DEPARTMENT OF THE INTERIOR
FRANKLIN K. LANE, Secretary

UNITED STATES GEOLOGICAL SURVEY
GEORGE OTIS SMITH, Director

Water-Supply Paper 438

SURFACE WATER SUPPLY OF THE UNITED STATES

1916

PART VIII. WESTERN GULF OF MEXICO BASINS

NATHAN C. GROVER, Chief Hydraulic Engineer
GLENN A. GRAY and ROBERT FOLLANSBEE, District Engineers

Prepared in cooperation with the
STATE OF TEXAS

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SURFACE WATER SUPPLY OF WESTERN GULF OF MEXICO BASINS, 1916.

AUTHORIZATION AND SCOPE OF WORK.

This volume is one of a series of 14 reports presenting results of measurements of flow made on streams in the United States during the year ending September 30, 1916.

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 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, 1895–1917.

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

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; cooperation of the second kind is acknowledged on page 12.

Measurements of stream flow have been made at about 4,100 points in the United States and also at many points in Alaska and the Hawaiian Islands. In July, 1916, 1,290 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. Information in regard to publications relating to water resources is presented in the appendix to this report.

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 of 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, acre-feet, and millions of cubic 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 by the use of the factors given in the tables of convenient equivalents (pp. 7 to 9).

"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 of 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.

"Millions of cubic feet" is applied to quantities of water stored in reservoirs, most frequently in connection with studies of flood control.

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 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 would fall if there were no flow.

CONVENIENT EQUIVALENTS.

The following is a list of convenient equivalents for use in hydraulic computations:

Table for converting discharge in second-feet per square mile into run-off in depth in inches over the area.

Discharge (second-feet per square mile).	Run-off (depth in inches).				
	1 day.	28 days.	29 days.	30 days.	31 days.
1.....	0.03719	1.041	1.079	1.116	1.153
2.....	.07438	2.083	2.157	2.231	2.306
3.....	.11157	3.124	3.236	3.347	3.459
4.....	.14876	4.165	4.314	4.463	4.612
5.....	.18595	5.207	5.393	5.578	5.764
6.....	.22314	6.248	6.471	6.694	6.917
7.....	.26033	7.289	7.550	7.810	8.070
8.....	.29752	8.331	8.628	8.926	9.223
9.....	.33471	9.372	9.707	10.041	10.376

NOTE.—For part of a month multiply the run-off for one day by the number of days.

Table for converting discharge in second-feet into run-off in acre-feet.

Discharge. (second-feet).	Run-off (acre-feet).				
	1 day.	28 days.	29 days.	30 days.	31 days.
1.....	1.983	55.54	57.52	59.50	61.49
2.....	3.967	111.1	115.0	119.0	123.0
3.....	5.950	166.6	172.6	178.5	184.5
4.....	7.934	222.1	230.1	238.0	246.0
5.....	9.917	277.7	287.6	297.5	307.4
6.....	11.90	333.2	345.1	357.0	368.9
7.....	13.88	388.8	402.6	416.5	430.4
8.....	15.87	444.3	460.2	476.0	491.9
9.....	17.85	499.8	517.7	535.5	553.4

NOTE.—For part of a month multiply the run-off for one day by the number of days.

Table for converting discharge in second-feet into run-off in millions of cubic feet.

Discharge. (second-feet).	Run-off (millions of cubic feet).				
	1 day.	28 days.	29 days.	30 days.	31 days.
1.....	0.0864	2.419	2.506	2.592	2.678
2.....	.1728	4.838	5.012	5.184	5.356
3.....	.2592	7.257	7.518	7.776	8.034
4.....	.3456	9.676	10.02	10.37	10.71
5.....	.4320	12.10	12.53	12.96	13.39
6.....	.5184	14.51	15.04	15.55	16.07
7.....	.6048	16.93	17.54	18.14	18.75
8.....	.6912	19.35	20.05	20.74	21.42
9.....	.7776	21.77	22.55	23.33	24.10

NOTE.—For part of a month multiply the run-off for one day by the number of days.

Table for converting discharge in second-feet into run-off in millions of gallons.

Discharge (second-feet).	Run-off (millions of gallons).				
	1 day.	28 days.	29 days.	30 days.	31 days
1	0.6463	18.10	18.74	19.39	20.04
2	1.293	36.20	37.48	38.78	40.08
3	1.939	54.30	56.22	58.17	60.12
4	2.585	72.40	74.96	77.56	80.16
5	3.232	90.50	93.70	96.95	100.2
6	3.878	108.6	112.4	116.3	120.2
7	4.524	126.7	131.2	135.7	140.3
8	5.171	144.8	149.9	155.1	160.3
9	5.817	162.9	168.7	174.5	180.4

NOTE.—For part of a month multiply the run-off for one day by the number of days.

Table for converting velocity in feet per second into velocity in miles per hour.

[1 foot per second=0.681818 mile per hour, or two-thirds mile per hour, very nearly; 1 mile per hour=1.4666 feet per second. In computing the table the figures 0.68182 and 1.4667 were used.]

Feet per second (units).	Miles per hour for tenths of foot per second.									
	0	1	2	3	4	5	6	7	8	9
0	0.000	0.068	0.136	0.205	0.273	0.341	0.409	0.477	0.545	0.614
1	.682	.750	.818	.886	.995	1.02	1.09	1.16	1.23	1.30
2	1.36	1.43	1.50	1.57	1.64	1.70	1.77	1.84	1.91	1.98
3	2.05	2.11	2.18	2.25	2.32	2.39	2.45	2.52	2.59	2.66
4	2.73	2.80	2.86	2.93	3.00	3.07	3.14	3.20	3.27	3.34
5	3.41	3.48	3.55	3.61	3.68	3.75	3.82	3.89	3.95	4.02
6	4.09	4.16	4.23	4.30	4.36	4.43	4.50	4.57	4.64	4.70
7	4.77	4.84	4.91	4.98	5.05	5.11	5.18	5.25	5.32	5.39
8	5.45	5.52	5.59	5.66	5.73	5.80	5.86	5.93	6.00	6.07
9	6.14	6.20	6.27	6.34	6.41	6.48	6.55	6.61	6.68	6.75

Table for converting discharge in second-feet into theoretical horsepower per foot of fall.

[1 second-foot=0.1136 theoretical horsepower per foot of fall. Weight of 1 cubic foot of water=62.5 pounds.]

Tens.	Units.									
	0	1	2	3	4	5	5	7	8	9
0	0.00	0.114	0.227	0.341	0.454	0.568	0.682	0.795	0.909	1.02
1	1.14	1.25	1.36	1.48	1.59	1.70	1.82	1.93	2.04	2.16
2	2.27	2.39	2.50	2.61	2.73	2.84	2.95	3.07	3.18	3.29
3	3.41	3.52	3.64	3.75	3.86	3.98	4.09	4.20	4.32	4.43
4	4.54	4.66	4.77	4.88	5.00	5.11	5.23	5.34	5.45	5.57
5	5.68	5.79	5.91	6.02	6.13	6.25	6.36	6.48	6.59	6.70
6	6.82	6.93	7.04	7.16	7.27	7.38	7.50	7.61	7.72	7.84
7	7.95	8.07	8.18	8.29	8.41	8.52	8.63	8.75	8.86	8.97
8	9.09	9.20	9.32	9.43	9.54	9.66	9.77	9.88	10.0	10.1
9	10.2	10.3	10.5	10.6	10.7	10.8	10.9	11.0	11.1	11.2

1 second-foot equals 40 California miner's inches (law of Mar. 23, 1901).

1 second-foot equals 38.4 Colorado miner's inches.

1 second-foot equals 40 Arizona miner's inches.

1 second-foot equals 7.48 United States gallons per second; equals 448.8 gallons per minute; equals 646,317 gallons for one day.

1 second-foot for one year (365 days) covers 1 square mile 1.131 feet, or 13.752 inches deep.

1 second-foot for one year (365 days) equals 31,536.000 cubic feet.

1 second-foot equals about 1 acre-inch per hour.

1 second-foot for one year (365 days) equals 724 acre-feet.
1 second-foot for one day equals 86,400 cubic feet.
1,000,000,000 (1 United States billion) cubic feet equals 11,570 second-feet for one day.
1,000,000,000 cubic feet equals 414 second-feet for one 28-day month.
1,000,000,000 cubic feet equals 399 second-feet for one 29-day month.
1,000,000,000 cubic feet equals 386 second-feet for one 30-day month.
1,000,000,000 cubic feet equals 373 second-feet for one 31-day month.
100 California miner's inches equals 18.7 United States gallons per second.
100 California miner's inches for one day equals 4.96 acre-feet.
100 Colorado miner's inches equals 2.60 second-feet.
100 Colorado miner's inches equals 19.5 United States gallons per second.
100 Colorado miner's inches for one day equals 5.17 acre-feet.
100 United States gallons per minute equals 0.223 second-foot.
100 United States gallons per minute for one day equals 0.442 acre-foot.
1,000,000 United States gallons per day equals 1.55 second-feet.
1,000,000 United States gallons equals 3.07 acre-feet.
1,000,000 cubic feet equals 22.95 acre-feet.
1 acre-foot equals 325,850 gallons.
1 inch deep on 1 square mile equals 2,323,200 cubic feet.
1 inch deep on 1 square mile equals 0.0737 second-foot per year.
1 foot equals 0.3048 meter.
1 mile equals 1.60935 kilometers.
1 mile equals 5,280 feet.
1 acre equals 0.4047 hectare.
1 acre equals 43,560 square feet.
1 acre equals 209 feet square, nearly.
1 square mile equals 2.59 square kilometers.
1 cubic foot equals 0.0283 cubic meter.
1 cubic foot of water weighs 62.5 pounds.
1 cubic meter per minute equals 0.5886 second-feet.
1 horsepower equals 550 foot-pounds per second.
1 horsepower equals 76.0 kilogram-meters per second.
1 horsepower equals 746 watts.
1 horsepower equals 1 second-foot falling 8.80 feet.
1½ horsepower equals about 1 kilowatt.

To calculate water power quickly: $\frac{\text{Second-feet} \times \text{fall in feet}}{11}$ = net horsepower on water wheel realizing 80 per cent of theoretical power.

EXPLANATION OF DATA.

The data presented in this report cover the year beginning October 1, 1915, and ending September 30, 1916. 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 mean discharge is determined.

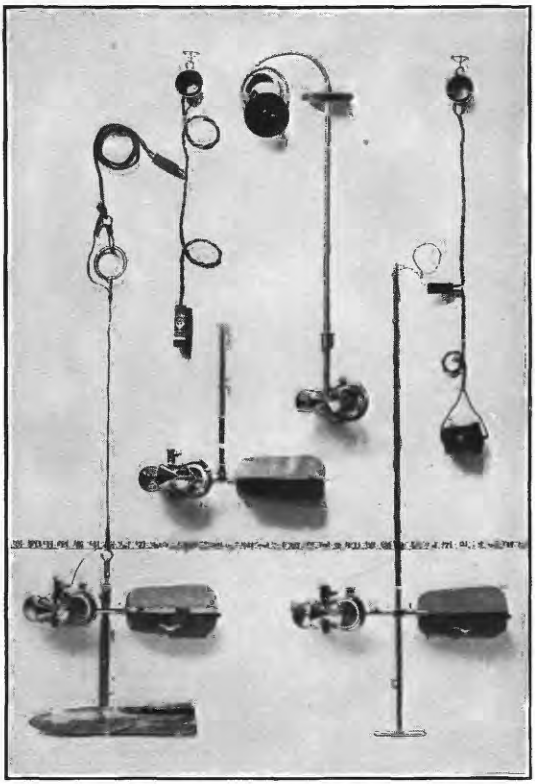
The data presented for each gaging station in the area covered by this report comprise a description of the station, a table giving results of discharge measurements, a table showing the daily discharge of the stream, and a table of monthly and yearly discharge and run-off.

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

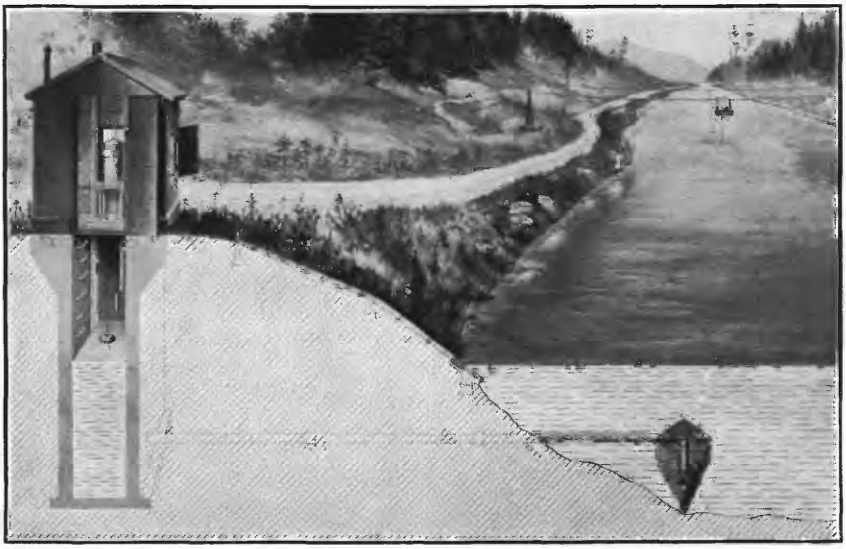
The description of the station gives, in addition to statements regarding location and equipment, information in regard to any conditions that may affect the constancy of the discharge relation, covering such subjects as the occurrence of ice, the use of the stream for log driving, shifting of control, 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 fluctuation 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.

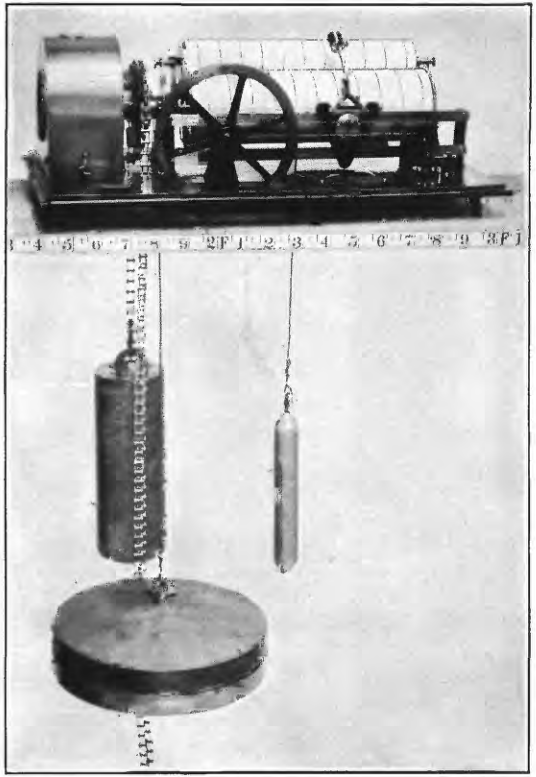
In the table of monthly discharge the column headed "Maximum" gives the mean flow for the day when the mean gage height was highest. As the gage height is the mean for the day it does not indicate correctly the stage when the water surface was at crest height, and the corresponding discharge was consequently larger than given in the maximum column. Likewise, in the column headed "Minimum" the quantity given is the mean flow for the day when



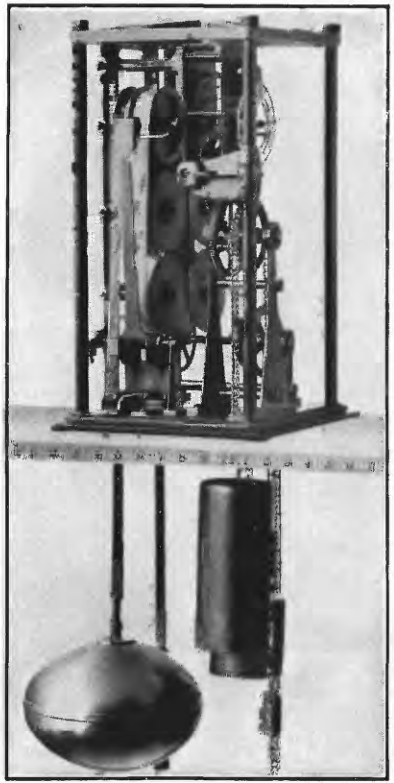
A. PRICE CURRENT METERS



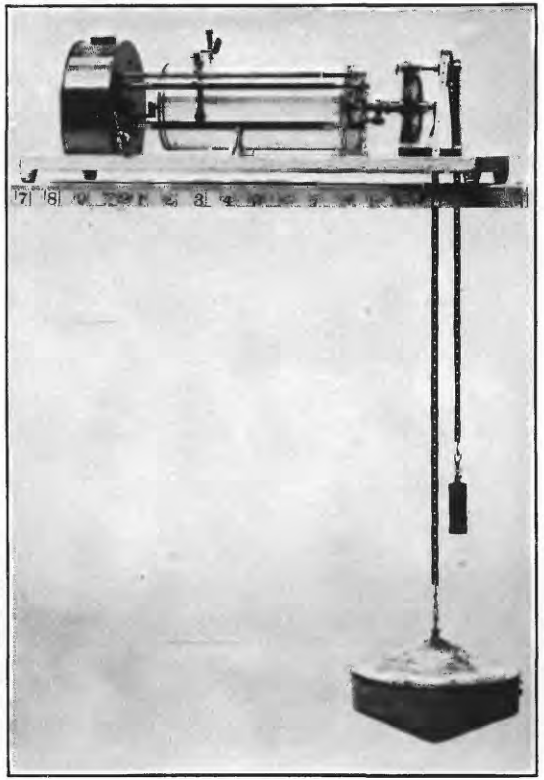
B. TYPICAL GAGING STATION.



A. STEVENS.



B. GURLEY PRINTING.



C. FRIEZ.

WATER-STAGE RECORDERS.

the mean gage height was lowest. The column headed "Mean" is the average flow in cubic feet for each second during the month. On this average flow computations recorded in the remaining columns, which are defined on page 8, are based.

The deficiency table presented for some of the gaging stations shows the number of days in each year on which the mean daily discharge was less than the discharge given in the table. By subtraction the table gives the number of days each year that the mean daily discharge was between the discharges given in the table and, also by subtraction, the number of days that the mean daily discharge was equal to or greater than the discharge given. If one discharge rating table was used throughout the period covered by the deficiency table, gage heights that correspond to the discharges are also given. For convenience the theoretical horsepower per foot of fall corresponding to the discharge is given in the table on page 8. In using the table for studies of power, allowance should be made for the various losses, the most important being wheel loss and head loss.

ACCURACY OF FIELD DATA AND COMPUTED RESULTS.

The accuracy of stream-flow data depends primarily (1) on the permanence of the 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 or footnotes added to the tables 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 heights to the rating table to obtain the daily discharge.[1]

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

[1] For a more detailed discussion of the accuracy of stream-flow data see Grover, N. C., and Hoyt, J. C., Accuracy of stream-flow data: U. S. Geol. Survey Water-Supply Paper 400, pp. 53–59, 1916.

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 table of monthly discharge gives 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.

During the year ending September 30, 1916, the work of measuring streams in Texas was carried on under cooperative agreement with the Director of the Federal Survey and the Board of Water Engineers for the State of Texas, consisting of J. C. Nagle, chairman, John Wilson, and E. B. Gore.

Special acknowledgments are due to the United States Reclamation Service and the United States Weather Bureau for equipment used and assistance rendered in Pecos River valley, upper Trinity and Brazos River basins, and Colorado River basin. The United States Weather Bureau furnished a large part of the equipment for the evaporation station near Austin.

The United States Indian Office paid the greater part of the observer's salary at the stations near Taos.

The following cities, organizations, private companies, and railroads have aided in the collection of records by furnishing funds or otherwise assisting: City of San Angelo; city of Corpus Christi; Cuero Commercial Club; San Marcos Utilities Co.; Barstow Irrigation Co.; Imperial Irrigation Co.; Arlington Land Co.; Kansas City, Mexico & Orient Railroad; San Antonio, Uvalde & Gulf Railroad Co.; Pecos Valley Lines; Texas & Pacific Railway; Gulf, Colorado & Santa Fe Railway; and International & Great Northern Railway.

DIVISION OF WORK.

The data for stations in Texas were collected and prepared for publication under the direction of Glenn A. Gray, district engineer, who was assisted by H. J. Dean, assistant engineer; R. C. Pierce and William Kessler, junior engineers; and R. C. Thaxton, Russell J. Hank, Victor Lieb, and W. C. Dodd, State hydrographers.

The data for stations in the Rio Grande drainage basin in New Mexico were collected and prepared for publication under the direction of Robert Follansbee, district engineer, who was assisted by

G. S. Cowdrey, jr., assistant engineer, and W. R. King, H. W. Fear, P. V. Hodges, and H. K. Smith, junior engineers.

The manuscript was assembled and reviewed by H. J. Dean and G. C. Stevens.

GAGING-STATION RECORDS.

TRINITY RIVER BASIN.

TRINITY RIVER AT BRIDGEPORT, TEX.

LOCATION.—At the suspension bridge on Balsora-Bridgeport road, half a mile southwest of center of Bridgeport, Wise County, a quarter of a mile above the Chicago, Rock Island & Gulf Railway Co. pumping plant, and 1 mile below mouth of Gentry Creek.

DRAINAGE AREA.—1,060 square miles (revised).

RECORDS AVAILABLE.—October 1, 1914, to September 30, 1916. Record of stage has been obtained by United States Weather Bureau from August 16, 1908, to October 16, 1915.

GAGE.—Weight-and-tape gage of the Mott type, fastened to downstream side of bridge, 56 feet from north end of guard rail; read by U. E. Byers.

DISCHARGE MEASUREMENTS.—Made from downstream side of bridge or by wading.

CHANNEL AND CONTROL.—Bed composed of clay, gravel, and sand. Banks are high, slightly wooded, and are overflowed at a stage of 25 feet. Channel straight above and below station for 100 feet. Control is a rock outcrop three-quarters of a mile below station.

EXTREMES OF DISCHARGE.—Maximum stage recorded during year, 22.70 feet at 6 p. m. April 2 (discharge, 10,800 second-feet); no flow October 8–11.

1908–1916: Maximum stage recorded, 28.9 feet June 8, 1915 (discharge not determined); no flow October 8–11, 1915.

ICE.—None reported during year.

DIVERSIONS.—None above station for power development; extensive irrigation not required, as ordinarily the precipitation in the drainage basin is sufficient to mature crops. The operation of the few small pumping plants along the stream produces little noticeable effect.

REGULATION.—Flow unaffected by water-power plants, dams, or reservoirs above or immediately below the station.

ACCURACY.—Stage-discharge relation changes slightly. Rating curve well defined. Gage read to hundredths twice daily. Daily discharge ascertained by applying mean-daily gage heights to rating table, except for periods during which stage-discharge relation was affected by shifting control. Results good except for low water for which they are fair.

COOPERATION.—Gage-height record for October 1–16 furnished by the United States Weather Bureau.

Discharge measurements of Trinity River at Bridgeport, Tex., during the year ending Sept. 30, 1916.

Date.	Made by—	Gage height.	Discharge.	Date.	Made by—	Gage height.	Discharge.
		Feet.	*Sec.-ft.*			*Feet.*	*Sec.-ft.*
Oct. 21	Gray and Thaxton	8.58	1,490	Apr. 5	R. J. Hank	20.06	7,450
Nov. 11	R. C. Thaxton	1.37	7.2	6	do	13.44	3,190
Jan. 15	R. C. Pierce	1.59	15.5	6	do	12.97	2,950
Mar. 18	R. J. Hank	1.30	4.7	6	do	12.35	2,950
Apr. 2	do	22.70	10,800	8	do	4.25	459
3	do	19.60	7,260	June 21	do	1.40	4.9
3	do	18.56	5,880	Sept. 8	do	1.87	27.4
3	do	18.41	5,920				

Daily discharge, in second-feet, of Trinity River at Bridgeport, Tex., for the year ending Sept. 30, 1916.

Day.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.
1	28	7.7	5.7	7.0	152	7.7	3,260	6,360	8.8	2.7	1.3	44
2	8.0	6.0	5.7	20	49	7.7	9,360	2,840	7.3	2.5	1.3	102
3	1.5	3.8	5.7	18	20	7.7	6,600	1,190	6.0	2.4	1.3	59
4	.7	2.4	5.4	15	16	7.7	7,950	676	6.0	2.4	1.2	12
5	.3	2.2	5.0	11	12	7.7	6,800	224	15	2.4	1.2	23
6	.3	2.0	5.0	10	14	7.3	2,780	160	17	2.3	1.2	176
7	.3	6.7	7.0	9.2	14	7.3	1,130	100	14	2.2	1.1	180
8	.0	7.0	7.0	8.4	21	7.0	457	81	12	2.2	1.1	22
9	.0	7.0	6.0	8.4	24	7.0	401	70	10	2.0	1.1	14
10	.0	7.0	5.7	7.7	18	7.0	285	55	8.8	2.0	1.0	17
11	.0	7.0	5.0	7.0	16	7.0	210	43	7.7	2.0	1.0	13
12	.7	7.0	5.0	7.0	12	6.7	119	35	6.0	1.9	1.0	12
13	.7	7.0	5.0	12	12	6.7	71	29	5.4	1.8	.9	10
14	.3	7.0	5.0	57	12	6.4	43	26	20	1.8	.9	8.8
15	.3	6.4	5.0	15	12	6.0	950	26	21	1.7	.9	7.3
16	.7	6.0	6.0	12	11	5.7	655	32	10	1.7	.9	5.7
17	1,180	5.7	7.0	11	10	5.7	682	39	5.0	1.6	.9	5.0
18	744	5.0	7.0	9.2	9.6	5.0	394	32	5.4	1.6	.9	2.5
19	1,160	4.5	6.0	7.0	9.2	5.4	247	28	5.0	1.6	.8	2.0
20	1,600	4.5	6.0	12	8.4	5.0	156	31	4.7	1.6	.7	1.3
21	1,520	4.5	5.7	3,530	8.4	5.0	116	222	5.4	1.5	.7	.9
22	436	4.5	5.0	1,330	10	5.4	86	152	4.3	1.5	.7	.7
23	97	4.5	5.0	1,280	10	5.4	63	114	3.4	1.5	.7	.7
24	45	4.5	5.0	210	10	6.0	81	74	2.9	1.5	.6	.6
25	34	5.0	5.0	97	9.2	197	65	37	2.5	1.5	.5	.6
26	22	6.0	5.0	170	8.4	121	56	27	2.5	1.4	.5	.6
27	20	6.0	5.0	611	8.4	49	49	21	2.5	1.4	.5	.6
28	16	6.0	5.0	210	8.0	20	37	17	2.4	1.4	.5	.5
29	15	6.0	5.0	58	7.7	9.2	24	15	2.5	1.3	.5	.5
30	13	6.0	5.0	105	.....	8.0	17	13	2.7	1.3	.5	.5
31	9.2	.....	6.4	462	.....	7.3	.....	10	.....	1.3	.4	.....

NOTE.—Discharge determined as follows: Oct. 1-16 and Oct 24 to May 1, from a well-defined rating curve; May 6 to Sept. 30, from a parallel rating curve; Oct. 17-23 and May 2-5, by indirect method for shifting control.

Monthly discharge of Trinity River at Bridgeport, Tex., for the year ending Sept. 30, 1916.

Month.	Discharge in second-feet.			Run-off (total in acre-feet).
	Maximum.	Minimum.	Mean.	
October	1,600	0.0	224	13,800
November	7.7	2.0	5.50	327
December	7.0	5.0	5.56	342
January	3,530	7.0	269	16,500
February	152	7.7	18.4	1,060
March	197	5.0	18.3	1,130
April	9,360	17	1,440	85,700
May	6,360	10	412	25,300
June	21	2.4	7.54	449
July	2.7	1.3	1.81	111
August	1.3	.4	.86	53
September	180	.5	24.1	1,430
The year	9,360	.0	201	146,000

BRAZOS RIVER BASIN.

BRAZOS RIVER NEAR GRAHAM, TEX.

LOCATION.—At the two-span steel highway bridge on the Murray road, 6 miles above mouth of Clear Fork, 10 miles west of Graham, Young County.

DRAINAGE AREA.—12,900 square miles.

RECORDS AVAILABLE.—November 13, 1915, to September 30, 1916.

GAGE.—Vertical staff on left downstream corner of middle pier; read by Mrs. John Timmons.

DISCHARGE MEASUREMENTS.—Made from upstream side of bridge or by wading.

CHANNEL AND CONTROL.—Channel straight above and below station. Bed composed of sand and clay; free from vegetation, shifting. Left bank high and not subject to overflow; right bank is of medium height and is overflowed during high stages.

EXTREMES OF DISCHARGE.—Maximum stage recorded during year, 9.50 feet at 6 p. m. April 2 (discharge, 4,100 second-feet; result obtained from extension of rating curve and possibly subject to considerable error); no flow March 29 and 30, and August 10–31.

ICE.—Slight amount of ice reported in January.

DIVERSIONS.—No information available to show that water is diverted above station in any large quantity for irrigation; no diversions between station and mouth of Clear Fork.

REGULATION.—Number of power plants and controlling works above station not known; gage-height record does not indicate that flow is regulated.

ACCURACY.—Stage-discharge relation not permanent; not affected by ice during the year. Rating curve poorly defined. Gage read to hundredths twice daily. Daily discharge ascertained by applying mean daily gage heights to rating table except for periods during which stage-discharge relation is affected by shifting control. Determinations of discharge above 2,000 second-feet obtained from an extension of rating curve and subject to considerable error. Results poor.

Discharge measurements of Brazos River near Graham, Tex., during the year ending Sept. 30, 1916.

Date.	Made by—	Gage height.	Discharge.	Date.	Made by—	Gage height.	Discharge.
		Feet.	*Sec.-ft.*			*Feet.*	*Sec.-ft.*
Oct. 22	Thaxton and Gray	6.57	1,450	Apr. 4	R. J. Hank	6.52	1,760
Nov. 13	R. C. Thaxton	4.41	86	7	do	6.25	1,020
Jan. 17	R. C. Pierce	[a] 3.70	9.7	June 22	do	4.71	41.5
Mar. 20	R. J. Hank	3.33	[b] 1.5	Sept. 9	do	4.90	164

[a] River frozen over in places but stage discharge relation not appreciably affected.
[b] Estimated.

Daily discharge, in second-feet, of Brazos River near Graham, Tex., for the year ending Sept. 30, 1916.

Day.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.
1	.....	12	15	13	4.0	219	572	732	462	3.4	1.0
2	.....	13	13	12	2.8	2,860	210	551	254	3.0	3.4
3	.....	13	13	11	2.6	3,390	101	420	173	5.6	1,600
4	.....	13	12	14	1.8	1,920	96	249	66	6.2	1,800
5	.....	13	13	14	3.0	1,590	151	177	53	4.6	996
6	.....	13	13	15	2.6	1,310	274	109	32	3.4	716
7	.....	20	13	14	2.2	1,080	139	614	18	2.2	593
8	.....	24	13	12	2.0	1,070	46	558	14	1.6	289
9	.....	15	13	13	1.0	635	31	444	10	1.0	166
10	.....	17	12	10	1.0	474	34	378	5.4	.0	177
11	.....	17	10	12	3.0	294	27	223	4.6	.0	127
12	.....	13	10	11	3.0	219	22	860	5.0	.0	89
13	86	13	10	10	1.8	148	21	1,040	4.6	.0	80
14	71	13	13	8.5	.6	450	16	748	3.8	.0	76
15	34	13	13	8.5	.9	1,610	22	558	3.4	.0	92
16	34	17	10	7.6	1.2	1,160	24	426	4.0	.0	72
17	29	40	10	6.6	1.4	656	18	289	4.4	.0	58
18	24	63	12	5.0	.6	495	12	133	4.8	.0	47
19	24	47	12	5.0	.4	354	11	87	5.0	.0	23
20	24	34	14	5.0	1.8	206	10	74	4.2	.0	18
21	24	34	37	5.0	1.2	289	1,720	57	4.0	.0	16
22	20	34	26	5.4	1.0	191	724	37	4.8	.0	13
23	17	34	16	5.2	1.8	139	462	26	4.0	.0	12
24	13	34	15	5.4	1.0	89	330	21	4.0	.0	11
25	13	24	13	5.0	1.4	52	142	15	3.8	.0	28
26	15	24	17	4.2	1.2	74	89	12	3.0	.0	18
27	13	24	14	3.4	1.0	65	58	33	2.8	.0	19
28	13	15	15	2.6	.2	71	2,220	916	2.4	.0	115
29	10	12	17	3.4	.0	402	820	812	3.0	.0	127
30	10	13	284	.....	.0	544	1,250	488	3.6	.0	84
31	.....	13	15	.....	1.0	.....	1,060	.....	2.8	.0	.....

NOTE.—Discharge determined from rating table Nov. 13 to Mar. 31 and by indirect method for shifting control Apr. 1 to Sept. 30.

Monthly discharge of Brazos River near Graham, Tex., for the year ending Sept. 30, 1916.

Month.	Discharge in second-feet.			Run-off (total in acre-feet).
	Maximum.	Minimum.	Mean.	
November 13–30	86	10	26.3	939
December	63	12	22.1	1,360
January	284	10	23.0	1,410
February	15	2.6	8.51	490
March	4.0	.0	1.53	94
April	3,390	52	735	43,700
May	2,220	10	3[illegible]	21,300
June	1,040	12	370	22,000
July	462	2.4	37.7	2,320
August	6.2	.0	1.00	61
September	1,800	1.0	2[illegible]	14,800
The period	.....	.....	.....	108,000

BRAZOS RIVER AT BRAZOS, TEX.

LOCATION.—At Texas & Pacific Railway bridge half a mile northeast of Brazos, Palo Pinto County, 1½ miles above mouth of Palo Pinto Creek.

DRAINAGE AREA.—20,200 square miles (revised).

RECORDS AVAILABLE.—October 1, 1914, to September 30, 1916. Records of stage have been obtained by the United States Weather Bureau since August 16, 1908.

GAGE.—Vertical staff on northwest side of and one foot from upstream edge of pier nearest the middle of the railway bridge; graduations above 4 feet painted on the pier; read by L. W. Boyett.

DISCHARGE MEASUREMENTS.—Made from three-span highway bridge about 600 feet below railway bridge.

CHANNEL AND CONTROL.—Bed composed of sand and gravel; shifts slightly at low water. Right bank high, rocky, wooded, and not subject to overflow; left bank composed of sand, gravel, and clay, wooded, medium in height, and subject to overflow at high water. Channel straight above and below for several thousand feet.

EXTREMES OF DISCHARGE.—Maximum stage recorded during year, 9.60 feet at 7 a. m., April 2 (discharge, 42,500 second-feet; result obtained from extension of rating curve and possibly subject to considerable error); minimum stage, no flow August 25 to September 1.

1908–1916: Maximum stage recorded, 22.0 feet May 24, 1908 (discharge not determined); no flow for several periods within limits of observations.

ICE.—None reported during year.

DIVERSIONS.—A few pumping plants have been installed along the stream for the purpose of irrigating small areas, but water so pumped will not greatly affect the flow of the stream.

REGULATION.—Flow unaffected by power plants, dams, or reservoirs above or immediately below station. Swamps and natural lakes are rare in the drainage basin above the station.

ACCURACY.—Stage-discharge relation not permanent. Two rating curves each fairly well defined below 18,000 second-feet, were used during the year. Gage read to half-tenths once daily. Daily discharge ascertained by applying daily gage heights to rating tables. Results fair. Determinations for extremely high stages obtained from extension of the rating curve and may be considerably in error.

COOPERATION.—Record of gage height October 1–19 furnished by the United States Weather Bureau.

Discharge measurements of Brazos River at Brazos, Tex., during the year ending Sept. 30, 1916.

Date.	Made by—	Gage height.	Discharge.	Date.	Made by—	Gage height.	Discharge.
		Feet.	*Sec.-ft.*			*Feet.*	*Sec.-ft.*
Oct. 20	Gray and Thaxton	6.90	12,000	Apr. 3	William Kessler	7.47	17,000
Nov. 10	R. C. Thaxton	1.45	272	June 26	R. J. Hank	1.20	130
Jan. 20	R. C. Pierce	.90	49.6	Sept. 11	do	1.60	344
Mar. 26	R. J. Hank	.48	27.3				

Daily discharge, in second-feet of Brazos River at Brazos, Tex., for the year ending Sept. 30, 1916.

Day.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.
1	2,880	695	130	88	180	40	4,730	3,710	6,720	660	20	0.0
2	2,430	625	130	88	130	37	35,900	7,450	2,960	1,760	18	.8
3	2,150	625	130	88	130	37	14,400	6,720	1,640	1,500	17	45
4	1,890	555	130	88	130	37	9,400	5,450	1,250	930	14	30
5	1,640	555	130	88	130	37	4,440	2,360	850	639	12	20
6	1,520	485	130	88	130	37	3,890	1,410	555	471	11	1,520
7	1,410	485	130	88	88	37	3,890	1,060	625	402	11	1,520
8	1,300	415	88	88	83	37	2,730	850	485	338	11	1,100
9	1,200	415	88	64	64	34	2,080	834	415	279	11	770
10	1,100	320	88	64	64	34	1,860	755	450	222	11	520
11	1,010	290	88	64	61	34	1,660	681	850	170	11	382
12	930	290	88	64	50	32	1,320	611	590	122	11	338
13	850	233	88	64	50	32	1,060	541	485	83	11	279
14	770	233	88	64	50	32	890	471	471	64	8.5	222
15	695	233	88	64	50	30	732	402	415	64	8.5	170
16	625	233	88	64	50	30	2,700	338	1,460	69	8.5	122
17	625	180	88	64	50	30	4,930	290	1,220	76	6.0	88
18	555	180	88	50	50	28	2,960	290	970	50	6.0	88
19	17,300	180	88	50	50	28	2,150	290	786	48	6.0	83
20	10,700	180	88	50	46	28	2,020	290	590	45	4.0	64
21	5,700	180	88	50	46	28	1,410	290	450	40	2.8	64
22	3,890	180	88	50	46	28	970	429	338	40	2.0	61
23	2,580	180	88	930	46	28	732	890	279	36	1.0	50
24	2,500	180	88	611	43	28	625	1,700	233	36	1.0	50
25	2,020	180	88	485	43	28	590	1,200	222	32	.0	50
26	1,580	180	88	320	43	28	471	786	155	28	.0	48
27	1,360	180	88	222	40	28	402	590	130	28	.0	40
28	1,060	180	88	180	40	28	350	450	122	26	.0	40
29	890	180	88	180	40	28	350	338	109	24	.0	38
30	732	180	88	180	.....	28	350	279	88	24	.0	32
31	695	.....	88	180	.....	28	.....	1,960	.....	24	.0	.....

NOTE.—Discharge determined from two rating tables applicable Oct. 1 to July 18 and July 19 to Sept. 30.

Monthly discharge of Brazos River at Brazos, Tex., for the year ending Sept. 30, 1916.

Month.	Discharge in second-feet.			Run-off (total in acre-feet).	Accuracy.
	Maximum.	Minimum.	Mean.		
October	17,300	555	2,410	148,000	C.
November	695	180	307	18,300	C.
December	130	88	97.5	6,000	C.
January	930	50	155	9,530	C.
February	180	40	69.8	4,010	C.
March	40	28	31.6	1,940	C.
April	35,900	350	3,670	218,000	C.
May	7,450	279	1,410	86,700	C.
June	6,720	88	864	51,400	C.
July	1,760	24	262	16,100	C.
August	20	.0	7.20	443	C.
September	1,520	.0	261	15,500	C.
The year	35,900	.0	794	576,000	

BRAZOS RIVER AT WACO, TEX.

LOCATION.—At suspension bridge on Bridge Street, in city of Waco, McLennan County, just below Southern Traction Co.'s bridge, 2½ miles below mouth of Bosque River, 4½ miles above mouth of Cottonwood Creek, about 10 miles above lock No. 8, now under construction.

DRAINAGE AREA.—25,500 square miles (revised).

RECORDS AVAILABLE.—September 14, 1898, to December 31, 1911; October 1, 1914, to September 30, 1916. Record of stage has been obtained by United States Weather Bureau since August 9, 1900.

GAGE.—Chain gage attached to downstream guard rail of bridge about 70 feet from southwest pier; read by A. E. Howell. Gage used from September 14, 1898, to February 29, 1908, was an inclined staff gage under left end of bridge. In 1902 a gage agreeing in datum with the inclined gage was marked off on the north pier of a new single-span highway bridge about 300 feet above the suspension bridge, and was used for high-water readings. From August 9, 1900, to May 21, 1902, the United States Weather Bureau used a vertical gage painted on the pier nearest the center of the St. Louis Southwestern Railway bridge. From September 25, 1914, to March 23, 1915, during reconstruction of suspension bridge, chain gage was on the one-span highway bridge. All gages were installed at same datum, but readings probably differ slightly because of differences in position.

DISCHARGE MEASUREMENTS.—Made from downstream side of first one-span highway bridge above station.

CHANNEL AND CONTROL.—Bed composed of sand and gravel; shifts. Banks are clay, medium in height, have been improved by the city, and are overflowed at extreme high water. Channel straight above and below for several thousand feet. Position of control not known.

EXTREMES OF DISCHARGE.—Maximum stage recorded during year, 33.8 feet at 8 a. m. April 2 (discharge, 113,000 second-feet; result obtained from extension of rating curve possibly subject to large error); minimum stage, 5.48 feet August 30 and 31 and September 1 and 2 (discharge, 119 second-feet).

1889–1916: Maximum stage recorded, 39.7 feet December 3, 1913 (discharge not determined); minimum stage, 2.00 feet March 8–10, 1902 (discharge, 20 second-feet).

ICE.—None reported during year.

DIVERSIONS.—So far as is known there are no diversions of any magnitude above station. Small areas of land are irrigated above station, but quantity of water diverted is only a small percentage of the total flow.

REGULATION.—Lock No. 8 will eventually control flow at this station; flow only slightly controlled at present.

ACCURACY.—Stage-discharge relation not permanent. Rating curve used as basis for ascertaining discharge by indirect method is fairly well defined. Gage read to quarter-tenths once daily. Slight errors may be introduced by taking one daily gage reading as the mean for the day. Daily discharge ascertained by indirect method for shifting control. Results fair.

COOPERATION.—Record of gage heights October 1–23 furnished by United States Weather Bureau.

Discharge measurements of Brazos River at Waco, Tex., during the year ending Sept. 30, 1916.

Date.	Made by—	Gage height.	Discharge.	Date.	Made by—	Gage height.	Discharge.
		Feet.	*Sec.-ft.*			*Feet.*	*Sec.-ft.*
Oct. 24	Gray and Thaxton	9.56	4,700	May 3	Kessler and Thaxton	16.76	28,500
Nov. 16	R. C. Thaxton	6.64	465	3	do	15.71	23,500
Jan. 21	R. C. Pierce	7.63	1,080	4	William Kessler	12.72	11,900
Mar. 17	R. J. Hank	6.58	374	4	do	12.42	10,900
Apr. 2	William Kessler	33.36	[a]109,000	June 27	R. J. Hank	7.13	751
4	do	15.69	19,000	Sept. 12	do	7.62	1,180
9	R. J. Hank	12.14	9,900				

[a] Only surface velocities obtained; coefficient of 0.88 used to reduce to mean velocity.

Daily discharge, in second-feet, of Brazos River at Waco, Tex., for the year ending Sept. 30, 1916.

Day.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.
1	6,230	1,280	316	296	8,050	607	50,700	5,750	1,270	489	215	119
2	5,600	1,130	288	338	3,400	594	97,800	45,600	1,120	467	220	119
3	4,550	1,040	274	338	2,690	533	46,100	25,700	955	715	200	125
4	3,620	880	282	378	2,360	522	21,000	12,500	5,540	436	192	200
5	2,720	730	324	414	2,210	478	18,600	13,500	3,570	1,210	180	555
6	2,270	672	316	360	1,940	533	10,000	10,300	2,680	478	245	760
7	1,970	646	937	360	1,680	522	46,500	7,450	2,500	1,580	200	445
8	1,580	594	872	330	1,540	489	18,800	6,040	6,640	1,260	180	348
9	1,360	544	1,040	324	1,510	478	10,000	4,860	4,250	1,090	172	306
10	1,270	522	640	324	1,430	489	8,050	4,070	2,220	880	172	245
11	1,270	467	427	324	1,320	450	6,900	3,350	1,780	708	160	278
12	1,270	467	396	320	1,310	436	5,680	2,770	1,390	607	265	1,180
13	1,360	427	352	310	1,130	436	4,840	2,340	1,060	533	245	1,090
14	1,360	594	334	274	1,010	436	4,420	2,140	937	478	215	910
15	1,270	467	334	264	982	404	3,760	1,850	10,000	436	186	672
16	1,090	436	373	264	964	391	13,800	1,610	6,610	400	172	533
17	910	400	341	242	895	378	5,470	1,430	3,550	382	156	400
18	1,840	355	341	235	880	391	4,840	7,780	2,090	382	140	341
19	3,440	338	440	235	820	391	3,980	6,330	3,190	320	137	285
20	5,200	327	418	327	805	404	3,480	3,480	2,330	285	137	260
21	11,100	327	494	880	820	404	5,470	10,000	1,920	391	125	240
22	8,510	302	427	3,730	805	391	4,380	3,730	1,680	278	122	220
23	5,620	302	396	2,360	790	391	3,870	2,570	1,400	320	225	215
24	4,660	327	382	1,480	745	382	3,800	2,330	1,160	250	160	200
25	4,250	334	316	3,550	745	404	2,850	1,920	1,040	245	137	196
26	3,930	288	306	2,690	692	382	2,300	1,610	880	250	125	196
27	3,300	274	302	6,100	659	348	1,840	1,430	745	240	140	250
28	2,540	274	296	3,910	692	348	1,630	2,660	659	240	137	400
29	2,280	248	288	2,860	626	895	1,490	2,300	730	225	125	220
30	1,890	274	296	2,630	.....	805	1,360	1,760	581	232	119	180
31	1,560	.....	302	9,620	.....	646	.....	1,460	.....	220	119	.....

Monthly discharge of Brazos River at Waco, Tex., for the year ending Sept. 30, 1916.

Month.	Discharge in second-feet.			Run-off (total in acre-feet).
	Maximum.	Minimum.	Mean.	
October	11,100	910	3,220	198,000
November	1,280	274	509	30,300
December	1,040	274	415	25,500
January	9,620	235	1,490	91,600
February	8,050	626	1,500	86,300
March	895	348	476	29,300
April	97,800	1,360	13,800	821,000
May	45,600	1,430	6,470	398,000
June	10,000	581	2,480	148,000
July	1,880	220	523	32,200
August	285	119	172	10,600
September	1,180	119	383	22,800
The year	97,800	119	2,610	1,890,000

Days of deficiency in discharge of Brazos River at Waco, Tex., for the years ending Sept. 30, 1901–1910 and 1915–16.

Discharge in second-feet.	Days of deficient discharge.											
	1900–01	1901–2	1902–3	1903–4	1904–5	1905–6	1906–7	1907–8	1908–9	1909–10	1914–15	1915–16
100	34	76	1	14	.....	.....	.....	.....	203	144	.....	.....
200	73	124	17	98	15	.....	1	2	260	220	.....	32
300	115	141	33	125	63	16	17	20	287	246	4	76
400	164	152	42	148	98	79	61	31	300	260	28	132
500	199	163	71	181	126	106	102	43	307	282	38	164
600	220	177	98	202	136	130	131	56	310	293	42	177
700	242	192	130	215	141	145	153	65	314	294	49	189
800	256	206	168	239	153	160	179	73	315	305	53	198
900	266	222	184	254	161	168	220	97	317	310	67	211
1,000	274	235	192	260	164	172	233	109	317	314	83	218
1,200	288	250	217	280	184	196	265	153	326	322	124	231
1,400	296	265	230	286	195	210	271	183	328	329	152	247
1,600	299	279	243	298	214	233	290	218	335	336	176	258
1,800	301	292	256	300	227	242	298	232	340	338	199	265
2,000	306	302	259	304	233	249	302	250	341	341	204	273
2,500	314	314	274	313	245	279	317	274	345	347	223	287
3,000	326	323	293	322	252	297	325	291	348	348	245	298
4,000	337	327	320	333	274	315	338	307	353	350	277	317
5,000	345	337	332	344	291	322	347	318	356	351	294	327
6,000	349	342	339	349	308	335	354	325	358	352	306	335
7,000	352	346	342	354	314	340	355	329	358	355	314	342
8,000	354	350	348	356	320	343	357	333	360	357	316	344
9,000	357	351	352	357	329	347	358	335	360	357	321	347
10,000	358	352	354	360	331	352	359	337	360	357	326	352
15,000	361	357	359	364	343	359	365	343	360	362	339	357
20,000	363	359	361	365	354	361	.....	348	362	362	344	359
40,000	365	361	365	366	362	364	.....	356	365	365	354	361
60,000	.....	363	.....	.....	364	365	.....	359	.....	.....	357	365
80,000	.....	365	.....	.....	364	.....	.....	360	.....	.....	361	365
100,000	.....	.....	.....	.....	365	.....	.....	363	.....	.....	365	366
150,000	.....	.....	.....	.....	.....	.....	.....	366	.....	.....	.....	.....

CLEAR FORK OF BRAZOS RIVER NEAR ELIASVILLE, TEX.

LOCATION.—At new suspension highway bridge 2½ miles northeast of Eliasville, Young County, 4½ miles southwest of South Bend, 6 miles above mouth of stream, and below all tributaries.

DRAINAGE AREA.—5,650 square miles.

RECORDS AVAILABLE.—November 12, 1915, to September 30, 1916.

GAGE.—Chain gage attached to downstream handrail of bridge; read by Alice Vaughn.

DISCHARGE MEASUREMENTS.—Made from bridge or by wading.

CHANNEL AND CONTROL.—Banks high, wooded, composed of clay and gravel, and not subject to overflow. Bed composed of sand and gravel; free from vegetation. Channel straight above and below station. A shoal about 600 feet below station serves as control for low and medium stages; control shifts slightly during changing stages.

EXTREMES OF DISCHARGE.—Maximum stage recorded during year, 18.2 feet 6 p. m. May 2 (discharge, 7,800 second-feet; result obtained from extension of rating curve and possibly subject to considerable error); no flow August 23 to September 30.

ICE.—None reported during year.

DIVERSIONS.—Much of the land now irrigated above station is in Jones and Taylor counties. Two diversions are made for irrigation between station and confluence of Clear Fork with Brazos River. Quantity of water diverted unknown. According to the First Report of the Board of Water Engineers for the State of Texas, the Sweetwater Light & Power Co. has filed on 100 acre-feet of water for storage in the headwater region.

REGULATION.—No large reservoir above or below station. The operation of a water-power gristmill 5 miles upstream produces some effect at the station.

ACCURACY.—Stage-discharge relation not permanent. Rating curve fairly well defined below 2,000 second-feet and poorly defined above. Gage read to hundredths twice daily; observer's work not entirely satisfactory; mean daily gage height may not be true index of daily flow because of regulation for power. Daily discharge ascertained by applying mean daily gage heigl t to rating table except for periods during which stage-discharge relation is affected by shifting control. Results fair.

Discharge measurements of Clear Fork of Brazos River near Eliasville, Tex., during the year ending Sept. 30, 1916.

Date.	Made by—	Gage height.	Discharge.	Date.	Made by—	Gage height.	Discharge.
		Feet.	*Sec.-ft.*			*Feet.*	*Sec.-ft.*
Oct. 22	Gray and Thaxton	5.55	586	Apr. 4	R. J. Hank	7.74	1,610
Nov. 12	R. C. Thaxton	3.11	6.6	7	do	4.69	127
Jan. 17	R. C. Pierce	2.91	1.7	June 22	do	3.81	52.6
Mar. 19	R. J. Hank	3.00	3.4	Sept. 9	do	2.69	.0

Daily discharge, in second-feet, of Clear Fork of Brazos River near Eliasville, Tex., for the year ending Sept. 30, 1916.

Day.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.
1			2.6	3.2	1.2	1.6	533	193	368	386	14	0.0
2			2.6	3.2	1.4	1.6	7,200	7,400	136	190	14	.0
3			2.6	3.0	1.4	1.6	3,200	1,240	104	130	12	.0
4			2.2	3.2	1.4	1.6	1,560	276	77	124	11	.0
5			2.3	3.5	1.4	1.6	1,080	213	63	116	10	.0
6			2.2	3.5	1.4	1.6	311	108	50	96	10	.0
7			2.3	2.9	1.7	1.6	129	102	47	82	10	.0
8			2.3	3.5	1.4	1.6	172	79	38	72	10	.0
9			2.3	4.5	1.4	1.6	138	58	33	52	6.8	.0
10			2.6	4.0	1.4	1.6	81	48	30	52	5.0	.0
11			2.6	3.2	1.4	1.6	71	44	21	52	4.5	.0
12		6.4	3.2	3.2	1.4	1.6	51	44	21	52	3.5	.0
13		7.6	2.6	2.8	1.4	1.6	51	40	21	52	3.5	.0
14		4.0	2.4	3.5	1.6	1.6	51	40	15	43	3.5	.0
15		3.8	2.3	3.5	1.6	1.6	51	28	15	35	3.4	.0
16		4.8	5.0	4.0	1.4	1.6	51	24	148	35	2.6	.0
17		5.0	5.2	3.2	1.4	1.6	51	24	95	35	2.0	.0
18		4.5	5.8	1.2	1.4	1.6	51	24	71	35	.5	.0
19		5.0	5.0	1.2	1.4	3.5	51	17	51	35	.5	.0
20		5.5	5.5	1.4	1.4	2.0	51	17	44	33	.5	.0
21		4.0	5.0	1.4	1.4	2.0	51	17	44	31	.5	.0
22		3.8	5.0	1.4	1.6	2.0	47	17	44	31	.4	.0
23		3.4	5.0	1.4	1.4	2.0	42	17	58	27	.0	.0
24		3.8	5.0	1.6	1.2	2.0	41	16	57	27	.0	.0
25		3.5	5.0	1.4	1.2	2.0	41	26	52	27	.0	.0
26		3.4	5.0	1.4	1.6	2.0	33	38	52	27	.0	.0
27		3.5	4.8	1.4	1.2	2.0	25	38	52	27	.0	.0
28		3.5	4.5	1.4	1.2	2.0	25	38	64	27	.0	.0
29		3.2	4.2	1.4	1.2	2.0	25	1,080	1,660	20	.0	.0
30		2.9	4.5	1.4	.....	2.0	33	5,200	1,040	14	.0	.0
31		.....	4.5	1.4	.....	2.0	.....	3,100	.....	14	.0	.....

NOTE.—Discharge determined as follows: Nov. 12 to Apr. 4, and May 2 to Sept. 30 from rating tables; Apr. 5 to May 1, by indirect method for shifting control.

Monthly discharge of Clear Fork of Brazos River near Eliasville, Tex., for the year ending Sept. 30, 1916.

Month.	Discharge in second-feet.			Run-off (total in acre-feet).
	Maximum.	Minimum.	Mean.	
November 12–30	7.6	2.9	4.29	162
December	5.8	2.2	3.75	231
January	4.5	1.2	2.49	153
February	1.7	1.2	1.40	81
March	3.5	1.6	1.82	112
April	7,200	25	510	30,300
May	7,400	16	629	38,700
June	1,660	15	152	9,040
July	386	14	63.8	3,920
August	14	.0	4.14	255
September	.0	.0	.00	0
The period				83,000

COLORADO RIVER BASIN.

COLORADO RIVER NEAR BRONTE, TEX.

LOCATION.—At wagon bridge 400 feet below Kansas City, Mexico & Orient Railroad bridge 1½ miles above mouth of Kickapoo Creek and below mouth of Live Oak Creek, 2½ miles south of Bronte, Coke County.

DRAINAGE AREA.—5,550 square miles.

RECORDS AVAILABLE.—September 19, 1915, to September 30, 1916.

GAGE.—Chain gage attached to downstream side of bridge near left bank; read by R. W. Legg. A vertical staff gage attached to left bent of railroad bridge 400 feet above present site and referred to same datum was used from September 19, 1915, to October 29, 1915.

DISCHARGE MEASUREMENTS.—Made from downstream side of bridge or by wading.

CHANNEL AND CONTROL.—Bed composed of a clay hardpan mixed with gravel; shifts. Channel straight about 500 feet above and below station. Right bank wooded, sloping, and subject to overflow at extreme stages; left bank high, clean, and not subject to overflow. Control probably at shoal 300 feet below gage.

EXTREMES OF DISCHARGE.—1915–16: Maximum stage recorded during year, 15.0 feet at 2 a. m. September 25, 1916 (discharge not determined); no flow May 13–29, June 8 to July 29, and August 6–21.

ICE.—None reported during year.

DIVERSIONS.—Some water is diverted for irrigating small areas in Coke and Mitchell counties and for municipal use of the city of Robert Lee. No large irrigation projects in drainage basin above station. The First Report of the Board of Water Engineers for the State of Texas records a filing at Robert Lee on a small quantity of water for storage, but this storage will not influence flow at station.

REGULATION.—Flow not affected by water-power plants or controlling works.

ACCURACY.—Stage-discharge relation not permanent. Rating curve well defined below 400 second-feet and is an extension above 450 second-feet. Gage read to hundredths twice daily. Daily discharge ascertained by applying mean daily gage heights to rating table except for periods during which stage-discharge relation is affected by ice. Results fair.

Discharge measurements of Colorado River near Bronte, Tex., during the period Sept. 19, 1915, to Sept. 30, 1916.

Date.	Made by—	Gage height.	Discharge.	Date.	Made by—	Gage height.	Discharge.
1915.		*Feet.*	*Sec.-ft.*	1916.		*Feet.*	*Sec.-ft.*
Sept. 19	Hank and Thaxton	2.62	156	Apr. 28	Hank and Gray	1.82	13.0
Oct. 29	R. J. Hank	1.87	28.5	June 20	R. J. Hank	1.43	.0
Dec. 18	do	1.61	3.7	Aug. 28	William Kessler	2.19	64.5
				28	do	2.10	51.0
1916.				29	do	2.00	32.6
Feb. 10	do	1.52	1.6	Sept. 5	R. J. Hank	2.65	179
Mar. 27	do	1.45	*a*.4	29	do	1.90	27.4

a Estimated.

Daily discharge, in second-feet, of Colorado River near Bronte, Tex., for the period Sept. 19, 1915, to Sept. 30, 1916.

Day.	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	June.	July.	Aug.	Sept.
1		107	18	2.8	2.2	2.2	1.4	272	217	36	0.0	8.0	63
2		87	16	2.8	2.2	2.2	1.4	63	49	18	.0	3.4	23
3		67	16	2.8	2.2	2.2	1.4	312	25	12	.0	1.8	178
4		49	16	2.8	4.1	2.2	1.4	440	14	8.0	.0	1.1	101
5		33	10	2.8	3.4	2.2	1.4	280	17	6.3	.0	1.1	162
6		26	10	14	3.0	2.2	1.1	169	11	5.5	.0	.0	93
7		20	10	15	3.0	1.8	.8	114	9.5	4.8	.0	.0	51
8		18	10	9.0	3.0	1.8	.8	79	9.0	.0	.0	.0	29
9		16	9.5	9.0	3.0	1.8	.8	53	7.0	.0	.0	.0	16
10		12	8.0	7.0	2.6	1.8	.3	36	6.3	.0	.0	.0	16
11		11	5.2	4.8	2.6	1.8	.3	29	6.3	.0	.0	.0	10
12		11	4.8	4.8	2.6	1.8	.3	25	5.2	.0	.0	.0	9.5
13		9.5	4.8	4.1	2.6	1.8	.3	20	.0	.0	.0	.0	8.5
14		8.0	4.5	4.1	2.4	1.8	.3	1,300	.0	.0	.0	.0	5.2
15		8.0	4.5	4.1	2.4	1.8	.3	292	.0	.0	.0	.0	5.6
16		7.0	4.5	4.1	2.4	1.6	.3	212	.0	.0	.0	.0	3.8
17		23	4.5	4.1	1.8	1.4	.3	171	.0	.0	.0	.0	23
18		926	4.5	3.8	2.4	1.4	.3	155	.0	.0	.0	.0	18
19	155	974	4.5	3.8	2.4	1.4	.3	120	.0	.0	.0	.0	13
20	97	541	4.5	3.4	2.4	1.4	.3	81	.0	.0	.0	.0	9.5
21	53	342	4.8	3.4	2.4	1.4	.3	67	.0	.0	.0	.0	5.9
22	33	201	4.5	3.2	2.2	1.4	.3	36	.0	.0	.0	1.4	4.5
23	1,050	151	4.1	2.8	2.2	1.4	.3	25	.0	.0	.0	330	49
24		118	3.8	2.6	2.2	1.4	.3	19	.0	.0	.0	233	310
25	417	83	3.4	2.4	2.2	1.4	.3	16	.0	.0	.0	699	1,160
26	900	63	3.0	2.4	2.2	1.4	.3	13	.0	.0	.0	252	160
27	651	53	2.4	2.4	2.2	1.4	.3	23	.0	.0	.0	122	89
28	485	41	3.4	2.4	2.2	1.4	.3	14	.0	.0	.0	83	49
29	330	33	3.4	2.2	2.2	1.4	.3	9.5	.0	.0	.0	28	25
30	155	21	3.4	2.2	2.2		.3	79	169	.0	4.5	15	16
31		20		2.2	2.2		.8		75		23	11	

NOTE.—Discharge determined as follows: Sept. 19 to Oct. 17, 1915, and Nov. 11, 1915, to Sept. 2, 1916, from rating table; Oct. 18 to Nov. 10, 1915, and Sept. 3–30, 1916, by indirect method for shifting control. Mean daily gage height Sept. 24, 1915, 8.55 feet; mean discharge estimated at slightly over 2,000 second-feet.

Monthly discharge of Colorado River near Bronte, Tex., for the year ending Sept. 30, 1916.

Month.	Discharge in second-feet.			Run-off (total in acre-feet).
	Maximum.	Minimum.	Mean.	
October	974	7.0	132	8,120
November	18	2.4	6.87	409
December	15	2.2	4.43	272
January	4.1	1.8	2.49	153
February	2.2	1.4	1.70	98
March	1.4	.3	.57	35
April	1,300	9.5	151	8,980
May	217	.0	20.0	1,230
June	36	.0	3.02	180
July	23	.0	.89	55
August	699	.0	57.7	3,550
September	1,160	3.8	88.2	5,250
The year	1,300	.0	393	28,300

COLORADO RIVER AT BALLINGER, TEX.

LOCATION.—At Hutchins Avenue highway bridge, 800 feet below Gulf, Colorado & Santa Fe Railway bridge in Ballinger, Runnels County, 1 mile above mouth of Elm Creek.

DRAINAGE AREA.—6,460 square miles (revised).

RECORDS AVAILABLE.—December 11, 1915, to September 30, 1916. Records of stage have been obtained by the United States Weather Bureau since July 1, 1903. Current-meter measurements were begun May 29, 1915.

GAGE.—Chain gage attached to downstream handrail of bridge; read by E. M. Eubank.

DISCHARGE MEASUREMENTS.—Made from downstream side of bridge or by wading.

CHANNEL AND CONTROL.—Banks consist of clay and gravel; medium height and wooded; subject to overflow at extremely high stages. Bed composed of hard clay, sand, and gravel; somewhat shifting. Control is shoal about 1,000 feet below gage; subject to change.

ICE.—None reported during year.

EXTREMES OF DISCHARGE.—Maximum stage recorded during year 9 feet at 9 a. m. September 25 (discharge, 6,300 second-feet; result obtained from extension of rating curve and possibly subject to considerable error). No flow July 3 to August 26 and September 16–24.

DIVERSIONS.—During low stages a large part of the flow is diverted above the station by gravity or by pumping, but the quantity diverted is small in comparison with the total run-off.

REGULATION.—No artificial regulation above station.

ACCURACY.—Stage-discharge relation not permanent. Rating curve fairly well defined below 600 second-feet and is an extension above that discharge. Gage read to hundredths once daily; readings for some days questionable. Daily discharge ascertained by applying daily gage heights to rating table except for periods during which stage-discharge relation is affected by shifting control. Results below 1,000 second-feet are fair; above 1,000 second-feet they may be subject to considerable error.

Discharge measurements of Colorado River at Ballinger, Tex., during the period May 29, 1915, to Sept. 30, 1916.

Date.	Made by—	Gage height.	Discharge.	Date.	Made by—	Gage height.	Discharge.
1915.		*Feet.*	*Sec.-ft.*	1916.		*Feet.*	*Sec.-ft.*
May 29	M. R. Hall	[a]0.75	46	Apr. 2	R. C. Thaxton	1.86	397
Sept. 16	Gray and Hank	1.73	253	27	Hank and Gray	.93	29.3
Oct. 23	R. J. Hank	1.61	243	June 17	R. J. Hank	.65	2.5
Dec. 11	....do	.87	20.5	Aug. 30	William Kessler	.94	34
1916.				Sept. 6	R. J. Hank	1.26	133
Feb. 12	....do	.81	8.7	27	....do	1.25	149
Mar. 29	....do	.52	[b].1				

[a] Gage height May 29 refers to U. S. Weather Bureau gage; relation to Survey chain gage not known.
[b] Discharge estimated.

Daily discharge, in second-feet, of Colorado River at Ballinger, Tex., for the year ending Sept. 30, 1916.

Day.	Dec.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.
1	.....	12	11	4.0	21	147	11	4.0	0.0	219
2	.....	11	11	4.0	409	601	11	2.0	.0	84
3	.....	11	11	4.0	196	147	11	.0	.0	259
4	.....	11	11	4.0	886	114	11	.0	.0	50
5	.....	12	11	4.0	491	35	11	.0	.0	33
6	.....	11	11	4.0	447	31	11	.0	.0	29
7	.....	9.6	11	4.0	302	28	11	.0	.0	18
8	.....	10	11	4.0	196	26	11	.0	.0	15
9	.....	9.6	11	3.4	138	23	11	.0	.0	7.5
10	.....	11	11	3.6	81	24	11	.0	.0	18
11	29	18	11	3.4	67	24	7.5	.0	.0	18
12	14	16	11	3.6	62	24	4.0	.0	.0	18
13	12	15	11	3.8	62	24	4.7	.0	.0	18
14	11	12	11	3.2	1,140	24	5.4	.0	.0	11
15	21	11	11	3.6	579	24	26	.0	.0	2.0
16	28	14	11	3.4	293	219	24	.0	.0	.0
17	31	11	11	2.8	154	24	24	.0	.0	.0
18	24	16	11	2.2	70	259	4.0	.0	.0	.0
19	14	18	11	2.2	62	137	4.0	.0	.0	.0
20	14	11	11	2.2	38	130	24	.0	.0	.0
21	18	11	11	2.0	37	42	4.0	.0	.0	.0
22	14	11	11	2.8	37	42	3.8	.0	.0	.0
23	16	11	11	2.8	38	42	3.6	.0	.0	.0
24	16	11	11	2.8	40	42	4.0	.0	.0	.0
25	14	11	11	2.4	40	24	3.6	.0	.0	5,500
26	14	11	4.0	2.2	33	24	4.0	.0	.0	976
27	14	11	4.0	2.0	26	24	3.6	.0	98	147
28	11	11	4.0	1.8	37	24	3.6	.0	98	127
29	9.6	11	4.0	.5	42	24	4.0	.0	2.0	73
30	14	11	.....	.1	94	24	4.0	.0	2.0	70
31	11	11	.....	.3	.....	24	.....	.0	21	.....

NOTE.—Discharge determined as follows: Dec. 11 to Apr. 1 and Apr. 14 to Aug. 31, from rating table Apr. 2-13 and Sept. 1-30, by indirect method for shifting control. Determination of discharge Sept. 25 obtained from extension of rating curve and possibly subject to considerable error.

Monthly discharge of Colorado River at Ballinger, Tex., for the year ending Sept. 30, 1916.

Month.	Discharge in second-feet.			Run-off (total in acre-feet).
	Maximum.	Minimum.	Mean.	
December 11-31	31	9.6	16.6	691
January	18	9.6	12.0	738
February	11	4.0	10.0	575
March	4	.1	2.87	176
April	1,140	21	204	12,100
May	601	23	77.5	4,770
June	26	3.6	9.19	547
July	4	.0	.19	12
August	98	.0	7.13	438
September	5,500	.0	256	15,200
The period	.....	.....	.....	35,300

COLORADO RIVER NEAR CHADWICK, TEX.

LOCATION.—At the Gulf, Colorado & Santa Fe Railway bridge half a mile below Chadwick dam, 1 mile above mouth of Elliott Creek, 2 miles west of Chadwick, on county line between San Saba and Lampasas counties, and 2½ miles below mouth of San Saba River.

DRAINAGE AREA.—26,400 square miles.

RECORDS AVAILABLE.—October 21, 1915, to September 30, 1916.

GAGE.—Inclined staff, in three sections, attached to rock ledge on left bank about 75 feet upstream from railroad bridge; read by A. G. Walker. A high-water section is painted on left face of left bridge pier. A vertical staff on right bank directly opposite inclined gage is used during low water.

DISCHARGE MEASUREMENTS.—Made from cable 400 feet below gage.

CHANNEL AND CONTROL.—Bed composed of rock and gravel; not likely to shift. Channel straight above and below station for 1,000 feet. Left bank high, rocky, wooded, and not subject to overflow; right bank medium in height, wooded, composed of clay and gravel, and subject to overflow during extreme stages. Position of control not known, but current-meter measurements indicate that it is practically permanent.

EXTREMES OF DISCHARGE.—Maximum stage recorded during year, 15.0 feet at 7 a. m. May 2 (discharge, 16,900 second-feet; result obtained from extension of rating curve and possibly subject to considerable error); minimum stage, 0.67 foot at 8 a. m. August 27 and 28 (discharge 30 second-feet).

ICE.—None reported during year.

DIVERSIONS.—No large irrigation works have been completed in drainage basin above station, but tracts ranging in size from 5 to 1,500 acres, adjacent to the main river and tributaries, are irrigated by diversion. A large part of the irrigated area is in Runnels, Brown, and Mills counties and along Concho and San Saba rivers. Several small dams have been constructed in the drainage basin above station. Chadwick dam, half a mile above, creates a small pond and serves only to divert to a water wheel that has not been operated for some time.

REGULATION.—Flow not regulated by dams or reservoirs.

ACCURACY.—Stage-discharge relation practically permanent. Rating curve well defined between 80 and 4,000 second-feet. Gage read to hundredths once daily. Daily discharge ascertained by applying daily gage heights to rating table. Results good below 4,000 second-feet; above 4,000 second-feet may be subject to error due to lack of current-meter measurements.

Discharge measurements of Colorado River near Chadwick, Tex., during the year ending Sept. 30, 1916.

Date.	Made by—	Gage height.	Discharge.	Date.	Made by—	Gage height.	Discharge.
		Feet.	*Sec.-ft.*			*Feet.*	*Sec.-ft.*
Dec. 5	R. C. Pierce	1.45	203	May 6	R. C. Thaxton	3.52	1,100
Feb. 15	R. C. Thaxton	1.44	212	June 13	R. J. Hank	.98	83
Apr. 29	Hank and Gray	1.55	239	Sept. 4	William Kessler	4.54	1,800
May 4	R. C. Thaxton	6.20	3,160	4	do	4.93	1,960
4	do	5.64	2,530	5	do	3.57	1,020
5	do	4.55	1,660	7	R. J. Hank	1.94	381
5	do	4.20	1,430	28	Victor Lieb	3.45	1,000

Daily discharge, in second-feet, of Colorado River near Chadwick, Tex., for the year ending Sept. 30, 1916.

Day.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May.	June.	Ju'y.	Aug.	Sept.
1	.....	320	190	248	378	155	750	750	290	34	48	166
2	.....	308	196	255	262	148	2,600	15,000	160	48	51	160
3	.....	290	199	255	255	140	4,190	10,600	160	47	51	130
4	.....	238	202	248	248	135	2,600	3,580	135	45	53	785
5	.....	283	196	238	244	135	1,150	1,550	130	42	55	1,040
6	.....	318	202	230	244	135	1,050	1,050	122	40	55	660
7	.....	272	3,220	230	238	130	1,300	825	110	38	48	388
8	.....	255	1,380	230	227	128	8,230	668	110	38	45	297
9	.....	262	482	230	220	122	1,690	580	110	42	40	190
10	.....	255	388	230	220	122	1,300	430	105	42	40	172
11	.....	255	342	220	211	122	1,080	395	90	42	40	160
12	.....	244	300	220	211	122	800	367	85	45	40	155
13	.....	255	290	220	211	122	465	325	81	45	40	430
14	.....	262	283	214	205	115	395	325	69	42	42	465
15	.....	248	283	205	205	115	1,900	308	69	42	42	500
16	.....	238	290	205	205	115	520	290	1,250	34	40	430
17	.....	227	290	205	199	115	412	290	850	31	40	325
18	.....	220	283	205	196	115	1,150	262	367	31	37	318
19	.....	214	255	205	190	115	423	2,060	220	37	35	248
20	.....	205	255	205	190	115	402	1,050	190	41	34	184
21	3,140	196	255	1,680	184	115	395	2,140	190	45	34	135
22	1,800	205	255	1,620	184	115	360	1,050	145	48	34	120
23	1,120	214	255	800	181	115	342	482	110	45	33	115
24	825	205	262	465	175	115	325	395	81	45	34	110
25	412	205	235	370	175	130	325	395	77	44	34	110
26	520	199	238	336	166	130	318	332	65	45	34	860
27	493	196	227	290	160	122	318	255	56	48	30	5,670
28	402	196	227	272	160	115	255	205	53	51	30	1,000
29	378	196	227	255	155	115	238	1,050	48	51	32	720
30	360	205	230	248	.....	110	220	500	41	51	32	395
31	*332	.....	248	465	.....	110	.....	395	.....	48	33	.....

Monthly discharge of Colorado River near Chadwick, Tex., for the year ending Sept. 30, 1916.

Month.	Discharge in second-feet.			Run-off (total in acre-feet).
	Maximum.	Minimum.	Mean.	
October 21-31	3,140	332	889	19,400
November	320	196	240	14,300
December	3,220	190	394	24,209
January	1,680	205	364	22,400
February	378	155	210	12,100
March	155	110	123	7,560
April	8,230	220	1,180	70,200
May	15,000	205	1,550	95,300
June	1,250	41	186	11,100
July	51	31	42.8	2,630
August	55	30	39.9	2,450
September	5,670	110	538	32,000
The year	.....	.....	.....	314,000

COLORADO RIVER AT AUSTIN, TEX.

LOCATION.—At the Congress Avenue concrete viaduct in Austin, Travis County, half a mile below Shoal Creek and above mouth of Waller Creek 3½ miles below Austin dam.

DRAINAGE AREA.—34,200 square miles (revised).

RECORDS AVAILABLE.—February 15, 1898, to December 31, 1911; October 1, 1914, to September 30, 1916; September 1, 1895, to April 7, 1900, at Austin Dam. Records of stage have been obtained by United States Weather Bureau since July 1, 1903.

GAGE.—Dexter water-stage recorder, installed June 18, 1915, at left end of concrete viaduct. Record of depth of water on crest of dam 3½ miles above Austin was kept from September 1, 1895, to April 7, 1900. Gage used February 15, 1898, to December 31, 1911, was a vertical gage attached to bathhouse on left bank 150 feet above Congress Avenue Bridge; during this period high-stage readings were made by means of a staff gage painted on first pier from left end of bridge and a chain gage attached to bridge. All gages at or near the bridge have been referred to the same datum.

DISCHARGE MEASUREMENTS.—Made by wading or from upstream side of Montopolis highway bridge, 4 miles downstream.

CHANNEL AND CONTROL.—Channel straight for 1,000 feet above and 500 feet below station. Right bank of medium height, composed of clay and gravel, clean, improved by city, and not subject to overflow; left bank resembles right bank except that it is high and nearly vertical in places. Bed composed of rock and gravel, clean; shifts. Control is a gravel and rock shoal 500 feet below gage; changes during high water and also during low water because of the removal of sand for municipal use.

EXTREMES OF DISCHARGE.—Maximum stage recorded during year, 13.1 feet at 4 a. m., May 22 (discharge, 46,000 second-feet); minimum stage, 0.30 foot at 7 a. m., September 21 (discharge, 80 second-feet).

1898–1911; 1914–1916: Maximum stage recorded, 33.5 feet April 7, 1900 (discharge, 122,000 second-feet); minimum stage, −0.50 foot December 13–17, 1914 (discharge, 2 second-feet).

ICE.—None reported during year.

DIVERSIONS.—The first report of the Board of Water Engineers for the State of Texas shows that approximately 35,000 acres of land were declared irrigated by diversions from Colorado River above station. The report also shows a filing by the city of Austin, for municipal uses, of 4,000 acre-feet per annum, with a storage of 30,000 acre-feet, 144 acre-feet per annum for Winchell waterworks, 60,000 acre-feet per annum for power from two reservoirs in Burnet County, and an unknown amount for Marble Falls waterworks, all above station. Much of the area irrigated is in the upper basin of the main stream and adjacent to large tributaries

REGULATION.—Flow entirely regulated by operations at the Austin Dam, about 3½ miles upstream.

ACCURACY.—Stage-discharge relation not permanent. Numerous discharge measurements are necessary to determine changes in stage-discharge relation. Standard rating curve is well defined below 40,000 second-feet. Error in determinations of mean daily discharge due to regulation of flow eliminated by use of a water-stage recorder. Mean daily gage heights, to half-tenths, obtained by inspecting the recorder graph, or, for days of considerable fluctuation, by averaging hourly gage heights. Daily discharge ascertained by indirect method for shifting control. Results good.

Discharge measurements of Colorado River at Austin, Tex., during the year ending Sept. 30, 1916.

Date.	Made by—	Gage height.	Discharge.	Date.	Made by—	Gage height.	Discharge.
		Feet.	*Sec.-ft.*			*Feet.*	*Sec.-ft.*
Oct. 16	R. C. Pierce	0.67	105	May 4	Gray and Hank	5.32	11,700
29	R. C. Thaxton	.67	124	16	Hank and Thaxton	1.58	814
Nov. 9	Thaxton and Pierce	1.55	640	22	Gray and Kessler	9.87	30,200
19	R. J. Hank	1.55	609	June 2	Hank and Thaxton	1.78	1,030
Dec. 1	Hank and Thaxton	1.45	562	12	Kessler and Thaxton	1.20	463
18	Gray and Thaxton	1.60	721	29	Hank and Thaxton	.83	254
Jan. 7	Gray and Hank	1.53	636	July 3	R. J. Hank	.73	200
26	Thaxton and Pierce	2.18	1,640	14	William Kessler	1.45	719
Feb. 16	Gray and Hank	1.56	597	22	Kessler and Lieb	1.73	1,130
Mar. 1	Hank and Kessler	1.44	481	Aug. 4	R. J. Hank	.97	346
15	R. J. Hank	1.19	365	19	Hank and Lieb	1.30	640
Apr. 16	Gray, Hank, and Kessler.	6.50	14,500	28	R. C. Thaxton	.98	368
				29	do	.92	337
17	Thaxton, Hank, and Kessler.	3.92	7,110	31	R. J. Hank	.75	238
				Sept. 2	William Kessler	.65	190
27	Thaxton and Kessler	1.68	1,020	7	do	.52	141
				30	Victor Lieb	.95	340

Daily discharge, in second-feet, of Colorado River at Austin, Tex., for the year ending Sept. 30, 1916.

Day.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.
1	2,980	810	520	700	870	488	7,000	1,060	1,070	225	394	189
2	3,520	774	480	700	810	466	13,800	1,220	992	202	368	170
3	3,520	774	480	650	858	431	4,680	8,560	992	202	368	152
4	3,390	720	480	605	1,000	445	4,840	12,600	921	202	400	152
5	2,980	720	520	650	926	410	5,920	9,480	869	202	368	120
6	2,900	690	1,010	650	858	424	4,260	6,080	753	202	335	138
7	2,770	690	4,060	650	798	459	3,000	3,420	654	202	335	138
8	2,630	641	3,790	605	740	424	2,300	2,440	610	202	368	173
9	2,500	641	4,470	605	740	424	2,300	1,910	574	335	374	945
10	2,360	596	3,250	560	632	403	5,610	1,590	484	1,230	374	696
11	2,420	596	2,040	605	632	368	3,700	1,380	448	975	374	460
12	2,280	641	1,470	650	632	334	2,580	1,200	457	975	342	354
13	2,010	578	1,300	560	632	410	1,910	1,040	465	780	348	194
14	480	623	1,120	520	632	410	1,470	960	438	720	348	173
15	115	623	968	520	587	375	1,690	830	438	720	380	173
16	100	623	834	480	587	310	12,900	830	400	720	380	173
17	100	623	774	480	587	340	7,000	830	400	720	324	173
18	115	605	720	445	632	310	3,560	1,040	438	840	500	194
19	115	605	670	445	587	310	2,240	1,280	475	1,140	460	173
20	115	650	720	560	587	310	2,240	1,470	660	1,140	500	173
21	115	650	578	650	623	340	1,870	9,330	1,050	1,410	590	80
22	115	520	536	650	578	310	1,710	28,200	780	1,140	500	173
23	375	520	578	884	578	280	1,490	7,160	438	1,050	816	313
24	1,350	520	623	1,280	536	280	1,220	4,540	475	1,050	816	313
25	1,450	578	623	1,470	536	280	1,220	4,400	438	975	696	313
26	1,660	496	660	1,680	488	250	1,140	3,000	368	975	318	313
27	560	496	614	1,430	488	250	1,060	2,160	308	900	264	313
28	154	496	488	1,240	488	250	908	1,690	252	840	348	313
29	134	496	452	1,070	488	250	908	1,470	252	620	387	341
30	118	520	528	898	.....	250	813	1,340	225	415	296	341
31	560	.....	614	898	.....	250	.....	1,170	.....	422	212	.....

Monthly discharge of Colorado River at Austin, Tex., for the year ending Sept. 30, 1916.

Month.	Discharge in second-feet.			Run-off (total in acre-feet).
	Maximum.	Minimum.	Mean.	
October	3,520	100	1,420	87,300
November	810	496	617	36,700
December	4,470	452	1,160	71,300
January	1,680	445	767	47,200
February	1,000	488	660	38,000
March	488	250	350	21,500
April	13,800	843	3,510	209,000
May	28,200	830	3,990	245,000
June	1,070	225	571	34,000
July	1,410	202	701	43,100
August	816	212	416	25,600
September	945	80	264	15,700
The year	28,200	80	1,200	874,000

Days of deficiency in discharge of Colorado River at Austin, Tex., for the years ending Sept. 30, 1902–1910 and 1915–16.

Discharge in second-feet.	1901–2	Days of deficient discharge.									
		1902–3	1903–4	1904–5	1905–6	1906–7	1907–8	1908–9	1909–10	1914–15	1915–16
100	.....	.....	.....	.....	.....	45	.....	.....	36	26	3
200	1	.....	3	20	45	103	1	34	55	44	28
300	20	10	22	75	135	204	11	94	102	68	52
400	68	30	130	150	185	228	41	156	165	72	97
500	167	59	189	177	198	253	78	195	228	83	145
600	216	77	223	196	207	261	92	203	241	95	177
700	236	90	243	218	221	292	142	226	266	112	222
800	251	108	259	234	224	300	166	234	279	120	238
900	263	122	266	242	251	305	179	244	281	135	257
1,000	271	148	273	247	234	310	190	250	294	142	272
1,200	284	197	286	263	241	315	225	273	307	205	286
1,400	292	218	292	273	247	323	256	293	319	240	300
1,600	301	232	300	282	255	327	261	299	321	255	310
1,800	313	247	305	291	263	331	271	310	321	262	315
2,000	317	260	309	296	267	334	276	317	322	262	318
3,000	330	307	322	315	291	342	299	332	335	289	338
4,000	338	321	332	327	301	345	317	342	338	307	346
5,000	341	331	337	334	314	347	322	347	341	314	353
6,000	343	340	342	339	320	348	329	349	343	324	355
7,000	344	344	346	342	323	348	331	352	345	338	358
8,000	347	346	348	345	325	348	336	354	350	347	359
9,000	349	350	350	347	330	348	340	355	352	348	360
10,000	353	351	352	348	335	352	344	356	344	349	362
20,000	356	360	359	359	350	363	351	362	364	355	365
30,000	361	362	364	363	359	365	357	365	365	367	366
40,000	365	365	365	364	362	.....	361	.....	.....	362	.....
50,000	.....	.....	366	364	362	.....	362	.....	.....	362	.....
60,000	.....	.....	.....	365	364	.....	364	.....	.....	363	.....
75,000	.....	.....	.....	.....	365	.....	366	.....	.....	364	.....
100,000	.....	.....	.....	.....	.....	.....	.....	.....	.....	365	.....

EVAPORATION NEAR AUSTIN, TEX.

LOCATION.—At reservoir on Hill's ranch, about 1,000 feet from ranch house, 5 miles south of Austin, Travis County. Elevation 475 feet above sea level.

RECORDS AVAILABLE.—April to September, 1916.

EQUIPMENT.—Two evaporation pans, one floating on surface of reservoir and the other on land about 30 feet from reservoir; auxiliary equipment consists of hook gages, rain gage, anemometer, maximum and minimum thermometers, and psychrometer.

Evaporation near Austin, Tex., for the period April to September, 1916.

Month.	Temperature.					Mean relative humidity.
	Air.			Water.		
	Mean maximum.	Mean minimum.	Mean.	Floating pan (mean).	Land pan (mean).	
	°F.	°F.	°F.	°F.	°F.	Per cent.
April	78.7	54.5	66.6	65.9	59.2	80.5
May	[a] 85.4	63.7	[b] 74.6	73.9	69.9	81.0
June	94.7	71.7	83.2	80.0	77.1	73.7
July	94.8	71.8	83.3	82.0	77.8	77.2
August	93.4	70.4	81.9	80.4	76.3	78.7
September	90.3	64.1	77.2	75.9	70.9	77.6

Month.	Wind.		Rainfall.	Evaporation.	
	Average miles per hour.	Prevailing direction.		Floating pan.	Land pan.
			Inches.	Inches.	Inches.
April	3.7	South...	3.54	[c] 4.76	[c] 6.88
May	2.5	...do.....	8.05	[d] 6.13	[c] 8.09
June	1.1	...do.....	.71	7.74	8.53
July	1.2	...do.....	2.97	6.50	7.76
August	1.0	...do.....	1.29	5.59	7.46
September	1.2	...do.....	2.94	5.00	6.84

[a] Mean for 27 days. [b] Mean for 29 days. [c] Total for 29 days. [d] Total for 28 days.

COLORADO RIVER AT COLUMBUS, TEX.

LOCATION.—At county highway bridge half a block from county jail, 400 feet below Galveston, Harrisburg & San Antonio Railway bridge in eastern edge of Columbus, Colorado County.

DRAINAGE AREA.—37,000 square miles (revised).

RECORDS AVAILABLE.—August 2, 1902, to December 31, 1911; May 22, 1916, to September 30, 1916. Records of stage have been obtained by the United States Weather Bureau since January 1, 1903.

GAGE.—Mott tape-and-weight gage, property of the United States Weather Bureau, installed December 17, 1907, on downstream handrail of bridge; read by W. E. Bridge. From August 2, 1902, to December 16, 1907, gage heights were obtained by measuring with a tagged chain and lead weight from point on top of bridge pier to water surface.

DISCHARGE MEASUREMENTS.—Made from upstream side of bridge, or by wading.

CHANNEL AND CONTROL.—Channel straight above and below station for 400 feet. Right bank composed of firm earth; high and not subject to overflow; left bank of medium height; overflow likely. Bed of stream clean and sandy; shifts during high stages. A sand and gravel section about 350 feet below gage serves as low-water control, but the stage-discharge relation during medium and high stages may be controlled by a bend in river below bridge.

EXTREMES OF DISCHARGE.—Maximum stage recorded during year, 24.7 feet from 9.50 a. m. to 2.30 p. m. May 23 (discharge, 36,800 second-feet); minimum stage, 6.38 feet at 7 a. m. and 6 p. m. September 25 (discharge, 278 second-feet).

1902–1911; 1916: Maximum stage recorded, 35.8 feet April 27, 1908 (discharge, 43,100 second-feet); minimum stage, 4.2 feet September 9 and 10, 1910 (discharge, 10 second-feet).

ICE.—None reported during year.

DIVERSIONS.—Considerable water is diverted for irrigation in the drainage basin above Austin, but between Austin and Columbus little water is pumped or diverted by gravity. The station is above the irrigated rice belt, which comprises several thousand acres. Filings have been made with the Board of Water Engineers for the State of Texas for continuous use of water for Smithville, Bastrop, and La Grange waterworks, all above station.

REGULATION.—Flow at Columbus during ordinary stages controlled by storage at Lake Austin.

ACCURACY.—Stage-discharge relation not permanent. Rating curve well defined below 45,000 second-feet. Gage read to hundredths twice a day. Mean of two readings may not be a true index of daily discharge because of regulation above station. Daily discharge ascertained by applying mean daily gage heights to rating table except for periods during which stage-discharge relation is affected by shifting control. Results good.

COOPERATION.—Morning gage readings furnished by United States Weather Bureau.

Discharge measurements of Colorado River at Columbus, Tex., during the year ending Sept. 30, 1916.

Date.	Made by—	Gage height.	Discharge.	Date.	Made by—	Gage height.	Discharge.
		Feet.	*Sec.-ft.*			*Feet.*	*Sec.-ft.*
May 22	R. C. Thaxton	20.92	30,600	June 30	R. C. Thaxton	6.8	596
23	do	24.70	36,600	July 10	do	6.8	566
23	do	24.25	35,700	27	do	8.2	1,370
24	do	18.05	16,206	Aug. 12	do	7.0	625
24	do	16.63	11,900	Sept. 6	Victor Lieb	6.6	481
25	do	14.20	7,840	6	do	6.6	417
June 17	do	7.19	788				

Daily discharge, in second-feet, of Colorado River at Columbus, Tex., for the year ending Sept. 30, 1916.

Day.	May.	June.	July.	Aug.	Sept.	Day.	May.	June.	July.	Aug.	Sept.
1		1,390	565	1,230	590	16		735	1,090	52	565
2		1,670	520	962	595	17		760	950	51	505
3		1,490	836	785	535	18		735	878	50	449
4		1,400	920	710	505	19		745	884	515	386
5		1,340	590	650	475	20		765	878	50	337
6		1,340	550	665	440	21		770	866	50	324
7		1,340	500	950	420	22	18,200	932	1,050	78	319
8		1,220	480	725	405	23	33,400	685	1,550	790	306
9		1,160	510	645	382	24	15,600	812	2,240	770	301
10		1,040	545	580	355	25	7,300	1,010	1,590	760	278
11		920	580	555	355	26	4,830	932	1,440	78	286
12		830	690	610	373	27	3,320	685	1,330	95	324
13		812	780	535	645	28	3,070	650	1,340	82	373
14		785	1,230	530	755	29	2,750	640	1,560	76	373
15		735	1,090	520	685	30	2,350	600	1,510	71	383
						31	2,200		1,390	66	

NOTE.—Discharge determined as follows: May 22 to June 5, June 25 to Aug. 1, and Sept. 4–12, from rating table; June 6–24, Aug. 2 to Sept. 3, and Sept. 13–30, by indirect method for shifting control.

Monthly discharge of Colorado River at Columbus, Tex., for the year ending Sept. 30, 1916.

Month.	Discharge in second-feet.			Run-off (total in acre-feet).
	Maximum.	Minimum.	Mean.	
May 22–31	33,400	2,200	9,360	186,000
June	1,890	600	981	58,400
July	2,240	480	996	61,200
August	1,230	505	697	42,900
September	755	278	433	25,800
The period				374,000

NORTH CONCHO RIVER AT SAN ANGELO, TEX.

LOCATION.—At the county concrete viaduct in San Angelo, Tom Green County, a mile above confluence of North Concho and South Concho rivers.

DRAINAGE AREA.—7,530 square miles.

RECORDS AVAILABLE.—October 27, 1915, to September 30, 1916.

GAGE.—Vertical staff attached to web of third pier of viaduct from left bank; read by H. M. Garden and L. E. Gage.

DISCHARGE MEASUREMENTS.—Made by wading 400 feet below viaduct.

CHANNEL AND CONTROL.—Bed composed of solid rock which is to some extent covered in high-water channel with grass and moss; permanent. Channel straight for 800 feet above and 400 feet below gage. Banks are sloping, clean, composed of rock and clay, and not subject to overflow except during high floods. About 20 feet below gage and at downstream side of viaduct is a concrete dam 4½ feet high, which, before the viaduct was constructed, served as part of a low-water crossing; this dam forms an artificial control and insures a permanent stage-discharge relation.

EXTREMES OF DISCHARGE.—Maximum stage recorded during year, 1.97 feet at 5.25 p. m. April 14 (discharge, 465 second-feet; result obtained from extension of rating curve and possibly subject to some error); no flow June 5–14 and June 22 to September 30.

ICE.—None reported during year.

DIVERSIONS.—According to First Report of the Board of Water Engineers for the State of Texas some water is diverted; amount diverted above station not known.

REGULATION.—Flow not regulated by water-power plants or reservoirs.

ACCURACY.—Stage-discharge relation permanent. Rating curve well defined below but possibly subject to error above 200 second-feet. Gage read to hundredths daily; oftener during high water. Daily discharge ascertained by applying mean daily gage height to rating table. Results good.

Discharge measurements of North Concho River at San Angelo, Tex., for the period Sept. 16, 1915, to Sept. 30, 1916.

Date.	Made by—	Gage height.	Discharge.	Date.	Made by—	Gage height.	Discharge.
1915.		*Feet.*	*Sec.-ft.*	1916.		*Feet.*	*Sec.-ft.*
Sept. 16	Hank and Thaxton	a 1.19	117	Feb. 11	R. J. Hank	0.33	12.1
17	do	a 1.00	45.4	Mar. 28	do	.78	8.0
18	do	a .88	18.9	Apr. 27	Gray and Hank	.85	13.5
Oct. 27	R. J. Hank	.73	6.8	June 20	R. J. Hank	.38	.5
Dec. 17	do	.79	8.6	Aug. 29	William Kessler		.0
				Sept. 5	R. J. Hank		.0
				30	do		.0

a Gage heights refer to temporary gage above viaduct and within influence of backwater from dam which serves as artificial control.

Daily discharge, in second-feet, of North Concho River at San Angelo, Tex., for the year ending Sept. 30, 1916.

Day.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May.	June.
1		6.4	6.4	6.4	11	14	62	19	0.7
2		6.4	6.4	6.4	11	14	22	17	.6
3		6.4	6.4	6.4	11	14	20	17	.5
4		6.4	6.4	6.4	11	14	19	17	.3
5		6.4	6.4	6.4	11	14	19	19	.0
6		6.4	6.4	6.4	11	14	17	17	.0
7		6.4	6.4	6.4	11	14	16	17	.0
8		6.4	6.4	6.4	12	14	16	16	.0
9		6.4	6.4	6.4	12	14	14	14	.0
10		6.4	6.6	6.4	13	14	14	13	.0
11		6.4	6.8	6.4	14	14	14	12	.0
12		6.4	7.3	6.4	14	14	14	12	.0
13		6.4	8.2	6.4	14	14	14	12	.0
14		6.4	9.2	6.4	14	14	455	12	.0
15		6.4	6.8	6.4	14	14	190	12	19
16		6.4	6.4	6.4	14	14	45	12	6.8
17		6.4	7.3	6.4	14	14	80	12	2.1
18		6.4	6.4	6.4	14	14	22	13	1.1
19		6.4	6.4	6.4	14	14	19	12	.7
20		6.4	6.4	6.4	14	14	16	11	.5
21		6.4	6.4	6.4	14	14	14	9.2	.2
22		6.4	6.4	6.4	14	14	14	8.2	.0
23		6.4	6.4	6.4	14	14	14	7.8	.0
24		6.4	6.4	9.2	14	14	14	6.4	.0
25		6.4	6.4	14	14	14	13	5.8	.0
26		6.4	6.4	17	14	12	13	5.0	.0
27	6.4	6.4	6.4	14	14	10	14	4.4	.0
28	6.4	6.4	6.4	12	14	9.2	16	3.6	.0
29	6.4	6.4	6.4	11	14	9.2	16	3.0	.0
30	6.4	6.4	6.4	11		8.7	16	2.4	.0
31	6.4		6.4	11		8.7		1.8	

NOTE.—No flow June 5–14 and June 22 to Sept. 30. Discharge interpolated because of missing gage heights Dec. 10–12, 29–30, Jan. 8, 9, Feb. 10, 13, 14, 20, 27, Mar. 6, 12, 26, and 27.

Monthly discharge of North Concho River at San Angelo, Tex., for the year ending Sept. 30, 1916.

Month.	Discharge in second-feet.			Run-off (total in acre-feet).
	Maximum.	Minimum.	Mean.	
October 27–31	6.4	6.4	6.40	63
November	6.4	6.4	6.40	381
December	9.2	6.4	6.64	408
January	17	6.4	7.95	489
February	14	11	12.1	754
March	14	8.7	13.2	812
April	455	13	39.1	2,330
May	19	1.8	11.1	682
June	19	.0	1.08	64
July	.0	.0	.00	0
August	.0	.0	.00	0
September	.0	.0	.00	0
The period				5,980

CONCHO RIVER NEAR SAN ANGELO, TEX.

LOCATION.—Half a mile below confluence of North Concho and South Concho rivers, 1¾ miles southeast of San Angelo, Tom Green County.

DRAINAGE AREA.—10,800 square miles.

RECORDS AVAILABLE.—September 17, 1915, to September 30, 1916.

GAGE.—Vertical staff in several sections attached to trees on left bank about 1,500 feet below an old ford; read by Mrs. B. H. Cummins.

DISCHARGE MEASUREMENTS.—Made by wading or from cable 80 feet below gage.

CHANNEL AND CONTROL.—Bed composed of solid rock and gravel. Channel straight for 1,000 feet above and below station. Right bank high, rocky, wooded, and not subject to overflow; left bank of medium height, composed of clay and gravel, covered with scattering trees, and subject to overflow at high stages. Rapids about 100 feet below the gage serve as control for medium and low stages; do not shift; position of control for high stages not known.

EXTREMES OF DISCHARGE.—1915–16: Maximum stage recorded, 13.5 feet during the night of September 24, 1915 (discharge not determined); minimum stage, 0.50 foot at 11 a. m. June 24, 1916 (discharge, 2.3 second-feet).

ICE.—None reported during year.

DIVERSIONS.—Considerable water is diverted above station, and pumping plants are immediately below. First Report of the Board of Water Engineers for the State of Texas shows a total of 25,000 acre-feet per annum is taken from the stream. About a mile above mouth of South Concho River a storage dam has been constructed by the San Angelo Light & Power Co. for waterworks, but as the capacity of the reservoir is small and the height of the dam constant, a large part of the natural flow of the stream that enters the reservoir will join the water of the North Concho at confluence of the two streams.

REGULATION.—Storage at the dam of the San Angelo Light & Power Co. has slight effect on flow at station; no regulation by storage on North Concho River.

ACCURACY.—Stage-discharge relation practically permanent. Rating curve well defined below 250 second-feet. Gage read to hundredths once daily. One reading daily may not be a true index of the mean daily discharge because of regulation and rapid fluctuation during floods. Daily discharge ascertained by applying daily gage heights to rating table. Results are good during medium stages, fair during extreme low stages, and poor during high stages; determinations of discharge above 400 second-feet may be considerably in error.

Discharge measurements of Concho River near San Angelo, Tex., for the period Sept. 17, 1915, to Sept. 30, 1916.

Date.	Made by—	Gage height.	Discharge.	Date.	Made by—	Gage height.	Discharge.
1915.		*Feet.*	*Sec.-ft.*	1916.		*Feet.*	*Sec.-ft.*
Sept. 17	Hank and Thaxton	2.00	166	Mar. 28	R. J. Hank	1.46	46.5
Oct. 27	R. J. Hank	1.76	107	Apr. 27	Gray and Hank	1.59	58
Dec. 16	do	1.69	84	June 20	R. J. Hank	.55	3.3
				Aug. 29	William Kessler	.57	3.5
1916.				Sept. 4	R. J. Hank	1.60	73
Feb. 11	do	1.68	80	29	do	1.10	22.9

Daily discharge, in second-feet, of Concho River near San Angelo, Tex., for the period Sept. 17, 1915, to Sept. 30, 1916.

Day.	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.
1	.....	126	83	72	85	88	34	114	64	6.8	4.3	4.9	625
2	.....	126	83	77	85	85	36	146	83	6.3	2.5	4.7	1,750
3	.....	126	81	77	83	88	36	126	74	5.9	3.3	4.5	126
4	.....	126	76	76	98	90	43	114	76	5.3	4.3	4.7	68
5	.....	120	85	83	95	88	51	108	72	3.7	6.1	4.7	45
6	.....	111	81	108	85	85	41	108	72	4.1	4.3	4.5	39
7	.....	120	83	108	81	83	35	111	51	4.1	4.3	4.3	36
8	.....	111	83	106	85	83	35	85	58	5.3	4.1	4.5	30
9	.....	106	83	98	95	79	40	90	51	10	3.7	4.1	32
10	.....	111	76	93	95	83	40	85	46	8.2	4.3	4.3	23
11	.....	106	58	85	95	81	33	88	41	4.1	5.3	4.3	17
12	.....	98	70	85	88	79	47	85	28	8.5	4.3	4.7	30
13	.....	98	70	95	88	79	51	88	30	6.3	4.9	4.3	445
14	.....	106	54	88	95	76	37	370	35	3.9	6.3	3.9	98
15	.....	98	66	85	90	79	24	303	37	7.1	4.3	3.9	51
16	.....	91	76	83	79	79	33	126	30	7.9	3.1	4.1	44
17	171	85	66	83	81	77	39	111	39	5.9	3.3	4.3	47
18	126	373	70	81	83	66	33	98	39	5.5	3.7	3.7	42
19	111	177	74	85	93	52	39	76	39	4.5	4.3	4.7	38
20	90	117	70	90	90	50	41	66	46	3.3	5.7	3.9	34
21	85	111	62	88	88	52	34	60	42	3.7	4.3	3.9	36
22	117	98	76	85	85	48	26	50	37	3.5	4.5	3.3	36
23	111	93	76	85	79	41	43	62	41	3.1	4.1	5.3	45
24	2,200	106	76	81	85	37	35	58	37	2.3	4.9	3.9	41
25	409	93	70	83	90	34	38	51	13	3.5	4.3	4.1	24
26	177	98	64	79	90	41	46	58	14	51	4.1	3.3	23
27	156	98	64	79	90	45	31	66	12	11	4.5	3.5	23
28	140	95	68	79	88	41	51	72	33	6.1	4.5	3.3	21
29	134	101	76	76	93	41	46	66	24	4.3	4.3	3.5	18
30	134	91	72	77	95	.....	41	68	8.5	5.3	6.1	3.5	21
31	.....	68	.....	79	95	.....	83	.....	7.4	.....	5.3	3.5	.....

NOTE.—Discharge for Sept. 24, 1915, and Apr. 14, Sept. 1, 2, and 13, 1916, determined from an extension of the rating curve; determinations subject to considerable error.

Monthly discharge of Concho River near San Angelo, Tex., for the period Sept. 17, 1915, to Sept. 30, 1916.

Month.	Discharge in second-feet.			Run-off (total in acre-feet).
	Maximum.	Minimum.	Mean.	
1915.				
September 17–30	2,200	85	297	8,250
1915–16.				
October	373	68	116	7,130
November	85	54	72.9	4,340
December	108	72	85.5	5,260
January	98	79	88.6	5,450
February	90	34	57.2	3,170
March	83	24	49.1	3,020
April	870	50	120	7,140
May	83	7.4	41.6	2,560
June	51	2.3	7.02	418
July	6.3	3.1	4.46	274
August	5.3	3.3	4.15	255
September	1,750	17	130	7,740
The year	1,750	2.3	64.6	46,900

CONCHO RIVER NEAR PAINT ROCK, TEX.

LOCATION.—At the Concho, San Saba & Llano Valley Railroad bridge a quarter of a mile below mouth of Kickapoo Creek, 2 miles northwest of Paint Rock, Concho County.

DRAINAGE AREA.—11,800 square miles.

RECORDS AVAILABLE.—September 20, 1915, to September 30, 1916.

GAGE.—Vertical staff attached to downstream end of middle railroad bridge pier; read by J. C. Godwin.

DISCHARGE MEASUREMENTS.—Made by wading or from downstream side of bridge.

CHANNEL AND CONTROL.—Bed composed of solid rock, smooth, clean, free from vegetation, and permanent. Channel straight for 500 feet above and below gage. Right bank 30 feet high, solid rock, clean, and not subject to overflow; left bank of medium height, sloping, wooded, and subject to overflow during high water. Permanent control during low and medium stages at a shoal in solid rock 400 feet below gage.

EXTREMES OF DISCHARGE.—1915–16: Maximum stage recorded, 8.6 feet 11.30 a. m. September 24, 1915 (discharge not computed); no flow July 4 to September 1, 1916.

ICE.—None reported during year.

DIVERSIONS.—Station is above a large part of the irrigable area in the vicinity of Paint Rock, but considerable water is diverted from the stream in that part of the basin above San Angelo; quantity of water diverted between San Angelo and this station not known but probably small.

REGULATION.—None apparent. There is one dam, known to be abandoned, in the stretch of river between San Angelo and the station, and possibly additional dams exist, but none of them appreciably affect the flow.

ACCURACY.—Stage-discharge relation practically permanent. Rating curve well defined below 250 second-feet; determinations above 250 second-feet possibly subject to error. Gage read to hundredths once daily; oftener during high water. Daily discharge ascertained by applying mean daily gage height to rating table. Results good.

Discharge measurements of Concho River near Paint Rock, Tex., for the period Sept. 20, 1915, to Sept. 30, 1916.

Date.	Made by—	Gage height.	Discharge.	Date.	Made by—	Gage height.	Discharge.
1915.		*Feet.*	*Sec.-ft.*	1916.		*Feet.*	*Sec.-ft.*
Sept. 20	Hank and Thaxton	1.85	123	Feb. 13	R. J. Hank	1.65	71
Oct. 25	R. J. Hank	1.78	101	Mar. 29	do	1.46	53.5
Dec. 12	do	1.73	83	Apr. 26	Gray and Hank	1.94	54
				June 17	R. J. Hank	.75	.8
				Aug. 30	William Kessler		.0
				Sept. 6	R. J. Hank	1.60	62

Daily discharge, in second-feet, of Concho River near Paint Rock, Tex., for the period Sept. 20, 1915, to Sept. 30, 1916.

Day.	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.
1	.....	120	103	80	84	84	38	246	62	14	0.8	0.0	0
2	.....	120	109	80	89	84	38	246	66	12	.4	.0	1,350
3	.....	120	96	84	89	84	38	186	62	11	.1	.0	438
4	.....	120	96	84	89	80	34	132	62	10	.0	.0	158
5	.....	120	96	84	96	80	34	132	52	9.0	.0	.0	108
6	.....	113	96	322	94	80	34	132	45	4.9	.0	.0	62
7	.....	108	96	153	84	80	34	127	41	5.5	.0	.0	41
8	.....	106	89	153	84	80	29	127	41	5.1	.0	.0	26
9	.....	103	84	145	84	80	29	120	38	5.1	.0	.0	21
10	.....	103	84	145	84	80	26	108	38	4.4	.0	.0	18
11	.....	103	84	137	84	80	26	96	34	3.8	.0	.0	52
12	.....	96	84	94	84	66	26	89	26	3.2	.0	.0	108
13	.....	96	84	96	84	73	24	84	24	3.0	.0	.0	158
14	.....	96	84	96	84	73	24	84	21	2.7	.0	.0	278
15	.....	96	80	89	94	73	24	396	21	2.2	.0	.0	127
16	.....	96	80	89	84	66	24	158	21	1.5	.0	.0	84
17	.....	96	73	89	84	66	21	132	24	.8	.0	.0	62
18	.....	108	73	84	84	66	21	108	34	.4	.0	.0	52
19	.....	374	73	84	80	66	21	96	29	16	.0	.0	45
20	120	186	73	84	80	66	21	89	26	11	.0	.0	45
21	96	145	73	84	80	62	18	80	26	6.9	.0	.0	41
22	96	108	73	84	80	58	16	73	24	5.8	.0	.0	41
23	96	103	73	84	80	52	18	66	24	4.7	.0	.0	38
24	1,810	103	73	80	73	45	21	62	24	3.8	.0	.0	34
25	848	108	73	80	80	43	24	52	24	3.0	.0	.0	108
26	294	103	80	80	84	41	26	45	24	2.7	.0	.0	52
27	186	103	89	80	80	41	26	45	21	2.2	.0	.0	38
28	172	103	80	80	80	38	26	41	21	1.8	.0	.0	29
29	153	103	80	80	80	34	29	41	18	1.5	.0	.0	24
30	132	103	80	80	96	.....	35	41	16	1.3	.0	.0	18
31	.....	103	.....	84	89	.....	41	.....	15	.....	.0	.....	.....

NOTE.—Mean gage height Sept. 24, 1915, 6.60 feet; discharge determined from extension of rating curve; result possibly subject to considerable error.

Monthly discharge of Concho River near Paint Rock, Tex., for the period Sept. 20, 1915, to Sept. 30, 1916.

Month.	Discharge in second-feet.			Run-off (total in acre-feet).
	Maximum.	Minimum.	Mean.	
1915.				
September 20-30	1,810	96	364	7,940
1915-16.				
October	374	96	118	7,260
November	103	73	83.2	4,950
December	153	80	96.1	5,910
January	96	73	84.2	5,180
February	84	34	66.2	3,810
March	41	16	27.5	1,690
April	326	41	113	6,660
May	66	15	32.4	1,990
June	16	.4	5.31	316
July	.8	.0	.04	2
August	.0	.0	.00	0
September	1,350	.0	122	7,260
The year	1,350	.0	62.0	45,000

SAN SABA RIVER AT MENARD, TEX.

LOCATION.—At steel highway bridge in Menard, Menard County, about 80 miles above mouth of stream.

DRAINAGE AREA.—1,140 square miles.

RECORDS AVAILABLE.—September 14, 1915, to September 30, 1916.

GAGE.—Chain gage attached to floor on downstream side of highway bridge; read by Henry Patton.

DISCHARGE MEASUREMENTS.—Made by wading or from downstream side of bridge.

CHANNEL AND CONTROL.—Channel straight 800 feet above and 100 feet below station; water flows through a series of shoals and ponds; channel above gage somewhat obstructed by reeds and grass, but below the gage it is clean and the flow is unobstructed. Right bank composed of gravel and clay, wooded, sloping, high, and not subject to overflow; left bank similar in material, wooded, low, and subject to overflow during high stages. A sand and gravel ford just below gage forms a practically permanent control during low and medium stages, but shifts at extremely high stages.

EXTREMES OF DISCHARGE.—Maximum stage recorded during year, 3 feet at 9 a. m. April 1 (discharge, 195 second-feet; result obtained by extension of rating curve and possibly subject to considerable error); minimum stage recorded, 1.76 feet at 6 p. m. August 16 and 4.20 p. m. August 17 (discharge, 6.8 second-feet), obtained by extension of rating curve; determinations possibly subject to considerable error.

1915–16: Maximum stage recorded, 13.6 feet at 2.30 a. m. September 16, 1915 (discharge not determined); minimum stage August 16 and 17, 1916 (see preceding paragraph).

ICE.—None reported during year.

DIVERSIONS.—Considerable land is irrigated with water diverted or pumped above station. Noyes canal, on right side of river, carries water that is diverted a short distance above gage. Several pumping plants are above and below gage. The First Report of the Board of Water Engineers for the State of Texas shows that approximately 2,400 acres are declared irrigated above the station by 4,800 acre-feet of water per annum.

REGULATION.—Flow unregulated by storage or water-power plants.

ACCURACY.—Stage-discharge relation practically permanent during low and medium stages, but changes during high water. Rating curve well defined between 10 and 100 second-feet. Determinations of discharge above 100 second-feet may be subject to considerable error. Gage read to hundredths twice daily; oftener during high water. Daily discharge ascertained by applying mean daily gage heights to rating table. Results excellent except for extreme stages, for which they may be considerably in error.

Discharge measurements of San Saba River at Menard, Tex., for the period Sept. 14, 1915, to Sept. 30, 1916.

Date.	Made by—	Gage height.	Discharge.	Date.	Made by—	Gage height.	Discharge.
1915.		*Feet.*	*Sec.-ft.*	1916.		*Feet.*	*Sec.-ft.*
Sept. 14	R. C. Thaxton	2.10	38.1	Feb. 17	R. C. Thaxton	2.17	37.5
Oct. 24	R. C. Pierce	2.37	62.1	Apr. 25	Hank and Gray	2.23	38.1
Dec. 7	....do	2.25	50.4	June 16	R. J. Hank	2.05	19.4
				Sept. 19	Victor Lieb	2.14	36.6
				20	....do	2.15	36.5

Discharge measurements of Noyes canal[a] at Menard, Tex., during the year ending Sept. 30, 1916.

Date.	Made by—	Gage height.	Discharge.	Date.	Made by—	Gage height.	Discharge.
		Feet.	*Sec.-ft.*			*Feet.*	*Sec.-ft.*
Feb. 17	R. C. Thaxton	.....	9.7	June 16	R. J. Hank	.....	12.0
Apr. 25	Hank and Gray	.....	10.8				

[a] See description of San Saba River at Menard, Tex.

Daily discharge, in second-feet, of San Saba River at Menard, Tex., for the period Sept. 14, 1915, to Sept. 30, 1916.

Day.	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.
1		78	60	34	37	37	43	113	113	28	20	23	15
2		78	62	32	37	37	41	87	84	22	14	19	16
3		73	62	32	37	37	37	59	84	23	13	16	17
4		70	59	32	37	37	37	67	78	23	11	19	15
5		70	60	32	37	37	46	67	78	22	9.6	19	14
6		70	60	47	37	37	46	73	73	22	10	18	13
7		70	60	43	37	36	48	70	77	18	10	17	12
8		70	62	39	35	36	44	64	77	12	11	19	13
9		70	60	35	35	34	48	67	73	14	11	30	13
10		70	60	34	35	35	51	70	73	14	12	30	13
11		70	53	32	36	35	48	67	73	14	11	22	12
12		70	26	32	35	37	46	67	72	13	10	12	14
13		70	30	34	32	35	40	65	70	11	9.6	11	46
14	39	70	30	36	32	32	46	70	65	9.6	9.2	9 2	43
15		70	30	37	35	34	46	70	60	10	10	7.7	39
16		70	30	37	35	35	44	70	62	16	10	7.1	26
17		70	30	37	32	37	47	70	57	21	10	7.1	31
18	250	105	30	37	32	35	73	68	51	22	11	8 4	30
19	129	73	30	37	34	36	78	70	51	21	10	9 2	32
20	84	70	30	37	37	35	80	70	41	20	12	10	32
21	91	70	30	37	43	32	73	51	41	19	22	9 6	32
22	78	70	30	37	39	35	54	40	43	16	14	10	32
23	87	70	30	37	37	35	36	40	40	18	14	12	32
24	87	70	28	37	37	35	35	46	35	12	13	14	32
25	87	67	28	37	35	35	34	44	34	13	14	11	32
26	87	64	30	37	37	35	32	39	33	12	15	12	32
27	87	64	32	37	37	43	27	40	34	12	15	13	32
28	78	60	34	37	37	41	28	40	32	18	14	13	32
29	78	60	31	37	37	41	30	40	32	18	14	14	34
30	78	60	34	37	37	.....	27	40	35	22	27	14	32
31	.....	59	.....	37	37	.....	27	.....	34	.....	44	14	.....

NOTE.—Mean gage height Sept. 15, 6.35 feet; Sept. 16, 10.61 feet; Sept. 17, 5.58 feet; discharge not determined.

Monthly discharge of San Saba River at Menard, Tex., for the year ending Sept. 30, 1916.

Month.	Discharge in second-feet.			Run-off (total in acre-feet).
	Maximum.	Minimum.	Mean.	
October	105	59	70.0	4,300
November	62	26	41.0	2,440
December	47	32	36.2	2,230
January	43	32	36.0	2,210
February	43	32	36.1	2,080
March	80	27	44.9	2,760
April	113	39	61.5	3,660
May	113	32	58.2	3,580
June	28	9.6	16.9	1,010
July	44	9.2	13.9	855
August	30	7.1	14.5	892
September	46	12	25.6	1,520
The year	113	7.1	37.9	27,500

SAN SABA RIVER NEAR SAN SABA, TEX.

LOCATION.—Two hundred feet above Beveridge highway bridge, a mile below mouth of China Creek, 2 miles northwest of San Saba, San Saba County, 3 miles below mouth of Richland Creek, 4 miles above mouth of Simpson Creek.

DRAINAGE AREA.—3,000 square miles.

RECORDS AVAILABLE.—December 30, 1904, to December 31, 1906; September 11, 1915, to September 30, 1916. Miscellaneous discharge measurements previous to 1904.

GAGE.—Vertical and inclined staff on right bank; read by J. M. Walker. From December 30, 1904, to December 31, 1906, gage heights were obtained by measuring with a tape from a reference point on the bridge to the water surface. Relation between datum used 1904–1906 and that of present gage is not known.

DISCHARGE MEASUREMENTS.—Made by wading or from downstream side of bridge.

CHANNEL AND CONTROL.—Channel straight above and below station for 100 feet. Bed composed of rock and gravel; shifts only during high floods. Left bank composed of gravel and clay, wooded, high, and not subject to overflow; right bank consists of clay and gravel, wooded, sloping, medium in height, and subject to overflow during high water. A shoal at a ford 75 feet below gage serves as control during medium and low stages; control is free from vegetation and does not shift during low and medium stages.

EXTREMES OF DISCHARGE.—Maximum stage recorded during year, 15.7 feet during night of May 1 (discharge not determined); minimum stage, 1.10 feet at times during afternoon of July 5, 12, 13, and 15 (discharge, 20 second-feet).

1904–1906; 1915–16: Maximum stage recorded, 31.7 feet August 7, 1906 (discharge not determined); minimum flow, December 20, 1904, when discharge measurement showed 15 second-feet (gage not read).

ICE.—None reported during year.

DIVERSIONS.—Considerable water is diverted or pumped from the stream and tributaries above station. There are also diversions below the station, but none in the vicinity of the station. The First Report of the Board of Water Engineers for the State of Texas shows that 4,360 acres of land were declared irrigated, and that approximately 8,700 acre-feet of water is used each year above station. Flood water from Brady Creek at Brady is stored for municipal uses; capacity of reservoir not known but probably small.

REGULATION.—Flow not regulated by dams or reservoirs.

ACCURACY.—Stage-discharge relation permanent during low and medium stages. Rating curve well defined between 20 and 300 second-feet; determinations above 300 second-feet possibly subject to considerable error. Gage read to hundredths twice daily; oftener during high water. Daily discharge ascertained by applying mean daily gage heights to rating table. Results excellent, except during periods of high water.

Discharge measurements of San Saba River near San Saba, Tex., for the period Sept. 11, 1915, to Sept. 30, 1916.

Date.	Made by—	Gage height.	Discharge.	Date.	Made by—	Gage height.	Discharge.
1915.		*Feet.*	*Sec.-ft.*	1916.		*Feet.*	*Sec.-ft.*
Sept. 11	R. J. Hank	1.75	111	June 12	R. J. Hank	1.33	37.8
Oct. 20	do	2.15	194	Sept. 3	William Kessler	1.28	33.6
23	R. C. Pierce	1.99	136	8	do	1.28	32.2
Dec. 2	R. C. Thaxton	1.84	107	28	Victor Lieb	1.68	85.0
1916.							
Feb. 11	R. C. Thaxton	1.82	110				
Apr. 29	Hank and Gray	1.75	93.8				

Daily discharge, in second-feet, of San Saba River near San Saba, Tex., for the period Sept. 11, 1915, to Sept. 30, 1916.

Day.	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.
1		207	130	112	122	278	94	565		70	20	47	33
2		194	122	112	120	130	88	870		70	25	47	34
3		176	130	110	118	122	87	448	1,230	68	31	49	36
4		170	122	106	112	122	85	218	396	62	25	54	35
5		156	124	102	112	122	83	166	252	57	24	54	31
6		156	122	1,200	112	120	85	142	207	55	26	47	32
7		156	124	1,420	110	118	82	167	178	55	32	45	34
8		142	122	263	102	112	78	156	164	53	29	41	39
9		142	130	164	104	112	83	138	142	49	44	36	40
10		142	132	148	110	112	94	130	434	40	29	39	39
11	112	142	132	138	112	110	88	122	122	40	30	36	40
12	88	142	132	130	112	110	88	120	124	45	24	37	42
13	82	142	132	123	110	102	82	112	120	37	22	38	128
14	82	142	138	122	106	102	78	116	112	32	24	41	56
15	242	142	152	126	102	102	82	148	112	173	23	43	44
16		142	122	126	106	102	83	134	114	73	32	42	42
17		142	124	132	110	102	83	122	159	56	28	44	42
18		673	124	124	102	102	79	118	194	52	24	44	40
19		302	124	122	114	102	78	114	156	48	24	36	46
20	760	194	118	122	122	102	70	104	130	33	26	43	50
21	505	173	102	118	185	100	70	102	126	37	118	41	52
22	350	145	102	118	142	99	82	102	118	38	36	41	49
23	310	138	102	112	126	102	87	99	112	39	54	43	48
24	270	126	102	122	112	95	94	94	104	38	50	39	48
25	270	126	106	112	112	94	92	94	104	41	46	38	278
26	235	122	102	112	112	85	85	96	106	32	50	39	134
27	218	126	104	112	118	85	73	94	88	30	52	41	88
28	200	126	102	112	118	85	72	92	79	28	60	39	82
29	200	122	104	114	118	85	70	92	78	24	56	36	60
30	235	122	106	114	120		64	87	72	26	51	36	55
31		130		120	228		67		70		51	37	

NOTE.—Discharge not determined Sept. 16–19, 1915, or May 1 and 2, 1916, as gage heights are above limit to which rating curve is defined. Mean gage height Sept. 16, 13.60 feet; Sept. 17, 13.50 feet; Sept. 18, 10.40 feet; Sept. 19, 4.72 feet; May 1, 4.50 feet; May 2, 9.25 feet; maximum stage recorded Sept. 17, [illegible] feet.

Monthly discharge of San Saba River near San Saba, Tex., for the year ending Sept. 30, 1916.

Month.	Discharge in second-feet.			Run-off (total in acre-feet).
	Maximum.	Minimum.	Mean.	
October	673	122	170	10,500
November	138	102	119	7,080
December	1,420	106	202	12,400
January	228	102	120	7,380
February	278	85	111	6,380
March	94	64	81.4	5,010
April	870	87	172	10,200
May 3–31	1,230	70	[illegible]	[illegible]
June	173	24	41.9	2,490
July	118	23	[illegible]	[illegible]
August	54	36	41.8	2,570
September	278	31	59.2	3,520

NORTH LLANO RIVER NEAR JUNCTION, TEX.

LOCATION.—About 500 feet above remains of old Wilson dam, 1 mile below mouth of Bear Creek, 2½ miles above North Llano highway bridge, 3 miles northwest of Junction, Kimble County, 4 miles above confluence of North Llano and South Llano rivers.

DRAINAGE AREA.—803 square miles.

RECORDS AVAILABLE.—September 14, 1915, to September 30, 1916.

GAGE.—Overhanging chain gage on left bank; read by J. R. Pettitt.

DISCHARGE MEASUREMENTS.—Made by wading or from highway bridge 2½ miles below station.

CHANNEL AND CONTROL.—Bed composed of solid rock; clean and permanent. Channel straight above and below for 400 feet, with a series of pools and rapids. Left bank high, clean, and not subject to overflow; right bank low, wooded, and subject to overflow during high stages. One channel at all stages; current sluggish at gage during low and medium stages. A solid rock ledge of approximately 2 feet vertical fall at site of old dam serves as a permanent control for medium and low stages; control clean and free from vegetation.

EXTREMES OF DISCHARGE.—Maximum stage recorded during year, 1.75 feet at 6.45 a. m. October 1 (discharge, 117 second-feet); minimum stage, 0.91 foot, at 8 a. m. September 16 (discharge, 1.2 second-feet).

1915–16: Maximum stage recorded, 18.0 feet during night of September 15, 1915 (discharge not determined); minimum stage, September 16, 1916 (see preceding paragraph).

ICE.—None reported during year.

DIVERSIONS.—Data do not show that large areas are irrigated in drainage above station; some land is irrigated below station with water taken from North Llano River.

REGULATION.—No indication that flow at station is regulated.

ACCURACY.—Stage-discharge relation practically permanent during low and medium stages. Rating curve well defined below 100 second-feet. Determinations of discharge above 100 second-feet possibly subject to error. Gage read to hundredths once daily; oftener during high water. Daily discharge ascertained by applying mean daily gage heights to rating table. Results excellent for medium stages and fair for extremely low stages, and possibly subject to considerable error at high stages.

Discharge measurements of North Llano River near Junction, Tex., for the period Sept. 14, 1915, to Sept. 30, 1916.

Date.	Made by—	Gage height.	Discharge.	Date.	Made by—	Gage height.	Discharge.
1915.		*Feet.*	*Sec.-ft.*	1916.		*Feet.*	*Sec.-ft.*
Sept. 14	Gray and Thaxton	1.25	15.6	Apr. 25	Hank and Gray	1.38	23.9
Oct. 25	R. C. Pierce	1.54	49.1	June 15	R. J. Hank	1.17	7.8
Dec. 10	Pierce and Thaxton	1.50	38.9	Sept. 16	Victor Lieb	.91	1.5
				18	do	1.04	1.4
1916.				22	do	.98	1.3
Feb. 18	R. C. Thaxton	1.45	30.6				

Daily discharge, in second-feet, of North Llano River near Junction, Tex., for the period Sept. 14, 1915, to Sept. 30, 1916.

Day.	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.
1	.....	117	52	31	31	49	26	103	39	14	3.4	12	4.5
2	.....	100	58	31	36	36	26	77	33	14	3.9	12	6.5
3	.....	100	52	31	36	36	24	42	28	14	3.9	12	6.5
4	.....	100	52	31	36	33	24	36	24	12	3.4	11	6.5
5	.....	83	52	31	36	33	28	36	24	12	3.9	16	5.5
6	.....	67	47	34	33	30	24	39	22	11	4.5	5.8	4.5
7	.....	67	47	37	30	30	24	36	20	11	5.5	16	4.5
8	.....	67	47	34	30	28	26	33	20	10	4.5	10	4.5
9	.....	67	39	34	30	28	26	30	20	10	14	16	4.5
10	.....	67	36	28	30	28	26	28	19	10	12	8.8	4.5
11	.....	67	36	28	30	28	26	28	19	10	11	7.6	4.5
12	.....	67	33	28	28	28	24	30	17	10	11	7.0	4.5
13	.....	67	33	34	28	28	24	30	17	10	11	6.0	3.9
14	13	67	36	34	28	28	22	30	17	8.8	11	5.0	3.9
15	172	83	36	34	28	28	22	28	17	8.8	10	4.2	3.9
16	.....	67	36	34	28	28	22	28	17	7.6	8.8	4.2	1.2
17	.....	52	36	31	28	28	22	28	17	7.6	8.8	4.2	2.8
18	.....	67	36	31	28	28	22	28	17	7.6	7.6	4.2	2.8
19	292	67	36	31	28	28	22	28	20	7.6	7.6	4.2	2.8
20	252	52	33	31	28	28	24	28	22	7.6	10	6.0	2.8
21	232	52	29	31	33	28	24	28	22	6.5	12	7.0	2.8
22	212	52	31	31	30	26	26	26	22	5.5	12	7.0	2.8
23	212	52	31	31	30	24	28	24	22	5.5	12	12	2.8
24	192	52	31	31	28	26	26	24	22	4.5	12	8.2	2.8
25	172	49	34	31	28	26	26	24	22	4.5	11	7.0	2.5
26	153	52	31	29	28	28	28	24	22	4.5	10	7.0	2.3
27	153	52	31	29	28	28	24	28	20	3.9	10	7.0	2.3
28	134	44	31	29	30	28	26	24	19	3.4	11	7.0	2.3
29	134	52	31	29	30	26	26	24	17	3.4	10	7.0	1.7
30	117	52	31	31	30	.....	26	24	15	3.4	10	5.5	1.7
31	.....	67	.....	31	67	.....	26	.....	14	.....	11	4.5	.....

NOTE.—Mean gage height Sept. 16, 14.00 feet; Sept. 17, 4.30 feet; Sept. 18, 2.90 feet; discharge not determined.

Monthly discharge of North Llano River near Junction, Tex., for the year ending Sept. 30, 1916.

Month.	Discharge in second-feet.			Run-off (total in acre-feet).
	Maximum.	Minimum.	Mean.	
October	117	49	66.4	4,080
November	58	29	38.1	2,270
December	37	28	31.3	1,920
January	67	28	31.4	1,930
February	49	24	29.3	1,680
March	28	22	24.8	1,520
April	103	24	33.2	1,980
May	39	14	20.8	1,280
June	14	3.4	8.29	493
July	14	3.4	8.93	549
August	12	4.2	7.61	468
September	6.5	1.2	3.64	217
The year	117	1.2	25.4	18,400

LLANO RIVER NEAR JUNCTION, TEX.

LOCATION.—One hundred feet north of Kerrville-Junction road, a quarter of a mile northeast of Oliver's ranch house, 3 miles below confluence of North and South Llano rivers, 3½ miles east of Junction, Kimble County, 4 miles above Johnson's Fork Creek entering river from the south.

DRAINAGE AREA.—1,700 square miles.

RECORDS AVAILABLE.—September 13, 1915, to September 30, 1916.

GAGE.—Vertical staff, reading from 0 to 7.5 feet, attached to tree on right bank, and inclined staff, reading from 7.6 to 19.5 feet, a few feet upstream from vertical staff; read by Sadie Oliver.

DISCHARGE MEASUREMENTS.—Made by wading at Mason road crossing a quarter of a mile above gage, or from cable 400 feet above station.

CHANNEL AND CONTROL.—Bed composed of solid rock, clean, and permanent. Channel straight for 700 feet above and 350 feet below the gage. Left bank of medium height, slightly wooded, and subject to overflow during high water; right bank is clean, high, and not subject to overflow. One channel at all stages except during extreme floods, when a small part of the flow may follow a slough that leaves the river a short distance above the gage, passes to the south of Oliver's ranch house, and enters the main stream below the gage. Such conditions do not occur, however, at intervals more frequent than 10 to 15 years and will not greatly affect results. Rock ledge about 75 feet below gage, forming a fall of approximately 3 feet, serves as permanent control for low and medium stages.

EXTREMES OF DISCHARGE.—Maximum stage recorded during year, 8.8 feet during night of May 21 (discharge not determined); minimum stage, 1.50 feet at 2 p. m. July 1, and 6 p. m. September 25 (discharge, 46 second-feet).

1915–16: Maximum stage recorded, 26.3 feet at 3 a. m. September 16, 1915 (discharge not determined); minimum stage July 1 and September 25, 1916 (see preceding paragraph).

ICE.—None reported during year.

DIVERSIONS.—The First Report of the Board of Water Engineers for the State of Texas shows that 4,281 acres of land have been declared irrigated requiring 8,562 acre-feet of water annually from Llano River above the station on the assumption that the duty of water is 2 acre-feet per acre. Available data show that a large part of this land is in the vicinity of Junction, near the confluence of North and South Llano rivers. A filing of 500 second-feet for continuous use in connection with hydraulic power for the Junction Gin and Waterworks is also listed in the same report.

REGULATION.—No apparent regulation of the flow at this point.

ACCURACY.—Stage-discharge relation practically permanent. Rating curve well defined between 40 and 300 second-feet. Gage read to hundredths once daily; during high water oftener. Determinations of discharge above 400 second-feet may be subject to error. Daily discharge ascertained by applying mean daily gage heights to rating table. Results excellent for medium and low stages.

Discharge measurements of Llano River near Junction, Tex., for the period Sept. 13, 1915, to Sept. 30, 1916.

Date.	Made by—	Gage height.	Discharge.	Date.	Made by—	Gage height.	Discharge.
1915.		*Feet.*	*Sec.-ft.*	1916.		*Feet.*	*Sec.-ft.*
Sept. 13	Gray and Thaxton	1.57	72.9	Apr. 24	Hank and Gray	1.61	85.6
Oct. 26	R. C. Pierce	1.85	179	June 15	R. J. Hank	1.62	90.8
Dec. 10	do	1.76	136	Sept. 14	Victor Lieb	1.54	57.5
				15	do	1.55	61.5
1916.				22	do	1.55	62.3
Feb. 18	R. C. Thaxton	1.68	115				

Daily discharge, in second-feet, of Llano River near Junction, Tex., for the period Sept. 15, 1915, to Sept. 30, 1916.

Day.	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.
1	.....	272	180	148	128	144	105	101	220	128	46	75	75
2	.....	260	176	148	128	140	101	140	240	120	53	75	68
3	.....	260	176	144	128	132	101	140	200	120	53	75	60
4	.....	240	176	144	124	128	101	152	196	116	60	75	60
5	.....	240	172	152	120	128	101	152	196	116	60	75	60
6	.....	232	172	152	120	128	101	152	192	116	68	75	60
7	.....	232	172	152	120	128	101	152	180	112	68	75	60
8	.....	220	172	152	120	124	97	152	180	112	68	68	60
9	.....	220	172	152	120	120	97	120	172	112	90	68	60
10	.....	212	172	144	120	120	97	112	160	101	90	68	60
11	.....	208	172	136	116	120	97	112	152	97	82	68	60
12	.....	204	172	136	116	116	101	109	136	82	75	68	60
13	71	200	172	136	116	112	101	109	120	82	60	60	68
14	64	200	172	160	116	112	101	109	97	82	60	60	68
15	.....	196	172	160	116	109	101	105	93	82	60	60	68
16	.....	196	168	160	120	109	101	101	93	86	68	60	68
17	.....	180	168	152	120	105	101	97	90	86	68	60	68
18	810	204	156	148	120	112	101	97	101	75	68	60	64
19	600	200	156	136	124	112	101	97	101	75	68	68	60
20	516	188	152	136	124	112	101	93	101	68	82	68	60
21	485	180	156	136	128	112	97	93	510	68	82	68	57
22	.....	180	156	132	128	109	97	93	1,390	60	75	82	64
23	560	180	152	132	124	105	97	97	710	60	75	82	64
24	460	180	152	132	124	105	97	97	280	60	68	75	64
25	240	180	148	132	124	105	97	82	240	53	68	75	46
26	348	180	148	132	120	105	97	82	220	53	68	75	60
27	348	180	148	132	120	105	101	82	216	53	60	75	68
28	302	180	148	128	120	105	101	82	160	53	60	75	68
29	289	180	148	128	120	105	101	82	160	53	60	75	60
30	280	180	148	128	152	.....	101	82	152	53	82	75	60
31	.....	180	.....	128	148	.....	101	.....	140	.....	120	75	.....

NOTE.—Mean gage height, Sept. 15, 6.05 feet; Sept. 16, 19.10 feet; Sept. 17, 4.50 feet; Sept. 22, 5.50 feet; discharge not determined.

Monthly discharge of Llano River, near Junction, Tex., for the year ending Sept. 30, 1916.

Month.	Discharge in second-feet.			Run-off (total in acre-feet).
	Maximum.	Minimum.	Mean.	
October	272	180	205	12,600
November	180	148	163	9,700
December	160	128	142	8,730
January	152	116	123	7,560
February	144	105	116	6,670
March	105	97	99.8	6,140
April	152	82	109	6,490
May	1,390	90	232	14,300
June	128	53	84.4	5,020
July	120	46	69.8	4,290
August	82	60	70.7	4,350
September	75	46	62.6	3,730
The year	1,390	46	128	89,600

GUADALUPE RIVER BASIN.

GUADALUPE RIVER AT NEW BRAUNFELS, TEX.

LOCATION.—Just below highway bridge on San Antonio–Austin post road 700 feet below International & Great Northern Railway bridge, 1 mile below mouth of Comal River, 1 mile northeast of center of New Braunfels, Comal County.

DRAINAGE AREA.—1,760 square miles.

RECORDS AVAILABLE.—March 13, 1898, to December 30, 1899; January 27, 1915, to September 30, 1916.

GAGE.—Vertical staff; three sections attached to trees on left bank 200 feet below highway bridge and one section on east side of left pier of highway bridge; read by J. F. Willman. Gage used from March 13, 1898, to December 30, 1899, was an inclined staff gage near the present highway bridge; relation between datum of inclined gage and that of present gage not known.

DISCHARGE MEASUREMENTS.—Made from downstream side of bridge.

CHANNEL AND CONTROL.—Bed composed of solid rock with pockets of coarse gravel. Banks gravel, clay, and rock, slightly wooded, high, and not subject to overflow. Rock and gravel shoal just below gage serves as control; subject to slight changes.

EXTREMES OF DISCHARGE.—Maximum stage recorded during year, 20.8 feet at 7 p. m. May 22 (discharge, determined from extension of rating curve, 28,500 second-feet); minimum stage, 1.68 feet September 23 and 24 (discharge, 370 second-feet).

1898–99 and 1915–16: Maximum stage recorded, 27.2 feet at 9.30 p. m. September 17, 1915, determined by leveling from flood marks (discharge not determined); minimum stage recorded, 1.70 feet September 27 to October 20, 1899 (discharge not determined, but according to discharge measurement of March 16, 1899, the flow was less than 358 second-feet).

ICE.—None reported during year.

DIVERSIONS.—Some water diverted for irrigation above station in Kerr and Comal counties, and, for water power, waterworks, and other municipal uses, in Kerr, Kendall, and Comal counties; amount not known.

REGULATION.—Flow at this point slightly regulated by operation of power plants.

ACCURACY.—Stage-discharge relation subject to slight changes. Rating curve well defined below 7,000 second-feet. Gage read to tenths once daily October 1 to November 9 and to hundredths twice daily thereafter. Mean daily gage height obtained from two readings may not be a true index of mean daily flow because of fluctuation caused by operations of power plants. Daily discharge ascertained by applying mean daily gage heights to rating table, except for periods during which stage-discharge relation was affected by shifting control. Results good.

Discharge measurements of Guadalupe River at New Braunfels, Tex., during the year ending Sept. 30, 1916.

Date.	Made by—	Gage height.	Discharge.	Date.	Made by—	Gage height.	Discharge.
		Feet.	*Sec.-ft.*			*Feet.*	*Sec.-ft.*
Nov. 10	Gray and Pierce	1.95	520	Apr. 24	William Kessler	2.24	630
Dec. 20	R. C. Thaxton	1.92	506	June 13	Gray and Thaxton	2.19	635
Feb. 24	Gray and Grover	1.88	466	July 8	Gray and Hank	2.19	597
Apr. 16	Hank and Gray	7.18	5,460	Aug. 28	Hank and Lieb	1.77	407

Daily discharge, in second-feet, of Guadalupe River at New Braunfels, Tex., for the year ending Sept. 30, 1916.

Day.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.
1	755	535	491	490	502	450	3,810	530	876	496	618	490
2	700	535	490	475	491	440	15,200	698	864	490	596	455
3	700	535	490	490	496	430	1,800	900	840	513	562	455
4	700	535	491	551	502	435	1,170	744	816	508	540	460
5	645	535	490	567	502	420	909	672	788	496	530	455
6	645	535	557	539	491	435	849	618	760	496	502	455
7	645	535	557	508	470	435	766	594	722	568	491	450
8	645	535	491	502	480	440	711	574	711	612	502	440
9	590	535	752	502	480	435	656	557	672	546	480	430
10	600	513	656	496	475	430	623	557	634	513	480	430
11	590	508	612	496	480	430	612	530	645	491	480	425
12	590	491	557	491	480	430	596	502	650	491	470	410
13	590	530	535	480	480	480	579	496	645	491	460	405
14	590	513	502	480	475	435	562	475	623	491	455	385
15	590	546	508	480	480	430	782	465	645	496	470	380
16	590	502	502	470	475	435	5,880	475	623	496	460	380
17	590	513	508	470	475	430	1,880	475	601	485	455	380
18	590	502	502	470	475	420	1,160	562	590	465	460	380
19	590	496	513	475	475	430	936	645	596	480	480	380
20	590	491	513	470	460	425	816	969	557	450	475	380
21	535	491	502	470	455	425	760	5,960	540	465	470	380
22	535	518	496	535	470	425	689	21,400	530	510	460	375
23	535	502	491	590	475	410	658	9,730	518	546	455	370
24	535	502	480	535	455	420	628	2,510	496	518	455	370
25	535	502	480	568	460	420	606	1,840	496	546	470	380
26	535	496	480	557	450	410	618	1,520	496	524	480	390
27	535	491	480	557	430	405	596	1,340	480	518	470	380
28	535	491	502	858	450	410	562	1,200	460	524	425	380
29	535	502	475	601	455	400	546	1,100	465	618	425	430
30	535	508	480	601	.....	405	524	969	470	1,250	430	420
31	535	.....	475	546	.....	460	.....	918	.....	782	480	.....

NOTE.—Discharge computed by indirect method for shifting control Apr. 17 to May 19 and June 20 to July 29. Discharge Apr. 28, interpolated; Apr. 2 and May 22 estimated from extension of rating curves.

Monthly discharge of Guadalupe River at New Braunfels, Tex., for the year ending Sept. 30, 1916.

Month.	Discharge in second-feet.			Run-off (total in acre-feet).
	Maximum.	Minimum.	Mean.	
October	755	535	594	36,500
November	546	491	514	30,600
December	782	475	513	31,900
January	858	470	533	32,200
February	502	430	474	27,300
March	450	400	425	26,100
April	15,200	524	1,550	92,200
May	21,400	465	1,960	120,000
June	876	460	627	37,300
July	1,250	450	550	33,800
August	618	425	483	29,700
September	490	370	419	24,900
The year	21,400	370	719	522,000

GUADALUPE RIVER NEAR GONZALES, TEX.

LOCATION.—Just below Guadalupe highway bridge, 1¼ miles south of Gonzales, Gonzales County, 1 mile below power house of Gonzales Water Power Co., 2½ miles below mouth of San Marcos River.

DRAINAGE AREA.—3,620 square miles (revised).

RECORDS AVAILABLE.—July 1, 1915, to September 30, 1916. The United States Weather Bureau has obtained records from a gage at power house of Gonzales Water Power Co. since September 1, 1904.

GAGE.—Vertical staff in three sections on right bank just below bridge; read by Albert Garcia. Relation between this gage and that of United States Weather Bureau not known.

DISCHARGE MEASUREMENTS.—Made from downstream side of highway bridge or from cable one-fourth mile below gage.

CHANNEL AND CONTROL.—Bed composed of gravel and sand; clean but somewhat shifting; channel below station is straight for 500 feet, but above is broken by an island and is straight for not more than 50 feet. Banks made up of gravel and clay; medium height; wooded along water's edge on the right and for some distance back on the left; subject to overflow only during extremely high stages. Position of control not known.

EXTREMES OF DISCHARGE.—1915–16: Maximum stage recorded, 23.25 feet at 7 a. m. May 25, 1916 (discharge, 22,800 second-feet; result obtained from extension of rating curve and possibly subject to error); minimum stage, 1.07 feet August 16 and 17 and September 18, 1916 (discharge, 452 second-feet).

ICE.—None reported during year.

DIVERSIONS.—Some water diverted for irrigation above this point by gravity or pumping, but amount is small in comparison with the total run-off. As rainfall is nearly sufficient for general farming, irrigation is intermittent and it is extremely difficult to estimate the amount of water used.

REGULATION.—Flow at this point regulated to a large extent by operation of water-power plants in the drainage above. Construction work at the dam of the Gonzales Water Power Co. causes a slight unnatural fluctuation.

ACCURACY.—Stage-discharge relation not permanent. Standard rating curve fairly well-defined below 7,000 second-feet. Gage read to hundredths twice daily. Mean daily gage height based on two readings may not be true index of mean daily discharge because of fluctuation caused by power operations. Daily discharge ascertained by applying mean daily gage heights to rating table and by indirect method for shifting control. Results are fair except above 7,000 second-feet when they may be considerably in error because of poorly defined rating curve.

Discharge measurements of Guadalupe River near Gonzales, Tex., during the year ending Sept. 30, 1916.

Date.	Made by—	Gage height.	Discharge.	Date.	Made by—	Gage height.	Discharge.
		Feet.	*Sec.-ft.*			*Feet.*	*Sec.-ft.*
Oct. 11	Pierce and Thaxton	2.15	951	May 23	Gray and Kessler	18.46	[a] 14,600
Nov. 18	Gray and Pierce	1.76	820	24	do	19.41	[a] 15,000
Jan. 11	R. C. Thaxton	1.80	815	26	R. C. Thaxton	12.75	5,370
Feb. 26	Gray and Grover	1.79	724	26	do	11.26	4,600
Apr. 4	R. C. Thaxton	16.15	[a] 10,700	26	do	10.21	4,410
4	Thaxton and Gray	15.34	[a] 8,880	26	do	9.21	3,840
4	do	14.47	[a] 7,850	27	do	5.97	2,780
4	do	14.00	[a] 7,430	June 20	do	1.74	1,010
5	do	7.21	3,190	July 26	Gray and Hank	1.64	751
5	do	6.78	2,940	Aug. 14	R. J. Hank	1.26	463
5	do	6.32	2,770	Sept. 29	William Kessler	1.06	471

[a] Surface velocities obtained and reduced to mean by a coefficient; results somewhat uncertain.

Daily discharge, in second-feet, of Guadalupe River near Gonzales, Tex., for the year ending Sept. 30, 1916.

Day.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.
1	1,020	902	891	842	788	729	646	861	1,720	838	1,11	524
2	1,020	864	880	1,590	729	726	664	1,100	1,630	808	4,61	520
3	1,020	845	880	895	726	722	12,300	4,180	1,510	823	94	517
4	1,020	864	880	861	693	711	9,760	1,940	1,430	811	88	520
5	994	857	895	868	729	715	3,670	1,160	1,300	795	76	520
6	974	830	902	861	718	722	1,630	1,070	1,260	760	711	510
7	954	811	1,100	861	711	729	1,450	1,040	1,270	726	64	506
8	970	868	1,070	883	708	722	1,340	1,010	1,230	842	61	502
9	990	849	970	861	718	722	1,160	974	1,230	926	58	492
10	910	830	974	830	711	718	1,120	950	1,200	902	56	495
11	958	811	1,090	815	729	715	1,030	891	1,190	868	53	495
12	930	853	1,010	762	715	711	1,020	830	1,150	826	51	492
13	958	834	926	766	722	711	1,010	785	1,120	807	48	481
14	970	834	918	709	718	715	1,030	777	1,100	781	46	474
15	930	815	891	762	704	711	1,050	766	1,070	740	45	470
16	958	894	857	766	715	711	1,070	758	1,060	726	43	459
17	994	815	857	762	729	711	2,670	750	1,040	697	45	456
18	962	819	849	758	708	704	5,170	769	1,030	686	45	452
19	994	838	849	766	711	708	2,690	788	1,020	686	48	499
20	962	842	872	766	718	704	1,970	804	1,020	711	50	584
21	974	849	864	974	715	700	1,570	950	1,040	729	52	477
22	974	842	834	2,240	729	686	1,320	5,570	992	751	52	488
23	998	849	815	1,040	711	667	1,190	15,500	934	747	50	481
24	938	857	841	853	744	643	1,110	16,600	910	762	49	474
25	938	868	811	788	722	632	1,010	20,300	868	754	477	477
26	998	861	819	769	708	632	986	4,090	872	751	47	492
27	1,020	861	811	834	722	650	970	2,060	861	792	477	495
28	958	864	819	773	729	643	958	3,110	868	792	47	502
29	958	876	826	978	729	639	946	2,660	857	857	47	513
30	1,020	857	838	1,050	.....	682	858	2,100	845	974	50	528
31	962	.....	849	853	.....	639	.....	1,900	.....	1,070	52	.....

NOTE.—Discharge computed by indirect method for shifting control Oct. 1 to Nov. 11; Jan. 2 to Apr. 2; May 23 and May 26 to Sept. 30.

Monthly discharge of Guadalupe River near Gonzales, Tex., for the year ending Sept. 30, 1916.

Month.	Discharge in second-feet.			Run-off (total in acre-feet).
	Maximum.	Minimum.	Mean.	
October	1,020	910	973	59,800
November	902	811	848	50,500
December	1,100	811	892	54,800
January	2,240	758	910	56,000
February	788	693	721	41,500
March	729	632	693	42,600
April	12,300	646	2,100	125,000
May	20,300	750	3,170	195,000
June	1,720	845	1,120	66,600
July	1,070	686	799	49,100
August	1,170	482	585	35,900
September	528	482	494	29,300
The year	20,300	482	1,116	806,000

GUADALUPE RIVER NEAR CUERO, TEX.

LOCATION.—At Schleicher Bridge, 300 feet below San Antonio & Arkansas Pass Railway bridge 2 miles southwest of Cuero, Dewitt County, 4 miles below a dam used for power development.

DRAINAGE AREA.—5,020 square miles (revised).

RECORDS AVAILABLE.—December 26, 1902, to December 31, 1906; August 19, 1915, to August 8, 1916, when station was discontinued.

GAGE.—Vertical staff; low-water section attached to piling under right end of railway bridge; high-water section bolted to left pier of highway bridge; gage read by M. D. Albright. Gage used from December 26, 1902, to July, 1903, was a vertical-staff gage at Carl Buchel's power house, 3 miles north of Cuero. In July, 1903, the station was moved downstream to the San Antonio & Aransas Pass Railway bridge, and gage heights were obtained by measuring with a tagged line the distance from a reference point on the bridge to the water surface. Gage used from 1904 to 1906 was a chain gage at the railway bridge and was referred to the datum of the reference point, but the relation between that datum and the datum of the present gage is not known.

DISCHARGE MEASUREMENTS.—Made from upstream side of highway bridge.

CHANNEL AND CONTROL.—Channel straight for 300 feet above and 1,500 feet below. Bed composed of rock, gravel, and sand; shifts. Left bank wooded, high, and not subject to overflow; right bank is of medium height, wooded, and is overflowed at extremely high stages. Position of control not known.

EXTREMES OF DISCHARGE.—Maximum stage recorded during year, 19.5 feet 7 a. m. May 27 (discharge not determined); minimum stage, 3.1 feet at 7 a. m. April 30 (discharge not determined).

1902–1906: Maximum stage recorded, 43.0 feet March 1, 1903 (discharge, 71,300 second-feet); minimum stage, 5.4 feet June 20, 1906 (discharge, 370 second-feet).

ICE.—None reported during year.

DIVERSIONS.—Flow at this point not greatly affected by diversions above, as water is diverted in small amounts only.

REGULATION.—Flow regulated by operation of water-power plants upstream, chiefly by a plant about 4 miles above.

ACCURACY.—Stage-discharge relation not permanent. Rating curve not developed. Gage read to hundredths twice daily. Mean daily gage height based on two readings may not be a true index of mean daily discharge because of fluctuations caused by operation of power plants. Daily discharge not determined.

Discharge measurements of Guadalupe River near Cuero, Tex., during the year ending Sept. 30, 1916.

Date.	Made by—	Gage height.	Discharge.	Date.	Made by—	Gage height.	Discharge.
		Feet.	*Sec.-ft.*			*Feet.*	*Sec.-ft.*
Oct. 10	Thaxton and Pierce....	5.68	985	Feb. 26	Gray and Grover.....	4.86	817
Nov. 18	Gray and Pierce.....	5.08	916	June 18	R. C. Thaxton.....	4.92	936
Jan. 9	R. C. Thaxton.....	4.81	847				

Daily gage height, in feet, of Guadalupe River near Cuero, Tex., for the year ending Sept. 30, 1916.

Day.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.
1	5.1	5.0	4.98	5.60	5.60	4.60	4.65	4.95	5.30	4.85	5.35
2	5.9	4.9	4.35	5.00	5.35	4.65	3.78	4.98	6.15	4.60	5.72
3	5.8	5.0	4.35	7.70	5.33	4.45	5.88	2.20	5.75	5.00	5.53
4	5.7	5.0	4.55	6.75	5.17	4.40	16.60	5.35	5.05	4.45	5.42
5	5.6	5.0	4.50	5.90	4.65	4.42	15.20	3.10	5.70	4.35	5.27
6	5.7	4.9	4.60	5.50	4.75	4.70	9.35	5.20	5.50	4.75	5.70
7	5.5	4.9	4.35	5.30	5.22	4.60	8.80	5.13	5.30	4.82	
8	5.3	5.0	4.75	5.22	4.95	4.75	5.75	5.18	5.32	5.21	
9	5.3	4.9	5.20	4.72	4.95	4.70	5.32	5.05	5.25	5.32	
10	5.2	4.9	5.05	5.10	4.95	4.65	5.80	4.99	5.22	4.95	
11	5.3	4.9	4.95	4.92	5.05	4.60	5.59	2.85	5.26	4.81	
12	5.3	4.9	5.00	5.02	4.55	4.22	5.38	4.90	5.30	4.75	
13	5.1	4.9	5.30	5.10	4.55	4.75	5.15	4.92	5.02	4.80	
14	5.1	4.9	5.02	5.25	5.15	4.70	4.90	4.72	5.12	4.70	
15	5.1	4.9	5.12	4.75	5.25	4.72	5.02	4.90	5.14	4.75	
16	5.2	4.9	5.02	4.05	4.80	4.90	5.15	4.81	4.90	4.32	
17	5.2	4.9	5.20	5.15	4.68	4.78	5.19	4.60	4.98	4.52	
18	5.2	4.95	5.00	4.68	4.50	4.10	8.00	5.24	4.98	4.60	
19	5.1	4.9	4.95	4.62	4.58	3.90	11.50	5.18	4.99	4.40	
20	5.1	5.0	4.95	4.88	4.45	4.42	7.60	5.08	4.88	4.40	
21	5.3	4.8	5.00	4.78	4.84	4.70	6.42	7.10	4.82	4.45	
22	5.1	5.0	4.95	5.30	4.60	4.28	5.70	8.62	4.85	4.32	
23	5.1	4.8	4.95	7.50	4.82	4.75	5.58	14.10	4.75	3.60	
24	5.1	4.8	5.00	5.42	4.80	4.82	5.55	16.45	4.78	4.50	
25	5.3	4.9	5.10	5.22	4.70	3.95	5.55	17.95	4.78	4.77	
26	5.1	4.9	4.90	4.72	4.52	3.94	5.30	18.80	4.55	4.90	
27	5.1	4.9	4.85	4.80	4.30	4.72	5.15	19.00	4.70	4.78	
28	5.0	4.9	4.90	4.98	4.78	4.44	5.08	7.99	4.38	4.60	
29	5.0	4.88	5.05	4.70	4.78	4.94	4.98	6.95	4.48	4.78	
30	4.8	4.75	5.00	5.10		4.05	4.90	6.94	4.70	4.42	
31	5.3		4.90	5.60		4.00		6.08		5.00	

GUADALUPE RIVER BELOW CUERO, TEX.

LOCATION.—Three-fourths mile upstream from Heard's bridge on the Arneckeville road, 1 mile south of the Dietze farmhouse, 2 miles below the Clinton bridge, 2½ miles southeast of Cuero, Dewitt County, 4 miles below the Schleicher bridge, 8 miles below dam used for power development.

DRAINAGE AREA.—5,020 square miles.

RECORDS AVAILABLE.—August 6, 1916, to September 30, 1916.

GAGE.—Stevens water-stage recorder on left bank.

DISCHARGE MEASUREMENTS.—Made from cable 40 feet upstream from gage.

CHANNEL AND CONTROL.—Channel straight above and below station for 1,000 feet. Bed composed of gravel and small rock; clean and not subject to shift. Left bank sand and dirt, covered with brush and open timber, 20 feet high, but at stages above a gage height of 20 feet is overflowed, the water submerging an area extending one-fourth mile back from the river; right bank composed of sand and dirt covered with brush and trees on sloping side and cultivated land on top; high and not subject to overflow. Rock and gravel rapids 250 feet below gage serves as a permanent control during low and medium stages.

EXTREMES OF DISCHARGE.—Maximum stage recorded during year, from water-stage recorder, 2.92 feet at 5 a. m. August 19 (discharge, 1,510 second-feet; determined from extension of rating curve); minimum stage, from water-stage recorder, 0.88 foot at 9 a. m. September 30 (approximate discharge, 360 second-feet); determinations of both maximum and minimum discharge obtained from extension of rating curve and possibly slightly in error.

ICE.—None reported during year.

DIVERSIONS.—Diversions of small quantities of water for irrigation in upper part of Guadalupe River basin does not greatly influence flow at station. The First Report of the Board of Water Engineers for the State of Texas shows filings for 730 acre-feet per annum for the city of Cuero, 3,410 second-feet for continuous use for municipal and manufacturing plants, 2,145 acre-feet per annum for New Braunfels, Seguin, and Gonzales, and 2,900 acre-feet storage per annum in the drainage basin above station.

REGULATION.—Flow regulated by operation of water-power plants upstream, chiefly by a plant about 8 miles above.

ACCURACY.—Stage-discharge relation practically permanent. Rating curve well defined between 500 and 1,100 second-feet. Operation of the water-stage recorder satisfactory. Daily discharge ascertained by applying to the rating table mean daily gage heights determined by use of planimeter. Results excellent.

Discharge measurements of Guadalupe River below Cuero, Tex., during the year ending Sept. 30, 1916.

Date.	Made by—	Gage height.	Discharge.	Date.	Made by—	Gage height.	Discharge.
		Feet.	*Sec.-ft.*			*Feet.*	*Sec.-ft.*
Aug. 6	Kessler and Lieb	1.99	855	Sept. 29	William Kessler	1.39	541
Sept. 7	Victor Lieb	1.66	667				

Daily discharge, in second-feet, of Guadalupe River below Cuero, Tex., for the year ending Sept. 30, 1916.

Day.	Aug.	Sept.	Day.	Aug.	Sept.	Day.	Aug.	Sept.
1	.....	730	11	662	547	21	1,140	601
2	.....	868	12	635	575	22	1,040	579
3	.....	782	13	621	616	23	730	571
4	.....	704	14	606	611	24	677	519
5	.....	646	15	592	683	25	800	503
6	831	611	16	579	611	26	770	555
7	770	579	17	587	583	27	630	563
8	709	583	18	621	559	28	625	543
9	699	527	19	1,200	539	29	597	527
10	683	511	20	933	531	30	592	475
						31	662	.....

Monthly discharge of Guadalupe River below Cuero, Tex., for the year ending Sept. 30, 1916.

Month.	Discharge in second-feet.			Run-off (total in acre-feet).
	Maximum.	Minimum.	Mean.	
August 6-31	1,200	579	739	37,600
September	868	475	594	35,300
The period	.....	.....	.....	72,900

SAN MARCOS RIVER AT SAN MARCOS, TEX.

LOCATION.—Just below Cape Ginning Co.'s mill, 300 feet southwest of the main San Marcos-Luling highway, 250 feet above the Mitchell farm house, 1 mile southeast of San Marcos, Hayes County, 1¼ miles above mouth of Blanco River, 1½ miles below dam of San Marcos Utilities Co. and the large springs that furnish a constant supply for the stream.

DRAINAGE AREA.—Indeterminate.

RECORDS AVAILABLE.—June 10, 1915, to January 19, 1916, March 13 to September 30, 1916. Miscellaneous measurements made from 1894 to 1903.

GAGE.—Stevens water-gage recorder on left bank, 300 feet below Cape Ginning Co.'s mill, installed March 13, 1916. Gage used June 10, 1915, to January 19, 1916, was a vertical staff gage attached to the sewer trestle of San Marcos Utilities Co. 1,000 feet below Austin-San Antonio highway bridge, 1¼ miles above present site. No known relation between datum of staff gage and that of water-stage recorder.

DISCHARGE MEASUREMENTS.—Made by wading or from highway or railroad bridges in San Marcos.

CHANNEL AND CONTROL.—Bed composed of gravel and sand; some vegetation in the flowing water. Channel straight for 200 feet above and below the station. Water very clear, deep, and with scarcely any sediment except during floods caused by local rains. Left bank wooded, high, and not subject to overflow; right bank wooded, low, and subject to overflow, the water spreading back 100 feet to a second bank. Position of control not known; current-meter measurements indicate that it changes slightly.

EXTREMES OF DISCHARGE.—1915-16: Maximum stage, from water-stage recorder 4.05 feet at 2 a. m. April 16 (discharge, 365 second-feet), minimum stage recorded, 0.58 foot at 6 p. m. August 1 (discharge, 55 second-feet), determinations of both maximum and minimum discharge obtained from extension of rating curve and possibly subject to considerable error.

ICE.—None reported during year.

DIVERSIONS.—A concrete dam just above the San Marcos-Luling road bridge makes a pond for Roger's resort and serves as a diversion dam for an irrigation plant on left bank; diversion intermittent, but when used takes about 95 second-feet from river. A water wheel is used to pump the water for irrigation and the water that passes through it is returned to the river above Cape Ginning Co.'s dam. About 1,000 feet above the station is a dam constructed for the purpose of creating a pond from which water is pumped to the south bank lands. Only pumping plant or diversion between station and mouth of Blanco River is about 250 feet below gage. The First Report of the Board of Water Engineers for the State of Texas shows a filing for this plant for a capacity of diversion works of 3 second-feet and irrigable area of 100 acres. This report also shows filings in Hayes County, which are believed to be above the gage, of 789 acres declared irrigated by beneficial use of 1,578 acre-feet per annum. Beckman dam, just below mouth of Blanco River, is used to impound water for irrigation. During ordinary stages in San Marcos and Blanco rivers this dam backs water up San Marcos River, a distance of three-quarters of a mile, but flood stages in Blanco River create backwater at the station.

REGULATION.—Flow at station entirely regulated by dams above, the greatest effect being that produced by the power dam of the San Marcos Utilities Co., in the upper part of San Marcos, near the springs. This dam backs water over the springs that form the source of supply of the river during ordinary stages. Water is stored at this point throughout the afternoon and evening and released during the morning. Large fluctuations are also caused by operation of water wheel at Cape Ginning Co.'s mill during ginning season.

ACCURACY.—Stage-discharge relation changes slightly; rating curve is fairly well defined from 100 to 240 second-feet. The periods of backwater from Blanco River are of short duration, and the constant flow of San Marcos River allows estimates of the discharge to be made without material reduction in accuracy. Mean daily gage height determined by averaging 24-hourly readings from recorder charts. Discharge determined by the indirect method for shifting control. Results good from March 13 to September 30, but poor prior to that period. The fluctuating stage and grass growth in the channel introduced large errors in results obtained previous to March 13.

Discharge measurements of San Marcos River at San Marcos, Tex., during the year ending Sept. 30, 1916.

Date.	Made by—	Gage height.	Discharge.	Date.	Made by—	Gage height.	Discharge.
		Feet.	*Sec.-ft.*			*Feet.*	*Sec.-ft.*
Oct. 13	Thaxton and Pierce	2.39	165	May 11	R. J. Hank	1.82	118
Nov. 20	Gray and Pierce	2.14	174	20	William Kessler	1.95	134
Dec. 29	R. C. Thaxton	2.10	147	20	....do	2.34	170
Jan. 15	R. J. Hank	1.99	192	24	....do	2.00	134
Feb. 27	Gray and Grover	2.07	136	June 13	Gray and Thaxton	1.95	138
Mar. 13	R. J. Hank	2.00	140	July 8	Gray and Hank	1.89	133
30	Gray and Kessler	1.92	126	28	R. J. Hank	1.96	126
Apr. 5	Thaxton and Gray	1.54	107	Aug. 15	Gray and Hank	1.85	112

NOTE.—Gage heights Oct. 13 to Feb. 27 refer to datum of staff gage 1½ miles above the water stage recorder.

Daily discharge, in second-feet, of San Marcos River at San Marcos, Tex., for the year ending Sept. 30, 1916.

Day.	Oct.	Nov.	Dec.	Jan.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.
1	182	149	194	182	.....	136	134	132	124	120	131
2	178	145	230	182	.....	139	144	125	127	126	122
3	182	118	218	218	.....	150	128	135	126	123	123
4	182	160	206	194	.....	142	130	141	127	121	127
5	187	160	206	237	.....	126	109	137	124	125	122
6	171	160	196	167	.....	133	124	137	127	126	121
7	171	160	178	230	.....	133	128	136	131	126	116
8	171	178	178	218	.....	142	131	130	132	118	115
9	167	187	189	206	.....	134	134	135	135	120	116
10	160	189	167	206	.....	138	130	130	136	123	116
11	167	213	173	206	.....	129	127	142	128	109	114
12	171	204	180	218	.....	138	118	126	130	100	118
13	175	206	192	225	130	139	129	134	115	105	118
14	171	206	192	228	133	126	120	132	110	108	116
15	171	201	178	264	135	172	130	136	118	109	126
16	160	194	164	242	130	218	129	135	123	108	119
17	149	184	147	225	130	130	125	133	122	109	120
18	171	182	136	256	120	130	127	134	121	108	122
19	160	175	142	189	139	140	127	128	121	112	123
20	171	164	147	.....	121	136	134	126	120	118	124
21	171	160	138	.....	118	136	138	125	125	123	119
22	138	169	189	.....	120	147	144	123	126	108	117
23	128	175	171	.....	137	134	143	123	134	109	130
24	128	182	178	.....	140	133	138	126	126	109	121
25	128	138	149	.....	133	138	134	125	131	115	123
26	114	164	156	.....	126	137	133	124	131	121	129
27	138	201	160	.....	138	137	130	124	132	127	119
28	160	182	171	.....	135	141	135	125	132	134	122
29	182	160	145	.....	133	120	132	121	132	138	118
30	206	158	173	.....	135	126	139	129	124	116	119
31	171	.....	171	.....	134	.....	127	.....	135	136	.....

Monthly discharge of San Marcos River at San Marcos, Tex., for the year ending Sept. 30, 1916.

Month.	Discharge in second-feet.			Run-off (total in acre-feet).
	Maximum.	Minimum.	Mean.	
October	206	114	164	10,100
November	206	118	174	10,400
December	230	136	175	10,800
January 1–19	264	167	215	8,100
March 13–31	140	118	131	4,940
April	218	120	139	8,270
May	144	109	130	7,990
June	142	121	131	7,800
July	138	116	127	7,810
August	138	100	118	7,260
September	131	114	121	7,200

SAN MARCOS RIVER AT OTTINE, TEX.

LOCATION.—Above highway bridge one-fourth mile southwest of Ottine, Gonzales County, 4 miles below mouth of Plum Creek, 10 miles above confluence of San Marcos and Guadalupe rivers.

DRAINAGE AREA.—Indeterminate.

RECORDS AVAILABLE.—June 22, 1915, to September 30, 1916.

GAGE.—Vertical staff in four sections attached to trees on left bank about 200 feet above bridge; read by J. H. Kaine. Gage used from June 22 to October 12, 1915 was a vertical staff under the highway bridge, but gage heights have been reduced to datum of present gage by means of a curve of relation.

DISCHARGE MEASUREMENTS.—Made by wading at shoal 100 feet below gage or from downstream side of highway bridge.

CHANNEL AND CONTROL.—Bed composed of sand, rock, and gravel; not subject to extreme shift. Both banks high and wooded; not overflowed except by extremely high water. Channel straight above and below the station for 150 feet. During high stages in Guadalupe River backwater destroys stage-discharge relation; backwater exists only a few days each year.

EXTREMES OF DISCHARGE.—1915-16: Maximum stage recorded, 22.2 feet at 7.30 p. m. May 22, 1916 (discharge, 5,800 second-feet). Minimum stage, 1.32 feet at 6.30 a. m. July 5, 1916 (discharge, 55 second-feet).

ICE.—None reported during year.

DIVERSIONS.—Small amounts of water are diverted by gravity or pumping for irrigation in drainage basin above station, but only a small part of the total run-off is so used.

REGULATION.—Flow regulated to a slight extent by the operation of a small cotton gin a short distance above station. The operation of several small water-power plants in the upper drainage basin near San Marcos and Martindale does not materially affect the flow at this station.

ACCURACY.—Stage-discharge relation permanent except during a few days when backwater from Guadalupe River occurs. Gage read once daily to hundredths. Owing to regulation of the flow the assumption that one daily gage reading gives the mean for the day causes errors in the determination. Daily discharge ascertained by applying daily gage heights to rating table except May 22 and 23 and June 30. Results fair.

Discharge measurements of San Marcos River at Ottine, Tex., during the year ending Sept. 30, 1916.

Date.	Made by—	Gage height.	Discharge.	Date.	Made by—	Gage height.	Discharge.
		Feet.	*Sec.-ft.*			*Feet.*	*Sec.-ft.*
Oct. 12	R. C. Pierce	2.06	194	May 23	Gray and Kessler	9.15	1,440
Nov. 19	Gray and Pierce	2.08	190	23	do	8.73	1,320
Jan. 12	R. C. Thaxton	2.02	184	23	do	7.78	1,080
Feb. 27	Gray and Grover	1.94	155	23	do	7.28	1,000
Apr. 4	G. A. Gray	2.28	564	24	do	4.77	738
5	Gray and Thaxton	3.10	400	24	do	4.68	695
May 3	R. J. Hank	5.52	883	June 20	R. C. Thaxton	1.91	169
3	do	4.92	722	July 26	Gray and Hank	2.09	182
22	Gray and Kessler	21.27	5,720	Aug. 7	Kessler and Lieb	2.00	179
23	do	13.31	2,070	Sept. 9	Victor Lieb	1.52	80.2
23	do	12.59	1,830	20	William Kessler	1.68	125
23	do	10.70	1,560				

Daily discharge, in second-feet, of San Marcos River at Ottine, Tex., for the year ending Sept. 30, 1916.

Day.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.
1	232	192	168	187	221	170	133	175	240	11[illegible]	365	137
2	232	173	171	377	204	164	2,430	149	217	12[illegible]	274	179
3	200	173	168	202	198	160	2,600	732	213	12[illegible]	198	137
4	200	183	183	321	200	160	573	291	213	12[illegible]	179	175
5	183	192	202	190	183	160	413	282	221	5[illegible]	160	137
6	200	192	202	175	190	164	333	225	198	5[illegible]	160	126
7	200	173	331	175	188	158	274	217	194	14[illegible]	179	122
8	192	183	339	171	181	160	244	187	202	14[illegible]	137	130
9	183	192	183	171	179	160	225	183	183	14[illegible]	160	145
10	183	217	183	171	181	158	228	187	181	17[illegible]	171	141
11	183	173	183	168	175	158	198	175	202	17[illegible]	122	137
12	196	183	175	179	175	160	194	168	171	20[illegible]	122	122
13	200	192	175	170	171	156	175	164	168	15[illegible]	118	141
14	192	183	175	164	164	158	171	164	194	15[illegible]	137	141
15	200	192	175	168	160	160	168	160	190	15[illegible]	156	130
16	200	173	183	170	170	156	175	160	187	12[illegible]	156	111
17	192	192	183	171	175	160	1,310	156	183	13[illegible]	152	104
18	200	183	175	160	166	158	553	171	168	12[illegible]	156	93
19	217	194	175	164	156	164	353	160	168	16[illegible]	86	100
20	200	194	183	175	156	162	365	175	160	12[illegible]	493	133
21	200	171	183	563	162	149	253	1,010	152	12[illegible]	111	137
22	183	168	183	664	160	145	221	4,350	156	12[illegible]	118	93
23	192	171	175	187	164	141	225	1,900	139	20[illegible]	213	96
24	225	190	194	185	164	143	221	759	126	25[illegible]	198	104
25	164	194	194	173	162	152	194	573	133	12[illegible]	198	86
26	173	194	175	179	158	149	190	473	130	217	149	93
27	173	187	183	187	164	130	187	373	137	16[illegible]	130	104
28	173	168	175	190	166	156	175	365	156	175	149	90
29	173	171	175	393	160	158	175	349	145	313	137	93
30	183	168	164	244	.....	158	171	295	132	156	137	93
31	200	.....	171	240	.....	166	.....	278	.....	[illegible]	275	.....

NOTE.—Discharge May 22 and 23 determined from current-meter measurements made on these days, as stage-discharge relation was disturbed by backwater from Guadalupe River. Discharge June 30 interpolated; reported gage height evidently erroneous.

Monthly discharge of San Marcos River at Ottine, Tex., for the year ending Sept. 30, 1916.

Month.	Discharge in second-feet.			Run-off (total in acre-feet).
	Maximum.	Minimum.	Mean.	
October	232	164	194	11,900
November	217	168	184	10,900
December	339	164	190	11,700
January	664	160	227	14,000
February	221	156	174	10,000
March	170	130	156	9,590
April	2,600	133	438	26,100
May	4,350	149	484	29,800
June	240	126	175	10,400
July	313	55	155	9,530
August	493	86	174	10,700
September	175	86	121	7,200
The year	4,350	55	223	162,000

SAN ANTONIO RIVER BASIN.

SAN ANTONIO RIVER AT SAN ANTONIO, TEX.

LOCATION.—At Presa Street Bridge, just below office of San Antonio Water Supply Co., in San Antonio, Bexar County, 3 miles below San Antonio Springs, the source of the river.

DRAINAGE AREA.—Indeterminate.

RECORDS AVAILABLE.—October 23, 1914, to September 30, 1916. Miscellaneous discharge measurements were made from 1895 to 1906.

GAGE.—Vertical staff attached to upstream side of second bent of bridge from right bank; read by E. L. Wilson. Gage used from October 23, 1914, to February 28, 1916, was a vertical staff gage attached to downstream side of middle bridge pier, Commerce Street Bridge; relation of the datums of these gages not known.

DISCHARGE MEASUREMENTS.—Made from downstream side of Market Street Bridge, first bridge above station.

CHANNEL AND CONTROL.—Channel straight for a short distance above and below station, but the general course is very crooked. Bed composed of gravel, sand, and silt; shifts slightly. Banks high and clean; not subject to overflow except during extremely high stages, at which time the river spreads over a wide area. A rock and gravel shoal just below the station, free from vegetation and not subject to extreme shifting, serves as a control.

EXTREMES OF DISCHARGE.—Maximum stage recorded during year, 9.40 feet at 10.45 a. m., September 25 (discharge, 2,650 second-feet), determined from extension of rating curve and possibly subject to considerable error; minimum stage, 1.30 feet March 15 to 23 (discharge, 72 second-feet).

1914–1916: Maximum stage recorded, 14.0 feet at 5.30 p. m., October 2, 1914 (discharge, 4,700 second-feet), determined from extension of rating curve and possibly subject to considerable error; minimum stage, 1.30 feet, March 15 to 23, 1916 (discharge, 72 second-feet).

ICE.—None reported during year.

DIVERSIONS.—Considerable land is irrigated in San Antonio and vicinity south of the city; quantity of water diverted not definitely known.

ACCURACY.—Stage-discharge relation was affected during various periods from October 1, 1915, to February 28, 1916, by backwater from a small loose rock dam; on February 29 the gage was moved to its present location, where the relation is subject only to slight changes. Rating curve well defined for first location and well defined below 350 second-feet for present location. Gage read to hundredths twice daily. Daily discharge ascertained by applying gage heights to rating tables except during periods when stage-discharge relation was affected by backwater. Results are good from March 1 to September 30, 1916, and fair prior to that period. The normal flow of San Antonio River comes from springs within the city limits, but two tributaries from the north furnish considerable run-off at times of heavy precipitation. Changes in stage during low flow are believed to be due to pumping from deep wells for the city water supply and the use of artesian water for irrigation in areas adjacent to the river, as it is thought that the wells draw from the underground reservoir that feeds the river by springs.

Discharge measurements of San Antonio River at San Antonio, Tex., during the year ending Sept. 30, 1916.

Date.	Made by—	Gage height.	Discharge.	Date.	Made by—	Gage height.	Discharge.
		Feet.	*Sec.-ft.*			*Feet.*	*Sec.-ft.*
Nov. 11	Gray and Pierce	2.25	101	May 30	William Kessler	1.60	115
Dec. 21	R. C. Thaxton	2.25	92	June 23	do	1.37	78
Feb. 25	Gray and Grover	2.38	82	July 7	Gray and Hank	1.38	75
28	R. C. Thaxton	1.43	85	20	William Kessler	1.35	76
Mar. 10	do	1.30	72	Aug. 28	R. J. Hank	1.60	112
Apr. 14	William Kessler	1.42	89	Sept. 25	William Kessler	2.38	253
14	do	1.42	93	26	do	1.49	98
22	R. C. Thaxton	1.46	93				

NOTE.—Gage heights Nov. 11 to Feb. 25 refer to datum of gage at Commerce Street Bridge; after Feb. 25, to new gage at Presa Street Bridge.

Daily discharge, in second-feet, of San Antonio River at San Antonio, Tex., for the year ending Sept. 30, 1916.

Day.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.
1	117	108	102	92	90	81	520	92	100	75	85	85
2	117	108	102	92	90	80	161	92	106	75	85	85
3	120	106	102	94	90	77	102	92	106	75	85	85
4	117	105	102	96	92	77	98	92	104	75	85	85
5	117	106	102	94	92	77	96	92	99	80	85	85
6	117	102	111	92	92	78	95	92	99	75	104	85
7	117	102	95	95	90	78	95	92	98	75	85	85
8	120	100	92	95	90	80	95	91	96	75	85	85
9	117	101	92	96	82	80	95	89	91	75	85	85
10	114	101	92	92	82	80	95	88	86	77	85	85
11	114	101	92	92	82	80	95	85	84	77	85	85
12	120	102	92	92	82	78	95	85	84	77	85	88
13	120	102	92	90	82	80	95	85	81	77	85	85
14	120	102	92	91	82	77	95	85	81	80	84	85
15	122	100	92	92	82	72	99	85	81	80	82	84
16	114	102	92	92	82	72	95	84	80	80	82	82
17	122	102	92	92	82	72	93	81	80	80	82	78
18	124	102	92	92	82	72	93	88	80	81	88	78
19	120	102	95	92	84	72	93	85	80	81	85	78
20	117	102	92	95	84	72	92	85	80	80	85	78
21	117	101	92	95	84	72	92	206	80	130	85	78
22	114	102	92	92	84	72	92	142	80	85	85	78
23	117	101	92	92	84	72	92	111	80	85	85	78
24	114	102	92	92	84	73	98	106	80	82	85	78
25	106	100	92	92	82	73	92	106	80	82	85	850
26	108	101	92	92	82	73	92	106	77	82	85	111
27	108	102	92	92	83	73	92	106	77	82	85	88
28	108	102	92	92	85	73	92	106	77	82	86	85
29	108	102	92	92	82	73	92	106	77	82	371	85
30	108	102	92	92	.....	73	92	106	77	99	117	85
31	108	.....	92	91	.....	73	.....	106	.....	88	92	.....

NOTE.—Discharge determined from rating tables Oct. 1-23, Mar. 8-31, Apr. 20 to June 8 and July 18 to Sept. 30; by indirect method for shifting control during rest of year.

Monthly discharge of San Antonio River at San Antonio, Tex., for the year ending Sept. 30, 1916.

Month.	Discharge in second-feet.			Run-off (total in acre-feet).
	Maximum.	Minimum.	Mean.	
October	124	106	116	7,130
November	108	100	102	6,070
December	111	92	94.4	5,800
January	96	90	92.7	5,700
February	92	82	85.0	4,890
March	81	72	75.3	4,630
April	520	92	111	6,600
May	206	81	98.9	6,080
June	106	77	86.2	5,130
July	130	75	81.6	5,020
August	371	82	95.9	5,900
September	850	78	110	6,550
The year	850	72	95.7	69,500

SAN PEDRO CREEK AT SAN ANTONIO, TEX.

LOCATION.—At Commerce Street Bridge, 1½ blocks west of courthouse in San Antonio, Bexar County, 1½ miles above mouth of Salsamora and Martinez creeks, 1½ miles below San Pedro Springs, source of creek, 3 miles above confluence with San Antonio River.

DRAINAGE AREA.—Indeterminate.

RECORDS AVAILABLE.—July 20, 1916, to September 30, 1916.

GAGE.—Vertical staff attached to wall of building No. 713 Commerce Street, on upstream side of bridge on left bank; read by E. L. Wilson.

DISCHARGE MEASUREMENTS.—Made by wading near second bridge below gage.

CHANNEL AND CONTROL.—Bed composed of rock, gravel, and mud, shifting. Channel straight above and below station. Both banks formed by walls of buildings. City improvements have confined the stream to a small channel during low and medium stages, but during floods the streets are covered with water for several blocks. A shoal subject to shift, about 100 feet below gage, serves as control.

EXTREMES OF STAGE.—Maximum stage recorded during year, 6.25 at 7.45 a. m. September 25; minimum stage recorded, 1.60 feet from August 10–17 and 20–27.

ICE.—None reported during year.

DIVERSIONS.—None.

REGULATION.—No dams, reservoirs, or controlling works that permanently regulate the flow. Slight fluctuations were caused during year by improvement work along the channel above the gage.

ACCURACY.—Stage-discharge relation not permanent. Rating curve not developed. Gage read to hundredths twice daily. Daily discharge not determined.

Entire flow of San Pedro Creek, except during times of heavy precipitation, is furnished by San Pedro Springs, and the flow at this station is believed to be that which reaches San Antonio River. Martinez and Salsamora Creeks carry no water except during heavy local rains and have been known to be dry for several years at a time.

Discharge measurements of San Pedro Creek at San Antonio, Tex., during the year ending Sept. 30, 1916.

Date.	Made by—	Gage height.	Discharge.	Date.	Made by—	Gage height.	Discharge.
		Feet.	*Sec.-ft.*			*Feet.*	*Sec.-ft.*
July 20	William Kessler	1.76	12.1	Sept. 25	William Kessler	1.98	9.2
Aug. 27	Hank and Lieb	1.73	6.3				

Daily gage height, in feet, of San Pedro Creek at San Antonio, Tex., for the year ending Sept. 30, 1916.

Day.	July.	Aug.	Sept.	Day.	July.	Aug.	Sept.	Day.	July.	Aug.	Sept.
1	.....	1.62	1.75	11	.....	1.60	1.68	21	2.23	1.60	1.70
2	.....	1.62	1.75	12	.....	1.60	1.72	22	1.62	1.60	1.70
3	.....	1.62	1.70	13	.....	1.60	1.70	23	1.64	1.60	1.70
4	.....	1.62	1.70	14	.....	1.60	1.70	24	1.65	1.60	1.70
5	.....	1.73	1.70	15	.....	1.60	1.70	25	1.71	1.70	2.49
6	.....	1.95	1.70	16	.....	1.60	1.70	26	1.64	1.60	1.95
7	.....	1.68	1.69	17	.....	1.60	1.70	27	1.68	1.60	1.95
8	.....	1.62	1.68	18	.....	1.68	1.70	28	1.64	1.65	1.95
9	.....	1.62	1.68	19	.....	1.62	1.70	29	1.62	1.60	1.95
10	.....	1.60	1.68	20	1.65	1.60	1.70	30	2.34	1.97	1.95
								31	1.76	1.75	.....

NUECES RIVER BASIN.

NUECES RIVER NEAR CINONIA, TEX.

LOCATION.—At suspension highway bridge near Oswald's ranch, 2 miles east of Cinonia, Zavalla County, 8 miles northeast of Crystal City, 20 miles above Winter Garden ranch dam.

DRAINAGE AREA.—2,060 square miles.

RECORDS AVAILABLE.—July 5, 1915, to September 30, 1916.

GAGE.—Vertical staff in several sections, on both banks, just below the highway bridge; read by C. C. Oswald.

DISCHARGE MEASUREMENTS.—Made by wading 100 feet below bridge or from downstream side of bridge.

CHANNEL AND CONTROL.—Bed composed of clay and gravel; free from vegetation; shifts. Banks high and wooded and not subject to overflow. Channel straight above and below station. Position of control not known. The stage-discharge relation has been seriously affected at times by collection of logs, leaves, and brush below gage.

EXTREMES OF DISCHARGE.—Maximum stage recorded during year, 18.2 feet at 7 p. m. August 19 (discharge not determined); minimum stage, 1.85 feet from July 1 to July 5 (discharge, 3.8 second-feet).

1915–16: Maximum stage recorded, 20.0 feet, at 6.30 a. m. September 19, 1915 (discharge not determined); minimum stage, July 1–5, 1916 (see preceding paragraph).

ICE.—None reported during year.

DIVERSIONS.—Considerable water diverted above station for irrigation; amount not known.

REGULATION.—Available data indicate no regulation above station.

ACCURACY.—Stage-discharge relation not permanent. Rating curve well defined below 200 second-feet. Gage read to half-tenths twice daily; gage heights subject to error because of careless observations. Daily discharge ascertained by applying mean gage heights to rating table except during periods for which stage-discharge relation was affected by shifting control. Discharge for high stages determined from extension of rating curve, and may be considerably in error. Results fair.

Backwater from a dam 40 feet high, constructed about 20 miles below station, extends within 2 miles of station when reservoir is full. A large part of the flow of the river is known to seep into the bed just below Uvalde, and returns to the surface just above the station. The condition of the underground waters may have an effect on this return water, and thus help to equalize the flow.

Discharge measurements of Nueces River near Cinonia, Tex., during the year ending Sept. 30, 1916.

Date.	Made by—	Gage height.	Discharge.	Date.	Made by—	Gage height.	Discharge.
		Feet.	*Sec.-ft.*			*Feet.*	*Sec.-ft.*
Oct. 2	Thaxton and Pierce	4.36	93.9	May 20	William Kessler	3.87	71.6
Nov. 12	Gray and Pierce	2.96	21.6	29	do	3.82	65.9
Jan. 4	R. C. Thaxton	3.00	17.8	June 21	do	2.06	7.1
Mar. 13	do	2.45	17.1	Aug. 26	R. J. Hank	2.55	19.3

Daily discharge, in second-feet, of Nueces River near Cinonia, Tex., for the year ending Sept. 30, 1916.

Day.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.
1	98	23	18	18	16	19	16	16	40	3.8	12	58
2	94	24	18	18	16	19	21	16	36	3.8	2	33
3	89	24	18	18	17	19	24	16	33	3.8	1	26
4	81	24	18	17	17	19	20	16	26	3.8	13	25
5	80	23	18	15	17	19	18	16	24	3.8	1	20
6	72	21	18	15	17	19	16	14	20	4.5	1	20
7	68	21	18	14	18	19	16	14	19	10	2	20
8	62	21	18	14	18	19	16	14	18	21	17	18
9	59	21	18	14	18	19	14	13	18	17	6	17
10	55	21	18	12	18	19	14	12	17	13	4.5	17
11	52	21	18	12	19	19	13	10	16	13	4.5	15
12	44	21	18	12	19	19	13	10	14	10	4.5	15
13	41	21	18	12	19	18	13	10	14	145	4.5	26
14	40	18	18	13	19	16	13	9.3	13	122	4.5	92
15	37	18	18	13	19	16	358	9.3	13	85	4.5	35
16	35	18	18	13	19	16	370	14	12	62	4.5	26
17	35	18	18	13	19	16	115	26	10	48	3	24
18	32	18	16	14	19	16	95	18	10	36	2	22
19	31	20	16	14	19	16	66	12	9.3	10	27	18
20	30	23	16	14	19	16	26	9.3	8.1	8.1	48	16
21	26	24	16	14	19	16	14	9.3	7.5	20	37	16
22	26	24	16	16	19	14	13	9.3	6.1	16	6	16
23	25	24	16	14	19	14	18	736	6.1	10	4	14
24	24	24	16	13	19	14	18	430	6.1	9.3	4	14
25	24	24	16	13	19	14	18	202	5.3	9.3	3	14
26	22	24	16	14	19	14	16	166	5.3	92	21	13
27	22	25	16	14	19	14	16	115	5.3	71	17	13
28	22	25	16	14	19	14	16	98	4.5	92	31	13
29	20	22	16	14	19	14	16	71	4.5	58	30	12
30	20	19	18	16	.....	14	16	55	4.5	33	7	12
31	24	.....	18	16	.....	14	.....	46	.....	118	7	.....

NOTE.—Discharge ascertained by use of rating table Feb. 13 to Sept. 30, and by indirect method for shifting control Oct. 1 to Feb. 12.

Monthly discharge of Nueces River near Cinonia, Tex., for the year ending Sept. 30, 1916.

Month.	Discharge in second-feet.			Run-off (total in acre-feet).
	Maximum.	Minimum.	Mean.	
October	98	20	44.8	2,750
November	25	18	21.8	1,300
December	18	16	17.2	1,060
January	18	12	14.3	879
February	19	16	18.4	1,060
March	19	14	16.6	1,020
April	370	13	47.3	2,810
May	734	9.3	71.1	4,370
June	40	4.5	14.2	845
July	145	3.8	37.5	2,310
August	462	4.5	78.5	4,830
September	92	12	22.7	1,350
The year	734	3.8	33.2	24,000

NUECES RIVER NEAR COTULLA, TEX.

LOCATION.—At Hargus dam, 4 miles west of Cotulla, Lasalle County.

DRAINAGE AREA.—5,030 square miles.

RECORDS AVAILABLE.—July 1, 1915, to September 30, 1916.

GAGE.—Vertical staff attached to trees on right bank just above end of dam; read by Irvin Peoples.

DISCHARGE MEASUREMENTS.—Made by wading below dam. No facilities for measurements at medium and high stages.

CHANNEL AND CONTROL.—Bed composed of gravel, rock, and sand; channel straight above and below station. Banks wooded, medium in height, and not subject to overflow. Long concrete dam just below gage serves as a control; crest of dam irregular.

EXTREMES OF DISCHARGE.—1915–16: Maximum stage recorded, 6.50 feet August 22, 1916 (discharge, 23,000 second-feet; results obtained from extension of rating curve and possibly subject to considerable error); no flow during a large part of each year.

ICE.—None reported during year.

DIVERSIONS.—Large part of ordinary flow above station pumped or diverted for irrigation. The station is in upper end of an irrigated section near Cotulla. Two large filings are listed in the First Report of the Board of Water Engineers for the State of Texas, in the name of Winter Garden Irrigation Co. and Nueces Valley Irrigation Co., in Zavalla and Dimmit counties; irrigable area under each system, 10,000 acres; capacities of diversion works of 95.0 and 6.65 second-feet, respectively.

REGULATION.—Flow at station regulated by storage reservoirs and pumping plants above.

ACCURACY.—Stage-discharge relation practically permanent. Rating curve based on low-water discharge measurements and discharge computed by formula using the dam as a weir; possibly subject to considerable error. Because of the length of the dam (600 feet) the station is non-sensitive. Gage read to hundredths once daily. Daily discharge ascertained by applying gage height to rating table. Results poor.

Discharge measurements of Nueces River near Cotulla, Tex., during the year ending Sept. 30, 1916.

Date.	Made by—	Gage height.	Discharge.	Date.	Made by—	Gage height.	Discharge.
		Feet.	*Sec.-ft.*			*Feet.*	*Sec.-ft.*
Nov. 13	Gray and Pierce	0.15	4.1	Apr. 20	R. C. Thaxton	1.10	1,570
Jan. 5	R. C. Thaxton	−1.00	.0	21	do	1.10	1,410
Apr. 19	do	.59	671	21	do	1.04	1,200
19	do	.69	722	June 20	William Kessler	−.60	a.3
20	do	1.05	1,420				

a Estimated leakage under dam.

NOTE.—Measurements on Apr. 19–21 made from bridge 6 miles below dam; due to pondage between the two points, the discharge does not represent the amount passing over the dam at the time the measurement was made. Stage-discharge relation uncertain, as the time interval could not be determined accurately.

Daily discharge, in second-feet, of Nueces River near Cotulla, Tex., for the year ending Sept. 30, 1916.

Day.	Oct.	Nov.	Jan.	Apr.	May.	June.	July.	Aug.	Sept.
1	107	14			4			487	2,020
2	107	13			4			660	2,350
3	127	12			2			854	1,710
4	147	11			1			660	1,180
5	107	10			1			337	752
6	107	10			1			267	467
7	67	9			1			147	267
8	67	8						14	147
9	67	8				1,070		107	67
10	67	7				957		107	107
11	67	6				957		67	67
12	67	5				957		67	67
13	67	4				1,070		44	67
14	67	4				1		44	567
15	44	4						22	2,350
16	44	4						14	1,420
17	44	4						7	782
18	337	2		1				7	567
19	147	2		660				267	467
20	147	2		1,210				1,880	267
21	337		4	875				267	147
22	854		3	295				147	67
23	407		3	107				107	67
24	207		3	62				67	67
25	67		2	44				44	44
26	67		2	31				22	44
27	44		2	22				22	22
28	44		2	19				14	22
29	37		2	13				22	14
30	29		1	7				267	14
31	21							267	

NOTE.—No water flowing on days for which discharge is not given. Discharge interpolated Oct. 3, 29–31, Nov. 2–12, and May 6.

Monthly discharge of Nueces River near Cotulla, Tex., for the year ending Sept. 30, 1916.

Month.	Discharge in second-feet.			Run-off (total in acre-feet).
	Maximum.	Minimum.	Mean.	
October	854	21	135	8,300
November	14	.0	4.63	276
December	.0	.0	.00	0
January	4	.0	.77	47
February	.0	.0	.00	0
March	.0	.0	.00	0
April	1,210	.0	112	6,660
May	4	.0	.45	28
June	1,070	.0	167	9,940
July	267	.0	35.3	2,170
August	23,000	7	4,300	265,000
September	2,350	14	365	21,800
The year	23,000	0	446	325,000

NUECES RIVER NEAR THREE RIVERS, TEX.

LOCATION.—At San Antonio, Uvalde & Gulf Railroad bridge 1 mile west of Kittie, 2 miles southeast of Three Rivers, Live Oak County, half a mile below mouth of Frio River.

DRAINAGE AREA.—15,600 square miles.

RECORDS AVAILABLE.—July 1, 1915, to September 30, 1916.

GAGE.—Vertical staff, attached to center pier of railroad bridge and left bridge abutment.

DISCHARGE MEASUREMENTS.—Made by wading or from highway bridge half a mile below gage.

CHANNEL AND CONTROL.—Bed composed of adobe shale; clean; does not change greatly. Channel straight above and below station. Banks wooded, high, and not subject to overflow. Position of high-water control not known; shoal just below gage probably forms low-water control.

EXTREMES OF DISCHARGE.—1915–16: Maximum stage recorded, 30 feet August 25, 1916 (discharge, 15,500 second-feet); no flow from March 16 to April 5, 1916.

ICE.—None reported during year.

DIVERSIONS.—Considerable land irrigated above station but there appears to be no irrigable land immediately above.

REGULATION.—Flow regulated somewhat by storage reservoirs and pumping in the drainage basin above, but the effect is not so pronounced as at the stations in the upper part of the drainage basin. Such water-power plants as exist in the area above the station are propably small.

ACCURACY.—Stage-discharge relation changes slightly. Rating curve well defined below 7,000 second-feet. Gage read to half-tenths twice daily; oftener when fluctuations of stage are rapid or extreme. Daily discharge ascertained by applying gage heights to rating table except during periods for which discharge relation is affected by shifting control.

Discharge measurements of Nueces River near Three Rivers, Tex., during the year ending Sept. 30, 1916.

Date.	Made by—	Gage height.	Discharge.	Date.	Made by—	Gage height.	Discharge.
		Feet.	*Sec.-ft.*			*Feet.*	*Sec.-ft.*
Oct. 7	R. C. Pierce	2.06	165	Apr. 22	William Kessler	15.84	3,910
Nov. 16	Gray and Pierce	.57	6.6	22	....do	14.80	3,510
Jan. 6	R. C. Thaxton	.27	a 1.2	22	....do	13.75	3,030
Mar. 11	....do	.13	a .2	23	....do	6.19	880
Apr. 12	William Kessler	1.58	55.1	23	....do	5.75	769
12	....do	1.56	53.1	June 17	....do	1.11	7.4
13	....do	1.40	39.9	Aug. 23	R. J. Hank	20.42	5,960
13	....do	1.38	35.8	23	Hank and Lieb	20.72	5,980
20	....do	16.72	2,240	24	Victor Lieb	24.46	9,380
21	....do	15.15	3,850	Sept. 26	William Kessler	6.53	1,010
21	....do	15.50	3,960	26	....do	6.97	1,160
21	....do	16.28	4,180	27	....do	4.54	534
21	....do	16.49	4,400	27	....do	4.11	478
22	....do	16.83	4,290				

a Estimated.

Daily discharge, in second-feet, of Nueces River near Three Rivers, Tex., for the year ending Sept. 30, 1916.

Day.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.
1	799	181	2.4	2.0	2.9	0.1	0.0	168	245	698	2,4[illegible]	5,150
2	645	173	2.4	1.7	2.4	.1	.0	132	142	586	1,9[illegible]	4,550
3	624	42	2.2	1.7	2.0	.1	.0	536	620	426	1,4[illegible]	3,390
4	444	28	2.2	1.7	2.0	.1	.0	742	178	396	1,140	3,100
5	302	22	1.7	1.7	2.0	.1	.0	258	91	281	1,5[illegible]	2,490
6	195	18	1.3	1.7	1.7	.1	1,180	210	37	1,460	1,4[illegible]	1,950
7	187	18	38	1.7	1.7	.1	3,310	107	34	592	1,5[illegible]	1,490
8	187	18	16	7.2	1.7	.1	3,810	81	29	980	1,2[illegible]	2,330
9	187	12	10	10	1.7	.1	596	51	23	426	1,1[illegible]	3,060
10	187	12	6.4	12	1.7	.1	213	48	18	432	1,0[illegible]	3,320
11	179	9.5	4.8	7.7	1.7	.1	94	43	31	396	8[illegible]	3,610
12	171	9.5	3.4	5.4	1.7	.1	52	37	68	178	6[illegible]	3,470
13	171	8.8	9.0	4.0	2.6	.1	34	32	28	165	4[illegible]	3,080
14	171	8.1	8.1	3.2	3.2	.1	25	28	12	1,120	3[illegible]	2,620
15	171	7.4	6.4	3.2	1.8	.1	22	26	17	2,060	3[illegible]	2,200
16	171	6.8	5.4	3.2	1.2	.0	320	24	14	2,000	3[illegible]	1,790
17	187	6.2	4.0	2.9	.6	.0	229	24	7.7	920	2[illegible]	1,440
18	187	5.6	3.4	2.4	.6	.0	94	22	4.2	691	2[illegible]	1,280
19	4,830	5.2	2.9	2.4	.6	.0	221	22	2.4	536	1,4[illegible]	1,130
20	4,670	5.2	2.4	2.4	.5	.0	1,510	22	2.0	329	2,9[illegible]	1,070
21	4,490	4.8	2.4	3.0	.4	.0	3,970	62	1.7	270	3,3[illegible]	817
22	1,510	4.8	2.0	3.0	.4	.0	3,750	31	2.0	286	4,0[illegible]	1,300
23	932	4.2	2.0	8.6	.4	.0	1,400	22	2.3	520	5,9[illegible]	1,750
24	724	4.2	1.7	9.0	.2	.0	556	68	2.3	612	9,7[illegible]	1,820
25	860	3.6	1.2	6.4	.2	.0	427	229	2.0	860	14,0[illegible]	1,980
26	691	3.2	1.2	5.4	.1	.0	396	526	1.0	889	9,4[illegible]	1,230
27	596	3.2	2.2	4.8	.1	.0	373	1,760	460	355	9,6[illegible]	853
28	636	2.9	2.4	4.2	.1	.0	536	1,840	526	1,080	11,9[illegible]	270
29	566	2.9	2.0	4.2	.1	.0	292	691	368	831	10,3[illegible]	142
30	496	2.4	2.0	3.6	.....	.0	232	486	532	686	7,7[illegible]	128
31	197	.....	2.0	3.2	.....	.0	.....	197	.....	2,060	6,2[illegible]	.....

NOTE.—Discharge computed by indirect method for shifting control Oct. 1–18 and May 29 to June 26.

Monthly discharge of Nueces River near Three Rivers, Tex., for the year ending Sept. 30, 1916.

Month.	Discharge in second-feet.			Run-off (total in acre-feet).
	Maximum.	Minimum.	Mean.	
October	4,830	171	848	52,100
November	181	2.4	21.1	1,260
December	38	1.2	4.95	304
January	12	1.7	4.31	265
February	3.2	.1	1.25	72
March	.1	.0	.05	3
April	3,970	.0	788	46,900
May	1,840	22	275	16,900
June	620	1.0	117	6,960
July	2,060	165	746	45,900
August	14,000	261	3,7[illegible]	228,000
September	5,150	128	2,1[illegible]	126,000
The year	14,000	.0	723	525,000

NUECES RIVER AT CALALLEN, TEX.

LOCATION.—At the old pump house for the city of Corpus Christi, half a mile northwest of Calallen, Nueces County, 18 miles west of Corpus Christi, 8 miles above Nueces Bay, half a mile above the edge of tidewater and the breakwater dam.

DRAINAGE AREA.—16,700 square miles.

RECORDS AVAILABLE.—August 12, 1915, to September 30, 1916.

GAGE.—Vertical staff attached to pipe-line support of old pump house; read by Henry Wagner.

DISCHARGE MEASUREMENTS.—Made by wading at the breakwater or from cable 125 feet below gage.

CHANNEL AND CONTROL.—Bed composed of clay and gravel. Channel straight above and below station. Left bank wooded, low, and bordered by levee constructed to prevent overflow; right bank wooded, medium in height, and not subject to overflow. The breakwater, which is a loose rock fill half a mile below, serves as control.

EXTREMES OF DISCHARGE.—1915–16: Maximum stage recorded, 8.38 feet September 5, 1916 (discharge, 6,190 second-feet); minimum stage, 0.65 foot March 14 to April 6, 1916 (discharge, 9.0 second-feet).

ICE.—None reported during year.

DIVERSIONS.—Considerable water taken from river for irrigation immediately above station. The city of Corpus Christi pumps water just below the gage for municipal supply and has made a filing with the Board of Water Engineers for the State of Texas for a continuous use of 0.93 second-foot and a storage of 675 acre-feet per annum. The pumping plant is between the breakwater and cable and gage, and during low stages corrections are made for the amount pumped during current-meter measurements. A second small pump for private use installed between city intake and breakwater is seldom operated. The quantities pumped are small and do not greatly affect the natural flow during ordinary stages

REGULATION.—No water-power plants of consequence above station.

ACCURACY.—Stage-discharge relation not permanent because of leakage through the breakwater dam. Rating curve is fairly well defined: Gage read to hundredths twice daily. Daily discharge ascertained by applying gage heights to rating table except during periods for which stage-discharge relation is affected by shifting control. Allowance made for rising and falling stages in computing discharge. Results fair.

Discharge measurements of Nueces River at Calallen, Tex., during the year ending Sept. 30, 1916.

Date.	Made by—	Gage height.	Discharge.	Date.	Made by—	Gage height.	Discharge.
		Feet.	*Sec.-ft.*			*Feet.*	*Sec.-ft.*
Oct. 9	Pierce and Thaxton	1.37	220	Apr. 11	William Kessler	3.82	1,880
Nov. 17	Gray and Pierce	.87	32.8	11	do	3.44	1,580
Jan. 7	R. C. Thaxton	.84	a12	11	do	3.11	1,260
Mar. 11	do	.65	b 8.3	11	do	2.90	1,120
Apr. 9	William Kessler	3.83	2,130	11	do	2.82	1,050
9	do	3.88	2,150	12	do	2.06	498
9	do	3.93	2,210	June 19	do	.70	38.6
9	do	3.95	2,210	Aug. 24	R. J. Hank	4.14	2,190
10	do	4.26	2,400	24	do	4.15	2,190
10	do	4.30	2,430	Sept. 28	William Kessler	2.83	1,220
10	do	4.37	2,510				

a Result poor; water flowing through breakwater dam on which discharge was measured.
b Estimated; discharge was from springs, no flow in river a few miles upstream.

Daily discharge, in second-feet, of Nueces River at Calallen, Tex., for the year ending Sept. 30, 1916.

Day.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.
1	1,330	514	32	12	20	22	9	77	385	309	1,190	5,960
2	1,390	333	32	14	20	21	9	77	330	414	1,970	6,050
3	1,000	186	32	16	20	20	9	74	183	782	2,110	5,980
4	940	117	32	16	20	20	9	72	201	934	1,570	6,100
5	804	88	32	19	20	17	9	320	201	490	1,240	6,190
6	466	68	34	19	22	17	9	684	197	594	1,390	6,110
7	306	64	38	17	22	17	15	75	197	934	1,320	5,780
8	230	64	38	17	22	16	482	73	169	847	1,320	5,520
9	194	61	38	17	22	16	2,160	73	155	922	1,390	4,930
10	176	61	38	14	22	15	2,520	70	148	783	1,1[illegible]	4,390
11	155	38	38	16	24	11	1,460	70	144	678	990	3,130
12	155	34	54	15	23	10	262	56	130	490	7[illegible]	2,460
13	148	29	54	15	23	10	75	41	96	706	810	2,320
14	138	29	54	14	23	9	70	32	80	894	6[illegible]	1,940
15	127	29	54	14	22	9	69	31	64	1,090	5[illegible]	1,900
16	130	31	41	16	22	9	69	27	54	1,610	870	1,620
17	130	31	41	16	22	9	66	24	58	1,890	172	1,260
18	130	31	41	16	22	9	69	22	54	1,640	171	1,060
19	257	31	41	16	22	9	83	22	41	860	105	776
20	632	31	41	16	22	9	77	20	39	615	313	550
21	1,850	31	29	18	22	9	669	17	39	520	1,290	550
22	2,430	31	23	17	22	9	1,490	15	39	398	1,600	958
23	1,960	31	23	17	22	9	2,310	13	39	338	2,000	990
24	1,060	32	23	15	22	9	2,330	12	38	632	2,450	1,150
25	568	32	22	15	22	9	1,630	11	38	759	2,290	1,310
26	1,090	32	21	17	22	9	440	11	36	700	3,470	1,390
27	997	32	19	17	22	9	186	11	36	760	4,140	1,160
28	825	32	16	17	22	9	72	11	36	594	4,770	1,240
29	685	32	15	17	22	9	77	1,090	36	508	5,090	860
30	615	32	13	17	.....	9	83	1,470	362	490	5,690	490
31	580	.....	12	17	.....	9	.....	478	.....	894	5,870	.....

NOTE.—Discharge computed by indirect method for shifting control Oct. 4–20, Nov. 1 to Feb. 9, and June 10–29.

Monthly discharge of Nueces River at Calallen, Tex., for the year ending Sept. 30, 1916.

Month.	Discharge in second-feet.			Run-off (total in acre-feet).
	Maximum.	Minimum.	Mean.	
October	2,430	127	693	42,600
November	514	29	72.9	4,340
December	54	12	32.9	2,020
January	19	12	16.1	990
February	24	20	21.8	1,250
March	22	9	12.1	744
April	2,520	9	561	33,400
May	1,470	11	164	10,100
June	385	36	118	7,020
July	1,890	309	778	47,800
August	5,870	105	1,890	116,000
September	6,190	490	2,900	167,000
The year	6,190	9	598	433,000

FRIO RIVER NEAR DERBY, TEX.

LOCATION.—At International & Great Northern Railway bridge 900 feet below mouth of Leona River, 4 miles south of Derby, Frio County.

DRAINAGE AREA.—3,500 square miles.

RECORDS AVAILABLE.—August 1, 1915, to September 30, 1916.

GAGE.—Vertical staff attached to railway bridge pier; read by John Speed.

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

CHANNEL AND CONTROL.—Bed composed of rock, sand, and gravel; channel curved above and below station but straight at gage for 150 feet. Banks wooded, high, and not subject to overflow. A concrete dam 50 feet below gage serves as control during low and medium stages; position of high-water control not known. Point of zero flow, gage height 0.12 feet.

EXTREMES OF DISCHARGE.—1915–16: Maximum stage recorded, 13.0 feet at 10.30 a. m. April 3, 1916 (discharge not determined); no flow in stream during several long periods.

ICE.—None reported during year.

DIVERSIONS.—Small areas are irrigated by diversion and pumping at the headwaters, but available information does not show that water is taken from this stream immediately above the station.

REGULATION.—None so far as is known.

ACCURACY.—Stage-discharge relation practically permanent. Gage read to hundredths once daily; oftener during extreme fluctuations. Rating curve well defined below 2,200 second-feet. Daily discharge ascertained by applying gage-heights to rating table. Results fair.

Discharge measurements of Frio River near Derby, Tex., during the year ending Sept. 30, 1916.

Date.	Made by—	Gage height.	Discharge.	Date.	Made by—	Gage height.	Discharge.
		Feet.	*Sec.-ft.*			*Feet.*	*Sec.-ft.*
Oct. 3	R. C. Pierce	0.20	2.7	Apr. 18	R. C. Thaxton	3.39	900
Nov. 13	Gray and Pierce		.0	18	do	2.99	779
Mar. 12	R. C. Thaxton		.0	19	do	1.74	295
Apr. 18	do	5.65	1,730	June 20	William Kessler		.0
18	do	4.40	1,110	Aug. 25	Hank and Lieb	.68	48.5

Daily discharge, in second-feet, of Frio River near Derby, Tex., for the year ending Sept. 30, 1916.

Day.	Oct.	Apr.	May.	June.	July.	Aug.	Sept.
1	7.2	833	4.7	6.7		81	270
2	5.2	3,620	4.7	4.2		25	121
3	2.7	4,850	3.2	2.5		7.2	49
4	2.7	1,220	1.9	.7		2.5	25
5		215	.7			1.5	16
6		78					14
7		37					8.1
8		20					4.7
9		15					1.5
10		11					.2
11		6.2			18		
12		3.7			22		
13		1.1			5.7		
14		.4			6.7		
15		7.2			3.7		60
16		2,630					21
17		4,520					9.0
18		1,520					6.2
19	223	263					12
20	229	163	187			74	6.7
21	60	27	44			63	3.2
22	24	23	765			158	1.5
23	6.7	104	2,930			221	
24	2.7	17	1,490			132	
25	1.9	13	353			45	
26		13	182			21	
27		15	98			12	
28		11	60			8.1	
29		8.1	34			5.7	
30		6.7	23		98	160	
31			12		60	235	

NOTE.—No flow on days for which discharge is not given.

Monthly discharge of Frio River near Derby, Tex., for the year ending Sept. 30, 1916.

Month.	Discharge in second-feet.			Run-off (total in acre-feet).
	Maximum.	Minimum.	Mean.	
October	229	0.0	18.2	1,120
November	.0	.0	.0	0
December	.0	.0	.0	0
January	.0	.0	.0	0
February	.0	.0	.0	0
March	.0	.0	.0	0
April	4,850	.4	675	40,200
May	2,930	.0	200	12,300
June	6.7	.0	.47	28
July	60	.0	5.29	325
August	235	.0	40.4	2,480
September	270	.0	21.0	1,250
The year	4,850	.0	79.4	57,700

FRIO RIVER AT FOWLERTON, TEX.

LOCATION.—At Frio River dam, about half a mile northeast of Fowlerton, Lasalle County, 1½ miles below diversion for Frio Lake storage reservoir, 8 miles below mouth of Jahuey Creek.

DRAINAGE AREA.—4,350 square miles.

RECORDS AVAILABLE.—July 1, 1915, to September 30, 1916.

GAGE.—Vertical staff attached to tree on right bank about 30 feet above dam; read by Joe McMains.

DISCHARGE MEASUREMENTS.—Made by wading below dam or from railroad bridge about a mile above.

CHANNEL AND CONTROL.—Channel straight for some distance above the station, but slightly curved below; banks about 5 feet high and not subject to overflow; right bank cultivated; left bank wooded. Concrete dam about 20 feet below gage serves as permanent control at all stages. Point of zero flow, gage height −0.05 feet.

EXTREMES OF DISCHARGE.—1915–16: Maximum stage recorded, 3.9 feet at 6 a. m., April 19, 1916 (discharge, 4,120 second-feet); no flow for extended periods.

ICE.—None reported during year.

DIVERSIONS.—Some water diverted for irrigation above station. A diversion for the Frio Lake reservoir is made 1½ miles above; other diversions are scattered; amount diverted and areas irrigated not known. A large part of the irrigated land in the drainage basin above the station is watered by wells.

REGULATION.—Flow regulated by the diversion into Frio Lake a short distance above gage; extent of regulation above Frio Lake diversion not known but probably small.

ACCURACY.—Stage-discharge relation practically permanent. Gage read once daily to hundredths; slight error may be introduced by the assumption that one reading gives the mean stage for the day. Rating curve well defined below 4,500 second-feet. Daily discharge ascertained by applying the gage heights to rating table. Results fair.

Discharge measurements of Frio River at Fowlerton, Tex., during the year ending Sept. 30, 1916.

Date.	Made by—	Gage height.	Discharge.	Date.	Made by—	Gage height.	Discharge.
		Feet.	*Sec.-ft.*			*Feet.*	*Sec.-ft.*
Oct. 4	R. C. Pierce	0.04	0.9	May 27	William Kessler	0.76	118
Nov. 14	Gray and Pierce	.....	.0	27	.....do	.74	156
Apr. 18	William Kessler	3.43	3,500	27	.....do	.72	157
19	.....do	3.60	3,590	27	.....do	.65	148
19	.....do	3.45	3,180	28	.....do	.49	80.9
May 26	.....do	1.63	776	June 22	.....do	−.74	a.1
26	.....do	1.56	657				

a Estimated.

Daily discharge, in second-feet, of Frio River at Fowlerton, Tex., for the year ending Sept. 30, 1916.

Day.	Oct.	Apr.	May.	June.	July.	Aug.	Sept.
1	19	.....	10	14	.....	20	71
2	14	.....	10	11	.....	103	140
3	1.2	337	10	10	.....	58	115
4	1.0	2,460	11	10	.....	24	58
5	.....	3,500	10	10	.....	14	42
6	.....	840	9.5	9.0	.....	10	28
7	.....	100	8.9	9.0	.....	9.3	19
8	.....	48	8.4	58	.....	8.5	13
9	.....	24	7.8	21	.....	7.8	10
10	.....	15	7.3	10	.....	7.0	10
11	.....	12	6.7	9.2	.....	6.3	10
12	.....	10	6.2	8.4	.....	5.6	10
13	.....	10	5.6	7.6	.....	4.8	24
14	.....	10	5.1	6.8	.....	4.1	137
15	.....	11	4.5	6.0	252	3.3	84
16	.....	28	4.0	5.2	79	2.6	35
17	.....	388	3.4	4.4	22	1.8	27
18	.....	2,460	2.9	3.6	11	1.0	20
19	.5	3,570	2.4	2.8	10	656	12
20	.....	840	1.6	2.0	9.2	774	10
21	162	133	1.0	1.0	8.4	420	9.3
22	51	63	23	.1	7.6	151	8.5
23	15	32	93	.1	6.8	129	7.8
24	5.8	22	600	.....	6.0	144	7.0
25	1.8	18	1,440	.....	5.2	176	6.3
26	.5	13	640	.....	4.4	109	5.6
27	.....	12	176	.....	3.6	38	4.8
28	.....	10	84	.....	2.8	25	4.1
29	.....	10	58	.....	2.0	15	3.3
30	.....	10	27	.....	58	12	2.6
31	.....	.....	19	.....	35	32	.....

NOTE.—No flow in stream on days for which discharge is not given. During the high water in the early part of April a small channel was cut around the left end of the dam; no flow over dam May 5–21, June 3–7, 10–23, July 19–29, Aug. 6–18, Sept. 9–12, and 20–30; amount in by-channel estimated from data furnished by the observer and engineers.

Monthly discharge of Frio River at Fowlerton, Tex., for the year ending Sept. 30, 1916.

Month.	Discharge in second-feet.			Run-off (total in acre-feet).
	Maximum.	Minimum.	Mean.	
October	162	0.0	8.77	539
November	0	.0	.00	0
December	0	.0	.00	0
January	0	.0	.00	0
February	0	.0	.00	0
March	0	.0	.00	0
April	3,570	.0	500	29,800
May	1,440	1.0	106	6,520
June	58	.0	7.31	435
July	252	.0	16.9	1,040
August	774	1.0	95.9	5,900
September	140	2.6	31.1	1,850
The year	3,570	.0	63.4	46,100

FRIO LAKE OUTLET NEAR FOWLERTON, TEX.

LOCATION.—At Frio Lake dam, 2 miles northeast of Fowlerton, Lasalle County, 1½ miles northeast of gaging station on Frio River.

DRAINAGE AREA.—Not measured.

RECORDS AVAILABLE.—July 1, 1915, to September 30, 1916.

GAGE.—Vertical staff attached to post on right bank about 100 feet above dam; read by Joe McMains.

DISCHARGE MEASUREMENTS.—Made by wading below dam or from railroad bridge about a mile above gage.

CHANNEL AND CONTROL.—Channel straight above and below station for some distance. Right bank clean, cultivated, about 8 feet high; left bank is wooded and is from 5 to 8 feet high; neither bank subject to overflow. Concrete dam about 100 feet below gage serves as control at all stages. Point of zero flow, height gage −0.05 feet.

EXTREMES OF DISCHARGE.—1915–16: Maximum stage recorded, 3.16 feet from 8.30 a. m. to 10 a. m. April 19 (discharge, 4,070 second-feet); no flow for extended periods.

ICE.—None reported during year.

DIVERSIONS.—Lake is used for storage; capacity not known.

REGULATION.—Flow controlled at intake on Frio River, some distance above; flow of Frio River above this diversion probably not regulated.

ACCURACY.—Stage-discharge relation practically permanent. Rating curve fairly well defined below 5,000 second-feet. Gage read to hundredths once daily; one daily gage reading may not be a true index of the mean daily discharge. Daily discharge ascertained by applying the gage heights to the rating table. Results fair.

Frio Lake is a storage reservoir fed by a diversion from Frio River. The diversion is made 1½ miles above the Frio River dam and the gaging station on the river. The water released from the lake is used for irrigation. This station is maintained in conjunction with that on Frio River at Fowlerton to show the total run-off at that point.

Discharge measurements of Frio Lake outlet near Fowlerton, Tex., during the year ending Sept. 30, 1916.

Date.	Made by—	Gage height.	Discharge.	Date.	Made by—	Gage height.	Discharge.
		Feet.	*Sec.-ft.*			*Feet.*	*Sec.-ft.*
Oct. 4	R. C. Thaxton	0.20	8.1	May 27	William Kessler	0.40	97.7
Nov. 14	Gray and Pierce		0	27	do	.40	91.6
Apr. 18	William Kessler	1.86	1,820	27	do	.39	88.6
18	do	2.13	2,350	28	do	.38	48.8
19	do	3.16	4,070	28	do	.38	48.3
May 26	do	.88	a 385	June 22	do	−.6[illegible]	.0
26	do	.84	a 310	Aug. 26	Victor Lieb	.39	78.8

a Results poor; measuring section clogged with débris.

Daily discharge, in second-feet, of Frio Lake outlet near Fowlerton, Tex., for the year ending Sept. 30, 1916.

Day.	Oct.	Apr.	May.	June.	July.	Aug.	Sept.
1	41	.....	0.4	5.4	.....	17	29
2	26	.....	6.8	4.0	.....	35	101
3	11	2.4	4.0	1.6	.....	41	76
4	10	1,960	4.7	.....	.....	9.6	41
5	6.8	3,380	5.4	.....	.....	5.4	23
6	4.7	912	3.2	.....	.....	4.0	23
7	3.2	80	1.6	.....	.....	1.6	11
8	1.6	38	.....	.....	.....	.....	8.2
9	.....	29	.....	17	.....	.....	3.2
10	.....	11	.....	4.7	.....	.....	.8
11	.....	8.9	.....	2.0	.....	.....	.....
12	.....	5.4	.....	.....	.....	.....	.....
13	.....	4.7	.....	.....	.....	.....	3.2
14	.....	4.0	.....	.....	.....	.....	70
15	.....	8.2	.....	.....	6.8	.....	41
16	.....	11	.....	.....	51	.....	11
17	.....	210	.....	.....	11	.....	9.6
18	.....	2,010	.....	.....	6.8	.....	6.8
19	.....	2,950	.....	.....	3.2	410	5.4
20	2.0	870	.....	.....	1.6	730	2.4
21	70	123	.....	.....	.....	370	.....
22	56	41	2.8	.....	.....	112	.....
23	32	35	29	.....	.....	61	.....
24	20	17	420	.....	.....	85	.....
25	10	14	1,160	.....	.....	112	.....
26	7.5	8.9	590	.....	.....	85	.....
27	5.4	9.6	123	.....	.....	23	.....
28	3.6	1.6	41	.....	.....	7.5	.....
29	2.4	.8	32	.....	.....	3.2	.....
30	.8	.8	17	.....	11	2.4	.....
31	.....	.....	8.2	.....	61	11	.....

NOTE.—No flow on days for which discharge is not given.

Monthly discharge of Frio Lake outlet near Fowlerton, Tex., for the year ending Sept. 30, 1916.

Month.	Discharge in second-feet.			Run-off (total in acre-feet).
	Maximum.	Minimum.	Mean.	
October	70	0	10.1	621
November	0	0	.0	0
December	0	0	.0	0
January	0	0	.0	0
February	0	0	.0	0
March	0	0	.0	0
April	3,380	0	425	25,300
May	1,160	0	79.0	4,860
June	17	0	1.16	69
July	61	0	4.92	303
August	730	0	68.6	4,220
September	101	0	15.5	922
The year	3,380	0	50.0	36,300

RIO GRANDE BASIN.

RIO GRANDE AT EMBUDO, N. MEX.

LOCATION.—Near sec. 27, T. 23 N., R. 9 E., 100 feet below the Santa Barbara Tie & Pole Co.'s bridge, a few hundred feet below the Denver & Rio Grande Railroad eating house at Embudo, a short distance above mouth of the box canyon, in the southeastern part of Rio Arriba County. Nearest tributary, Embudo Creek, joins the Rio Grande about 3 miles above station.

DRAINAGE AREA.—Approximately 10,100 square miles.

RECORDS AVAILABLE.—December 21, 1888, to December 31, 1903; September 8, 1912, to September 30, 1916.

GAGE.—Friez water-stage recorder on right bank. From January 1 to February 28, 1889, an inclined staff gage was maintained 1 mile above Embudo, but it was moved to a point 1,500 feet above the Santa Barbara Tie & Pole Co.'s bridge March 1, 1889, and used until December 31, 1903; relation of datum of these gages unknown, but the datum remained unchanged from March 1, 1889, to December 31, 1903. A Friez water-stage recorder, referred to a new datum, was installed September 8, 1912, on the downstream side of the Santa Barbara Tie & Pole Co.'s bridge pier and this gage was operated until June 20, 1914, when it was moved to the present site; datum unchanged since station was reestablished in 1912.

DISCHARGE MEASUREMENTS.—Made by wading or from cable just below gage.

CHANNEL AND CONTROL.—Bed composed of rock, gravel, and sand; shifts at extremely high stages. Banks high and not subject to overflow. A shoal just below station serves as a control.

EXTREMES OF DISCHARGE.—Maximum stage during year, from water-stage recorder, 9.9 feet at 6 a. m. May 13 (discharge, 16,000 second-feet); minimum stage, 2.28 feet at 2 p. m. October 14 (discharge, 393 second-feet).

1888–1903; 1912–1915: Maximum stage recorded, 15.8 feet June 19, 1909 (discharge, 15,900 second-feet); minimum stage recorded, 6.6 feet June 13, 1899 (discharge, 65 second-feet).

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

DIVERSIONS.—Considerable water diverted for irrigation above station. Between the Colorado-New Mexico State line and Embudo the river flows through a canyon and water is diverted for irrigation only in the small areas of bottom lands bordering the stream. Above the State line and along the tributaries entering the Rio Grande in the canyon large areas of land are irrigated by diversions.

REGULATION.—The operation of storage reservoirs in Colorado affect the discharge to slight extent.

ACCURACY.—Stage-discharge relation practically permanent, except for one temporary change; not affected by ice during year. Rating curve well defined between 400 and 7,000 second-feet. Operation of water-stage recorder satisfactory. Daily discharge ascertained by applying to rating table mean daily gage height determined from inspection of gage-height graph except during period for which stage-discharge relation is affected by shifting control. Results excellent.

Discharge measurements of Rio Grande at Embudo, N. Mex., during the year ending Sept. 30, 1916.

Date.	Made by—	Gage height.	Discharge.	Date.	Made by—	Gage height.	Discharge.
		Feet.	*Sec.-ft.*			*Feet.*	*Sec.-ft.*
Apr. 10	W. R. King	3.54	1,100	Sept. 14	Follansbee and Wallace	3.3	887
May 23	do	5.79	3,230				

Daily discharge, in second-feet, of Rio Grande at Embudo, N. Mex., for the year ending Sept. 30, 1916.

Day.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.
1	660	483	407	479	495	740	1,340	4,260	2,770	1,320	745	800
2	614	479	535	467	539	695	1,380	4,080	2,750	1,240	882	740
3	614	471	531	459	527	650	1,340	3,490	2,710	1,170	1,060	725
4	600	479	539	471	523	685	1,490	3,080	2,660	1,140	1,750	730
5	596	467	582	483	515	710	1,370	2,820	2,690	1,100	2,250	715
6	578	475	614	483	511	680	1,300	3,000	2,900	1,030	2,470	705
7	551	479	586	475	523	675	1,240	4,080	3,080	1,000	2,300	685
8	523	463	596	467	555	705	1,180	5,760	2,840	946	2,360	655
9	487	432	582	487	568	730	1,060	8,520	2,710	882	2,470	645
10	475	424	573	503	568	750	1,070	12,000	2,690	855	2,650	645
11	447	443	560	507	578	789	1,130	13,900	2,900	800	2,360	645
12	424	428	535	503	622	822	1,140	15,200	3,520	800	2,250	645
13	407	435	515	467	640	904	1,130	15,400	3,930	800	2,140	745
14	396	444	491	459	622	994	1,180	13,800	4,120	970	1,840	882
15	410	452	531	479	636	1,010	1,230	12,300	3,970	1,140	1,750	882
16	424	461	527	495	670	1,050	1,280	10,300	3,770	1,170	1,890	855
17	435	469	443	499	670	1,140	1,400	6,700	3,600	1,280	2,040	828
18	435	478	424	515	675	1,160	1,600	4,840	3,600	1,480	1,990	772
19	435	487	447	511	695	1,200	1,640	4,780	3,570	1,360	1,940	720
20	451	495	447	591	705	1,280	1,550	4,280	3,670	1,320	1,890	695
21	459	535	428	543	715	1,440	1,620	4,050	3,670	1,140	1,750	670
22	447	609	443	511	730	1,580	1,640	3,810	3,520	1,030	1,520	645
23	443	660	455	507	740	1,680	1,660	3,220	3,380	940	1,440	645
24	439	735	471	527	767	1,800	1,800	2,990	3,020	855	1,400	645
25	424	735	467	523	762	1,700	2,110	3,040	2,710	818	1,200	622
26	428	636	451	523	789	1,540	2,470	3,020	2,300	781	1,140	600
27	455	573	471	515	789	1,390	2,770	3,090	2,040	744	1,030	578
28	467	523	439	519	778	1,340	3,150	3,010	1,800	707	970	564
29	471	455	376	531	745	1,340	3,370	2,840	1,570	670	910	564
30	475	414	487	519	.....	1,340	3,270	2,780	1,420	695	882	564
31	483	.....	487	471	.....	1,300	.....	2,700	.....	745	855	.....

NOTE.—Discharge interpolated Nov. 14–19; July 25–28; gage heights not available. Rise Nov. 21–28 due to release of stored water in Colorado. Discharge computed by indirect method for shifting control Mar. 21 to May 17.

Monthly discharge of Rio Grande at Embudo, N. Mex., for the year ending Sept. 30, 1916.

Month.	Discharge in second-feet.			Run-off (total in acre-feet).
	Maximum.	Minimum.	Mean.	
October	660	396	482	29,600
November	735	414	504	30,000
December	614	376	493	30,600
January	811	459	509	31,300
February	789	495	643	37,000
March	1,900	650	1,090	67,000
April	3,370	1,090	1,660	100,000
May	15,400	2,780	6,040	371,000
June	4,120	1,400	2,930	179,000
July	1,480	670	997	61,300
August	2,650	745	1,680	103,000
September	882	564	694	41,300
The year	15,400	376	1,490	1,080,000

RIO GRANDE NEAR SAN MARCIAL, N. MEX.

LOCATION.—In sec. 19, T. 7 S., R. 1 W., at the Atchison, Topeka & Santa Fe Railway bridge, 1 mile south of San Marcial. No important tributaries enter in the immediate vicinity of the station.

DRAINAGE AREA.—Not measured.

RECORDS AVAILABLE.—January 29, 1895, to September 30, 1916.

GAGE.—Inclined staff established January 29, 1895, and destroyed by flood in 1906. Wire gage established in its place at same datum. This was soon abandoned and gage heights have since been obtained by measuring with a graduated rod from the bridge deck to the water surface. Gage datum unchanged.

DISCHARGE MEASUREMENTS.—Made from the bridge.

CHANNEL AND CONTROL.—Sandy and very shifting; broken by several bridge piers. No information on control section.

EXTREMES OF DISCHARGE.—Maximum mean daily discharge during year, 15,100 second-feet on May 14; minimum mean daily discharge, 125 second-feet on October 4, 1895–1916: Maximum mean daily discharge, 33,000 second-feet on October 11, 1904; minimum mean daily discharge, no flow for several periods.

DIVERSIONS.—Considerable water diverted for irrigation above station.

ACCURACY.—Stage-discharge relation not permanent; not affected by ice. Owing to the shifting control, determinations of daily discharge are based almost entirely on frequent current-meter measurements.

COOPERATION.—Records furnished by United States Reclamation Service, and reduced to three significant figures by the United States Geological Survey.

Discharge measurements of Rio Grande near San Marcial, N. Mex., during the year ending Sept. 30, 1916.

[Made by King and Kabelin.]

Date.	Gage height.	Discharge.	Date.	Gage height.	Discharge.	Date.	Gage height	Discharge.
	Feet.	*Sec.-ft.*		*Feet.*	*Sec.-ft.*		*Feet.*	*Sec.-ft.*
Oct. 3	9.9	262	Feb. 3	11.4	583	June 6	12.5	3,810
6	10.1	302	6	11.7	871	9	12.7	4,110
9	10.1	235	9	11.7	622	12	12.6	3,720
12	10.1	237	12	11.8	908	15	13.0	4,110
15	10.2	218	15	11.9	850	18	12.8	3,790
18	10.1	234	18	11.9	981	21	12.5	3,300
21	10.0	174	21	12.0	979	24	12.5	2,940
24	9.9	212	24	12.1	1,130	27	12.0	2,270
27	10.1	163	29	12.0	790	30	11.9	1,450
30	10.1	156	Mar. 3	12.3	1,170	July 3	11.3	944
Nov. 3	10.4	214	6	11.8	746	6	11.3	544
6	10.5	290	9	12.1	1,080	9	11.3	375
9	10.7	281	12	12.0	1,080	12	11.4	514
12	10.7	432	15	12.5	1,980	15	11.7	784
15	10.7	348	18	12.9	2,800	18	11.8	1,070
18	10.8	389	21	13.1	3,240	21	12.0	1,370
21	10.8	367	24	14.2	7,110	24	11.5	783
25	11.0	468	27	13.0	4,470	27	11.8	939
28	11.4	734	Apr. 4	12.7	3,130	31	12.1	1,260
Dec. 4	11.1	521	7	13.4	4,580	Aug. 3	11.4	1,480
7	11.4	663	10	13.0	2,730	6	11.6	1,110
10	11.5	693	13	12.8	2,660	9	12.2	2,300
13	11.5	722	16	13.0	3,610	12	11.8	1,870
16	11.4	566	19	13.2	4,120	15	11.9	1,990
19	11.6	707	22	13.0	4,210	18	12.4	2,310
22	11.1	459	25	13.1	4,040	23	12.4	2,390
25	11.3	448	28	13.9	4,950	26	11.8	1,510
28	11.5	466	May 1	14.2	8,210	29	11.7	974
31	11.7	684	4	13.5	6,630	31	11.6	825
Jan. 3	11.3	427	7	13.3	5,220	Sept. 3	11.3	600
6	11.4	495	10	14.1	8,960	6	11.4	472
9	11.6	564	14	15.2	a 15,400	9	11.3	294
12	11.5	539	16	14.6	13,100	12	11.6	526
15	11.8	764	19	13.4	8,400	15	11.4	248
18	11.7	777	22	13.3	6,710	18	11.4	247
21	12.2	1,670	25	12.8	5,130	21	11.6	300
24	11.8	1,010	28	12.9	5,920	24	11.4	242
27	11.6	769	31	12.8	5,920	27	11.2	179
31	11.6	772	June 3	12.7	4,700	30	11.2	173

a Estimated; meter lost in observations.

Daily discharge, in second-feet, of Rio Grande near San Marcial, N. Mex., for the year ending Sept. 30, 1916.

Day.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.
1	365	165	660	620	630	980	4,480	8,320	4,700	1,150	1,160	760
2	325	195	575	555	630	1,040	3,580	7,640	4,860	1,030	1,700	655
3	240	214	550	430	580	1,170	3,140	7,420	4,700	902	1,420	600
4	125	250	525	460	630	960	3,140	6,530	3,820	769	1,390	520
5	300	285	525	495	680	830	3,140	4,820	4,210	678	1,500	445
6	305	290	595	530	820	750	2,910	4,400	3,810	544	1,510	470
7	155	255	665	530	740	855	4,800	5,040	4,000	488	2,210	290
8	250	265	650	565	655	910	3,460	6,400	3,920	432	2,260	320
9	225	280	680	565	620	1,080	2,940	8,120	3,980	375	2,460	295
10	230	300	695	530	590	1,120	2,730	9,140	3,480	375	2,240	295
11	235	350	690	515	710	1,040	2,730	10,000	3,300	578	1,940	290
12	240	430	730	540	910	1,140	2,500	11,600	3,880	578	1,800	525
13	205	375	700	615	855	1,620	2,580	14,300	3,540	424	1,540	230
14	190	345	625	620	750	2,260	3,820	15,100	3,820	694	1,630	215
15	220	315	560	765	800	1,980	3,800	14,400	4,160	784	1,580	195
16	225	345	530	700	845	2,290	3,610	13,300	4,100	352	1,460	250
17	230	365	600	775	990	3,320	3,100	12,800	3,560	640	2,540	360
18	235	370	600	745	980	2,700	3,480	10,300	3,720	928	2,000	250
19	175	380	670	1,200	930	2,800	4,240	8,210	3,380	849	1,960	295
20	175	375	585	1,330	1,030	3,020	4,300	5,020	3,460	1,070	1,910	345
21	205	365	535	1,670	980	3,240	4,220	6,720	3,300	1,370	1,930	255
22	240	390	440	1,570	980	4,120	4,220	6,720	3,350	1,140	295	270
23	215	415	450	1,060	1,020	5,000	4,220	5,760	3,060	841	1,680	255
24	155	440	435	1,010	1,120	7,110	3,830	5,610	2,940	783	1,500	230
25	155	465	425	950	970	5,790	4,080	4,820	2,880	783	1,580	210
26	160	500	445	830	890	5,620	4,270	5,000	2,740	756	1,430	210
27	165	565	445	770	806	4,360	4,780	5,760	2,200	913	1,230	180
28	160	735	440	890	800	4,100	4,890	5,920	1,970	512	955	180
29	160	715	575	830	790	3,840	6,580	6,090	1,600	459	900	175
30	155	695	575	710	.....	3,660	8,210	5,560	1,370	406	700	175
31	155	.....	685	715	.....	4,200	.....	5,020	.....	1,420	925	.....

Monthly discharge of Rio Grande near San Marcial, N. Mex., for the year ending Sept. 30, 1916.

Month.	Discharge in second-feet.			Run-off (total in acre-feet).
	Maximum.	Minimum.	Mean.	
October	365	125	212	13,000
November	735	165	381	22,700
December	730	425	576	35,400
January	1,670	430	777	47,800
February	1,120	580	818	47,100
March	7,110	750	2,670	164,000
April	8,210	2,500	3,930	234,000
May	15,100	4,400	7,930	488,000
June	4,860	1,370	3,460	206,000
July	1,420	352	743	45,700
August	2,540	295	1,590	97,800
September	760	175	325	19,400
The year	15,100	125	1,960	1,420,000

RIO GRANDE AT EAGLE PASS, TEX.

LOCATION.—Half a mile above the highway bridge between Eagle Pass, Tex., and Ciudad Porfirio Diaz, Mexico.

DRAINAGE AREA.—Not measured.

RECORDS AVAILABLE.—May 1, 1900, to April 30, 1916, when station was discontinued.

GAGE.—Vertical and inclined staff.

DISCHARGE MEASUREMENTS.—Made from cable.

CHANNEL.—Extremely shifting; banks subject to large amount of overflow, beginning at stage of 22 feet.

EXTREMES OF DISCHARGE.—Maximum stage recorded during year, 6.5 feet in afternoon of October 3 (discharge, 15,980 second-feet for mean daily gage height of 6.25 feet); minimum stage recorded, 1.6 feet February 27–29 (discharge, 2,130 second-feet).

1900–1916: Maximum stage recorded, 34.6 feet at midnight June 29, 1905 (mean daily discharge June 30, 1905, 238,300 second-feet); minimum mean daily discharge, 1,030 second-feet, April 15, 1913.

DIVERSIONS.—No information.

ACCURACY.—Owing to the shifting control, estimates of daily discharge are based almost entirely on frequent current-meter measurements.

COOPERATION.—Station maintained and records furnished by the Commission for the Equitable Distribution of the waters of the Rio Grande.

Discharge measurements of Rio Grande at Eagle Pass, Tex., during the year ending Sept. 30, 1916.

[Made by L. C. Gilliam and C. F. Carson.]

Date.	Gage height.	Discharge.	Date.	Gage height.	Discharge.	Date.	Gage height.	Discharge.
	Feet.	*Sec.-ft.*		*Feet.*	*Sec.-ft.*		*Feet.*	*Sec.-ft.*
Oct. 6	4.8	7,197	Dec. 20	2.2	2,927	Mar. 3	2.5	3,162
16	3.0	4,398	23	2.0	2,807	6	2.4	3,124
18	2.9	4,666	31	2.0	2,668	9	2.6	3,228
21	2.8	4,185	Jan. 4	2.0	2,538	12	2.5	3,173
24	2.6	3,720	8	2.0	2,479	15	2.5	3,160
28	2.6	3,678	13	2.0	2,492	18	2.5	3,163
31	2.6	3,618	15	2.0	2,543	21	2.5	3,144
Nov. 3	2.5	3,461	18	2.0	2,569	24	2.5	3,165
6	2.4	3,393	21	2.0	2,631	27	2.4	3,146
9	2.4	3,390	24	2.0	2,495	31	2.4	3,133
12	2.3	3,371	27	2.0	2,381	Apr. 3	2.35	3,113
15	2.3	3,287	31	2.0	2,458	6	2.45	3,144
18	2.2	3,159	Feb. 3	2.0	2,316	9	2.4	3,145
22	2.0	3,020	6	1.9	2,283	12	2.5	3,162
25	2.0	2,886	9	1.8	2,295	15	2.45	3,138
30	2.0	2,892	12	1.8	2,378	18	2.45	3,150
Dec. 3	2.0	2,953	15	1.7	2,146	21	2.35	3,144
6	2.0	2,900	18	1.7	2,171	24	2.0	3,100
9	2.0	2,879	21	1.6	2,147	27	1.7	3,034
13	2.0	2,860	24	1.6	2,137	30	1.5	2,958
16	2.1	2,832	26	1.6	2,139			

NOTE.—Measurements Jan. 13 to Feb. 26 made by C. F. Carson.

Daily discharge, in second-feet, of Rio Grande at Eagle Pass, Tex., for the year ending Sept. 30, 1916.

Day.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.
1	9,230	3,570	2,910	2,380	2,300	3,190	3,130
2	12,230	3,510	2,930	2,530	2,400	3,160	3,120
3	15,980	a3,460	a2,950	2,540	a2,460	a3,160	a3,110
4	12,950	3,460	2,930	a2,540	2,460	3,130	3,110
5	10,530	3,390	2,920	2,520	2,370	3,120	3,120
6	a7,500	a3,390	a2,900	2,510	a2,200	a3,120	a3,140
7	6,690	3,390	2,890	2,500	2,200	3,120	3,130
8	6,300	3,390	2,890	a2,480	2,200	3,120	3,130
9	5,980	a3,390	a2,880	2,470	a2,200	a3,230	a3,140
10	5,730	3,390	2,870	2,460	2,320	3,190	3,150
11	5,660	3,390	2,870	2,450	2,350	3,170	3,160
12	5,600	a3,380	2,860	a2,440	a2,300	a3,160	a3,160
13	5,470	3,340	a2,860	2,490	2,380	3,160	3,150
14	5,340	3,410	2,850	2,520	2,220	3,160	3,150
15	5,150	3,340	2,840	a2,540	a2,150	a3,160	a3,140
16	a4,900	a3,290	a2,830	2,540	2,150	3,160	3,140
17	4,900	3,290	2,840	2,550	2,160	3,160	3,140
18	a4,670	a3,160	2,900	a2,570	a2,170	a3,160	a3,150
19	4,470	3,160	2,910	2,590	2,160	3,150	3,160
20	4,270	3,120	a2,990	2,610	2,150	3,150	3,150
21	a4,190	3,050	2,830	a2,630	a2,150	a3,140	a3,140
22	4,070	a3,020	2,820	2,590	2,140	3,150	3,150
23	3,950	2,970	a2,810	2,550	2,140	3,160	3,130
24	a3,720	2,930	2,790	a2,500	a2,140	a3,170	a3,100
25	3,710	a2,890	2,770	2,460	2,140	3,170	3,090
26	3,700	2,890	2,760	2,420	a2,140	3,160	3,050
27	3,690	2,890	2,740	a2,380	2,130	a3,150	a3,030
28	a3,680	2,890	2,720	2,400	a2,130	3,150	2,990
29	3,680	2,890	2,700	2,420	2,130	3,150	2,970
30	3,620	a2,890	2,690	2,440	.....	3,140	a2,960
31	a3,620	.....	a2,670	a2,460	.....	a3,130	.....

a See also discharge-measurement table.

Monthly discharge of Rio Grande at Eagle Pass, Tex., for the year ending Sept. 30, 1916.

Month.	Discharge in second-feet.			Run-off (total in acre-feet).
	Maximum.	Minimum.	Mean.	
October	15,980	3,620	5,974	367,299
November	3,570	2,890	3,218	191,464
December	2,950	2,670	2,841	174,652
January	2,630	2,380	2,500	153,700
February	2,460	2,130	2,245	129,132
March	3,230	3,120	3,155	196,300
April	3,160	2,960	3,110	185,000
The period				1,400,000

RIO PUEBLO DE TAOS NEAR TAOS, N. MEX.

LOCATION.—About sec. 2, T. 25 N., R. 13 E., at Glorietta Grove, 2 miles above Taos Pueblo, 4½ miles northeast of Taos, near the center of Taos County. A number of intermittent tributaries enter above and below the station.

DRAINAGE AREA.—Not measured.

RECORDS AVAILABLE.—December 19, 1910, to December 9, 1916, when station was discontinued. Fragmentary records March to December, 1910.

GAGE.—Bristol water-stage recorder installed on the right bank a short distance above Glorietta Grove. A vertical staff gage was installed April 7, 1910, but was destroyed by flood before July 12, 1910. On October 12, 1910, a new gage was installed at the same site, but was referred to a datum 0.27 foot lower than the original. The water-stage recorder was installed December 19, 1910, at the same site and referred to the datum of the second gage.

DISCHARGE MEASUREMENTS.—Made by wading or from footbridge.

CHANNEL AND CONTROL.—Bed of stream composed of rock and gravel; flows through a series of pools and rapids. Banks are low, but are seldom overflowed because of the small discharge. Control shifting.

EXTREMES OF DISCHARGE.—Not determined.

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

DIVERSIONS.—One small diversion above station and several below.

REGULATIONS.—None.

ACCURACY.—Stage-discharge relation not permanent; control shifting during high water. Standard rating curve fairly well defined. Operation of water-stage recorder unsatisfactory. Weekly staff gage readings available. Daily discharge ascertained by indirect method for shifting control. Results fair.

Discharge measurements of Rio Pueblo de Taos near Taos, N. Mex., during the year ending Sept. 30, 1916.

Date.	Made by—	Gage height.	Discharge.	Date.	Made by—	Gage height.	Discharge.
		Feet.	*Sec.-ft.*			*Feet.*	*Sec.-ft.*
Apr. 8	W. R. King	2.17	36.5	July 4	C. R. Dwire	1.12	51
May 21	do	3.24	194	Sept. 12	Follansbee and Mondragon	1.38	13.3

Daily discharge, in second-feet, of Rio Pueblo de Taos near Taos, N. Mex., for the year ending Sept. 30, 1916.

Day.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.
1	12	6.4	9.6	8.4	7.4	11	31	201	183	60	27	
2	11	6.4	11	7.4	8.4	11	29	174			28	15
3	12	7.4	12	9.6	8.4	9.6	31	134	166		24	
4	13	6.4	8.4	9.6	8.4	12	35	134		50	24	
5	14	9.6	8.4	9.6	8.4	12	38	192			29	
6	13	8.4	7.4	13	8.4	13	31	250			26	
7	14	7.4	7.4	13	8.4	11	33	325			24	
8	13	11	6.4	11	8.4	14	35	358		42	1	
9	11	11	8.4	8.4	9.6	16	35	402			24	15
10	11	8.4	12	7.4	9.6	23	40	402	149		24	
11	12	4.8	8.4	7.4	9.6	31	56	336		47	24	
12	13	6.4	6.4	7.4	8.4	35	56	270			1	13
13	12	8.4	7.4	7.4	8.4	43	46	325		38		
14	11	7.4	9.6	9.6	9.6	46	46					
15	9.6	9.6	8.4	9.6	9.6	43	40			30		
16	9.6	12	9.6	8.4	11	40	40					12
17	9.6	11	12	8.4	14	50	53		119			12
18	12	7.4	8.4	8.4	14	50	87			34		
19	12	12	9	8.4	13	46	98				19	
20	13	9.6	9.5	12	13	50	68	220		32		
21	12	8.4	10	12	13	53	68	192				
22	12	8.4	10	12	13	53	82			32		
23	9.6	9.6	11	9.6	12	50	99					11
24	9.6	11	12	8.4	13	46	112	210	77			
25	13	6.4	12	8.4	12	38	149			32		
26	13	5.6	8.4	8.4	13	31	166			17		
27	9.6	8.4	8.4	8.4	13	31	137	270		31		
28	12	7.4	7.4	8.4	13	33	166					
29	12	7.4	9.6	8.4	13	40	230			27		
30	9.6	8.4	11	9.6		35	260	240				30
31	7.4		12	9.6		33						

Daily discharge, in second-feet, of Rio Pueblo de Taos near Taos, N. Mex., for the period Oct. 1 to Dec. 1, 1916.

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

Monthly discharge of Rio Pueblo de Taos near Taos, N. Mex., for the year ending Sept. 30, 1916.

Month.	Discharge in second-feet.			Run-off (total in acre-feet).
	Maximum.	Minimum.	Mean.	
October	14	7.4	11.6	713
November	12	4.8	8.40	500
December	12	6.4	9.40	578
January	13	7.4	9.25	569
February	14	7.4	10.7	616
March	53	9.6	32.6	2,000
April	260	29	80.2	4,770

RIO LUCERO NEAR TAOS, N. MEX.

LOCATION.—In sec. 11, T. 26 N., R. 13 E., just above head gate of Seco ditch, at mouth of canyon, 9 miles above Taos, near center of Taos County. No important tributaries near station.

DRAINAGE AREA.—17 square miles (measured by Indian Service Survey).

RECORDS AVAILABLE.—December 17, 1910, to September 30, 1916. Fragmentary records from March to October, 1910.

GAGE.—Bristol water-stage recorder on the right bank at same site and datum as staff gage which was used April 7 to December 16, 1910. Gage read by Manuel Mondragon.

DISCHARGE MEASUREMENTS.—Made by wading or from footbridge 50 feet upstream from gage.

CHANNEL AND CONTROL.—Bed composed of sand and gravel. Banks are of medium height, but are not overflowed, as discharge is small. Control just below gage; shifts badly.

EXTREMES OF DISCHARGE.—Data too meager to determine.

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

DIVERSIONS.—None above station; below station water is diverted for irrigation.

REGULATION.—None.

ACCURACY.—Stage-discharge relation not permanent; control badly shifting. Operation of water-stage recorder so unsatisfactory that records were discarded; weekly staff gage readings available; poorly defined rating curve applied indirectly during year. Discharge determined only for days on which staff gage was read. Results poor.

Discharge measurements of Rio Lucero near Taos, N. Mex., during the year ending Sept. 30, 1916.

Date.	Made by—	Gage height.	Discharge.	Date.	Made by—	Gage height.	Discharge.
		Feet.	*Sec.-ft.*			*Feet.*	*Sec.-ft.*
Apr. 9	W. R. King	1.24	17.5	July 4	C. R. Dwire	1.5	72
May 22	do	1.74	87	Sept. 12	Follansbee and Mondragon.	1.2	18.4

Daily discharge, in second-feet, of Rio Lucero near Taos, N. Mex., for the year ending Sept. 30, 1916.

Day.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.
1				13			19			68		
2	10								130			17
3												
4			14			15			74			
5					10						28	
6		14						49				
7												
8				13			16			57		
9	9						18					22
10									149			
11			14			25						
12					14						28	18
13		22						149				
14												
15				14			20			45		
16	6											16
17									126			
18			18			29						
19					16						21	
20		18						106				
21								87				
22				14			29			38		
23	9											14
24									87			
25			13			19						
26					16						29	
27		16						134				
28												
29				14			47			31		
30	16											11
31												

NOTE.—Discharge estimated because of ice Dec. 18, 25, Jan. 1 and 8.

Daily discharge, in second-feet, of Rio Lucero near Taos, N. Mex., for the period Oct. 1 to Dec. 2, 1916.

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

CHAMA RIVER NEAR CHAMA, N. MEX.

LOCATION.—In sec. 25, T. 31 N., R. 3 E., at highway bridge on main road from Chama to Tierra Amarilla, 2½ miles southeast of Chama, 200 feet above mouth of Little Chama River, in northern part of Rio Arriba County.

DRAINAGE AREA.—Not measured.

RECORDS AVAILABLE.—May 27, 1914, to September 30, 1916. From September 23, 1912, to May 26, 1914, a station was maintained on Chama River at Chama, 2 miles upstream. No intervening tributaries of consequence.

GAGE.—Stevens water-stage recorder attached to downstream side of bridge pier.

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

CHANNEL AND CONTROL.—Bed composed of sand, gravel, and rock. Banks are of medium height but are not overflowed except during extremely high stages. Control located at rapids 100 feet downstream; shifts slightly.

EXTREMES OF DISCHARGE.—Maximum stage during year, from water-stage recorder, 4.65 feet at midnight May 7 (discharge, 1,550 second-feet); minimum stage, 1.53 feet at 4 p. m. November 5 (discharge, 22 second-feet).

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

DIVERSIONS.—City ditch diverts approximately 2 second-feet from June to September.

REGULATION.—None.

ACCURACY.—Stage-discharge relation not permanent; control shifted after high water; affected by ice during winter. Rating curve fairly well defined; applied indirectly May 9 to September 30. Operation of water-stage recorder satisfactory. Daily discharge ascertained by applying to rating table mean daily gage heights determined from inspection of gage-height graph. Results good.

Discharge measurements of Chama River near Chama, N. Mex., during the year ending September 30, 1916.

Date.	Made by—	Gage height.	Discharge.	Date.	Made by—	Gage height.	Discharge.
		Feet.	*Sec.-ft.*			*Feet.*	*Sec.-ft.*
Apr. 12	King and Cowdrey	2.62	265	Aug. 7	G. S. Cowdrey, jr.	1.95	111
May 8	G. S. Cowdrey, jr.	3.95	1,210	Sept. 16	Follansbee and Cowdrey	1.66	47.6

Daily discharge, in second-feet, of Chama River near Chama, N. Mex., for the year ending Sept. 30, 1916.

Day.	Oct.	Nov.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.
1	33	26	.....	117	1,020	787	320	106	52
2	33	25	.....	134	655	747	350	100	50
3	33	25	.....	152	599	747	340	97	50
4	31	24	.....	149	755	738	331	100	49
5	29	24	.....	126	952	703	311	97	47
6	30	26	.....	117	1,140	708	284	100	48
7	30	.....	.....	110	1,440	698	256	97	46
8	29	.....	.....	117	1,720	648	231	100	41
9	28	.....	.....	142	2,020	648	210	.....	152
10	27	.....	.....	214	1,840	700	199	99	110
11	27	.....	.....	222	1,510	692	202	99	76
12	26	.....	.....	270	1,260	626	182	99	62
13	26	.....	.....	274	1,220	619	159	100	57
14	26	.....	.....	270	1,080	592	149	99	52
15	27	.....	.....	244	880	540	156	99	51
16	29	.....	.....	274	787	546	239	99	49
17	28	.....	.....	407	771	552	146	74	47
18	27	.....	.....	521	755	558	134	.....	47
19	27	.....	.....	462	846	564	134	99	46
20	27	.....	.....	370	916	571	126	99	46
21	26	.....	423	365	771	521	122	99	44
22	26	.....	311	560	823	508	117	58	43
23	26	.....	302	710	715	470	115	58	41
24	26	.....	292	860	795	456	117	97	41
25	26	.....	149	1,000	907	439	126	99	40
26	26	.....	123	1,150	934	426	115	99	40
27	26	.....	126	1,150	872	412	128	97	39
28	26	.....	172	1,320	872	396	117	97	38
29	26	.....	180	1,500	808	386	110	97	39
30	26	.....	199	1,350	893	381	110	99	38
31	26	.....	126	.....	854	.....	126	97	.....

NOTE.—Discharge Apr. 20-May 1, June 16-19 estimated from comparative hydrographs of other stations in basin.

Monthly discharge of Chama River near Chama, N. Mex., for the year ending Sept. 30, 1916.

Month.	Discharge in second-feet.			Run-off (total in acre-feet).
	Maximum.	Minimum.	Mean.	
October	33	26	27.7	1,700
November 1-6	26	24	25.0	298
March 21-31	423	123	205	4,470
April	1,500	110	491	29,200
May	2,020	599	1,010	62,100
June	787	381	577	34,300
July	370	110	187	11,500
August	191	53	88.9	5,470
September	152	38	53.1	3,160

CHAMA RIVER AT PARK VIEW, N. MEX.

LOCATION.—In sec. 7, T. 29 N., R. 4 E., at highway bridge half a mile northwest of Park View, about 800 feet below confluence of Brazos and Chama Rivers, in north-central part of Rio Arriba County.

DRAINAGE AREA.—Not measured.

RECORDS AVAILABLE.—November 25, 1912, to September 30, 1916, when station was discontinued.

GAGE.—Friez water-stage recorder attached to downstream side of right bridge pier. During 1912 and 1913 the recorder was attached to the downstream side of right abutment of bridge but was moved to the present site because of changes in channel in 1914; original datum unchanged.

DISCHARGE MEASUREMENTS.—Made from bridge or by wading.

CHANNEL AND CONTROL.—Bed composed of large cobblestones, sand and gravel; shifts extremely during high water. Right bank high and not subject to overflow; left bank is low and is overflowed at extremely high stages. Control composed of loose bowlders and coarse gravel; 100 feet downstream.

EXTREMES OF STAGE.—Maximum stage during year, from water-stage recorder, 5.85 feet at 9 a. m. May 5. Minimum stage from water-stage recorder, 2.88 feet September 28.

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

DIVERSIONS.—Between Chama and Park View approximately 8 second-feet is diverted from Chama River and 16 second-feet from intervening tributaries during irrigation season.

REGULATION.—None.

ACCURACY.—Stage-discharge relation not permanent; control shifts extremely during and after high water; measurements insufficient to permit estimates to be made by indirect method. Operation of water-stage recorder fairly satisfactory.

Discharge measurements of Chama River at Park View, N. Mex., during the year ending Sept. 30, 1916.

Date.	Made by—	Gage height.	Discharge.	Date.	Made by—	Gage height.	Discharge.
		Feet.	*Sec.-ft.*			*Feet.*	*Sec.-ft.*
Apr. 13	King and Cowdrey	4.25	602	July 18	G. S. Cowdrey, jr	3.54	360
May 11	G. S. Cowdrey, jr	5.55	4,210	Sept. 15	Follansbee and Cowdrey	3.04	77

Daily gage height, in feet, of Chama River at Park View, N. Mex., for the year ending Sept. 30, 1916.

Day.	Oct.	Nov.	Apr.	May.	June.	July.	Aug.	Sept.
1	3.17	3.08	.....	5.08	5.08	3.94	3.57	3.21
2	3.15	3.06	.....	4.96	5.04	3.89	3.69	3.18
3	3.13	3.06	.....	4.78	4.97	3.84	3.76	3.20
4	3.12	3.06	.....	4.93	4.96	3.78	3.48	3.18
5	3.11	3.06	.....	5.17	4.89	3.77	3.41	3.15
6	3.12	3.07	.....	.....	4.95	3.75	3.64	3.33
7	3.12	3.16	.....	.....	4.87	3.71	3.42	3.22
8	3.11	3.17	.....	.....	4.83	3.66	3.40	3.15
9	3.10	3.16	4.07	.....	4.84	3.64	3.31	3.50
10	3.09	3.18	4.25	.....	4.86	3.63	3.32	3.52
11	3.09	3.08	4.46	5.45	4.85	3.80	3.25	3.24
12	3.09	.....	4.38	5.40	4.78	3.58	3.23	3.15
13	3.10	.....	4.33	5.42	4.76	.....	3.53	3.10
14	3.10	.....	4.31	5.44	4.72	.....	3.44	3.06
15	3.10	.....	4.36	5.37	4.67	.....	3.62	3.04
16	3.12	2.86	4.39	5.34	4.61	3.87	3.76	3.01
17	3.12	.....	4.66	5.33	4.59	3.66	3.46	.....
18	3.12	.....	4.85	5.35	4.58	3.53	3.35	.....
19	3.11	.....	4.80	5.32	4.53	3.47	3.28	.....
20	3.10	.....	4.54	5.35	4.46	3.46	3.26	.....
21	3.09	.....	4.54	5.47	4.42	3.47	3.31	.....
22	3.08	.....	4.86	5.19	4.39	3.47	3.35	.....
23	3.08	.....	4.95	5.19	4.28	3.47	3.28	2.92
24	3.08	.....	5.06	5.36	4.15	3.46	3.30	2.89
25	3.08	.....	5.22	5.48	4.19	3.32	3.25	2.87
26	3.08	.....	5.30	5.42	4.08	3.36	3.31	2.84
27	3.07	.....	5.29	5.22	4.06	3.46	3.27	2.83
28	3.07	.....	5.39	5.28	4.03	3.43	3.24	2.81
29	3.08	.....	5.45	5.28	4.00	3.50	3.18	2.81
30	3.08	.....	5.33	5.27	3.97	3.50	3.33	2.80
31	3.08	.....	.....	5.21	.....	3.58	3.26	.....

NOTE.—Stage-discharge relation affected by ice Nov. 7–10.

CHAMA RIVER NEAR EL VADO, N. MEX.[1]

LOCATION.—In T. 28 N., R. 2 E., at entrance to box canyon, 1 mile below El Vado, 15 miles southwest of Tierra Amarilla, near center of Rio Arriba County. Nutrias Creek, which is the south line of the Tierra Amarilla land grant, joins Chama River from the north 4 miles below station.

DRAINAGE AREA.—Not measured.

RECORDS AVAILABLE.—September 28, 1913, to September 30, 1916.

GAGE.—Stevens water-stage recorder attached to rock wall on right bank.

DISCHARGE MEASUREMENTS.—Made by wading or from cable just above gage

CHANNEL AND CONTROL.—Bed composed of solid rock overlain with gravel; changes slightly. Banks are high and not subject to overflow.—Rock reef just below gage serves as control.

EXTREMES OF DISCHARGE.—Maximum stage during year, from water-stage recorder, 9.1 feet at 7 a. m. May 10 (discharge, 4,860 second-feet); minimum stage —0.10 foot at noon October 28 (discharge, 28 second-feet).

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

DIVERSIONS.—Between Park View and the station near El Vado, approximately 3 second-feet is diverted from Chama River and 2 second-feet from intervening tributaries during irrigation season.

REGULATION.—None.

ACCURACY.—Stage-discharge relation not permanent; control shifts between fairly well defined limits; affected by ice during winter. Rating curve fairly well defined; applied indirectly May 9 to August 15. Operation of water-stage recorder satisfactory. Daily discharge ascertained by applying to rating table mean daily gage height determined from inspection of gage-height graph. Results good.

Discharge measurements of Chama River near El Vado, N. Mex., during the year ending Sept. 30, 1916.

Date	Made by—	Gage height.	Discharge.	Date.	Made by—	Gage height.	Discharge.
		Feet.	*Sec.-ft.*			*Feet.*	*Sec.-ft.*
Apr. 13	King and Cowdrey	3.27	903	July 18	G. S. Cowdrey, jr	1.48	339
May 12	G. S. Cowdrey, jr	7.05	3,480	Sept. 16	Follansbee and Cowdrey	.41	85

[1] Known as "Chama River near Tierra Amarilla" in previous reports.

Daily discharge, in second-feet, of Chama River near El Vado, N. Mex., for the year ending Sept. 30, 1916.

Day.	Oct.	Nov.	Apr.	May.	June.	July.	Aug.	Sept.
1	60	41	.....	1,910	2,320	535	453	126
2	55	55	.....	1,760	2,260	477	506	102
3	52	53	.....	1,590	2,090	435	573	92
4	50	54	.....	1,570	2,240	429	326	90
5	49	61	.....	2,050	2,050	402	274	86
6	50	61	.....	2,700	2,160	410	450	83
7	50	49	.....	3,300	1,990	390	334	129
8	49	47	.....	3,700	1,900	390	269	100
9	48	48	774	4,060	1,870	344	221	86
10	46	48	914	4,280	1,900	336	192	252
11	46	50	1,220	4,280	1,910	430	182	308
12	44	43	1,040	3,530	1,820	390	208	170
13	45	.....	958	3,570	1,720	390	221	136
14	47	.....	954	3,500	1,640	350	366	113
15	44	.....	942	2,750	1,520	405	245	97
16	44	.....	946	2,420	1,440	455	673	89
17	42	.....	1,190	2,450	1,340	347	374	85
18	41	.....	1,460	2,300	1,320	329	234	83
19	36	.....	1,440	2,550	1,300	271	184	83
20	39	43	970	2,860	1,200	278	159	82
21	39	.....	938	2,210	1,080	290	168	76
22	38	.....	1,220	2,300	966	245	154	71
23	40	.....	1,500	2,360	906	308	127	68
24	38	.....	1,600	2,540	814	287	208	65
25	41	.....	1,860	3,010	762	303	143	62
26	41	.....	1,980	2,960	711	292	139	60
27	39	.....	1,960	2,680	662	259	137	59
28	35	.....	2,240	2,660	629	370	136	58
29	44	.....	2,570	2,680	586	245	124	58
30	42	.....	2,420	2,620	563	370	106	58
31	38	.....	.....	2,580	.....	336	154	.....

NOTE.—Discharge estimated July 11–16 from comparative hydrographs of stations in same basin.

Monthly discharge of Chama River near El Vado, N. Mex., for the year ending Sept. 30, 1916.

Month.	Discharge in second-feet.			Run-off (total in acre-feet).
	Maximum.	Minimum.	Mean.	
October	60	35	44.3	2,720
November 1–12, 20	61	41	50.2	1,290
April 9–30	2,570	774	1,410	61,500
May	4,200	1,500	2,760	170,000
June	2,320	563	1,460	86,900
July	535	245	353	21,700
August	673	106	259	15,900
September	303	58	100	5,950

BRAZOS RIVER NEAR BRAZOS, N. MEX.

LOCATION.—At mouth of the box canyon 3 miles east of Brazos, 15 miles southeast of Chama, in northern part of Rio Arriba County, about 1½ miles above mouth of Little Brazos River.

DRAINAGE AREA.—Not measured.

RECORDS AVAILABLE.—September 18, 1913, to September 30, 1916.

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

DISCHARGE MEASUREMENTS.—Made by wading or from cable near gage.

CHANNEL AND CONTROL.—Bed of stream composed of rock, gravel, and sand; permanent except during high stages when slight changes occur. Banks are of medium height and are overflowed only during extremely high stages. Control at small rapids 150 feet downstream; practically permanent.

EXTREMES OF DISCHARGE.—Maximum stage during year, from water-stage recorder, 4.07 feet at 9 p. m. May 24 (discharge 2,760 second-feet); minimum stage, 0.29 foot at 4 p. m. November 11 (discharge, 10 second-feet).

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

DIVERSIONS.—None above station; approximately 8 second-feet diverted below during irrigation season.

REGULATION.—None.

ACCURACY.—Stage-discharge relation practically permanent; affected by ice during winter. Rating curve well defined between 15 and 2,000 second-feet. Operation of water-stage recorder satisfactory. Daily discharge ascertained by applying to rating table daily gage heights determined from inspection of gage height graph. Results excellent.

Discharge measurements of Brazos River, near Brazos, N. Mex., during the year ending Sept. 30, 1916.

Date.	Made by—	Gage height.	Discharge.	Date.	Made by—	Gage height.	Discharge.
		Feet.	*Sec.-ft.*			*Feet.*	*Sec.-ft.*
Apr. 14	King and Cowdrey	0.90	76	July 18	G. S. Cowdrey, jr.	1.1[illegible]	127
May 13	G. S. Cowdrey, jr.	3.28	1,840	Sept. 16	Follansbee and Cowdrey	.[illegible]	32.6

Daily discharge, in second-feet, of Brazos River near Brazos, N. Mex., for the year ending Sept. 30, 1916.

Day.	Oct.	Nov.	Apr.	May.	June.	July.	Aug	Sept.
1	24	16	.....	698	1,500	295	1[illegible]	50
2	24	15	.....	668	1,420	277	1[illegible]	45
3	23	17	.....	617	1,410	268	2[illegible]	52
4	21	17	.....	739	1,300	241	1[illegible]	41
5	21	16	.....	981	1,370	282	[illegible]	36
6	21	17	.....	1,510	1,310	228	211	61
7	21	16	.....	1,940	1,160	215	17[illegible]	38
8	21	14	.....	1,920	1,090	207	1[illegible]	25
9	21	14	.....	1,960	1,050	188	[illegible]	65
10	20	12	.....	1,970	1,000	192	[illegible]	120
11	19	12	.....	1,960	934	335	7[illegible]	80
12	19	16	.....	1,840	895	192	7[illegible]	57
13	19	15	.....	2,000	854	169	1[illegible]	46
14	18	15	.....	1,930	819	199	1[illegible]	40
15	19	15	80	1,440	745	180	[illegible]	36
16	22	15	85	1,350	706	254	2[illegible]	34
17	21	.....	126	1,340	691	159	1[illegible]	32
18	20	.....	159	1,420	668	142	[illegible]	30
19	19	.....	169	1,650	646	117	[illegible]	34
20	17	.....	152	1,490	588	111	[illegible]	35
21	18	.....	135	1,260	538	102	7[illegible]	35
22	17	.....	135	1,370	490	100	[illegible]	34
23	17	.....	177	1,510	498	114	[illegible]	34
24	18	.....	232	1,890	437	105	[illegible]	32
25	17	.....	305	2,090	388	98	[illegible]	29
26	17	.....	383	1,840	493	78	7[illegible]	29
27	17	.....	428	1,690	345	76	[illegible]	30
28	16	.....	541	1,660	335	74	7[illegible]	25
29	17	.....	653	1,740	315	80	[illegible]	28
30	17	.....	729	1,780	315	162	[illegible]	24
31	17	.....	.....	1,810	.....	199	[illegible]	.....

NOTE.—Discharge interpolated Nov. 7-10, 13-16, because of ice.

Monthly discharge of Brazos River near Brazos, N. Mex., for the year ending Sept. 30, 1916.

Month.	Discharge in second-feet.			Run-off (total in acre-feet).
	Maximum.	Minimum.	Mean.	
October	24	16	19.3	1,190
November 1–16	17	12	15.1	479
April 15–30	729	80	278	8,920
May	2,080	617	1,530	94,100
June	1,500	315	819	48,100
July	335	74	174	10,700
August	211	54	99.3	6,110
September	180	24	43.6	2,590

PECOS RIVER NEAR DAYTON, N. MEX.

LOCATION.—In sec. 13, T. 18 S., R. 26 E., 3 miles east of Dayton, Eddy County, half a mile above mouth of Penasco River.

DRAINAGE AREA.—Not measured.

RECORDS AVAILABLE.—March 24, 1905, to September 30, 1916.

GAGE.—Stevens water-stage recorder on right bank; installed August 27, 1914, at same site and datum as staff gage installed September 7, 1905. Original gage, which was 100 feet below the mouth of Penasco River and half a mile below present gage, was washed out September 6, 1905.

DISCHARGE MEASUREMENTS.—Made from cable.

CHANNEL AND CONTROL.—Bed composed of sand and gravel; shifts, especially during high stages. Right bank consists of clay, left bank of sand; both are subject to overflow during extremely high stages. No well-defined control.

EXTREMES OF DISCHARGE.—Maximum stage recorded during year, 10.73 feet from 11 a. m. to 1 p. m. August 24 (discharge, 7,200 second-feet). Minimum stage 2.45 feet from 11 p. m. July 26 to 1 a. m. July 27 (discharge, 23 second-feet).

ICE.—None reported during year.

DIVERSIONS.—Considerable water is diverted above station for the use of irrigable valley lands; quantity not known but not in conflict with rights of Carlsbad project of the United States Reclamation Service, which serves about 20,000 acres in the vicinity of Carlsbad and stores part of the water used near Carlsbad in Lake McMillan, 10 miles below gage.

REGULATION.—None.

ACCURACY.—Stage-discharge relation not permanent; periods of change are covered by discharge measurements. Daily gage heights determined by interpolating gage-height graph, or, for days of considerable fluctuation, by averaging hourly gage heights. Discharge determined by indirect method for shifting control.

COOPERATION.—Records furnished by the United States Reclamation Service.

Discharge measurements of Pecos River near Dayton, N. Mex., during the year ending Sept. 30, 1916.

[Made by engineers of United States Reclamation Service.]

Date.	Gage height.	Discharge.	Date.	Gage height.	Discharge.	Date.	Gage height.	Discharge.
	Feet.	*Sec.-ft.*		*Feet.*	*Sec.-ft.*		*Feet.*	*Sec.-ft.*
Oct. 1	5.30	1,039	Jan. 24	4.88	590	June 10	4.19	283
Oct. 2	5.42	849	Feb. 1	4.00	312	June 21	3.77	207
Oct. 11	3.43	219	Feb. 10	3.98	321	July 1	2.76	43
Oct. 21	3.55	228	Feb. 21	3.75	266	July 1	2.76	44
Oct. 21	3.54	228	Mar. 1	3.57	204	July 11	2.77	47
Nov. 1	2.93	137	Mar. 12	3.16	144	Aug. 1	2.94	67
Nov. 11	2.88	133	Mar. 21	4.25	383	Aug. 10	5.80	605
Nov. 23	3.63	248	Apr. 1	3.71	287	Aug. 21	6.06	945
Dec. 1	3.42	206	Apr. 19	4.86	542	Aug. 25	7.51	2,050
Dec. 11	3.91	293	May 3	5.68	849	Sept. 1	4.92	451
Dec. 22	3.81	274	May 14	6.90	1,497	Sept. 12	4.57	229
Jan. 1	3.84	266	May 21	5.69	746			
Jan. 11	3.88	272	June 1	4.76	421			

Daily discharge, in second-feet, of Pecos River near Dayton, N. Mex., for the year ending Sept. 30, 1916.

Day.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.
1	651	139	206	274	337	212	246	786	404	43	9	260
2	771	141	197	284	316	189	230	745	366	38	3	374
3	529	143	205	343	325	176	228	820	355	78	9	1,524
4	377	141	210	328	325	170	203	1,158	305	70	2	536
5	305	137	210	310	325	169	201	1,074	282	51	2	1,352
6	278	135	222	310	325	158	212	965	282	43	2	1,052
7	268	135	245	308	325	155	207	745	278	62	24	740
8	295	135	261	300	325	149	194	718	272	76	94	326
9	258	133	305	294	325	148	205	673	292	78	1,60	260
10	232	134	310	282	322	150	222	685	280	44	60	214
11	209	135	302	278	310	151	387	855	284	38	47	189
12	200	141	305	264	304	142	385	1,074	264	30	41	316
13	203	184	285	280	295	140	398	1,172	270	30	37	656
14	214	214	263	284	290	141	397	1,413	252	28	45	752
15	240	226	262	288	288	136	529	1,375	216	28	41	326
16	215	230	280	296	287	133	606	1,222	212	28	39	236
17	576	222	283	294	288	142	666	1,150	192	30	30	192
18	398	212	284	296	280	234	558	1,102	188	40	26	177
19	290	215	280	300	265	352	507	1,054	182	30	47	163
20	256	252	275	300	268	382	445	864	192	30	53	152
21	226	254	278	324	270	382	671	742	192	28	64	144
22	200	256	282	338	278	340	795	660	174	25	1,10	138
23	187	256	280	621	267	307	730	554	163	26	2,00	130
24	181	238	283	542	235	292	677	520	159	28	6,30	124
25	177	214	282	433	245	370	558	487	141	28	2,35	120
26	173	216	283	379	250	373	492	487	135	25	1,28	119
27	172	220	296	367	242	394	534	454	114	25	83	117
28	162	238	302	336	247	388	589	414	102	30	63	113
29	152	228	302	338	240	376	596	400	72	30	57	111
30	145	213	290	328	.....	346	631	490	50	128	51	109
31	144	.....	282	326	.....	298	.....	404	.....	120	44	.....

Monthly discharge of Pecos River near Dayton, N. Mex., for the year ending Sept. 30 1916.

Month.	Discharge in second-feet.			Run-off (total in acre-feet).
	Maximum.	Minimum.	Mean.	
October	771	144	280	17,200
November	256	133	191	11,400
December	310	197	269	16,500
January	621	264	331	20,400
February	337	235	290	16,700
March	394	139	242	14,900
April	795	194	443	26,400
May	1,413	460	809	49,700
June	404	50	222	13,200
July	128	25	44.8	2,750
August	6,300	27	786	48,300
September	1,524	109	367	21,800
The year	6,300	25	357	259,000

NOTE.—Monthly discharge computed by engineers of United States Geological Survey.

Days of deficiency in discharge of Pecos River near Dayton, N. Mex., for the years ending Sept. 30, 1905–1916.

Discharge in second-feet.	Days of deficient discharge.										
	1905–6	1906–7	1907–8	[a] 1908–9	1909–10	1910–11	1911–12	1912–13	1913–14	1914–15	1915–16
50	.....	.....	7	80	19	.....	1	3	.....	.....	28
75	.....	.....	54	119	61	9	18	26	.....	4	34
100	13	12	94	154	106	37	34	83	3	22	37
125	20	40	136	171	179	91	62	151	37	34	47
150	49	75	162	200	216	120	82	184	68	37	76
175	64	84	173	225	237	165	109	218	105	42	88
200	84	120	180	230	248	193	126	234	118	56	106
250	115	148	189	263	272	248	185	262	172	85	155
300	158	175	210	285	320	282	241	295	236	116	222
350	188	208	244	318	324	303	280	320	258	157	264
400	225	243	279	339	331	311	303	333	271	226	284
450	242	262	299	342	339	317	309	340	276	263	294
500	254	282	306	346	344	325	315	344	278	275	301
550	267	307	314	347	347	329	327	346	288	283	310
600	287	318	314	347	349	336	332	347	294	292	317
650	304	328	314	347	349	337	332	349	297	299	323
700	320	339	319	347	353	339	338	349	305	306	331
800	337	347	322	350	354	341	342	350	312	317	341
900	347	351	326	352	355	347	346	352	317	327	346
1,000	351	358	334	352	355	350	357	353	326	333	347
1,200	358	359	341	354	356	357	362	356	336	243	356
1,400	358	361	343	356	357	359	365	356	344	349	360
1,700	361	363	353	356	358	360	365	358	354	354	363
2,000	362	364	358	356	358	361	365	358	357	356	363
2,500	363	364	361	356	360	362	365	362	359	361	365
3,000	364	364	363	356	360	362	365	362	362	361	365
4,000	365	365	365	356	361	362	366	362	363	362	365
6,000	.....	.....	365	357	362	362	.....	364	363	362	365
8,000	.....	.....	366	.....	363	363	.....	364	364	362	366
10,000	.....	.....	.....	.....	365	364	.....	364	364	362	.....
15,000	.....	.....	.....	.....	.....	365	.....	365	364	363	.....
50,000	.....	.....	.....	.....	.....	.....	.....	.....	365	365	.....

[a] Daily discharge for July 26 to Aug. 2, 1908, not included. Figures given for discharge above 90 second-feet are therefore subject to error.

PECOS RIVER AT CARLSBAD, N. MEX.

LOCATION.—In the SE. ¼ sec. 6, T. 22 S., R. 27 E., at Green Street Bridge in Carlsbad, Eddy County, 300 feet downstream from Atchison, Topeka & Santa Fe Railway station, 1,500 feet above mouth of Dark Canyon, 2,000 feet below Tansil Dam.

DRAINAGE AREA.—Not measured.

RECORDS AVAILABLE.—May 28, 1903, to March 31, 1908, and May 13, 1914, to September 30, 1916.

GAGE.—Vertical staff, attached to the upstream side of middle bridge pier installed May 18, 1914. Gage used from May 28, 1903, to October, 1904, was an inclined staff gage at the present site. From October, 1904, to March 31, 1908, vertical staff gage at the same site was used.

DISCHARGE MEASUREMENTS.—Made by wading or from bridge.

CHANNEL AND CONTROL.—Bed composed of gravel and rock; nearly permanent, but changes may occur after high stages and slight changes have taken place during the lower stages. Banks of medium height; not subject to overflow. Position of control not known.

EXTREMES OF DISCHARGE.—Maximum stage recorded during year about 21.0 feet August 7 (discharge, 85,700 second-feet [1]); minimum stage, 0.75 foot December 2–19 (discharge 95 second-feet).

1903–1908, 1914–1916: Maximum stage recorded about 21.0 feet August 7, 1916 (discharge, 85,700 [1] second-feet); minimum discharge 60 second-feet January 10–12 and 21, 1915 (gage height 0.80 foot).

ICE.—None reported during year.

[1] Discharge at Avalon dam; reported by engineers of United States Reclamation Service.

DIVERSIONS.—Large quantities of water are stored a few miles above station in Lakes McMillan and Avalon by the United States Reclamation Service for irrigating lands near Carlsbad. Water is also diverted for irrigation in valleys adjacent to river above Lake McMillan. Capacity of storage reservoirs in connection with the Carlsbad project, 58,500 acre-feet. Considerable water seeps into the river between the storage reservoirs and the gaging station, the quantity depending on the quantity being used for irrigation between the two points.

REGULATION.—Flow at this point completely controlled by storage reservoirs of the Carlsbad project.

ACCURACY.—Stage-discharge relation not permanent. Standard rating curve fairly well defined below 8,000 second-feet. Gage read to half-tenths once daily. One daily reading may not be a true index of the mean daily discharge because of fluctuations due to operation of gates at storage reservoirs. Daily discharge ascertained by applying daily gage heights to rating table except during periods for which the stage-discharge relation is affected by shifting control. Results fair.

COOPERATION.—Gage-height record furnished by United States Reclamation Service.

Discharge measurements of Pecos River at Carlsbad, N. Mex., during the year ending Sept. 30, 1916.

Date.	Made by—	Gage height.	Discharge.	Date.	Made by—	Gage height.	Discharge.
		Feet.	*Sec.-ft.*			*Feet.*	*Sec.-ft.*
May 28	R. J. Hank	2.08	924	Aug. 18	William Kessler	2.08	472
July 18	do	.76	87.2	Sept. 20	R. J. Hank	1.58	181

Daily discharge, in second-feet, of Pecos River at Carlsbad, N. Mex., for the year ending Sept. 30, 1916.

Day.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.
1	1,400	217	105	395	115	185	125	137	161	125	105	137
2	1,200	275	95	395	115	155	125	179	161	125	115	278
3	525	395	95	395	115	140	125	383	161	125	110	419
4	425	395	95	395	115	140	125	443	161	125	105	2,100
5	335	185	95	395	115	140	125	581	413	125	105	3,570
6	305	155	95	395	115	140	125	2,440	149	125	105	2,000
7	335	155	95	395	115	125	125	1,200	149	125	1,100	157
8	275	155	95	395	115	125	125	323	149	125	27,000	113
9	335	140	95	395	115	125	125	217	143	125	600	134
10	335	140	95	395	115	125	125	149	137	125	611	195
11	335	140	95	185	115	125	125	149	137	125	400	236
12	365	115	95	185	115	755	125	383	789	125	300	277
13	317	115	95	185	110	125	125	443	125	125	131	318
14	335	115	95	185	105	125	125	1,280	125	125	400	359
15	335	115	95	185	105	125	125	383	125	125	407	299
16	335	115	95	185	105	125	125	1,100	125	125	347	255
17	365	115	95	185	115	125	125	1,860	125	105	161	211
18	365	115	95	185	115	125	125	1,000	125	105	275	167
19	365	115	95	185	115	125	125	235	125	105	347	167
20	353	115	275	185	115	125	125	651	125	105	317	245
21	335	105	225	155	115	125	125	176	125	105	275	167
22	347	105	225	155	140	125	125	176	125	105	1,200	167
23	353	105	205	155	140	125	440	409	125	105	16,500	137
24	329	105	205	155	155	125	780	161	125	105	10,300	137
25	305	105	225	155	155	125	1,770	161	125	105	8,500	123
26	287	105	225	155	155	125	245	161	125	105	6,500	123
27	275	105	225	155	1,960	125	137	161	125	105	4,700	123
28	265	105	225	140	395	125	137	161	125	115	2,900	123
29	260	105	205	140	185	125	137	161	125	115	1,200	113
30	250	105	205	128	.....	125	137	161	125	925	974	113
31	233	.....	205	115	.....	125	.....	161	.....	105	777	.....

NOTE.—Discharge computed by indirect method for shifting control Apr. 26 to June 12, Aug. 9-22, and Aug. 29 to Sept. 30. Discharge Aug. 7-8 furnished by U. S. Reclamation Service and based on flow at Lake Avalon.

Monthly discharge of Pecos River at Carlsbad, N. Mex., for the year ending Sept. 30, 1916.

Month.	Discharge in second-feet.			Run-off (total in acre-feet).
	Maximum.	Minimum.	Mean.	
October	1,400	233	393	24,200
November	395	105	148	8,810
December	275	95	144	8,850
January	395	115	239	14,700
February	1,960	105	195	11,209
March	755	125	150	9,220
April	1,770	125	218	13,000
May	2,440	137	505	31,100
June	789	125	165	9,820
July	925	105	142	8,730
August	27,000	105	2,810	173,000
September	3,870	113	443	26,400
The year	27,000	95	467	339,000

EVAPORATION NEAR CARLSBAD, N. MEX.

LOCATION.—At head gates on Lake Avalon of the United States Reclamation Service, 6 miles north of Carlsbad. Approximate elevation about 3,200 feet above sea level.

RECORDS AVAILABLE.—August, 1914, to August, 1916.

EQUIPMENT.—Heavy galvanized-iron pan, 3 feet square and 18 inches deep, floated on reservoir. Auxiliary equipment, standard rain gage, thermometer, and measuring cup.

Evaporation near Carlsbad, N. Mex., for the year ending Sept. 30, 1916.

Month.	Temperature.		Rainfall.	Evaporation.
	In pan.	Outside of pan.		
	° F.	° F.	*Inches.*	*Inches.*
October	64	62	.12	5.90
November	51	52	.00	4.46
December	46	45	.52	3.34
January	42	43	.20	3.36
February	49	49	.12	3.33
March	56	56	.05	6.20
April	58	58	1.34	6.29
May	66	67	.20	8.77
June	73	74	.06	10.82
July	76	77	4.87	9.25
August 1–7	77	79	.00	2.02
The period			7.48	63.74

NOTE.—Pan destroyed Aug. 7 by high water.

PECOS RIVER NEAR ANGELES, TEX.

LOCATION.—In T. 26 S., R. 29 E., just below Pecos Valley Railroad bridge crossing Delaware Creek at its mouth, 2 miles north of the New Mexico-Texas State line, 2¼ miles southeast of Red Bluff, Eddy County, N. Mex., 8½ miles northwest of Angeles, Reeves County, Tex.

DRAINAGE AREA.—Not measured.

RECORDS AVAILABLE.—May 27, 1914, to September 30, 1916.

GAGE.—Stevens continuous water-stage recorder installed over a vertical float box drift bolted to the first outcrop of rock on the right bank about 600 feet below railroad bridge and mouth of Delaware Creek.

DISCHARGE MEASUREMENTS.—Made by wading or from cable half a mile downstream.

CHANNEL AND CONTROL.—Bed and banks composed of sand, gravel, and rock; banks not subject to overflow. Control formed by a series of rapids about 200 feet below the gage; shifts slightly.

EXTREMES OF DISCHARGE.—Maximum stage during year, 21.5 feet 10 a. m. August 8, measured by leveling from flood marks (discharge not determined); minimum stage from water-stage recorder, 0.20 foot the last part of February or the first part of March (discharge, 140 second-feet).

1914–1916: Maximum stage recorded, 21.5 feet 10 a. m. August 8, 1916; minimum discharge, 124 second-feet at 10 p. m. July 6, 1915 (gage height from water-stage recorder, 0.23 foot).

ICE.—Stage-discharge relation not seriously affected by ice; open channel ratings curve assumed applicable.

DIVERSIONS.—The Carlsbad project of the United States Reclamation Service, with reservoirs of a capacity of 58,500 acre-feet, diverts a large part of the natural runoff above Carlsbad, N. Mex. During the season of irrigation considerable water is returned to the stream by seepage from the lands in the vicinity of Carlsbad. In addition to the water used by the Carlsbad project, some diversions are made for irrigation in the basin above the storage reservoirs of the Carlsbad project.

REGULATION.—The operation of a water-power plant of 300 horsepower capacity above station, just below Carlsbad, N. Mex., does not materially regulate flow at gage. The flow is, however, regulated to a large extent by waters stored in the reservoirs of the Carlsbad project. In the season of irrigation the effect of the regulation is decreased by return seepage waters, but during the winter the flow depends on water released at the reservoirs.

ACCURACY.—Stage-discharge relation not permanent. Standard rating curve, used for computing daily discharge by indirect method for shifting control, fairly well defined between 140 and 4,500 second-feet. Gage height record not continuous due to imperfect operation of recorder. Mean daily gage heights obtained by inspecting recorder graph, or, for days of considerable fluctuation, by averaging the hourly gage heights. Daily discharge ascertained by indirect method for shifting control. Results fair.

Discharge measurements of Pecos River near Angeles, Tex., during the year ending Sept. 30, 1916.

Date.	Made by—	Gage height.	Discharge.	Date.	Made by—	Gage height.	Discharge.
		Feet.	*Sec.-ft.*			*Feet.*	*Sec.-ft.*
Oct. 5	Gray and Hank	0.88	614	Mar. 28	R. C. Thaxton	0.2[illegible]	168
Nov. 9	R. J. Hank	.45	259	May 23	R. J. Hank	.3[illegible]	174
Feb. 7	....do	.34	170	July 19	....do	.2[illegible]	159

Daily discharge, in second-feet, of Pecos River near Angeles, Tex., for the year ending Sept. 30, 1916.

Day.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.
1	552	305	222	236	212	.....	212	216	172	200	295	480
2	920	325	222	236	212	.....	224	200	192	200	188	468
3	1,070	325	222	228	212	.....	188	216	180	176	168	463
4	1,070	248	220	228	196	.....	184	390	176	180	164	456
5	616	216	220	228	156	.....	224	402	200	176	188	456
6	536	229	220	224	156	.....	236	295	196	196	188	450
7	552	232	220	220	160	.....	240	680	172	180	656	444
8	544	240	220	224	164	.....	216	584	160	176	.....	438
9	536	260	216	224	168	.....	188	474	168	204	.....	432
10	536	232	204	216	164	.....	216	462	164	196	.....	426
11	528	212	200	204	168	.....	224	459	172	188	.....	420
12	536	212	200	204	176	.....	232	455	168	180	.....	414
13	512	212	204	204	.....	.....	224	452	172	180	.....	408
14	474	220	200	208	.....	.....	228	448	176	172	.....	384
15	468	224	192	216	.....	.....	220	444	208	184	.....	468
16	468	225	188	232	.....	.....	176	672	212	168	.....	512
17	456	225	180	224	.....	.....	184	1,050	176	172	.....	576
18	456	225	180	232	.....	.....	216	1,020	168	176	.....	1,280
19	432	225	188	236	.....	.....	232	752	204	164	.....	1,290
20	420	225	184	244	.....	.....	200	560	172	156	.....	720
21	420	225	180	252	.....	.....	216	584	180	180	1,190	378
22	414	225	184	248	.....	.....	216	310	168	184	864	350
23	408	222	188	248	.....	.....	200	192	184	188	12,600	330
24	414	222	252	248	.....	.....	204	180	188	196	14,000	315
25	414	222	285	256	.....	.....	216	176	265	200	6,000	310
26	414	222	256	244	.....	.....	196	180	184	196	4,700	310
27	402	222	216	236	.....	200	200	200	188	172	2,930	300
28	384	222	212	244	.....	172	325	172	184	350	2,040	295
29	378	222	218	236	.....	176	468	160	176	300	1,400	290
30	366	222	224	224	.....	184	320	240	208	208	980	300
31	345	.....	230	220	.....	188	.....	192	.....	216	640	.....

NOTE.—No gage-height record Nov. 16 to Dec. 7, Dec. 29–31, Feb. 13 to Mar. 26, May 11–14, Aug. 8–20, Aug. 24 to Sept. 2, and Sept. 4–12; discharge, except Feb. 13 to Mar. 26 and Aug. 8–20, estimated from record at Carlsbad and notes furnished by engineers.

Monthly discharge of Pecos River near Angeles, Tex., for the year ending Sept. 30, 1916

Month.	Discharge in second-feet.			Run-off (total in acre-feet).
	Maximum.	Minimum.	Mean.	
October	1,070	345	517	31,800
November	325	212	234	13,900
December	285	180	211	13,000
January	256	204	230	14,100
February 1–12	212	156	179	4,260
March 27–31	200	172	184	1,820
April	468	176	228	13,600
May	1,050	160	413	25,400
June	265	160	184	10,900
July	350	156	195	12,000
September	1,290	285	472	28,100

PECOS RIVER ABOVE BARSTOW, TEX.

LOCATION.—Three-quarters of a mile below head gate of Biggs irrigation project, 1 mile east of Patrole siding on Pecos Valley Railway, 1½ miles above head gate of Barstow Irrigation Co., 14 miles northwest of Barstow, Reeves County, 10 miles northwest of Pecos.

DRAINAGE AREA.—Not measured.

RECORDS AVAILABLE.—February 1, 1916, to September 30, 1916.

GAGE.—Stevens water-stage recorder on right bank.

DISCHARGE MEASUREMENTS.—Made by wading or from cable 150 feet below gage.

CHANNEL AND CONTROL.—Channel straight 100 feet above and 300 feet below station. Bed composed of gravel, clay, and sand; not permanent. Right bank is clay, clean, and fairly permanent; left bank loose sand covered with salt cedar; both banks are overflowed at gage height about 10 feet. Shoal 250 feet below gage serves as control; shifts during high water.

EXTREMES OF DISCHARGE.—Maximum stage during year, from water-stage recorder, 12.1 feet at 6 a. m. August 10 (discharge not determined); minimum stage, 0.88 foot morning of July 10 (discharge, 36 second-feet).

ICE.—None reported during year.

DIVERSIONS.—In addition to the water stored and lands irrigated in New Mexico by the Carlsbad project of the United States Reclamation Service, some lands in Texas are irrigated just above the station. Considerable water is returned to the river by seepage below the reservoirs. The First Report of the Board of Water Engineers for the State of Texas shows that 26,200 acres were declared irrigated above the station, the quantity of water necessary, under an assumed duty of 2 feet, being 78,600 acre-feet.

REGULATION.—Storage in connection with the Carlsbad project controls the run-off during parts of the year. The operation of a water-power plant of 300 horsepower capacity, below Carlsbad, does not affect the flow at this point.

ACCURACY.—Stage-discharge relation not permanent. Rating curve well defined below 700 second-feet and poorly defined above. Mean daily gage height determined by inspecting the gage-height graph, or, for days of considerable fluctuation, by averaging the hourly gage height. Breaks in gage-height record caused by collections of silt in float box. Daily discharge ascertained by applying mean daily gage height to rating table, except from March 26 to May 13, and May 22 to August 23, when obtained by indirect method for shifting control. Determination of discharge during extremely high stages subject to error caused by water flowing over both banks. Results for periods during which water-stage recorder operated satisfactorily are good for low and medium stages and fair for high stages.

Discharge measurements of Pecos River above Barstow, Tex., during the year ending Sept. 30, 1916.

Date.	Made by—	Gage height.	Discharge.	Date.	Made by—	Gage height.	Discharge.
		Feet.	*Sec.-ft.*			*Feet.*	*Sec.-ft.*
Feb. 1	R. J. Hank	2.30	194	Aug. 9	William Kessler	(a)	4,020
9	do	1.95	144	16	do	3.34	342
Mar. 26	R. C. Thaxton	1.39	94	17	do	3.81	546
May 25	R. J. Hank	2.66	392	24	do	9.86	3,120
July 16	do	1.05	49	Sept. 24	R. J. Hank	3.02	250

a Measurement made 4 miles above Pecos, gage height of 10.50 feet was determined from water-stage recorder chart.

Daily discharge, in second-feet, of Pecos River above Barstow, Tex., for the year ending Sept. 30, 1916.

Day.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.
1	194	485	108	301	81	77	116	650
2	188	256	146	228	77	81	124	659
3	182	220	146	186	77	78	141	1,790
4	176	323	136	146	72	61	93	.....
5	168	282	117	123	68	46	77	.....
6	162	232	99	147	67	47	73	.....
7	156	184	113	248	68	49	80	.....
8	150	170	131	252	71	41	542	.....
9	144	231	131	359	81	37	3,230	.....
10	.....	165	127	483	77	39	3,960	.....
11	.....	259	99	323	78	45	2,100	.....
12	.....	178	98	343	75	54	1,260	.....
13	.....	174	106	218	75	41	916	.....
14	.....	171	118	220	90	41	596	.....
15	.....	167	119	220	178	50	423	.....
16	.....	166	98	220	122	51	357	.....
17	.....	164	112	500	86	59	578	.....
18	.....	162	96	800	80	76	772	.....
19	.....	155	86	750	79	63	638	.....
20	.....	145	80	500	78	73	510	.....
21	.....	136	85	400	73	65	876	.....
22	.....	127	93	325	72	54	1,260	.....
23	.....	118	93	259	72	55	884	.....
24	.....	109	95	401	77	67	2,140	249
25	.....	100	95	426	81	67	2,560	231
26	.....	92	93	332	82	66	3,070	210
27	.....	85	94	278	100	69	3,020	207
28	.....	93	97	216	96	78	2,860	199
29	.....	95	93	161	84	124	2,000	182
30	.....	89	140	138	79	231	220	181
31	.....	84	.....	105	.....	177	650	.....

NOTE.—Discharge computed by indirect method for shifting control Mar. 26 to May 13 and May 22 to Aug. 23. No gage height record obtained for Feb. 2–8, 10–29, Mar. 19–25, May 14–21, and Sept. 4–23. Discharge Feb. 2–8, Mar. 19–25, and May 14–21 estimated by comparison with records at other stations. Discharge not estimated for Feb. 10–29 and Sept. 4–23. Maximum gage height Sept. 19 was 6.70 feet.

Monthly discharge of Pecos River above Barstow, Tex., for the year ending Sept. 30, 1916.

Month.	Discharge in second-feet.			Run-off (total in acre-feet).
	Maximum.	Minimum.	Mean.	
February 1–9	194	144	169	3,020
March	485	84	175	10,800
April	146	80	108	6,430
May	800	105	319	19,100
June	178	67	83.2	4,950
July	231	37	69.7	4,290
August	3,960	73	1,180	72,600

PECOS RIVER NEAR GRANDFALLS, TEX.

LOCATION.—At highway bridge on Grandfalls-Fort Stockton road, 3 miles south of Grandfalls, on line between Ward and Pecos counties, 3 miles above diversion dam of the Zimmerman irrigation project, 3½ miles below diversion dam for silt-line canal of the Imperial Irrigation Co., 21 miles south of Monahans.

DRAINAGE AREA.—Not measured.

RECORDS AVAILABLE.—November 6, 1915, to September 30, 1916.

GAGE.—Stevens water-stage recorder attached to downstream side of middle pier of highway bridge.

DISCHARGE MEASUREMENTS.—Made by wading 200 feet below gage or from highway bridge.

CHANNEL AND CONTROL.—Bed composed of gravel and rock. Channel straight above and below station for 200 feet. Right bank is rock, medium in height, and subject to overflow during extreme stages; left bank sandy, high, clean and not subject to overflow. Shoal 200 feet below serves as control for low and medium stages but is likely to shift; position of high-water control not known.

EXTREMES OF DISCHARGE.—Maximum stage during year, from water-stage recorder, 12.8 feet at 8 a. m. August 29 discharge, 4,370 second-feet; result obtained from extension of rating curve and possibly considerably in error; minimum stage, 0.38 foot 1 a. m. April 17 (discharge not determined).

ICE.—None reported during year.

DIVERSIONS.—Station is 3½ miles below diversion of silt-line canal of Imperial Irrigation Co., 20 miles below diversion for the Imperial reservoir (capacity 17,000 acre-feet), 17 miles below diversion for Grandfalls project, and 3 miles above diversion for Zimmerman project. Available data show that tracts aggregating approximately 143,000 acres are irrigable between station and lower limits of Carlsbad project of United States Reclamation Service. First Report of Board of Water Engineers for the State of Texas shows total number of acres declared irrigated in Texas above the station to be 57,300, the amount of water required under an assumed duty of 2 acre-feet per acre, being 171,900 acre-feet. The effect of diversions is somewhat counterbalanced by water returned to stream by seepage.

REGULATION.—None.

ACCURACY.—Stage-discharge relation not permanent. Rating curve well defined below 3,200 second-feet. Gage-height record somewhat fragmentary due to stoppage of water-stage recorder. Mean daily gage heights obtained by inspecting gage-height graph, or, for days of considerable fluctuation, by use of planimeter. Daily discharge ascertained by applying mean daily gage heights to rating table except for periods during which stage-discharge relation was affected by shifting control. Results fair.

Discharge measurements of Pecos River near Grandfalls, Tex., during the year ending Sept. 30, 1916.

Date.	Made by—	Gage height.	Discharge.	Date.	Made by—	Gage height.	Discharge.
		Feet.	*Sec.-ft.*			*Feet.*	*Sec.-ft.*
Nov. 7	R. J. Hank	2.38	68.6	Aug. 12	William Kessler	9.92	2,580
Feb. 3	do	2.28	27.2	13	do	10.52	2,270
Mar. 30	R. C. Thaxton	.95	9.2	13	do	8.74	1,860
May 26	R. J. Hank	1.00	12.3	13	do	7.58	1,410
July 21	do	1.18	19.5	14	do	5.34	740
Aug. 11	Watrous and Sullivan	9.08	2,410	23	do	5.07	677
12	William Kessler	9.64	2,470	Sept. 23	R. J. Hank	3.94	311

Daily discharge, in second-feet, of Pecos River near Grandfalls, Tex., for the year ending Sept. 30, 1916.

Day.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.
1	.....	77	170	28	31	8.6	73	7.2	10	32	730
2	.....	99	170	25	73	8.0	78	6.8	9.8	33	610
3	.....	114	170	26	74	7.4	79	7.6	9.6	36	760
4	.....	120	170	23	31	7.8	44	8.2	11	39	1,310
5	.....	132	170	20	19	8.4	27	7.4	12	41	1,260
6	88	147	170	24	16	9.6	34	7.0	11	40	1,690
7	72	147	172	25	15	10	42	7.6	11	42	1,720
8	63	146	169	25	14	9.8	49	8.0	12	45	1,600
9	60	146	166	26	14	9.8	63	8.2	12	65	1,080
10	58	145	163	22	13	10	74	8.6	11	1,290	915
11	54	.....	160	35	13	10	82	8.2	11	1,960	855
12	49	.....	159	48	14	9.2	85	8.0	12	2,400	825
13	50	.....	158	61	13	10	86	8.0	12	2,180	735
14	50	.....	157	56	14	10	78	8.0	13	711	645
15	49	.....	133	51	13	8.4	80	8.0	15	495	585
16	47	.....	119	46	11	1.0	82	8.4	16	445	555
17	47	.....	85	41	12	.7	85	8.8	18	420	525
18	44	.....	61	36	14	5.0	76	8.8	20	555	495
19	42	.....	54	31	14	9.4	68	8.8	20	735	420
20	64	.....	37	31	12	12	183	8.8	20	585	445
21	68	.....	20	32	12	12	68	9.4	20	445	513
22	85	.....	20	33	11	12	83	9.8	20	445	765
23	93	.....	21	34	11	10	41	11	21	621	372
24	94	.....	21	35	10	12	22	11	21	516	235
25	78	.....	26	36	10	12	18	11	21	1,230	160
26	78	.....	32	36	10	12	12	11	22	2,050	122
27	78	.....	38	35	10	14	10	11	23	2,900	100
28	80	.....	43	33	10	26	9.4	10	23	4,020	81
29	82	.....	41	32	10	42	8.6	10	25	4,180	72
30	82	.....	36	.....	8.6	59	8.8	10	27	3,910	63
31	.....	.....	31	.....	10	.....	8.0	.....	29	1,350	.....

NOTE.—Discharge computed by indirect method for shifting control Dec. 11 to May 3 and July 14 to Aug. 8. No gage-height record Dec. 7–9, Dec. 11 to Jan. 6, Jan. 9, 10, 12, 13, 15–17, 19, 20, 22, 23, 25–27, 30, Feb. 1, 11, 12, 14–18, 20–25, and 27–29, May 6, 7, Sept. 1–3, 5 and 9–18; discharge for these days, except Dec. 11–31, estimated or interpolated.

Monthly discharge of Pecos River near Grandfalls, Tex., for the year ending Sept. 30, 1916.

Month.	Discharge in second-feet.			Run-off (total in acre-feet).
	Maximum.	Minimum.	Mean.	
November 6–30	94	42	66.2	3,280
December 1–10	147	77	1[illegible]7	2,520
January	172	20	1[illegible]	6,150
February	61	20	34.0	1,360
March	74	8.6	17.5	1,080
April	59	.7	12.5	744
May	183	8.0	56.7	3,490
June	11	6.8	8.82	525
July	29	9.6	16.7	1,030
August	4,180	32	1,090	67,000
September	1,720	63	675	40,200

PECOS RIVER NEAR COMSTOCK, TEX.[1]

LOCATION.—At the Pecos high bridge of the Galveston, Harrisburg & San Antonio Railway Co., 11 miles west of Comstock, Val Verde County, 18 miles east of Langtry, 14 miles by stream above confluence with Rio Grande, and below all tributaries.

DRAINAGE AREA.—Not measured.

RECORDS AVAILABLE.—May 1, 1900, to September 30, 1916 (also gage heights for 1898).

GAGE.—Vertical staff attached to the downstream side of bridge pier on left bank; read by W. A. Clare.

DISCHARGE MEASUREMENTS.—Made from cable 1,000 feet above bridge.

CHANNEL AND CONTROL.—Banks and stream bed composed of rock and gravel; water flows through a series of rapids and pools in a canyon approximately 300 feet deep; banks are not subject to overflow. Stage-discharge relation at the lower stages changes slightly.

EXTREMES OF DISCHARGE.—Maximum stage recorded during year, 33.0 feet at 10 p. m. September 1 (discharge not determined); minimum stage, 0.30 foot from 6 p. m. June 24 to 6 p. m. June 25 (discharge, 205 second-feet).

1900–1916: Maximum stage recorded, 35.75 feet April 6, 1900 (discharge not determined); minimum discharge recorded, 110 second-feet May 13, 14, 1904 (gage height, 0.5 foot).

ICE.—None reported during year.

DIVERSIONS.—Considerable water is diverted and stored above the station for irrigation. Lake McMillan and Lake Avalon, of the Carlsbad project of the United States Reclamation Service, with a combined capacity of 58,500 acre-feet, are on Pecos River a few miles above Carlsbad, N. Mex. In addition to the water stored in New Mexico, water from Pecos River is used to irrigate large areas of land in the vicinity of Barstow and Grandfalls, Tex. There are no diversions below the station. Return waters tend to equalize effects of diversions in lower part of drainage basin.

REGULATION.—Yearly run-off at this point controlled by storage and diversions for irrigation above station. No water-power plants operated in the drainage basin, except a public utility plant of about 300 horsepower, near Carlsbad, N. Mex, which does not control the flow at this point.

ACCURACY.—Stage-discharge relation subject to slight changes. Gage read to hundredths twice daily; mean of two readings may not be a true index of mean daily discharge. Rating curve well defined between 200 and 4,000 second-feet. Daily discharge ascertained by applying mean daily gage heights to rating table except during periods for which the stage-discharge relation is affected by shifting control. Results fair.

Discharge measurements of Pecos River near Comstock, Tex., during the year ending Sept. 30, 1916.

Date.	Made by—	Gage height.	Discharge.	Date.	Made by—	Gage height.	Discharge.
		Feet.	*Sec.-ft.*			*Feet.*	*Sec.-ft.*
Nov. 12	W. C. Dodd	1.10	484	Apr. 18	W. C. Dodd	.58	292
24	do	.90	377	May 18	do	.48	263
Dec. 11	do	.90	422	June 17	do	.32	212
22	Thaxton and Dodd	1.05	473	July 18	do	.48	253
Jan. 15	W. C. Dodd	1.00	524	Aug 12	do	.32	208
Feb. 18	do	.75	343	18	do	1.55	783
Mar. 18	Thaxton and Dodd	.62	304	Sept. 2	do	5.18	4,500

[1] Published in earlier reports as Pecos River near Moorhead, Tex.

Daily discharge, in second-feet, of Pecos River near Comstock, Tex., for the year ending Sept. 30, 1916.

Day.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.
1	1,330	709	384	438	370	323	320	280	247	211	265	8,010
2	1,310	709	374	438	362	302	465	283	241	211	241	14,800
3	1,750	709	374	460	350	312	323	283	241	211	235	2,560
4	1,310	679	406	438	350	295	316	283	241	211	229	1,610
5	739	649	406	420	370	312	320	283	241	214	229	1,200
6	838	619	410	495	350	295	316	280	241	217	229	1,010
7	804	589	420	465	350	302	316	280	235	217	226	866
8	908	589	438	456	350	312	316	280	235	229	223	679
9	804	589	424	460	350	312	320	280	235	232	226	1,470
10	943	589	438	442	350	312	316	280	235	235	226	1,730
11	873	532	424	446	330	312	316	277	235	238	223	1,840
12	804	480	460	475	330	312	316	277	238	241	214	1,590
13	739	480	438	480	330	302	316	280	235	235	211	1,800
14	739	619	438	470	330	302	316	280	235	235	220	1,350
15	838	589	438	465	330	312	316	277	235	241	1,280	950
16	804	526	485	521	330	312	316	280	235	247	1,550	845
17	771	554	460	490	330	312	316	271	220	253	1,670	915
18	804	470	438	485	338	316	295	262	211	259	790	880
19	1,230	438	424	505	350	309	289	259	211	253	950	845
20	838	420	438	475	350	312	295	456	211	247	845	697
21	804	379	438	446	330	306	292	280	205	804	625	697
22	771	370	460	480	312	306	289	280	208	262	560	715
23	649	358	460	460	330	312	289	271	211	289	500	679
24	771	370	438	442	330	306	289	259	208	271	465	758
25	771	379	438	428	330	312	283	256	205	262	470	1,010
26	771	392	438	402	330	309	280	253	211	244	456	894
27	739	384	470	397	323	302	277	253	211	238	532	733
28	709	388	451	392	312	295	280	259	211	235	739	625
29	709	379	424	370	323	306	280	259	211	235	1,310	613
30	649	370	424	370	.....	302	274	259	211	238	2,060	543
31	709	.....	460	370	.....	295	.....	253	.....	268	2,240	.....

NOTE.—Discharge computed by indirect method for shifting control Oct. 1 to Dec. 7 and Jan. 5–27.

Monthly discharge of Pecos River near Comstock, Tex., for the year ending Sept. 30, 1916.

Month.	Discharge in second-feet.			Run-off (total in acre-feet).
	Maximum.	Minimum.	Mean.	
October	1,750	649	878	54,000
November	709	358	510	30,300
December	485	374	433	26,600
January	521	370	448	27,500
February	370	312	339	19,500
March	323	295	307	18,900
April	465	274	308	18,300
May	456	253	278	17,100
June	247	205	225	13,400
July	804	211	258	15,900
August	2,240	211	651	40,000
September	14,800	543	1,760	105,000
The year	14,800	205	532	386,000

Days of deficiency in discharge of Pecos River near Comstock, Tex., for the year ending Sept. 30, 1901–1916.

Discharge in second-feet.	Days of deficient discharge.							
	1900–1901	1901–2	1902–3	1903–4	1904–5	1905–6	1906–7	1907–8
100	.....	.....	.....	.....	.....	.....	.....	.....
150	.....	.....	.....	45	.....	.....	.....	.....
200	19	.....	5	130	.....	.....	3	.....
250	29	20	59	256	.....	.....	38	12
300	73	57	109	291	.....	.....	81	17
350	88	81	125	305	.....	.....	83	63
400	114	108	150	306	.....	.....	115	101
450	143	127	232	306	.....	16	175	128
500	185	165	269	309	.....	39	200	158
600	251	208	333	317	18	98	316	199
700	280	256	339	326	47	188	329	232
800	299	273	345	334	107	255	361	258
900	306	290	348	344	162	320	365	293
1,000	313	307	350	344	176	325	.....	313
1,200	330	326	350	346	211	336	.....	330
1,500	345	338	352	352	247	354	.....	350
1,800	352	345	352	354	290	356	.....	355
2,200	360	353	365	357	315	359	.....	355
2,600	363	360	.....	357	328	359	.....	359
3,000	363	364	.....	358	338	359	.....	364
3,500	363	364	.....	361	342	359	.....	364
4,000	363	364	.....	361	345	359	.....	364
5,000	364	364	.....	362	355	361	.....	364
7,000	364	364	.....	362	362	361	.....	364
10,000	365	364	.....	362	364	362	.....	365
15,000	.....	364	.....	365	365	362	.....	366
20,000	.....	364	.....	366	.....	363	.....	.....
25,000	.....	365	.....	.....	.....	363	.....	.....
30,000	.....	.....	.....	.....	.....	364	.....	.....
35,000	.....	.....	.....	.....	.....	364	.....	.....
37,000	.....	.....	.....	.....	.....	365	.....	.....

Discharge in second-feet.	Days of deficient discharge.							
	1908–9	1909–10	1910–11	1911–12	1912–13	1913–14	1914–15	1915–16
100	.....	.....	.....	.....	.....	.....	.....	.....
150	.....	.....	.....	54	10	.....	.....	.....
200	19	78	21	129	63	.....	.....	.....
250	82	123	128	187	150	18	.....	65
300	157	238	217	325	214	91	.....	121
350	212	309	264	363	255	130	.....	181
400	293	345	295	365	283	151	28	211
450	334	350	310	365	299	193	57	243
500	338	352	321	265	305	216	76	273
600	344	353	331	365	316	239	141	287
700	348	354	336	365	325	272	193	300
800	350	357	340	365	331	285	240	320
900	352	358	343	365	335	297	281	337
1,000	354	358	345	365	339	310	290	342
1,200	358	359	347	366	346	322	303	344
1,500	362	363	353	.....	352	331	321	353
1,800	365	364	356	.....	353	339	331	359
2,200	.....	364	358	.....	357	347	333	362
2,600	.....	364	363	.....	359	352	337	364
3,000	.....	364	363	.....	359	353	344	364
3,500	.....	364	363	.....	359	355	346	364
4,000	.....	364	364	.....	360	356	350	364
5,000	.....	364	364	.....	361	360	354	364
7,000	.....	364	364	.....	362	361	361	364
10,000	.....	364	364	.....	362	365	362	365
15,000	.....	364	365	.....	362	.....	363	365
20,000	.....	364	.....	.....	365	.....	363	.....
25,000	.....	364	.....	.....	.....	.....	363	.....
30,000	.....	365	.....	.....	.....	.....	364	.....
35,000	.....	.....	.....	.....	.....	.....	364	.....
37,000	.....	.....	.....	.....	.....	.....	365	.....

MISCELLANEOUS MEASUREMENTS.

Miscellaneous discharge measurements in Texas during the year ending Sept. 30, 1916.

Date.	Stream.	Tributary to—	Locality.	Gage height.	Discharge.
				Feet.	*Sec.-ft.*
Aug. 29	Colorado River	Gulf of Mexico	Austin dam, Tex		231
31	do	do	do		179
Sept. 2	do	do	do		157
6	do	do	do		109
Aug. 29	Barton Creek	Colorado River	¼ mile above mouth, 2 miles southwest of Austin.		32.9
31	do	do	do		30.5
Sept. 2	do	do	do		30.1
6	do	do	do		28.2
Aug. 13	Imperial Reservoir intake.	Diverts from Pecos River.	3 miles south of Grandfalls.		322

INDEX.

STREAM-GAGING STATIONS

AND

PUBLICATIONS RELATING TO WATER RESOURCES

PART VIII. WESTERN GULF OF MEXICO DRAINAGE BASINS

STREAM-GAGING STATIONS AND PUBLICATIONS RELATING TO WATER RESOURCES.

INTRODUCTION.

Investigation of water resources by the United States Geological Survey has consisted in large part of measurements of the volume of flow of streams and studies of the conditions affecting that flow, but it has comprised also investigation of such closely allied subjects as irrigation, water storage, water powers, underground waters, and quality of waters. Most of the results of these investigations have been published in the series of water-supply papers, but some have appeared in the bulletins, professional papers, and annual reports, and monographs.

The results of stream-flow measurements are now published annually in 12 parts, each part covering an area whose boundaries coincide with natural drainage features as indicated below:

Part I. North Atlantic basins.
II. South Atlantic and eastern Gulf of Mexico basins.
III. Ohio River basin.
IV. St. Lawrence River basin.
V. Upper Mississippi River and Hudson Bay basins.
VI. Missouri River basin.
VII. Lower Mississippi River basin.
VIII. Western Gulf of Mexico basins.
IX. Colorado River basin.
X. Great Basin.
XI. Pacific basins in California.
XII. North Pacific basins (in three volumes).

HOW GOVERNMENT REPORTS MAY BE OBTAINED OR CONSULTED.

Water-supply papers and other publications of the United States Geological Survey containing data in regard to the water resources of the United States may be obtained or consulted as indicated below.

1. Copies may be obtained free of charge by applying to the Director of the Geological Survey, Washington, D. C. The edition printed for free distribution is, however, small and is soon exhausted.

2. Copies may be purchased at nominal cost from the Superintendent of Documents, Government Printing Office, Washington, D. C., who will furnish lists giving prices.

3. Sets of the reports may be consulted in the libraries of the principal cities in the United States.

4. Complete sets are available for consultation in the local offices of the water-resources branch of the Geological Survey, as follows:

Boston, Mass., 2500, Customhouse.
Albany, N. Y., Room 18, Federal Building.
Atlanta, Ga., Post Office Building.
St. Paul, Minn., Old Capitol Building.
Madison, Wis., Capitol Building, care of Railroad Commission of Wisconsin.
Helena, Mont., Montana National Bank Building.
Denver, Colo., 403 New Post Office Building.
Salt Lake City, Utah, Federal Building.
Boise, Idaho, 615 Idaho Building.
Phoenix, Ariz., 417 Fleming Building.
Austin, Tex., Old Post Office Building.
Portland, Oreg., 416 Couch Building.
Tacoma, Wash., 406 Federal Building.
San Francisco, Cal., 328 Customhouse.
Los Angeles, Cal., Federal Building.
Honolulu, Hawaii, Kapiolani Building.

A list of the Geological Survey's publications may be obtained by applying to the Director of the United States Geological Survey, Washington, D. C.

STREAM-FLOW REPORTS.

Stream-flow records have been obtained at more than 4,100 points in the United States, and the data obtained have been published in the reports tabulated below:

Steam-flow data in reports of the United States Geological Survey.

[A=Annual Report; B=Bulletin; W=Water-Supply Paper.]

Report.	Character of data.	Year.
10th A, pt. 2	Descriptive information only	
11th A, pt. 2	Monthly discharge and descriptive information	1884 to Sept., 1890.
12th A, pt. 2	do	1884 to June 30, 1891.
13th A, pt. 3	Mean discharge in second-feet	1884 to Dec. 31, 1892.
14th A, pt. 2	Monthly discharge (long-time records, 1871 to 1893)	1893 to Dec. 31, 1893.
B 131	Descriptions, measurements, gage heights, and ratings	1893 and 1894.
16th A, pt. 2	Descriptive information only	
B 140	Descriptions, measurements, gage heights, ratings, and monthly discharge (also many data covering earlier years).	1895.
W 11	Gage heights (also gage heights for earlier years)	1896.
18th A, pt. 4	Descriptions, measurements, ratings, and monthly discharge (also similar data for some earlier years).	1895 and 1896.
W 15	Descriptions, measurements, and gage heights, eastern United States, eastern Mississippi River, and Missouri River above junction with Kansas.	1897.
W 16	Descriptions, measurements, and gage heights, western Mississippi River below junction of Missouri and Platte, and western United States.	1897.
19th A, pt. 4	Descriptions, measurements, ratings, and monthly discharge (also some long-time records).	1897.
W 27	Measurements, ratings, and gage heights, eastern United States, eastern Mississippi River, and Missouri River.	1898.
W 28	Measurements, ratings, and gage heights, Arkansas River and western United States.	1898.
20th A, pt. 4	Monthly discharge (also for many earlier years)	1898.
W 35 to 39	Descriptions, measurements, gage heights, and ratings	1899.

Stream-flow data in reports of the United States Geological Survey—Continued.

Report.	Character of data.	Year.
21st A, pt. 4	Monthly discharge	1899.
W 47 to 52	Descriptions, measurements, gage heights, and ratings	1900.
22d A, pt. 4	Monthly discharge	1900.
W 65, 66	Descriptions, measurements, gage heights, and ratings	1901.
W 75	Monthly discharge	1901.
W 82 to 85	Complete data	1902.
W 97 to 100	do	1903.
W 124 to 135	do	1904.
W 165 to 178	do	1905.
W 201 to 214	do	1906.
W 241 to 252	do	1907–8.
W 261 to 272	do	1909.
W 281 to 292	do	1910.
W 301 to 312	do	1911.
W 321 to 332	do	1912.
W 351 to 362	do	1913.
W 381 to 394	do	1914.
W 401 to 414	do	1915.
W 431 to 444	do	1916.

NOTE.—No data regarding stream flow are given in the 15th and 17th annual reports.

The records at most of the stations discussed in these reports extend over a series of years, and miscellaneous measurements at many points other than regular gaging stations have been made each year. An index of the reports containing records obtained prior to 1904 has been published in Water-Supply Paper 119.

The table below gives, by years and drainage basins, the numbers of the papers on surface-water supply published from 1899 to 1913. The data for any particular station will in general be found in the reports covering the years during which the station was maintained. For example, data for Machias River at Whitneyville, Me., 1903 to 1913, are published in Water-Supply Papers 97, 124, 165, 201, 241, 261, 281, 301, 321, 351, 381, 401, and 431, which contain records for the New England streams from 1903 to 1916. Results of miscellaneous measurements are published by drainage basins.

In these papers and in the following lists the stations are arranged in downstream order. The main stem of any river is determined by measuring or estimating its drainage area—that is, the headwater stream having the largest drainage area is considered the continuation of the main stream, and local changes in name and lake surface are disregarded. All stations from the source to the mouth of the main stem of the river are presented first, and the tributaries in regular order from source to mouth follow, the streams in each tributary basin being listed before those of the next basin below.

The exceptions to this rule occur in the records for Mississippi River, which are given in four parts, as indicated on page III, and in the records for large lakes, where it is simpler to take up the streams in regular order around the rim of the lake than to cross back and forth over the lake surface.

Numbers of water-supply papers containing results of stream measurements, 1899–1916.

Year.	North Atlantic coast (St. John River to York River).	South Atlantic coast and eastern Gulf of Mexico (James River to the Mississippi).	Ohio River.	St. Lawrence River and Great Lakes.	Hudson Bay and upper Mississippi River.	Missouri River.	Lower Mississippi River.	Western Gulf of Mexico.	Colorado River.	Great Basin.	Pacific coast in California.	North Pacific drainage basins.		
												Pacific basins in Washington and upper Columbia River.	Snake River basin.	Lower Columbia River and Pacific basins in Oregon.
1899[a]	35	[b] 35, 36	36	36	36	[i] 36, 37	37	37	[d] 37, 38	38, [e] 39	38, [f] 39	38	38	38
1900[g]	47, [h] 48	48	48, [c] 49	49	49	49, [j] 50	50	50	50	51	51	51	51	51
1901	65, 75	65, 75	65, 75	65, 75	[k] 65, 66, 75	66, 75	[k] 65, 66, 75	66, 75	66, 75	66, 75	66, 75	66, 75	66, 75	66, 75
1902	82	[b] 82, 83	84	[l] 82, 83	[k] 83, 85	84	[k] 83, 84	84	85	85	85	85	85	85
1903	97	[b] 97, 98	98	97	[k] 98, 99, [m] 100	99	[k] 98, 99	99	100	100	100	100	100	100
1904	[n] 124, [o] 125, [p] 126	[p] 126, 127	128	129	[k] 128, 130	130, [q] 131	[k] 128, 131	132	133	133, [r] 134	134	135	135	135
1905	[n] 165, [o] 166, [p] 167	[p] 167, 168	169	170	171	172	[k] 169, 173	174	175, [s] 177	176, [r] 177	177	178	178	[t] 177, 178
1906	[n] 201, [o] 202, [p] 203	[p] 203, 204	205	206	207	208	[k] 205, 209	210	211	212, [r] 213	213	214	214	214
1907–8	241	242	243	244	245	246	247	248	249	250, [r] 251	251	252	252	252
1909	261	262	263	264	265	266	267	268	269	270, [r] 271	271	272	272	272
1910	281	282	283	284	285	286	287	288	289	290	291	292	292	292
1911	301	302	303	304	305	306	307	308	309	310	311	312	312	312
1912	321	322	323	324	325	326	327	328	329	330	331	332A	332B	332C
1913	351	352	353	354	355	356	357	358	359	360	361	362A	362B	362C
1914	381	382	383	384	385	386	387	388	389	390	391	392	393	394
1915	401	402	403	404	405	406	407	408	409	410	411	412	413	415
1916	431	432	433	434	435	436	437	438	439	440	441	442	443	444

[a] Rating tables and index to Water-Supply Papers 35–39 contained in Water-Supply Paper 30. Estimates for 1899 in Twenty-first Annual Report, Part IV.
[b] James River only.
[c] Scioto River.
[d] Green and Gunnison rivers and Grand River above junction with Gunnison.
[e] [illegible] have [illegible] only.
[f] [illegible]ings and Kern rivers and south Pacific coast basin.
[g] Rating tables and index to Water-Supply Papers 47–52 and data on precipitation, wells, and irrigation in California and Utah contained in Water-Supply Paper 52. Estimates for 1900 in Twenty-second Annual Report, Part IV.
[h] Wissahickon and Schuylkill rivers to James River.
[i] Gallatin River.
[j] Loup and Platte rivers near Columbus, Nebr., and all tributaries below junction with Platte.
[k] Tributaries of Mississippi from east.
[l] Lake Ontario and tributaries to St. Lawrence River proper.
[m] Hudson Bay only.
[n] New England Rivers only.
[o] Hudson River to Delaware River, inclusive.
[p] Susquehanna River to Yadkin River, inclusive.
[q] Platte and Kansas rivers.
[r] Great Basin in California except Truckee and Carson river basins.
[s] Below junction with Gila.
[t] Rogue, Umpqua, and Siletz rivers only.

PART VIII. WESTERN GULF OF MEXICO DRAINAGE BASINS.

PRINCIPAL STREAMS.

The western Gulf of Mexico drainage basins include all streams draining into the Gulf of Mexico west of the mouth of the Mississippi and into the Rio Grande. The largest streams flowing into the Gulf of Mexico north of the mouth of the Rio Grande are Sabine, Trinity, and Brazos rivers, Colorado River of Texas, and Guadalupe River. The principal tributaries of the Rio Grande are Chama River, Rio Puerco, and Pecos River in the United States and Rio Salado and Rio San Juan in Mexico. The streams drain wholly or in part the States of Colorado, Louisiana, New Mexico, Texas, and northern States of Mexico.

In addition to the list of gaging stations and annotated list of publications relating specifically to the section, these pages contain a similar list of reports that are of general interest in many sections and cover a wide range of hydrologic subjects, and also brief references to reports published by State and other organizations. (See p. XVII.)

GAGING STATIONS.

NOTE.—Dash after a date indicates that station was being maintained September 30, 1916; period after a date indicates discontinuance. Tributaries are indicated by indention.

SABINE RIVER BASIN.

Sabine River near Longview, Tex., 1904–1906.
Sabine River at Logansport, La., 1903–1906.
  Neches River at Evadale, Tex., 1904–1906.

TRINITY RIVER BASIN.

Trinity River at Bridgeport, Tex., 1915–
Trinity River at Dallas, Tex., 1898–99; 1903–1906.
Trinity River at Riverside, Tex., 1903–1906.

BRAZOS RIVER BASIN.

Brazos River near Graham, Tex., 1915–
Brazos River at Brazos, Tex., 1914–
Brazos River at Waco, Tex., 1898–1911; 1914–
Brazos River near Lewis (Hearne), Tex., 1898–99.
Brazos River at Richmond, Tex., 1903–1906.
Clear Fork of Brazos River near Eliasville, Tex., 1915–

COLORADO RIVER (OF TEXAS) BASIN.

Colorado River near Bronte, Tex., 1915–
Colorado River at Ballinger, Tex., 1915–
Colorado River near Chadwick, Tex., 1915–

Colorado River at Austin, Tex., 1895–1911; 1914–
Evaporation near Austin, Tex., 1916–
Colorado River at Columbus, Tex., 1903–1911; 1916–
North Concho River at San Angelo, Tex., 1915–
Concho River near San Angelo, Tex., 1915–
Concho River near Paint Rock, Tex., 1915–
San Saba River at Menard, Tex., 1915–
San Saba River near San Saba, Tex., 1905–6; 1915–
North Llano River near Junction, Tex., 1915–
Llano River near Junction, Tex., 1915–

GUADALUPE RIVER BASIN.

Guadalupe River near New Braunfels, Tex., 1898–99; 1915–
Guadalupe River near Gonzales, Tex., 1915–
Guadalupe River near Cuero, Tex., 1903–1906; 1915–
Guadalupe River below Cuero, Tex., 1916–
San Marcos River at San Marcos, Tex., 1915–
San Marcos River at Ottine, Tex., 1915–

SAN ANTONIO RIVER BASIN.

San Antonio River at San Antonio, Tex., 1915–
San Pedro Creek at San Antonio, Tex., 1916–

NUECES RIVER BASIN.

Nueces River near Cinonia, Tex., 1915–
Nueces River near Cotulla, Tex., 1915–
Nueces River near Three Rivers, Tex., 1915–
Nueces River at Calallen, Tex., 1915–
Frio River near Derby, Tex., 1915–
Frio River at Fowlerton, Tex., 1915–
Frio River at Three Rivers, Tex., 1915.
Frio Lake outlet near Fowlerton, Tex., 1915–

RIO GRANDE BASIN.

Rio Grande at Thirtymile Bridge near Creede, Colo., 1909–1913.
Rio Grande near Creede (Wason), Colo., 1907–1913.
Rio Grande near Del Norte, Colo., 1889–1906; 1908–1913.
Rio Grande near Alamosa, Colo., 1894–95; 1903; 1912–13.
Rio Grande near Lobatos (Cenicero), Colo., 1899–1913.
Rio Grande at Embudo, N. Mex., 1899–1903; 1912–
Rio Grande near Buckman, N. Mex. (Rio Grande near Ildefonso), 1895–1905; 1909–1914.
Rio Grande near San Marcial, N. Mex., 1895–
Rio Grande near El Paso, Tex., 1889–1893; 1895–1915.
Rio Grande near Fort Hancock, Tex., 1900–1903.
Rio Grande above Presidio, Tex., 1900–1914.
Rio Grande below Presidio, Tex., 1900–1915.
Rio Grande near Langtry, Tex., 1900–1914.
Rio Grande near Devils River, Tex., 1900–1915.
Rio Grande at Eagle Pass, Tex., 1900–1916.
Rio Grande near Laredo, Tex., 1900–1914.
Rio Grande near Roma, Tex., 1900–1914.
Rio Grande near Brownsville, Tex., 1900–1914.
Clear Creek near Creede, Colo., 1910.

INTERIOR BASINS IN NEW MEXICO.

REPORTS ON WATER RESOURCES OF THE WESTERN GULF STATES.

PUBLICATIONS OF UNITED STATES GEOLOGICAL SURVEY.

WATER-SUPPLY PAPERS.

Water-supply papers are distributed free by the Geological Survey as long as its stock lasts. An asterisk (*) indicates that this stock has been exhausted. Many of the papers marked in this way may, however, be purchased (at price noted) from the SUPERINTENDENT OF DOCUMENTS, WASHINGTON, D. C. Omission of the price indicates that the report is not obtainable from Government sources. Water-supply papers are of octavo size.

*10. Irrigation in Mesilla Valley, N. Mex., by F. C. Barker. 1898. 51 pp., 11 pls. 10c.

Describes primitive methods of irrigation and agriculture employed in an area lying along both sides of the Rio Grande, extending from Fort Seldon, N. Mex., on the north, to within 3 miles of El Paso on the south. Chiefly of historic interest.

*13. Irrigation systems in Texas, by W. F. Hutson. 1898. 68 pp., 10 pls.

Discusses climate, rainfall, irrigation works and projects in Texas; considers use of both surface and underground waters.

*40. The Austin dam, by T. U. Taylor. 1900. 52 pp., 16 pls. 15c.

Describes preliminary projects, construction, economic aspect, and failure of the dam across Colorado River.

57. Preliminary list of deep borings in the United States, Part I (Alabama-Montana), by N. H. Darton. 1902. 60 pp. (See No. 149.) 5c.

61. Preliminary list of deep borings in the United States, Part II (Nebraska-Wyoming), by N. H. Darton. 1902. 67 pp. 5c.

Nos. 57 and 61 contain information as to depth, diameter, yield, and head of water in borings more than 400 feet deep; under head "Remarks" gives information concerning temperature, quality of water, purposes of boring, etc. The lists are arranged by States, and the States are arranged alphabetically. A second, revised, edition was published in 1905 as Water-Supply Paper 149 (q. v.). 5c.

71. Irrigation systems of Texas, by T. U. Taylor. 1902. 137 pp., 9 pls. 10c.

Discusses principal irrigation systems in geographic order and gives statistics as to the location, cost, and benefits of the devices for obtaining water; describes rice irrigation systems, and appends a brief statement of laws governing irrigation in the State.

74. Water resources of the State of Colorado, by A. L. Fellows. 1902. 151 pp., 14 pls. 25c.

Discusses drainage and irrigation and gives records of stream flow.

93. Proceedings of first conference of engineers of the Reclamation Service, with accompanying papers, compiled by F. H. Newell, chief engineer. 1904. 361 pp. 25c. [Inquiries concerning this report should be addressed to the Reclamation Service.]

Contains "Investigations in Pecos Valley," by W. M. Reed.

101. Underground waters of southern Louisiana, by G. D. Harris, with discussions of their uses for water supplies and for rice irrigation, by M. L. Fuller. 1904. 98 pp., 11 pls. 20c.

Discusses the topography and stratigraphic geology of the area and the origin of the well waters, gives statistics of artesian wells, describes methods of well drilling and pumping, and treats briefly of rice cultivation.

105. The water powers of Texas, by T. U. Taylor. 1904. 116 pp., 17 pls. 15c.

Gives a résumé of the available data regarding water powers and briefly describes the principal streams.

114. Underground waters of eastern United States, by M. L. Fuller, geologist in charge. 1905. 285 pp., 18 pls. 25c.

Contains brief report on Louisiana and southern Arkansas; discusses the geologic formation as related to water supply; gives a list of the principal publications.

140. Field measurements of the rate of movement of underground waters, by C. S. Slichter. 1905. 122 pp., 15 pls. 15c.

Contains a chapter giving results of tests of typical pumping plants in the Rio Grande valley in Texas and New Mexico.

141. Observations on the ground waters of the Rio Grande valley, by C. S. Slichter. 1905. 83 pp., 5 pls. 5c.

Describes investigation of the underflow in the valley of the Rio Grande in Texas and New Mexico, gives details of tests of pumping plants near El Paso, Tex., in Mesilla Valley, N. Mex., and near Berino, N. Mex., and analyses of well waters and data concerning wells at and near El Paso.

147. Destructive floods in the United States in 1904, by E. C. Murphy and others. 1905. 206 pp., 18 pls. 15c. Contains:

Pecos River basin flood, New Mexico, from report of Frank S. Dobson.
Failures of Lake Avalon dam near Carlsbad, N. Mex., by E. C. Murphy.
Rio Grande floods, New Mexico, by E. C. Murphy.

149. Preliminary list of deep borings in the United States, second edition, with additions, by N. H. Darton. 1905. 175 pp. 10c.

Gives, by States (and within the States by counties), location, depth, diameter, yield, height of water, and other available information, concerning wells 400 feet or more in depth; includes all wells listed in Water-Supply Papers 57 to 61; mentions also principal publications relating to deep borings.

158. Preliminary report on the geology and underground waters of the Roswell artesian area, New Mexico, by C. A. Fisher. 1906. 29 pp., 9 pls. 15c.

Discusses topography and geology of a belt lying along Pecos River from Roswell to Lake McMillan; discusses area and extent of artesian basins, source, amount, pressure, quality (with analyses), and waste of artesian waters, and irrigation; lists typical wells and gives well records.

*162. Destructive floods in the United States in 1905, with a discussion of flood discharge and frequency and an index to flood literature, by E. C. Murphy and others. 1906. 105 pp., 4 pls. 15c.

Gives accounts of floods on Pecos and Hondo rivers and the Rio Grande, and estimates of flood frequency and discharge for Rio Grande at San Marcial, N. Mex., and Colorado River (of Texas) at Austin; contains also index to literature on floods in American streams.

*188. Water resources of the Rio Grande valley in New Mexico, and their development, by W. T. Lee. 1907. 59 pp., 10 pls. 20c.

Describes the physical features of the valley, rock formation and structure, the Engle, San Acaci, San Felipe, and Espanola reservoir sites, surface and underground waters by districts, the origin, course, and quantity of the underflow, the chemical character of the water in the Mesilla and other districts, and the utilization of the underflow by wells and seepage ditches.

*190. Underground waters of Coastal Plain of Texas, by Thomas U. Taylor. 1907. 73 pp., 3 pls. 15c.

Describes topography, drainage, and geology, and discusses the underground waters by counties; gives many well records and analyses.

236. The quality of surface waters in the United States: Part I.—Analyses of waters east of the one hundredth meridian, by R. B. Dole. 1909. 123 pp. 10c.

Describes collection of samples, methods of examination, preparation of solutions, accuracy of estimates, and expression of analytical results; gives results of analyses of waters of Brazos and Colorado (of Texas) rivers and the Rio Grande.

240. Geology and water resources of the San Luis Valley, Colorado, by C. E. Siebenthal. 1910. 128 pp., 13 pls. 25c.

Describes the topography, drainage, climate, geologic features, flowing and nonflowing wells, springs, the grouping of wells, and variations in flow and temperature, and the quality (with analyses) and uses of the water; discusses briefly well-drilling methods and costs, and approximate measurements of flows.

260. Preliminary report on the ground waters of Estancia Valley, New Mexico, by O. E. Meinzer. 1910. 33 pp. 5c. (See Water-Supply Paper 275.)

Discusses briefly the geographic relation and industrial development, geology, and soils; discusses the source, disposal, recovery, quality, and utilization of the ground waters, cost of pumping, windmills, value of crops, and the alkali problem.

274. Some stream waters of the western United States, with chapters on sediment carried by the Rio Grande and the industrial application of water analyses, by Herman Stabler. 1911. 188 pp. 15c.

Describes collection of samples, plan of analytical work, and methods of analysis; discusses soap-consuming power of waters, water softening, boiler waters, and water for irrigation; gives results of analyses of waters of the Rio Grande and of Pecos, Gallinas, and Hondo rivers.

275. Geology and water resources of Estancia Valley, New Mexico, with notes on ground-water conditions in adjacent parts of central New Mexico, by O. E. Meinzer. 1911. 89 pp., 14 pls. 20c.

Describes physiographic features and geologic formations, soils and climate; discusses the source and disposal of the water supply, the head of the water supply, artesian conditions, yield of wells and quantity of water available, the quality of the water (dissolved solids, chlorine, sulphates, carbonates, and bicarbonates), the storage of storm water, the present and future use of ground water for irrigation, proper types of wells, windmills, cost of pumping, value of crops; and the alkali problem; tables give depths to water and field assays. Contains also briefs reports on physiography, geology, soil, ground water, and irrigation in Encino and Pinos Wells basins.

317. Geology and underground waters of the Wichita region, north-central Texas, by C. H. Gordon. 1913. 88 pp., 2 pls. 10c.

Describes the physiography, climate, surface, and deep waters of an area in Montague, Clay, Wichita, Wilbarger, Hardeman, Foard, Knox, Baylor, Archer, Jack, Young, Throckmorton, and Haskell counties; gives details by counties.

*335. Geology and underground waters of the southeastern part of the Texas Coastal Plain, by Alexander Deussen. 1914. 365 pp., 9 pls. 55c.

Describes an area lying east of Brazos River and south of a line extending east and west through Jefferson, in Marion County; discusses the underground-water horizons of the region and the artesian conditions and prospects in the several counties; gives well sections and tabulated details of the wells.

343. Geology and water resources of Tularosa Basin, New Mexico, by O. E. Meinzer and R. F. Hare. 1915. 317 pp., 19 pls. 40c.

Describes a closed basin lying between the Pecos and the Rio Grande; gives an account of the climate, history of previous investigations and literature, and industrial development; discusses the physiography and drainage, rocks, sources of the underground water, yield of wells, and quality of the waters in the various formations; suggests methods of drilling, boring, digging, casing, and finishing wells; discusses also soil and native vegetation in relation to water supply, irrigation from streams, springs, flood waters, and wells, and railroad and public water supplies; gives detailed information in regard to watering places on routes of travel.

*345. Contributions to the hydrology of the United States. 1914. N. C. Grover, chief hydraulic engineer. 1915. 225 pp., 17 pls. 30c. Contains:

(c) Underground water of Luna County, N. Mex., by N. H. Darton, with results of pumping tests, by A. T. Schwennesen, pp. 25–40.

Describes briefly the extent and thickness of the water-bearing beds underlying the wide bolsons of Luna County, the source and quality of the underground waters, the wells in the region about Deming, Iola, Waterloo, Columbus, and Myndus in the Carne region, lower Mimbres Valley, the region west of Red Mountain, and other parts of the county; discusses the depletion of supply by the pumping plants. The pumping tests were made at plants representing average types.

358. Water resources of the Rio Grande basin, 1888–1913, by Robert Follansbee and H. J. Dean, including surface water supply of the western Gulf of Mexico basins, 1913, by Robert Follansbee, W. W. Follett, and G. A. Gray. 1915. 725 pp., 3 pls. 50c.

Describes the general features of the Rio Grande basin and the closed basins lying between the Rio Grande and the Pecos, west of the Rio Grande, and in Mexico; discusses the distribution of precipitation, forestation, and population. Contains "not only all data concerning stream flow in the Rio Grande basin collected by the Survey and cooperating parties but also records furnished by individuals connected with private interests." Most of the records have been taken from publications of the Geological Survey, but original estimates have been revised where later data have indicated errors.

421. Profile surveys in 1915 along the Rio Grande, Pecos River, and Mora River, New Mexico, prepared under the direction of W. H. Herron, acting chief geographer. 1916. 11 pp., 11 pls. 15c.

Gives results of surveys made to determine the location of undeveloped water power on some of the rivers of the United States that are adapted to the development of power by low or medium heads at 20 to 100 feet.

ANNUAL REPORTS.

Each of the papers contained in the annual reports was also issued in separate form.

Annual reports are distributed free by the Geological Survey as long as its stock lasts. An asterisk (*) indicates that this stock has been exhausted. Many of the papers so marked, however, may be purchased from the SUPERINTENDENT OF DOCUMENTS, WASHINGTON, D. C.

*Tenth Annual Report of the United States Geological Survey, 1888–89, J. W. Powell, Director. 1890. 2 parts. *Pt. II, Irrigation, viii, 123 pp. 35c.

Makes a preliminary report on the organization and prosecution of the survey of the arid lands for purposes of irrigation; includes an account of the methods of topographic and hydraulic work, the segregation work on reservoir sites and irrigable lands, field and office methods, and brief descriptions of the topography of some of the river basins.

Eleventh Annual Report of the United States Geological Survey, 1889–90, J. W. Powell, Director. 1891. 2 parts. Pt. II, Irrigation, xiv, 395 pp., 30 pls. and maps. $1.25. Contains:

*Hydrography, pp. 1–110. Discusses scope of work, methods of stream measurement, rainfall and evaporation, and describes the more important streams; sediment in the Rio Grande, pp. 55–57.

*Engineering, pp. 111–200. Defines the scope of the work and gives an account of the surveys in the Sun River basin and in the Arkansas, Rio Grande, California, Lahontan, Utah, and Snake River divisions.

*The arid lands, pp. 201–289. Includes statement of the Director to the House Committee on Irrigation, extracts from the constitutions of States relating to irrigation, and a report on artesian irrigation on the Great Plains, including a discussion of the general considerations affecting artesian water supply, the economic limit to the utilization of artesian water for irrigation, irrigation by artesian wells in various countries, and the geologic conditions and statistics of artesian wells on the Great Plains.

*Topography, pp. 291–343. Comprises reports of the topographic surveys in California, Nevada, Colorado, Idaho, Montana, and New Mexico, and a report on reservoir sites.

*Irrigation literature, pp. 345–388. Gives a list of books and pamphlets on irrigation and allied subjects, mainly contained in the library of the United States Geological Survey.

Twelfth Annual Report of the United States Geological Survey, 1890–91, J. W. Powell, Director. 1891. 2 parts. Pt. II, Irrigation, xviii, 576 pp., 93 pls. $2. Contains:

*Report upon the location and survey of reservoir sites during the fiscal year ending June 30, 1891, by A. H. Thompson, pp. 1–212, pls. 54–57. Describes reservoir sites in Rio Arriba, Taos, Santa Fe, Bernalillo, Mora, San Miguel, Valencia, Socorro, and Sierra counties, New Mexico, and on tributaries of the Rio Grande; for each reservoir site gives the location, height of dam, areas inclosed by contour, approximate contents of reservoir, position of irrigable lands, and areas of segregated lands.

*Hydrography of the arid regions, by F. H. Newell, pp. 213–361, pls. 58–106. Discusses the available water supply of the arid regions, the duty of water, flood waters, relation of rainfall to river flow; classifies the drainage basins; and describes the rivers of the Missouri, Arkansas, Rio Grande, Colorado, Sacramento, and San Joaquin basins, and the principal streams of the Great Basin in Nevada and Utah and the Snake River drainage.

Thirteenth Annual Report of the United States Geological Survey, 1891–92, J. W. Powell, Director. 1892. (Pts. II and III, 1893.) 3 parts. *Pt. III, Irrigation, xi, 486 pp., 77 pls. $1.85. Contains:

*Engineering results of irrigation survey, by H. N. Wilson, pp. 351–437, pls. 147–182. Discusses surveys, flood-water storage, dam site, estimated cost of El Paso reservoir, Texas.

Sixteenth Annual Report of the United States Geological Survey, 1894–95, Charles D. Walcott, Director. 1896. (Pts. II, III, and IV, 1895.) 4 parts. *Pt. II–Papers of an economic character, xix, 598 pp., 43 pls. $1.25. Contains:

The public lands and their water supply, by F. H. Newell, pp. 457–533, pls. 35–39. Describes general character of the public lands, the lands disposed of (railroad, grant, and swamp lands, and private miscellaneous entries), lands reserved (Indian, forest, and military reservations), the vacant lands, and the rate of disposal of vacant lands; discusses the streams, wells, and reservoirs as sources of water supply; gives details for each State.

Eighteenth Annual Report of the United States Geological Survey, 1896–97, Charles D. Walcott, Director. 1897. (Pts. II and III, 1898.) 5 parts in 6 vols. *Pt. II—Papers chiefly of a theoretic nature, v, 653 pp., 105 pls. $1.65. Contains:

*Geology of portions of the Edwards Plateau and Rio Grande Plain adjacent to Austin and San Antonio, Tex., with especial reference to the occurrence of artesian and other underground waters, by R. T. Hill and T. W. Vaughan, pp. 193–322, pls. 21–64. Discusses the general principles of artesian waters, the capacity of the various rock sheets for water, the nonflowing wells, the gravity springs, and artesian wells of the Edwards Plateau and Rio Grande Plain; the probable identity of source of artesian and fissure spring waters, and the availability and limitations of underground waters; treats of the chemical quality of the artesian well waters, and gives analyses of waters from the various beds and of spring waters from Austin and vicinity.

Twenty-first Annual Report of the United States Geological Survey, 1899–1900, Charles D. Walcott, Director. 1900. (Parts III, IV, VI, VI continued, and VII, 1901.) 7 parts in 8 vols., and separate case for maps with Pt. V. *Pt. IV, Hydrography, 768 pp., 156 pls. $2.35. Contains:

*The High Plains and their utilization, by W. D. Johnson, pp. 601–741, pls. 113–146. Describes the area lying in an irregular belt about midway across the long eastward slope of the Great Plains and including parts of Wyoming, Colorado, and Nebraska (North and South Platte, Platte, Republican, and Smoky Hill River basins), Colorado, Kansas, New Mexico, Oklahoma, and Texas (Arkansas River basin), and Colorado, New Mexico, and Texas (Rio Grande basin); discusses the origin and structure of the High Plains, the precipitation, temperature, and other factors of climate, experiments with irrigation, and the use of mountain streams, local storm-water storage, and artesian waters. Concluded in the Twenty-second Annual Report.

Twenty-second Annual Report of the United States Geological Survey, 1900–1901, Charles D. Walcott, Director. 1901. (Pts. III and IV, 1902.) 4 parts. *Pt. IV, Hydrography, 631–669 pp., pls. 51–65. $2.20. Contains:

*Conclusion of The High Plains and their utilization.

BULLETINS.

An asterisk (*) indicates that the Geological Survey's stock of the paper is exhausted. Many of the papers so marked may be purchased from the SUPERINTENDENT OF DOCUMENTS, WASHINGTON, D. C. Bulletins are of octavo size.

*264. Records of deep-well drilling for 1904, by M. L. Fuller, E. F. Lines, and A. C. Veatch. 1905. 106 pp. 10c.

Discusses the importance of accurate well records to the driller, to owners of oil, gas, and water wells, and to geologists; describes the general methods of work; gives tabulated records of wells in Colorado, Louisiana, Mew Mexico, and Texas, and detailed record of well near Houston, Harris County, Tex. This well was selected because it affords definite stratigraphic information.

*298. Record of deep-well drilling for 1905, by M. L. Fuller and Samuel Sanford. 1906. 209 pp. 25c.

Gives an account of progress in the collection of well records and samples; contains tabulated records of wells in Colorado, Louisiana, New Mexico, and Texas; and detailed records of wells in Eddy and Torrance counties, New Mexico; and Bexar, Cameron, Coleman, Dallas, Dimmit, Duval, Fayette, Fort Bend, Guadalupe, Hardin, Harris, Hays, Jasper, Johnson, Kendall, Lampasas, Liberty, Medina, Navarro, Nueces, Parker, Williamson, and Zavalla counties, Tex. The wells of which detailed sections are given were selected because they afford valuable stratigraphic information.

GEOLOGIC FOLIOS.

Under the plan adopted for the preparation of a geologic map of the United States the entire area is divided into small quadrangles, bounded by certain meridians and parallels, and these quadrangles, which number several thousand, are separately surveyed and mapped.[1] The unit of survey is also the unit of publication, and the maps and description of each quadrangle are issued in the form of a folio. When all the folios are completed they will constitute the Geologic Atlas of the United States.

A folio is designated by the name of the principal town or of a prominent natural feature within the quadrangle. Each folio includes maps showing the topography, geology, underground structure, and mineral deposits of the area mapped and several pages of descriptive text. The text explains the maps and describes the topographic and geologic features of the country and its mineral products. The topographic map shows roads, railroads, waterways, and, by contour lines, the shapes of the hills and valleys and the height above sea levels of all points in the quadrangle. The areal-geology map shows the distribution of the various rocks at the surface. The structural-geology map shows the relations of the rocks to one another underground. The economic-geology map indicates the location of mineral deposits that are commercially valuable. The artesian-water map shows the depth to underground-water horizons. Economic-geology and artesian-water maps are included in folios if the conditions in the areas mapped warrant their publication. The folios are of special interest to students of geography and geology and are valuable as guides in the development and utilization of mineral resources.

The folios numbered from 1 to 163, inclusive, are published in only one form (18 by 22 inches), called the library edition. Some of the folios that bear numbers higher than 163 are published also in an octavo edition (6 by 9 inches). Owing to a fire in the Geological Survey building May 18, 1913, the stock of geological folios was more or less damaged by fire and water, but 80 or 90 per cent of the folios are usable. They will be sold at the uniform price of 5 cents each, with no reduction for wholesale orders. This rate applies to folios in stock from 1 to 184, inclusive, also to the library edition of folio 186. The library edition of folios 185, 187, and higher numbers sells for 25 cents a copy, except that some folios which contain an unusually large amount of matter sell for 50 cents a copy. The octavo edition of folio 185 and higher numbers sells for 50 cents a copy. If 34 folios selling at 25 cents each (or their equivalent in higher-priced folios) are ordered at one time a discount of 40 per cent is allowed; $5.10 is the minimum amount accepted at this rate.

All the folios contain descriptions of the drainage of the quadrangles. The folios in the following list contain also brief discussions of the underground waters in connection with the economic resources of the areas and more or less information concerning the utilization of the water resources.

An asterisk (*) indicates that the stock of the folio is exhausted.

42. Nueces, Texas. 5c.

Describes geography and geology, and relations of geologic formations to underground waters.

*64. Uvalde, Texas.

Describes the topography and geology of the area, the streams, springs and wells, and discusses the possibility of obtaining artesian flows.

*76. Austin, Texas.

Describes the topography and geology of the area, the drainage, and discusses the possibility of obtaining artesian water.

*120. Silverton, Colorado.

[1] Index maps showing areas in the western Gulf of Mexico basins covered by topographic maps and by geologic folios will be mailed on receipt of request addressed to the Director, U. S. Geological Survey Washington, D. C.

*166. El Paso,[1] Texas.
Gives analyses of underground waters.

183. Llano-Burnet,[1] Texas. 5c.
Under "Mineral Resources" discusses rainfall, streams, springs, wells, tanks, and cisterns.

194. Van Horn, Texas. 25c.
Gives analyses of water from railroad wells at Van Horn and well at Figure 2 ranch headquarters.

MISCELLANEOUS REPORTS.

Other Federal bureaus, State and other organizations, have from time to time published reports relating to the water resources of various sections of the country. Notable among those pertaining to the western Gulf of Mexico drainage basins are the reports of the State geological surveys of Louisiana and Texas, the reports of the State engineers of Colorado and New Mexico, and the annual reports of the United States Reclamation Service. The following deserve special mention:

Report of commission appointed to revise the laws of the State of Colorado regulating the appropriation, distribution, and use of water. 1890.

Preliminary examination of reservoir sites in Wyoming and Colorado; letter from the Secretary of War transmitting a letter from the Chief of Engineers, together with a report of Captain Chittenden: 55th Cong., 2d sess., House Doc. 141.

Report on the underground waters of Louisiana, by G. D. Harris, A. C. Veatch, and others, made under the direction of the State experiment stations. Louisiana Geol. Survey Bull. 1, 1905.

Preliminary report on the soils and waters of the upper Rio Grande and Pecos valleys in Texas, by H. H. Harrington: Texas Geol. Survey Bull. 2, 1890.

Water supply of southwest Texas, compiled by H. M. Madison. 1912.

Artesian water on the Llano Estacado, by G. G. Shumard: Texas Geol. Survey Bull. 1, 1892.

Preliminary reports on the artesian wells of the Gulf coastal slope, by J. A. Singley, and on the organic remains from the deep well at Galveston, by Gilbert D. Harris: Texas Geol. Survey Fourth Ann. Rept., 1892.

A study of the use of water for irrigation on the Rio Grande del Norte, by W. W. Follett: International (Water) Boundary Comm. Proc., pp. 284–323, 1903.

Silt in the Rio Grande, by W. W. Follett: International Boundary Comm. Proc., 1913.

Silt survey on Pecos River: U. S. Recl. Service Third Ann. Rept., 1905.

GEOLOGICAL SURVEY HYDROLOGIC REPORTS OF GENERAL INTEREST.

The following list comprises reports not readily classifiable by drainage basins and covering a wide range of hydrologic investigations:

WATER-SUPPLY PAPERS.

*1. Pumping water for irrigation, by H. M. Wilson. 1896. 57 pp., 9 pls.
Describes pumps and motive powers, windmills, water wheels, and various kinds of engines; also storage reservoirs to retain pumped water until needed for irrigation.

*3. Sewage irrigation, by G. W. Rafter. 1897. 100 pp., 4 pls. (See Water-Supply Paper 22.) 10c.
Discusses methods of sewage disposal by intermittent filtration and by irrigation; describes utilization of sewage in Germany, England, and France, and sewage purification in the United States.

[1] Issued in two editions (see p. XVI). Specify edition desired.

*8. Windmills for irrigation, by E. C. Murphy. 1897. 49 pp., 8 pls. 10c.

Gives results of experimental tests of windmills during the summer of 1896 in the vicinity of Garden, Kans.; describes instruments and methods and draws conclusions.

*14. New tests of certain pumps and water lifts used in irrigation, by O. P. Hood. 1898. 91 pp., 1 pl. 10c.

Discusses efficiency of pumps and water lifts of various types.

*20. Experiments with windmills, by T. O. Perry. 1899. 97 pp., 12 pls. 15c.

Includes tables and descriptions of wind wheels, makes comparisons of wheels of several types, and discusses results.

*22. Sewage irrigation, Part II, by G. W. Rafter. 1899. 100 pp., 7 pls. 15c.

Gives résumé of Water-Supply Paper 3; discusses pollution of certain streams, experiments on purification of factory wastes in Massachusetts, value of commercial fertilizers, and describes American sewage-disposal plants by States; contains bibliography of publications relating to sewage utilization and disposal.

*41. The windmill, its efficiency and economic use, Part I, by E. C. Murphy. 1901. 72 pp., 14 pls.

*42. The windmill, its efficiency and economic use, Part II, by E. C. Murphy. 1901. 75 pp., 2 pls. 10c.

Nos. 41 and 42 give details of results of experimental tests with windmills of various types.

*43. Conveyance of water in irrigation canals, flumes, and pipes, by Samuel Fortier. 1901. 86 pp., 15 pls. 15c.

*56. Methods of stream measurement. 1901. 51 pp., 12 pls. 15c.

Describes the methods used by the Survey in 1901–2. See also Nos. 64, 94, and 95.

64. Accuracy of stream measurements, by E. C. Murphy. 1902. 99 pp., 4 pls. (See No. 95.) 10c.

Describes methods of measuring velocity of water and of measuring and computing stream flow, and compares results obtained with the different instruments and methods; describes also experiments and results at the Cornell University hydraulic laboratory. A second, enlarged, edition published as Water-Supply Paper 95.

*67. The motions of underground waters, by C. S. Slichter. 1902. 106 pp., 8 pls. 15c.

Discusses origin, depth, and amount of underground waters; permeability of rocks and porosity of soils; causes, rates, and laws of motions of underground water; surface and deep zones of flow, and recovery of waters by open wells and artesian and deep wells; treats of the shape and position of the water table; gives simple methods of measuring yield of flowing well; describes artesian wells at Savannah, Ga.

72. Sewage pollution in the metropolitan area near New York City and its effect on inland water resources, by M. O. Leighton. 1902. 75 pp., 8 pls. 10c.

Defines "normal" and "polluted" waters and discusses the damage resulting from pollution.

*80. The relation of rainfall to run-off, by G. W. Rafter. 1903. 104 pp. 10c.

Treats of measurements of rainfall and laws and measurements of stream flow; gives rainfall, run-off, and evaporation formulas; discusses effect of forests on rainfall and run-off.

87. Irrigation in India (second edition), by H. M. Wilson. 1903. 238 pp., 27 pls. 25c.

First edition was published in Part II of the Twelfth Annual Report.

93. Proceedings of first conference of engineers of Reclamation Service, with accompanying papers, compiled by F. H. Newell, chief engineer. 1904. 361 pp. 25c.

Contains, in addition to an account of the organization of the hydrographic [water-resources] branch of the United States Geological Survey and the reports of the conferences, the following papers of more or less general interest:

Limits of an irrigation project, by D. W. Ross.
Relation of Federal and State laws to irrigation, by Morris Bien.
Electrical transmission of power for pumping, by H. A. Storrs.
Correct design and stability of high masonry dams, by Geo. Y. Wisner.
Irrigation surveys and the use of the plane table, by J. B. Lippincott.
The use of alkaline waters for irrigation, by Thomas A. Means.

*94. Hydrographic manual of the United States Geological Survey, prepared by E. C. Murphy, J. C. Hoyt, and G. B. Hollister. 1904. 76 pp., 3 pls. 10c.

Gives instruction for field and office work relating to measurements of stream flow by current meters. See also No. 95.

*95. Accuracy of stream measurements (second, enlarged edition), by E. C. Murphy. 1904. 169 pp., 6 pls.

Describes methods of measuring and computing stream flow and compares results derived from different instruments and methods. See also No. 94.

103. A review of the laws forbidding pollution of inland waters in the United States, by E. B. Goodell. 1904. 120 pp. (See No. 152.)

Explains the legal principles under which antipollution statutes become operative, quotes court decisions to show authority for various deductions, and classifies according to scope the statutes enacted in the different States.

110. Contributions to the hydrology of eastern United States, 1904; M. L. Fuller, geologist in charge. 1905. 211 pp., 5 pls. 10c.

Contains the following reports of general interest. The scope of each paper is indicated by its title.

Description of underflow meter used in measuring the velocity and direction of underground water, by Charles S. Slichter.

The California or "stovepipe" method of well construction, by Charles S. Slichter.

Approximate methods of measuring the yield of flowing wells, by Charles S. Slichter.

Corrections necessary in accurate determinations of flow from vertical well casings, from notes furnished by A. N. Talbot.

Experiment relating to problems of well contamination at Quitman, Ga., by S. W. McCallie.

113. The disposal of strawboard and oil-well wastes, by R. L. Sackett and Isaiah Bowman. 1905. 52 pp., 4 pls. 5c.

The first paper discusses the pollution of streams by sewage and by trade wastes, describes the manufacture of strawboard, and gives results of various experiments in disposing of the waste. The second paper describes briefly the topography, drainage, and geology of the region about Marion, Ind., the contamination of rock wells and of streams by waste oil and brine.

114. Underground waters of eastern United States, by M. L. Fuller, geologist in charge. 1905. 285 pp., 18 pls. 25c.

Contains report on "Occurrence of underground waters," by M. L. Fuller, discussing sources, amount, and temperature of waters, permeability and storage capacity of rocks, water-bearing formations, recovery of water by springs, wells, and pumps, essential conditions of artesian flows, and general conditions affecting underground waters in eastern United States.

119. Index to the hydrographic progress reports of the United States Geological Survey, 1888 to 1903, by J. C. Hoyt and B. D. Wood. 1905. 253 pp. 15c.

Scope indicated by title.

120. Bibliographic review and index of papers relating to underground waters published by the United States Geological Survey, 1879–1904, by M. L. Fuller. 1905. 128 pp. 10c.

Scope indicated by title.

*122. Relation of the law to underground waters, by D. W. Johnson. 1905. 55 pp. 5c.

Defines and classifies underground waters, gives common-law rules relating to their use, and cites State legislative acts affecting them.

140. Field measurements of the rate of movement of underground waters, by C. S. Slichter. 1905. 122 pp., 15 pls. 15c.

Discusses the capacity of sand to transmit water, describes measurements of underflow in Rio Hondo, San Gabriel, and Mohave River valleys, Cal., and on Long Island, N. Y.; gives results of tests of wells and pumping plants and describes stovepipe method of well construction.

143. Experiments on steel-concrete pipes on a working scale, by J. H. Quinton. 1905. 61 pp., 4 pls.

Scope indicated by title.

144. The normal distribution of chlorine in the natural waters of New York and New England, by D. D. Jackson. 1905. 31 pp., 5 pls. 10c.

Discusses common salt in coast and inland waters, salt as an index to pollution of streams and wells, the solutions and methods used in chlorine determinations, and the use of the normal chlorine map; gives charts and tables for chlorine in the New England States and New York.

145. Contributions to the hydrology of eastern United States, 1905; M. L. Fuller, geologist in charge. 1905. 220 pp., 6 pls. 10c.

Contains brief reports of general interest as follows:

Drainage of ponds into drilled wells, by Robert E. Horton. Discusses efficiency, cost, and capacity of drainage wells, and gives statistics of such wells in southern Michigan.

Construction of so-called fountain and geyser springs, by Myron L. Fuller.

A convenient gage for determining low artesian heads, by Myron L. Fuller.

146. Proceedings of second conference of engineers of the Reclamation Service, with accompanying papers, compiled by F. H. Newell, chief engineer. 1905. 267 pp. 15c.

Contains brief account of the organization of the hydrographic [water-resources] branch and the Reclamation Service, reports of conferences and committees, circulars of instruction, and many brief reports on subjects closely related to reclamation, and a bibliography of technical papers by members of the service. Of the papers read at the conference those listed below (scope indicated by title) are of more or less general interest:

Proposed State code of water laws, by Morris Bien.

Power engineering applied to irrigation problems, by O. H. Ensign.

Estimates on tunneling in irrigation projects, by A. L. Fellows.

Collection of steam-gaging data, by N. C. Grover.

Diamond-drill methods, by G. A. Hammond.

Mean-velocity and area curves, by F. W. Hanna.

Importance of general hydrographic data concerning basins of streams gaged, by R. E. Horton.

Effect of aquatic vegetation on stream flow, by R. E. Horton.

Sanitary regulations governing construction camps, by M. O. Leighton.

Necessity of draining irrigated land, by Thos. H. Means.

Alkali soils, by Thos. H. Means.

Cost of stream-gaging work, by E. C. Murphy.

Equipment of a cable gaging station, by E. C. Murphy.

Silting of reservoirs, by W. M. Reed.

Farm-unit classification, by D. W. Ross.

Cost of power for pumping irrigating water, by H. A. Storrs.

Records of flow at current-meter gaging stations during the frozen season, by F. H. Tillinghast.

147. Destructive floods in United States in 1904, by E. C. Murphy and others. 1905. 206 pp., 18 pls. 15c.

Contains a brief account of "A method of computing cross-section area of waterways," including formulas for maximum discharge and area of cross section.

150. Weir experiments, coefficients, and formulas, by R. E. Horton. 1906. 189 pp., 38 pls. (See Water-Supply Paper 200.) 15c.

Scope indicated by title.

*151. Field assay of water, by M. O. Leighton. 1905. 77 pp., 4 pls. 10c.

Discusses methods, instruments, and reagents used in determining turbidity, color, iron, chlorides, and hardness in connection with the studies of the quality of water in various parts of the United States.

152. A review of the laws forbidding poHution of inland waters in the United States (second edition), by E. B. Goodell. 1905. 149 pp. 10c.

Scope indicated by title.

*155. Fluctuations of the water level in wells, with special reference to Long Island, N. Y., by A. C. Veatch. 1906. 83 pp., 9 pls. 25c.

Includes general discussion of fluctuation due to rainfall and evaporation, barometric changes, temperature changes in rivers, changes in lake level, tidal changes, effects of settlement, irrigation, dams, underground-water developments, and to indeterminate causes.

*160. Underground-water papers, 1906; M. L. Fuller, geologist in charge. 1906. 104 pp., 1 pl.

Gives account of work in 1905, lists of publications relating to underground waters, and contains the following brief reports of general interest:

Significance of the term "artesian," by Myron L. Fuller.
Representation of wells and springs on maps, by Myron L. Fuller.
Total amount of free water in the earth's crust, by Myron L. Fuller.
Use of fluorescein in the study of underground waters, by R. B. Dole.
Problems of water contamination, by Isaiah Bowman.
Instances of improvement of water in wells, by Myron L. Fuller.

*162. Destructive floods in the United States in 1905, with a discussion of flood discharge and frequency and an index to flood literature, by E. C. Murphy and others. 1906. 105 pp., 4 pls. 15c.

*163. Bibliographic review and index of underground-water literature published in the United States in 1905, by M. L. Fuller, F. G. Clapp, and B. L. Johnson. 1906. 130 pp. 15c.

Scope indicated by title.

*179. Prevention of stream pollution by distillery refuse, based on investigations at Lynchburg, Ohio, by Herman Stabler. 1906. 34 pp., 1 pl. 10c.

Describes grain distillation, treatment of slop, sources, character, and effects of effluents on streams; discusses filtration, precipitation, fermentation, and evaporation methods of disposal of wastes without pollution.

*180. Turbine water-wheel tests and power tables, by R. E. Horton. 1906. 134 pp., 2 pls. 20c.

Scope indicated by title.

*185. Investigations on the purification of Boston sewage, by C-E. A. Winslow and E. B. Phelps. 1906. 163 pp. 25c.

Discusses composition, disposal, purification, and treatment of sewages and recent tendencies in sewage-disposal practice in England, Germany, and the United States; describes character of crude sewage at Boston, removal of suspended matter, treatment in septic tanks, and purification in intermittent sand filtration and coarse material; gives bibliography.

*186. Stream pollution by acid-iron wastes, a report based on investigations made at Shelby, Ohio, by Herman Stabler. 1906. 36 pp., 1 pl. 10c.

Gives history of pollution by acid-iron wastes at Shelby, Ohio, and resulting litigation; discusses effect of acid-iron liquors on sewage-purification processes, recovery of copperas from acid-iron wastes, and other processes for removal of pickling liquor.

*187. Determination of stream flow during the frozen season, by H. K. Barrows and R. E. Horton. 1907. 93 pp., 1 pl. 15c.

Scope indicated by title.

*189. The prevention of stream pollution by strawboard waste, by E. B. Phelps. 1906. 29 pp., 2 pls. 5c.

Describes manufacture of strawboard, present and proposed methods of disposal of waste liquors, laboratory investigations of precipitation and sedimentation, and field studies of amounts and character of water used, raw material and finished product, and mechanical filtration.

*194. Pollution of Illinois and Mississippi rivers by Chicago sewage (a digest of the testimony taken in the case of the State of Missouri *v.* the State of Illinois and the Sanitary District of Chicago), by M. O. Leighton. 1907. 369 pp., 2 pls. 40c.

Scope indicated by amplification of title.

*200. Weir experiments, coefficients, and formulas, revision of paper No. 150, by R. E. Horton. 1907. 195 pp., 38 pls. 35c.

Scope indicated by title.

*226. The pollution of streams by sulphite-pulp waste, a study of possible remedies, by E. B. Phelps. 1908. 37 pp., 1 pl. 10c.

Describes manufacture of sulphite pulp, the waste liquors, and the experimental work leading to suggestions as to methods of preventing stream pollution.

*229. The disinfection of sewage and sewage filter effluents, with a chapter on the putrescibility and stability of sewage effluents, by E. B. Phelps. 1909. 91 pp., 1 pl. 15c.

Scope indicated by title.

*234. Papers on the conservation of water resources. 1909. 96 pp., 2 pls. 15c.

Contains the following papers, whose scope is indicated by their titles: Distribution of rainfall, by Henry Gannett; Floods, by M. O. Leighton; Developed water powers, compiled under the direction of W. M. Steuart, with discussion by M. O. Leighton; Undeveloped water powers, by M. O. Leighton; Irrigation, by F. H. Newell; Underground waters, by W. C. Mendenhall; Denudation, by R. B. Dole and Herman Stabler; Control of catchment areas, by H. N. Parker.

*235. The purification of some textile and other factory wastes, by Herman Stabler and G. H. Pratt. 1909. 76 pp. 10c.

Discusses waste waters from wool scouring, bleaching and dyeing cotton yarn, bleaching cotton piece goods, and manufacture of oleomargarine, fertilizer, and glue.

236. The quality of surface waters in the United States: Part I, Analyses of waters east of the one hundredth meridian, by R. B. Dole. 1909. 123 pp. 10c.

Describes collections of samples, methods of examination, preparation of solutions, accuracy of estimates, and expression of analytical results.

238. The public utility of water powers and their governmental regulation, by René Tavernier and M. O. Leighton. 1910. 161 pp. 15c.

Discusses hydraulic power and irrigation, French, Italian, and Swiss legislation relative to the development of water powers, and laws proposed in the French Parliament; reviews work of bureau of hydraulics and agricultural improvement of the French department of agriculture, and gives résumé of Federal and State water-power legislation in the United States.

*255. Underground waters for farm use, by M. L. Fuller. 1910. 58 pp., 17 pls. 15c.

Discusses rocks as sources of water supply and the relative safety of supplies from different materials; springs, and their protection; open or dug and deep wells, their location, yield, relative cost, protection, and safety; advantages and disadvantages of cisterns and combination wells and cisterns.

*257. Well-drilling methods, by Isaiah Bowman. 1911. 139 pp., 4 pls. 15c.

Discusses amount, distribution, and disposal of rainfall, water-bearing rocks, amount of underground water, artesian conditions, and oil and gas bearing formations; gives history of well drilling in Asia, Europe, and the United States; describes in detail the various methods and the machinery used; discusses loss of tools and geologic difficulties; contamination of well waters and methods of prevention; tests of capacity and measurement of depth; and costs of sinking wells.

*258. Underground-water papers, 1910, by M. L. Fuller, F. G. Clapp, G. C. Matson, Samuel Sanford, and H. C. Wolff. 1911. 123 pp., 2 pls. 15c.

Contains the following papers (scope indicated by titles) of general interest:
Drainage by wells, by M. L. Fuller.
Freezing of wells and related phenomena, by M. L. Fuller.
Pollution of underground waters in limestone, by G. C. Matson.
Protection of shallow wells in sandy deposits, by M. L. Fuller.
Magnetic wells, by M. L. Fuller.

259. The underground waters of southwestern Ohio, by M. L. Fuller and F. G. Clapp, with a discussion of the chemical character of the waters, by R. B. Dole. 1912. 228 pp., 9 pls. 35c.

Describes the topography, climate, and geology of the region, the water-bearing formations, the source, mode of occurrence, and head of the waters, and municipal supplies; gives details by counties; discusses in supplement, under chemical character, method of analysis and expression of results, mineral constituents, effect of the constituents on waters for domestic, industrial, or medicinal uses, methods of purification, and chemical composition; many analyses and field assays. The matter in the supplement was also published in Water-Supply Paper 254 (The underground waters of north-central Indiana).

280. Gaging stations maintained by the United States Geological Survey, 1888–1910, and Survey publications relating to water resources, compiled by B. D. Wood. 1912. 102 pp. 10c.

*315. The purification of public water supplies, by G. A. Johnson. 1913. 84 pp., 8 pls. 10c.

Discusses ground, lake, and river waters as public supplies, development of waterworks systems in the United States, water consumption, and typhoid fever; describes methods of filtration and sterilization of water, and municipal water softening.

334. The Ohio Valley flood of March–April, 1913 (including comparisons with some earlier floods), by A. H. Horton and H. J. Jackson. 1913. 96 pp., 22 pls. 20c.

Although relating specifically to floods in the Ohio Valley, this report discusses also the causes of floods and the prevention of damage by floods.

337. The effects of ice on stream flow, by William Glenn Hoyt. 1913. 77 pp., 7 pls. 15c.

Discusses methods of measuring the winter flow of streams.

*345. Contributions to the hydrology of the United States. 1914. N. C. Grover, chief hydraulic engineer. 1915. 225 pp., 17 pls. 30c. Contains:

*(*e*) A method of determining the daily discharge of rivers of variable slope, by M. R. Hall, W. E. Hall, and C. H. Pierce, pp. 53–65. Scope indicated by title.

364. Water analyses from the laboratory of the United States Geological Survey, tabulated by F. W. Clarke, chief chemist. 1914. 40 pp. 5c.

Contains analyses of waters from rivers, lakes, wells, and springs in various parts of the United States, including analyses of waters of the geysers in Yellowstone National Park, hot springs in Montana, brines from Death Valley, water from the Gulf of Mexico, and mine waters from Tennessee, Michigan, Missouri and Oklahoma, Montana, Colorado and Utah, Nevada, and Arizona, and California.

371. Equipment for current-meter gaging stations, by G. J. Lyon. 1915. 64 pp., 37 pls. 20c.

Describes methods of installing automatic and other gages and of constructing gage wells, shelters, and structures for making discharge measurements and artificial controls.

*375. Contributions to the hydrology of the United States, 1915. N. C. Grover, chief hydraulic engineer. 1916. 181 pp., 9 pls.

(*c*) The relation of stream gaging to the science of hydraulics, by C. H. Pierce and R. W. Davenport, pp. 77–84.

(*e*) A method for correcting river discharge for changing stage, by B. E. Jones, pp. 117–130.

(*f*) Conditions requiring the use of automatic gages in obtaining stream-flow records, by C. H. Pierce, pp. 131–139.

Papers presented at conference of engineers of water-resources branch in December, 1914.

400. Contributions to the hydrology of the United States, 1916. N. C. Grover, chief hydraulic engineer. Contains:

(*a*) The people's interest in water-power resources, by G. O. Smith, pp. 1–8.

(*c*) The measurement of silt-laden streams, by R. C. Pierce, pp. 39–51.

(*d*) Accuracy of stream-flow data, by N. C. Grover and J. C. Hoyt, pp. 53–59.

416. The divining rod, a history of water witching, with a bibliography, by Arthur J. Ellis. 1917. 59 pp. 10c.

ANNUAL REPORTS.

*Fifth Annual Report of the United States Geological Survey, 1883–84, J. W. Powell, Director. 1885. xxxvi, 469 pp., 58 pls. $2.25. Contains:

*The requisite and qualifying conditions of artesian wells, by T. C. Chamberlin, pp. 125 to 173, pl. 21. Scope indicated by title.

Twelfth Annual Report of the United States Geological Survey, 1890–91, J. W. Powell, Director. 1891. 2 parts. Pt. II, Irrigation, xviii, 576 pp., 93 pls. $2. Contains:

*Irrigation in India, by H. M. Wilson, C. E., pp. 363–561, pls. 107–146. See Water-Supply Paper 87.

Thirteenth Annual Report of the United States Geological Survey, 1891–92, J. W. Powell, Director. 1892. (Pts. II and III, 1893.) 3 parts. *Pt. III, Irrigation, xi, 486 pp., 77 pls. $1.85. Contains:

*American irrigation engineering, by H. M. Wilson, C. E., pp. 101–349, pls. 111–145. Discusses the economical aspects of irrigation, alkaline drainage, silt and sedimentation; gives brief history of legislation; describes perennial canals in Idaho-California, Wyoming, and Arizona; discusses water storage at reservoirs of the California and other projects, subsurface sources of supply, pumping, and subirrigation.

Fourteenth Annual Report of the United States Geological Survey, 1892–93, J. W. Powell, Director. 1893. (Pt. II, 1894.) 2 parts. *Pt. II, Accompanying papers, xx, 597 pp., 73 pls. $2.10. Contains:

*The potable waters of eastern United States, by W J McGee, pp. 1–47. Discusses cistern water, stream waters, and ground waters, including mineral springs and artesian wells.

*Natural mineral waters of the United States, by A. C. Peale, pp. 49–88, pls. 3–4. Discusses the origin and flow of mineral springs, the source of mineralization, thermal springs, the chemical composition and analysis of spring waters, geographic distribution, and the utilization of mineral waters; gives a list of American mineral spring resorts; contains also some analyses.

Nineteenth Annual Report of the United States Geological Survey, 1897–98, Charles D. Walcott, Director. 1898. (Parts II, III, and V, 1899.) 6 parts in 7 vols. and separate case for maps with Pt. V. *Pt. II, Papers chiefly of a theoretic nature, v, 958 pp., 172 pls. $2.65. Contains:

*Principles and conditions of the movements of ground water, by F. H. King, pp. 59–294, pls. 6–16. Discusses the amount of water stored in sandstone, in soil, and in other rocks, the depth to which ground water penetrates; gravitational, thermal, and capillary movements of ground waters, and the configuration of the ground-water surface; gives the results of experimental investigations on the flow of air and water through a rigid, porous medium, and through sands, sandstones, and silts; discusses results obtained by other investitagors, and summarizes results of observations; discusses also rate of flow of water through sand and rock, the growth of rivers, rate of filtration through soil, interference of wells, etc.

*Theoretical investigation of the motion of ground waters, by C. S. Slichter, pp. 295–384, pl. 17. Scope indicated by title.

PROFESSIONAL PAPERS.

*72. Denudation and erosion in the southern Appalachian region and the Monongahela basin, by L. C. Glenn. 1911. 137 pp., 21 pls. 35c.

Describes the topography, geology, drainage, forests, climate and population, and transportation facilities of the region, the relation of agriculture, lumbering, mining, and power development to erosion and denudation, and the nature, effects, and remedies of erosion; gives details of conditions in Holston, Nolichucky, French Broad, Little Tennessee, and Hiwassee river basins, along Tennessee River proper, and in the basins of the Coosa-Alabama system, Chattahoochee, Savannah, Saluda, Broad, Catawba, Yadkin, New, and Monongahela rivers.

BULLETINS.

*32. Lists and analyses of the mineral springs of the United States (a preliminary study), by A. C. Peale. 1886. 235 pp.

Defines mineral waters, lists the springs by States, and gives tables of analyses so far as available.

*319. Summary of the controlling factors of artesian flows, by Myron L. Fuller. 1908. 10c.

Describes underground reservoirs, the sources of underground waters, the confining agents, the primary and modifying factors of artesian circulation, the essential and modifying factors of artesian flow, and typical artesian systems.

*479. The geochemical interpretation of water analyses, by Chase Palmer. 1911. 31 pp. 5c.

Discusses the expression of chemical analyses, the chemical character of water and the properties of natural waters; gives a classification of waters based on property values and reacting values, and discusses the character of the waters of certain rivers as interpreted directly from the results of analyses; discusses also the relation of water properties to geologic formations, silica in river water, and the character of the water of the Mississippi and the Great Lakes and St. Lawrence River as indicated by chemical analyses.

INDEX BY AREAS AND SUBJECTS.

[A=Annual Reports; M=Monograph; B=Bulletin; P=Professional Paper; W=Water-Supply Paper G F=Geologic folio.]

[1] Many of the reports contain brief subject bibliographies. See abstracts.

[2] Many analyses of river, spring, and well waters are scattered through publications, as noted in abstracts

INDEX OF STREAMS.