-0.8	-0.6	-0.8	-0.8	-0.8	-0.6	-0.6	-0.6	-0.6	-0.3	0.1
26.0	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	0.0
30.0	-1.0	-1.0	-1.1	-1.2	-1.5	-1.0	-1.4	-1.2	-0.4	-0.4	-0.9	-1.1	-1.3	-1.0	-1.0	-0.9	-0.3	-0.1
34.0	-1.3	-1.3	-1.5	-1.4	-1.7	-1.2	-1.3	-1.3	-0.6	-0.6	-1.0	-1.1	-1.4	-1.1	-1.1	-1.2	--	-0.2
35.0	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	-0.3	--
37.0	-1.6	-1.6	-1.6	-1.5	-1.7	-1.2	-1.5	-1.4	-0.8	-0.6	-0.9	-1.1	-1.4	-1.0	-1.3	-1.0	--	-0.3
40.0	-1.4	-1.7	-1.7	-1.5	-1.7	-1.3	-1.5	-1.4	-0.8	-0.6	-0.9	-1.4	-1.6	-1.0	-1.1	-1.1	-0.6	0.0
45.0	-1.5	-1.6	-1.3	-1.6	-1.8	-1.4	-1.6	-1.4	-0.8	-0.8	-1.1	-1.2	-1.4	-1.2	-1.2	-1.1	-0.3	0.0
47.0	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	0.0
50.0	-1.5	-1.4	-1.5	-1.4	-1.6	-1.3	-1.6	-1.5	-0.7	-0.8	-1.2	-1.1	-1.2	-1.2	-1.3	-1.0	-0.2	-0.2
55.0	-1.4	-1.4	-1.3	-1.1	-1.4	-0.9	-1.2	-1.2	-0.7	-0.8	-0.8	-1.0	-1.2	-0.9	-1.1	-0.8	-0.7	-0.3
57.5	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	-0.8	--
60.0	-1.0	-1.0	-1.1	-1.2	-1.3	-0.9	-0.8	-1.0	-0.6	-0.8	-0.8	-0.8	-0.6	-0.8	-0.4	-0.7	-0.7	-0.2
62.0	--	--	--	--	--	--	--	--	--	--	--	--	-0.6	-0.4	--	--	-0.1	--
65.0	-0.9	-1.1	-1.3	-1.2	-1.1	-0.7	-1.1	-1.1	-0.6	0.0	-0.7	-0.8	-0.4	-0.6	-0.6	-0.6	0.0	-0.1
67.0	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	0.1	--
68.0	-1.1	-1.2	-1.2	-1.1	-1.4	-0.7	-1.1	-1.1	-0.4	-0.2	-0.7	-0.8	-0.4	-0.5	-0.7	-0.6	--	-0.1
70.0	--	--	--	--	--	--	--	--	--	--	--	--	--	-0.5	-0.6	-0.4	-0.1	--
71.0	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	0.0
72.0	-0.5	-0.5	-0.7	-0.8	-1.1	-0.7	-0.6	-0.7	-0.3	0.0	-0.3	-0.3	0.0	-0.4	-0.4	-0.3	--	0.0
75.0	-0.1	-0.3	-0.1	-0.5	-0.3	-0.4	0.0	0.0	0.0	-0.2	0.0	0.0	0.2	0.0	0.0	0.0	0.3	0.2
77.0	-0.6	-0.7	-0.7	-0.8	-0.7	-0.4	0.0	-0.1	-0.2	0.0	-0.1	-0.2	0.2	0.0	0.1	-0.1	--	0.1
79.0	-0.9	-0.9	-1.0	-1.1	-0.8	-0.7	-0.1	-0.2	-0.1	0.0	0.3	0.0	0.2	-0.1	-0.1	-0.2	--	0.1
80.0	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	0.0	--
85.0	--	--	--	--	--	--	--	--	--	--	--	--	-0.3	-0.3	--	-0.4	-0.2	--
89.0	-0.2	-0.2	-1.0	-1.0	-0.7	0.4	-0.3	-0.3	-0.2	-0.2	-0.6	0.1	-0.4	-0.8	-0.7	-0.8	-0.5	0.0
90.0	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	0.5	--
91.0	0.6	0.6	0.4	0.5	0.4	0.9	0.6	0.5	0.5	0.6	0.6	0.6	0.6	0.6	0.8	0.5	--	1.0
93.0	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	1.2	--
95.0	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	3.3	--
95.5	3.2	3.3	3.1	3.2	3.2	3.2	3.3	3.1	3.1	3.2	3.1	3.2	3.2	3.2	3.2	3.2	--	3.3
100.0	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
101.7	3.4	3.3	3.2	3.2	3.2	3.2	3.3	3.2	3.3	3.2	3.3	3.6	3.3	3.6	3.6	3.3	--	3.6

Table 18.--*Summary of stream-channel cross-section data for selected sites on Fountain and Monument Creeks, water years 1985-88*--Continued

Distance, in feet from left stream-bank (station)	Streambed elevation, in feet above streamgage datum																		
	1985							1986				1987				1988			
	01-11	04-16	05-15	07-11	07-23	08-12	10-29	04-14	07-11	08-26	11-07	04-28	07-15	08-27	11-03	04-26	06-15	07-01	09-07
07105800 FOUNTAIN CREEK AT SECURITY (SITE F13)																			
0.0	8.1	8.2	8.1	8.1	8.1	8.1	8.1	8.1	8.1	8.1	8.1	8.2	8.5	8.2	8.5	8.2	8.5	8.2	8.5
12.0	6.0	6.0	5.9	5.9	6.0	6.0	6.1	5.9	6.0	5.9	6.0	6.0	6.0	5.9	6.0	6.0	--	--	6.0
14.0	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	5.7	5.8	--
20.0	5.3	5.4	5.3	5.3	5.4	5.4	5.5	5.3	5.4	5.3	5.3	5.3	5.3	5.3	5.2	5.4	--	--	5.3
21.0	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	5.1	5.1	--
24.0	2.9	3.5	3.3	3.3	3.5	3.4	3.6	3.2	3.6	3.6	3.4	3.5	3.5	3.6	3.0	3.7	3.5	3.6	3.3
25.5	0.9	0.8	1.7	0.8	2.2	2.5	2.3	1.8	1.6	1.8	2.5	1.9	1.8	1.6	1.6	2.2	--	--	2.3
26.0	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	2.0	2.0	--
26.5	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	1.0	--	--
27.0	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	0.7	0.8	0.7
28.0	1.1	0.8	1.8	1.1	0.9	1.0	1.6	1.7	1.4	1.0	0.9	0.8	0.7	0.7	0.8	0.8	--	--	0.7
30.0	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	0.6	0.6	--
32.0	1.9	1.2	1.9	1.6	1.0	1.1	1.9	1.9	1.8	1.4	0.9	0.8	0.6	0.6	0.7	0.6	--	--	0.5
33.0	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	0.5
35.0	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	0.4	0.4	--
40.0	2.1	1.4	1.3	1.8	0.7	0.7	1.8	1.8	1.7	0.7	0.6	0.6	0.4	0.4	0.6	0.3	0.4	0.4	0.4
45.0	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	0.1	0.2	--
50.0	1.9	1.1	0.9	1.5	0.7	1.2	1.1	0.5	0.4	0.3	0.3	0.2	0.5	0.5	0.8	-0.1	0.03	-0.1	-0.2
55.0	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	0.1	0.2	--
60.0	1.9	1.3	0.7	1.4	1.0	1.7	0.9	0.4	0.8	0.5	0.4	0.4	0.8	0.7	0.8	0.1	0.2	0.5	0.0
65.0	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	0.2	0.0	0.3
70.0	1.9	1.2	0.8	1.6	1.1	1.8	1.2	0.6	0.8	0.6	1.0	0.3	1.2	0.8	0.8	0.7	0.3	0.2	0.4
75.0	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	0.3	0.4	--
80.0	2.0	1.1	1.1	1.6	1.1	1.6	1.1	0.6	0.6	0.7	1.2	0.6	1.4	0.8	1.2	0.9	0.6	0.7	0.5
85.0	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	1.0	1.0	--
88.5	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	1.0	--	--
90.0	2.1	1.4	1.2	1.9	0.9	1.1	1.1	0.6	0.7	0.8	1.3	0.9	1.4	0.9	1.5	1.9	1.1	1.1	0.0
95.0	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	1.2	1.1	--
100.0	2.3	1.7	1.2	1.8	0.7	1.1	1.1	0.8	0.8	0.8	1.5	0.9	0.5	1.4	1.6	1.6	1.3	1.2	0.7
105.0	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	1.2	1.2	--
109.5	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	0.7
110.0	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	0.8	0.9	--
111.0	2.1	1.8	1.4	1.6	1.2	1.1	1.2	1.2	1.2	1.2	1.2	0.2	1.1	1.1	1.4	1.3	--	--	1.1
111.5	3.3	3.6	3.1	2.9	2.3	2.4	2.3	3.7	3.3	3.1	3.8	--	3.1	3.6	3.7	3.0	1.2	1.1	3.2
112.0	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	3.8	3.1	--
115.0	5.4	5.6	5.5	5.3	5.3	5.3	--	--	--	5.4	5.4	--	--	--	--	--	5.4	5.4	--
120.0	6.8	6.6	6.8	6.7	6.8	6.7	6.7	6.7	6.8	6.8	6.7	6.8	6.8	6.7	6.8	6.8	6.8	6.8	6.8
122.8	7.4	7.4	7.4	7.5	7.6	7.3	7.1	7.5	7.6	7.4	7.6	7.6	7.6	7.4	7.6	7.5	--	--	7.4
122.9	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	7.5	7.4	--

Table 18.--*Summary of stream-channel cross-section data for selected sites on Fountain and Monument Creeks, water years 1985-88*--Continued

Distance, in feet from left streambank (station)	Streambed elevation, in feet above arbitrary datum													
	1985						1986			1987			1988	
	01-10	04-16	05-15	07-11	08-12	10-29	04-14	07-10	08-25	04-27	07-14	11-03	04-26	09-07
	07103780 MONUMENT CREEK ABOVE NORTH GATE BOULEVARD AT U.S. AIR FORCE ACADEMY (SITE M5)													
0.0	12.5	12.5	12.4	12.5	12.5	12.5	12.5	12.5	12.5	12.8	12.6	12.6	12.6	12.6
4.0	12.3	12.2	12.2	12.2	12.1	12.1	12.1	12.1	12.2	12.2	12.2	12.1	12.2	12.1
8.0	12.0	12.0	11.9	11.9	11.9	11.9	11.9	11.8	11.8	11.8	11.9	11.9	11.9	11.9
11.0	11.4	11.5	11.4	11.4	11.5	11.4	11.3	11.4	11.4	11.4	11.4	11.4	11.4	11.4
12.5	11.0	10.7	11.0	10.9	10.7	10.7	10.9	11.0	10.9	10.6	11.0	10.9	10.9	10.9
15.0	10.2	10.1	9.8	9.9	9.9	9.6	9.9	9.9	9.6	9.8	8.8	9.7	9.8	9.9
18.0	9.5	9.4	8.8	8.8	8.7	8.7	8.7	8.8	8.7	8.8	7.8	8.8	8.9	8.8
21.0	8.7	8.5	8.3	8.2	8.2	8.1	8.1	8.1	8.1	8.2	8.2	8.1	8.3	8.3
23.0	8.4	8.2	8.1	8.1	8.1	8.1	8.0	8.0	8.0	8.0	6.8	7.6	7.7	7.7
24.0	--	--	--	--	--	--	--	--	--	--	--	--	--	7.4
25.0	8.0	7.9	7.9	7.7	7.7	7.7	7.7	7.7	7.6	7.6	7.4	7.4	7.5	7.3
27.0	7.6	7.8	7.6	7.3	7.5	7.5	7.4	7.4	7.4	7.2	7.1	7.1	7.0	7.0
29.0	7.5	7.4	7.3	7.2	7.2	7.3	7.1	7.2	7.2	7.0	7.0	7.0	7.1	7.0
31.0	7.0	7.5	7.2	7.0	7.2	7.1	7.1	7.0	7.0	7.1	7.1	7.1	7.1	7.1
33.0	7.3	7.2	6.9	6.9	6.9	6.9	6.8	7.2	6.8	6.9	7.1	7.0	7.1	7.0
35.0	7.5	7.2	6.6	6.7	6.8	6.7	6.7	6.6	6.7	6.7	7.0	7.0	6.7	6.9
35.5	--	--	--	--	--	--	--	--	--	--	--	--	--	7.3
36.5	8.0	8.1	8.3	8.5	8.4	8.5	8.0	8.0	8.1	7.1	6.8	7.9	7.9	8.0
37.5	8.6	9.0	8.4	8.7	9.0	8.8	8.9	9.0	8.9	8.3	8.0	8.0	7.8	8.5
41.0	9.7	9.1	9.4	9.7	9.4	9.1	9.4	9.6	9.4	--	9.0	9.0	8.9	9.6
44.0	--	--	--	--	--	--	--	--	--	9.6	--	--	--	--
46.0	11.2	11.3	11.2	11.2	11.2	11.2	11.2	11.1	11.1	10.0	11.1	11.1	11.2	11.1
50.6	12.1	12.0	12.0	12.0	12.0	12.0	12.0	12.0	12.1	12.0	12.0	12.0	12.0	12.0

Table 18.--*Summary of stream-channel cross-section data for selected sites on Fountain and Monument Creeks, water years 1985-88*--Continued

Distance, in feet from left streambank (station)	Streambed elevation, in feet above streamgage datum														
	1985				1986				1987				1988		
	01-10	05-15	08-12	10-29	04-14	07-10	08-25	11-07	04-29	07-14	08-27	11-03	04-26	06-30	09-07
							07104000 MONUMENT CREEK AT PIKEVIEW (SITE M10)								
0	--	--	--	--	--	--	--	--	--	22.5	19.3	22.8	22.5	22.9	23.5
2.0	--	--	--	--	--	--	--	--	--	--	--	--	--	22.0	--
3.4	18.8	18.4	18.6	19.1	18.9	19.0	19.0	19.2	19.0	19.2	19.1	19.2	19.2	--	19.2
3.5	--	--	--	--	--	--	--	--	--	--	--	--	--	18.9	--
12.0	--	--	--	--	--	--	--	--	19.1	19.2	19.1	19.0	19.1	--	19.1
18.0	17.2	17.2	17.6	18.2	18.2	18.6	18.7	18.7	--	--	--	--	--	19.2	--
22.0	--	--	--	--	--	--	--	--	19.1	19.3	19.4	19.5	19.5	19.4	19.5
32.0	16.7	16.6	17.6	18.6	18.5	18.8	19.1	19.1	--	--	--	--	--	19.3	--
42.0	--	--	--	--	--	--	--	--	--	--	--	--	--	19.5	--
52.0	--	--	--	--	--	--	--	--	19.0	19.3	19.2	19.3	19.3	--	19.4
54.0	17.2	17.0	18.0	18.9	18.7	18.8	19.0	18.9	19.1	19.3	19.2	19.3	19.3	19.3	19.3
72.0	18.7	18.6	19.0	19.3	19.2	19.4	19.4	19.3	18.7	19.4	19.4	19.4	19.5	19.4	19.5
82.0	17.2	17.2	17.9	18.7	18.5	18.6	18.6	18.7	18.6	18.8	18.8	18.7	18.8	18.9	18.9
84.0	18.2	18.1	18.5	18.8	18.6	18.6	18.9	18.9	18.8	19.0	19.0	--	19.0	--	19.0
87.0	--	--	--	--	--	--	--	--	--	--	--	--	--	19.3	--
92.0	18.8	18.7	19.3	19.4	19.2	19.0	19.3	19.3	19.0	19.3	19.4	19.2	19.3	19.3	19.3
97.0	--	--	--	--	--	--	--	--	--	--	--	--	--	18.5	--
102.0	--	--	--	--	--	--	--	--	--	--	--	--	--	18.2	--
105.0	17.7	17.1	18.3	18.3	17.8	17.6	--	--	--	--	--	--	--	--	18.1
106.0	16.9	16.8	17.4	17.5	17.4	17.7	17.7	17.5	17.9	16.1	17.3	17.5	17.9	17.1	17.4
107.0	--	--	--	--	--	--	--	--	--	--	16.4	--	--	17.0	17.3
112.0	--	--	--	--	--	--	--	--	--	--	--	--	--	16.9	--
117.0	16.7	16.2	16.6	17.3	17.4	17.5	17.4	17.4	--	16.8	16.8	--	--	16.9	16.9
122.0	--	--	--	--	--	--	--	--	--	--	--	--	--	--	17.3
125.0	--	--	--	--	--	--	--	--	--	--	17.1	17.5	17.9	--	17.3
126.0	16.9	16.4	16.6	17.3	17.3	17.5	17.3	17.6	17.7	17.0	17.4	--	--	--	--
127.0	--	--	--	--	--	--	--	--	--	--	--	--	--	17.1	--
132.0	16.5	16.3	16.8	17.1	17.2	17.3	17.2	17.6	17.9	17.0	17.0	17.5	17.9	17.0	17.4
137.0	16.6	16.2	16.9	16.9	17.1	17.3	17.3	17.6	17.9	17.1	17.0	17.5	17.7	16.7	17.4
142.0	16.4	16.3	16.8	17.0	17.5	17.3	17.5	17.5	17.6	16.8	17.0	17.4	17.8	16.9	17.3
147.0	16.2	16.2	16.8	17.0	17.5	17.1	17.3	17.4	17.7	16.6	17.2	17.2	17.8	16.9	17.2
152.0	16.4	16.1	16.7	17.1	17.3	17.3	17.0	17.3	17.7	16.3	17.2	17.1	17.6	16.8	17.1
154.0	16.9	16.5	16.7	16.9	17.4	17.3	17.1	17.3	18.2	16.5	17.1	17.2	17.6	--	17.1
155.0	--	--	--	--	--	--	--	--	--	--	--	--	--	17.2	--
155.5	--	--	--	--	--	--	--	--	--	--	--	--	--	--	17.3
156.0	--	--	--	--	--	--	--	--	--	--	17.4	--	--	--	--
157.0	--	--	--	--	--	--	--	--	--	--	--	--	--	18.2	--
158.0	18.1	18.0	18.1	18.1	17.1	18.2	18.3	18.2	18.3	18.3	18.3	18.2	18.4	--	18.5
162.0	19.1	19.1	19.1	19.1	19.1	19.2	19.1	19.2	19.3	19.2	19.1	19.1	19.2	19.2	19.3
167.0	--	--	--	--	--	--	--	--	--	--	--	--	--	21.1	--
172.0	23.5	23.5	22.8	22.8	22.8	22.8	22.8	22.8	22.8	22.8	22.8	23.5	22.8	23.8	23.5

Table 19.--*Species list, replicate samples, and mean density of benthic invertebrates for selected sites on Fountain and Monument Creeks*
[Densities are rounded to standard significant figures

(Britton and Greeson, 1989)]

Taxa	Replicate sample, number of organisms			Mean density, numbers of organisms per square meter
	1	2	3	
07103700 FOUNTAIN CREEK NEAR COLORADO SPRINGS (SITE F4) SAMPLE DATE: APRIL 16, 1985				
INSECTA				
Ephemeroptera (mayflies)				
Callibaetis sp.	3	1	3	25
Epeorus longimanus	2	0	0	7
Ephemerella inermis	2	0	0	7
Plecoptera (stoneflies)				
Chloroperlidae	2	0	0	7
Diptera (true flies)				
Cricotopus sp.	64	26	15	380
Diamesa sp.	9	8	6	83
Micropsectra sp.	1	0	0	4
Orthocladius sp.	13	6	7	93
Thienemanniella sp.	1	0	0	4
Chironomidae pupa	7	0	1	29
COLLEMBOLA (springtails)				
Isotomurus palustris	1	1	0	7
OLIGOCHAETA (worms)				
Limnodrilus sp.	140	21	9	600
TOTAL	240	63	41	1,200

Table 19.--*Species list, replicate samples, and mean density of benthic invertebrates for selected sites on Fountain and Monument Creeks*--Continued

Taxa	Replicate sample, number of organisms 1	2	3	Mean density, numbers of organisms per square meter
07103700 FOUNTAIN CREEK NEAR COLORADO SPRINGS (SITE F4) Sample Date: July 11, 1985				
INSECTA				
Ephemeroptera (mayflies)				
Ameletus cooki	2	0	2	14
Baetis tricaudatus	60	60	100	790
Cinygmula sp.	12	4	2	65
Drunella grandis grandis	0	0	2	7
Epeorus longimanus	0	2	0	7
Ephemerella infrequens	6	0	8	50
Plecoptera (stoneflies)				
Amphinemura banksi	0	0	2	7
Isoperla sobria	0	0	2	7
Pteronarcella badia	0	0	10	36
Chloroperlidae	4	8	4	57
Trichoptera (caddisflies)				
Glossosoma sp.	2	0	0	7
Hydropsyche sp.	0	0	1	4
Lepidoptera (aquatic caterpillars)				
Parargyractis sp.	4	4	2	36
Diptera (true flies)				
Boreoheptagyia sp.	4	0	0	14
Chelifera sp.	0	0	2	7
Cricotopus sp.	36	34	12	290
Diamesa sp.	2	2	0	14
Micropsectra sp.	2	4	2	29
Orthocladius sp.	40	14	10	230
Parametriocnemus sp.	62	58	56	630
Psychoda sp.	2	0	0	7
Thienemanniella sp.	0	2	6	29
Thienemannimyia sp. group	6	0	2	29
Tipula sp.	0	0	2	7
Chironomidae pupa	8	2	0	36
OLIGOCHAETA (worms)				
Limnodrilus sp.	300	440	1,000	6,400
Lumbricidae	0	0	1	4
TOTAL	550	630	1,200	8,800

Table 19.--*Species list, replicate samples, and mean density of benthic invertebrates for selected sites on Fountain and Monument Creeks*--Continued

Taxa	Replicate sample, number of organisms			Mean density, numbers of organisms per square meter
	1	2	3	
07103700 FOUNTAIN CREEK NEAR COLORADO SPRINGS (SITE F4) Sample Date: August 12, 1985				
INSECTA				
Ephemeroptera (mayflies)				
Baetis tricaudatus	39	90	14	510
Drunella doddsi	0	1	0	4
Epeorus longimanus	1	0	0	4
Plecoptera (stoneflies)				
Pteronarcella badia	0	2	2	14
Capniidae	0	1	0	4
Chloroperlidae	0	1	0	4
Trichoptera (caddisflies)				
Hydropsyche sp.	0	2	0	7
Diptera (true flies)				
Cricotopus sp.	4	10	1	54
Orthocladius sp	3	0	0	11
Parametriocnemus sp.	12	8	4	86
Thienemanniella sp.	1	0	0	4
Thienemannimyia sp. group	0	1	0	4
Tipula sp.	0	0	1	4
Chironomidae pupa	1	1	1	11
Coleoptera (beetles)				
Dytiscus sp.	1	0	0	4
Helichus striatus	0	1	0	4
Heterlimnius corpulentus	0	0	1	4
COLLEMBOLA (springtails)				
Isotomurus palustris	0	1	0	4
OLIGOCHAETA (worms)				
Limnodrilus sp.	26	0	2	100
Tubificidae	0	0	1	4
TOTAL	88	119	27	840

Table 19.--*Species list, replicate samples, and mean density of benthic invertebrates for selected sites on Fountain and Monument Creeks*--Continued

Taxa	Replicate sample, number of organisms			Mean density, numbers of organisms per square meter
	1	2	3	
07103700 FOUNTAIN CREEK NEAR COLORADO SPRINGS (SITE F4)				
Sample Date: October 28, 1985				
INSECTA				
Ephemeroptera (mayflies)				
Baetis tricaudatus	190	170	130	1,800
Drunella grandis grandis	5	5	1	39
Ephemerella inermis	3	5	2	36
Plecoptera (stoneflies)				
Isoperla sobria	0	0	1	4
Prostoia besametsa	1	0	0	4
Chloroperlidae	0	3	4	25
Trichoptera (caddisflies)				
Arctopsyche grandis	1	0	0	4
Glossosoma sp.	5	6	7	65
Hydropsyche sp.	57	5	44	380
Diptera (true flies)				
Antocha sp.	1	0	1	7
Cordites sp.	0	1	4	18
Cricotopus sp.	1	3	3	25
Dicranota sp.	0	1	0	4
Eukiefferiella sp.	0	0	1	4
Pagastia sp.	0	1	1	7
Parametriocnemus sp.	8	4	7	68
Prosimulium sp.	1	0	3	14
Tipula sp.	0	1	1	7
Chironomidae pupa	2	1	1	14
MOLLUSCA				
Gastropoda (snails)				
Physa sp.	0	1	0	4
OLIGOCHAETA (worms)				
Tubificidae	11	8	11	110
TOTAL	290	220	220	2,600

Table 19.--*Species list, replicate samples, and mean density of benthic invertebrates for selected sites on Fountain and Monument Creeks*--Continued

Taxa	Replicate sample, number of organisms			Mean density, numbers of organisms per square meter
	1	2	3	
07103700 FOUNTAIN CREEK NEAR COLORADO SPRINGS (SITE F4) Sample Date: April 14, 1986				
INSECTA				
Ephemeroptera (mayflies)				
Ameletus sp.	0	0	16	57
Baetis tricaudatus	58	80	92	830
Drunella grandis grandis	3	8	4	54
Epeorus longimanus	32	0	4	130
Ephemerella inermis	21	12	16	180
Plecoptera (stoneflies)				
Amphinemura sp.	1	0	0	4
Isoperla sobria	1	0	0	4
Taenionema nigripenne	1	0	0	4
Chloroperlidae	1	0	2	11
Trichoptera (caddisflies)				
Glossosoma sp.	1	0	0	4
Hydropsyche sp.	22	84	44	540
Lepidostoma sp.	0	0	4	14
Rhyacophila acropedes	5	4	8	61
Rhyacophila hyalinata	0	4	0	14
Diptera (true flies)				
Antocha sp.	12	0	8	72
Chelifera sp.	0	0	4	14
Cricotopus sp.	260	310	200	2,800
Diamesa sp.	190	170	88	1,600
Dicranota sp.	0	0	4	14
Eukiefferiella sp.	28	24	8	220
Micropsectra sp.	0	4	0	14
Orthocladius sp.	48	28	44	430
Parametriocnemus sp.	20	16	8	160
Thienemanniella sp.	0	4	0	14
Thienemannimyia sp. group	0	4	0	14
Tipula sp.	0	1	0	4
Chironomidae pupa	20	0	4	86
OLIGOCHAETA (worms)				
Tubificidae	96	76	64	850
TOTAL	820	830	620	8,200

Table 19.--*Species list, replicate samples, and mean density of benthic invertebrates for selected sites on Fountain and Monument Creeks*--Continued

Taxa	Replicate sample, number of organisms 1	2	3	Mean density, numbers of organisms per square meter
07103700 FOUNTAIN CREEK NEAR COLORADO SPRINGS (SITE F4) Sample Date: July 10, 1986				
INSECTA				
Ephemeroptera (mayflies)				
Baetis bicaudatus	88	12	14	410
Baetis tricaudatus	64	40	86	680
Cinygmula sp.	4	0	0	14
Epeorus longimanus	0	0	2	7
Ephemerella inermis	0	0	2	7
Plecoptera (stoneflies)				
Pteronarcella badia	0	0	2	7
Chloroperlidae	4	0	0	14
Trichoptera (caddisflies)				
Cheumatopsyche sp.	0	4	2	22
Hydropsyche sp.	20	0	4	86
Rhyacophila sp.	4	0	0	14
Diptera (true flies)				
Chelifera sp.	4	0	0	14
Chironomus sp.	0	0	2	7
Corynoneura sp.	0	4	0	14
Cricotopus sp.	24	16	10	180
Diamesa sp.	4	0	0	14
Eukiefferiella sp.	4	0	0	14
Micropsectra sp.	4	0	2	22
Parametriocnemus sp.	8	0	0	29
Prosimulium sp.	20	0	2	79
Simulium vittatum complex	0	0	2	7
Chironomidae pupa	4	0	2	22
HYDRACARINA (water mites)	12	0	0	43
OLIGOCHAETA (worms)				
Eiseniella tetraedra	8	4	0	43
Tubificidae	180	240	100	1,800
TOTAL	460	320	230	3,500

Table 19.--*Species list, replicate samples, and mean density of benthic invertebrates for selected sites on Fountain and Monument Creeks*--Continued

Taxa	Replicate sample, number of organisms			Mean density, numbers of organisms per square meter
	1	2	3	
07103700 FOUNTAIN CREEK NEAR COLORADO SPRINGS (SITE F4) SAMPLE DATE: AUGUST 25, 1986				
INSECTA				
Ephemeroptera (mayflies)				
Baetis bicaudatus	0	0	5	18
Baetis tricaudatus	15	13	18	160
Diptera (true flies)				
Prodiamesa sp.	12	6	3	75
Thienemannimyia sp. group	2	0	1	11
Chironomidae pupa	1	0	0	4
OLIGOCHAETA (worms)				
Eiseniella tetraedra	1	0	0	4
Limnodrilus sp.	0	7	3	36
TOTAL	31	26	30	310

Table 19.--*Species list, replicate samples, and mean density of benthic invertebrates for selected sites on Fountain and Monument Creeks*--Continued

Taxa	Replicate sample, number of organisms 1	2	3	Mean density, numbers of organisms per square meter
07103700 FOUNTAIN CREEK NEAR COLORADO SPRINGS (SITE F4)				
Sample Date: November 5, 1986				
INSECTA				
Ephemeroptera (mayflies)				
Baetis bicaudatus	30	8	4	150
Baetis tricaudatus	84	31	19	480
Callibaetis sp.	0	7	25	120
Drunella grandis	1	0	0	4
Ephemerella infrequens	11	1	1	47
Rhithrogena hageni	1	0	0	4
Plecoptera (stoneflies)				
Capniidae	0	0	3	11
Trichoptera (caddisflies)				
Hydropsyche sp.	23	5	2	110
Rhyacophila acropedes	1	1	0	7
Diptera (true flies)				
Chelifera sp.	2	0	4	22
Cricotopus sp.	3	0	0	11
Diamesa sp.	0	2	0	7
Dicranota sp.	6	6	6	65
Orthocladius sp.	2	0	0	7
Pagastia sp.	0	1	0	4
Palpomyia complex	1	0	0	4
Parametriocnemus sp.	0	7	2	32
Prodiamesa sp.	14	6	7	97
Prosimulium sp.	6	0	0	22
Protanyderus margarita	1	0	0	4
Thienemanniella sp. group	1	6	0	25
Thienemannimyia sp.	1	0	0	4
Chironomidae pupa	1	0	3	14
Tipulidae pupa	1	1	0	7
Coleoptera (beetles)				
Curculionidae	0	0	1	4
HYDRACARINA (water mites)	1	0	1	7
CRUSTACEA				
Amphipoda (scuds)				
Gammarus lacustris	1	0	0	4
OLIGOCHAETA (worms)				
Limnodrilus sp.	10	14	4	100
TOTAL	200	96	82	1,400

Table 19.--*Species list, replicate samples, and mean density of benthic invertebrates for selected sites on Fountain and Monument Creeks*--Continued

Taxa	Replicate sample, number of organisms			Mean density, numbers of organisms per square meter
	1	2	3	
07103700 FOUNTAIN CREEK NEAR COLORADO SPRINGS (SITE F4) Sample Date: April 27, 1987				
INSECTA				
Ephemeroptera (mayflies)				
Ameletus sp.	58	9	19	310
Baetis bicaudatus	1	1	0	7
Plecoptera (stoneflies)				
Pteronarcella sp.	0	0	1	4
Chloroperlidae	0	0	1	4
Diptera (true flies)				
Chelifera sp.	0	1	0	4
Cricotopus sp.	6	0	5	39
Diamesa sp.	9	0	13	79
Dicranota sp.	0	0	1	4
Micropsectra sp.	1	0	0	4
Molophilus sp.	0	0	1	4
Orthocladius sp.	27	9	40	270
Parametriocnemus sp.	25	14	36	270
Prodiamesa sp.	27	1	19	170
Thienemanniella sp.	4	2	0	21
Tipula sp.	0	0	1	4
Chironomidae pupa	2	3	4	32
COLLEMBOLA (springtails)	0	0	1	4
OLIGOCHAETA (worms)				
Eiseniella tetraedra	2	0	2	14
Limnodrilus sp.	12	20	3	130
TOTAL	170	60	150	1,400

Table 19.--*Species list, replicate samples, and mean density of benthic invertebrates for selected sites on Fountain and Monument Creeks*--Continued

Taxa	Replicate sample, number of organisms			Mean density, numbers of organisms per square meter
	1	2	3	
07103700 FOUNTAIN CREEK NEAR COLORADO SPRINGS (SITE F4) Sample Date: July 15, 1987				
INSECTA				
Ephemeroptera (mayflies)				
Baetis bicaudatus	47	9	32	320
Baetis tricaudatus	18	8	6	120
Cinygmula sp.	0	1	2	11
Epeorus longimanus	3	0	0	11
Ephemerella sp.	1	0	0	4
Plecoptera (stoneflies)				
Pteronarcella badia	2	0	0	7
Chloroperlidae	1	0	0	4
Diptera (true flies)				
Cricotopus sp.	2	2	2	21
Cryptochironomus sp.	0	2	0	7
Hexatoma sp.	1	0	0	4
Orthocladius sp.	3	2	6	39
Parametriocnemus sp.	21	11	21	190
Simulium sp.	6	0	2	29
Thienemanniella sp.	1	1	0	7
Thienemannimyia sp. group	2	0	1	11
Chironomidae pupa	1	1	1	11
HYDRACARINA (water mites)	1	0	0	4
OLIGOCHAETA (worms)				
Limnodrilus sp.	33	54	40	460
HIRUDINEA (leeches)				
Erpobdella punctata	1	0	0	4
TOTAL	140	91	110	1,300

Table 19.--*Species list, replicate samples, and mean density of benthic invertebrates for selected sites on Fountain and Monument Creeks*--Continued

Taxa	Replicate sample, number of organisms			Mean density, numbers of organisms per square meter
	1	2	3	
07103700 FOUNTAIN CREEK NEAR COLORADO SPRINGS (SITE F4) Sample Date: August 26, 1987				
INSECTA				
Ephemeroptera (mayflies)				
Baetis bicaudatus	41	130	27	720
Baetis tricaudatus	48	36	24	390
Drunella grandis	0	0	1	4
Plecoptera (stoneflies)				
Pteronarcella badia	1	14	1	57
Chloroperlidae	0	2	1	11
Trichoptera (caddisflies)				
Hydropsyche sp.	0	16	2	65
Lepidoptera (aquatic caterpillars)				
Simyra sp.	0	1	0	4
Diptera (true flies)				
Cricotopus sp.	3	0	2	18
Eukiefferiella sp.	7	2	2	40
Parametriocnemus sp.	15	10	5	110
Simulium sp.	0	26	3	100
Thienemannimyia sp. group	3	0	0	11
Empididae pupa	0	2	0	7
OLIGOCHAETA (worms)				
Limnodrilus sp.	0	10	0	36
TOTAL	118	249	68	1,600

Table 19.--*Species list, replicate samples, and mean density of benthic invertebrates for selected sites on Fountain and Monument Creeks*--Continued

Taxa	Replicate sample, number of organisms			Mean density, numbers of organisms per square meter
	1	2	3	
07103700 FOUNTAIN CREEK NEAR COLORADO SPRINGS (SITE F4)				
Sample Date: November 4, 1987				
INSECTA				
Ephemeroptera (mayflies)				
Baetis bicaudatus	9	31	3	150
Baetis tricaudatus	59	170	52	1,000
Drunella grandis grandis	2	2	4	29
Ephemerella infrequens	2	1	0	11
Plecoptera (stoneflies)				
Alloperla sp.	2	0	0	7
Hesperoperla pacifica	1	0	0	4
Pteronarcella badia	5	0	0	18
Capniidae	2	2	1	18
Trichoptera (caddisflies)				
Arctopsyche grandis	2	0	0	7
Glossoma sp.	1	0	1	7
Hydropsyche sp.	44	0	6	180
Diptera (true flies)				
Chelifera sp.	0	1	0	4
Dicranota sp.	3	5	2	36
Orthocladius sp.	1	0	1	7
Parametriocnemus sp.	2	5	4	39
Prosimulium sp.	3	2	4	32
Thienemanniella sp.	0	0	1	4
Thienemannimyia sp. group	3	4	1	29
Tipula sp.	2	1	1	14
Coleoptera (beetles)				
Optioservus divergens	0	1	0	4
OLIGOCHAETA (worms)				
Eiseniella tetraedra	1	0	1	7
Limnodrilus sp.	12	23	3	140
TOTAL	160	250	85	1,700

Table 19.--*Species list, replicate samples, and mean density of benthic invertebrates for selected sites on Fountain and Monument Creeks*--Continued

Taxa	Replicate sample, number of organisms			Mean density, numbers of organisms per square meter
	1	2	3	
07103700 FOUNTAIN CREEK NEAR COLORADO SPRINGS (SITE F4) Sample Date: April 25, 1988				
INSECTA				
Ephemeroptera (mayflies)				
Baetis tricaudatus	0	0	2	7
Callibaetis sp.	4	0	6	36
Drunella grandis	0	1	0	4
Plecoptera (stoneflies)				
Chloroperlidae	2	1	0	11
Trichoptera (caddisflies)				
Hydropsyche sp.	0	2	0	7
Diptera (true flies)				
Boreoheptogyia sp.	2	0	0	7
Diamesa sp.	6	3	14	83
Dicranota sp.	2	0	2	14
Eukiefferiella sp.	2	2	0	14
Micropsectra sp.	2	3	2	25
Orthocladius sp.	10	1	8	68
Pagastia sp.	6	10	8	86
Parametriocnemus sp.	18	3	2	83
Thienemannimyia sp. group	0	2	0	7
Chironomidae pupa	10	2	6	67
COLLEMBOLA (springtails)				
Isotomurus palustris	6	0	2	29
CRUSTACEA				
Amphipoda (sideswimmers)				
Hyalella azteca	0	1	0	4
OLIGOCHAETA (worms)				
Eiseniella tetraedra	2	0	0	7
Limnodrilus sp.	16	0	2	67
TOTAL	88	31	54	630

Table 19.--*Species list, replicate samples, and mean density of benthic invertebrates for selected sites on Fountain and Monument Creeks*--Continued

Taxa	Replicate sample, number of organisms			Mean density, numbers of organisms per square meter
	1	2	3	
07103700 FOUNTAIN CREEK NEAR COLORADO SPRINGS (SITE F4) Sample Date: June 30, 1988				
INSECTA				
Ephemeroptera (mayflies)				
Baetis tricaudatus	6	40	0	160
Plecoptera (stoneflies)				
Chloroperlidae	1	0	0	4
Trichoptera (caddisflies)				
Hydropsyche sp.	1	8	0	32
Diptera (true flies)				
Chelifera sp.	1	0	0	4
Orthocladius sp.	0	4	0	14
Pagastia sp.	0	0	2	7
Parametriocnemus sp.	3	0	10	47
Simulium sp.	1	4	2	25
Thienemannimyia sp. group	0	4	0	14
Chironomidae pupa	0	0	4	14
Coleoptera (beetles)				
Helophorus sp.	0	8	6	50
OLIGOCHAETA (worms)				
Eiseniella tetraedra	0	8	0	29
Limnodrilus sp.	2	12	12	93
TOTAL	15	88	36	490

Table 19.--*Species list, replicate samples, and mean density of benthic invertebrates for selected sites on Fountain and Monument Creeks*--Continued

Taxa	Replicate sample, number of organisms			Mean density, numbers of organisms per square meter
	1	2	3	
07103700 FOUNTAIN CREEK NEAR COLORADO SPRINGS (SITE F4) Sample Date: September 7, 1988				
INSECTA				
Ephemeroptera (mayflies)				
Baetis tricaudatus	1	0	1	7
Trichoptera (caddisflies)				
Hydropsyche sp.	2	3	0	18
Diptera (trueflies)				
Cyptolabis sp.	1	0	0	4
Eukiefferiella sp.	0	2	0	7
Micropsectra sp.	0	1	0	4
Parametriocnemus sp.	2	5	0	25
Simulium sp.	1	4	0	18
OLIGOCHAETA (worms)				
Eiseniella tetraedra	0	2	0	7
TOTAL	7	17	1	90

Table 19.--*Species list, replicate samples, and mean density of benthic invertebrates for selected sites on Fountain and Monument Creeks*--Continued

Taxa	Replicate sample, number of organisms			Mean density, numbers of organisms per square meter
	1	2	3	
07105500 FOUNTAIN CREEK AT COLORADO SPRINGS (SITE F8) Sample Date: April 16, 1985				
INSECTA				
Ephemeroptera (mayflies)				
Baetis tricaudatus	1	0	2	11
Ephemerella inermis	1	0	1	7
Plecoptera (stonefies)				
Isogenoides zionensis	1	0	0	4
Chloroperlidae	0	1	5	22
Diptera (true flies)				
Cricotopus sp.	0	0	8	29
Diamesa sp.	3	5	24	120
Orthocladius sp.	4	2	29	130
Palpomyia complex	1	0	0	4
Parametriocnemus sp.	4	0	6	36
Thienemanniella sp.	0	1	1	7
Chironomidae pupa	0	1	0	4
OLIGOCHAETA (worms)				
Limnodrilus sp.	10	14	3	97
TOTAL	25	24	79	470

Table 19.--*Species list, replicate samples, and mean density of benthic invertebrates for selected sites on Fountain and Monument Creeks*--Continued

Taxa	Replicate sample, number of organisms			Mean density, numbers of organisms per square meter
	1	2	3	
07105500 FOUNTAIN CREEK AT COLORADO SPRINGS (SITE F8)				
Sample Date: July 11, 1985				
INSECTA				
Ephemeroptera (mayflies)				
Ameletus cooki	0	0	3	11
Baetis tricaudatus	22	7	71	360
Epeorus longimanus	2	2	4	29
Tricorythodes minutus	0	4	8	43
Plecoptera (stoneflies)				
Pteronarcella badia	0	1	0	4
Chloroperlidae	0	0	2	7
Trichoptera (caddisflies)				
Hydropsyche sp.	1	0	3	14
Ochrotrichia sp.	0	0	1	4
Diptera (true flies)				
Chelifera sp.	0	0	2	7
Cordites sp.	1	0	0	4
Cricotopus sp.	7	8	54	250
Dixa sp.	0	0	1	4
Ephydra sp.	0	0	5	18
Micropsecta sp.	0	1	1	7
Orthocladius sp.	34	24	140	720
Parametriocnemus sp.	71	99	440	2,200
Phaenopsecta sp.	0	1	0	4
Psychoda sp.	0	0	3	11
Simulium sp.	0	0	21	75
Thienemanniella sp.	0	1	3	14
Thienemannimyia sp. group	0	1	0	4
Chironomidae pupa	4	5	29	140
Dolichopidae	0	1	0	4
Coleoptera (beetles)				
Agabus sp.	0	0	1	4
COLLEMBOLA (spingtails)				
Isotomurus palustris	0	2	2	14
OLIGOCHAETA (worms)				
Limnodrilus sp.	120	15	0	480
Lumbricidae	1	0	0	4
TOTAL	260	170	790	4,400

Table 19.--*Species list, replicate samples, and mean density of benthic invertebrates for selected sites on Fountain and Monument Creeks*--Continued

Taxa	Replicate sample, number of organisms			Mean density, numbers of organisms per square meter
	1	2	3	
07105500 FOUNTAIN CREEK AT COLORADO SPRINGS (SITE F8) Sample Date: August 12, 1985				
INSECTA				
Trichoptera (caddisflies)				
Hydropsyche sp.	0	0	1	4
Lepidoptera (aquatic caterpilers)				
Parargyractis sp.	0	1	0	4
Diptera (true flies)				
Hexatoma sp.	0	0	1	4
Micropsectra sp.	1	0	0	4
Orthocladius sp.	0	0	1	4
Parametriocnemus sp.	2	1	4	25
Phaenopsectra sp.	0	1	0	4
Thienemanniella sp.	1	0	1	7
Coleoptera (beetles)				
Listronotus sp.	0	2	0	7
HYDRACARINA (water mites)				
Mideopsis sp.	1	0	0	4
COLLEMBOLA (springtails)				
Isotomurus palustris	1	1	0	7
OLIGOCHAETA (worms)				
Limnodrilus sp.	1	8	4	47
TOTAL	7	14	12	120

Table 19.--*Species list, replicate samples, and mean density of benthic invertebrates for selected sites on Fountain and Monument Creeks*--Continued

Taxa	Replicate sample, number of organisms			Mean density, numbers of organisms per square meter
	1	2	3	
07105500 FOUNTAIN CREEK AT COLORADO SPRINGS (SITE F8) Sample Date: October 28, 1985				
INSECTA				
Ephemeroptera (mayflies)				
Baetis tricaudatus	0	2	0	11
Tricorythodes minutus	0	1	0	4
Trichoptera (caddisflies)				
Hydropsyche sp.	0	2	0	7
Diptera (true flies)				
Cordites sp.	0	2	0	7
Eukiefferiella sp.	0	1	12	47
Micropsectra sp.	0	1	0	4
Orthocladius sp.	0	0	1	4
Pagastia sp.	0	2	0	7
Parametriocnemus sp.	0	7	19	93
Thienemannimyia sp. group	0	1	0	4
Chironomidae pupa	0	1	4	18
Hemiptera (true bugs)				
Corixidae	1	0	0	4
OLIGOCHAETA (worms)				
Tubificidae	29	27	6	220
TOTAL	30	47	42	430

Table 19.--*Species list, replicate samples, and mean density of benthic invertebrates for selected sites on Fountain and Monument Creeks*--Continued

Taxa	Replicate sample, number of organisms			Mean density, numbers of organisms per square meter
	1	2	3	
07105500 FOUNTAIN CREEK AT COLORADO SPRINGS (SITE F8) Sample Date: April 14, 1986				
INSECTA				
Ephemeroptera (mayflies)				
Baetis tricaudatus	0	2	0	7
Diptera (true flies)				
Cricotopus sp.	3	0	7	36
Diamesa sp.	2	0	7	32
Orthocladius sp.	7	6	13	93
Palpomyia complex	0	0	1	4
Parametriocnemus sp.	2	1	1	14
Simulium canonicolum	0	1	0	4
Thienemanniella sp.	0	0	1	4
Chironomidae pupa	4	0	5	32
OLIGOCHAETA (worms)				
Tubificidae	5	25	0	110
TOTAL	23	35	35	340
07105500 FOUNTAIN CREEK AT COLORADO SPRINGS (SITE F8) Sample Date: July 10, 1986				
INSECTA				
Ephemeroptera (mayflies)				
Baetis bicaudatus	0	2	0	7
Baetis tricaudatus	0	9	4	47
Trichoptera (caddisflies)				
Glossosoma sp.	0	1	0	4
Diptera (true flies)				
Chironomus sp.	0	0	8	29
Cricotopus sp.	6	19	22	170
Eukiefferiella sp.	4	1	0	18
Micropsectra sp.	6	0	0	21
Parametriocnemus sp.	2	3	0	18
Chironomidae pupa	4	0	0	14
COLLEMBOLA (springtails)				
Isotomurus palustris	2	1	0	11
OLIGOCHAETA (worms)				
Tubificidae	6	5	0	39
TOTAL	30	41	34	380

Table 19.--*Species list, replicate samples, and mean density of benthic invertebrates for selected sites on Fountain and Monument Creeks*--Continued

Taxa	Replicate sample, number of organisms			Mean density, numbers of organisms per square meter
	1	2	3	
07105500 FOUNTAIN CREEK AT COLORADO SPRINGS (SITE F8) Sample Date: August 25, 1986				
INSECTA				
Ephemeroptera (mayflies)				
Baetis tricaudatus	0	6	4	36
Plecoptera (stoneflies)				
Pteronarcella badia	0	0	1	4
Trichoptera (caddisflies)				
Hydropsyche sp.	0	0	1	4
Diptera (true flies)				
Cryptochironomus sp.	0	2	2	14
Micropsectra sp.	0	1	0	4
Parametriocnemus sp.	2	0	0	7
Prodiamesa sp.	2	15	9	93
Simulium sp.	0	1	0	4
Thienemannimyia sp. group	1	0	0	4
Chironomidae pupa	0	7	4	39
OLIGOCHAETA (worms)				
Eiseniella tetraedra	0	0	1	4
Limnodrilus sp.	7	6	0	47
TOTAL	12	38	22	260

Table 19.--*Species list, replicate samples, and mean density of benthic invertebrates for selected sites on Fountain and Monument Creeks*--Continued

Taxa	Replicate sample, number of organisms			Mean density, numbers of organisms per square meter
	1	2	3	
07105500 FOUNTAIN CREEK AT COLORADO SPRINGS (SITE F8) Sample Date: November 5, 1986				
INSECTA				
Ephemeroptera (mayflies)				
Baetis tricaudatus	0	1	1	7
Tricorythodes minutus	0	1	0	4
Diptera (true flies)				
Chelifera sp.	0	2	0	7
Diamesa sp.	0	2	1	11
Euparyphus sp.	0	1	0	4
Micropsectra sp.	0	1	0	4
Orthocladius sp.	0	5	0	18
Palpomyia complex	0	1	1	7
Parametriocnemus sp.	5	10	3	65
Prodiamesa sp.	0	70	4	270
Prosimilium sp.	0	3	1	14
Thienemannymia sp. group	0	1	0	4
Chironomidae pupa	0	2	2	14
OLIGOCHAETA (worms)				
Limnodrilus sp.	120	43	17	640
Tubificidae	0	0	1	4
TURBELLARIA (flat worms)				
Dugesia sp.	0	0	1	4
TOTAL	120	140	32	1,100

Table 19.--*Species list, replicate samples, and mean density of benthic invertebrates for selected sites on Fountain and Monument Creeks*--Continued

Taxa	Replicate sample, number of organisms			Mean density, numbers of organisms per square meter
	1	2	3	
07105500 FOUNTAIN CREEK AT COLORADO SPRINGS (SITE F8) Sample Date: April 27, 1987				
INSECTA				
Ephemeroptera (mayflies)				
Ameletus sp.	6	7	1	50
Baetis tricaudatus	0	1	0	4
Plecoptera (stoneflies)				
Pteronarcella sp.	0	0	1	4
Diptera (true flies)				
Chryptochironomus sp.	6	0	1	25
Cricotopus sp.	1	0	2	11
Diamesa sp.	0	1	7	29
Limnophora sp.	1	0	0	4
Micropsectra sp.	0	1	0	4
Orthocladius sp.	5	7	30	150
Palpomyia complex	0	2	0	7
Parametriocnemus sp.	7	6	110	440
Phaenopsectra sp.	0	0	1	4
Prodiamesa sp.	0	0	11	39
Chironomidae pupa	1	2	1	14
Coleoptera (beetles)				
Curculionidae	0	0	1	4
OLIGOCHAETA (worms)				
Limnodrilus sp.	60	74	130	950
TOTAL	87	100	300	1,700

Table 19.--*Species list, replicate samples, and mean density of benthic invertebrates for selected sites on Fountain and Monument Creeks*--Continued

Taxa	Replicate sample, number of organisms			Mean density, numbers of organisms per square meter
	1	2	3	
07105500 FOUNTAIN CREEK AT COLORADO SPRINGS (SITE F8) Sample Date: July 15, 1987				
INSECTA				
Ephemeroptera (mayflies)				
Baetis bicaudatus	1	6	2	32
Baetis tricaudatus	2	0	3	18
Ephemerella sp.	0	0	1	4
Tricorythodes minutus	1	6	4	39
Plecoptera (stoneflies)				
Chloroperlidae	1	0	0	4
Trichoptera (caddisflies)				
Hydropsyche sp.	1	0	1	7
Diptera (true flies)				
Cricotopus sp.	1	1	2	14
Cryptochironomus sp.	3	0	0	11
Limnophora sp.	1	1	2	14
Orthocladius sp.	6	2	0	29
Palpomyia complex	0	1	0	4
Parametriocnemus sp.	51	14	41	380
Prosimulium sp.	0	0	1	4
Simulium sp.	2	1	4	25
Thienemanniella sp.	1	3	1	18
Chironomidae pupa	5	2	2	32
HYDRACARINA (water mites)	0	0	1	4
OLIGOCHAETA (worms)				
Limnodrilus sp.	7	20	7	120
TOTAL	83	57	72	760

Table 19.--*Species list, replicate samples, and mean density of benthic invertebrates for selected sites on Fountain and Monument Creeks*--Continued

Taxa	Replicate sample, number of organisms			Mean density, numbers of organisms per square meter
	1	2	3	
07105500 FOUNTAIN CREEK AT COLORADO SPRINGS (SITE F8) Sample Date: September 1, 1987				
INSECTA				
Ephemeroptera (mayflies)				
Baetis bicaudatus	3	2	1	22
Baetis tricaudatus	2	1	1	14
Tricorythodes sp.	0	3	0	11
Plecoptera (stoneflies)				
Pteronarcella badia	0	1	0	4
Diptera (true flies)				
Cryptochironomus sp.	3	7	6	57
Dixella sp.	1	0	0	4
Eukiefferiella sp.	1	0	0	4
Parametriocnemus sp.	19	12	2	120
Thienemanniella sp.	1	0	0	4
Chironomidae pupa	7	3	2	43
OLIGOCHAETA (worms)				
Limnodrilus sp.	5	3	6	50
TOTAL	42	32	18	330

Table 19.--*Species list, replicate samples, and mean density of benthic invertebrates for selected sites on Fountain and Monument Creeks*--Continued

Taxa	Replicate sample, number of organisms			Mean density, numbers of organisms per square meter
	1	2	3	
07105500 FOUNTAIN CREEK AT COLORADO SPRINGS (SITE F8)				
Sample Date: November 4, 1987				
INSECTA				
Ephemeroptera (mayflies)				
Baetis bicaudatus	1	0	1	7
Baetis tricaudatus	10	15	1	93
Callibaetis sp.	0	0	1	4
Ephemerella inermis	0	3	1	14
Tricorythodes minutus	1	0	0	4
Diptera (true flies)				
Cricotopus sp.	2	4	1	25
Diamesa sp.	0	2	1	11
Eukiefferiella sp.	5	11	2	65
Euparyphus sp.	0	0	1	4
Limnophila sp.	1	0	0	4
Orthocladius sp.	8	9	1	65
Parametriocnemus sp.	28	55	7	320
Prosimulium sp.	0	6	1	25
Tipula sp.	0	1	0	4
Chironomidae pupa	2	12	0	50
OLIGOCHAETA (worms)				
Limnodrilus sp.	14	7	4	90
TOTAL	72	120	22	780
07105500 FOUNTAIN CREEK AT COLORADO SPRINGS (SITE F8)				
Sample Date: April 25, 1988				
INSECTA				
Diptera (true flies)				
Diamesa sp.	0	3	0	11
Eukiefferiella sp.	0	1	0	4
Odontomyia sp.	1	0	0	4
Orthocladius sp.	2	0	0	7
Pagastia sp.	0	1	0	4
Parametriocnemus sp.	7	6	1	50
Thienemanniella sp.	1	1	0	7
Chironomidae pupa	0	1	0	4
Tabanidae	0	1	0	4
CRUSTACEA				
Amphipoda (sideswimmers)				
Hyalella azteca	0	1	0	4
OLIGOCHAETA (worms)				
Limnodrilus sp.	3	2	7	43
TOTAL	14	17	8	140

Table 19.--*Species list, replicate samples, and mean density of benthic invertebrates for selected sites on Fountain and Monument Creeks*--Continued

Taxa	Replicate sample, number of organisms			Mean density, numbers of organisms per square meter
	1	2	3	
07105500 FOUNTAIN CREEK AT COLORADO SPRINGS (SITE F8)				
Sample Date: June 30, 1988				
INSECTA				
Ephemeroptera (mayflies)				
Baetis tricaudatus	0	2	1	11
Plecoptera (stoneflies)				
Chloroperlidae	0	2	0	7
Trichoptera (caddisflies)				
Hydropsyche sp.	0	0	1	4
Diptera (true flies)				
Cricotopus sp.	0	2	0	7
Orthocladius sp.	1	0	0	4
Parametriocnemus sp.	1	4	2	25
Coleoptera (beetles)				
Helophorus sp.	2	0	0	7
COLLEMBOLA (springtails)				
Isotomurus palustris	1	0	0	4
OLIGOCHAETA (worms)				
Eiseniella tetraedra	0	0	1	4
Limnodrilus sp.	4	6	3	47
TOTAL	9	16	8	120
07105500 FOUNTAIN CREEK AT COLORADO SPRINGS (SITE F8)				
Sample Date: September 7, 1988				
INSECTA				
Ephemeroptera (mayflies)				
Baetis bicaudatus	17	1	1	68
Diptera (true flies)				
Eukiefferiella sp.	6	0	1	25
Othocladius sp.	5	1	0	22
Parametriocnemus sp.	83	16	30	460
Phaenopsectra sp.	6	1	3	36
Simulium sp.	3	0	0	11
Thienemannimyia sp. group	1	0	0	4
Chironomidae pupa	2	0	8	36
OLGOCHAETA (worms)				
Tubificidae	3	0	1	14
TOTAL	130	19	44	680

Table 19.--*Species list, replicate samples, and mean density of benthic invertebrates for selected sites on Fountain and Monument Creeks*--Continued

Taxa	Replicate sample, number of organisms			Mean density, numbers of organisms per square meter
	1	2	3	
07105800 FOUNTAIN CREEK AT SECURITY (SITE F13) Sample Date: April 16, 1985				
INSECTA				
Plecoptera (stoneflies)				
Chloroperlidae	1	0	0	4
Diptera (true flies)				
Cricotopus sp.	1	1	0	7
Diamesa sp.	0	0	2	7
Nemotelus sp.	4	4	0	29
Parametriocnemus sp.	2	1	0	11
Phaenopsectra sp.	0	0	2	7
Thienemanniella sp.	0	0	1	4
Chironomidae pupa	5	1	1	25
OLIGOCHAETA (worms)				
Limnodrilus sp.	18	13	21	190
TOTAL	31	20	27	280

Table 19.--*Species list, replicate samples, and mean density of benthic invertebrates for selected sites on Fountain and Monument Creeks*--Continued

Taxa	Replicate sample, number of organisms 1	2	3	Mean density, numbers of organisms per square meter
07105800 FOUNTAIN CREEK AT SECURITY (SITE F13) Sample Date: July 11, 1985				
INSECTA				
Ephemeroptera (mayflies)				
Baetis tricaudatus	2	12	0	50
Tricorythodes minutus	1	0	0	4
Diptera (true flies)				
Cordites sp.	0	2	2	14
Cricotopus sp.	0	4	8	43
Hemerodromia sp.	0	0	2	7
Micropsectra sp.	3	2	10	54
Ormosia sp.	0	2	6	29
Orthocladius sp.	7	52	54	400
Parametriocnemus sp.	100	170	160	1,500
Simulium arcticum	0	4	6	36
Tabanus sp.	0	0	2	7
Thienemanniella sp.	2	0	0	7
Chironomidae pupa	3	14	38	200
Coleoptera (beetles)				
Zaitzevia parvula	0	2	0	7
Hemiptera (true bugs)				
Corixidae	0	0	2	7
COLLEMBOLA (springtails)				
Isotomurus palustris	0	2	0	7
OLIGOCHAETA (worms)				
Limnodrilus sp.	920	720	950	9,300
TURBELLARIA (flat worms)				
Polycelis coronata	0	0	2	7
COELENTERATA (hydroids)				
Hydroida	0	2	0	7
TOTAL	1,000	990	1,200	12,000

Table 19.--*Species list, replicate samples, and mean density of benthic invertebrates for selected sites on Fountain and Monument Creeks*--Continued

Taxa	Replicate sample, number of organisms			Mean density, numbers of organisms per square meter
	1	2	3	
07105800 FOUNTAIN CREEK AT SECURITY (SITE F13) Sample Date: August 12, 1985				
INSECTA				
Diptera (true flies)				
Dixella sp.	1	0	0	4
Micropsectra sp.	0	1	0	4
Orthocladius sp.	0	1	0	4
Parametriocnemius sp.	4	2	5	39
Paratanytarsus sp.				
OLIGOCHAETA (worms)				
Limnodrilus sp.	16	10	4	110
TOTAL	21	14	9	160
07105800 FOUNTAIN CREEK AT SECURITY (SITE F13) Sample Date: October 28, 1985				
INSECTA				
Ephemeroptera (mayflies)				
Ephemerella inermis	1	0	0	4
Diptera (true flies)				
Micropsectra sp.	1	0	0	4
Orthocladius sp.	1	0	1	7
Parametriocemus sp.	0	3	1	14
Chironomidae pupa	2	0	0	7
Coleoptera (beetles)				
Zaitzevia parvula	1	0	0	4
OLIGOCHAETA (worms)				
Tubificidae	200	160	130	1,700
TURBELLARIA (flat worms)				
Polycelis coronata	1	1	0	7
TOTAL	210	160	130	1,700

Table 19.--*Species list, replicate samples, and mean density of benthic invertebrates for selected sites on Fountain and Monument Creeks*--Continued

Taxa	Replicate sample, number of organisms			Mean density, numbers of organisms per square meter
	1	2	3	
07105800 FOUNTAIN CREEK AT SECURITY (SITE F13) Sample Date: April 14, 1986				
INSECTA				
Diptera (true flies)				
Cricotopus sp.	22	4	11	130
Diamesa sp.	0	0	1	4
Eukiefferiella sp.	0	2	0	7
Orthocladius sp.	36	20	33	320
Chironomidae pupa	0	2	1	11
CRUSTACEA				
Isopoda (sow bugs)	2	2	0	14
OLIGOCHAETA (worms)				
Eiseniella tetraedra	2	2	0	14
Tubificidae	180	200	150	1,900
TOTAL	240	230	200	2,400
07105800 FOUNTAIN CREEK AT SECURITY (SITE F13) Sample Date: July 10, 1986				
INSECTA				
Ephemeroptera (mayflies)				
Baetis bicaudatus	0	0	4	14
Baetis tricaudatus	0	0	4	14
Tricorythodes minutus	8	0	0	29
Diptera (true flies)				
Chironomus sp.	8	0	0	29
Cricotopus sp.	32	4	36	260
Eukiefferiella sp.	4	0	0	14
Parametriocnemus sp.	8	0	0	29
Simulium vittatum complex	0	0	4	14
Chironomidae pupa	0	0	4	14
OLIGOCHAETA (worms)				
Tubificidae	300	50	300	2,400
TOTAL	360	54	350	2,800

Table 19.--*Species list, replicate samples, and mean density of benthic invertebrates for selected sites on Fountain and Monument Creeks*--Continued

Taxa	Replicate sample, number of organisms 1	2	3	Mean density, numbers of organisms per square meter
07105800 FOUNTAIN CREEK AT SECURITY (SITE F13) Sample Date: August 25, 1986				
INSECTA				
Diptera (true flies)				
Parametriocnemus sp.	0	1	1	7
Prodiamesa sp.	4	23	5	120
Chironomidae pupa	0	2	1	11
Empididae pupa	0	1	0	4
Tipulidae pupa	0	2	3	18
OLIGOCHAETA (worms)				
Eiseniella tetraedra	0	1	2	11
Limnodrilus sp.	0	24	7	110
TOTAL	4	54	19	280
07105800 FOUNTAIN CREEK AT SECURITY (SITE F13) Sample Date: November 5, 1986				
INSECTA				
Ephemeroptera (mayflies)				
Ephemerella infrequens	1	0	0	4
Plecoptera (stone flies)				
Capniidae	1	0	0	4
Diptera (true flies)				
Chironomus sp.	0	0	1	4
Micropsectra sp.	1	0	0	4
Orthocladius sp.	1	0	0	4
Palpomyia complex	0	1	0	4
Parametricnemus sp.	5	0	0	18
Prodiamesa sp.	7	3	2	43
Tipulidae pupae	1	0	0	4
Coleoptera				
Circulionidae	0	1	0	4
COLLEMBOLA (springtails)				
Isotomurus palustris	0	0	1	4
OLIGOCHAETA (worms)				
Limnodrilus sp.	740	240	86	3,800
Tubificidae	0	4	0	14
TOTAL	760	250	90	3,900

Table 19.--*Species list, replicate samples, and mean density of benthic invertebrates for selected sites on Fountain and Monument Creeks*--Continued

Taxa	Replicate sample, number of organisms			Mean density, numbers of organisms per square meter
	1	2	3	
07105800 FOUNTAIN CREEK AT SECURITY (SITE F13) Sample Date: April 27, 1987				
INSECTA				
Ephemeroptera (mayflies)				
Ameletus sp.	0	1	1	7
Ephemerella inermis	1	0	0	4
Diptera (true flies)				
Cricotopus sp.	6	0	0	21
Diamesa sp.	11	0	1	43
Micropsectra sp.	3	0	0	11
Orthocladius sp.	40	3	0	150
Palpomyia complex	0	0	1	4
Parametriocnemus sp.	370	6	8	1,400
Prodiamesa sp.	17	0	0	61
Simulium sp.	0	0	1	4
Thienemanniella sp.	1	0	1	7
Thienemannimyia sp. group	1	0	0	4
Chironomidae pupa	8	2	3	47
Coleoptera (beetles)				
Dytiscus sp.	1	0	0	4
OLIGOCHAETA (worms)				
Eiseniella tetraedra	8	0	4	43
Limnodrilus sp.	3,700	150	440	16,000
TOTAL	4,200	160	460	18,000

Table 19.--*Species list, replicate samples, and mean density of benthic invertebrates for selected sites on Fountain and Monument Creeks*--Continued

Taxa	Replicate sample, number of organisms			Mean density, numbers of organisms per square meter
	1	2	3	
07105800 FOUNTAIN CREEK AT SECURITY (SITE F13) Sample Date: July 15, 1987				
INSECTA				
Ephemeroptera (mayflies)				
Tricorythodes sp.	2	1	5	29
Diptera (true flies)				
Chironomus sp.	0	0	1	4
Orthocladius sp.	2	0	2	14
Palpomyia complex	0	0	1	4
Parametriocnemus sp.	19	19	39	280
Phaenopsectra sp.	1	0	0	4
Simulium sp.	0	1	8	32
Chironomidae pupa	3	2	2	25
CRUSTACEA				
Isopoda (sow bugs)				
Asellus sp.	0	0	1	4
OLIGOCHAETA (worms)				
Limnodrilus sp.	580	420	730	6,200
TOTAL	610	440	790	6,600

Table 19.--*Species list, replicate samples, and mean density of benthic invertebrates for selected sites on Fountain and Monument Creeks*--Continued

Taxa	Replicate sample, number of organisms			Mean density, numbers of organisms per square meter
	1	2	3	
07105800 FOUNTAIN CREEK AT SECURITY (SITE F13) Sample Date: September 1, 1987				
INSECTA				
Ephemeroptera (mayflies)				
Baetis tricaudatus	0	0	5	18
Tricorythodes minutus	1	0	6	25
Diptera (true flies)				
Chironomus sp.	1	0	1	7
Cricotopus sp.	0	0	1	4
Cryptochironomus sp.	0	1	0	4
Eukiefferiella sp.	0	0	1	4
Parametriocnemus sp.	6	17	21	160
Thienemannimyia sp. group	0	0	1	4
Chironomidae pupa	1	0	2	11
Hemiptera (true bugs)				
Corixidae	0	0	2	7
OLIGOCHAETA (worms)				
Limnodrilus sp.	34	71	200	1,100
TOTAL	43	89	240	1,300
07105800 FOUNTAIN CREEK AT SECURITY (SITE F13) Sample Date: November 4, 1987				
INSECTA				
Diptera (true flies)				
Orthocladius sp.	4	0	0	1
Parametriocnemus sp.	8	8	4	72
Pericoma sp.	12	0	0	43
Chironomidae pupa	4	0	0	14
OLIGOCHAETA (worms)				
Eiseniella tetraedra	0	0	4	14
Limnodrilus sp.	94	610	440	4,100
TOTAL	120	620	450	4,300

Table 19.--*Species list, replicate samples, and mean density of benthic invertebrates for selected sites on Fountain and Monument Creeks*--Continued

Taxa	Replicate sample, number of organisms 1	2	3	Mean density, numbers of organisms per square meter
07105800 FOUNTAIN CREEK AT SECURITY (SITE F13) Sample Date: April 25, 1988				
INSECTA				
Ephemeroptera (mayflies)				
Callibaetis sp.	1	1	0	7
Trichoptera (caddisflies)				
Hydropsyche sp.	0	1	0	4
Diptera (true flies)				
Cricotopus sp.	6	0	4	36
Diamesa sp.	3	0	5	29
Eukiefferiella sp.	0	2	2	14
Micropsectra sp.	0	0	1	4
Orthocladius sp.	17	3	5	90
Pagastia sp.	5	3	1	32
Parametriocnemus sp.	45	11	31	310
Tipula sp.	0	0	1	4
Chironomidae pupa	4	3	3	36
Tabanidae	0	0	1	4
Coleoptera (beetles)				
Phanocerus sp.	0	1	0	4
CRUSTACEA				
Isopoda (sow bugs)				
Asellus sp.	1	0	0	4
Amphipoda (sideswimmers)				
Hyalella azteca	0	0	1	4
OLIGOCHAETA (worms)				
Eiseniella tetraedra	11	17	18	160
Limnodrilus sp.	420	57	160	2,300
TOTAL	510	99	230	3,000

Table 19.--*Species list, replicate samples, and mean density of benthic invertebrates for selected sites on Fountain and Monument Creeks*--Continued

Taxa	Replicate sample, number of organisms			Mean density, numbers of organisms per square meter
	1	2	3	
07105800 FOUNTAIN CREEK AT SECURITY (SITE F13)				
Sample Date: June 30, 1988				
INSECTA				
Ephemeroptera (mayflies)				
Baetis tricaudatus	2	1	0	11
Tricorythodes minutus	0	1	0	4
Plecoptera (stoneflies)				
Pteronarcella badia	0	0	1	4
Diptera (true flies)				
Micropsectra sp.	1	0	0	4
Orthocladius sp.	0	2	0	7
Pagastia sp.	0	0	3	11
Parametriocnemus sp.	5	21	15	150
Protanyderus margarita	0	0	1	4
Simulium sp.	0	1	0	4
Thienemannimyia sp. group	0	0	1	4
Chironomidae pupa	0	1	2	11
Hemiptera (true bugs)				
Tritorixa sp.	0	1	0	4
OLIGOCHAETA (worms)				
Eiseniella tetraedra	0	0	1	4
Limnodrilus sp.	5	10	5	72
TOTAL	13	38	29	290
07105800 FOUNTAIN CREEK AT SECURITY (SITE F13)				
Sample Date: September 7, 1988				
INSECTA				
Ephemeroptera (mayflies)				
Tricorythodes minutus	0	0	8	29
Diptera (true flies)				
Cricotopus sp.	2	16	32	180
Erioptera sp.	0	4	0	14
Eukiefferiella sp.	0	4	24	100
Micropsectra sp.	0	28	24	190
Orthocadius sp.	0	4	32	130
Parametriocnemus sp.	7	890	2,000	10,000
Simulium sp.	0	8	8	57
Chironomidae pupa	2	48	48	350
OLIGOCHAETA (worms)				
Tubificidae	95	1,500	2,100	13,000
TOTAL	110	2,500	4,300	24,000

Table 19.--*Species list, replicate samples, and mean density of benthic invertebrates for selected sites on Fountain and Monument Creeks*--Continued

Taxa	Replicate sample, number of organisms			Mean density, numbers of organisms per square meter
	1	2	3	
07103780 MONUMENT CREEK ABOVE NORTH GATE BOULEVARD AT U.S. AIR FORCE ACADEMY (SITE M5) Sample Date: April 16, 1985				
INSECTA				
Ephemeroptera (mayflies)				
Baetis tricaudatus	2	0	1	11
Ephemerella inermis	0	1	2	11
Plecoptera (stoneflies)				
Chloroperlidae	1	0	0	4
Diptera (true flies)				
Cricotopus sp.	4	5	4	47
Diamesa sp.	4	1	1	22
Erioptera sp.	2	0	0	7
Orthocladius sp.	7	4	10	75
Palpomyia complex	1	0	0	4
Prosimulium sp.	0	1	0	4
Thienemanniella sp.	3	0	1	14
Chironomidae pupa	2	0	1	11
OLIGOCHAETA (worms)				
Limnodrilus sp.	62	3	4	250
TURBELLARIA (flat worms)				
Polycelis coronata	0	1	0	4
TOTAL	88	16	24	460

Table 19.--*Species list, replicate samples, and mean density of benthic invertebrates for selected sites on Fountain and Monument Creeks*--Continued

Taxa	Replicate sample, number of organisms			Mean density, numbers of organisms per square meter
	1	2	3	
07103780 MONUMENT CREEK ABOVE NORTH GATE BOULEVARD AT U.S. AIR FORCE ACADEMY (SITE M5) Sample Date: July 11, 1985				
INSECTA				
Ephemeroptera (mayflies)				
Baetis tricaudatus	770	370	580	6,200
Drunella grandis grandis	0	2	0	7
Epeorus longimanus	190	140	160	1,800
Tricorythodes minutus	32	10	48	320
Plecoptera (stoneflies)				
Pteronarcella badia	4	0	0	14
Chloroperlidae	4	6	4	50
Perlodidae	0	4	4	29
Trichoptera (caddisflies)				
Hydropsyche sp.	40	14	36	320
Diptera (true flies)				
Antocha sp.	0	2	0	7
Chelifera sp.	0	2	4	22
Cordites sp.	36	24	12	260
Cricotopus sp.	60	110	96	940
Hexatoma sp.	0	0	2	7
Micropsectra sp.	0	20	12	120
Orthocladius sp.	28	110	72	750
Palpomyia complex	4	8	8	72
Parametriocnemus sp.	76	86	140	1,100
Phaenopsectra sp.	100	22	52	620
Simulium sp.	280	22	100	1,500
Thienemanniella sp.	0	2	8	36
Chironomidae pupa	16	12	4	120
Coleoptera (beetles)				
Heterlimnius corpulentus	4	6	0	36
Hydrobios sp.	0	2	0	7
CRUSTACEA				
Amphipoda (scuds)				
Hyalella azteca	0	0	4	14
OLIGOCHAETA (worms)				
Limnodrilus sp.	560	120	420	3,900
COELENTERATA (hydroids)				
Hydroida	0	8	0	29
TOTAL	2,200	1,100	1,800	18,000

Table 19.--*Species list, replicate samples, and mean density of benthic invertebrates for selected sites on Fountain and Monument Creeks*--Continued

Taxa	Replicate sample, number of organisms			Mean density, numbers of organisms per square meter
	1	2	3	
07103780 MONUMENT CREEK ABOVE NORTH GATE BOULEVARD AT U.S. AIR FORCE ACADEMY (SITE M5) Sample Date: August 12, 1985				
INSECTA				
Ephemeroptera (mayflies)				
Baetis bicaudatus	540	160	600	4,700
Baetis tricaudatus	60	56	12	460
Tricorythodes minutus	0	0	4	14
Plecoptera (stoneflies)				
Chloroperlidae	16	0	0	57
Trichoptera (caddisflies)				
Hydropsyche sp.	60	16	140	780
Diptera (true flies)				
Eukiefferiella sp.	140	0	16	560
Hexatoma sp.	0	4	8	43
Parametriocnemus sp.	140	36	60	860
Simulium sp.	320	40	96	1,600
Thienemanniella sp.	0	4	56	220
Chironomidae pupa	12	0	12	86
Coleoptera (beetles)				
Optioservus castanipennis	0	0	4	14
Zaitzevia parvula	4	0	0	14
HYDRACARINA (water mites)				
Sperchon sp.	0	4	4	29
COLLEMBOLA (springtails)				
Isotomurus palustris	0	4	0	14
OLIGOCHAETA (worms)				
Limnodrilus sp.	4	0	4	29
TOTAL	1,300	320	1,000	9,500

Table 19.--*Species list, replicate samples, and mean density of benthic invertebrates for selected sites on Fountain and Monument Creeks*--Continued

Taxa	Replicate sample, number of organisms			Mean density, numbers of organisms per square meter
	1	2	3	
07103780 MONUMENT CREEK ABOVE NORTH GATE BOULEVARD AT U.S. AIR FORCE ACADEMY (SITE M5) Sample Date: October 29, 1985				
INSECTA				
Ephemeroptera (mayflies)				
Baetis bicaudatus	28	110	120	920
Baetis tricaudatus	660	630	60	4,800
Ephemerella inermis	150	140	48	1,200
Paraleptophlebia heteronea	7	8	0	54
Tricorythodes minutus	2	4	0	22
Plecoptera (stoneflies)				
Isoperla sobria	16	12	0	100
Pteronarcella badia	0	4	0	14
Chloroperlidae	86	60	0	520
Perlodidae	8	32	0	140
Trichoptera (caddisflies)				
Hydropsyche sp.	300	450	52	2,900
Diptera (true flies)				
Antocha sp.	0	4	0	14
Cordites sp.	0	4	0	14
Cricotopus sp.	33	80	68	650
Diamesa sp.	26	76	36	500
Eukiefferiella sp.	4	8	4	57
Hexatoma sp.	6	16	0	79
Micropsectra sp.	2	0	16	65
Orthocladius sp.	3	12	52	240
Palpomyia complex	0	4	8	43
Parametriocnemus sp.	14	40	32	310
Prosimulium sp.	31	20	4	200
Chironomidae pupa	0	4	16	72
Coleoptera (beetles)				
Optioservus castsnipennis	7	1	4	39
Zaitzevia parvula	2	0	0	7
OLIGOCHAETA (worms)				
Tubificidae	130	1,000	250	5,000
TOTAL	1,500	2,700	770	18,000

Table 19.--*Species list, replicate samples, and mean density of benthic invertebrates for selected sites on Fountain and Monument Creeks*--Continued

Taxa	Replicate sample, number of organisms			Mean density, numbers of organisms per square meter
	1	2	3	
07103780 MONUMENT CREEK ABOVE NORTH GATE BOULEVARD AT U.S. AIR FORCE ACADEMY (SITE M5) Sample Date: April 14, 1986				
INSECTA				
Ephemeroptera (mayflies)				
Baetis bicaudatus	0	1	0	4
Baetis tricaudatus	39	56	34	460
Ephemerella inermis	35	34	3	260
Plecoptera (stoneflies)				
Isoperla sobria	3	2	2	25
Trichoptera (caddisflies)				
Hydropsyche occidentalis	40	10	3	190
Hydropsyche sp.	6	2	1	32
Diptera (true flies)				
Cricotopus sp.	2	24	8	120
Diamesa sp.	0	4	8	43
Eukiefferiella sp.	4	4	1	22
Hexatoma sp.	4	1	1	22
Orthocladius sp.	180	64	48	1,000
Palpomyia complex	30	20	24	270
Parametriocnemus sp.	26	72	0	350
Thienemannimyia sp.	0	0	24	86
Thienemannimyia sp. group	4	8	0	43
OLIGOCHAETA (worms)				
Eiseniella tetraedra	2	1	0	11
Tubificidae	440	310	230	3,500
TOTAL	820	610	390	6,400

Table 19.--*Species list, replicate samples, and mean density of benthic invertebrates for selected sites on Fountain and Monument Creeks*--Continued

Taxa	Replicate sample, number of organisms			Mean density, numbers of organisms per square meter
	1	2	3	
07103780 MONUMENT CREEK ABOVE NORTH GATE BOULEVARD AT U.S. AIR FORCE ACADEMY (SITE M5) Sample Date: July 10, 1986				
INSECTA				
Ephemeroptera (mayflies)				
Baetis bicaudatus	92	340	300	2,600
Baetis tricaudatus	170	150	25	1,200
Cinygmula sp.	12	4	0	57
Tricorythodes minutus	44	32	44	430
Trichoptera (caddisflies)				
Cheumatopsyche sp.	4	80	16	360
Hydropsyche sp.	4	40	56	360
Hydroptila sp.	4	0	0	14
Diptera (true flies)				
Cordites sp.	20	4	0	86
Cricotopus sp.	0	0	12	43
Chrionomus sp.	4	0	0	14
Eukiefferiella sp.	12	12	0	86
Hexatoma sp.	4	0	2	22
Limnophora aequifrons	0	0	4	14
Micropsectra sp.	0	0	4	14
Orthocladius sp.	8	0	0	29
Palpomyia complex	0	4	0	14
Parametriocnemus sp.	28	110	160	1,100
Prosimulium sp.	0	4	8	43
Simulium vittatum complex	8	20	4	120
Thienemanniella sp.	0	0	4	14
Thienemannimyia sp. group	24	0	0	86
Chironomidae pupa	4	0	0	14
COLLEMBOLA (springtails)				
Isotomurus palustris	0	4	0	14
OLIGOCHAETA (worms)				
Tubificidae	880	310	520	6,200
TOTAL	1,300	1,100	1,200	13,000

Table 19.--*Species list, replicate samples, and mean density of benthic invertebrates for selected sites on Fountain and Monument Creeks*--Continued

Taxa	Replicate sample, number of organisms 1	2	3	Mean density, numbers of organisms per square meter
07103780 MONUMENT CREEK ABOVE NORTH GATE BOULEVARD AT U.S. AIR FORCE ACADEMY (SITE M5) Sample Date: AUGUST 25, 1986				
INSECTA				
Ephemeroptera (mayflies)				
Baetis bicaudatus	150	150	100	1,400
Baetis tricaudatus	780	610	150	5,600
Ephemerella infrequens	4	8	4	57
Tricorythodes minutus	8	8	36	190
Plecoptera (stoneflies)				
Chloroperlidae	8	40	28	270
Trichoptera (caddisflies)				
Hydropsyche accidentalis	96	300	170	2,000
Hydropsyche sp.	210	480	490	4,200
Ochrotrichia sp.	16	0	0	57
Diptera (true flies)				
Cryptochironomus sp.	4	0	0	14
Dicranota sp.	0	4	0	14
Dixa sp.	0	4	0	14
Hexatoma sp.	0	4	0	14
Palpomyia complex	4	0	0	14
Parametriocnemius sp.	12	4	0	57
Prodiamesa sp.	190	72	150	1,500
Prosimulium sp.	4	0	0	14
Simulium sp.	12	4	0	57
Thienemannimyia sp.	4	8	0	43
Chironomidae pupa	24	0	0	86
Coleoptera (beetles)				
Heterlimnius corpulentus	0	4	8	43
Zaitzevia parvula	0	0	4	14
Odonata (dragonflies)				
Ophiogomphus severus	0	0	2	7
CRUSTACEA				
Amphipoda (scuds)				
Gammarus lacustris	0	4	0	14
OLIGOCHAETA (worms)				
Eiseniella tetraedra	28	20	16	230
Limnodrilus sp.	210	110	64	1,400
TOTAL	1,800	1,800	1,200	17,000

Table 19.--*Species list, replicate samples, and mean density of benthic invertebrates for selected sites on Fountain and Monument Creeks*--Continued

Taxa	Replicate sample, number of organisms			Mean density, numbers of organisms per square meter
	1	2	3	
07103780 MONUMENT CREEK ABOVE NORTH GATE BOULEVARD AT U.S. AIR FORCE ACADEMY (SITE M5) Sample Date: NOVEMBER 5, 1986				
INSECTA				
Ephemeroptera (mayflies)				
Baetis bicaudatus	220	90	130	1,600
Baetis tricaudatus	220	162	94	1,700
Caenis sp.	1	0	0	4
Ephemerella infrequens	66	61	110	860
Paraleptophlebia sp.	1	0	0	4
Tricorythodes minutus	73	39	49	580
Plecoptera (stoneflies)				
Cultus sp.	25	5	5	130
Isoperla sobria	0	0	1	4
Chloroperlidae	5	3	2	36
Trichoptera (caddisflies)				
Cheumatopsyche sp.	120	54	120	1,000
Hydropsyche occidentalis	210	160	220	2,100
Hydropsyche sp.	230	140	120	1,800
Ochrotrichia sp.	3	0	0	11
Diptera (true flies)				
Antocha sp.	0	0	1	4
Chelifera sp.	1	0	1	7
Cryptochironomus sp.	0	0	1	4
Diamesa sp.	110	99	140	1,300
Dicranota sp.	7	3	15	90
Hexatoma sp.	1	1	5	25
Micropsectra sp.	44	13	16	260
Orthocladius sp.	1	1	0	7
Palpomyia complex	34	24	14	260
Parametriocnemus sp.	13	10	1	86
Pericoma sp.	1	0	0	4
Prodiamesa sp.	340	350	400	3,900
Prosimulium sp.	53	15	12	290
Simulium sp.	45	27	8	290
Thienemanniella sp.	11	10	7	100
Thienemannimyia sp. group	20	6	2	100
Tipula sp.	2	0	0	7
Chironomidae pupa	2	2	1	18
Tipulidae pupa	1	2	0	11

Table 19.--*Species list, replicate samples, and mean density of benthic invertebrates for selected sites on Fountain and Monument Creeks*--Continued

Taxa	Replicate sample, number of organisms			Mean density, numbers of organisms per square meter
	1	2	3	
07103780 MONUMENT CREEK ABOVE NORTH GATE BOULEVARD AT U.S. AIR FORCE ACADEMY (SITE M5) Sample Date: NOVEMBER 5, 1986--Continued				
INSECTA--Continued				
Coleoptera (beetles)				
Helichus sp.	1	0	04	
Heterelmis corpulentus	0	0	1	4
Optioservus castanipennis	8	4	7	68
Zaitzevia parvula	1	0	0	4
HYDRACARINA	2	0	0	7
OLIGOCHAETA (worms)				
Eiseniella tetraedra	0	0	9	32
Limnodrilus sp.	420	130	230	2,800
TOTAL	2,300	1,400	1,700	20,000

Table 19.--*Species list, replicate samples, and mean density of benthic invertebrates for selected sites on Fountain and Monument Creeks*--Continued

Taxa	Replicate sample, number of organisms 1	2	3	Mean density, numbers of organisms per square meter
07103780 MONUMENT CREEK ABOVE NORTH GATE BOULEVARD AT U.S. AIR FORCE ACADEMY (SITE M5) SAMPLE DATE APRIL 27, 1987				
INSECTA				
Ephemeroptera (mayflies)				
Baetis bicaudatus	1	5	0	21
Baetis tricaudatus	47	13	7	240
Ephemerella inermis	10	3	13	93
Plecoptera (stoneflies)				
Isoperla sp.	0	0	1	4
Chloroperlidae	0	0	1	4
Trichoptera (caddisflies)				
Cheumatopsyche sp.	2	1	0	11
Hydropsyche sp.	11	9	5	90
Diptera (true flies)				
Cricotopus sp.	1	1	1	11
Diamesa sp.	0	6	5	39
Micropsectra sp.	3	0	0	11
Orthocladius sp.	9	5	23	130
Palpomyia complex	9	0	23	120
Parametriocnemus sp.	64	44	190	1,000
Prodiamesa sp.	5	0	5	36
Thienemanniella sp.	0	1	0	4
Thienemannimyia sp. group	2	0	0	7
Chironomidae pupa	3	0	10	47
Coleoptera (beetles)				
Optioservus sp.	1	0	2	11
Odonata (dragonflies and damselflies)				
Ophiogomphus severus	0	0	1	4
CRUSTACEA				
Amphipoda (scuds)				
Hyalella sp.	1	0	0	4
OLIGOCHAETA (worms)				
Eiseniella tetraedra	1	0	0	4
Limnodrilus sp.	120	140	1,400	6,100
TOTAL	290	230	1,700	8,000

Table 19.--*Species list, replicate samples, and mean density of benthic invertebrates for selected sites on Fountain and Monument Creeks*--Continued

Taxa	Replicate sample, number of organisms			Mean density, numbers of organisms per square meter
	1	2	3	
07103780 MONUMENT CREEK ABOVE NORTH GATE BOULEVARD AT U.S. AIR FORCE ACADEMY (SITE M5) SAMPLE DATE JULY 14, 1987				
INSECTA				
Ephemeroptera (mayflies)				
Baetis bicaudatus	77	520	84	2,400
Baetis tricaudatus	6	32	8	160
Cinygmula sp.	0	16	0	57
Ephemerella sp.	0	12	0	43
Tricorythodes minutus	5	64	14	300
Trichoptera (caddisflies)				
Hydropsyche sp.	7	180	2	660
Hydropsychidae (immature)	2	68	32	370
Diptera (true flies)				
Cricotopus sp.	3	8	6	61
Cryptochironomus sp.	2	0	0	7
Eukiefferiella sp.	10	4	8	79
Hexatoma sp.	1	4	2	18
Micropsectra sp.	0	4	2	21
Orthocladius sp.	15	12	16	150
Palpomyia complex	15	0	14	100
Parametriocnemus sp.	120	76	110	1,100
Prosimulium sp.	0	4	12	57
Simulium sp.	33	32	30	340
Thienemanniella sp.	2	0	0	7
Thienemannimyia sp. group	2	0	0	7
Chironomidae pupa	3	8	2	47
Coleoptera (beetles)				
Optioservus castanipennis	0	4	0	14
Elmidae (immature)	2	0	2	14
CRUSTACEA				
Amphipoda (scuds)				
Hyalella azteca	2	0	0	7
Gammaridae	0	0	2	7
OLIGOCHAETA (worms)				
Limnodrilus sp.	39	72	50	580
TOTAL	350	1,100	400	6,600

Table 19.--*Species list, replicate samples, and mean density of benthic invertebrates for selected sites on Fountain and Monument Creeks*--Continued

Taxa	Replicate sample, number of organisms			Mean density, numbers of organisms per square meter
	1	2	3	
07103780 MONUMENT CREEK ABOVE NORTH GATE BOULEVARD AT U.S. AIR FORCE ACADEMY (SITE M5) Sample Date: AUGUST 26, 1987				
INSECTA				
Ephemeroptera (mayflies)				
Baetis bicaudatus	290	460	270	3,700
Baetis tricaudatus	72	40	4	420
Ephemerella inermis	4	0	0	14
Tricorythodes minutus	8	28	4	140
Plecoptera (stoneflies)				
Megarcys sp.	8	0	0	29
Chloroperlidae	0	12	10	79
Trichoptera (caddisflies)				
Hydropsyche sp.	420	280	66	2,700
Diptera (true flies)				
Chironomus sp.	0	4	0	14
Cricotopus sp.	12	12	6	110
Cryptochironomus sp.	4	0	2	22
Eukiefferiella sp.	0	8	12	72
Hexatoma sp.	12	36	12	220
Micropsectra sp.	4	0	0	14
Palpomyia complex	24	28	48	360
Parametriocnemus sp.	100	150	110	1,300
Phaenopsectra sp.	0	0	4	14
Simulium sp.	24	16	2	150
Thienemanniella sp.	4	0	8	43
Thienemannimyia sp. group	0	0	4	14
Coleoptera (beetles)				
Optioservus divergens	12	12	0	86
OLIGOCHAETA (worms)				
Limnodrilus sp.	36	40	96	620
TOTAL	1,000	1,100	660	10,000

Table 19.--*Species list, replicate samples, and mean density of benthic invertebrates for selected sites on Fountain and Monument Creeks*--Continued

Taxa	Replicate sample, number of organisms			Mean density, numbers of organisms per square meter
	1	2	3	
07103780 MONUMENT CREEK ABOVE NORTH GATE BOULEVARD AT U.S. AIR FORCE ACADEMY (SITE M5) Sample Date: NOVEMBER 4, 1987				
INSECTA				
Ephemeroptera (mayflies)				
Baetis bicaudatus	62	12	27	360
Baetis tricaudatus	37	1	18	200
Ephemerella inermis	24	2	20	160
Tricorythodes minutus	24	4	32	220
Plecoptera (stoneflies)				
Alloperla sp.	11	0	0	39
Capnia sp.	6	0	0	21
Megarcys sp.	0	0	1	4
Perlodidae	2	0	2	14
Trichoptera (caddisflies)				
Cheumatopsyche sp.	45	3	47	340
Hydropsyche sp.	34	2	86	440
Hydropsychidae	0	3	35	140
Diptera (true flies)				
Cricotopus sp.	12	42	13	240
Cryptochironomus sp.	1	1	1	11
Diamesa sp.	11	5	8	86
Dicranota sp.	7	0	1	29
Eukiefferiella sp.	47	15	19	290
Hexatoma sp.	2	4	9	54
Micropsectra sp.	18	6	40	230
Orthocladius sp.	10	16	10	130
Pagastia sp.	5	0	1	21
Palpomyia complex	22	47	8	280
Parametriocnemus sp.	56	55	49	570
Pericoma sp.	1	0	0	4
Prosimulium sp.	10	24	3	130
Simulium sp.	27	4	4	130
Thienemanniella sp.	6	0	11	61
Thienemannimyia sp. group	2	3	12	61
Tipula sp.	11	4	0	54
Chironomidae pupa	8	4	0	43
Coleoptera (beetles)				
Optioservus divergens	4	1	9	50

Table 19.--*Species list, replicate samples, and mean density of benthic invertebrates for selected sites on Fountain and Monument Creeks*--Continued

Taxa	Replicate sample, number of organisms			Mean density, numbers of organisms per square meter
	1	2	3	
07103780 MONUMENT CREEK ABOVE NORTH GATE BOULEVARD AT U.S. AIR FORCE ACADEMY (SITE M5) Sample Date: NOVEMBER 4, 1987--Contined				
CRUSTACEA				
Amphipoda (scuds)				
Gammarus lacustris	0	1	0	4
MOLLUSCA				
Gastropoda (snails)				
Physa sp.	3	0	0	11
OLIGOCHAETA (worms)				
Eiseniella tetraedra	5	0	1	21
Limnodrilus sp.	450	1,200	26	6,100
TOTAL	960	1,500	490	10,000

Table 19.--*Species list, replicate samples, and mean density of benthic invertebrates for selected sites on Fountain and Monument Creeks*--Continued

Taxa	Replicate sample, number of organisms			Mean density, numbers of organisms per square meter
	1	2	3	
07103780 MONUMENT CREEK ABOVE NORTH GATE BOULEVARD AT U.S. AIR FORCE ACADEMY (SITE M5) Sample Date: APRIL 25, 1988				
INSECTA				
Ephemeroptera (mayflies)				
Ephemerella inermis	2	2	3	25
Plecoptera (stoneflies)				
Isoperla fulva	1	0	0	4
Trichoptera (caddisflies)				
Hydropsyche sp.	6	1	0	25
Diptera (true flies)				
Cricotopus sp.	1	2	0	11
Dicranota sp.	0	1	0	4
Hexatoma sp.	0	1	0	4
Micropsectra sp.	2	0	1	11
Orthocladius sp.	0	1	1	7
Pagastia sp.	15	10	4	100
Palpomyia complex	4	0	2	22
Parametriocnemus sp.	11	11	6	100
Prosimulium sp.	1	1	1	11
Chironomidae pupa	2	3	0	18
OLIGOCHAETA (worms)				
Eiseniella tetraedra	0	2	0	7
Limnodrilus sp.	8	44	39	330
TOTAL	53	79	57	680

Table 19.--*Species list, replicate samples, and mean density of benthic invertebrates for selected sites on Fountain and Monument Creeks*--Continued

Taxa	Replicate sample, number of organisms			Mean density, numbers of organisms per square meter
	1	2	3	
07103780 MONUMENT CREEK ABOVE NORTH GATE BOULEVARD AT U.S. AIR FORCE ACADEMY (SITE M5) Sample Date: JUNE 30, 1988				
INSECTA				
Ephemeroptera (mayflies)				
Baetis bicaudatus	240	200	290	2,600
Baetis tricaudatus	0	0	8	29
Cinygmula sp.	4	0	4	29
Tricorythodes minutus	52	12	100	590
Plecoptera (stoneflies)				
Chloroperlidae	4	0	0	14
Trichoptera (caddisflies)				
Hydropsyche sp.	4	56	96	560
Ochrotrichia sp.	4	0	4	29
Diptera (true flies)				
Cricotopus sp.	4	0	0	14
Micropsectra sp.	4	0	4	29
Orthocladius sp.	12	24	8	160
Pagastia sp.	4	0	0	14
Palpomyia complex	8	20	12	140
Parametriocnemus sp.	88	56	140	1,000
Simulium sp.	20	28	20	240
Thienemanniella sp.	0	0	4	14
Thienemannimyia sp. group	0	0	4	14
Chironomidae pupa	4	4	4	43
CRUSTACEA				
Amphipoda (sideswimmers)				
Hyalella azteca	0	0	16	57
OLIGOCHAETA (worms)				
Eiseniella tetraedra	0	0	4	14
Limnodrilus sp.	68	4	12	300
TOTAL	520	400	730	5,900

Table 19.--*Species list, replicate samples, and mean density of benthic invertebrates for selected sites on Fountain and Monument Creeks*--Continued

Taxa	Replicate sample, number of organisms			Mean density, numbers of organisms per square meter
	1	2	3	
07103780 MONUMENT CREEK ABOVE NORTH GATE BOULEVARD AT U.S. AIR FORCE ACADEMY (SITE M5) Sample Date: SEPTEMBER 7, 1988				
INSECTA				
Ephemeroptera (mayflies)				
Baetis bicaudatus	93	4	170	970
Baetis tricaudatus	36	4	130	610
Ephemerella infrequens	0	4	4	29
Tricorythodes minutus	33	93	14	500
Plecoptera (stoneflies)				
Isoperla sobria	1	0	0	4
Chloroperlidae	1	1	6	29
Perlodidae	1	0	2	11
Trichoptera (caddisflies)				
Cheumatopsyche sp.	15	12	18	160
Hydropsyche sp.	150	92	300	2,000
Ochrotrichia sp.	1	0	0	4
Diptera (true flies)				
Cricotopus sp.	1	4	12	61
Hexatoma sp.	1	0	0	4
Micropsectra sp.	2	0	2	14
Orthocladius sp.	3	1	0	14
Palpomyia complex	0	4	2	22
Parametriocnemus sp.	33	28	56	420
Phaenopsectra sp.	1	1	0	7
Simulium sp.	0	1	70	260
Thienemannimyia sp. group	1	1	0	7
Chironomidae pupa	1	4	0	18
Coleoptera (beetles)				
Heterlimnius corpulentus	3	1	2	22
Odonata (dragonflies and damselflies)				
Ophiogomphus severus	3	2	0	18
CRUSTACEA				
Amphipoda (sideswimmers)				
Hyalella azteca	1	0	2	11
MOLLUSCA				
Gastropoda (snails)				
Lymnaea sp.	0	1	0	4
OLIGOCHAETA (worms)				
Eiseniella tetraedra	0	2	0	7
Tubificidae	5	19	10	120
TOTAL	390	280	800	5,300

Table 19.--*Species list, replicate samples, and mean density of benthic invertebrates for selected sites on Fountain and Monument Creeks*--Continued

Taxa	Replicate sample, number of organisms			Mean density, numbers of organisms per square meter
	1	2	3	
07104000 MONUMENT CREEK AT PIKEVIEW (SITE M10) Sample Date: APRIL 16, 1985				
INSECTA				
Diptera (true flies)				
Diamesa sp.	0	0	2	7
Orthocladius sp.	1	2	1	14
Chironomidae pupa	1	1	0	7
OLIGOCHAETA (worms)				
Limnodrilus sp.	2	0	2	14
TOTAL	4	3	5	42
07104000 MONUMENT CREEK AT PIKEVIEW (SITE M10) Sample Date: JULY 11, 1985				
INSECTA				
Ephemeroptera (mayflies)				
Baetis bicaudatus	3	5	12	72
Tricorythodes minutus	3	4	9	57
Diptera (true flies)				
Cordites sp.	1	0	1	7
Cricotopus sp.	0	3	0	11
Ephydra sp.	0	1	0	4
Micropsectra	0	2	0	7
Orthocladius sp.	3	15	9	97
Parametriocnemus sp.	10	23	18	180
Phaenopsectra sp.	1	11	2	50
Prosimlium sp.	2	1	0	11
Simulium sp.	0	1	0	4
Tipula sp.	1	2	0	11
Chironomidae pupa	0	3	2	18
COLLEMBOLA (springtails)				
Isotomurus palustris	2	0	1	11
OLIGOCHAETA (worms)				
Limnodrilus sp.	7	25	71	370
TOTAL	33	96	120	910

Table 19.--*Species list, replicate samples, and mean density of benthic invertebrates for selected sites on Fountain and Monument Creeks*--Continued

Taxa	Replicate sample, number of organisms 1	2	3	Mean density, numbers of organisms per square meter
07104000 MONUMENT CREEK AT PIKEVIEW (SITE M10) Sample Date: AUGUST 12, 1985				
INSECTA				
Diptera (true flies)				
Micropsectra sp.	0	0	2	7
Orthocladius sp.	0	0	1	4
Parametriocnemus sp.	0	1	2	11
Prosimulium sp.	0	1	0	4
Chironomidae pupa	0	1	0	4
COLLEMBOLA (springtails)				
Isotomurus palustris	0	1	1	7
OLIGOCHAETA (worms)				
Limnodrilus sp.	2	16	15	120
TOTAL	2	20	21	160
07104000 MONUMENT CREEK AT PIKEVIEW (SITE M10) Sample Date: OCTOBER 28, 1985				
INSECTA				
Plecoptera (stoneflies)				
Taenionema nigripenne	0	1	0	4
Diptera (true flies)				
Orthocladius sp.	0	0	2	7
Parametriocnemus sp.	1	0	0	4
OLIGOCHAETA (worms)				
Tubificidae	7	2	54	230
TOTAL	8	3	56	240
07104000 MONUMENT CREEK AT PIKEVIEW (SITE M10) Sample Date: APRIL 14, 1986				
INSECTA				
Plecoptera (stoneflies)				
Isoperla sobria	0	0	2	7
Diptera (true flies)				
Cricotopus sp.	4	0	16	72
Diamesa sp.	1	0	0	4
Orthocladius sp.	3	0	4	25
OLIGOCHAETA (worms)				
Tubificidae	4	8	0	43
TOTAL	12	8	22	150

Table 19.--*Species list, replicate samples, and mean density of benthic invertebrates for selected sites on Fountain and Monument Creeks*--Continued

Taxa	Replicate sample, number of organisms			Mean density, numbers of organisms per square meter
	1	2	3	
07104000 MONUMENT CREEK AT PIKEVIEW (SITE M10) Sample Date: JULY 10, 1986				
INSECTA				
Ephemeroptera (mayflies)				
Baetis bicaudatus	1	0	2	11
Diptera (true flies)				
Chironomus sp.	1	0	0	4
Corynoneura sp.	1	0	0	4
Cricotopus sp.	3	2	1	22
Hexatoma sp.	3	2	0	18
Limnophora aequifrons	0	4	0	14
Micropsectra sp.	2	40	23	230
Orthocladius sp.	0	2	3	18
Palpomyia complex	0	0	1	4
Parametriocnemus sp.	1	0	0	4
Prosimulium sp.	1	0	0	4
Simulium vittatum complex	0	0	1	4
Thienemanniella sp.	0	0	1	4
Chironomidae pupa	0	2	1	11
Coleoptera (beetles)				
Heterlimnius corpulentus	0	0	1	4
HYDRACARINA (water mites)	3	0	0	11
CRUSTACEA				
Amphipoda (scuds)				
Gammarus lacustris	1	0	0	4
OLIGOCHAETA (worms)				
Eiseniella tetraedra	1	0	1	7
Tubificidae	17	34	22	260
TOTAL	35	86	57	640

Table 19.--*Species list, replicate samples, and mean density of benthic invertebrates for selected sites on Fountain and Monument Creeks*--Continued

Taxa	Replicate sample, number of organisms 1	2	3	Mean density, numbers of organisms per square meter
07104000 MONUMENT CREEK AT PIKEVIEW (SITE M10) Sample Date: AUGUST 25, 1986				
INSECTA				
Ephemeroptera (mayflies)				
Baetis tricaudatus	4	0	0	14
Diptera (true flies)				
Cryptochironomus sp.	0	0	3	11
Parametriocnemus sp.	0	1	0	4
Prodiamesa sp.	12	2	4	65
OLIGOCHAETA (worms)				
Limnodrilus sp.	24	3	3	110
TOTAL	40	6	10	200
07104000 MONUMENT CREEK AT PIKEVIEW (SITE M10) Sample Date: NOVEMBER 5, 1986				
INSECTA				
Diptera (true flies)				
Micropsectra sp.	2	0	3	18
Orthocladius sp.	1	0	0	4
Parametriocnemus sp.	5	3	35	150
Prodiamesa sp.	0	3	3	22
Chironomidae pupa	0	1	0	4
OLIGOCHAETA (worms)				
Limnodrilus sp.	83	52	85	790
TOTAL	91	59	126	990
07104000 MONUMENT CREEK AT PIKEVIEW (SITE M10) SAMPLE DATE APRIL 27, 1987				
INSECTA				
Diptera (true flies)				
Cryptochironomus sp.	0	1	0	4
Orthocladius sp.	3	4	3	36
Parametriocnemus sp.	8	0	3	39
OLIGOCHAETA (worms)				
Limnodrilus sp.	22	220	68	1,100
TOTAL	33	220	74	1,200

Table 19.--*Species list, replicate samples, and mean density of benthic invertebrates for selected sites on Fountain and Monument Creeks*--Continued

Taxa	Replicate sample, number of organisms			Mean density, numbers of organisms per square meter
	1	2	3	
07104000 MONUMENT CREEK AT PIKEVIEW (SITE M10) Sample Date: JULY 14, 1987				
INSECTA				
Ephemeroptera (mayflies)				
Baetis bicaudatus	19	4	3	93
Baetis tricaudatus	3	0	0	11
Tricorythodes minutus	26	0	5	110
Trichoptera (caddisflies)				
Hydropsyche sp.	0	1	1	7
Diptera (true flies)				
Cryptochironomus sp.	6	2	3	39
Molophilus sp.	1	0	0	4
Orthocladius sp.	1	3	3	25
Parametriocnemus sp.	20	5	14	140
Simulium sp.	5	2	4	39
Thienemanniella sp.	1	2	0	11
Chironomidae pupa	0	1	1	7
OLIGOCHAETA (worms)				
Limnodrilus sp.	15	12	23	180
TOTAL	97	32	57	670
07104000 MONUMENT CREEK AT PIKEVIEW (SITE M10) Sample Date: AUGUST 26, 1987				
INSECTA				
Diptera (true flies)				
Cryptochironomus sp.	23	31	7	220
Dixella sp.	1	0	0	4
Ephydra sp.	1	0	0	4
Eukiefferiella sp.	1	0	0	4
Palpomyia complex	0	1	0	4
Parametriocnemus sp.	6	6	7	68
OLIGOCHAETA (worms)				
Limnodrilus sp.	25	54	22	360
TOTAL	57	92	36	660

Table 19.--*Species list, replicate samples, and mean density of benthic invertebrates for selected sites on Fountain and Monument Creeks*--Continued

Taxa	Replicate sample, number of organisms			Mean density, numbers of organisms per square meter
	1	2	3	
07104000 MONUMENT CREEK AT PIKEVIEW (SITE M10) Sample Date: NOVEMBER 4, 1987				
INSECTA				
Diptera (true flies)				
Cricotopus sp.	0	0	1	4
Cryptochironomus sp.	3	1	0	14
Eukiefferiella sp.	1	0	0	4
Micropsectra sp.	2	0	0	7
Orthocladius sp.	1	1	3	18
Palpomyia complex	2	0	0	7
Parametriocnemus sp.	3	4	4	39
Pericoma sp.	0	1	1	7
Prosimulium sp.	1	0	0	4
Simulium sp.	0	1	0	4
Chironomidae pupa	0	0	1	4
COLLEMBOLA (springtails)				
Isotomurus palustris	1	1	0	7
CRUSTACEA				
Amphipoda (scuds)				
Stygobromus n. sp. ?	0	0	1	4
OLIGOCHAETA (worms)				
Limnodrilus sp.	26	22	21	250
TOTAL	40	31	32	370
07104000 MONUMENT CREEK AT PIKEVIEW (SITE M10) Sample Date: APRIL 25, 1988				
INSECTA				
Diptera (true flies)				
Pagastia sp.	2	0	4	22
Parametriocnemus sp.	8	3	4	54
Thienemannimyia sp. group	0	1	0	4
OLIGOCHAETA (worms)				
Limnodrilus sp.	6	0	7	47
TOTAL	16	4	15	130

Table 19.--*Species list, replicate samples, and mean density of benthic invertebrates for selected sites on Fountain and Monument Creeks*--Continued

Taxa	Replicate sample, number of organisms			Mean density, numbers of organisms per square meter
	1	2	3	
07104000 MONUMENT CREEK AT PIKEVIEW (SITE M10)				
Sample Date: JUNE 30, 1988				
INSECTA				
Ephemeroptera (mayflies)				
Baetis bicaudatus	1	0	3	14
Ephemerella inermis	0	0	1	4
Diptera (true flies)				
Micropsectra sp.	0	1	0	4
Orthocladius sp.	0	0	1	4
Palpomyia complex	1	0	0	4
Parametriocnemus sp.	2	0	1	11
Thienemanniella sp.	1	0	0	4
Chironomidae pupa	0	1	0	4
COLLEMBOLA (springtails)				
Isotomurus palustris	0	0	1	4
OLIGOCHAETA (worms)				
Limnodrilus sp.	24	15	42	290
TOTAL	29	17	49	340
07104000 MONUMENT CREEK AT PIKEVIEW (SITE M10)				
Sample Date: SEPTEMBER 7, 1988				
INSECTA				
Ephemeroptera (mayflies)				
Baetis bicaudatus	1	0	0	4
Callibaetis sp.	0	0	1	4
Trichoptera (caddisflies)				
Hydropsyche sp.	3	0	1	14
Diptera (true flies)				
Palpomyia complex	0	2	3	18
Phaenopsectra sp.	46	55	22	440
Chironomidae pupa	1	0	1	7
Coleoptera (beetles)				
Heterlimnius corpulentus	1	0	0	4
COLLEMBOLA (springtails)				
Isotomurus palustris	0	0	1	4
OLIGOCHAETA (worms)				
Tubificidae	0	39	1	140
TOTAL	52	96	30	640

*U.S. GOVERNMENT PRINTING OFFICE: 1990-0-773-204/20013