

DEPARTMENT OF THE INTERIOR

ALBERT B. FALL, Secretary

UNITED STATES GEOLOGICAL SURVEY

GEORGE OTIS SMITH, Director

WATER-SUPPLY PAPER 477

SURFACE WATER SUPPLY OF THE  
UNITED STATES

1918

PART VII. LOWER MISSISSIPPI RIVER BASIN

NATHAN C. GROVER, Chief Hydraulic Engineer

ROBERT FOLLANSBEE and ROGER C. RICE, District Engineers

Prepared in cooperation with the States of  
COLORADO AND KANSAS



WASHINGTON

GOVERNMENT PRINTING OFFICE

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# SURFACE WATER SUPPLY OF THE LOWER MISSISSIPPI RIVER BASIN, 1918.

## AUTHORIZATION AND SCOPE OF WORK.

This volume is one of a series of 14 reports presenting records of measurements of flow made on streams in the United States during the year ending September 30, 1918.

The data presented in these reports were collected by the United States Geological Survey under the following authority contained in the organic law (20 Stat. L., p. 394) :

*Provided*, That this officer [the Director] shall have the direction of the Geological Survey and the classification of public lands and examination of the geological structure, mineral resources, and products of the national domain.

The work was begun in 1888 in connection with special studies relating to irrigation in the arid West. Since the fiscal year ending June 30, 1895, successive sundry civil bills passed by Congress have carried the following item and appropriations:

For gaging the streams and determining the water supply of the United States, and for the investigation of underground currents and artesian wells, and for the preparation of reports upon the best methods of utilizing the water resources.

### *Annual appropriations for the fiscal years ending June 30, 1895-1918.*

1895 -----	\$12, 500
1896 -----	20, 000
1897 to 1900, inclusive -----	50, 000
1901 to 1902, inclusive -----	100, 000
1903 to 1906, inclusive -----	200, 000
1907 -----	150, 000
1908 to 1910, inclusive -----	100, 000
1911 to 1917, inclusive -----	150, 000
1918 -----	175, 000

In the execution of the work many private and State organizations have cooperated, either by furnishing data or by assisting in collecting data. Acknowledgments for cooperation of the first kind are made in connection with the description of each station affected; co-operation of the second kind is acknowledged on page 9.

Measurements of stream flow have been made at about 4,510 points in the United States and also at many points in Alaska and the Hawaiian Islands. In July, 1918, 1,180 gaging stations were being

maintained by the Survey and the cooperating organizations. Many miscellaneous discharge measurements are made at other points. In connection with this work data were also collected in regard to precipitation, evaporation, storage reservoirs, river profiles, and water power in many sections of the country and will be made available in water-supply papers from time to time.

### DEFINITION OF TERMS.

The volume of water flowing in a stream—the “run-off” or “discharge”—is expressed in various terms, each of which has become associated with a certain class of work. These terms may be divided into two groups—(1) those that represent a rate of flow, as second-feet, gallons per minute, miners’ inches, and discharge in second-feet per square mile, and (2) those that represent the actual quantity of water, as run-off in depth in inches, acre-feet, and millions of cubic feet. The principal terms used in this series of reports are second-feet, second-feet per square mile, run-off in inches, and acre-feet. They may be defined as follows:

“Second-feet” is an abbreviation for “cubic feet per second.” A second-foot is the rate of discharge of water flowing in a channel of rectangular cross section 1 foot wide and 1 foot deep at an average velocity of 1 foot per second. It is generally used as a fundamental unit from which others are computed.

“Second-feet per square mile” is the average number of cubic feet of water flowing per second from each square mile of area drained, on the assumption that the run-off is distributed uniformly both as regards time and area.

“Run-off (depth in inches)” is the depth to which an area would be covered if all the water flowing from it in a given period were uniformly distributed on the surface. It is used for comparing run-off with rainfall, which is usually expressed in depth in inches.

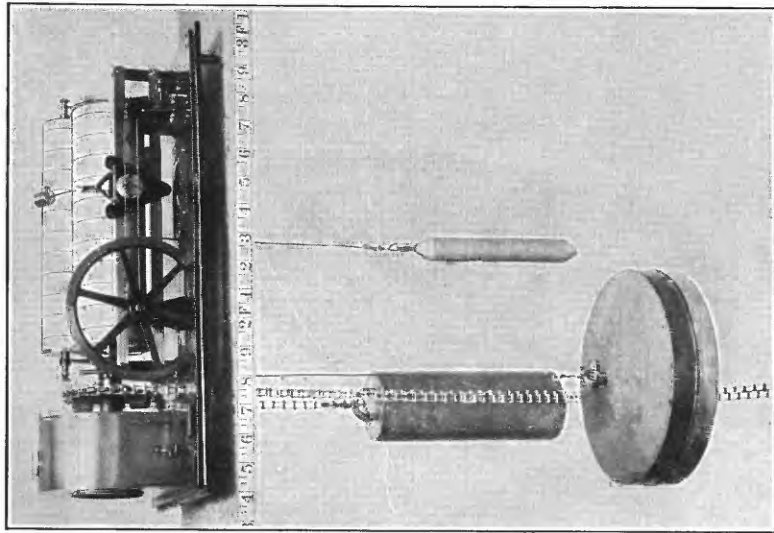
An “acre-foot,” equivalent to 43,560 cubic feet, is the quantity required to cover an acre to the depth of 1 foot. The term is commonly used in connection with storage for irrigation.

The following terms not in common use are here defined:

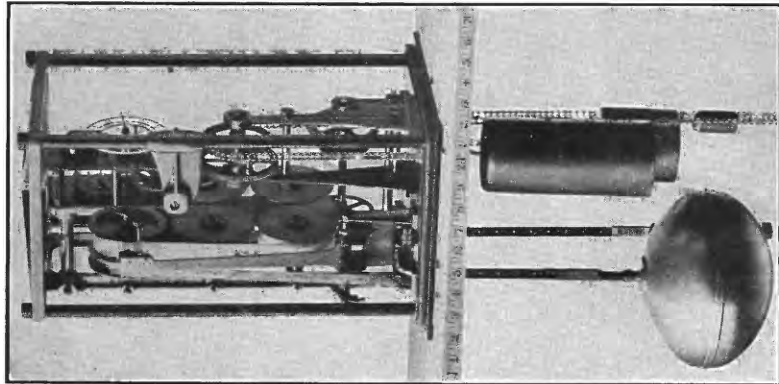
“Stage-discharge relation,” an abbreviation for the term “relation of gage height to discharge.”

“Control,” a term used to designate the section or sections of the stream channel below the gage which determine the stage-discharge relation at the gage. It should be noted that the control may not be the same section or sections at all stages.

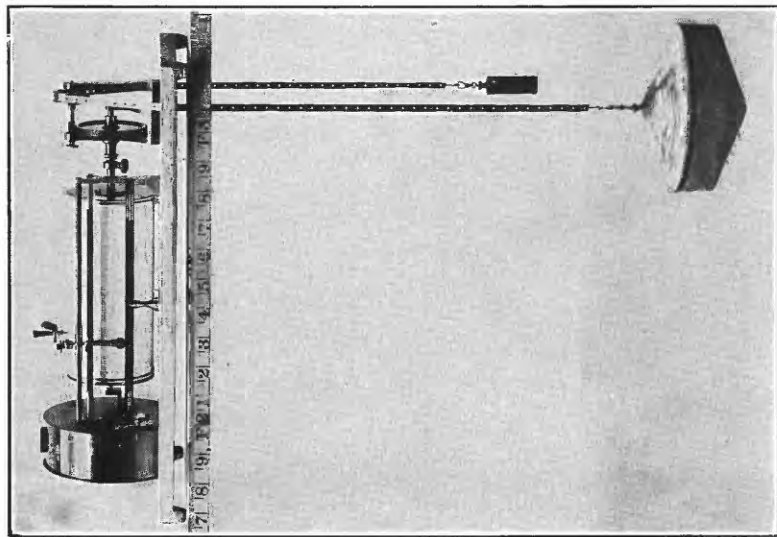
The “point of zero flow” for a given gaging station is that point on the gage—the gage height—to which the surface of the river falls when the discharge is reduced to zero.



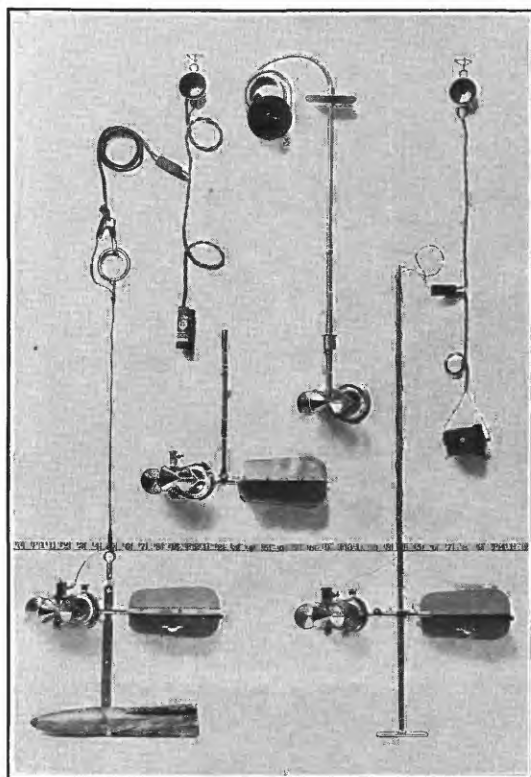
A. STEVENS CONTINUOUS.



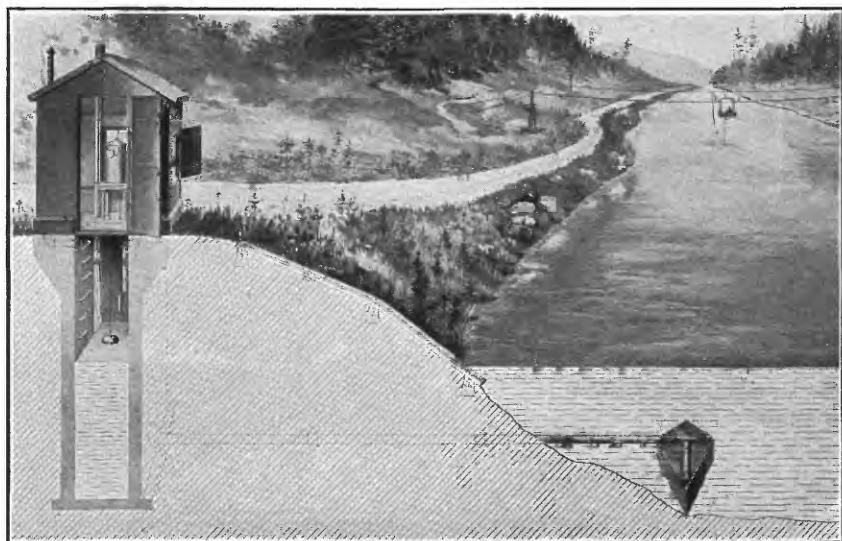
B. GURLEY PRINTING.  
WATER-STAGE RECORDERS.



C. FRIEZ.



A. PRICE CURRENT METERS.



B. TYPICAL GAGING STATION.

### EXPLANATION OF DATA.

The data presented in this report cover the year beginning October 1, 1917, and ending September 30, 1918. At the beginning of January in most parts of the United States much of the precipitation in the preceding three months is stored as ground water, in the form of snow or ice, or in ponds, lakes, and swamps, and this stored water passes off in the streams during the spring break-up. At the end of September, on the other hand, the only stored water available for run-off is possibly a small quantity in the ground; therefore the run-off for the year beginning October 1 is practically all derived from precipitation within that year.

The base data collected at gaging stations consist of records of stage, measurements of discharge, and general information used to supplement the gage heights and discharge measurements in determining the daily flow. The records of stage are obtained either from direct readings on a staff gage or from a water-stage recorder that gives a continuous record of the fluctuations. Measurements of discharge are made with a current meter. (See Pls. I, II.) The general methods are outlined in standard textbooks on the measurement of river discharge.

From the discharge measurements rating tables are prepared that give the discharge for any stage, and these rating tables, when applied to the gage heights, give the discharge from which the daily, monthly, and yearly means of discharge are determined.

The data presented for each gaging station in the area covered by this report comprise a description of the station, a table giving records of discharge measurements, a table showing the daily discharge of the stream, and a table of monthly and yearly discharge and run-off.

If the base data are insufficient to determine the daily discharge, tables giving daily gage height and records of discharge measurements are published.

The description of the station gives, in addition to statements regarding location and equipment, information in regard to any conditions that may affect the permanence of the stage-discharge relation, covering such subjects as the occurrence of ice, the use of the stream for log driving, shifting of control, and the cause and effect of backwater; it gives also information as to diversions that decrease the flow at the gage, artificial regulation, maximum and minimum recorded stages, and the accuracy of the records.

The table of daily discharge gives, in general, the discharge in second-feet corresponding to the mean of the gage heights read each day. At stations on streams subject to sudden or rapid diurnal fluctuations the discharge obtained from the rating table and the



mean daily gage height may not be the true mean discharge for the day. If such stations are equipped with water-stage recorders the mean daily discharge may be obtained by averaging discharge at regular intervals during the day or by using the discharge integrator, an instrument operating on the principle of the planimeter and containing as an essential element the rating curve of the station.

In the table of monthly discharge the column headed "Maximum" gives the mean flow for the day when the mean gage height was highest. As the gage height is the mean for the day it does not indicate correctly the stage when the water surface was at crest height and the corresponding discharge was consequently larger than given in the maximum column. Likewise, in the column headed "Minimum", the quantity given is the mean flow for the day when the mean gage height was lowest. The column headed "Mean" is the average flow in cubic feet per second during the month. On this average flow computations recorded in the remaining columns, which are defined on page 6, are based.

#### **ACCURACY OF FIELD DATA AND COMPUTED RECORDS.**

The accuracy of stream-flow data depends primarily (1) on the permanency of the stage-discharge relation and (2) on the accuracy of observation of stage, measurements of flow, and interpretation of records.

A paragraph in the description of the station gives information regarding the (1) permanence of the stage-discharge relation, (2) precision with which the discharge rating curve is defined, (3) refinement of gage readings, (4) frequency of gage readings, and (5) methods of applying daily gage height to the rating table to obtain the daily discharge.

For the rating tables "well defined" indicates, in general, that the rating is probably accurate within 5 per cent; "fairly well defined," within 10 per cent; "poorly defined," within 15 to 25 per cent. These notes are very general and are based on the plotting of the individual measurements with reference to the mean rating curve.

The monthly means for any station may represent with high accuracy the quantity of water flowing past the gage, but the figures showing discharge per square mile and depth of run-off in inches may be subject to gross errors caused by the inclusion of large non-contributing districts in the measured drainage area, by lack of information concerning water diverted for irrigation or other use, or by inability to interpret the effect of artificial regulation of the flow of the river above the station. "Second-feet per square mile" and "run-off (depth in inches)" are therefore not computed if such errors appear probable. The computations are also omitted for stations on streams draining areas in which the annual rainfall is less than 20

inches. All figures representing "second-feet per square mile" and "run-off (depth in inches)" previously published by the Survey should be used with caution because of possible inherent sources of error not known to the Survey.

The tables of monthly discharge give only a general idea of the flow at the station and should not be used for other than preliminary estimates; the tables of daily discharge allow more detailed studies of the variation in flow. It should be borne in mind, however, that the observations in each succeeding year may be expected to throw new light on data previously published.

### COOPERATION.

The United States Forest Service furnished winter readings on East Fork of Arkansas River and Tennessee Fork near Leadville, Colo. It also furnished the service of a hydrographer during the winter.

The United States Reclamation Service paid for the maintenance of the stations on Medicine Bluff Creek and Little Medicine Bluff Creek near Lawton and the evaporation station in Lawton reservoir, Okla.

In Kansas the work was done in coopération with the Kansas Water Commission, H. A. Rice, secretary, under terms of the water-commission act of the legislature of 1917 (Session laws of Kansas, 1917, chap. 172, p. 218), authorizing an investigation of the water resources of Kansas. The cooperative agreement with the commission was made May 11, 1917, and district headquarters were established June 1, 1917, in the Federal Building, Topeka.

### DIVISION OF WORK.

Data for stations in Colorado and Oklahoma were collected and prepared for publication under the direction of Robert Follansbee, assisted by S. B. Soulé, H. W. Fear, T. J. Watkins, P. V. Hodges, J. B. Spiegel, and Miss E. M. Dye.

Data for stations in Kansas were collected and prepared for publication by Roger C. Rice, district engineer, assisted by E. L. Grant and A. K. Gowans.

### GAGING-STATION RECORDS.

#### ARKANSAS RIVER BASIN.

##### EAST FORK OF ARKANSAS RIVER NEAR LEADVILLE, COLO.

LOCATION.—In sec. 16, T. 9 S., R. 80 W., at highway bridge 200 yards above mouth of Tennessee Fork, 3 miles northwest of Leadville, Lake County.

DRAINAGE AREA.—52 square miles (measured on topographic map).

RECORDS AVAILABLE.—April 25 to August 31, 1890; June 18 to October 11, 1903; June 5, 1911, to September 30, 1918.

**GAGE.**—Vertical staff on left bridge abutment, near upstream end; read by Fred Coquoz. No known relation between present gage and gages used prior to 1911.

**DISCHARGE MEASUREMENTS.**—Made from bridge or by wading.

**CHANNEL AND CONTROL.**—Bed composed of coarse gravel and small boulders. Control 30 feet downstream from gage; practically permanent during 1918. Banks low, subject to overflow at extreme high water.

**EXTREMES OF DISCHARGE.**—Maximum stage recorded during year, 1.95 feet at 8 a. m. June 12 (discharge, 680 second-feet); minimum discharge probably occurred during winter.

**ICE.**—Stage-discharge relation seriously affected by ice; observations discontinued during winter.

**DIVERSIONS.**—The Leadville Water Co. makes a continuous diversion of 2 second-feet from the East Fork above the station. During winter this diversion may be increased to 3 second-feet.

**REGULATION.**—None.

**ACCURACY.**—Stage-discharge relation permanent, except as affected by ice. Rating curve well defined below 300 second-feet. Gage read to hundredths twice daily. Owing to high altitude of drainage area (9,700 feet), alternate melting and freezing during certain seasons causes considerable diurnal fluctuation, and mean daily gage heights based on morning and evening readings may be somewhat in error. Daily discharge ascertained by applying mean daily gage height to rating table. Records good.

*Discharge measurements of East Fork of Arkansas River near Leadville, Colo., during the year ending Sept. 30, 1918.*

Date.	Made by—	Gage height.	Dis-charge.
		<i>Fect.</i>	<i>Sec.-ft.</i>
Oct. 20	S. B. Soulé.....	0.20	11.8
Jan. 18	do.....		5.4
May 20	Robert Pollansbee.....	.84	136

*Daily discharge, in second-feet, of East Fork of Arkansas River near Leadville, Colo., for the year ending Sept. 30, 1918.*

Day.	Oct.	May.	June.	July.	Aug.	Sept.	Day.	Oct.	May.	June.	July.	Aug.	Sept.
1....	6	.....	127	148	34	16	16....	6	.....	322	94	34	22
2....	5	.....	148	138	34	19	17....	5	.....	275	94	34	21
3....	5	.....	183	134	36	21	18....	6	.....	285	89	34	21
4....	5	.....	220	124	34	21	19....	9	.....	270	82	34	20
5....	5	.....	265	120	36	22	20....	12	148	255	82	31	17
6....	6	.....	322	124	36	20	21....	5	163	240	75	29	16
7....	6	.....	350	99	31	16	22....	6	134	270	60	28	16
8....	5	.....	415	120	28	20	23....	5	195	322	70	28	16
9....	5	.....	480	120	36	26	24....	5	225	350	70	26	16
10....	6	.....	512	120	42	42	25....	5	270	285	68	24	16
11....	8	.....	615	115	42	37	26....	6	285	205	66	21	14
12....	6	.....	650	107	42	33	27....	8	255	175	52	21	16
13....	5	.....	650	104	40	29	28....	6	275	159	47	20	16
14....	5	.....	580	99	37	28	29....	6	255	148	42	17	16
15....	6	.....	350	94	34	26	30....	5	255	155	42	16	16
							31....	5	187	.....	37	16	.....

*Monthly discharge of East Fork of Arkansas River near Leadville, Colo., for the year ending Sept. 30, 1918.*

Month.	Discharge in second-feet.			Run-off in acre-feet.
	Maximum.	Minimum.	Mean.	
October.....	12	5	5.9	363
May 20-31.....	285	134	221	5,260
June.....	650	127	319	19,000
July.....	148	37	91.5	5,630
August.....	42	16	30.8	1,890
September.....	42	14	21.2	1,260

#### ARKANSAS RIVER AT GRANITE, COLO.

**LOCATION.**—In sec. 31, T. 11 S., R. 79 W., at Granite, Lake County, below mouth of Lake Creek and above Lost Canyon and Clear creeks.

**DRAINAGE AREA.**—425 square miles.

**RECORDS AVAILABLE.**—May 1, 1897, to September 10, 1899; April 6, 1910, to September 30, 1918.

**GAGE.**—Bristol water-stage recorder of float type on right bank 200 feet below highway bridge at Granite. Prior to October 26, 1917, inclined gage located on left bank half a mile upstream. Relation between gages not determined.

**DISCHARGE MEASUREMENTS.**—Made from highway bridge near railroad station or by wading.

**CHANNEL AND CONTROL.**—Bed composed of coarse gravel and small boulders. Control not permanent. Banks not subject to overflow.

**EXTREMES OF DISCHARGE.**—Maximum mean daily stage during year, 4.67 feet June 11 (discharge, 2,630 second-feet); minimum discharge occurs during winter.

**ICE.**—Stage-discharge relation not seriously affected by ice.

**DIVERSIONS.**—There are court decrees for diversions of 90 second-feet from Arkansas River between this station and the junction of Tennessee and East forks.

**REGULATION.**—Discharge affected by operation of Twin Lakes reservoir, which has a storage decree for 54,450 acre-feet.

**COOPERATION.**—Complete records furnished by State engineer, who has maintained station since October, 1917.

*Discharge measurements of Arkansas River at Granite, Colo., during the year ending Sept. 30, 1918.*

Date.	Made by—	Gage height.	Dis-charge.	Date.	Made by—	Gage height.	Dis-charge.
		<i>Feet.</i>	<i>Sec.-ft.</i>			<i>Feet.</i>	<i>Sec.-ft.</i>
Oct. 23	S. B. Soulé.....	<sup>a</sup> 1.32	82	May 4	M. N. Grant, jr.....	1.95	228
Dec. 1	M. N. Grant, jr.....	<sup>b</sup> 1.32	74	May 9	.....do.....	2.67	668
Feb. 7	.....do.....	1.50	85	June 29	.....do.....	1.60	218
Mar. 3	.....do.....	1.50	73				

<sup>a</sup> Old gage read 1.54.

<sup>b</sup> Old gage read 1.60.

*Daily discharge, in second-feet, of Arkansas River at Granite, Colo., for the year ending Sept. 30, 1918.*

Day.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May.	June.	July	Aug.	Sept.
1.....	103	112	100	36	88	73	100	206	1,110	744	330	470
2.....	103	100	104	36	88	73	100	210	1,050	690	375	420
3.....	103	105	110	36	88	73	106	198	1,160	654	605	420
4.....	106	110	97	36	65	73	100	295	1,230	672	590	414
5.....	106	106	98	36	69	72	90	400	1,280	672	518	420
6.....	95	103	112	36	88	71	76	484	1,320	666	447	300
7.....	109	100	112	40	85	70	86	498	1,280	702	405	348
8.....	109	100	104	41	88	69	88	568	1,620	806	429	297
9.....	112	100	100	40	88	68	115	696	2,170	924	450	345
10.....	112	104	110	36	73	67	115	638	2,560	988	550	360
11.....	100	118	114	28	88	67	112	540	2,630	1,040	605	330
12.....	100	116	110	28	85	67	158	526	2,490	940	595	294
13.....	115	95	110	28	88	36	186	533	2,510	924	621	259
14.....	118	100	108	28	80	12	202	452	2,430	738	585	242
15.....	118	102	100	36	73	11	182	400	2,200	684	570	270
16.....	106	106	110	30	80	25	182	505	2,070	828	526	285
17.....	92	100	124	45	88	43	166	645	2,210	792	366	270
18.....	80	97	128	45	88	58	162	760	1,860	708	300	259
19.....	95	100	120	33	88	61	146	922	1,440	648	248	242
20.....	82	95	112	36	80	61	210	1,170	1,090	565	224	237
21.....	85	92	104	36	77	63	150	1,160	1,080	462	190	216
22.....	98	92	104	36	76	67	198	1,150	1,180	462	176	188
23.....	72	92	106	36	75	67	235	1,150	1,030	402	164	200
24.....	100	92	104	36	74	78	215	1,270	904	375	170	200
25.....	115	112	100	36	73	109	215	1,350	949	369	245	190
26.....	120	140	97	36	85	61	255	1,340	841	345	285	190
27.....	120	134	94	36	81	56	250	1,120	904	339	282	186
28.....	130	108	90	40	73	100	198	1,170	931	360	300	182
29.....	110	104	87	65	-----	78	194	1,160	877	336	458	174
30.....	112	104	84	88	-----	100	182	1,110	814	342	482	182
31.....	110	-----	81	80	-----	100	-----	1,180	-----	336	470	-----

NOTE.—Stage-discharge relation affected by ice Jan. 1 to Mar. 11; discharge based on discharge measurements and comparison with records for Salida.

*Monthly discharge of Arkansas River at Granite, Colo., for the year ending Sept. 30, 1918.*

Month.	Discharge in second-feet.			Run-off in acre-feet.
	Maximum.	Minimum.	Mean.	
October.....	130	72	104	6,400
November.....	140	92	105	6,250
December.....	128	81	104	6,400
January.....	88	28	40.1	2,470
February.....	88	65	81.1	4,500
March.....	109	11	65.5	4,030
April.....	255	76	159	9,460
May.....	1,350	198	768	47,200
June.....	2,630	814	1,510	89,800
July.....	1,040	336	629	38,700
August.....	621	164	405	24,900
September.....	470	174	280	16,700
The year.....	2,630	11	355	257,000

#### ARKANSAS RIVER AT SALIDA, COLO.

LOCATION.—In sec. 32, T. 50 N., R. 9 E., at Salida, Chaffee County, some distance above mouth of South Fork of Arkansas River, nearest large tributary.

DRAINAGE AREA.—1,160 square miles.

RECORDS AVAILABLE.—April 11, 1895, to October 31, 1903; November 3, 1909, to September 30, 1918.

GAGE.—Bristol water-stage recorder on right bank 400 feet below highway bridge in City Park; installed by State engineer.

DISCHARGE MEASUREMENTS.—Made from highway bridge.

CHANNEL AND CONTROL.—Bed composed of coarse gravel; shifts at intervals. No well-defined control. Banks high and not subject to overflow.

EXTREMES OF DISCHARGE.—Maximum mean daily stage recorded during year, 6.2 feet June 13 and 14 (discharge, 4,840 second-feet); minimum mean daily stage, 0.3 foot February 3, 4, 15, and 16 (discharge, 178 second-feet).

ICE.—Stage-discharge relation not affected by ice, as river is kept open by springs.

DIVERSIONS.—There are court decrees for diversions of 154 second-feet from the Arkansas between this station and Granite.

REGULATION.—Flow at station regulated to some extent by Twin Lakes and Clear Creek reservoirs, which have storage decrees for 54,450 and 11,500 acre-feet, respectively.

COOPERATION.—Complete records furnished by State engineer, who has maintained station since October, 1917.

*Discharge measurements of Arkansas River at Salida, Colo., during the year ending Sept. 30, 1918.*

[Made by M. N. Grant, jr.]

Date.	Gage height.	Discharge.	Date.	Gage height.	Discharge.
	<i>Feet.</i>	<i>Sec.ft.</i>		<i>Feet.</i>	<i>Sec.ft.</i>
Feb. 8.....	0.40	200	June 28.....	4.10	2,660
May 8.....	1.85	844	Sept. 20.....	1.40	502

*Daily discharge, in second-feet, of Arkansas River at Salida, Colo., for the year ending Sept. 30, 1918.*

Day.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.
1.....	270	305	270	212	188	198	266	320	1,580	1,980	650	820
2.....	270	305	270	209	188	198	266	320	1,380	1,620	650	820
3.....	270	305	255	206	178	242	266	320	1,540	1,620	700	650
4.....	270	305	240	203	178	220	242	350	1,840	1,620	1,090	650
5.....	255	305	202	200	220	242	242	335	2,180	1,710	1,090	820
6.....	240	305	218	198	198	242	242	470	2,330	1,540	950	820
7.....	246	305	235	198	198	242	242	600	2,630	1,540	760	650
8.....	255	305	252	198	198	242	242	650	2,880	1,620	760	650
9.....	240	270	270	198	198	220	220	790	3,300	1,983	880	650
10.....	240	305	270	198	188	198	242	760	3,740	1,890	880	650
11.....	240	305	270	198	198	198	266	675	3,850	1,890	1,230	950
12.....	240	305	270	198	198	198	266	650	4,070	1,890	1,160	950
13.....	240	305	270	198	198	198	292	575	4,840	1,890	1,160	700
14.....	235	270	270	198	198	198	350	530	4,840	1,620	1,160	650
15.....	228	305	270	198	178	198	320	490	4,620	1,300	1,160	650
16.....	228	305	270	198	178	198	266	550	4,620	1,540	1,160	650
17.....	228	270	255	198	188	198	266	730	4,840	1,380	700	650
18.....	228	270	240	198	198	198	266	950	4,620	1,380	650	600
19.....	228	270	240	198	198	220	266	1,020	4,070	1,300	550	575
20.....	215	270	240	198	198	242	266	1,300	4,070	1,160	470	550
21.....	235	270	240	188	198	242	266	1,420	4,460	1,160	470	530
22.....	240	270	240	188	198	242	266	1,380	4,840	950	470	470
23.....	240	270	240	188	220	242	320	1,460	3,520	950	430	470
24.....	240	270	215	188	220	266	320	1,620	2,980	760	430	470
25.....	240	270	215	188	198	292	320	1,800	2,780	760	430	490
26.....	255	270	215	188	198	292	320	1,890	2,580	700	430	470
27.....	270	270	215	188	198	320	320	1,710	2,580	600	430	470
28.....	270	270	215	188	198	350	350	1,670	2,530	550	550	450
29.....	270	270	215	188	.....	266	350	1,710	2,490	510	550	430
30.....	270	270	215	188	.....	242	320	1,760	2,180	650	650	390
31.....	288	.....	215	188	.....	266	.....	1,670	.....	650	820	.....

*Monthly discharge of Arkansas River at Salida, Colo., for the year ending Sept. 30, 1918.*

Month.	Discharge in second-feet.			Run-off in acre-feet.
	Maximum.	Minimum.	Mean.	
October.....	270	215	248	15, 200
November.....	305	270	286	17, 000
December.....	270	202	242	14, 900
January.....	212	188	196	12, 100
February.....	220	178	196	10, 900
March.....	350	198	236	14, 500
April.....	350	220	282	16, 800
May.....	1, 890	320	985	60, 600
June.....	4, 840	1, 380	3, 290	196, 000
July.....	1, 980	510	1, 310	80, 600
August.....	1, 230	430	761	46, 800
September.....	950	390	625	37, 200
The year.....	4, 840	178	722	523, 000

**TENNESSEE FORK NEAR LEADVILLE, COLO.**

**LOCATION.**—In sec. 16, T. 9 S., R. 80 W., at highway bridge a few hundred yards above mouth of stream and 3 miles northwest of Leadville, Lake County.

**DRAINAGE AREA.**—45 square miles (measured on topographic map).

**RECORDS AVAILABLE.**—May 10 to October 31, 1890; June 18 to October 16, 1903; February 8, 1911, to September 30, 1918.

**GAGE.**—Vertical staff on downstream side of left bridge abutment; datum lowered 0.40 foot October 6, 1914; read by Fred Coquoz. No known relation between present gage and gages used in 1890 and 1903.

**DISCHARGE MEASUREMENTS.**—Made from bridge or by wading.

**CHANNEL AND CONTROL.**—Bed rough and composed of small boulders. Control at rapids a short distance below gage; practically permanent. Banks subject to overflow during extremely high water.

**EXTREMES OF DISCHARGE.**—Maximum stage recorded during year, 2.05 feet at 8 a. m. June 14 (discharge, 450 second-feet); minimum stage, 0.10 foot during latter part of October and first of November (discharge, 1 second-foot).

**ICE.**—Stage-discharge relation seriously affected by ice.

**DIVERSIONS.**—There are court decrees for diversions of 24 second-feet above station; also for diversion of 18.5 second-feet from the basin of Eagle River through Ewing ditch to basin of Tennessee Fork above station. During 1918, 2,210 acre-feet were diverted from Eagle River basin.

**REGULATION.**—None.

**ACCURACY.**—Stage-discharge relation permanent except as affected by ice. Rating curve well defined between 10 and 240 second-feet. Gage read to hundredths twice daily. Owing to high altitude of drainage basin (9,700 feet), alternate melting and freezing at certain seasons causes considerable diurnal fluctuation, and mean daily gage heights based on morning and evening readings may be somewhat in error. Daily discharge ascertained by applying mean daily gage height to rating table. Records good.

*Discharge measurements of Tennessee Fork near Leadville, Colo., during the year ending Sept. 30, 1918.*

Date.	Made by—	Gage height.	Dis-charge.	Date.	Made by—	Gage height.	Dis-charge.
		<i>Feet.</i>	<i>Sec.-ft.</i>			<i>Feet.</i>	<i>Sec.-ft.</i>
Oct. 20	S. B. Soulé.....	0.38	3.7	Feb. 26	T. J. Watkins.....	0.40	10.9
Jan. 18	.....do.....	a .49	5.9	May 20	Robert Follansbee.....	1.32	200

\* Stage-discharge relation affected by ice.

*Daily discharge, in second-feet, of Tennessee Fork near Leadville, Colo., for the year ending Sept. 30, 1918.*

Day.	Oct.	May.	June.	July.	Aug.	Sept.	Day.	Oct.	May.	June.	July.	Aug.	Sept.
1....	5.0	.....	194	86	23	6.2	16....	2.3	.....	395	45	15	12
2....	5.0	.....	194	84	21	8.0	17....	2.0	.....	395	46	15	11
3....	5.0	.....	209	84	19	8.0	18....	2.0	.....	378	56	15	11
4....	5.6	.....	256	77	19	9.8	19....	2.0	.....	360	56	15	11
5....	4.4	.....	256	70	19	10	20....	2.0	224	360	46	13	9.8
6....	3.5	.....	290	66	17	10	21....	2.0	224	342	46	13	9.8
7....	4.4	.....	290	77	15	8.0	22....	2.0	209	308	46	11	8.0
8....	5.0	.....	308	98	15	9.8	23....	1.8	256	325	46	11	8.0
9....	3.8	.....	360	77	19	11	24....	1.8	256	290	46	11	8.6
10....	4.4	.....	360	66	19	33	25....	1.4	273	256	43	11	11
11....	5.0	.....	360	66	19	33	26....	1.0	273	256	38	9.8	11
12....	5.0	.....	395	66	19	24	27....	1.0	273	256	36	8.6	11
13....	4.4	.....	395	62	19	19	28....	1.0	240	224	32	8.0	11
14....	2.6	.....	412	56	17	15	29....	1.0	240	194	29	8.0	11
15....	2.6	.....	325	56	15	14	30....	1.0	224	88	26	7.4	11
							31....	1.0	194	.....	24	6.2	.....

*Monthly discharge of Tennessee Fork near Leadville, Colo., for the year ending Sept. 30, 1918.*

Month.	Discharge in second-feet.			Run-off in acre-feet.
	Maximum.	Minimum.	Mean.	
October.....	5.6	1.0	2.94	181
November.....	.....	.....	4.5	265
December.....	.....	.....	4.5	277
January.....	.....	.....	5.0	307
February.....	.....	.....	10.0	555
March.....	.....	.....	12.0	738
May 20-31.....	273	194	240	5,710
June.....	412	88	301	17,900
July.....	98	24	56.5	3,470
August.....	23	6.2	14.6	898
September.....	33	6.2	12.5	744

NOTE.—Discharge from November to March estimated from discharge measurements, gage heights, and temperature records.



**COTTONWOOD CREEK BELOW HOT SPRINGS, NEAR BUENA VISTA, COLO.**

**LOCATION.**—In sec. 22, T. 14 S., R. 79 W., half a mile below old Hot Springs Hotel and 6 miles west of Buena Vista, Chaffee County. Nearest tributary, South Fork, enters 2 miles above.

**DRAINAGE AREA.**—69 square miles (revised measurement on Hayden atlas).

**RECORDS AVAILABLE.**—April 7, 1911, to September 30, 1918. From September 23, 1910, to September 13, 1911, a station was maintained in sec. 21, a mile above present site. Discharge at the two sites comparable.

**GAGE.**—Vertical staff; read by E. D. Masters. On February 19, 1915, gage was moved from side of left abutment to downstream end and reset to same datum. In present position water does not pile up on gage, especially during high water, and therefore for same discharge gage height will be less.

**DISCHARGE MEASUREMENTS.**—Made from bridge or by wading.

**CHANNEL AND CONTROL.**—Bed composed of boulders; very rough. Control, a short distance below gage; shifted during 1918. Banks high; probably not subject to overflow.

**EXTREMES OF DISCHARGE.**—Maximum stage recorded during year, 2 feet at 6 a. m. June 9 and 10 (discharge, 467 second-feet); minimum stage recorded, 0.35 foot at 7 a. m. March 23 (discharge, 12 second-feet).

**ICE.**—Stage-discharge relation not affected by ice; hot springs keep creek open.

**DIVERSIONS.**—There are court decrees for diversions of 148 second-feet from Cottonwood Creek, of which 28 second-feet are above gaging station.

**REGULATION.**—None.

**ACCURACY.**—Stage-discharge relation not permanent; shifting during high water.

Rating curve used October 1 to June 5 fairly well defined between 20 and 350 second-feet; curve used June 25 to September 30 well defined between 40 and 250 second-feet. Gage read to hundredths twice daily. Owing to high altitude of drainage area, alternate melting and freezing at certain seasons causes considerable diurnal fluctuation, and mean daily gage heights based on morning and evening readings may be somewhat in error. Daily discharge ascertained by applying mean daily gage height to rating table; shifting-control method used June 6–24. Records good except during high water, for which they are fair.

*Discharge measurements of Cottonwood Creek below Hot Springs, near Buena Vista, Colo., during the year ending Sept. 30, 1918.*

Date.	Made by—	Gage height.	Dis-charge.	Date.	Made by—	Gage height.	Dis-charge.
		<i>Feet.</i>	<i>Sec.-ft.</i>			<i>Feet.</i>	<i>Sec.-ft.</i>
Oct. 1...	H. W. Fear.....	0.78	39.1	June 25..	Robert Follansbee.....	1.55	210
Jan. 17..	S. B. Soule.....	.54	20.9	Aug. 3..	J. B. Spiegel.....	.75	44.0
June 13..	Robert Follansbee.....	1.72	363				

*Daily discharge, in second-feet, of Cottonwood Creek below Hot Springs, near Buena Vista, Colo., for the year ending Sept. 30, 1918.*

Day.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.
1.....	37	26	25	24	20	18	20	22	92	134	41	30
2.....	39	28	26	24	21	18	19	26	87	129	39	32
3.....	39	28	25	24	21	19	18	26	143	122	39	32
4.....	35	30	22	24	20	19	19	33	172	110	39	25
5.....	33	30	32	24	21	19	18	35	236	106	39	41
6.....	33	31	25	22	21	19	17	44	263	106	39	49
7.....	33	32	22	22	20	20	17	50	283	122	41	41
8.....	32	27	22	22	20	20	18	50	348	106	38	40
9.....	32	26	25	23	18	16	18	50	417	100	35	44
10.....	32	25	25	22	19	18	19	50	442	100	39	81
11.....	32	25	24	21	20	19	19	38	442	93	50	86
12.....	33	26	24	20	18	19	19	35	417	89	50	70
13.....	35	27	24	23	19	20	20	35	417	89	54	60
14.....	32	26	24	23	19	18	20	47	370	81	58	58
15.....	32	28	25	23	19	18	20	54	370	89	44	54
16.....	31	26	24	23	19	18	19	71	325	86	38	53
17.....	30	25	24	23	20	16	19	78	317	76	35	50
18.....	26	24	24	23	19	17	19	82	287	70	30	48
19.....	25	24	24	23	19	18	17	82	267	66	30	44
20.....	32	26	24	23	19	18	17	107	251	66	30	43
21.....	31	26	23	23	19	19	17	82	224	66	34	41
22.....	29	26	22	22	20	18	18	82	255	60	24	41
23.....	31	26	23	21	20	18	18	107	228	60	30	43
24.....	29	25	23	21	19	18	19	123	228	63	30	44
25.....	28	26	22	22	20	18	20	130	207	73	30	44
26.....	29	26	22	22	19	18	24	107	192	58	29	48
27.....	26	22	22	21	19	19	23	118	162	53	29	43
28.....	28	24	22	21	18	18	19	130	140	50	28	39
29.....	22	25	22	21	.....	19	19	123	134	47	27	38
30.....	28	26	22	21	.....	19	20	118	134	44	27	37
31.....	27	.....	22	21	.....	19	.....	100	.....	41	27	.....

*Monthly discharge of Cottonwood Creek below Hot Springs, near Buena Vista, Colo., for the year ending Sept. 30, 1918.*

Month.	Discharge in second-feet.			Run-off in acre-feet.
	Maximum.	Minimum.	Mean.	
October.....	39	22	31.0	1,910
November.....	32	22	26.4	1,570
December.....	32	22	23.7	1,460
January.....	24	20	22.3	1,370
February.....	21	13	19.5	1,080
March.....	20	16	18.4	1,130
April.....	24	17	19.0	1,130
May.....	130	22	72.1	4,430
June.....	442	87	262	15,600
July.....	134	41	82.4	5,070
August.....	58	27	36.5	2,240
September.....	86	30	47.0	2,800
The year.....	442	16	54.9	39,800

# **CHALK CREEK (UPPER STATION) NEAR ST. ELMO, COLO.**

**LOCATION.**—In sec. 27, T. 15 S., R. 80 W., a quarter of a mile below power plant of Tin Cup Gold Dredging Co. and  $1\frac{1}{4}$  miles below St. Elmo, Chaffee County.

Nearest tributary, Coal Creek, enters a quarter of a mile below.

**DRAINAGE AREA.**—48 square miles (measured on Forest atlas).

**RECORDS AVAILABLE.**—November 15, 1913, to September 30, 1918.

**GAGE.**—Friez water-stage recorder on left bank.

**DISCHARGE MEASUREMENTS.**—Made from footbridge near gage or by wading.

**CHANNEL AND CONTROL.**—Bed composed of coarse gravel. Control at small rapids a short distance below gage; permanent during 1918. Banks not subject to overflow.

**EXTREMES OF DISCHARGE.**—Maximum stage recorded during year, 3.4 feet at 8 p. m. June 10 (discharge, 575 second-feet); minimum discharge occurred during winter.

**ICE.**—Stage-discharge relation not seriously affected by ice except for occasional short periods; observations discontinued during winter.

**DIVERSIONS.**—There are no court decrees for diversions of water that is not returned to the stream above the station. Below there are decrees for diversions of 133 second-feet from Chalk Creek.

**REGULATION.**—Low-water flow regulated to a certain extent by a small reservoir at St. Elmo, formed by the diversion dam for Tin Cup Gold Dredging Co.'s power house; not used during 1918.

**ACCURACY.**—Stage-discharge relation permanent. Rating curve well defined between 10 and 300 second-feet. Operation of water-stage recorder satisfactory. Daily discharge ascertained by applying to rating table mean daily gage height determined by inspecting recorder graph. Records excellent.

*Discharge measurements of Chalk Creek (upper station) near St. Elmo, Colo., during the year ending Sept. 30, 1918.*

Date.	Made by—	Gage height.	Dis-charge.
Oct. 1...	H. W. Fear.....	<i>Fed.</i> 1.11	<i>Sec.-ft.</i> 20.2
May 21..	Robert Follansbee.....	1.90	132

*Daily discharge, in second-feet, of Chalk Creek (upper station) near St. Elmo, Colo., for the year ending Sept. 30, 1918.*

Day.	Oct.	Nov.	Dec.	Apr.	May.	June.	July.	Aug.	Sept.
1.....	19	13	11	.....	27	140	104	31	26
2.....	20	13	12	.....	28	170	98	31	25
3.....	19	13	13	.....	37	245	96	31	26
4.....	17	14	13	.....	49	281	94	34	31
5.....	16	15	12	.....	61	320	90	31	36
6.....	16	16	12	.....	77	350	90	31	40
7.....	18	13	12	.....	82	359	113	32	35
8.....	16	13	11	.....	77	341	108	28	30
9.....	16	13	.....	12	77	374	100	27	39
10.....	15	12	.....	11	70	413	90	30	75
11.....	15	12	.....	10	57	410	86	31	62
12.....	15	13	.....	12	54	419	77	27	58
13.....	14	12	.....	12	65	395	77	31	54
14.....	14	12	.....	12	98	320	72	39	53
15.....	14	12	.....	11	128	335	73	36	50
16.....	14	12	.....	11	158	350	84	30	46
17.....	14	13	.....	14	164	311	75	27	42
18.....	12	11	.....	14	150	269	64	26	40
19.....	12	11	.....	14	200	251	61	24	39
20.....	14	11	.....	16	185	242	65	26	37
21.....	15	11	.....	18	145	260	57	48	36
22.....	15	11	.....	12	155	317	62	34	35
23.....	13	11	.....	13	215	263	79	31	37
24.....	14	11	.....	14	251	239	70	28	42
25.....	13	10	.....	18	236	212	77	28	41
26.....	13	11	.....	20	209	188	57	27	41
27.....	15	11	.....	17	212	167	47	26	37
28.....	12	12	.....	21	230	145	37	27	34
29.....	12	10	.....	20	245	130	36	28	31
30.....	13	10	.....	25	206	116	34	24	30
31.....	14	.....	.....	.....	158	.....	33	24	.....

*Monthly discharge of Chalk Creek (upper station) near St. Elmo, Colo., for the year ending Sept. 30, 1918.*

Month.	Discharge in second-feet.			Run-off in acre-feet.
	Maximum	Minimum.	Mean.	
October.....	20	12	14.8	910
November.....	16	10	12.1	720
December 1-8.....	13	11	12.0	190
April 9-30.....	25	10	14.9	650
May.....	251	27	132	8,120
June.....	419	116	278	16,500
July.....	113	33	74.4	4,570
August.....	48	24	29.9	1,840
September.....	75	25	40.3	2,400

#### SOUTH FORK OF ARKANSAS RIVER AT PONCHA, COLO.

**LOCATION.**—In sec. 10, T. 49 N., R. 8 E., at single-span highway bridge half a mile from Poncha, Chaffee County. Nearest tributary, Poncha Creek, enters a quarter of a mile below.

**DRAINAGE AREA.**—140 square miles (measured on Forest atlas).

**RECORDS AVAILABLE.**—January 14, 1911, to April 30, 1918, when station was discontinued.

**GAGE.**—Vertical staff on left bridge abutment; read by Winne Holman. Datum lowered 1.00 foot August 19, 1914.

**DISCHARGE MEASUREMENTS.**—Made from bridge or by wading.

**CHANNEL AND CONTROL.**—Bed composed of coarse gravel and small boulders; rough. Control at small rapids 20 feet below gage. Banks not subject to overflow.

**EXTREMES OF DISCHARGE.**—Maximum mean daily stage during period, 1.72 feet December 24 (discharge, 50 second-feet); minimum mean daily stage, 0.89 foot April 22, 24, and 26 (discharge, 1.3 second-feet).

**ICE.**—Stage-discharge relation only slightly affected by ice, as river is kept open by springs.

**DIVERSIONS.**—There are court decrees for diversions of 136 second-feet from the South Fork above station, and 60 second-feet below.

**REGULATION.**—None.

**ACCURACY.**—Stage-discharge relation practically permanent. Rating curve well defined between 3 and 30 second-feet. Gage read to hundredths twice daily. Daily discharge ascertained by applying mean daily gage height to rating table. Records good.

*Discharge measurements of South Fork of Arkansas River at Poncha, Colo., during the year ending Sept. 30, 1918.*

Date.	Made by—	Gage height.	Discharge.
		Feet.	Sec.-ft.
Oct. 2	H. W. Fear.....	1.00	3.4
Feb. 8	M. N. Grant, Jr.....	1.50	32.2
Mar. 4	.....do.....	1.48	27.6

*Daily discharge, in second-feet, of South Fork of Arkansas River at Poncha, Colo., for the year ending Sept. 30, 1918.*

Day.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.
1.....	4.5	18	44	43	28	32	7.0
2.....	3.4	20	36	42	39	33	7.0
3.....	3.4	18	47	44	38	36	8.0
4.....	3.4	15	47	34	37	31	6.3
5.....	3.0	12	43	36	37	33	6.6
6.....	3.8	13	42	33	30	37	5.2
7.....	3.2	14	44	34	41	34	9.0
8.....	3.2	11	42	44	33	33	4.5
9.....	2.6	15	43	37	34	28	4.1
10.....	2.8	11	43	35	37	31	4.5
11.....	2.4	16	43	33	35	32	3.8
12.....	2.8	10	39	36	38	34	3.4
13.....	3.4	12	39	36	33	35	3.8
14.....	3.4	15	39	30	30	33	3.4
15.....	3.4	25	47	32	33	30	3.8
16.....	5.9	24	44	30	38	28	1.4
17.....	7.0	21	35	30	27	27	2.2
18.....	3.4	21	44	36	27	25	2.4
19.....	3.2	25	39	34	31	11	1.8
20.....	6.3	27	44	34	38	17	2.6
21.....	12.0	23	46	30	37	12	1.8
22.....	9.0	23	44	30	36	11	1.3
23.....	8.0	23	46	30	38	11	1.4
24.....	7.0	20	50	34	34	15	1.3
25.....	8.0	20	46	37	33	11	1.4
26.....	6.3	15	44	39	31	13	1.3
27.....	9.0	16	38	37	34	15	1.4
28.....	11.0	17	42	34	41	10	1.4
29.....	8.0	21	38	36	.....	9.0	1.4
30.....	20.0	43	39	35	.....	8.0	3.4
31.....	18.0	.....	43	34	.....	10	.....

*Monthly discharge of South Fork of Arkansas River at Poncha, Colo., for the year ending Sept. 30, 1918.*

Month.	Discharge in second-feet.			Run-off in acre-feet.
	Maximum.	Minimum.	Mean.	
October.....	20	2.4	6.15	378
November.....	43	10	18.8	1,120
December.....	50	35	42.6	2,620
January.....	44	30	35.1	2,160
February.....	41	27	34.6	1,920
March.....	37	8.0	23.4	1,440
April.....	9.0	1.3	3.56	212

#### PONCHA CREEK AT PONCHA, COLO.

**LOCATION.**—In sec. 10, T. 49 N., R. 8 E., at single-span highway bridge on outskirts of Poncha, Chaffee County, a quarter of a mile above mouth of creek.

**DRAINAGE AREA.**—56 square miles (revised measurement on Hayden atlas).

**RECORDS AVAILABLE.**—January 14, 1911, to April 30, 1918, when station was discontinued.

**GAGE.**—Vertical staff on downstream side of left abutment; read by Winne Holman: Gage originally 20 feet upstream on opposite bank; moved to present site on May 6, 1914, and datum lowered 1.00 foot.

**DISCHARGE MEASUREMENTS.**—Made from bridge or by wading..

**CHANNEL AND CONTROL.**—Bed composed of coarse gravel which shifts slightly. No well-defined control. Banks are overflowed to small extent during extremely high water

**EXTREMES OF DISCHARGE.**—Maximum mean daily stage, 1.64 feet April 27 (discharge, 23 second-feet); minimum mean daily stage, 0.9 foot April 28 and 29 (discharge, 1.0 second-foot).

**ICE.**—Stage-discharge relation only slightly affected by ice, as creek is kept open by springs.

**DIVERSIONS.**—There are court decrees for diversions of 7 second-feet above station, but none below.

**REGULATION.**—None.

**ACCURACY.**—Stage-discharge relation shifting. Standard rating curve well defined. Gage read to hundredths twice daily. Daily discharge ascertained by applying mean daily gage height to rating table; shifting-control method used December 11 to April 20. Records good.

*Discharge measurements of Poncha Creek at Poncha, Colo., during the year ending Sept. 30, 1918.*

Date.	Made by—	Gage height.	Dis-charge.
		<i>Feet.</i>	<i>Sec.-ft.</i>
Oct. 2	H. W. Fear.....	1.32	8.2
Feb. 8	M. N. Grant, jr.....	1.35	6.1
Mar. 4	.....do.....	1.38	7.6

*Daily discharge, in second-feet, of Poncha Creek at Poncha, Colo., for the year ending Sept. 30, 1918.*

Day.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.
1.....	10	6	10	11	8	10	15
2.....	12	6	10	11	7	7	15
3.....	12	5	12	11	6	7	15
4.....	11	4	12	8	6	7	17
5.....	8	3	8	9	6	8	18
6.....	8	3	5	7	6	8	20
7.....	8	9	6	8	8	7	18
8.....	8	5	5	5	7	8	15
9.....	7	6	5	5	7	10	18
10.....	7	6	5	5	7	6	16
11.....	6	4	6	10	6	9	20
12.....	6	4	7	18	7	9	21
13.....	6	5	6	10	7	10	20
14.....	6	8	6	8	7	6	20
15.....	5	9	10	8	7	6	17
16.....	6	6	8	8	6	5	16
17.....	6	6	9	7	6	6	8
18.....	2	6	12	6	7	4	6
19.....	4	7	11	6	7	6	12
20.....	6	8	14	7	7	5	12
21.....	7	10	14	9	7	7	14
22.....	6	9	11	6	6	8	13
23.....	6	5	12	6	7	8	14
24.....	5	8	10	8	9	5	9
25.....	5	7	12	8	7	7	15
26.....	4	10	10	8	6	16	20
27.....	4	11	10	7	7	15	23
28.....	5	11	12	6	6	16	1
29.....	4	11	12	7	.....	14	1
30.....	5	10	12	7	.....	15	2
31.....	6	.....	8	7	.....	14	.....

*Monthly discharge of Poncha Creek at Poncha, Colo., for the year ending Sept. 30, 1918.*

Month.	Discharge in second-feet.			Run-off in acre-feet.
	Maximum.	Minimum.	Mean.	
October.....	12	2	6.5	400
November.....	11	3	6.9	411
December.....	14	5	9.4	578
January.....	18	5	8.0	492
February.....	9	6	6.8	378
March.....	16	4	8.7	535
April.....	23	1	14.4	857

**WEST BEAVER CREEK NEAR VICTOR, COLO.**

**LOCATION.**—In sec. 30, T. 16 S., R. 68 W., Fremont County, at Skaguay power station of Arkansas Valley Railway, Light & Power Co., 7 miles southeast of Victor.

**DRAINAGE AREA.**—70 square miles.

**RECORDS AVAILABLE.**—January 1, 1905, to September 30, 1918.

**DETERMINATION OF DISCHARGE.**—Water used through power house is brought by pipe line from reservoir  $3\frac{1}{2}$  miles upstream; quantity measured hourly by weir, and a quantity representing the gain or loss in the reservoir during the period is added or subtracted. To determine the natural flow of the stream the seepage through the dam is measured by weir and added to the total quantity thus obtained. This method takes no account of evaporation from the surface of the reservoir.

**DIVERSIONS.**—Above the power reservoir are three reservoirs from which the town of Victor obtains its municipal supply. In the upper basin are four reservoirs from which water is diverted into Lake Moraine, and thence by natural channels to Colorado Springs, where it is used as municipal supply. Filings on these diversions from the basin—52 second-feet by ditch and 5 second-feet by pipe line—have not yet been adjudicated. Below the power plant, adjudicated decrees for diversions of 126 second-feet from Beaver Creek, which is formed by East and West Beaver creeks. In addition, there is an irrigation reservoir in operation which has a filing for 4,760 acre-feet.

**COOPERATION.**—Records are furnished through courtesy of Arkansas Valley Railway, Light & Power Co., and are probably correct within 5 per cent.

*Monthly discharge of West Beaver Creek, near Victor, Colo., for the year ending Sept. 30, 1918.*

Month.	Mean discharge in second-feet.	Run-off in acre-feet.	Month	Mean discharge in second-feet	Run-off in acre-feet
October.....	9.79	602	May.....	16.1	990
November.....	5.68	338	June.....	16.5	982
December.....	4.83	297	July.....	49.8	3,060
January.....	4.27	263	August.....	30.6	1,880
February.....	2.72	151	September.....	17.6	1,050
March.....	7.48	460	The year.....		10,700
April.....	11.3	672			

**BOEHMER CREEK NEAR PIKES PEAK, COLO.**

**LOCATION.**—In NW.  $\frac{1}{4}$  sec. 32, T. 14 S., R. 68 W.,  $3\frac{1}{2}$  miles south of Pikes Peak, El Paso County, above Little Beaver and Sackett creeks. Elevation of station, 11,000 feet.

**DRAINAGE AREA.**—7.2 square miles (measured on topographic map). About 75 per cent of this area is above timber line. To the natural drainage has been added that of West Beaver Creek above Strickler tunnel intake.

**RECORDS AVAILABLE.**—October 1, 1909, to September 30, 1918.

**DETERMINATION OF DISCHARGE.**—Flow measured by sharp-crested weir, 60 inches long, with complete end contraction. A stake is driven into bed of stream in pool above weir, so that its head is level with crest of weir; depth of water over stake is measured by steel scale. Discharge is computed by Francis formula.

**REGULATION.**—Flow regulated by series of three reservoirs having an aggregate capacity of 1,400 acre-feet; reservoirs operated by Colorado Springs water department.

**DIVERSIONS.**—Water diverted above weir for use in Victor is measured and added to flow over Boehmer Creek weir to show total run-off.

**COOPERATION.**—Monthly discharge computed from records furnished by Colorado Springs water department.

*Monthly discharge of Boehmer Creek near Pikes Peak, Colo., for the year ending Sept. 30, 1918.*

[Drainage area, 7.2 square miles.] •

Month.	Discharge in second-feet.				Run-off.	
	Maximum.	Minimum.	Mean.	Per square mile.	Inches.	Acre-feet.
October.....	10.5	1.58	3.56	0.494	0.57	219
November.....	18.7	.92	7.06	.981	1.09	420
December.....	.92	.55	.73	.101	.12	44.9
January.....	.55	.55	.55	.076	.09	33.8
February.....	.55	.55	.55	.076	.08	30.6
March.....	.64	.55	.55	.076	.09	33.8
April.....	.73	.64	.70	.097	.11	41.7
May.....	19.6	.73	8.05	1.12	1.29	495
June.....	10.8	3.20	5.72	.794	.89	340
July.....	18.2	6.96	13.0	1.81	2.09	799
August.....	18.1	8.80	12.0	1.67	1.92	738
September.....	8.80	3.20	5.95	.826	.92	354
The year.....	19.6	.55	4.90	.682	9.26	3,559

#### LITTLE BEAVER CREEK NEAR PIKES PEAK, COLO.

**LOCATION.**—In NW.  $\frac{1}{4}$  NW.  $\frac{1}{4}$  sec. 32, T. 14 S., R. 68 W., just above mouth of creek and  $3\frac{1}{2}$  miles south of Pikes Peak, El Paso County. Little Beaver Creek enters Boehmer Creek from west 0.3 mile above reservoir No. 4. Elevation of station, 11,000 feet.

**DRAINAGE AREA.**—1.00 square mile (measured on topographic map). Approximately 25 per cent of area above timber line; remainder sparsely timbered.

**RECORDS AVAILABLE.**—October 1, 1909, to September 30, 1918.

**DETERMINATION OF DISCHARGE.**—Flow measured by sharp-crested weir, 24 inches long, with complete end contraction. A stake is driven into bed of stream in pool above weir, so that its head is level with crest of weir; depth of water over stake is measured by steel scale. Discharge is computed by Francis formula.

**DIVERSIONS.**—None.

**REGULATION.**—None.

**COOPERATION.**—Monthly discharge computed from records furnished by Colorado Springs water department.



*Monthly discharge of Little Beaver Creek near Pikes Peak, Colo., for the year ending Sept. 30, 1918.*

[Drainage area, 1.00 square mile.]

Month.	Discharge in second-feet.				Run-off.	
	Maximum.	Minimum.	Mean.	Per square mile.	Inches.	Acre-feet.
October.....	0.54	0.22	0.43	0.43	0.50	26.4
November.....	.22	.16	.21	.21	.23	12.5
December.....	.18	.10	.14	.14	.16	8.6
January.....	.00	.00	.00	.00	.00	.0
February.....	.00	.00	.00	.00	.00	.0
March.....	.00	.00	.00	.00	.00	.0
April.....	.00	.00	.00	.00	.00	.0
May.....	1.53	.00	.74	.74	.85	45.5
June.....	2.06	.72	1.01	1.01	1.13	60.1
July.....	2.81	.63	1.19	1.19	1.37	73.2
August.....	2.06	.93	1.47	1.47	1.70	90.4
September.....	1.28	.29	.64	.64	.71	38.1
The year.....	2.81	.00	.49	.49	6.65	355

**SACKETT CREEK NEAR PIKES PEAK, COLO.**

LOCATION.—In SE.  $\frac{1}{4}$  NW.  $\frac{1}{4}$  sec. 32, T. 14 S., R. 68 W., just above mouth of creek and 4 miles southeast of Pikes Peak, El Paso County. Sackett Creek enters Boehmer Creek from north a short distance above reservoir No. 4. Elevation of station, 11,000 feet.

DRAINAGE AREA.—0.65 square mile (measured on topographic map). Approximately 30 per cent of area above timber line; remainder sparsely timbered.

RECORDS AVAILABLE.—October 1, 1909, to September 30, 1918.

DETERMINATION OF DISCHARGE.—Flow measured by sharp-crested weir 24 inches long with complete end contraction. A stake is driven into bed of stream in pool above weir, so that its head is level with crest of weir; depth of water over stake is measured by steel scale. Discharge is computed by Francis formula.

DIVERSIONS.—None.

REGULATION.—None.

COOPERATION.—Monthly discharge computed from records furnished by Colorado Springs water department.

*Monthly discharge of Sackett Creek near Pikes Peak, Colo., for the year ending Sept. 30, 1918.*

[Drainage area, 0.65 square miles.]

Month.	Discharge in second-feet.				Run-off.	
	Maximum.	Minimum.	Mean.	Per square mile.	Inches.	Acre-feet.
October.....			0.05	.077	0.09	3.1
November.....			.04	.062	.07	2.4
December.....			.03	.046	.05	1.8
January.....	0.00	0.00	.00	.000	.00	.0
February.....	.00	.00	.00	.000	.00	.0
March.....	.00	.00	.00	.000	.00	.0
April.....	.00	.00	.00	.000	.00	.0
May.....	1.78	.00	.90	1.38	1.59	55.3
June.....	2.34	.36	.86	1.32	1.47	51.2
July.....	1.53	.63	.89	1.37	1.58	54.7
August.....	.82	.29	.60	.923	1.06	36.9
September.....	.36	.16	.26	.400	.45	15.5
The year.....	2.34	.00	.31	.477	6.36	221

**LION CREEK NEAR HALFWAY, COLO.**

**LOCATION.**—In NW.  $\frac{1}{4}$  sec. 15, T. 14 S., R. 68 W., at mouth of creek, half a mile southwest of Halfway, El Paso County. Lion Creek enters Ruxton Creek from the west. Elevation of station, 9,250 feet.

**DRAINAGE AREA.**—2.00 square miles (measured on topographic map). Includes all area above the Crater apparently tributary to Sheep Creek. About 30 per cent of area above timber line; remainder sparsely timbered.

**RECORDS AVAILABLE.**—April 1, 1908, to September 30, 1918.

**DETERMINATION OF DISCHARGES.**—Flow measured by sharp-crested weir 30 inches long with complete end contraction. A stake is driven into bed of stream in pool above weir, so that its head is level with crest of weir; depth of water over stake is measured by steel scale. Discharge is computed by Francis formula.

**DIVERSIONS.**—None.

**REGULATION.**—None.

**COOPERATION.**—Monthly discharge computed from records furnished by Colorado Springs water department.

*Monthly discharge of Lion Creek near Halfway, Colo., for the year ending Sept. 30, 1918.*

[Drainage area, 2.00 square miles.]

Month.	Discharge in second-feet.				Run-off.	
	Maximum.	Minimum.	Mean.	Per square mile.	Inches.	Acre-feet.
October.....	1.10	0.85	0.91	0.455	0.52	56.0
November.....	.91	.73	.80	.400	.45	47.6
December.....	.85	.61	.66	.330	.38	40.6
January.....	.61	.46	.54	.270	.31	33.2
February.....	.56	.41	.48	.240	.25	26.7
March.....	1.03	.46	.67	.335	.39	41.2
April.....	1.38	.51	.75	.375	.42	44.6
May.....	.97	.61	.79	.395	.46	48.6
June.....	1.50	.46	.69	.345	.38	41.1
July.....	1.17	.61	.84	.420	.48	51.6
August.....	1.90	.97	1.47	.735	.85	90.4
September.....	1.83	1.38	1.55	.775	.86	92.2
The year.....	1.90	.41	.85	.424	5.75	614

**SHEEP CREEK NEAR HALFWAY, COLO.**

**LOCATION.**—In SW.  $\frac{1}{4}$  sec. 11, T. 14 S., R. 68 W., a quarter of a mile west of Halfway, El Paso County. No tributary between station and mouth. Sheep Creek enters Ruxton Creek from the west a short distance above Halfway. Elevation of station, 9,100 feet.

**DRAINAGE AREA.**—0.73 square mile (measured on topographic map). Does not include any area above the Crater as this is probably tributary to Lion Creek. Practically all below timber line, but sparsely timbered.

**RECORDS AVAILABLE.**—April 1, 1908, to September 30, 1918.

**DETERMINATION OF DISCHARGE.**—Flow measured by sharp-crested weir 30 inches long with complete end contraction. A stake is driven into bed of stream in pool above weir, so that its head is level with crest of weir; depth of water over stake is measured by steel scale. Discharge is computed by Francis formula.

DIVERSIONS.—None.

REGULATION.—None.

COOPERATION.—Monthly discharge computed from records furnished by Colorado Springs water department.

*Monthly discharge of Sheep Creek near Halfway, Colo., for the year ending Sept. 30, 1918.*

[Drainage area, 0.73 square mile.]

Month.	Discharge in second-feet.				Run-off.	
	Maximum.	Minimum.	Mean.	Per square mile.	Inches.	Acre-feet.
October.....	0.41	0.36	0.37	0.507	0.58	22.8
November.....	.36	.23	.31	.425	.47	18.4
December.....	.23	.20	.20	.274	.32	12.3
January.....	.20	.10	.14	.192	.22	8.6
February.....	.13	.10	.13	.178	.19	7.2
March.....	.41	.10	.23	.315	.36	14.1
April.....	.81	.23	.43	.589	.66	26.0
May.....	.91	.51	.69	.945	1.09	42.4
June.....	.79	.27	.51	.699	.78	30.4
July.....	1.24	.41	.70	.959	1.11	43.0
August.....	1.03	.67	.81	1.11	1.28	49.8
September.....	.73	.46	.59	.808	.90	35.1
The year.....	1.24	.10	.43	.586	7.96	310

#### SOUTH RUXTON CREEK AT HALFWAY, COLO.

LOCATION.—In SW.  $\frac{1}{4}$  sec. 11, T. 14 S., R. 68 W., just above hydroelectric intake at Halfway, El Paso County. No tributary between station and mouth, a short distance below. South Ruxton Creek enters Ruxton Creek from the south at Halfway. Elevation of station, 9,000 feet.

DRAINAGE AREA.—3.95 square miles (measured on topographic map). Practically all below timber line and heavily timbered.

RECORDS AVAILABLE.—June 1, 1906, to September 30, 1918.

DETERMINATION OF DISCHARGE.—Flow measured by two sharp-crested weirs, with complete end contraction. Discharge is computed by Francis formula. The main weir is one-third of a mile above mouth of creek and a short distance above the hydroelectric intake, which has a capacity of 4.63 second-feet. The second weir is halfway between main weir and mouth of creek and measures the inflow chiefly from springs below the intake and a small amount of seepage. At all times, except during high water, the capacity of the intake is sufficient to take the entire flow passing main weir, and flow at the two weirs is combined to give total run-off from the basin. During high water the excess passing the intake and recorded at the lower weir does not represent increased flow between the weirs, and is discarded. In its place is used a constant quantity based on inflow and seepage at other times.

DIVERSIONS.—None.

REGULATION.—None.

COOPERATION.—Monthly discharge computed from records furnished by Colorado Springs water department.

*Monthly discharge of South Ruxton Creek at Halfway, Colo., for the year ending Sept. 30, 1918.*

[Drainage area, 3.95 square miles.]

Month.	Discharge in second-feet.				Run-off.	
	Maximum.	Minimum.	Mean.	Per square mile.	Inches.	Acre-feet.
October.....	2.10	1.60	1.83	0.463	0.53	113
November.....	1.60	1.24	1.44	.365	.41	86
December.....	1.52	1.03	1.18	.299	.34	73
January.....	1.10	.97	1.00	.253	.29	61
February.....	.97	.91	.93	.235	.24	52
March.....	1.90	.79	1.11	.281	.32	68
April.....	2.67	1.03	1.42	.360	.40	84
May.....	2.84	1.75	2.17	.549	.63	133
June.....	3.80	1.75	2.35	.595	.66	140
July.....	7.29	2.84	4.85	1.23	1.42	298
August.....	6.05	3.00	4.16	1.05	1.21	256
September.....	3.22	2.03	2.65	.671	.75	158
The year.....	7.29	.79	2.10	.531	7.20	1,520

**CABIN CREEK NEAR HALFWAY, COLO.**

**LOCATION.**—In SW.  $\frac{1}{4}$  NW.  $\frac{1}{4}$  sec. 11, T. 14 S., R. 68 W., just above hydroelectric intake, about three-eighths of a mile north of Halfway, El Paso County. Cabin Creek enters Ruxton Creek half a mile below Halfway. Elevation of station, approximately 9,000 feet.

**DRAINAGE AREA.**—2.4 square miles (measured on topographic map). About 15 per cent of area above timber line; remainder sparsely timbered.

**RECORDS AVAILABLE.**—October 1, 1906, to September 30, 1918.

**DETERMINATION OF DISCHARGE.**—Flow measured by two sharp-crested weirs with complete end contraction. Discharge computed by Francis formula. The main weir is about one-third of a mile above mouth of creek and just above the hydroelectric intake. The second weir is 50 feet above mouth of creek and measures the flow from springs and small tributaries entering below the intake. Except during high water measured flow at the weirs is combined to give total run-off from the basin. During high water the record from lower weir is discarded and the inflow estimated. (See description of South Ruxton Creek at Halfway, Colo.)

**DIVERSIONS.**—None.

**REGULATION.**—None.

**COOPERATION.**—Monthly discharge computed from records furnished by Colorado Springs water department.

*Monthly discharge of Cabin Creek near Halfway, Colo., for the year ending Sept. 30, 1918.*

[Drainage area, 2.4 square miles.]

Month.	Discharge in second-feet.				Run-off.	
	Maximum.	Minimum.	Mean.	Per square mile.	Inches.	Acre-feet.
October.....	1.03	0.73	0.86	0.358	0.41	52.9
November.....	.91	.61	.69	.288	.32	41.1
December.....	.61	.41	.51	.212	.24	31.4
January.....	.46	.23	.38	.158	.18	23.4
February.....	.41	.23	.29	.121	.13	16.1
March.....	.85	.23	.59	.246	.28	36.3
April.....	1.90	.56	.88	.367	.41	52.4
May.....	2.07	1.38	1.71	.712	.82	105
June.....	2.49	1.03	1.55	.646	.72	92.2
July.....	2.93	1.45	2.15	.896	1.03	132
August.....	3.50	2.57	2.76	1.15	1.33	170
September.....	2.84	1.63	2.17	.904	1.01	129
The year.....	3.50	.23	1.22	.507	6.88	882

**SUTHERLAND CREEK NEAR MANITOU, COLO.**

**LOCATION.**—In SW.  $\frac{1}{4}$  sec. 9, T. 14 S., R. 67 W.,  $1\frac{1}{2}$  miles southeast of Manitou, El Paso County. No important tributary between station and mouth, 1 mile below. Elevation of station, 6,600 feet.

**DRAINAGE AREA.**—4.4 square miles (measured on topographic map). Practically all below timber line.

**RECORDS AVAILABLE.**—January 1 to September 30, 1918.

**DETERMINATION OF DISCHARGE.**—Flow measured by sharp-crested weir, 30 inches long, with complete end contraction. A stake is driven into bed of stream in pool above weir, so that its head is level with crest of weir; depth of water over stake is measured by steel scale. Discharge is computed by Francis formula.

**DIVERSIONS.**—None.

**REGULATIONS.**—None.

**COOPERATION.**—Monthly discharge computed from records furnished by Colorado Springs water department.

*Monthly discharge of Sutherland Creek near Manitou, Colo., for the year ending Sept. 30, 1918.*

[Drainage area, 4.4 square miles.]

Month.	Discharge in second-feet.				Run-off.	
	Maximum.	Minimum.	Mean.	Per square mile.	Inches.	Acre-feet.
January.....	0.60	0.60	0.60	0.136	0.16	36.9
February.....	.67	.67	.67	.152	.16	37.2
March.....	.91	.61	.75	.170	.20	46.1
April.....	.91	.61	.75	.170	.19	44.6
May.....	.91	.79	.85	.193	.22	52.3
June.....	1.45	.67	.96	.218	.24	57.1
July.....	11.61	.67	2.45	.557	.64	151
August.....	1.90	.85	1.40	.318	.37	86.1
September.....	1.10	.79	.96	.218	.24	57.1
The period.....						568

**BEAR CREEK NEAR COLORADO SPRINGS, COLO.**

**LOCATION.**—In NE.  $\frac{1}{4}$  sec. 21, T. 14 S., R. 67 W.,  $3\frac{1}{2}$  miles west of Colorado Springs, El Paso County. Nearest tributary, Hunters Run, enters a short distance above. Elevation of station, 6,615 feet.

**DRAINAGE AREA.**—6.9 square miles (measured on topographic map). Practically all below timber line.

**RECORDS AVAILABLE.**—March 1 to September 30, 1918.

**DETERMINATION OF DISCHARGE.**—Flow measured by sharp-crested weir, 30 inches long, with complete end contraction. A stake is driven into bed of stream in pool above weir, so that its head is level with crest of weir; depth of water over stake is measured by steel scale. Discharge is computed by Francis formula.

**DIVERSIONS.**—None.

**REGULATIONS.**—None.

**COOPERATION.**—Monthly discharge computed from records furnished by Colorado Springs water department.

*Monthly discharge of Bear Creek near Colorado Springs, Colo., for the year ending Sept. 30, 1918.*

[Drainage area, 6.9 square miles.]

Month.	Discharge in second-feet.				Run-off.	
	Maximum.	Minimum.	Mean.	Per square mile.	Inches.	Acre-feet.
March.....	1.90	0.73	1.60	0.232	0.27	98
April.....	2.75	1.03	2.01	.291	.32	120
May.....	5.51	1.60	2.21	.321	.37	136
June.....	5.74	1.38	2.39	.346	.39	142
July.....	9.66	2.07	5.04	.730	.84	310
August.....	4.63	2.40	3.31	.480	.55	204
September.....	2.75	2.07	2.38	.345	.38	142
The period.....						1,150

**NEOSHO RIVER NEAR IOLA, KANS.**

**LOCATION.**—In NE.  $\frac{1}{4}$  sec. 9, T. 25 S., R. 18 E., 3 miles southwest of Iola, Allen County. Elm Creek enters from east 1 mile upstream, and Owl Creek enters from west 8 miles downstream.

**DRAINAGE AREA.**—Not measured.

**RECORDS AVAILABLE.**—October 12, 1917, to September 30, 1918. The gaging station was formerly maintained about 4 miles upstream, 1 mile west of Iola, at city water and power-house dam for period August 1, 1895, to November 30, 1903. The United States Weather Bureau staff gage is a short distance upstream from this dam.

**GAGE.**—Stevens water-stage recorder on left bank. Staff gage at this location is in two sections; lower inclined, upper vertical and fastened to downstream side of concrete gage well. Staff gage was read daily by observer, Ruth Conger, during periods when recorder was not operating satisfactorily.

**DISCHARGE MEASUREMENTS.**—Made from cable at gage or by wading above Pipe Line ford, about three-fourths of a mile downstream from gage.

**CHANNEL AND CONTROL.**—Control is long shale riffle half a mile downstream from gage terminating at Pipe Line ford, where a 16-inch gas pipe line, anchored by concrete blocks in channel, crosses the stream bed; probably permanent. At low water, pooled section at gage. Bed composed of gravel. Left bank is high, and well-defined ledge of limestone confines the flood channel on the left bank near the gage. Right bank is lower but is overflowed only for about three-fourths of a mile at extreme high stages. On account of the high banks this section of the river is less subject to overflow than elsewhere along the Neosho Valley. Channel is straight for a long distance upstream and bends slightly downstream from gage.

**EXTREMES OF DISCHARGE.**—Maximum stage recorded during year, 14.5 feet at 3 p. m. June 1 (discharge, 13,800 second-feet); minimum stage recorded, 2.45 feet, August 13 to 17 (discharge, 4 second-feet).

1895–1903 (United States Geological Survey record): Maximum stage recorded, 22.0 feet, June 3, 1904 (discharge, 39,100 second-feet); higher discharge given for 20.1 feet, May 24, 1896 (discharge, 45,600 second-feet).

1904: Maximum stage, 24.0 feet, July 10, 1904, determined from high-water marks (discharge estimated as 74,600 second-feet). Minimum discharge, 0 second-feet, occurred on days in September and October, 1897.

**ICE.**—Stage-discharge relation affected by ice; flow estimated from observer's notes and records of precipitation and temperature. No winter discharge measurements made.

**DIVERSIONS.**—Water is taken from river by cities upstream for purposes of domestic water supply.

**REGULATION.**—Low-water flow is regulated by dams upstream.

**ACCURACY.**—Stage-discharge relation practically permanent. Rating curve well defined below 10,000 second-feet; extended to cover high-water stages by area-velocity curve study. Water-stage recorder checked weekly by observer reading outside staff gage to quarter-tenths. January 11–18, no gage record, as cog on escapement wheel of gage clock was broken. May 7–11, 17–31, and June 1, 18–30, water-stage recorder not working satisfactorily. Discharge May 7–11, 21, and 29–31, determined from gage heights obtained by use of curve showing relation between stage at United States Weather Bureau gage above dam at Iola (see "Location") and United States Geological Survey water-stage recorder, using United States Weather Bureau gage record; May 19, 24, June 1, 24–28 and 30, determined from observer's daily readings of staff gage; May 17, 18, 20, 22, 23, 25–28, June 18–23 and 29, estimated. Daily discharge for remainder of year ascertained by applying mean daily gage height to rating table, except for period of ice effect, January 5 to February 25, for which it was estimated from observer's notes and records of precipitation and temperature. Records good for low and medium stages, fair for high stages on account of intake clogging and unsatisfactory gage record.

*Discharge measurements of Neosho River near Iola, Kans., during the year ending Sept. 30, 1918.*

[Made by R. C. Rice.]

Date.	Gage height.	Dis-charge.	Date.	Gage height.	Dis-charge.	Date.	Gage height.	Dis-charge.
	<i>Feet.</i>	<i>Sec.-ft.</i>		<i>Feet.</i>	<i>Sec.-ft.</i>		<i>Feet.</i>	<i>Sec.-ft.</i>
Oct. 29.....	2.85	38	May 15.....	3.37	187	June 5.....	4.73	890
Mar. 8.....	3.22	128	June 5.....	4.83	891	Aug. 15.....	2.48	5.2

*Daily gage height, in feet, of Neosho River near Iola, Kans., for the year ending Sept. 30, 1918.*

Day.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.
1.....	-----	2.85	2.95	2.9	3.1	3.0	2.9	4.95	14.5	3.15	2.65	3.0
2.....	-----	2.9	2.95	2.9	3.1	3.0	2.9	5.1	13.3	3.1	2.6	3.0
3.....	-----	2.9	2.9	2.9	3.1	3.0	2.9	4.5	7.75	3.1	2.6	2.9
4.....	-----	2.9	2.9	2.9	3.05	3.0	2.9	4.1	5.75	3.1	2.6	2.95
5.....	-----	2.85	2.9	3.0	3.1	3.25	3.0	3.9	4.8	3.0	2.6	2.9
6.....	-----	2.85	2.9	3.0	3.0	3.2	3.05	3.85	4.6	2.85	2.55	2.85
7.....	-----	2.85	2.9	2.95	2.9	3.2	3.1	-----	4.8	2.8	2.55	2.8
8.....	-----	2.85	2.95	2.9	2.95	3.2	3.15	-----	4.25	2.8	2.55	2.8
9.....	-----	2.85	2.9	2.95	3.0	3.25	3.1	-----	4.0	2.55	2.5	2.8
10.....	-----	2.9	2.9	2.95	3.0	3.15	3.1	-----	3.85	2.55	2.5	2.8
11.....	-----	2.95	2.9	-----	3.0	3.1	3.0	-----	3.75	2.55	2.5	2.8
12.....	3.0	3.0	2.9	-----	3.0	3.1	3.0	-----	3.65	3.7	2.6	2.5
13.....	2.95	2.95	2.95	-----	3.0	3.1	3.0	-----	3.6	3.6	2.6	2.45
14.....	2.9	2.95	2.95	-----	3.05	3.05	3.05	-----	3.5	3.55	3.1	2.45
15.....	2.85	3.0	2.9	-----	3.1	3.0	3.1	3.35	3.5	3.2	2.45	2.7
16.....	2.85	3.0	2.9	-----	3.15	3.0	3.05	3.3	3.45	3.15	2.45	2.75
17.....	2.9	3.0	2.9	-----	3.0	3.0	3.05	-----	3.4	3.1	2.45	2.7
18.....	2.9	3.0	2.9	-----	3.0	3.0	3.0	-----	-----	3.05	2.5	2.7
19.....	2.85	3.0	2.9	3.0	3.0	2.95	3.0	3.2	-----	3.3	2.55	2.75
20.....	2.9	3.0	2.9	3.0	3.0	2.95	3.0	-----	-----	3.5	2.6	2.7
21.....	2.9	2.95	2.9	3.0	3.0	2.9	3.7	-----	-----	3.5	2.6	2.7
22.....	2.85	2.95	2.9	3.0	3.0	2.9	3.65	-----	-----	3.5	2.6	2.7
23.....	2.8	2.95	2.9	2.95	3.0	2.9	3.55	-----	-----	3.45	2.55	2.7
24.....	2.65	3.0	2.95	2.95	3.0	2.9	3.65	3.5	3.2	3.3	2.55	2.65
25.....	2.5	2.9	2.9	2.95	3.0	2.9	3.8	-----	3.2	3.15	2.55	2.65
26.....	2.6	2.9	2.95	2.9	3.0	2.9	3.9	-----	3.4	3.05	2.55	2.65
27.....	2.75	2.95	2.95	2.95	3.0	2.85	4.05	-----	4.2	2.95	3.15	2.6
28.....	2.8	2.9	2.95	3.0	3.0	2.85	4.8	-----	3.65	2.8	3.4	2.6
29.....	2.85	2.9	2.95	3.05	-----	2.9	4.35	-----	-----	2.7	3.3	2.6
30.....	2.85	2.9	2.9	3.05	-----	2.9	4.15	-----	3.2	2.7	3.2	2.6
31.....	2.85	-----	2.9	3.1	-----	2.9	-----	-----	-----	2.65	3.1	-----

NOTE.—No record Jan. 11-18, May 7-11, 17-18, 20-31, June 18-23, 29. Gage heights given for May 19, 24, June 1, 24-28, 30, are observer's daily readings on staff gage. Stage-discharge relation affected by ice Jan. 5 to Feb. 25.



*Daily discharge, in second-feet, of Neosho River near Iola, Kans., for the year ending Sept. 30, 1918.*

Day.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.
1.....		38	57	46		68	46	989	13,800	110	14	68
2.....		46	57	46		68	46	1,080	11,600	96	10	68
3.....		46	46	46		68	46	728	3,550	96	10	46
4.....		46	46	46	40	68	46	514	1,520	96	10	57
5.....		38	46			143	68	410	902	68	10	46
6.....		38	46	46		126	82	387	786	38	8	38
7.....		38	46	46	46	126	96	670	902	38	8	30
8.....		38	57	57		126	110	618	592	30	8	30
9.....		38	46	46		143	96	514	462	8	6	30
10.....		46	46		50	110	96	462	387	8	6	30
11.....		57	46			96	68	364	343	8	6	30
12.....	68	68	46			96	68	296	320	10	6	24
13.....	57	57	57			96	68	276	276	10	4	18
14.....	46	57	57			82	82	238	258	96	4	24
15.....	38	68	46		80	68	96	180	238	126	4	18
16.....												
17.....	38	68	46			68	82	160	216	110	4	24
18.....	46	68	46		75	68	68	137	186	82	4	18
19.....	38	68	46			57	68	126	176	160	8	24
20.....	46	68	46	30		57	68	245	166	238	10	18
21.....	46	57	46			46	320	364	156	238	10	18
22.....	38	57	46		68	46	296	322	146	238	10	18
23.....	30	57	46			46	258	280	136	216	8	18
24.....	14	68	57			46	296	238	126	160	8	14
25.....	6	46	46			46	364	246	126	110	8	14
26.....	10	46	57		68	46	410	253	196	82	8	14
27.....	24	57	57		68	38	488	261	566	57	110	10
28.....	30	46	57		68	38	902	268	296	30	196	10
29.....	38	46	57			46	644	276	211	18	160	10
30.....	38	46	46			46	540	670	126	18	126	10
31.....	38		46			46		7,780		14	96	

NOTE.—Stage-discharge relation affected by ice Jan. 5 to Feb. 25. Braced figures show mean discharge for periods indicated.

*Monthly discharge of Neosho River near Iola, Kans., for the year ending Sept. 30, 1918.*

Month.	Discharge in second-feet.			Run-off in acre-feet.
	Maximum.	Minimum.	Mean.	
October 12-31.....	68	6	36.8	1,460
November.....	68	38	52.8	3,140
December.....	57	46	49.5	3,040
January.....			34.6	2,130
February.....			59.4	3,300
March.....	143	38	74.0	4,550
April.....	902	46	200	11,900
May.....	7,780	126	629	38,700
June.....	13,800	126	1,300	77,400
July.....	238	8	87.3	5,370
August.....	196	4	28.6	1,760
September.....	88	10	26.5	1,580
The period.....				154,000

## RED RIVER BASIN.

## MEDICINE BLUFF CREEK NEAR LAWTON, OKLA.

**LOCATION.**—In sec. 18, T. 3 N., R. 12 W., at Medicine Park, 12 miles northwest of Lawton, Comanche County. Nearest tributary, Little Medicine Bluff Creek, enters half a mile above.

**DRAINAGE AREA.**—About 110 square miles.

**RECORDS AVAILABLE.**—November 26, 1912, to September 30, 1918.

**GAGE.**—Stevens continuous water-stage recorder installed February 16, 1915, on left bank one-third of a mile below Medicine Park Hotel. Original gage was vertical staff on left bank a short distance below hotel, and set to datum 0.68 foot higher than that of present gage; fall between the two points, 0.18 foot. On February 19, 1917, dam was completed 200 feet downstream which turned a section of the creek into a pool and changed control completely. Datum of water-stage recorder raised. No definite relations between gage heights before and after completion of dam.

**DISCHARGE MEASUREMENTS.**—Made from cable 100 yards above gage or by wading.

**CHANNEL AND CONTROL.**—Control is crest of concrete dam.

**EXTREMES OF DISCHARGE.**—Maximum stage during year, from water-stage recorder, 2.35 feet June 4 (discharge, 285 second-feet); no flow, May 27 and 28.

**ICE.**—Stage-discharge relation not affected by ice.

**DIVERSIONS.**—Average diversions from Lawton reservoir, October 1 to March 31, 3.1 second-feet; April 1 to June 30, 3.9 second feet; July 1 to August 31, 4.6 second-feet; September 1–30, 4.3 second-feet.

**REGULATION.**—Flow controlled to a great extent by Lawton reservoir, which is  $1\frac{1}{2}$  miles upstream; capacity 14,000 acre-feet.

**NATURAL RUN-OFF.**—To show natural run-off of Medicine Bluff Creek, by months, computations have been made which include flow past gage, daily loss from evaporation, gain or loss by storage, and diversion for Lawton waterworks.

**ACCURACY.**—Stage-discharge relation permanent. Lower part of rating curve based on discharge measurements; upper part on weir formula owing to lack of measurements. Operation of water-stage recorder not very satisfactory. Daily discharge ascertained by applying to rating table mean daily gage height obtained by inspecting recorder graph, except for periods indicated in footnote to daily-discharge table. Records fair.

The following discharge measurement was made by Robert Follansbee:  
February 22, 1918: Gage height, 1.62 feet; discharge, 0.8 second-foot.

*Daily discharge, in second-feet, of Medicine Bluff Creek near Lawton, Okla., for the year ending Sept. 30, 1918.*

Day.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.
1.....		.8	2.6	2.2	3.1	3.9	5.0
2.....		1.7	2.6	2.6	3.1	4.1	4.5
3.....		1.7	2.6	1.7	3.6	3.6	3.6
4.....		1.7	2.6	1.2	64.0	3.1	.....
5.....		1.7	2.6	.3	17.0	2.6	.....
6.....		1.2	2.6	.3	9.0	1.7	.....
7.....		.8	2.6	.3	8.0	2.2	.....
8.....		.8	2.6	.3	6.0	1.7	.....
9.....		.2	2.6	.3	6.0	.3	.....
10.....		.3	2.6	.2	6.0	.8	.....
11.....		.3	2.6	.2	5.0	2.2	.....
12.....		.3	2.6	.2	4.1	1.7	.....
13.....		.3	2.6	.2	4.5	1.2	.....
14.....		.2	2.6	.3	4.1	3.6	.....
15.....		.3	2.6	.3	3.1	3.1	.....
16.....		1.2	2.6	1.2	2.6	1.7	.....
17.....		1.2	2.6	1.2	2.6	3.1	.....
18.....		.8	1.2	2.2	2.6	1.2	.....
19.....		1.2	.3	2.2	3.1	.2	.....
20.....		1.2	.3	2.2	4.5	.0	.....
21.....		1.2	.8	.3	3.6	.0	.....
22.....		1.2	.8	.3	3.6	.1	.....
23.....	1.2	1.2	1.2	.3	1.7	.3	.....
24.....	.3	1.2	2.2	.2	2.0	1.7	.....
25.....	.3	1.2	2.2	.1	2.3	1.7	.....
26.....	.2	2.6	2.2	.1	2.6	2.6	.....
27.....	.2	1.2	2.2	.0	2.8	2.6	.....
28.....	.3	1.2	2.6	.0	3.1	3.1	.....
29.....		1.2	2.6	2.6	3.4	2.6	.....
30.....		2.6	2.2	2.6	3.7	4.5	.....
31.....		2.6	.....	2.6	.....	9.0	.....

NOTE.—Discharge estimated Mar. 20–24, 28; Apr. 1–6, 8–16; May 6–11; June 24 to July 1. No record Oct. 1 to Feb. 22 and Aug. 4 to Sept. 30.

*Monthly discharge of Medicine Bluff Creek near Lawton, Okla., for the year ending Sept. 30, 1918.*

Month.	Discharge in second-feet.			Run-off in acre-feet.
	Maximum.	Minimum.	Mean.	
October.....			2.0	123
November.....			1.5	89
December.....			1.5	92
January.....			1.5	92
February.....			1.5	83
March.....	2.6	0.2	1.14	70
April.....	2.6	.3	2.17	129
May.....	2.6	0	.93	57
June.....	64	1.7	6.36	378
July.....	9	0	2.26	139
August.....			4.0	246
September.....			4.0	238
The year.....	64	0	2.40	1,740

NOTE.—Monthly discharge October to February, August, and September estimated; flow nearly constant, as shown by elevations of Lawton reservoir.

*Corrected monthly discharge of Medicine Bluff Creek near Lawton, Okla., for the year ending Sept. 30, 1918.*

Month.	Mean discharge in second-feet.	Run-off in acre-feet.	Month.	Mean discharge in second-feet.	Run-off in acre-feet.
October.....	0.0	0	May.....	1.4	86
November.....	.0	0	June.....	23.8	1,420
December.....	.0	0	July.....	4.8	295
January.....	3.3	203	August.....	8.2	504
February.....	.0	0	September.....	13.9	827
March.....	4.5	277			
April.....	4.5	268	The year.....		3,880

NOTE.—Record corrected for storage, evaporation, and diversion from Lawton reservoir.

#### LITTLE MEDICINE BLUFF CREEK NEAR LAWTON, OKLA.

**LOCATION.**—150 feet below west line of sec. 18, T. 3 N., R. 12 W., half a mile above mouth of creek, and 12½ miles northwest of Lawton, Comanche County.

**DRAINAGE AREA.**—About 10 square miles.

**RECORDS AVAILABLE.**—November 26, 1912, to September 30, 1918.

**GAGE.**—Vertical staff on left bank half a mile above mouth of creek; read by Robert McCalmant and sanitary corps, United States Army. Upstream 200 feet is a gage referred to same datum, which is read by observer during flood to determine slope between it and regular gage.

**DISCHARGE MEASUREMENTS.**—Made by wading near gage.

**CHANNEL AND CONTROL.**—Bed composed of ledge rock overlain with sand. Control is rock ledge just below gage. Between station and crest of small dam on Medicine Bluff Creek just below Little Medicine Bluff Creek there is a fall of about 8 feet.

**EXTREMES OF DISCHARGE.**—Maximum stage recorded during year, 0.8 foot, August 24 (discharge, 23 second-feet); stream dry except for a few days during year.

**ICE.**—Stage-discharge relation not affected by ice.

**DIVERSIONS.**—None.

**REGULATION.**—None.

Discharge, August 24, 2.2 second-feet; September 4, 2 second-feet. Creek practically dry all other days in the year.

#### EVAPORATION STATION NEAR LAWTON, OKLA.

**LOCATION.**—In a somewhat sheltered bay on west side of Lawton reservoir, 12 miles northwest of Lawton, Comanche County.

**RECORDS AVAILABLE.**—February 20, 1913, to September 30, 1918.

**EQUIPMENT FOR MEASUREMENT.**—A galvanized iron pan 3 feet square and 18 inches deep floating in the center of a skeleton raft about 75 feet from the shore; in the center of the pan is a vertical needle point which is the reference point for measuring evaporation. Rainfall measured by rain gage placed on raft from February 30, 1913, to February 20, 1917, when rain gage moved to dam three-quarters of a mile distant. On September 29, 1917, rain gage again moved to point on shore near evaporation pan.

*Daily evaporation, in inches, at Lawton reservoir, near Lawton, Okla., for the year ending Sept. 30, 1918.*

Day.	Oct.	Nov.	Dec.	Feb.	Mar.	June.	July.	Aug.	Sept.
1.....	0.19	0.14	0.05	.....	0.02	.....	.....	0.04	0.48
2.....	.21	.12	.06	.....	.10	.....	.....	.43	.....
3.....	.18	.10	.08	.....	.06	.....	.....	.57	.....
4.....	.20	.12	.06	.....	.08	.....	.....	.57	.....
5.....	.18	.14	.04	.....	.08	.....	.....	.72	.21
6.....	.19	.16	.02	.....	.06	.....	.....	.67	.18
7.....	.16	.14	.00	.....	.05	.....	.....	.52	.18
8.....	.20	.12	.02	.....	.05	.....	.....	.54	.36
9.....	.18	.14	.02	.....	.06	.....	.....	.32	.41
10.....	.16	.16	.04	.....	.04	.....	.....	.42	.38
11.....	.14	.11	.06	.....	.06	.....	.....	.55	.40
12.....	.16	.13	.04	.....	.06	.....	.....	.56	.43
13.....	.18	.09	.02	.....	.04	.....	.....	.50	.57
14.....	.20	.10	.04	.....	.04	.....	.....	.53	.65
15.....	.18	.12	.02	.....	.04	0.35	.....	.48	.....
16.....	.16	.06	.02	.....	.04	.45	.....	.56	.25
17.....	.18	.14	.04	.....	.....	.32	.....	.....	.....
18.....	.16	.10	.06	.....	.....	.30	.....	.44	.....
19.....	.14	.08	.04	.....	.....	.40	.....	.58	.....
20.....	.16	.11	.02	.....	.....	.45	0.31	.36	.32
21.....	.10	.09	.04	.....	.....	.....	.50	.42	.29
22.....	.12	.09	.02	.....	.....	.....	.51	.....	.28
23.....	.14	.10	.00	.....	.....	.....	.36	.16	.36
24.....	.16	.07	.00	0.04	.....	.20	.47	.....	.....
25.....	.14	.07	.02	.02	.....	.52	.52	.46	.36
26.....	.16	.06	.04	.04	.....	.41	.61	.24	.30
27.....	.14	.05	.02	.06	.....	.....	.52	.47	.....
28.....	.10	.05	.00	.04	.....	.51	.57	.50	.....
29.....	.12	.06	.00	.....	.....	.....	.....	.51	.25
30.....	.14	.04	.02	.....	.....	.....	.....	.....	.37
31.....	.16	.....	.03	.....	.....	.....	.....	.43	.....

### MISCELLANEOUS MEASUREMENTS.

*Miscellaneous measurements in lower Mississippi River drainage basin during the year ending Sept. 30, 1918.*

Date.	Stream.	Tributary to—	Locality.	Dis-charge.
July 25	Cottonwood River	Neosho River.....	4 miles below dam at Cottonwood Falls, Kans.	Sec.-ft. a 17
26	.....do.....	.....do.....	Sec 24, T. 19S. R. 7 E., 4½ miles above dam at Cottonwood Falls, Kans., 1 mile below Diamond Creek.	b 18

a Normal leakage through the dam.

b Represents flow during period of very dry weather.

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