STREAMFLOW AND SUSPENDED-SEDIMENT TRANSPORT IN GARVIN BROOK, WINONA COUNTY, SOUTHEASTERN MINNESOTA—HYDROLOGIC DATA FOR 1982

By G. A. Payne

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CONVERSION FACTORS

The following factors may be used to convert the inch-pound units published herein to the International System of units (SI):

Multiply	By	To obtain
foot (ft)	0.3048	meter (m)
cubic foot per second (ft^3/s)	0.02832	cubic meter per second (m^3/s)
mile (mi)	1.609	kilometer (km)
ton (short)	0.9072	megagrams (Mg) or metric tons

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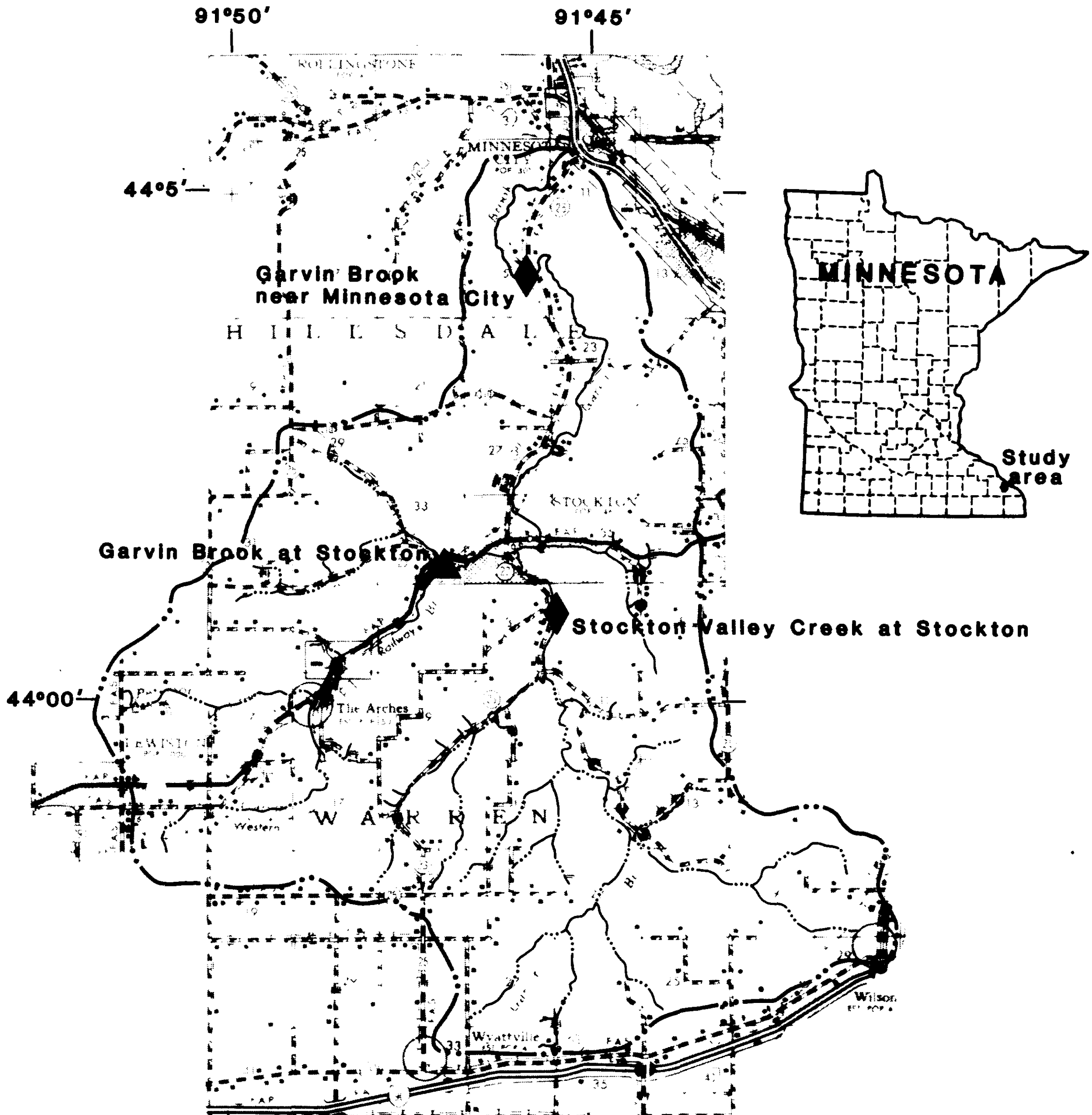
ABSTRACT

Streamflow and suspended-sediment-transport data were collected in Garvin Brook watershed in Winona County, southeastern Minnesota, during 1982. The data collection was part of a study to determine the effectiveness of agricultural best-management practices designed to improve rural water quality. The study is part of a Rural Clean Water Program demonstration project undertaken by the U.S. Department of Agriculture. Continuous streamflow data were collected at three gaging stations during March through September 1982. Suspended-sediment samples were collected at two of the gaging stations. Samples were collected manually at weekly intervals. During periods of rapidly changing stage, samples were collected at 30-minute to 12-hour intervals by stage-activated automatic samplers. The samples were analyzed for suspended-sediment concentration and particle-size distribution. Particle-size distributions were also determined for one set of bed-material samples collected at each sediment-sampling site. The streamflow and suspended-sediment-concentration data were used to compute records of mean-daily flow, mean-daily suspended-sediment concentration, and daily suspended-sediment discharge. The daily records are documented and results of analyses for particle-size distribution and of vertical sampling in the stream cross sections are given.

INTRODUCTION

Garvin Brook is located in a predominantly agricultural area of southeast Minnesota (fig. 1). The watershed contains intensively farmed upland areas separated by deeply incised valleys. Agricultural land use in combination with the adjacent steeply sloping terrain causes severe erosion of upland and valley soils. Water-quality problems occur when runoff from rainfall and snowmelt carries eroded soil and nutrients, bacteria, and pesticides into Garvin Brook and its tributaries.

The Garvin Brook watershed was selected by the U.S. Department of Agriculture for application and demonstration of best-management practices as part of the Rural Clean Water Program (RCWP). The RCWP provides assistance to landowners for implementation and maintenance of management practices that are designed to abate agricultural non-point-source pollution.



Base from Minnesota Department of Highways
General Highway Map of Winona County, 1981

0 2 MILES
0 2 KILOMETERS

EXPLANATION

▲ Streamflow gaging station

◆ Streamflow gaging station and sediment-data collection site

—··— Watershed boundary

Figure 1.--Location of data-collection sites

The Minnesota Pollution Control Agency (MPCA) was designated responsiblity for monitoring water-quality in Garvin Brook in order to investigate the effectiveness of the best-management practices. The MPCA requested the assistance of the U.S. Geological Survey in determination of the streamflow and suspended-sediment transport aspects of the investigation.

The purpose of the U.S. Geological Survey's part of the study is to provide quantitative determination of streamflow and suspended-sediment characteristics that can be used to document water-quality conditions in Garvin Brook before and during implementation of the RCWP project.

The results of the investigations will be compiled into a data base that will be used to relate changes in water quality to the application of the best-management practices. The purpose of this report is to document the data collected during the first year of study (1982).

The scope of the investigation of streamflow and suspended-sediment has been limited thus far to the establishment and operation of three streamflow-gaging stations. Two of the gaging stations were instrumented for automatic collection of suspended-sediment data.

Suspended-sediment samples were collected once weekly by an observer. Stage-activated automatic samplers were used to collect samples more frequently during periods of rapidly changing stage. The samples were analyzed for suspended-sediment concentration. Selected suspended-sediment and one set of bed-material samples from each site were analyzed for particle-size distribution.

This report contains data collected from February 25, 1982, when the first gaging station was activated, through September 30, 1982, the end of the 1982 water year.

METHODS AND APPROACH

Site Selection and Location

The location of data-collection sites is shown in figure 1. The site at Garvin Brook near Minnesota City was selected for determining characteristics of streamflow and sediment discharge from the entire watershed. The site was established at river-mile 4.5, the most downstream location where good streamflow records could be obtained.

Data-collection sites were also established at Stockton Valley Creek at Stockton and Garvin Brook at Stockton. These locations were selected to facilitate data collection near the most downstream point in each of the two major subdivisions of Garvin Brook watershed.

Instrumentation

Stage recorders were installed to collect streamflow data at all three sites. In addition, two of the sites, Garvin Brook near Minnesota City and Stockton Valley Creek at Stockton, were instrumented for collection of sediment data.

Digital, punched-tape recorders operating at 15-minute intervals were used to record stage data. The site at Garvin Brook near Minnesota City was also equipped with an auxillary graphic (strip-chart) recorder to facilitate interpretation of the record during periods when stage is affected by ice.

Standard Price AA current meters were used to make measurements of instantaneous stream velocity.

Depth-integrating D-49 and DH-48 samplers were used for manual collection of sediment samples (observer's samples and multiple-vertical, cross-section samples collected by U.S. Geological Survey personnel).

Stage-activated, pumping type, automatic samplers were used to collect suspended-sediment samples during periods of rapidly-changing stage caused by heavy precipitation or rapid snowmelt. Sampling intervals were varied from 30 minutes to 12 hours depending on the anticipated hydrologic response of the stream.

Data Collection and Computation

Data for this study were collected by standard methods adopted by the U.S. Geological Survey. The methods are described in detail in the U.S. Geological Survey report series Techniques of Water-Resources Investigations. Methods for collection of streamflow data are given in Buchanan and Somers (1968), Carter and Davidian (1968), and Buchanan and Somers (1969). Methods for collection of sediment data are given in Guy and Norman (1970).

The following is a brief summary of the pertinent methods used for data collection and computation in this study:

Streamflow-data collection and computation is based on the record of stage and the discharge measurements obtained at the gaging stations. Stage-discharge relations are determined by plotting discharge (determined by current-meter and cross-sectional-area measurements) versus stage to obtain stage-discharge curves. Rating tables giving the discharge for each 0.01-foot increment of stage are prepared from the stage-discharge curves. Records of mean-daily discharge are prepared by comparison of stage records to the rating tables.

Changes in the stage-discharge relation may occur because of changes in the physical features (control) of the stream or because of aquatic growth or debris that lodges on the control. These changes are indicated by the discharge measurements and corrections are made when stage records are compared to the rating table.

Occassionally, stage record is not obtained because of equipment malfunctions. Daily discharge for periods of no gage-height record is estimated from records obtained before and after the malfunction, discharge measurements, weather records, high-water marks, and comparison to records from gaging stations on the same or nearby streams.

Suspended-sediment concentrations are determined either from depth-integrated samples collected at several verticals in the cross section or from a sample collected at a fixed point to which a coefficient must be applied to determine the mean concentration in the cross section.

Laboratory methods for determining suspended-sediment concentrations and particle-size distributions are given in Guy (1969). Briefly stated, the methods involve either evaporation or filtration procedures for determination of concentration. Particle-size analyses involve use of sieve-pipet, visual-accumulation tube-pipet, or bottom-withdrawal tube visual-accumulation procedures. The procedure used by each laboratory is determined by the equipment available, the concentration and approximate size of sediment in the sample, and the settling medium used.

Office procedures used for computing fluvial-sediment discharge are given in Porterfield (1972). The daily suspended-sediment discharge (load in tons per day) is the product of discharge (streamflow) times the mean-daily concentration times a unit-conversion factor (0.0027). On days of rapidly changing streamflow and sediment concentrations, daily loads are computed on the basis of time-discharge-weighted averages. Therefore, some daily load values listed in the report differ from the product of discharge times concentration times 0.0027.

For periods when no samples were collected, daily loads are estimated from records of streamflow, from suspended-sediment concentrations observed immediately before and after the unsampled periods, and from the relation of sediment discharge to streamflow observed during periods when samples were collected.

SUMMARY OF INVESTIGATIONS

Streamflow Investigations

Gaging stations were established and stage recorders were activated on Stockton Valley Creek at Stockton on February 26, 1982, on Garvin Brook near Minnesota City on March 4, and on Garvin Brook at Stockton on March 5. Complete stage record was obtained at all three gaging stations except for August 7-31 at the station Garvin Brook at Stockton. Flow record for that period was estimated on the basis of one discharge measurement and by correlation with flow record from Stockton Valley Creek at Stockton.

A total of 22 current-meter measurements were obtained and used to develop stage-discharge relations for the gaging stations. The measurements showed that stage-discharge relations were stable at the Stockton Valley Creek station and at the Garvin Brook station near Minnesota City. The stage-discharge relation for Garvin Brook at Stockton was affected by aquatic growth in the channel. However, shifts were well defined by current-meter measurements and good records of flow (tables 1, 2, and 3) were obtained. Streamflow hydrographs are shown on figures 2, 3, and 4.

Table 1.--Mean-daily discharge for Garvin Brook near Minnesota City

[in cubic feet per second]

DAY	MAR	APR	MAY	JUN	JUL	AUG	SEP
1	26	35	30	36	29	28	36
2	26	36	30	34	28	28	28
3	26	36	31	33	29	28	27
4	26	34	31	33	28	28	26
5	25	34	39	32	28	28	27
6	26	33	40	33	31	28	27
7	26	33	37	35	46	27	26
8	28	33	34	34	30	27	26
9	25	34	33	34	30	26	26
10	27	34	33	34	30	27	28
11	26	34	32	33	30	27	27
12	28	33	37	32	29	26	26
13	33	33	41	30	29	27	29
14	34	32	35	30	29	28	28
15	33	33	34	31	29	28	27
16	51	34	35	30	28	27	27
17	41	36	36	30	28	27	27
18	37	34	38	30	28	27	27
19	39	34	35	29	27	27	27
20	35	34	34	30	27	27	25
21	34	33	33	30	27	26	25
22	33	31	35	29	27	28	25
23	36	32	34	29	27	27	25
24	38	32	33	29	27	35	25
25	36	32	32	30	27	30	25
26	34	32	33	29	27	28	25
27	33	31	34	29	33	26	25
28	33	42	33	29	29	26	25
29	33	26	32	29	28	28	27
30	40	23	32	29	28	28	40
31	38	---	84	---	28	27	---
TOTAL	1006	993	1110	935	901	855	814
MEAN	32.5	33.1	35.8	31.2	29.1	27.6	27.1
MAX	51	42	84	36	46	35	40
MIN	25	23	30	29	27	26	25

Table 2.--Mean-daily discharge for Stockton Valley Creek at Stockton

[in cubic feet per second]

DAY	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1	---	9.2	13	11	13	9.7	8.7	12
2	---	9.2	13	11	12	9.3	8.5	9.5
3	---	9.2	13	11	12	9.5	8.5	9.1
4	---	9.2	13	12	11	9.2	8.6	8.8
5	---	9.1	13	15	11	9.2	8.6	9.1
6	---	9.1	12	14	11	12	8.4	9.0
7	---	9.0	12	12	11	13	8.4	8.9
8	---	9.2	12	11	11	9.6	8.4	8.8
9	---	9.2	12	11	11	9.7	8.3	8.8
10	---	9.1	12	11	11	9.7	8.3	9.5
11	---	9.6	12	11	10	9.8	8.5	9.1
12	---	11	13	12	11	9.5	8.3	8.9
13	---	12	12	12	10	9.3	8.6	11
14	---	12	12	11	11	9.0	8.4	11
15	---	12	13	11	11	9.3	8.5	9.9
16	---	18	13	13	11	9.1	8.6	9.4
17	---	14	14	13	11	9.2	8.4	9.6
18	---	14	13	13	10	9.0	8.3	9.4
19	---	14	12	12	10	8.9	8.4	9.2
20	---	13	12	12	11	8.9	8.5	9.1
21	---	12	12	12	10	8.8	8.1	8.9
22	---	12	12	12	10	9.0	8.8	8.9
23	---	13	11	11	10	8.6	8.6	8.9
24	---	14	11	11	9.7	8.6	12	8.9
25	9.0	13	11	11	11	8.8	9.6	8.9
26	9.1	13	11	12	10	8.8	8.9	8.8
27	9.2	12	11	12	9.7	11	8.9	8.9
28	9.1	12	11	11	9.4	9.1	8.4	9.0
29	---	12	11	11	10	9.0	9.6	9.6
30	---	14	11	11	9.7	8.8	9.4	18
31	---	13	---	32	---	8.8	9.0	---
TOTAL	---	361.1	363	385	319.5	292.2	270.5	288.9
MEAN	---	11.6	12.1	12.4	10.7	9.43	8.73	9.63
MAX	---	18	14	32	13	13	12	18
MIN	---	9.0	11	11	9.4	8.6	8.1	8.8

Table 3.--Mean-daily discharge for Garvin Brook at Stockton

[in cubic feet per second]

DAY	MAR	APR	MAY	JUN	JUL	AUG	SEP
1	9.8	12	11	13	11	11	13
2	9.8	12	11	12	11	11	10
3	9.8	12	10	12	11	12	9.8
4	9.8	11	11	12	11	12	9.7
5	9.8	11	13	12	12	11	9.8
6	9.9	11	13	12	17	11	9.7
7	9.9	11	12	12	13	11	9.5
8	9.9	11	12	12	12	11	9.5
9	9.8	11	11	12	11	11	9.4
10	10	11	11	12	11	11	10
11	10	11	10	12	11	10	9.7
12	11	11	14	12	11	10	9.5
13	12	11	15	12	11	10	10
14	12	11	13	12	11	10	10
15	12	11	12	12	11	10	10
16	15	12	13	12	11	10	9.7
17	13	12	13	12	11	10	9.8
18	13	11	13	12	11	10	9.5
19	13	11	12	12	11	10	9.4
20	12	11	12	12	11	10	9.2
21	12	11	12	12	11	10	9.1
22	12	11	12	11	11	10	8.9
23	13	11	12	12	11	10	8.9
24	13	11	12	11	11	14	8.8
25	13	11	12	12	11	11	8.9
26	12	11	12	11	11	10	8.7
27	12	11	12	11	13	10	8.7
28	12	11	12	11	11	10	8.9
29	12	11	12	11	11	10	9.7
30	15	11	12	10	11	10	14
31	13	---	24	---	11	9.8	---
TOTAL	360.5	335	386	353	353	326.8	291.8
MEAN	11.6	11.2	12.5	11.8	11.4	10.5	9.73
MAX	15	12	24	13	17	14	14
MIN	9.8	11	10	10	11	9.8	8.7

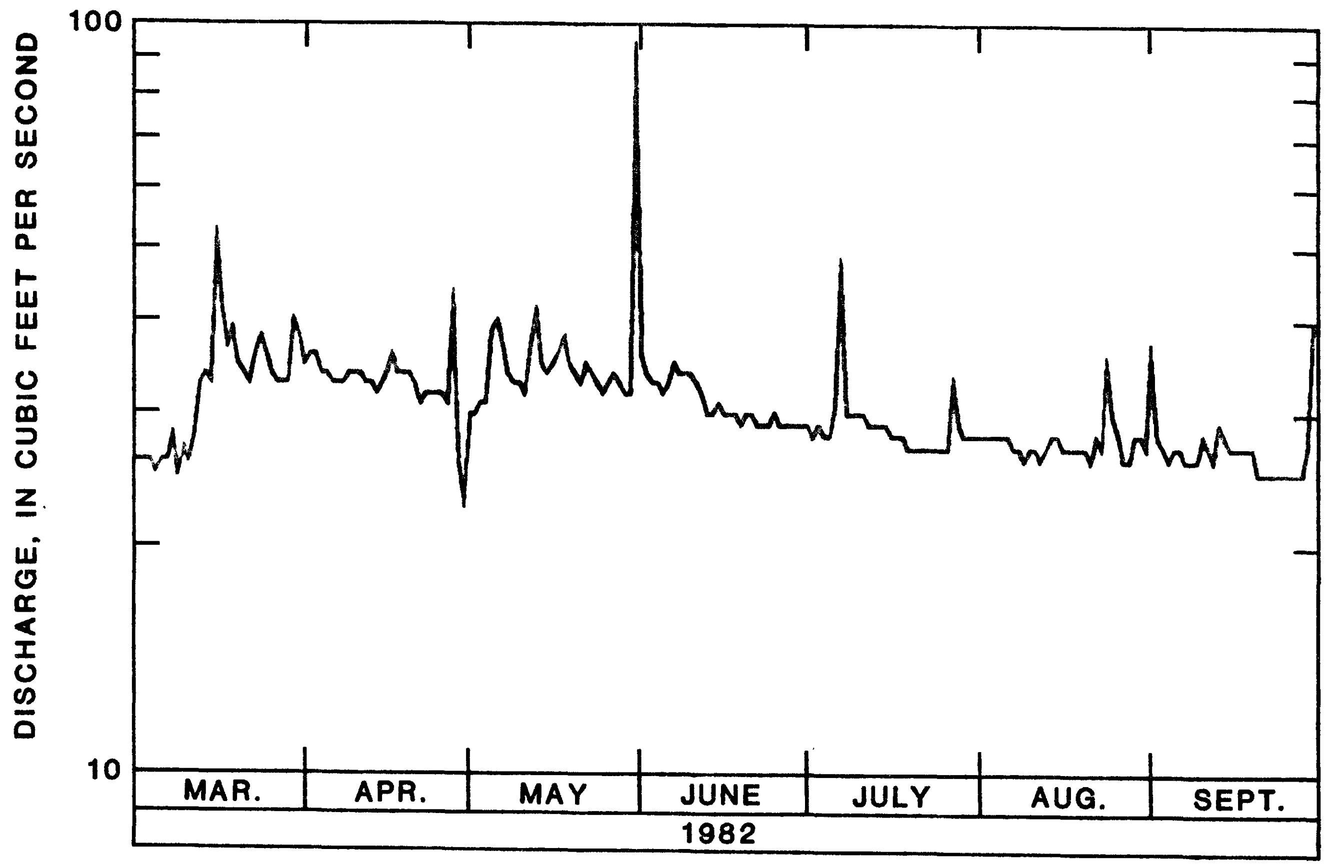


Figure 2.--Mean-daily streamflow in Garvin Brook near Minnesota City

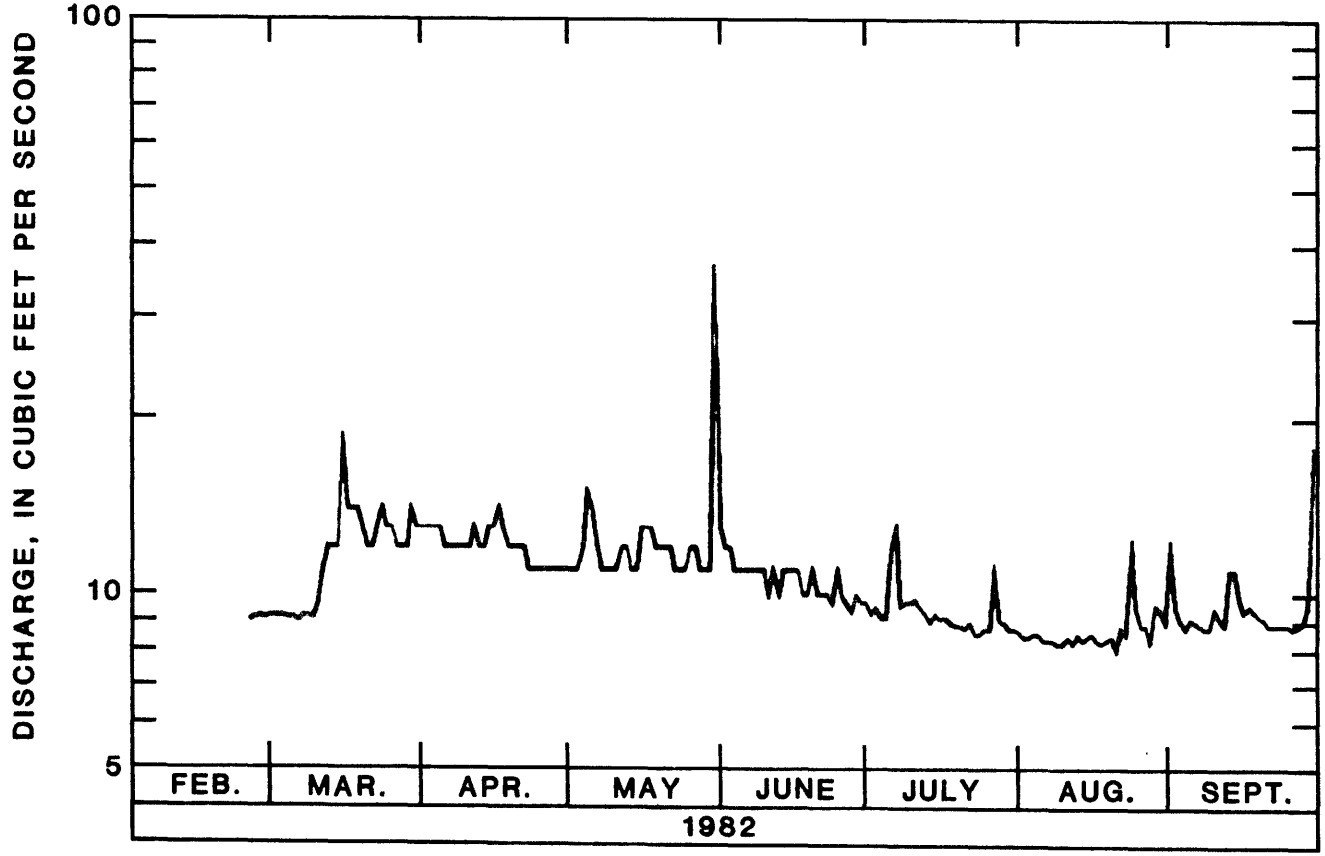


Figure 3.--Mean-daily streamflow in Stockton Valley Creek at Stockton

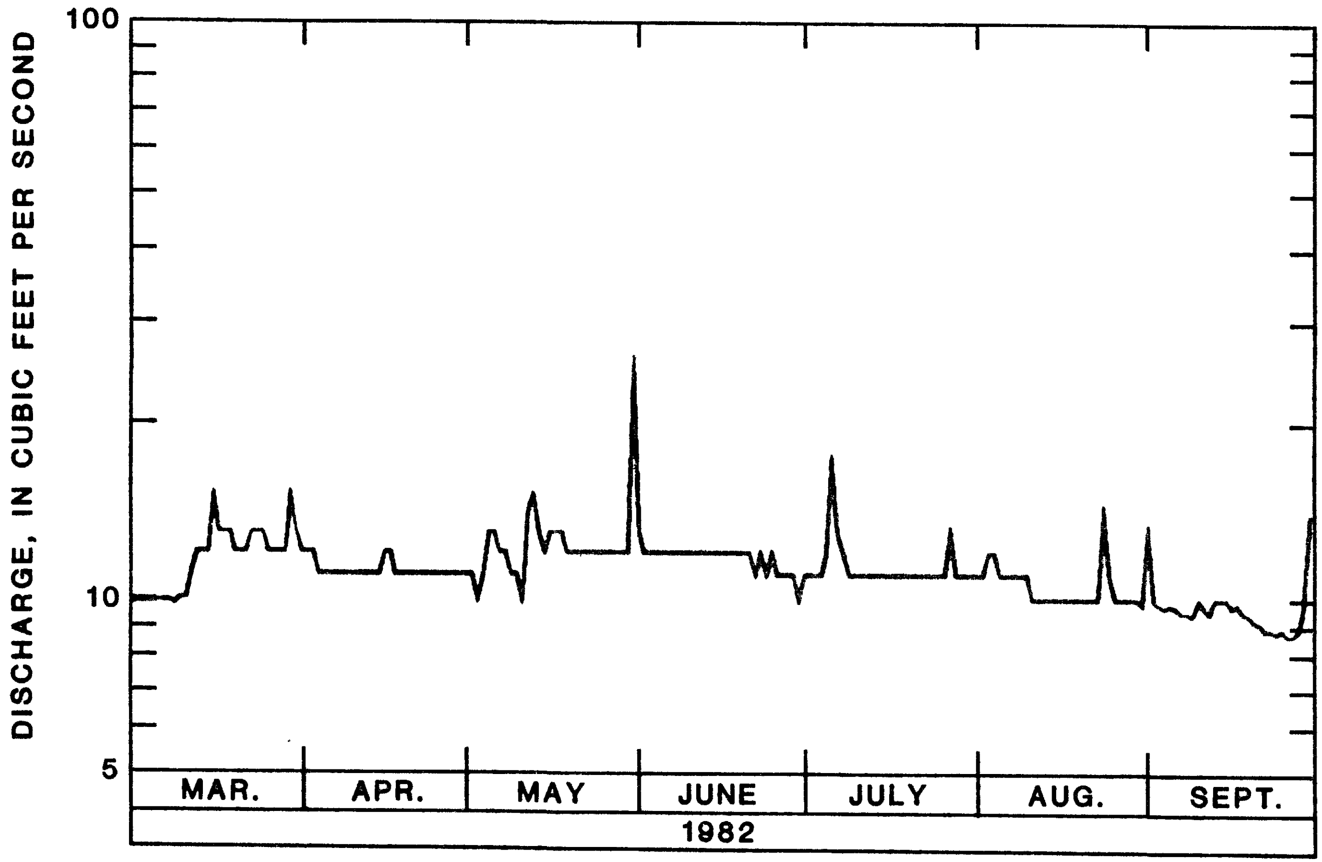


Figure 4.--Mean-daily streamflow in Garvin Brook at Stockton

The discharge records show that Stockton Valley Creek at Stockton (table 2) and Garvin Brook at Stockton (table 3) have similar base-flow characteristics. Base flow was stable and nearly equal at both stations, showing a gradual decline from about 12 ft^3/s in April to about 9 ft^3/s in September. Both streams responded rapidly to runoff from storms. Flows generally peaked within 1 hour after rain commenced and then quickly receded. The streams returned to base flow within 24 hours after the storm.

Base flow of Garvin Brook near Minnesota City also was stable (table 1), declining gradually from about 33 ft^3/s in April to about 25 ft^3/s in September. Response to rainfall was not as rapid as at the upstream stations. Flows peaked about 8 hours after the onset of rain and receded for more than 24 hours after rainfall ceased.

Because high flows did not occur during 1982, an evaluation of response to extremely heavy rains will depend on continued operation of the gaging stations.

Sediment Investigations

The daily suspended-sediment-discharge record for Garvin Brook near Minnesota City (table 4) was computed from the results of analyses of 61 manual and 75 automatic samples. The daily suspended-sediment-discharge record for Stockton Valley Creek at Stockton (table 5) was computed from the results of 57 manual and 42 automatic samples. Particle-size analyses of suspended sediment were determined for three samples collected at Garvin Brook near Minnesota City and for one sample collected at Stockton Valley Creek at Stockton (table 6). One bed-material sample was collected and analyzed for particle size at each sediment-sampling site (table 6). Four sets of cross-section samples were obtained at each site (table 7).

The suspended-sediment data (tables 4 and 5) show that, during base flow, suspended-sediment concentrations were generally less than 50 mg/L in Stockton Valley Creek and less than 80 mg/L in Garvin Brook near Minnesota City. These concentrations resulted in discharges that were generally less than 2 tons per day in Stockton Valley Creek and less than 4 tons per day in Garvin Brook near Minnesota City. In contrast, sudden rises in stage were accompanied by large increases in sediment concentration and discharge. On May 31, for example, the mean-daily concentration in Stockton Valley Creek increased to 1,720 mg/L and the daily discharge totaled 251 tons (table 5).

Table 4.--Mean-daily suspended-sediment concentrations and daily suspended-sediment discharge for Garvin Brook near Minnesota City

DAY	MEAN CONCENTRATION (MG/L) MARCH	LOADS (T/DAY) MARCH	MEAN CONCENTRATION (MG/L) APRIL	LOADS (T/DAY) APRIL	MEAN CONCENTRATION (MG/L) MAY	LOADS (T/DAY) MAY
1	30	2.1	39	3.7	33	2.7
2	30	2.1	38	3.7	32	2.6
3	30	2.1	43	4.2	32	2.7
4	30	2.1	40	3.7	33	2.8
5	30	2.0	36	3.3	90	9.5
6	30	2.1	32	2.9	70	7.6
7	30	2.1	28	2.5	44	4.4
8	30	2.3	23	2.0	42	3.9
9	30	2.0	18	1.7	42	3.7
10	30	2.2	15	1.4	42	3.7
11	30	2.1	15	1.4	42	3.6
12	41	3.1	15	1.3	132	14
13	42	3.7	16	1.4	120	14
14	38	3.5	16	1.4	67	6.3
15	22	2.0	24	2.1	66	6.1
16	148	22	40	3.7	68	6.4
17	80	8.9	53	5.2	84	8.2
18	59	5.9	51	4.7	86	8.8
19	59	6.2	49	4.5	74	7.0
20	37	3.5	48	4.4	71	6.5
21	35	3.2	47	4.2	74	6.6
22	35	3.1	45	3.8	142	13
23	43	4.2	43	3.7	75	6.9
24	54	5.5	41	3.5	65	5.8
25	41	4.0	39	3.4	65	5.6
26	37	3.4	38	3.3	71	6.3
27	37	3.3	36	3.0	76	7.0
28	36	3.2	72	11	63	5.6
29	35	3.1	63	4.4	56	4.8
30	58	6.3	47	2.9	60	5.2
31	53	5.4	---	---	1110	302
TOTAL	---	126.7	---	102.4	---	493.3

Table 4.--Mean-daily suspended-sediment concentrations and daily suspended-sediment discharge for Garvin Brook near Minnesota City--Continued

DAY	MEAN CONCEN- TRATION (MG/L) JUNE	LOADS (T/DAY) JUNE	MEAN CONCEN- TRATION (MG/L) JULY	LOADS (T/DAY) JULY	MEAN CONCEN- TRATION (MG/L) AUGUST	LOADS (T/DAY) AUGUST	MEAN CONCEN- TRATION (MG/L) SEPTEMBER	LOADS (T/DAY) SEPTEMBER
1	132	13	50	3.9	58	4.4	308	29
2	86	7.9	50	3.8	54	4.1	68	5.1
3	80	7.1	50	3.9	50	3.8	65	4.7
4	78	6.9	50	3.8	47	3.6	62	4.4
5	76	6.6	50	3.8	44	3.3	58	4.2
6	74	6.6	228	25	43	3.3	55	4.0
7	72	6.8	362	60	42	3.1	52	3.7
8	70	6.4	83	6.7	39	2.8	49	3.4
9	83	7.6	76	6.2	38	2.7	46	3.2
10	84	7.7	72	5.8	37	2.7	43	3.3
11	85	7.6	67	5.4	36	2.6	39	2.8
12	84	7.3	62	4.9	34	2.4	37	2.6
13	79	6.4	58	4.5	32	2.3	35	2.7
14	76	6.2	57	4.5	31	2.3	32	2.4
15	72	6.0	85	6.7	30	2.3	31	2.3
16	67	5.4	126	9.5	30	2.2	33	2.4
17	63	5.1	109	8.2	30	2.2	36	2.6
18	58	4.7	91	6.9	30	2.2	38	2.8
19	52	4.1	85	6.2	30	2.2	37	2.7
20	50	4.1	83	6.1	30	2.2	34	2.3
21	50	4.1	82	6.0	30	2.1	32	2.2
22	50	3.9	80	5.8	30	2.3	29	2.0
23	50	3.9	78	5.7	30	2.2	26	1.8
24	52	4.1	81	5.9	153	17	23	1.6
25	74	6.0	80	5.8	109	8.8	26	1.8
26	131	10	74	5.4	85	6.4	33	2.2
27	105	8.2	104	9.3	75	5.3	40	2.7
28	78	6.1	68	5.3	68	4.8	45	3.0
29	63	4.9	66	5.0	74	5.6	47	3.4
30	52	4.1	64	4.8	50	3.8	223	27
31	---	---	62	4.7	22	1.6	---	---
TOTAL	---	188.8	---	249.5	---	116.6	---	138.3

TOTAL LOAD FOR YEAR: 1415.6 TONS.

Table 5.--Mean-daily suspended-sediment concentrations and daily suspended-sediment discharge for Stockton Valley Creek at Stockton

DAY	FEBRUARY MEAN CONCENTRATION (MG/L)	FEBRUARY LOADS (T/DAY)	MARCH MEAN CONCENTRATION (MG/L)	MARCH LOADS (T/DAY)	APRIL MEAN CONCENTRATION (MG/L)	APRIL LOADS (T/DAY)	MAY MEAN CONCENTRATION (MG/L)	MAY LOADS (T/DAY)
1	---	---	20	.50	55	1.9	24	.71
2	---	---	20	.50	50	1.8	24	.71
3	---	---	20	.50	45	1.6	24	.71
4	---	---	20	.50	40	1.4	40	1.3
5	---	---	20	.49	35	1.2	145	5.9
6	---	---	20	.49	40	1.3	90	3.4
7	---	---	20	.49	35	1.1	50	1.6
8	---	---	20	.50	30	.97	40	1.2
9	---	---	20	.50	25	.81	35	1.0
10	---	---	20	.49	20	.65	30	.89
11	---	---	25	.65	20	.65	30	.89
12	---	---	29	.86	30	1.1	144	4.7
13	---	---	36	1.2	35	1.1	78	2.5
14	---	---	31	1.0	40	1.3	64	1.9
15	---	---	16	.52	50	1.8	56	1.7
16	---	---	144	7.5	60	2.1	138	4.8
17	---	---	68	2.6	65	2.5	100	3.5
18	---	---	95	3.6	60	2.1	82	2.9
19	---	---	82	3.1	50	1.6	80	2.6
20	---	---	52	1.8	50	1.6	70	2.3
21	---	---	43	1.4	50	1.6	60	1.9
22	---	---	39	1.3	45	1.5	52	1.7
23	---	---	35	1.2	40	1.2	50	1.5
24	---	---	30	1.1	37	1.1	45	1.3
25	20	.49	25	.88	35	1.0	40	1.2
26	20	.49	20	.70	35	1.0	50	1.6
27	20	.50	20	.65	30	.89	70	2.3
28	20	.49	20	.65	30	.89	60	1.8
29	---	---	25	.81	25	.74	54	1.6
30	---	---	71	2.7	25	.74	55	1.6
31	---	---	60	2.1	---	---	1720	251
TOTAL	---	1.97	---	41.28	---	39.24	---	312.71

Table 5.--Mean-daily suspended-sediment concentrations and daily suspended-sediment discharge for Stockton Valley Creek at Stockton--Continued

DAY	MEAN CONCEN-TRATION (MG/L) JUNE	LOADS (T/DAY) JUNE	MEAN CONCEN-TRATION (MG/L) JULY	LOADS (T/DAY) JULY	MEAN CONCEN TRATION (MG/L) AUGUST	LOADS (T/DAY) AUGUST	MEAN CONCEN-TRATION (MG/L) SEPTEMBER	LOADS (T/DAY) SEPTEMBER
1	130	4.6	31	.81	30	.70	43	1.4
2	90	2.9	30	.75	25	.57	30	.77
3	74	2.4	40	1.0	25	.57	25	.61
4	60	1.8	51	1.3	56	1.3	25	.59
5	55	1.6	50	1.2	50	1.2	25	.61
6	50	1.5	87	4.1	40	.91	20	.49
7	45	1.3	88	3.1	35	.79	20	.48
8	40	1.2	62	1.6	30	.68	20	.48
9	35	1.0	60	1.6	25	.56	20	.48
10	35	1.0	60	1.6	25	.56	25	.64
11	35	.95	60	1.6	30	.69	22	.54
12	33	.98	60	1.5	30	.67	20	.48
13	30	.81	50	1.3	35	.81	60	1.8
14	35	1.0	40	.97	30	.68	35	1.0
15	50	1.5	50	1.3	30	.69	28	.75
16	45	1.3	63	1.5	30	.70	25	.63
17	40	1.2	60	1.5	30	.68	19	.49
18	35	.95	60	1.5	30	.67	16	.41
19	32	.86	60	1.4	29	.66	12	.30
20	35	1.0	60	1.4	30	.69	10	.25
21	35	.95	60	1.4	25	.55	10	.24
22	35	.95	65	1.6	30	.71	10	.24
23	30	.81	65	1.5	30	.70	10	.24
24	30	.79	68	1.6	35	1.1	10	.24
25	40	1.2	60	1.4	30	.78	10	.24
26	32	.86	50	1.2	26	.62	10	.24
27	30	.79	57	1.7	24	.58	10	.24
28	30	.76	50	1.2	22	.50	20	.49
29	30	.81	40	.97	36	.93	100	2.6
30	30	.79	40	.95	30	.76	180	8.7
31	---	---	30	.71	14	.34	---	---
TOTAL	---	38.56	---	45.26	---	22.35	---	26.67

TOTAL LOAD FOR YEAR: 528.04 TONS.

Table 6.--Results of analyses for particle-size distribution

Date	Time	Instantaneous streamflow (ft^3/s)	Sediment concentration (mg/L)	Sediment discharge (tons/day)	Percent finer than size indicated in millimeters									
					0.002	0.004	0.016	0.062	0.125	0.250	0.500	1.00	2.00	4.00
GARVIN BROOK NEAR MINNESOTA CITY														
SUSPENDED SEDIMENT														
5-31-82	1000	109	1430	421	68	83	90	100						
5-31-82	1100	92	1270	315	69	83	92	100						
7- 6-82	2110	42	1630	185	31	37	59	99						
BED MATERIAL														
9-15-82	1020	27				3		28	36	46	90	97	99	100
STOCKTON VALLEY CREEK AT STOCKTON														
SUSPENDED SEDIMENT														
5-31-82	1130	18	2140		73	83	95	99						
BED MATERIAL														
9-15-82	1000	10				2		20	41	73	98	99	100	

Table 7.--Results of multiple- and single-vertical sampling in stream cross sections

[Point samples are single-vertical samples collected at the observer's sampling point, EWI samples are composites of multiple-vertical samples collected laterally across the stream using the equal-width-increment method, and auto samples are collected by an automatic pumping sampler at a single point in the stream.]

Date	Time	Type of sample	Concentration (milligrams per liter)		Stage (ft)	Streamflow (ft^3/s)
			Multiple-vertical samples	Single-vertical samples		
GARVIN BROOK NEAR MINNESOTA CITY						
3-12-82	1725	Point	--	46	0.96	29
	1735-1743	EWI	80	--	.96	29
	1755	Point	--	63	.96	29
3-16-82	1155	Point	--	228	1.28	58
	1200	Auto	--	223	1.28	58
	1205-1213	EWI	220	--	1.28	58
	1220	Point	--	224	1.28	58
6-30-82	1455	Point	--	44	97	30
	1550-1554	EWI	83	--	.97	30
	1610	Point	--	54	.97	30
8-31-82	1230	Point	--	21	.95	26
	1400-1404	EWI	19	--	.95	26
	1420	Point	--	55	.95	26
STOCKTON VALLEY CREEK AT STOCKTON						
3-12-82	1512-1515	EWI	30	--	2.03	10
3-16-82	0905-0906	EWI	316	--	2.34	20
7-1-82	0845	Point	--	29	2.03	9.4
	0938-0942	EWI	31	--	2.03	9.4
	0955	Point	--	38	2.03	9.4
8-31-82	1510	Point	--	14	2.02	8.9
	1555-1557	EWI	7	--	2.02	8.9
	1605	Point	--	20	2.02	8.9

Particle-size analyses of samples collected May 31 in Garvin Brook near Minnesota City (table 6) showed that 100 percent of the particles were smaller than 0.062 mm, 90 percent were smaller than 0.016 mm, 83 percent were smaller than 0.004 mm, and 68 percent were smaller than 0.002 mm. Similar results were obtained at Stockton Valley Creek (table 6). Particle-size analyses were also performed on samples collected in Garvin Brook near Minnesota City during a storm on July 6. The analyses showed that 99 percent of the particles were smaller than 0.062 mm, but that only 59 percent were smaller than 0.016 mm, 37 percent were smaller than 0.004 mm, and 31 percent were smaller than 0.002 mm.

The particle-size analyses showed that the suspended-sediment discharge at both sites during 1982 was comprised of clay- and silt-sized particles (<0.062 mm) and that most of the suspended particles on the day of peak discharge (May 31) at Garvin Brook near Minnesota City were of clay size (<0.004 mm).

In contrast, analyses of bed material (table 6) collected on September 15 showed that 80 percent of the material at Stockton Valley Creek was comprised of sand-sized particles (particles >0.062 mm). At Garvin Brook near Minnesota City, 72 percent of the bed material was comprised of sand-sized particles.

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DEFINITION OF TERMS

Bed material is the unconsolidated material of which a streambed, lake, pond, reservoir, or estuary bottom is composed.

Cubic foot per second (ft^3/s) is the rate of discharge representing a volume of 1 cubic foot passing a given point during 1 second and is equivalent to approximately 7.48 gallons per second, 448.8 gallons per minute, or 0.02832 cubic meters per second.

Discharge is the volume of water (or more broadly, volume of fluid plus suspended sediment), that passes a given point within a given period of time.

Mean discharge (mean) is the arithmetic mean of individual daily mean discharges during a specific period.

Instantaneous discharge is the discharge at a particular instant of time.

Gage height (G.H.) is the water-surface elevation referred to some arbitrary gage datum. Gage height is often used interchangeably with the more general term "stage," although gage height is more appropriate when used with a reading on a gage.

Gaging station is a particular site on a stream, canal, lake, or reservoir where systematic observations of hydrologic data are obtained.

Milligrams per liter (mg/L) is a unit for expressing the concentration of chemical consitituents in solution. Milligrams per liter represent the mass of solute per unit volume (liter) of water. Concentration of suspended sediment also is expressed in mg/L, and is based on the mass of sediment per liter of water-sediment mixture.

Particle size is the diameter, in millimeters (mm), of suspended sediment or bed material determined by either sieve or sedimentation methods. Sedimentation methods (pipet, bottom-withdrawal tube, visual-accumulation tube) determine fall diameter of particles in distilled water (chemically dispersed).

Particle-size classification used in this report agrees with recommendations made by the American Geophysical Union Subcommittee on Sediment Terminology.

The classification is as follows:

Classification	Size (mm)
Clay	0.00024 - 0.004
Silt	.004 - .062
Sand	.062 - 2.0
Gravel	2.0 - 64.0

Sediment is solid material that originates mostly from disintegrated rocks and is transported by, suspended in, or deposited from water; it includes chemical and biochemical precipitates and decomposed organic material, such as humus. The quantity, characteristics, and cause of the occurrence of sediment in streams are influenced by environmental factors. Some major factors are degree of slope, length of slope, soil characteristics, land usage, and quantity and intensity of precipitation.

Suspended sediment is the sediment that at any given time is maintained in suspension by the upward components of turbulent currents or that exists in suspension as a colloid.

Suspended-sediment concentration is the velocity-weighted concentration of suspended sediment in the sampled zone (from the water surface to a point approximately 0.3 foot above the bed) expressed as milligrams of dry sediment per liter of water-sediment mixture (mg/L).

Suspended-sediment discharge (tons/day) is the rate at which dry weight of sediment passes a section of a stream or is the quantity of sediment, as measured by dry weight or volume, that passes a section in a given time. It is computed by multiplying discharge times mg/L times 0.0027.

Suspended-sediment load is quantity of suspended sediment passing a section in a specified period.

Mean concentration is the time-weighted concentration of suspended sediment passing a stream section during a 24-hour day.

Stage-discharge relation is the relation between gage height (stage) and volume of water per unit of time, flowing in a channel.

Streamflow is the discharge that occurs in a natural channel. Although the term "discharge" can be applied to the flow of a canal, the word "streamflow" uniquely describes the discharge in a surface stream course. The term "streamflow" is more general than "runoff" as streamflow may be applied to discharge whether or not it is affected by diversion or regulation.

Time-weighted average is computed by multiplying the number of days in the sampling period by the concentrations of individual constituents for the corresponding period and dividing the sum of the products by the total number of days. A time-weighted average represents the composition of water that would be contained in a vessel or reservoir that had received equal quantities of water from the stream each day for the year.

Tons per day is the quantity of substance in solution or suspension that passes a stream section during a 24-hour day.

Weighted average is used in this report to indicate discharge-weighted average. It is computed by multiplying the discharge for a sampling period by the concentrations of individual constituents for the corresponding period and dividing the sum of the products by the sum of the discharge. A discharge-weighted average approximates the composition of water that would be found in a reservoir containing all the water passing a given location during the water year after thorough mixing in the reservoir.