DEPARTMENT OF THE INTERIOR
HUBERT WORK, Secretary

UNITED STATES GEOLOGICAL SURVEY
GEORGE OTIS SMITH, Director

Water-Supply Paper 528

SURFACE WATER SUPPLY OF THE UNITED STATES

1921

PART VIII. WESTERN GULF OF MEXICO BASINS

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Prepared in cooperation with the
STATE OF TEXAS

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SURFACE WATER SUPPLY OF WESTERN GULF OF MEXICO BASINS, 1921.

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, 1921.

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 1886 in connection with special studies relating to irrigation in the arid West. Since the fiscal year ending June 30, 1895, successive sundry civil bills passed by Congress have carried the following item and appropriations:

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

Annual appropriations for the fiscal years ended June 30, 1895–1922.

1895	$12,500.00
1896	20,000.00
1897 to 1900, inclusive	50,000.00
1901 to 1902, inclusive	100,000.00
1903 to 1906, inclusive	200,000.00
1907	150,000.00
1908 to 1910, inclusive	100,000.00
1911 to 1917, inclusive	150,000.00
1918	175,000.00
1919	148,244.10
1920	175,000.00
1921	180,000.00
1922	180,000.00

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 10.

Measurements of stream flow have been made at about 5,200 points in the United States and also at many points in Alaska and the Hawaiian Islands. In July, 1921, 1,350 gaging stations were being maintained by the Survey and the cooperating organizations. Many miscellaneous discharge measurements were made at other points. In connection with this work data were also collected in regard to precipitation, evaporation, storage reservoirs, river profiles, and water power in many sections of the country and will be made available in water-supply papers from time to time.

DEFINITION OF TERMS.

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

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

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

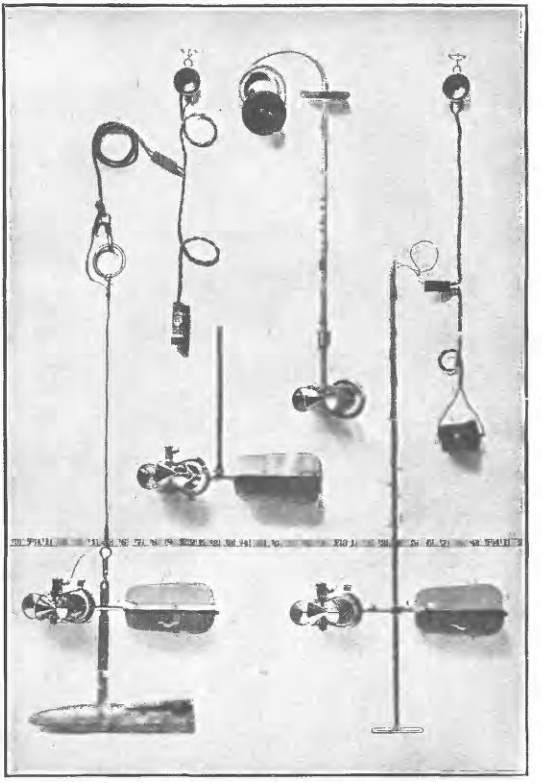
"Run-off in inches" is the depth to which an area would be covered if all the water flowing from it in a given period were uniformly distributed on the surface. It is used for comparing run-off with rainfall, which is usually expressed in depth in inches.

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

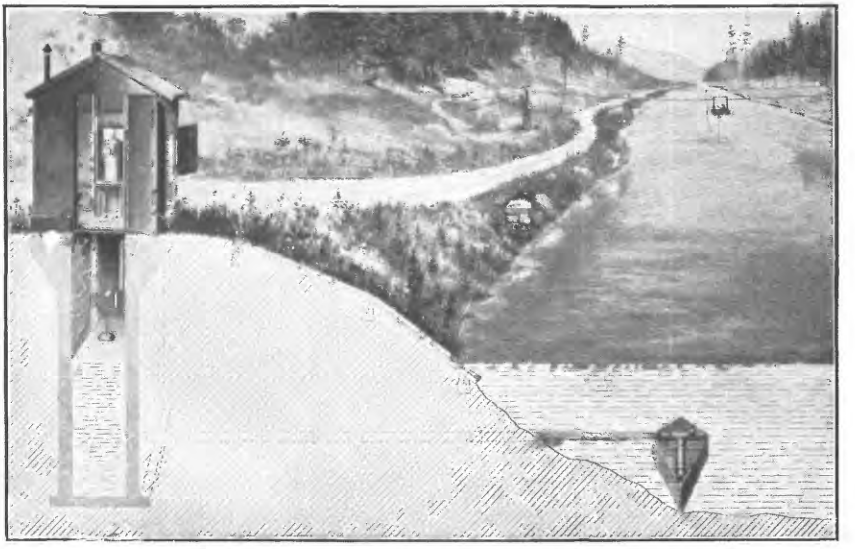
The following terms not in common use are here defined:

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

"Control," a term used to designate the section or sections of the stream below the gage which determines 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.



A. PRICE CURRENT METERS.



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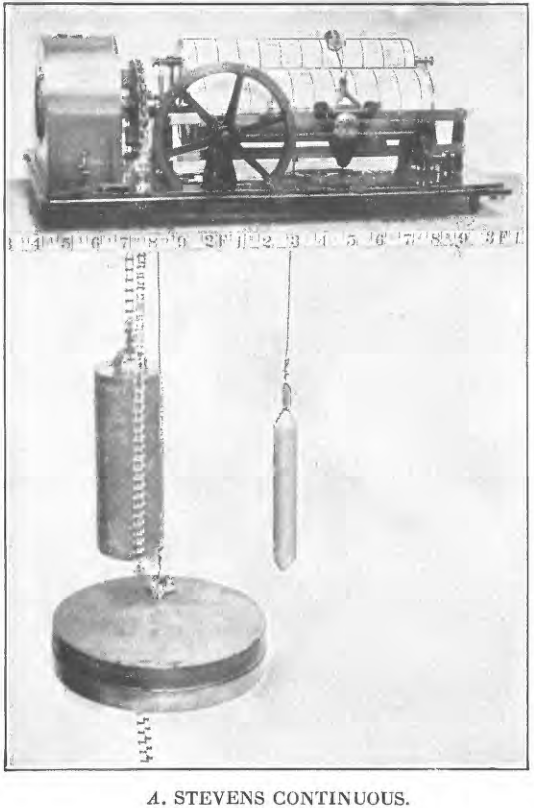

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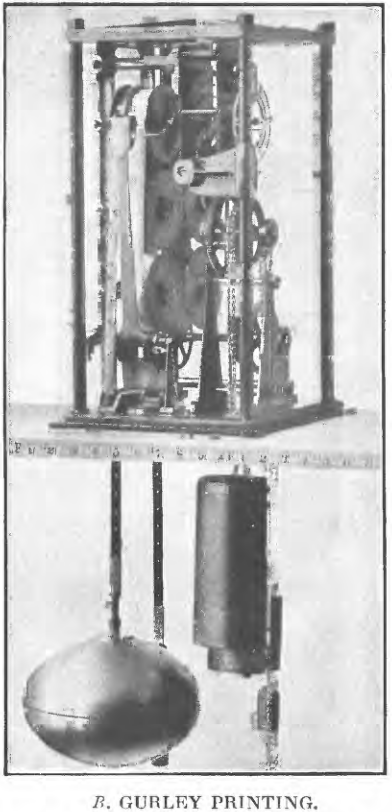
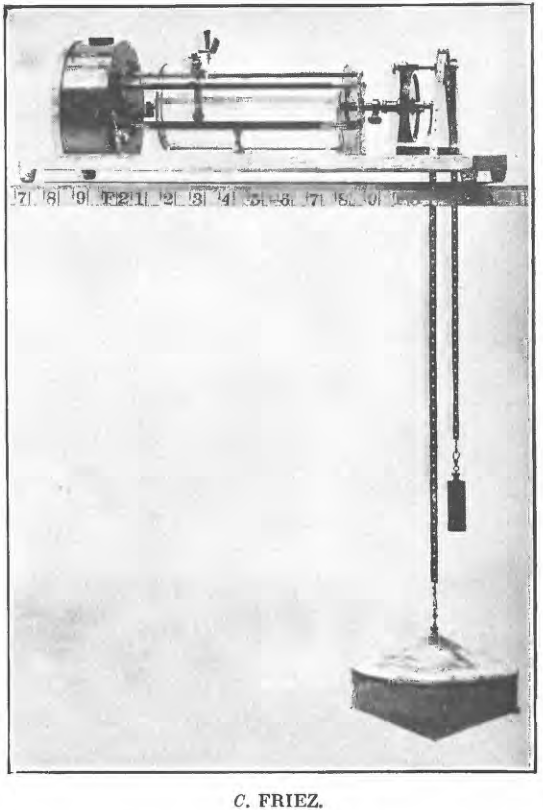


B. GURLEY PRINTING.



C. FRIEZ.

WATER-STAGE RECORDERS.

The "point of zero flow" for a gaging station is that point on the gage—the gage height—at which water ceases to flow over the control.

EXPLANATION OF DATA.

The data presented in this report cover the year beginning October 1, 1920, and ending September 30, 1921. 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. The application of the daily gage height to these rating tables gives the daily discharge from which the 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 permanence of the stage-discharge relation, covering such subjects as the occurrence of ice, the use of the stream for log driving, shifting of control, and the cause and effect of backwater; it gives also information as to diversions that decrease the flow at the gage, artificial regulation, maximum and minimum recorded stages, and the accuracy of the records.

The table of daily discharge gives, in general, the discharge in second-feet corresponding to the mean of the gage heights read each

day. At stations on streams subject to sudden or rapid diurnal 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 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 2, are based.

ACCURACY OF FIELD DATA AND COMPUTED RESULTS.

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

A paragraph in the description of the station 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 run-off in inches may be subject to gross errors caused by the inclusion of large noncontributing districts in the measured drainage area, by lack of information concerning water diverted for irrigation or other use, or by

[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.

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 in inches" are therefore not computed if such errors appear probable. The computations are also omitted for stations on streams draining areas in which the annual rainfall is less than 20 inches. All figures representing "second-feet per square mile" and "run-off in inches" published by the Survey in earlier reports should be used with caution because of possible inherent sources of error not known to the Survey.

Many gaging stations on streams in the irrigated areas of the United States are located above most of the diversions from those streams, and the discharge recorded does not show the water supply available for further development as prior appropriations below the stations must first be satisfied. To give an idea of the amount of prior appropriations, a paragraph on diversions is presented in each station description. The figures given can not be considered exact but represent the best information available.

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.

PUBLICATIONS.

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 investigations 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, monographs, and annual reports.

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 slope basins.
II. South Atlantic slope 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.

Part X. Great Basin.
XI. Pacific slope basins in California.
XII. North Pacific slope basins; in three volumes:
A. Pacific slope basins in Washington and upper Columbia River basin.
B. Snake River basin.
C. Lower Columbia River basin and Pacific slope basins in Oregon.

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 on application furnish list 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., 704 Journal Building.
Trenton, N. J., State House.
Asheville, N. C., 33–35 Broadway.
Chattanooga, Tenn., 37 Municipal Building.
Columbus, Ohio, Orton Hall, Ohio State University.
Chicago, Ill., 1404 Kimball Building.
Madison, Wis., care of Railroad Commission of Wisconsin.
Ames, Iowa, 103 Engineering Hall, Iowa State College.
Rolla, Mo., Rolla Building, School of Mines and Metallurgy.
Topeka, Kans., 23 Federal Building.
Helena, Mont., 52 Montana National Bank Building.
Denver, Colo., 403 Post Office Building.
Salt Lake City, Utah, 313 Federal Building.
Idaho Falls, Idaho, 228 Federal Building.
Boise, Idaho, 615 Idaho Building.
Tacoma, Wash., 406 Federal Building.
Portland, Oreg., 606 Post Office Building.
San Francisco, Calif., 328 Customhouse.
Los Angeles, Calif., 602 Federal Building.
Tucson, Ariz., 210 Agricultural Building, University of Arizona.
Austin, Tex., State Capitol.
Honolulu, Hawaii, 25 Capitol 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 records have been obtained at about 5,200 points in the United States, and the data obtained have been published in the reports tabulated on pages 7 and 8.

Stream-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 September, 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)	1888 to Dec. 31, 1893.
B 131	Descriptions, measurements, gage heights, and ratings	1893 and 1894.
16th A, pt. 2	Descriptive information only	1895.
B 140	Descriptions, measurements, gage heights, ratings, and monthly discharge (also many data covering earlier years).	
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.
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.
W 451 to 464	do	1917.
W 471 to 484	do	1918.
W 501 to 514	do	1919–20.
W 521 to 534	do	1921.

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 following table gives, by years and drainage basins, the numbers of the papers on surface-water supply published from 1899 to 1921. The data for any particular station will, as a rule, be found in the reports covering the years during which the station was maintained. For example, data for Machias River at Whitneyville, Maine, 1903 to 1921, are published in Water-Supply Papers 97, 124, 165, 201, 241, 261, 281, 301, 321, 351, 381, 401, 431, 451, 471, 501, and 521, which contain records for the New England streams from 1903 to 1921. Results of miscellaneous measurements are published by drainage basins.

Numbers of water-supply papers containing results of stream measurements, 1899–1921.

Year.	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII		
												North Pacific slope basins.		
	North Atlantic slope (St. John River to York River).	South Atlantic 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 slope in California.	Pacific slope in Washington and upper Columbia River.	Snake River basin.	Lower Columbia River and Pacific slope in Oregon.
1899 [a]	35	[b] 35, 36	36	36	36	[c] 36, 37	37	37	[d] 37, 38	38, [e] 39	38, [f] 39	38	38	38
1900 [g]	47, [h] 48	48	48, [i] 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, 78	66, 75
1902	82	[b] 82, 83	83	[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	414
1916	431	432	433	434	435	436	437	438	439	440	441	442	443	444
1917	451	452	453	454	455	456	457	458	459	460	461	462	463	464
1918	471	472	473	474	475	476	477	478	479	480	481	482	483	484
1919–20	501	502	503	504	505	506	507	508	509	510	511	512	513	514
1921	521	522	523	524	525	526	527	528	529	530	531	532	533	534

[a] Rating tables and index to Water-Supply Papers 35–39 contained in Water-Supply Paper 39. Monthly discharge for 1899 in Twenty-first Annual Report, Part IV.
[b] James River only.
[c] Gallatin River.
[d] Green and Gunnison rivers and Grand River above junction with Gunnison.
[e] Mohave River only.
[f] Kings and Kern rivers and south Pacific slope basins.
[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. Monthly discharge for 1900 in Twenty-second Annual Report, Part IV.
[h] Wissahickon and Schuylkill rivers to James River.
[i] Scioto 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.

COOPERATION.

The work of measuring streams in Texas during the year ending September 30, 1921, was carried on in cooperation with the State through the Board of Water Engineers, consisting of W. T. Potter, chairman; C. S. Clark; and John A. Norris, to whom special acknowledgments are due for the efficient and cordial manner in which they represented the State in the cooperative investigations.

Acknowledgments are due the United States Reclamation Service for records furnished and general assistance at the stations on Pecos River in New Mexico, and to the United States Weather Bureau for climatologic data and equipment for the evaporation station near Austin.

The cities of Corpus Christi, Dallas, Fort Worth, and San Antonio, and the Pecos Valley Lines have aided in the collection of records by furnishing funds or giving general assistance.

DIVISION OF WORK.

Data for stations in Texas were collected and prepared for publication under the direction of C. E. Ellsworth, district engineer, assisted by Clarence E. McCashin, Donald A. Dudley, Harvey B. Kinnison, Trigg Twichell, Robert G. West, H. C. Pritchett, and Kate Casparis.

The manuscript was reviewed by B. J. Peterson.

GAGING-STATION RECORDS.

TRINITY RIVER BASIN.

WEST FORK OF TRINITY RIVER AT BRIDGEPORT, TEX.[1]

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

DRAINAGE AREA.—1,060 square miles (measured on standard topographic maps; post-route map; and topographic map of Texas, compiled in 1899 by Robert T. Hill, of the United States Geological Survey; scale 1 inch=25 miles).

RECORDS AVAILABLE.—October 1, 1914, to September 30, 1921. Records of stage have been obtained by the United States Weather Bureau since August 12, 1908.

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 Mrs. 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 rock outcrop three-quarters of a mile below station.

EXTREMES OF DISCHARGE.—Maximum stage recorded, 21.85 feet at 7 a. m. July 11 (discharge, 9,740 second-feet); minimum discharge, 0.5 second-foot May 27.

1908–1921: Maximum stage recorded, 28.9 feet June 8, 1915 (discharge not determined); no flow during several periods.

[1] Published in earlier reports as Trinity River at Bridgeport, Tex.

ICE.—None reported.

DIVERSIONS.—Practically the only diversion above station is by city of Bridgeport which diverts a small amount for municipal uses.

REGULATION.—None.

ACCURACY.—Stage-discharge relation practically permanent, except for slight changes at extreme low stages caused by filling and scouring of fissures in the rock control, and slight changes during floods. Rating curve well defined below 11,000 second-feet. Gage read to hundredths once daily and oftener during floods. Daily discharge ascertained by applying mean daily gage height to rating table; shifting-control method used July 14 to September 30. Records good except those for extremely low stages which are fair.

Discharge measurements of West Fork of Trinity River at Bridgeport, Tex., during the year ending Sept. 30, 1921.

Date.	Made by—	Gage height.	Discharge.
		Feet.	*Sec.-ft.*
Jan. 17	R. G. West	2.79	136
Aug. 4	C. E. Ellsworth	.50	1.4

Daily discharge, in second-feet, of West Fork of Trinity River at Bridgeport, Tex., for the year ending Sept. 30, 1921.

Day.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.
1	6.8	424	15	19	3.7	34	27	3.3	26	13	1.3	1.3
2	5.8	321	6.2	16	4.3	26	23	65	35	2.2	1.1	1.1
3	5.2	212	27	12	3.9	19	19	73	126	7.9	1.2	1.0
4	4.5	135	23	8.5	3.1	16	16	16	542	12	1.2	.9
5	3.5	59	26	6.0	2.5	14	12	6.8	36	3.9	1.4	.8
6	2.9	18	24	5.0	2.7	14	90	3.9	19	2.2	1.4	61
7	2.4	14	183	4.3	2.5	13	64	2.7	7.0	2.0	1.2	98
8	2.2	12	179	3.5	2.4	12	42	60	614	1.8	162	21
9	2.0	12	212	3.1	2.4	12	21	127	734	1.5	97	7.9
10	2.0	19	158	2.7	2.3	13	202	32	2,380	1.0	50	4.8
11	2.2	223	142	19	2.2	11	89	17	1,050	7,760	17	9.7
12	2.3	187	140	366	2.1	16	68	5.8	926	1,830	4.1	8.5
13	2.2	187	131	299	2.0	168	78	3.5	1,020	58	2.2	7.6
14	2.1	160	131	344	1.8	662	41	2.5	366	11	2.4	6.5
15	2.7	129	129	170	1.6	223	33	2.3	71	32	3.3	5.8
16	6.0	104	124	52	1.5	131	14	2.1	37	10	42	4.8
17	6.5	77	114	73	5.2	81	5.5	1.8	25	8.8	13	3.7
18	8.5	43	104	63	662	48	5.2	1.7	15	7.0	4.8	3.5
19	494	24	97	42	1,530	662	5.0	1.6	14	8.5	3.1	3.9
20	255	21	86	32	590	590	4.5	1.5	12	15	2.0	3.3
21	234	14	255	27	470	266	4.1	1.4	9.1	80	1.8	2.5
22	299	12	299	25	196	129	3.3	1.3	5.2	24	1.6	2.4
23	401	9.7	212	21	138	108	4.3	1.1	23	12	1.5	2.4
24	3,740	8.5	154	17	102	66	3.5	1.0	7.3	11	1.3	2.2
25	2,340	183	142	14	90	36	3.1	.9	26	12	1.3	5.8
26	2,980	1,020	73	12	73	32	3.5	.7	9.7	13	1.3	8.2
27	2,420	189	60	7.3	53	30	4.8	.5	7.9	7.3	1.3	8.5
28	1,410	127	46	5.8	41	36	4.3	28	5.8	4.3	1.2	12
29	974	61	34	5.0	.....	39	3.1	22	22	3.3	1.2	17
30	590	28	26	4.3	.....	38	2.5	11	61	2.2	1.2	16
31	590	.....	21	3.5	.....	34	.....	10	.....	1.7	1.3	.....

Monthly discharge of West Fork of Trinity River at Bridgeport, Tex., for the year ending Sept. 30, 1921.

Month.	Discharge in second-feet.			Run-off in acre-feet.
	Maximum.	Minimum.	Mean.	
October	3,740	2.0	542	33,300
November	1,020	8.5	134	7,970
December	299	6.2	109	6,700
January	366	2.7	54.3	3,340
February	1,530	1.5	143	7,940
March	662	11	115	7,070
April	202	2.5	29.9	1,780
May	127	.5	16.4	1,010
June	2,380	5.2	274	16,300
July	7,760	1.0	321	19,700
August	162	1.1	13.8	848
September	98	.8	11.1	660
The year	7,760	.5	147	107,000

WEST FORK OF TRINITY RIVER AT FORT WORTH, TEX.

LOCATION.—At old intake pump house of Fort Worth Power & Light Co.'s plant, in Fort Worth, Tarrant County, one-fourth mile below mouth of Clear Fork of Trinity River and 150 feet above Paddock viaduct.

DRAINAGE AREA.—2,420 square miles (measured on post-route map of Texas).

RECORDS AVAILABLE.—October 1, 1920, to September 30, 1921. Records of stage have been kept by United States Weather Bureau at Paddock viaduct since March 1, 1910.

GAGE.—Gurley graph water-stage recorder, installed October 11, 1920, in the old pump house of Fort Worth Power & Light Co.

DISCHARGE MEASUREMENTS.—Made by wading, from highway bridge 1,000 feet above gage, or from North Twelfth Street Bridge 2 miles below gage.

CHANNEL AND CONTROL.—Channel straight for 500 feet above, and 1,000 feet below section. Right bank high, brushy, and not subject to overflow; left bank low, with protection levee, but subject to overflow at high stages. Bed composed of rock, gravel, and clay. Control is a concrete dam just below gage and is permanent.

EXTREMES OF DISCHARGE.—Maximum stage during year from water-stage recorder, 10.11 feet at 8.30 a. m. April 5 (discharge, 9,480 second-feet); minimum stage, 0.9 foot October 10, by comparison with United States Weather Bureau record (discharge, 1.9 second-feet).

1910–1921: Maximum stage by levels from mark made at time of flood, 21.4 feet June 10, 1915 (discharge, 44,000 second-feet); no flow during several periods of record.

ICE.—None during year.

DIVERSIONS.—The city of Fort Worth diverts for municipal use about 15 second-feet from the storage reservoir on the West Fork, known as Lake Worth.

REGULATION.—Flow is partly regulated by the storage at Lake Worth, which has a capacity of about 30,000 acre-feet.

ACCURACY.—Stage-discharge relation permanent. Rating curve well defined below 14,000 second-feet; fairly well defined above that point. Operation of water-stage recorder not satisfactory. Daily discharge ascertained by applying to rating table mean daily gage height obtained from recorder graph by inspection or by use of planimeter, and for days of considerable fluctuation in stage by averaging discharge for intervals of the day as indicated in footnote to daily-discharge table. Records fair.

Discharge measurements of West Fork of Trinity River at Fort Worth, Tex., during the period Aug. 21, 1920, to Sept. 30, 1921.

Date.	Made by—	Gage height.	Discharge.	Date.	Made by—	Gage height.	Discharge.
1920.		*Feet.*	*Sec.-ft.*	1921.		*Feet.*	*Sec.-ft.*
Aug. 21	C. E. Ellsworth	1.73	219	Jan. 18	R. G. West	2.67	799
30	Ellsworth and Twichell	3.60	1,740	Apr. 5	C. E. McCashin	7.35	a6,490
Oct. 5	Ellsworth and West	1.16	39.4	6	do	4.46	2,660
12	R. G. West	1.13	32.6	May 24	R. G. West	1.21	47.1
Dec. 15	C. E. Ellsworth	1.74	222	Aug. 5	C. E. Ellsworth	1.06	16.4
17	do	1.49	128				

a Surface velocities observed and coefficient used to reduce to mean velocities. Rapidly falling stage.

Daily discharge, in second-feet, of West Fork of Trinity River at Fort Worth, Tex., for the year ending Sept. 30, 1921.

Day.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.
1	21	1,650	328	202	302	527	240	138	47	71	38	9.3
2	42	850	268	153	297	508	219	164	52	55	32	8.0
3	68	487	232	150	283	478	202	187	215	42	27	8.0
4	68	352	273	146	287	424	1,090	176	527	38	20	8.0
5	42	249	206	142	283	390	6,030	195	460	38	16	9.3
6	42	228	195	131	254	379	2,760	202	400	47	12	9.3
7	8.0	215	268	142	369	364	2,100	176	287	40	11	40
8	21	195	219	153	317	527	1,280	164	302	21	12	47
9	8.0	187	219	135	259	597	804	245	653	14	11	21
10	1.9	240	278	104	292	424	555	283	684	80	9.3	16
11	32	348	268	214	249	284	400	297	764	312	25	14
12	27	206	259	460	232	460	348	297	1,030	1,310	17	14
13	25	176	292	1,990	219	460	384	232	1,260	1,720	14	13
14	23	172	217	1,470	198	460	384	183	1,500	2,100	13	13
15	21	206	206	1,170	195	348	322	287	1,670	2,580	14	12
16	27	191	142	1,090	215	400	348	135	1,530	3,380	17	11
17	27	172	131	955	206	348	232	91	955	2,100	13	8.0
18	29	168	128	796	2,030	249	183	80	484	937	12	7.4
19	45	168	128	676	3,800	460	172	68	245	780	7.4	9.3
20	297	168	124	597	2,100	460	161	58	150	508	7.4	6.8
21	131	168	548	534	1,940	660	408	60	114	104	6.8	6.2
22	590	168	892	527	2,100	1,000	454	60	369	65	6.8	5.6
23	478	131	646	656	1,990	1,270	292	55	632	85	5.6	5.0
24	2,700	97	590	534	1,400	590	195	50	740	107	5.0	4.3
25	2,460	97	424	527	955	348	187	47	448	111	5.6	5.0
26	2,100	131	390	436	748	297	278	40	395	77	7.4	6.2
27	2,100	430	302	358	639	292	307	36	297	65	11	6.8
28	2,460	406	215	353	569	338	254	50	202	80	11	8.0
29	3,100	604	191	395	.....	297	206	50	142	68	9.3	13
30	3,240	448	191	364	.....	259	172	45	97	47	8.0	14
31	2,700	.....	179	302	.....	259	.....	38	.....	42	8.0	.....

NOTE.—Discharge for following days determined from reading of U. S. Weather Bureau staff gage reduced to datum of United States Geological Survey gage: Oct. 1–10, 15, 20–22, 24–29, Nov. 5, 11, 12, 18–26, Jan. 12, Mar. 12–25, and July 16–22. Discharge partly estimated, owing to incomplete record on following days: Oct. 14, 23, Nov. 6, 10, 13, 17, 27, Dec. 3, 4, 11, Mar. 26, May 18–20, July 23, and July 30 to Aug. 5. Discharge averaged for intervals of the day, Nov. 1–4, Dec. 14, 21, Jan. 11, Feb. 18, Apr. 4, 21, and June 3.

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Monthly discharge of West Fork of Trinity River at Fort Worth, Tex., for the year ending Sept. 30, 1921.

Month.	Discharge in second-feet.			Run-off in acre-feet.
	Maximum.	Minimum.	Mean.	
October	3,240	1.9	740	45,500
November	1,650	97	310	18,400
December	892	124	289	17,800
January	1,990	104	512	31,500
February	3,800	195	812	45,100
March	1,270	249	457	28,100
April	6,030	161	699	41,600
May	297	36	135	8,300
June	1,670	47	555	33,000
July	3,380	14	549	33,800
August	38	5.0	13.3	818
September	47	4.3	12.0	714
The year	6,030	1.9	421	305,000

TRINITY RIVER AT DALLAS, TEX.

LOCATION.—On Commerce Street viaduct in city of Dallas, Dallas County, 800 feet below Texas & Pacific Railway bridge, one block from county courthouse, one block upstream from union station, 3 miles by air line, and 5 miles by river below confluence of Elm Fork and West Fork of Trinity River.

DRAINAGE AREA.—5,920 square miles (measured on standard topographic maps; post-route map; and topographic map of Texas, compiled in 1899 by Robert T. Hill, of the United States Geological Survey, scale 1 inch =25 miles).

RECORDS AVAILABLE.—October 1, 1898, to December 31, 1899 (discharge not computed); July 1, 1903, to December 31, 1906; and October 1, 1920, to September 30, 1921. Gage readings by United States Weather Bureau available since 1903.

GAGE.—Chain gage attached to downstream handrail of Commerce Street viaduct; read by C. J. Anderson. From October 1, 1898, to December 31, 1899, gage was at Turtle Creek pumping plant, 2 miles above present gage. Relation between gages not known.

DISCHARGE MEASUREMENTS.—Made by wading or from upstream side of Commerce Street viaduct, or from "Millers Ferry" bridge, 6 miles downstream from gage.

CHANNEL AND CONTROL.—Channel practically straight for 1,000 feet above and 600 feet below station. Right bank medium in height, composed of clay and gravel, wooded, and subject to overflow; left bank high, fairly clean, and not subject to overflow except at extremely high stages. Bed is composed of clay and gravel and not likely to shift. Low-water control is a gravel and clay shoal, 300 feet below gage. High-water control not known. A lock and dam, 13 miles below gage, will back water at station to a gage height of 11.65 feet when wickets are closed. This, however, seldom occurs.

EXTREMES OF DISCHARGE.—Maximum stage recorded during year, 34.3 feet from 4.20 p. m. April 7 to 9.40 a. m. April 8 (discharge, 18,200 second-feet); minimum stage, 4.35 feet at 4.45 p. m. September 27 (discharge, 20 second-feet).

1898–1899; 1903–1906; 1921: Maximum and minimum discharge in 1921 (see above).

Maximum flood on record, 52.6 feet at 6 p. m. May 26, 1908, from records of United States Weather Bureau (discharge not determined).

ICE.—None reported during year.

DIVERSIONS.—Only known diversions are for municipal use. No irrigation of importance above.

REGULATION.—Ordinary flow is regulated by municipal dams, on West Fork 40 miles above, and on Elm Fork, 6 miles above gage.

ACCURACY.—Stage-discharge relation permanent. Rating curve well defined from 20 to 75,000 second-feet. Gage read to hundredths twice daily. Daily discharge ascertained by applying mean daily gage height to rating table. Records good.

Discharge measurements of Trinity River at Dallas, Tex., during the period Aug. 30, 1920, to Sept. 30, 1921.

Date.	Made by—	Gage height.	Discharge.	Date.	Made by—	Gage height.	Discharge.
1920.		*Feet.*	*Sec.-ft.*	1920.		*Feet.*	*Sec.-ft.*
Aug. 30	Ellsworth and Twichell	25.70	[a]6,700	Dec. 15	C. E. Ellsworth	10.62	847
31	do	27.17	[a]7,630				
Sept. 1	do	28.39	8,770	1921.			
2	do	30.79	10,400	Jan. 15	Ellsworth and West	33.04	13,200
3	Twichell and Bailey	30.39	9,960	19	R. G. West	16.60	2,390
4	T. Twichell	20.17	3,860	Apr. 7	C. E. McCashin	34.14	18,800
5	do	17.41	3,250	May 27	R. G. West	6.92	191
Oct. 9	Ellsworth and West	6.92	188	Aug. 3	C. E. Ellsworth	5.27	58.2
18	R. G. West	6.38	146	Sept. 24	do	4.36	19.7

[a] Surface velocities observed over part of section and coefficient of 1.04 used to reduce to mean velocities. Coefficient determined from well-defined vertical velocity curves taken on Aug. 30 and Sept. 1 and 2.

Daily discharge, in second-feet, of Trinity River at Dallas, Tex., for the year ending Sept. 30, 1921.

Day.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.
1	310	3,780	1,250	680	950	1,540	825	1,250	440	355	98	26
2	240	3,100	775	660	900	1,400	750	1,350	775	370	84	28
3	230	2,350	825	640	875	1,350	725	800	2,700	220	69	163
4	210	1,450	750	560	875	1,300	660	700	2,700	190	63	28
5	200	950	725	540	850	1,180	3,660	620	2,050	190	54	28
6	190	800	725	540	850	1,100	10,300	580	1,120	210	46	30
7	190	700	1,020	520	850	1,080	16,800	540	1,050	181	51	26
8	190	620	1,600	500	925	1,350	17,200	540	1,400	190	91	22
9	190	580	1,660	500	1,280	2,230	13,200	640	2,860	163	181	22
10	180	1,000	1,200	500	1,220	1,630	8,150	1,320	2,320	154	325	22
11	180	1,200	1,000	580	825	1,480	5,050	1,150	2,320	121	295	24
12	180	1,250	950	3,500	800	4,710	1,840	825	2,520	200	250	26
13	180	1,200	850	8,080	750	2,700	1,300	700	2,820	725	200	36
14	163	900	850	12,700	660	1,720	1,250	620	2,350	1,320	154	28
15	145	620	825	14,200	620	2,290	1,280	1,020	2,140	1,750	190	26
16	145	560	640	11,800	640	3,100	1,200	1,720	1,990	2,380	38	24
17	145	600	580	9,080	1,100	2,200	1,000	800	1,300	2,860	28	22
18	145	560	500	4,900	1,510	1,990	925	640	1,380	2,460	36	22
19	220	520	500	2,490	5,650	1,990	800	355	950	1,320	40	21
20	370	500	480	2,050	11,400	2,050	850	310	660	700	43	26
21	1,180	500	1,600	1,810	15,000	2,230	875	310	420	420	40	33
22	1,100	480	5,800	1,660	12,500	2,170	3,700	295	700	295	30	28
23	2,140	480	7,320	1,660	10,500	1,660	2,420	295	2,520	310	28	24
24	7,080	460	6,570	1,750	6,400	1,960	1,300	230	3,380	355	26	21
25	8,990	480	4,900	1,690	3,260	2,420	800	210	2,050	460	26	22
26	10,800	750	2,350	1,540	2,200	1,900	1,660	181	1,350	950	24	22
27	10,400	3,020	1,100	1,350	1,900	1,630	3,220	181	1,020	640	24	20
28	10,200	3,500	1,020	1,150	1,630	1,380	2,260	181	750	265	22	21
29	6,790	3,020	900	1,100	.....	1,320	1,100	181	660	181	24	21
30	3,580	1,720	725	1,100	.....	1,380	1,150	181	400	145	26	21
31	3,620	.....	700	1,100	.....	1,000	.....	250	.....	113	28	.....

Monthly discharge of Trinity River at Dallas, Tex., for the year ending Sept. 30, 1921.

Month.	Discharge in second-feet.			Run-off in acre-feet.
	Maximum.	Minimum.	Mean.	
October	10,800	145	2,250	138,000
November	3,780	460	1,260	75,000
December	7,320	480	1,640	101,000
January	14,200	500	2,930	180,000
February	15,000	620	3,100	172,000
March	4,710	1,000	1,850	114,000
April	17,200	660	3,540	211,000
May	1,720	181	612	37,600
June	3,380	400	1,640	97,600
July	2,860	113	651	40,000
August	325	22	85.0	5,230
September	163	20	29.4	1,750
The year	17,200	20	1,620	1,170,000

ELM FORK OF TRINITY RIVER NEAR DALLAS, TEX.

LOCATION.—At city of Dallas pumping plant and dam (known as Record Crossing plant), 300 feet above Record Crossing highway bridge, 2,800 feet above Chicago, Rock Island & Gulf Railway bridge, 1.2 miles above confluence with West Fork, and 5 miles northwest of Dallas, Dallas County.

DRAINAGE AREA.—2,480 square miles (measured on post-route map of Texas).

RECORDS AVAILABLE.—October 17, 1920, to September 30, 1921.

GAGE.—Vertical staff in three sections, attached to pump house; read by W. J. Selby.

DISCHARGE MEASUREMENTS.—Made from Record Crossing highway bridge 200 feet below gage, from Rock Island Railway bridge half a mile below, or by wading.

CHANNEL AND CONTROL.—Bed composed of sand and gravel; shifting. Control is concrete dam; permanent. Left bank high, wooded, and not subject to overflow, except at extremely high stages. Right bank medium in height, wooded, and subject to overflow.

EXTREMES OF DISCHARGE.—Maximum stage recorded, 16.2 feet from 8 a. m. April 7 to 8 a. m. April 8 (discharge, 15,800 second-feet; this figure may be somewhat too large owing to possible backwater effect from West Fork of Trinity River); no flow during several periods.

ICE.—None reported.

DIVERSIONS.—No diversions except for municipal use, the largest being at the Record Crossing plant. The sum of all the diversions is believed to be but a small percentage of the total run-off during years of ordinary flow.

REGULATION.—Flow regulated during extremely low stages by city of Dallas reservoir at Carrolton.

ACCURACY.—Stage-discharge relation permanent. Rating curve well defined below 1,100 second-feet and fairly well defined for all stages above, except that there are no measurements between 1,100 and 6,200 second-feet. Gage read to hundredths twice daily and oftener during floods. Daily discharge ascertained by applying mean daily gage height to rating table. Records fair.

Discharge measurements of Elm Fork of Trinity River near Dallas, Tex., during the period Aug. 30, 1920, to Sept. 30, 1921.

Date.	Made by—	Gage height.	Discharge.	Date.	Made by—	Gage height.	Discharge.
1920.		*Feet.*	*Sec.-ft.*	1921.		*Feet.*	*Sec.-ft.*
Aug. 30	Ellsworth and Twichell	10.63	6,200	Jan. 19	R. G. West	4.77	1,000
31	do	11.75	6,560	Apr. 8	McCashin and Huffaker.	16.07	14,900
Sept. 1	do	13.96	8,530	9	do	15.21	11,400
4	T. Twichell	4.84	1,070	10	C. E. McCashin	a13.79	6,980
Oct. 17	R. G. West	3.13	68	May 26	R. G. West	3.22	88.7
Dec. 14	Ellsworth and Clark	3.95	419	Aug. 3	C. E. Ellsworth	2.90	9.9

a Rapidly falling stage.

Daily discharge, in second-feet, of Elm Fork of Trinity River near Dallas, Tex., for the year ending Sept. 30, 1921.

Day.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.
1	.....	670	540	395	434	602	368	351	152	180	15	0.0
2	.....	1,170	434	368	406	583	330	602	635	200	10	.0
3	.....	1,050	384	330	395	570	300	384	2,380	124	9.4	.0
4	.....	552	368	315	395	540	290	330	1,490	110	8.3	.0
5	.....	395	340	290	395	468	4,330	254	1,650	82	3.8	.0
6	.....	340	378	290	395	450	11,200	245	340	152	2.0	.0
7	.....	330	892	268	412	528	15,800	200	268	82	.4	.0
8	.....	290	1,330	268	406	780	15,100	200	422	92	.0	.0
9	.....	276	1,170	268	635	705	11,400	236	1,330	64	272	18
10	.....	855	705	245	462	450	8,750	930	1,090	47	315	32
11	.....	705	540	384	384	705	892	498	2,540	50	110	12
12	.....	705	462	2,460	351	1,970	685	281	1,490	79	34	12
13	.....	616	570	8,280	315	1,250	602	209	1,650	498	18	6.1
14	.....	422	439	11,000	315	855	570	180	855	498	12	.8
15	.....	325	356	10,600	315	1,730	635	160	705	439	5.0	.0
16	.....	290	325	9,270	315	2,050	855	290	281	160	1.4	.0
17	64	268	290	5,180	290	1,170	498	254	192	96	.0	.0
18	67	268	268	1,410	1,130	602	395	209	152	64	.0	.0
19	124	245	268	1,050	7,450	635	340	168	152	50	.0	.0
20	510	245	268	855	11,200	1,810	340	140	120	39	.0	.0
21	1,010	245	1,570	818	11,900	1,810	384	113	120	37	.0	.0
22	892	245	4,670	780	10,500	1,330	1,330	113	222	34	.0	.0
23	1,050	245	6,230	742	6,590	780	1,090	113	1,330	70	.0	.0
24	3,060	222	2,210	780	1,330	1,130	670	92	780	99	.0	.0
25	8,630	200	705	780	930	1,650	351	85	930	340	.0	.0
26	9,400	670	570	705	818	1,010	930	85	705	930	.0	.0
27	9,400	2,210	540	570	705	635	2,630	85	395	422	.0	.0
28	9,010	2,880	498	498	635	818	1,170	85	300	102	.0	.0
29	1,130	1,810	434	480	.....	635	522	79	180	50	.0	.0
30	522	780	395	480	.....	818	540	79	140	37	.0	.0
31	474	.....	395	450	.....	462	.....	102	.....	23	.0	.....

NOTE.—Possibly some backwater from West Fork Oct. 24–29, Dec. 22–25, Jan. 13–18, Feb. 19–24, Mar. 12, Apr. 6–8, 10, and 11. No flow Aug. 8, Aug. 17 to Sept. 8, and Sept. 15–30.

Monthly discharge of Elm Fork of Trinity River near Dallas, Tex., for the year ending Sept. 30, 1921.

Month.	Discharge in second-feet.			Run-off in acre-feet.
	Maximum.	Minimum.	Mean.	
October 17–31	9,400	64	3,020	89,800
November	2,880	200	651	38,700
December	6,230	268	921	56,600
January	11,000	245	1,960	121,000
February	11,900	290	2,140	119,000
March	2,050	450	953	58,600
April	15,800	290	2,770	165,000
May	930	79	231	14,200
June	2,540	120	767	45,600
July	930	23	169	10,400
August	315	.0	26.3	1,620
September	32	.0	2.70	161
The period	.....	.....	.....	721,000

BRAZOS RIVER BASIN.

BRAZOS RIVER AT WACO, TEX.

LOCATION.—At Southern Traction Co.'s bridge in Waco, McLennan County, 2½ miles below mouth of Bosque River, 4½ miles above mouth of Cottonwood Creek, and 9 miles above Lock No. 8.

DRAINAGE AREA.—25,500 square miles (measured on standard topographic maps; post-route map; and topographic map of Texas, compiled in 1899 by Robert T. Hill, of the United States Geological Survey, scale 1 inch=25 miles).

RECORDS AVAILABLE.—September 14, 1898, to December 31, 1911; October 1, 1914, to September 30, 1921. Records of stage have been obtained by United States Weather Bureau since August 9, 1900.

GAGE.—Gurley graph water-stage recorder installed March 29, 1918, on downstream side of pier of Southern Traction Co.'s bridge, 100 feet upstream from suspension bridge; inspected by Manton Hannah. For history of gages used prior to March 29, 1918, see Water-Supply Paper 508, page 12.

DISCHARGE MEASUREMENTS.—Made from upstream side of first one-span highway bridge above gage.

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 extremely high stages. Channel straight above and below for several thousand feet. Location of control not known.

EXTREMES OF DISCHARGE.—Maximum stage from water-stage recorder, 18.0 feet at 8 a. m. June 11 (discharge, 31,100 second-feet); minimum discharge, 91 second-feet on August 25.

1898–1921: Maximum stage recorded, 39.7 feet December 3, 1913 (discharge not determined); no flow August 20–21, 1918.

ICE.—None reported during year.

DIVERSIONS.—Record of the Board of Water Engineers for the State of Texas show that numerous small diversions are made above station for mining, irrigation, and municipal uses, but total probably does not appreciably affect the flow except during low stages.

REGULATION.—None.

ACCURACY.—Stage-discharge relation not permanent. Standard rating curve fairly well defined below 30,000 second-feet; above 30,000 second-feet curve based on one measurement made at discharge of 109,000 second-feet. Operation of water-stage recorder not satisfactory as indicated in footnote to daily-discharge table. Mean daily gage height obtained from recorder chart by inspection or by planimeter. Daily discharge determined by shifting-control method, except as noted in footnote to daily-discharge table. Records fair.

Discharge measurements of Brazos River at Waco, Tex., during the year ending Sept. 30, 1921.

Date.	Made by—	Gage height.	Discharge.	Date.	Made by—	Gage height.	Discharge.
		Feet.	*Sec.-ft.*			*Feet.*	*Sec.-ft.*
Oct. 4	R. G. West	7.07	787	Apr. 2	W. E. Colgin, jr	7.40	908
20	West and Colgin	6.48	459	16	do	7.60	1,010
Nov. 20	W. E. Colgin, jr	8.45	1,850	30	do	6.85	665
Dec. 4	do	7.94	1,710	May 14	do	7.28	858
Jan. 1	do	7.05	926	28	do	5.90	262
15	do	10.58	5,410	Aug. 3	T. Twichell	6.50	235
29	do	8.05	1,600	Sept. 8	D. A. Dudley	6.34	232
Feb. 27	do	9.08	2,690	26	do	7.35	789
Mar. 19	do	8.05	1,490				

Daily discharge, in second-feet, of Brazos River at Waco, Tex., for the year ending Sept. 30, 1921.

Day.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.
1	1,010	3,280	2,450	920	1,370	2,020	990	594	475	1,410	214	119
2	928	2,520	2,380	890	1,310	2,020	928	730	624	1,310	181	109
3	830	2,230	1,990	868	1,250	2,090	890	890	702	1,150	242	119
4	793	1,960	1,760	830	1,210	1,830	852	560	485	1,010	245	119
5	758	1,680	1,610	793	1,180	1,660	852	465	830	928	245	109
6	737	1,510	1,550	779	1,150	1,460	3,820	440	648	875	245	106
7	723	1,280	1,490	751	1,090	1,370	3,680	431	480	808	233	104
8	688	1,050	1,450	751	1,060	1,460	4,200	808	898	793	208	220
9	654	942	1,380	723	1,190	4,100	2,750	838	1,890	786	192	206
10	630	1,070	1,320	695	1,100	2,020	1,770	560	11,900	543	176	186
11	600	3,720	1,270	709	1,040	1,560	1,290	490	29,800	543	164	184
12	566	4,700	1,230	920	990	4,700	1,110	583	22,900	5,520	152	171
13	538	7,220	1,170	7,350	950	4,400	2,380	730	14,400	1,660	145	159
14	511	5,520	1,100	7,350	912	4,300	2,230	974	14,800	1,030	136	152
15	495	4,100	1,030	5,200	882	2,450	1,340	1,480	13,800	730	130	140
16	465	3,350	982	4,600	851	2,020	1,050	1,040	9,500	572	121	132
17	465	2,750	935	4,300	830	1,770	928	577	5,980	516	115	123
18	465	2,300	912	3,800	935	1,630	868	422	5,100	465	111	543
19	465	2,160	898	3,200	6,540	1,560	898	365	6,880	516	108	2,240
20	450	1,890	890	2,900	9,800	2,020	890	386	6,200	465	106	2,750
21	465	1,610	1,620	2,520	6,650	2,380	1,100	344	4,200	394	104	2,230
22	485	1,410	3,500	2,300	4,500	1,660	1,560	307	3,420	394	102	1,680
23	624	1,260	2,230	2,090	3,950	1,480	1,520	303	5,870	394	98	1,360
24	2,090	1,130	1,460	2,090	3,580	1,430	1,340	289	4,020	352	96	1,100
25	15,400	1,030	1,460	2,230	3,120	1,450	1,100	268	4,020	314	91	905
26	14,400	3,580	1,540	2,520	2,680	1,430	1,200	271	4,700	296	96	779
27	7,600	11,000	1,380	1,890	2,380	1,350	838	258	2,450	262	220	654
28	6,420	4,400	1,240	1,720	2,090	1,570	744	268	1,770	262	171	577
29	4,700	2,820	1,130	1,630	.....	1,300	681	268	1,830	262	125	495
30	3,500	2,380	1,050	1,550	.....	1,150	636	258	1,720	262	125	422
31	4,100	.....	982	1,460	.....	1,050	.....	242	.....	230	121	.....

NOTE.—Gage-height record of United States Weather Bureau used for following days when water-stage recorder did not operate: Oct. 17–19, Mar. 5–12, and July 10 to Aug. 1. Discharge partly estimated on following dates: Oct. 16, 20, Mar. 18, 19, Apr. 15, 16, 22, May 13, 14, June 6, 24, 25, July 1, 2, 8, 9, Aug. 2, 11, 12, Sept. 24, and 25.

Monthly discharge of Brazos River at Waco, Tex., for the year ending Sept. 30, 1921.

Month.	Discharge in second-feet.			Run-off in acre-feet.
	Maximum.	Minimum.	Mean.	
October	15,400	450	2,340	144,000
November	11,000	942	2,860	170,000
December	3,500	890	1,460	89,800
January	7,350	695	2,270	140,000
February	9,800	830	2,310	128,000
March	4,700	1,050	2,020	124,000
April	4,200	636	1,480	88,100
May	1,480	242	530	32,600
June	29,800	475	6,080	362,000
July	5,520	230	808	49,700
August	245	91	155	9,530
September	2,750	104	606	36,100
The year	29,800	91	1,900	1,370,000

BRAZOS RIVER NEAR COLLEGE STATION, TEX.

LOCATION.—At Jones Bridge, 4 miles below Munson Shoals, 6 miles southwest of College Station, Brazos County, 7 miles below mouth of Little Brazos River, and 19 miles above mouth of Yegua River.

DRAINAGE AREA.—35,400 square miles (measured on standard topographic maps; post-route map; and topographic map of Texas, compiled in 1899 by Robert T. Hill, of the United States Geological Survey, scale 1 inch=25 miles).

RECORDS AVAILABLE.—February 23, 1918, to September 30, 1921.

GAGE.—Vertical staff in two sections on fourth pier from right bank. Section 0 to 14 feet is attached to sheet piling around footing of pier. Section 14 to 52 feet is painted on same pier. Read by Jim Daniel or Alex Brown.

DISCHARGE MEASUREMENTS.—Made from bridge to which gage is attached.

CHANNEL AND CONTROL.—Bed composed of sand and mud; shifting. Location of control not known. Banks high and free from vegetation. Right bank subject to overflow at extremely high stages (about 40 feet).

EXTREMES OF DISCHARGE.—Maximum stage recorded during year 53.0 feet 1 to 3 a. m. September 12 (discharge not determined); minimum stage, 5.0 feet, August 26–29 (discharge, 215 second-feet).

1918–1921: Maximum stage, that of September 12, 1921; minimum stage, 3.75 feet September 4, 1918 (discharge, 92 second-feet).

ICE.—None reported during year.

DIVERSIONS.—No important diversions above or below station.

REGULATION.—None. A lock and dam is being constructed by the War Department about 25 miles upstream, which may eventually regulate the flow during extremely low stages.

ACCURACY.—Stage-discharge relation not permanent. Rating curve well defined below 40,000 second-feet, and poorly defined from 40,000 to 58,000 second-feet. Gage read to tenths twice daily. Daily discharge determined by shifting-control method, except as noted in footnote to daily-discharge table. Records fair.

Discharge measurements of Brazos River near College Station, Tex., during the year ending Sept. 30, 1921.

Date.	Made by—	Gage height.	Discharge.	Date.	Made by—	Gage height.	Discharge.
		Feet.	*Sec.-ft.*			*Feet.*	*Sec.-ft.*
Oct. 3	Ellsworth and West	8.28	2,330	Aug. 4	T. Twichell	6.20	752
Nov. 20	J. L. Lochridge	9.90	4,300	Sept. 8	D. A. Dudley	5.30	307
Dec. 17	do	8.40	2,590	14	Dudley and Lochridge	41.5	[a]58,700
Jan. 22	do	10.10	4,310	14	do	39.6	[a]56,200
Feb. 26	do	10.40	4,600	15	do	29.7	[a]23,800
Mar. 26	do	9.00	2,880	15	do	26.7	[a]17,200
May 3	do	9.80	3,860	24	D. A. Dudley	9.05	3,030
May 29	do	7.10	1,240				

[a] Surface velocities observed and coefficient of 0.95 used to reduce to mean velocities. Measurements at falling stage with probable backwater.

Daily discharge, in second-feet, of Brazos River near College Station, Tex., for the year ending Sept. 30, 1921.

Day.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.
1	2,220	4,640	12,800	2,620	3,230	4,100	3,230	6,280	1,140	8,480	1,140	305
2	2,220	5,480	6,860	2,700	3,140	4,100	2,700	4,310	1,140	4,530	1,080	290
3	2,380	4,640	5,870	2,700	3,050	4,100	2,380	3,900	1,140	3,500	885	275
4	2,220	4,310	4,640	2,380	3,050	4,100	2,220	3,900	1,140	3,050	770	275
5	2,150	3,600	4,420	2,380	3,050	4,000	2,080	3,900	3,500	2,780	770	260
6	1,630	3,320	4,100	2,380	2,960	3,500	3,230	3,800	4,420	2,620	715	245
7	1,560	2,870	3,700	2,380	2,960	3,230	11,200	3,500	4,420	2,150	715	245
8	1,560	2,700	3,320	2,380	2,870	3,230	24,200	3,140	4,420	2,000	715	340
9	1,560	2,460	3,320	2,300	2,460	3,410	20,800	2,870	3,410	2,000	660	4,200
10	1,560	2,460	3,140	2,300	2,460	4,000	18,800	19,600	4,100	2,460	660	21,500
11	1,560	2,460	3,140	2,220	2,380	7,340	11,400	12,600	12,400	10,800	660	.....
12	1,420	2,620	3,140	2,220	2,380	7,980	7,180	9,920	21,700	17,900	660	.....
13	1,420	2,620	3,140	2,700	2,380	6,280	8,480	6,860	24,700	18,300	660	.....
14	1,420	7,820	2,540	3,500	2,380	6,140	11,700	4,640	21,100	14,700	660	.....
15	2,220	7,660	2,540	4,530	2,380	8,840	12,400	3,500	20,800	8,840	632	40,300
16	2,620	5,610	2,540	6,700	2,380	8,300	9,020	4,100	18,500	4,870	578	18,100
17	5,610	5,610	2,540	6,280	2,380	5,740	4,420	4,100	17,100	2,460	528	10,600
18	4,870	4,640	2,460	5,350	2,700	4,100	4,000	3,320	11,700	2,000	505	8,660
19	1,920	4,420	2,460	5,110	3,900	3,800	3,800	3,140	9,560	1,920	460	7,500
20	1,700	4,420	2,460	4,870	6,140	3,700	3,800	2,780	7,820	1,850	400	6,140
21	2,220	4,420	2,540	4,420	8,660	3,700	3,800	2,300	7,340	1,630	340	4,990
22	4,000	3,700	3,140	4,200	9,380	3,600	12,800	2,300	8,840	1,560	305	4,990
23	2,300	3,410	4,100	4,100	7,660	3,600	12,100	2,150	17,500	1,280	275	4,750
24	2,960	3,410	4,100	4,000	6,140	3,700	10,500	2,000	12,400	1,280	275	3,900
25	5,870	2,700	4,310	4,200	5,110	3,500	9,920	1,780	9,380	1,420	275	4,530
26	15,500	5,350	4,200	4,870	4,750	3,050	11,000	1,700	9,380	1,210	215	4,420
27	18,500	8,660	3,700	5,230	4,310	2,870	12,100	1,700	10,300	1,210	215	4,420
28	11,000	20,800	3,230	4,200	4,200	3,500	13,200	1,700	12,400	1,140	215	4,530
29	8,660	21,500	3,230	4,000	.....	3,700	10,600	1,490	12,800	1,140	215	4,530
30	6,700	14,500	3,230	3,600	.....	3,230	7,180	1,560	11,700	1,140	245	4,750
31	5,350	.....	3,230	3,230	.....	2,870	.....	1,420	.....	1,140	305	.....

NOTE.—Discharge, Sept. 11–14 not determined because stage was above the limit for which rating curve is defined. Discharge, Sept. 18–30, doubtful, because section of gage below 14 feet was carried away.

Monthly discharge of Brazos River near College Station, Tex., for the year ending Sept. 30, 1921.

Month.	Discharge in second-feet.			Run-off in acre-feet.
	Maximum.	Minimum.	Mean.	
October	18,500	1,420	4,090	251,000
November	21,500	2,460	5,760	343,000
December	12,800	2,460	3,810	234,000
January	6,700	2,220	3,680	226,000
February	9,380	2,380	3,890	216,000
March	8,840	2,870	4,430	272,000
April	24,200	2,080	9,010	536,000
May	19,600	1,420	4,200	258,000
June	24,700	1,140	10,200	607,000
July	18,300	1,140	4,240	261,000
August	1,140	215	540	33,200

LITTLE RIVER AT CAMERON, TEX.

LOCATION.—200 feet below city pumping plant, half a mile south of Cameron, Milam County, 1 mile above Gulf, Colorado & Santa Fe Railway bridge, 6 miles below mouth of San Gabriel River, and 25 miles above confluence with Brazos River.

DRAINAGE AREA.—7,010 square miles (measured on standard topographic maps; post-route map; and topographic map of Texas, compiled in 1899 by Robert T. Hill, of the United States Geological Survey, scale 1 inch=25 miles).

RECORDS AVAILABLE.—November 1, 1916, to September 30, 1921.

GAGE.—Vertical and inclined staff; three sections attached to trees on left bank a short distance below home of pumpman; read by M. H. Hayes.

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

CHANNEL AND CONTROL.—Bed composed of rock, gravel, and sand; permanent during normal flow and free from vegetation. Banks composed of clay and gravel; medium height; wooded; subject to overflow only during extreme stages. At a stage of about 18 feet (discharge, 6,950 second-feet) water begins to enter old channel a mile above gage and returns to main channel below the gage; consequently, all records of discharge greater than 6,950 second-feet do not represent the total flow of the stream, but only that in the main channel. Rock and gravel shoal 100 feet below gage serves as control for low and medium stages; subject to change during flood stages. During extremely high stages on Brazos River, backwater may reach gage.

EXTREMES OF DISCHARGE.—Maximum stage recorded during year, 49.5 feet at 2.30 p. m. September 10 (discharge, 647,000 second-feet, determined by slope method using a value of 0.035 for "n" in Kutters formula; see "Channel and control" in station description); minimum stage, 1.82 feet from 6.30 p. m. September 6 to 7.25 a. m. September 8 (discharge, 112 second-feet).

1917–1921: Maximum stage recorded that of September 10, 1921; minimum stage, 0.78 foot at 7 a. m. September 3, 5, and 7, 1918 (discharge, 2.6 second-feet).

ICE.—None reported.

DIVERSIONS.—Numerous small diversions are made for irrigation and municipal uses, but such diversions have little effect on flow at station except during extremely low stages. Records of the Board of Water Engineers for the State of Texas show that about 2,500 acres have been declared irrigated above the station. No diversions of consequence below the station. During time of low flow, water pumped by Cameron Power & Light Co. will affect the flow at this station.

REGULATION.—Slight effect of pumping for city of Cameron.

ACCURACY.—Stage-discharge relation not permanent. Extremely high stages of Brazos River may cause backwater at this station. Rating curve well defined below 1,500 second-feet, and fairly well defined between 1,500 and 14,000 second-feet. However, this curve is for main channel only. Gage read to half-tenths twice daily and oftener during floods. Daily discharge ascertained by applying mean daily gage height to rating table; shifting-control method used October 1–14 and August 12 to September 30. Records of discharge do not include the water diverted past the station by an old channel 1 mile above the gage when the flow is above 6,950 second-feet. Records good for medium stages; fair for low and high stages.

Discharge measurements of Little River at Cameron, Tex., during the year ending Sept. 30, 1921.

Date.	Made by—	Gage height.	Discharge.	Date.	Made by—	Gage height.	Discharge.
		Feet.	*Sec.-ft.*			*Feet.*	*Sec.-ft.*
Oct. 2	Ellsworth and West...	5.00	1,000	Sept. 12	D. A. Dudley.....	32.8	[b] 13,900
July 10	T. Twichell.....	5.03	1,100	13	.....do.....	31.16	12,800
Aug. 4	.....do.....	2.40	236	21	.....do.....	5.76	1,230
Sept. 9	D. A. Dudley.....	2.00	177	21	.....do.....	5.70	1,220
10	.....do.....	49.5	[a]647,000				

[a] Includes flow in secondary channel; see "Channel and control." Used value of 0.035 for "n" in Kutters formula.

[b] Surface velocities observed and coefficient used to reduce to mean velocities. Estimated flow in other channel, 14,000 second-feet.

Daily discharge, in second-feet, of Little River at Cameron, Tex., for the year ending Sept. 30, 1921.

Day.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.
1	787	1,020	2,660	1,060	991	1,270	991	1,200	503	923	270	129
2	957	1,060	2,040	1,020	991	1,340	923	1,200	472	787	255	127
3	889	923	1,800	991	957	1,480	889	1,130	721	721	250	129
4	721	821	1,760	957	923	1,160	889	1,060	2,480	658	244	124
5	627	721	1,680	957	923	991	923	991	1,300	627	228	118
6	627	689	1,680	923	923	957	1,560	991	889	596	223	113
7	596	627	1,600	923	923	923	3,600	957	923	753	228	112
8	565	596	1,560	923	889	957	8,620	923	821	658	211	117
9	534	565	1,480	889	855	1,130	9,240	4,870	534	627	194	167
10	534	565	1,410	889	855	1,100	3,690	11,600	1,060	1,060	192	.....
11	503	658	1,340	855	821	1,200	1,880	9,140	2,040	3,690	190	.....
12	503	721	1,300	889	821	2,560	1,410	2,610	1,720	11,600	182	14,000
13	503	821	1,270	889	855	1,800	4,110	1,560	7,370	9,000	178	13,200
14	472	957	1,240	923	821	2,040	7,180	1,340	10,400	1,270	173	.....
15	2,120	1,020	1,200	1,130	787	4,350	4,250	1,060	5,830	787	169	.....
16	4,680	1,020	1,160	1,240	787	2,560	1,640	991	2,000	658	167	.....
17	2,740	1,160	1,100	1,240	787	1,560	1,480	1,060	1,760	565	160	.....
18	855	1,340	1,060	1,200	787	1,340	1,270	1,130	1,920	534	156	.....
19	658	1,440	1,020	1,130	855	1,240	1,130	1,060	1,880	488	150	.....
20	550	1,440	1,060	1,200	991	1,130	1,130	957	1,840	472	144	.....
21	534	1,410	1,160	1,200	1,060	1,160	2,920	923	1,720	441	140	1,240
22	821	923	1,300	1,130	1,130	1,240	7,030	957	1,720	426	134	1,150
23	889	855	1,410	1,130	1,100	1,380	5,260	855	7,370	394	131	1,060
24	658	787	1,340	1,100	1,100	1,200	2,200	753	5,350	379	129	977
25	787	753	1,060	2,080	1,100	1,130	1,560	689	1,520	364	124	889
26	1,520	1,060	1,200	2,200	1,200	1,130	2,740	658	2,040	348	120	821
27	1,600	5,740	1,160	1,440	1,340	1,160	7,420	596	3,240	332	120	923
28	923	9,960	1,130	1,130	1,410	1,130	3,790	565	1,520	317	129	1,020
29	753	7,180	1,100	1,160	.....	1,130	1,680	560	1,270	302	133	991
30	658	4,490	1,240	1,100	.....	1,100	1,300	534	1,240	286	134	1,520
31	787	.....	1,060	1,060	.....	1,020	.....	503	.....	270	129	.....

NOTE.—Discharge not determined for following days when gage height was above limit for which rating curve is defined: Sept. 10, 39.8 feet; Sept. 11, 39.8 feet. Gage not read Sept. 14-20. Discharge interpolated Sept. 22-24; gage not read.

Monthly discharge of Little River at Cameron, Tex., for the year ending Sept. 30, 1921.

Month.	Discharge in second-feet.			Run-off in acre-feet.
	Maximum.	Minimum.	Mean.	
October	4,680	472	979	60,200
November	9,960	565	1,710	102,000
December	2,660	1,020	1,370	84,200
January	2,200	855	1,130	69,500
February	1,410	787	964	53,500
March	4,350	923	1,420	87,300
April	9,240	889	3,090	184,000
May	11,600	503	1,720	106,000
June	10,400	472	2,450	146,000
July	11,600	270	1,300	79,900
August	270	120	174	10,700

NOTE.—The above table shows the discharge in main channel only. See "Channel and control."

COLORADO RIVER BASIN.

COLORADO RIVER AT BALLINGER, TEX.

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

DRAINAGE AREA.—12,500 square miles (revised; measured on standard topographic maps; post-route map; and topographic map of Texas, compiled in 1899 by Robert T. Hill, of the United States Geological Survey, scale 1 inch=25 miles).

RECORDS AVAILABLE.—December 11, 1915, to September 30, 1921. 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 A. J. Voelkel. Zero of gage lowered 1 foot on May 4.

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; shifting. Control is shoal 1,000 feet below gage; shifts.

ICE.—None reported during year.

EXTREMES OF DISCHARGE.—Maximum stage recorded during year, 15 feet, during night of June 7 (discharge, 17,400 second-feet, determined from extension of rating curve); no flow July 15 to September 2, and September 23–30.

1916–1921: Maximum stage recorded, 18.50 feet at 7.30 a. m. July 21, 1919 (discharge not determined); no flow during several periods.

DIVERSIONS.—During low stages a large part of the flow is diverted a few miles above the station for irrigation. Records of the Board of Water Engineers for the State of Texas show that about 6,900 acres have been declared irrigated above station.

REGULATION.—None of consequence.

ACCURACY.—Stage-discharge relation not permanent. Rating curve fairly well defined below 12,000 second-feet. Gage read to hundredths twice daily. Daily discharge determined by shifting-control method. Records fair.

Discharge measurements of Colorado River at Ballinger, Tex., during the year ending Sept. 30, 1921.

[Made by D. A. Dudley.]

Date.	Gage height.	Discharge.	Date.	Gage height.	Discharge.	Date.	Gage height.	Discharge.
	Feet.	*Sec.-ft.*		*Feet.*	*Sec.-ft.*		*Feet.*	*Sec.-ft.*
Oct. 7	0.56	44.6	Feb. 4	0.22	19.7	May 4	[a]0.86	0.81
Dec. 7	.52	37.7	Mar. 12	.09	12.0	June 28	1.30	57.8
Jan. 10	.38	19.5	Apr. 19	.04	5.80	Aug. 6	.27	0

[a] Zero of gage lowered 1 foot before this measurement was made.

Daily discharge, in second-feet, of Colorado River at Ballinger, Tex., for the year ending Sept. 30, 1921.

Day.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.
1	56	73	38	24	24	38	40	3.4	17	69	.....	.....
2	51	65	38	24	23	33	37	2.6	9.7	40	.....	.....
3	49	60	35	24	23	29	29	1.7	5.0	27	.....	1,110
4	49	54	35	22	23	24	24	.8	2.8	23	.....	492
5	45	47	37	22	20	23	22	.2	2.4	17	.....	194
6	45	51	38	22	20	23	22	.1	2.4	12	.....	123
7	44	44	35	22	17	23	52	.3	9,720	5.5	.....	94
8	38	42	32	22	16	23	51	.5	7,060	3.2	.....	73
9	42	42	32	22	14	19	42	3.2	3,180	.8	.....	49
10	38	269	32	20	14	13	65	14	1,960	.4	.....	38
11	37	872	32	23	14	13	52	15	805	.9	.....	30
12	37	655	29	27	14	13	44	9.7	404	.3	.....	22
13	32	243	29	30	14	13	32	5.5	537	.2	.....	20
14	30	200	29	33	14	13	29	4.2	718	.3	.....	14
15	27	171	29	33	14	13	22	970	606	.....	.....	9.7
16	26	125	29	33	14	13	22	243	2,150	.....	.....	8.6
17	24	107	29	33	14	13	22	148	330	.....	.....	5.0
18	23	89	29	33	17	13	19	65	140	.....	.....	3.7
19	1,560	81	26	33	17	29	14	103	96	.....	.....	2.4
20	188	69	26	33	22	42	13	116	79	.....	.....	.9
21	105	63	26	32	22	30	12	73	128	.....	.....	.8
22	67	58	26	32	24	26	11	51	168	.....	.....	.6
23	60	56	26	32	23	23	10	38	92	.....	.....	.....
24	1,900	51	26	40	19	17	9.6	29	71	.....	.....	.....
25	185	51	26	38	17	17	8.7	23	118	.....	.....	.....
26	160	51	26	35	17	15	7.8	19	81	.....	.....	.....
27	148	49	24	40	17	140	7.0	14	67	.....	.....	.....
28	148	47	23	47	19	100	6.1	11	56	.....	.....	.....
29	130	44	23	42	.....	75	5.2	9.7	49	.....	.....	.....
30	105	40	26	27	.....	56	4.3	5.5	112	.....	.....	.....
31	89	.....	26	27	.....	41	.....	29	.....	.....	.....	.....

NOTE.—No flow July 15 to Sept. 2, and Sept. 23–30. Gage not read Apr. 20 to May 3: discharge interpolated.

Monthly discharge of Colorado River at Ballinger, Tex., for the year ending Sept. 30, 1921.

Month.	Discharge in second-feet.			Run-off in acre-feet.
	Maximum.	Minimum.	Mean.	
October	1,900	23	179	11,000
November	872	40	129	7,680
December	38	23	29.6	1,820
January	47	20	29.9	1,840
February	24	14	18.1	1,000
March	140	13	31.1	1,910
April	65	4.3	24.5	1,460
May	970	.1	64.8	3,980
June	9,720	2.4	959	57,100
July	69	0	6.44	396
August	0	0	0	0
September	1,110	0	76.4	4,550
The year	9,720	0	128	92,700

COLORADO RIVER NEAR CHADWICK, TEX.

LOCATION.—At 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 line between San Saba and Lampasas counties, and 2½ miles below mouth of San Saba River.

DRAINAGE AREA.—26,400 square miles (measured on standard topographic maps; post-route map; and topographic map of Texas, compiled in 1899 by Robert T. Hill, of the United States Geological Survey, scale 1 inch=25 miles).

RECORDS AVAILABLE.—October 21, 1915, to September 30, 1921.

GAGE.—Vertical and inclined staff, in 4 sections, on right bank, 75 feet upstream from railway bridge. A high-water section is painted on second concrete pier from left abutment of railway bridge; read by A. G. Walker. For history of gages used prior to April 1, 1920, see Water-Supply Paper 508, page 28.

DISCHARGE MEASUREMENTS.—Made either by wading or from railroad bridge at gage, or from Red Bluff highway bridge, 2½ miles below gage.

CHANNEL AND CONTROL.—Bed composed of rock and gravel; shifts slightly. 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. Location of control not known, but current-meter measurements indicate that it shifts affecting stage-discharge relation at low stages.

EXTREMES OF DISCHARGE.—Maximum stage recorded during year, 17.4 feet at 11.30 a. m. June 10 (discharge, 18,000 second-feet); minimum stage, 0.64 foot at 5 p. m. August 26 (discharge, 39 second-feet).

1916–1921: Maximum stage, 41.35 feet at 9.20 a. m. November 10, 1919 (discharge, 77,100 second-feet); minimum stage, 0.16 foot August 22 and 23, 1918 (discharge, 1.5 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. Records of the Board of Water Engineers for State of Texas show that about 30,000 acres have been declared irrigated above the station.

REGULATION.—None of consequence except possibly during extremely low stages.

ACCURACY.—Stage-discharge relation for low stages not permanent owing to sand and gravel on control, but not seriously affected during medium and high stages. Rating curve well defined below 80,000 second-feet. Gage ordinarily read daily to hundredths during low and medium stages, and to tenths during high stages. One reading a day may not be a true index to discharge, owing to rapid fluctuations. Daily discharge determined by shifting-control method except as noted in footnote to daily-discharge table. Records fair.

Discharge measurements of Colorado River near Chadwick, Tex., during the year ending Sept. 30, 1921.

Date.	Made by—	Gage height.	Discharge.	Date.	Made by—	Gage height.	Discharge.
		Feet.	*Sec.-ft.*			*Feet.*	*Sec.-ft.*
Oct. 15	D. A. Dudley	1.48	247	Apr. 27	D. A. Dudley	1.18	137
Dec. 1	do	2.01	442	May 20	do	2.00	420
Jan. 27	do	1.52	233	Aug. 9	do	.69	38.4
Mar. 3	Dudley and Fellows	1.64	294	Sept. 1	do	.82	63.8

Daily discharge, in second-feet, of Colorado River near Chadwick, Tex., for the year ending Sept. 30, 1921.

Day.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.
1	297	615	430	248	220	277	253	143	218	200	57	63
2	291	595	395	238	220	294	248	149	184	200	54	48
3	291	412	380	238	220	294	248	151	149	195	51	45
4	291	380	365	232	215	261	248	153	129	155	51	305
5	288	320	365	232	212	255	242	153	121	151	48	264
6	288	320	365	228	212	248	241	153	117	143	50	900
7	285	320	350	225	212	248	240	155	117	131	50	335
8	288	320	335	224	212	368	232	157	133	123	50	305
9	285	320	335	222	212	750	232	155	8,520	115	50	264
10	280	760	323	220	215	430	225	157	18,000	75	46	210
11	274	810	322	222	218	395	218	159	15,600	69	46	205
12	269	1,310	320	222	222	392	218	161	6,460	60	44	195
13	264	1,240	314	225	228	362	210	163	7,220	60	44	190
14	258	1,050	311	228	228	532	210	163	9,990	75	48	180
15	248	840	310	230	228	389	202	163	7,740	62	54	175
16	248	770	308	228	225	389	202	232	6,000	62	51	135
17	248	713	302	225	225	356	202	240	4,210	77	48	95
18	248	656	302	225	225	356	195	248	1,840	62	46	79
19	245	496	299	218	225	356	190	255	1,300	46	46	83
20	245	430	297	215	232	522	190	420	750	58	46	75
21	245	430	297	212	353	687	185	308	705	60	45	72
22	245	395	294	212	338	504	185	269	750	63	43	69
23	248	377	291	232	320	482	178	264	365	63	41	66
24	518	365	288	238	283	482	157	258	305	63	40	66
25	518	359	285	232	272	380	153	256	277	63	40	60
26	1,040	1,140	280	232	264	332	141	253	277	58	39	57
27	1,200	1,920	277	232	258	317	137	248	277	56	68	60
28	875	1,680	272	222	264	302	137	242	215	50	58	57
29	825	1,260	264	222	.....	285	137	238	210	50	58	57
30	728	850	264	222	.....	285	140	235	210	50	54	60
31	638	.....	261	222	.....	285	.....	222	.....	56	54	.....

NOTE.—Gage not read Oct. 25–27; discharge estimated by comparison with records of flow for other stations. Gage not read and discharge interpolated Oct. 21, Nov. 17, 26, 29, Dec. 11, 15, 23, Jan. 1, 8, Feb. 7, Mar. 20, Apr. 6, 30, May 3, 18, 25, June 2, 19, and Aug. 19.

Monthly discharge of Colorado River near Chadwick, Tex., for the year ending Sept. 30, 1921.

Month.	Discharge in second-feet.			Run-off in acre-feet.
	Maximum.	Minimum.	Mean.	
October	1,200	245	404	24,800
November	1,920	320	715	42,500
December	430	261	316	19,400
January	248	212	227	14,000
February	353	212	241	13,400
March	750	248	381	23,400
April	253	137	200	11,900
May	420	143	210	12,900
June	18,000	117	3,080	183,000
July	200	46	88.7	5,450
August	68	39	49.0	3,010
September	900	45	159	9,460
The year	18,000	39	502	363,000

COLORADO RIVER AT MARBLE FALLS, TEX.

LOCATION.—At steel highway bridge one-fourth mile south of Marble Falls, Burnet County, 10 miles below mouth of Sandy Creek, 16 miles below mouth of Llano River, and 23 miles above mouth of Pedernales River.

DRAINAGE AREA.—32,200 square miles (measured on topographic and post-route maps).

RECORDS AVAILABLE.—October 1, 1916, to September 30, 1921. Miscellaneous discharge measurements were made in 1902. Records of stage have been obtained by the United States Weather Bureau since January 1, 1908.

GAGE.—United States Weather Bureau weight and tape gage on upstream side of bridge; read by M. M. Galloway.

DISCHARGE MEASUREMENTS.—Made from bridge or by wading.

CHANNEL AND CONTROL.—Bed composed of solid rock. Banks composed of rock, gravel, and clay; high, wooded, and not subject to overflow. Rapids just below gage serve as fairly permanent control.

EXTREMES OF DISCHARGE.—Maximum stage recorded during year, 10.3 feet at 5.30 p. m. June 12 (discharge, 28,800 second-feet); minimum stage, 0.35 foot at 5.30 p. m. August 23, 24, and at 7.30 a. m. August 25 (discharge, 33 second-feet).

1900–1921: Maximum stage, 23.9 feet, April 7, 1900 (discharge not determined); no flow August 7, 8, 11–25, 1918, caused by storing water above gage.

ICE.—None reported during year.

DIVERSIONS.—Several large projects have been proposed in the drainage basin above station, but none have been developed. Numerous small diversions for irrigation and municipal uses are made above the station. Total amount diverted not known. Records of the Board of Water Engineers for the State of Texas show that approximately 36,000 acres have been declared irrigated by diversions above station. Little water is diverted between Marble Falls and Austin.

REGULATION.—None of importance except possibly during extremely low stages.

ACCURACY.—Stage-discharge relation fairly permanent. Rating curve well defined. Gage read to hundredths twice daily, though influence of wind on tape may introduce some error. Daily discharge determined by applying mean daily gage height to rating table; shifting-control method used September 12–30. Records good.

Discharge measurements of Colorado River at Marble Falls, Tex., during the year ending Sept. 30, 1921.

[Made by D. A. Dudley.]

Date.	Gage height.	Discharge.	Date.	Gage height.	Discharge.
	Feet.	*Sec.-ft.*		*Feet.*	*Sec.-ft.*
May 21	1.68	343	Aug. 10	0.65	57.7
June 24	2.75	990	Sept. 2	1.28	179

Daily discharge, in second-feet, of Colorado River at Marble Falls, Tex., for the year ending Sept. 30, 1921.

Day.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.
1	585	1,060	1,180	618	492	552	618	304	230	618	76	154
2	585	848	1,060	522	492	492	618	304	195	552	66	187
3	848	762	946	492	552	552	552	268	195	465	58	222
4	762	762	897	492	522	552	552	268	177	344	66	170
5	618	762	762	492	492	552	618	268	182	304	54	133
6	618	688	762	492	552	618	762	230	177	268	54	118
7	618	618	762	492	552	653	688	203	163	230	46	133
8	653	618	688	492	492	688	848	268	177	214	48	137
9	552	585	618	552	552	618	688	492	163	230	62	2,500
10	492	552	618	492	492	618	618	1,430	4,740	208	60	3,450
11	438	618	618	552	438	618	552	1,720	20,400	214	56	1,300
12	438	653	618	618	413	618	618	1,300	28,200	230	62	725
13	413	618	688	618	438	688	762	1,180	10,400	203	66	725
14	438	762	618	618	388	688	1,180	1,060	9,340	177	56	552
15	492	848	585	618	388	688	1,240	618	10,100	170	48	388
16	438	1,060	552	585	388	946	1,060	388	7,230	158	46	324
17	413	1,240	552	552	388	848	946	344	3,930	154	48	286
18	388	1,000	552	492	438	848	762	344	2,500	137	54	252
19	438	848	552	492	552	848	552	304	2,230	154	44	236
20	438	848	618	552	492	688	438	286	2,050	133	37	200
21	492	762	618	585	438	618	388	304	1,720	154	35	175
22	438	725	618	618	388	1,300	366	268	1,060	154	37	175
23	762	688	618	618	438	2,050	344	268	762	133	39	152
24	1,300	688	552	688	618	1,360	388	252	848	114	35	152
25	1,300	688	618	762	552	1,180	388	304	762	97	35	131
26	1,300	1,720	552	688	552	946	492	268	946	80	44	128
27	3,120	3,930	618	618	492	848	618	236	848	80	48	116
28	3,330	3,450	552	585	492	848	492	230	762	86	56	109
29	1,570	2,600	552	552	.....	725	344	236	688	80	54	116
30	1,180	1,300	552	552	.....	653	304	252	618	66	58	131
31	1,060	.....	552	492	.....	618	.....	214	.....	68	80	.....

Monthly discharge of Colorado River at Marble Falls, Tex., for the year ending Sept. 30, 1921.

Month.	Discharge in second-feet.			Run-off in acre-feet.
	Maximum.	Minimum.	Mean.	
October	3,330	388	855	52,600
November	3,930	552	1,080	64,300
December	1,180	552	666	41,000
January	762	492	567	34,900
February	618	388	482	26,800
March	2,050	492	791	48,600
April	1,240	304	627	37,300
May	1,720	203	465	28,600
June	28,200	163	3,730	222,000
July	618	66	202	12,400
August	80	35	52.5	3,230
September	3,450	109	453	27,000
The year	28,200	35	826	599,000

COLORADO RIVER AT AUSTIN, TEX.

LOCATION.—At Congress Avenue concrete viaduct in Austin, Travis County, half a mile below Shoal Creek and above mouth of Waller Creek, 1 mile below mouth of Barton Creek, and 3½ miles below Austin dam.

DRAINAGE AREA.—34,200 square miles (measured on standard topographic maps; post-route map; and topographic map of Texas compiled in 1899 by Robert T. Hill, of the United States Geological Survey, scale 1 inch=25 miles).

RECORDS AVAILABLE.—February 15, 1898, to December 31, 1911; October 1, 1914, to September 30, 1921. 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.—Stevens water-stage recorder installed April 26, 1918, on downstream side of pier of viaduct, inspected by engineers from United States Geological Survey. Record of depth of water on crest of dam, 3½ miles above Austin was kept August 13, 1895, to April 7, 1900. Gage used February 15, 1898, to December 31, 1911, was a vertical staff, attached to bathhouse on left bank of river 150 feet above Congress Avenue Bridge; during this period high-stage readings were made by means of a gage painted on first pier from left end of bridge, and a chain gage attached to bridge. From October 1, 1914, to June 18, 1915, the vertical gage of United States Weather Bureau was read. Record from June 18, 1915, to April 25, 1918, was obtained by means of Dexter water-stage recorder installed at end of viaduct. All gages at or near bridge have been referred to same datum.

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

CHANNEL AND CONTROL.—Channel straight for 1,000 feet above and 500 feet below gage. Right bank of medium height, composed of clay and gravel, clean, improved by city, and subject to overflow; left bank resembles right bank except that it is high and nearly vertical in places. Bed clean and composed of rock, gravel, and sand; 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 during year from water-stage recorder, 19.4 feet at 11.55 p. m. September 10 (discharge, 75,700 second-feet); minimum stage, zero at 9 p. m. September 1 (discharge, 56 second-feet).

1898–1911; 1914–1921: Maximum stage recorded, 33.5 feet, just after failure of dam, which occurred at 11 30 a. m. April 7, 1900 (discharge, 236,000 second-feet, determined from extension of rating curve and subject to considerable error). At time of failure, the depth of water over crest of dam was 11.07 feet, the computed discharge being 151,000 second-feet (a revision of previously published discharge). According to information obtained from persons living near Congress Avenue Bridge, the stage rose 6.1 feet as a result of failure of dam. From this, the gage height corresponding to a discharge of 151,000 second-feet was 27.4 feet. According to Mr. W. P. Johnson, who was in charge of the power plant at the dam, the flood appeared to be practically at crest stage when the dam failed. Minimum stage, —0.18 foot at 6 p. m. August 18, 1918 (discharge, 13.0 second-feet).

ICE.—None during year.

DIVERSIONS.—Records of the Board of Water Engineers for the State of Texas show that approximately 36,000 acres of land have been declared irrigated by diversions above the station. Most of the area irrigated is in the upper basin of the main stream and adjacent to large tributaries. Little water is diverted between Austin and Columbus.

REGULATION.—Flow entirely regulated at times by operation at the Austin dam, about 3½ miles upstream. Neither sluice-gates, crest-gates, nor power plant at the dam were in operation during the years ending September 30, 1919, 1920, and 1921. Capacity of reservoir about 24,000 acre-feet.

ACCURACY.—Stage-discharge relation not permanent. Numerous measurements made throughout the year. Standard curve well defined between 20 and 30,000 second-feet and fairly well defined between 30,000 and 75,000 second-feet. Operation of water-stage recorder satisfactory except for short breaks in record as noted in footnote to daily-discharge table. Mean daily gage height obtained from water-stage recorder chart by inspection or by use of planimeter. Daily discharge ascertained by shifting-control method except as noted in footnote to daily-discharge table. Records good.

From recent information it is thought that the discharge as published in Water-Supply Paper 408 for December 13–26, 1914, and February 9–17, 1915, is too low. Discharge on these days probably exceeded 20 second-feet.

Discharge measurements of Colorado River at Austin, Tex., during the year ending Sept. 30, 1921.

Date.	Made by—	Gage height.	Discharge.	Date.	Made by—	Gage height.	Discharge.
		Feet.	*Sec.-ft.*			*Feet.*	*Sec.-ft.*
Oct. 2	T. Twichell	1.34	886	May 28	T. Twichell	0.98	532
23	do	1.04	543	June 7	C. E. Ellsworth	.72	316
Nov. 6	do	1.32	891	13	Ellsworth and Dudley	13.68	a43,100
20	do	1.45	1,240	20	McCashin and Dudley	2.13	2,860
Dec. 4	do	1.52	1,210	July 4	T. Twichell	1.20	701
Jan. 13	do	1.10	626	18	do	.74	320
27	do	1.30	860	23	do	.58	227
Feb. 15	do	1.00	539	30	do	.45	164
Mar. 2	do	1.16	700	Aug. 5	R. G. West	.30	121
18	do	1.35	998	8	T. Twichell	.26	113
Apr. 2	do	1.16	705	15	do	.12	75.7
16	do	1.97	2,620	27	do	.04	63.5
30	do	1.28	1,010	Sept. 26	do	.92	382
May 14	do	1.56	1,450				

a Made during rapidly falling stage.

Daily discharge, in second-feet, of Colorado River at Austin, Tex., for the year ending Sept. 30, 1921.

Day.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.
1	810	1,340	1,970	750	664	677	735	939	405	890	148	66
2	856	1,170	1,500	677	651	690	690	873	369	825	137	64
3	840	1,130	1,320	664	612	677	690	765	472	720	130	66
4	1,220	1,020	1,180	651	625	780	677	720	432	677	130	70
5	1,060	922	1,040	664	599	939	720	720	378	625	123	88
6	890	890	1,000	651	612	922	1,460	810	344	560	112	144
7	780	840	922	651	677	873	3,450	780	304	494	109	215
8	720	810	795	677	573	873	3,560	840	288	461	112	222
9	651	765	810	651	560	840	2,830	1,170	296	450	112	6,320
10	638	765	795	599	586	765	2,580	2,360	304	441	106	45,800
11	599	735	795	638	560	906	2,170	2,200	5,290	423	102	31,500
12	573	765	780	664	549	972	2,100	2,470	25,600	423	85	4,850
13	560	750	780	651	560	1,060	3,110	1,950	50,200	423	80	2,300
14	599	972	664	651	573	1,080	4,130	1,460	12,600	405	78	1,500
15	612	1,100	705	651	573	1,020	3,530	1,220	8,990	369	70	1,170
16	586	1,380	651	651	612	1,130	2,550	988	10,800	352	70	972
17	549	1,780	664	664	586	1,200	1,950	810	7,640	328	72	840
18	527	1,540	677	664	612	1,040	1,740	720	4,850	296	75	720
19	494	1,340	677	625	638	939	1,580	664	3,530	274	80	651
20	505	1,260	677	625	516	840	1,460	651	2,830	274	75	586
21	560	1,200	795	638	549	840	1,580	705	2,800	260	75	549
22	573	1,100	720	638	625	795	1,520	677	2,300	248	75	517
23	549	1,020	651	638	612	939	1,360	638	1,800	234	70	484
24	586	972	677	664	573	1,630	1,540	795	1,520	241	68	452
25	856	906	720	780	573	1,670	1,650	765	1,420	228	66	419
26	1,340	1,080	735	840	735	1,480	1,670	664	2,100	210	70	387
27	1,300	1,340	690	856	750	1,340	1,420	586	1,460	195	68	352
28	2,660	3,140	638	840	664	1,110	1,340	549	1,260	180	66	320
29	3,030	3,620	690	810	.....	922	1,200	505	1,100	175	68	336
30	2,100	2,830	735	720	.....	890	1,040	472	988	162	66	336
31	1,630	.....	735	664	.....	840	.....	423	.....	154	66	.....

NOTE.—Discharge, June 12, 13, 14, Sept. 9, 10, and 11, determined by averaging the discharge for intervals of the day. No record and discharge interpolated Sept. 22–25, and partly estimated Sept. 26.

Monthly discharge of Colorado River at Austin, Tex., for the year ending Sept. 30, 1921.

Month.	Discharge in second-feet.			Run-off in acre-feet.
	Maximum.	Minimum.	Mean.	
October	3,030	494	944	58,000
November	3,620	735	1,280	76,200
December	1,970	638	845	52,000
January	856	599	684	42,100
February	750	516	608	33,800
March	1,670	677	990	60,900
April	3,560	677	1,870	111,000
May	2,470	423	964	59,300
June	50,200	288	5,090	303,000
July	890	154	387	23,800
August	148	66	89.2	5,480
September	45,800	64	3,410	203,000
The year	50,200	64	1,420	1,030,000

EVAPORATION NEAR AUSTIN, TEX.

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

RECORDS AVAILABLE.—April 1, 1916, to September 30, 1921.

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 gage, rain gage, anemometer, maximum and minimum thermometers, and psychrometer. Reservoir about 30 feet wide and 250 feet long.

ACCURACY.—Moss and weed growth in reservoir may at times affect results. Record from land pan more accurate than that from floating pan. Observations made daily at 8 a. m. Observer's work good.

Evaporation near Austin, Tex., for the year ending September 30, 1921.

Month.	Temperature (°F.).					Mean relative humidity (per cent).	Wind.		Rainfall (inches).	Evaporation.	
	Air.			Water.			Average velocity (miles per hour).	Prevailing direction.		Floating pan.	Land pan.
	Mean maximum.	Mean minimum.	Mean.	Floating pan (mean).	Land pan (mean).						
October	80.8	55.7	68.2	67.7	63.3	83.2	1.2	Southeast	3.65	3.386	4.280
November	64.1	43.9	54.0	54.6	50.7	88.1	1.7	North and southwest.	3.02	2.324	2.805
December	64.3	35.5	49.9	48.2	46.3	86.1	2.3	Southwest	1.17	2.326	[a]3.031
January	66.9	42.8	54.8	52.6	48.7	86.9	2.3	Southeast	2.15	1.771	2.565
February	68.5	40.1	54.3	52.0	46.6	84.6	3.1	West	.76	2.821	3.652
March	75.6	55.9	65.8	64.8	61.6	89.5	2.3	Southeast	3.54	3.480	4.283
April	75.9	52.4	64.2	64.4	59.7	80.3	2.4	Southeast	8.67	[a]5.188	[a]6.671
May	85.5	62.0	73.8	74.4	69.5	80.0	1.5	South	2.91	5.827	6.196
June	88.5	69.4	79.9	80.7	76.1	82.7	1.5	South	7.43	5.479	6.881
July	92.2	70.8	81.5	82.3	78.1	80.6	1.5	South	2.24	7.119	8.080
August	95.4	69.8	82.6	81.0	76.8	73.6	1.5	South	.00	8.110	9.428
September	89.5	70.1	79.8	79.8	76.4	86.9	1.1	South	18.21	4.881	5.263
The year	78.9	55.7	67.3	66.9	62.8	83.5	1.9		53.75	52.712	63.135

[a] Estimated.

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 (measured on standard topographic maps; post-route map; and topographic map of Texas, compiled in 1899 by Robert T. Hill, of the United States Geological Survey, scale 1 inch=25 miles).

RECORDS AVAILABLE.—August 2, 1902, to December 31, 1911; May 22, 1916, to September 30, 1921. Records of stage have been obtained by the United States Weather Bureau since January 1, 1903.

GAGE.—Gurley graph water-stage recorder; inspected by A. S. Lowrey, J. H. Moore, or J. H. Hastedt. 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. Mott tape-and-weight gage on downstream handrail of bridge, property of the United States Weather Bureau, was read from December 17, 1907, to February 9, 1917, when regulation United States Geological Survey chain gage was installed and used until April 30, 1919, when present Gurley water-stage recorder was installed. All gages referred to same datum.

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. A sand and gravel section 350 feet below gage may serve as low-water control; the stage-discharge relation during medium and high stages may be controlled by a bend in river below bridge.

EXTREMES OF DISCHARGE.—Maximum stage during year from United States Weather Bureau records, 33.8 feet at 7 a. m. September 13 (discharge, 57,300 second-feet); minimum discharge, 257 second-feet September 4.

1902–1911; 1916–1921: Maximum stage recorded, 35.8 feet April 27, 1908 (revised discharge, 60,300 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 little water is diverted between Austin and Columbus. Station is above irrigated rice belt, which comprises several thousand acres. Records of the Board of Water Engineers for the State of Texas show that about 36,000 acres have been declared irrigated above Austin.

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

ACCURACY.—Stage-discharge relation not permanent. Rating curve fairly well defined below 55,000 second-feet. Operation of water-stage recorder satisfactory except for short breaks in record as noted in footnote to daily-discharge table. Mean daily gage height obtained from recorder chart by inspection or by planimeter. Daily discharge ascertained by shifting-control method. Records fair.

Discharge measurements of Colorado River at Columbus, Tex., during the year ending Sept. 30, 1921.

Date.	Made by—	Gage height.	Discharge.	Date.	Made by—	Gage height.	Discharge.
		Feet.	*Sec.-ft.*			*Feet.*	*Sec.-ft.*
Oct. 28	Kinnison and Pritchett	8.22	1,600	Aug. 17	R. G. West	5.62	305
Jan. 5	H. C. Pritchett	7.26	897	Sept. 13	C. E. McCashin	32.43	[a] 49,700
Mar. 23	do	7.76	1,560	14	do	16.95	[a b] 10,800
Apr. 27	R. G. West	11.00	4,350	14	do	15.40	[a b] 8,910
July 16	C. E. McCashin	7.14	993	15	do	13.00	5,750

[a] Rapidly falling stage. [b] Surface velocities observed and coefficient used to reduce to mean velocity.

Daily discharge, in second-feet, of Colorado River at Columbus, Tex., for the year ending Sept. 30, 1921.

Day.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.
1	1,260	3,330	3,160	908	1,060	869	1,630	1,820	824	2,410	302	274
2	1,230	2,600	3,730	908	1,010	2,950	1,500	1,710	764	2,010	310	271
3	1,160	2,100	3,060	914	954	4,540	1,450	1,600	698	1,820	313	271
4	1,160	1,820	2,360	914	908	3,110	1,360	1,480	662	1,670	320	257
5	1,300	1,630	1,930	908	895	1,970	3,670	1,410	728	1,600	324	260
6	1,230	1,560	1,740	888	895	1,440	2,140	1,300	1,600	1,520	340	264
7	1,410	1,480	1,560	882	850	1,260	6,700	1,260	986	1,410	328	268
8	1,480	1,410	1,440	862	824	1,230	37,900	1,200	752	1,370	324	271
9	1,340	1,370	1,370	843	812	1,260	29,500	1,230	1,060	1,370	320	310
10	1,200	1,300	1,300	830	806	1,220	13,500	2,180	1,100	1,220	313	313
11	1,140	1,220	1,230	843	824	4,800	10,600	4,280	862	2,140	310	30,000
12	1,070	1,160	1,230	908	794	21,000	7,360	5,500	740	1,780	313	50,900
13	1,040	1,140	1,200	973	776	11,600	5,650	3,110	1,060	2,360	320	48,300
14	1,010	1,170	1,120	1,010	770	10,000	6,250	2,850	29,500	1,410	316	16,400
15	1,340	1,220	1,080	960	664	9,670	8,210	2,850	37,900	1,100	313	8,390
16	1,340	1,210	1,060	928	752	4,670	5,220	2,460	16,200	1,010	296	5,800
17	1,090	1,300	1,020	882	740	2,900	5,080	2,010	11,000	934	302	4,410
18	1,300	1,410	1,000	869	752	2,320	4,030	1,740	12,900	876	306	3,550
19	1,160	1,480	992	862	1,180	2,140	3,220	1,560	11,000	806	299	3,000
20	1,010	1,900	973	869	1,860	2,050	2,700	1,370	7,700	752	292	2,550
21	1,120	1,860	1,600	876	1,340	1,860	2,360	1,230	5,500	710	288	2,230
22	1,520	1,710	1,710	869	1,050	1,710	6,400	1,150	4,410	656	285	2,010
23	1,670	1,560	1,120	862	1,010	1,560	3,790	1,090	43,400	628	282	1,820
24	3,220	1,480	1,050	856	928	1,480	3,670	1,040	18,400	606	282	1,860
25	1,560	1,370	1,060	1,200	843	1,420	2,230	1,020	8,750	535	274	1,970
26	2,460	1,410	980	1,860	824	1,390	2,320	954	9,110	485	278	1,600
27	3,000	2,800	928	1,930	800	1,780	3,910	934	12,500	396	324	1,370
28	1,740	2,360	928	1,480	758	2,140	3,220	973	7,700	356	278	1,440
29	1,670	2,100	928	1,260	.....	1,970	2,700	954	5,950	320	274	1,600
30	1,710	1,820	928	1,200	.....	1,900	2,010	954	3,000	302	274	1,480
31	2,600	.....	921	1,130	.....	2,180	.....	882	.....	306	274	.....

NOTE.—Discharge, June 11-30 and Sept. 4-13, determined from gage heights obtained from Weather Bureau chain gage readings. Discharge partly estimated owing to incomplete records Mar. 2, 3, 11, 12, Sept. 2, and 3.

Monthly discharge of Colorado River at Columbus, Tex., for the year ending Sept. 30, 1921.

Month.	Discharge in second-feet.			Run-off in acre-feet.
	Maximum.	Minimum.	Mean.	
October	3,220	1,010	1,500	92,200
November	3,330	1,140	1,680	100,000
December	3,730	921	1,440	88,500
January	1,930	830	1,020	62,700
February	1,860	664	917	50,900
March	21,000	869	3,560	219,000
April	37,900	1,360	6,340	377,000
May	5,500	882	1,750	108,000
June	43,400	662	8,560	509,000
July	2,410	302	1,120	68,900
August	340	274	302	18,600
September	50,900	257	6,450	384,000
The year	50,900	257	2,870	2,080,000

COLORADO RIVER AT WHARTON, TEX.

LOCATION.—At highway bridge in western edge of Wharton, Wharton County, 200 feet below Galveston, Harrisburg & San Antonio Railway bridge.

DRAINAGE AREA.—37,400 square miles (measured on standard topographic maps; post-route map; and topographic map of Texas, compiled in 1899 by Robert T. Hill, of the United States Geological Survey, scale 1 inch=25 miles).

RECORDS AVAILABLE.—July 12 to August 31, 1916; July 3 to August 18, 1917; July 11 to August 4, 1918; and March 19, 1919, to September 30, 1921.

GAGE.—Gurley graph water-stage recorder attached to pier of highway bridge near left bank, installed March 19, 1919; recorder was removed July 18, 1921, owing to repairs to pier and a temporary chain gage at same datum, attached to downstream guard rail of the bridge was used July 18 to September 30, 1921. Prior to March 19, 1919, vertical staff on right bank 75 feet below bridge; zero of this gage, 1.93 feet higher than zero of recorder.

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

CHANNEL AND CONTROL.—Channel straight above and below station for a few hundred feet. Bed composed of sand and clay; shifting. Banks medium in height, composed of clay, and subject to overflow during extreme stages.

EXTREMES OF DISCHARGE.—Maximum stage recorded during year, 31.55 feet at 11.56 a. m. September 14 (discharge, 35,900 second-feet, ascertained from extension of rating curve); minimum stage, 4.35 feet at 12.46 p. m. August 27 (discharge, 45 second-feet, ascertained from extension of rating curve).

1916–1921: Maximum stage recorded during periods of record, 33.9 feet at midnight October 15, 1919 (discharge, 39,600 second-feet, determined from extension of rating curve); minimum discharge, that of August 27, 1921.

ICE.—None reported.

DIVERSIONS.—Station is in area of rice irrigation, roughly estimated to cover about 75,000 acres, about one-third of which is irrigated by diversion from Colorado River between Columbus and Wharton, and the remaining two-thirds by diversion below Wharton. During periods of maximum demand, practically the entire flow is diverted, unless the river is above ordinary stage.

REGULATION.—Flow at low and medium stages is regulated to some extent by storage in Lake Austin at Austin, Tex.

ACCURACY.—Stage-discharge relation not permanent. Rating curve well defined from 500 to 15,000 second-feet, and fairly well defined to 30,000 second-feet, and extended above. Operation of water-stage recorder from October 1 to July 17 satisfactory, except for short breaks in record as indicated in footnote to daily-discharge table. From July 18 to September 30, recorder was not used and staff gage was read to hundredths once daily and oftener during floods. October 1 to March 2, daily discharge ascertained by applying to rating table mean daily gage height, determined from recorder graph by inspection or by planimeter. Shifting-control method used for remainder of year, except as noted in footnote to daily-discharge table. Records good except for extremely high and low stages.

Discharge measurements of Colorado River at Wharton, Tex., during the year ending Sept. 30, 1921.

Date.	Made by—	Gage height.	Discharge.	Date.	Made by—	Gage height.	Discharge.
		Feet.	*Sec.-ft.*			*Feet.*	*Sec.-ft.*
Oct. 26	Kinnison and Pritchett	7.00	1,670	July 17	C. E. McCashin	7.19	1,330
Jan. 3	H. C. Pritchett	6.00	1,000	Aug. 18	R. G. West	4.85	216
Mar. 24	do	6.92	1,510	Sept. 16	C. E. McCashin	13.51	6,370
Apr. 29	R. G. West	9.24	3,420				

Daily discharge, in second-feet, of Colorado River at Wharton, Tex., for the year ending Sept. 30, 1921.

Day.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.
1	1,730	2,330	1,890	1,060	1,270	890	2,600	2,510	840	3,750	500	272
2	1,570	3,250	2,600	1,000	1,130	1,060	1,970	2,150	790	3,250	482	290
3	1,570	2,780	3,550	1,000	1,130	5,270	1,570	1,970	690	2,870	465	272
4	1,490	2,330	3,250	1,000	1,060	4,930	1,410	1,810	690	2,510	430	238
5	1,410	1,970	2,690	1,000	1,000		2,600	1,730	650	2,330	412	272
6	1,410	1,810	2,240	1,000	1,000		6,470	1,570	610	2,150	430	325
7	1,490	1,650	1,970	1,000	940		4,710	1,490	890	1,970	482	325
8	1,490	1,570	1,810	1,000	940	1,750	13,700	1,410	1,000	1,810	465	290
9	1,650	1,490	1,650	940	890		27,300	1,340	790	1,810	465	325
10	1,570	1,410	1,570	940	890		21,300	1,340	790	2,060	308	360
11	1,410	1,340	1,490	940	890		12,600	1,810	1,130	1,890	220	3,350
12	1,340	1,270	1,410	940	890	2,780	10,500	3,850	1,000	3,650	238	27,300
13	1,270	1,200	1,340	1,060	890	16,500	7,860	5,270	890	2,870	238	32,100
14	1,200	1,200	1,340	1,060	840	9,160	6,470	3,450	10,200	2,690	220	35,000
15	1,270	1,270	1,270	1,060	840	10,200	7,600	2,960	25,500	2,150	220	13,400
16	1,270	1,200	1,270	1,060	840	7,990	8,120	2,870	20,700	1,570	150	7,990
17	1,490	1,270	1,200	1,000	840	4,490	5,990	2,600	12,400	1,340	150	5,270
18	1,270	1,270	1,200	1,000	890	3,150	5,630	2,060	12,000	1,130	202	4,160
19	1,270	1,340	1,130	940	890	2,510	4,710	1,730	11,900	1,060	290	3,550
20	1,340	1,410	1,130	940	1,000	2,150	3,950	1,490	9,420	1,000	325	3,150
21	1,410	1,650	1,130	940	1,650	1,970	3,350	1,270	7,340	940	308	2,780
22	1,340	1,810	1,340	940	1,650	1,810	3,450	1,130	9,680	790	308	2,420
23	1,410	1,730	2,060	940	1,270	1,650	6,950	1,060	25,600	740	325	2,240
24	1,730	1,570	1,410	940	1,130	1,490	4,380	940	30,700	790	308	2,060
25	3,550	1,490	1,270	940	1,060	1,410	3,950	890	15,200	650	238	1,890
26	1,890	1,490	1,200	940	1,000	1,410	2,960	890	9,550	650	202	2,060
27	1,970	1,490	1,130	1,490	890	1,340	2,870	890	12,900	610	45	1,730
28	2,960	2,240	1,130	1,970	890	1,490	4,160	840	10,600	518	448	1,570
29	2,060	2,510	1,060	1,730	.....	1,890	3,550	840	7,210	518	62	1,570
30	1,730	2,240	1,060	1,410	.....	2,240	3,250	840	4,820	518	150	1,730
31	1,730	.....	1,060	1,270	.....	3,450	.....	840	.....	535	255	.....

NOTE.—Discharge partly estimated owing to incomplete record Oct. 24, 25, Mar. 4, 12, 25, 26, June 15, 16, 24, and 25. No gage-height record Mar. 5–11; discharge estimated by comparison with records of flow at Columbus. Discharge Aug. 27 and 29 determined from extension of rating curve.

Monthly discharge of Colorado River at Wharton, Tex., for the year ending Sept. 30, 1921.

Month.	Discharge in second-feet.			Run-off in acre-feet.
	Maximum.	Minimum.	Mean.	
October	3,550	1,200	1,620	99,600
November	3,250	1,200	1,720	102,000
December	3,550	1,060	1,610	99,000
January	1,970	940	1,080	66,400
February	1,650	840	1,020	56,600
March	16,500	890	3,340	205,000
April	27,300	1,410	6,530	389,000
May	5,270	840	1,800	111,000
June	30,700	610	8,220	489,000
July	3,750	518	1,650	101,000
August	500	45	301	18,500
September	35,000	238	5,280	314,000
The year	35,000	45	2,830	2,050,000

NORTH CONCHO RIVER AT SAN ANGELO, TEX.

LOCATION.—At county concrete viaduct in San Angelo, Tom Green County, 1 mile above confluence of North Concho and South Concho rivers.

DRAINAGE AREA.—1,520 square miles (revised; measured on post-route map and topographic map of Texas, compiled in 1899 by Robert T. Hill, of the United Geological States Survey, scale 1 inch=25 miles).

RECORDS AVAILABLE.—October 27, 1915, to September 30, 1921.

GAGE.—Stevens continuous water-stage recorder, attached to left side of web of third pier of viaduct from left bank, installed September 1, 1920; inspected by engineers of United States Geological Survey and by B. W. Wynn. Prior to this date, gage used was vertical staff, attached to same pier. Both recorder and staff gage referred to same datum.

DISCHARGE MEASUREMENTS.—Made from second highway bridge upstream from gage, or by wading 400 feet below.

CHANNEL AND CONTROL.—Bed composed of solid rock which is, to some extent, covered in high-water channel with grass and moss. 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 about 4½ feet high, which, before the viaduct was constructed, served as part of low-water crossing; this dam forms an artificial control and insures a permanent stage-discharge relation.

EXTREMES OF DISCHARGE.—Maximum stage during year from water-stage recorder, 1.98 feet at 1.20 a. m. October 24 (discharge, 564 second-feet, determined from extension of rating curve); no flow October 13–21, June 1–8, and July 3 to September 30.

1916–1921: Maximum stage recorded, 5.5 feet at 5 p. m. October 25, 1918 (discharge, 7,370 second-feet, determined from curve extended by using formula $Q=CLH\ \frac{3}{2}$ and may be considerably in error); no flow for several periods during record.

ICE.—None reported during year.

DIVERSIONS.—Records of the Board of Water Engineers for the State of Texas show that about 600 acres have been declared irrigated by diversions from North Concho River, all above station.

REGULATION.—None of consequence.

ACCURACY.—Stage-discharge relation permanent. Rating curve well defined below 125 second-feet and extended above by use of formula $Q=CLH\ \frac{3}{2}$ for broad crested weirs, using a value of 2.20 for C and may be considerably in error. Operation of water-stage recorder satisfactory. Daily discharge ascertained by applying to rating table mean daily gage height obtained from recorder graph by inspection or by use of planimeter; for days of considerable fluctuation in stage, discharge averaged for intervals of the day. Records good, except those for extremely low or high stages, which may be subject to considerable error.

Discharge measurements of North Concho River at San Angelo, Tex., during the year ending Sept. 30, 1921.

[Made by D. A. Dudley.]

Date.	Gage height.	Discharge.	Date.	Gage height.	Discharge.	Date.	Gage height.	Discharge.
	Feet.	*Sec.-ft.*		*Feet.*	*Sec.-ft.*		*Feet.*	*Sec.-ft.*
Oct. 7	0.30	*a* 0.3	May 5	0.70	6.3	Aug. 6	.....	0.0
Jan. 8	.74	7.0	June 27	.46	*a*.2			

a Estimated.

Daily discharge, in second-feet, of North Concho River at San Angelo, Tex., for the year ending Sept. 30, 1921.

Day.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.
1	0.2	1.2	4.5	8.5	6.2	20	7.9	2.5	.....	0.2
2	.2	1.4	3.9	8.5	7.2	14	7.9	1.9	.....	.2
3	.2	1.4	4.9	8.5	6.2	13	7.9	1.5	.....	.....
4	.1	1.2	6.2	7.9	6.2	9.8	7.9	1.4	.....	.....
5	.1	1.2	6.2	6.6	5.8	9.8	8.5	3.9	.....	.....
6	.1	1.1	6.2	7.2	6.2	8.5	9.8	7.2	.....	.....
7	.1	1.1	6.6	7.2	6.2	8.5	11	4.9	.....	.....
8	.1	1.3	7.2	7.2	6.2	9.8	9.8	7.2	.....	.....
9	.1	2.9	7.2	7.2	6.2	9.2	9.8	7.2	38	.....
10	.1	4.5	7.2	7.2	6.2	7.9	9.2	5.8	1.2	.....
11	.1	18	7.2	7.9	6.6	7.2	11	4.5	.7	.....
12	.1	64	7.9	8.5	7.2	7.2	11	6.6	.4	.....
13	.....	28	7.2	8.5	7.2	7.2	9.2	3.2	126	.....
14	.....	14	7.2	9.2	9.2	7.9	9.2	1.9	50	.....
15	.....	12	7.2	8.5	8.5	8.5	8.5	1.8	8.5	.....
16	.....	9.2	7.9	8.5	7.9	8.5	7.9	3.2	6.2	.....
17	.....	8.5	8.5	8.5	7.9	9.2	7.9	1.8	5.3	.....
18	.....	8.5	9.2	9.2	7.9	11	7.9	2.5	3.5	.....
19	.....	7.9	9.8	7.9	8.5	19	8.5	2.5	2.3	.....
20	.....	6.6	9.8	7.9	8.5	14	8.5	1.9	1.4	.....
21	.....	7.2	9.2	7.2	7.9	12	8.5	1.3	2.1	.....
22	.1	9.2	9.8	7.9	8.5	11	8.5	1.1	1.8	.....
23	.8	7.9	9.8	7.9	8.5	11	7.2	.9	1.3	.....
24	134	5.8	9.8	7.2	8.5	8.5	6.6	.8	1.1	.....
25	13	4.5	9.8	7.2	8.5	7.9	5.3	.5	.8	.....
26	4.5	4.5	9.8	7.2	7.9	7.9	4.5	.5	.7	.....
27	2.1	4.5	9.8	6.6	7.9	7.2	3.5	.4	.6	.....
28	1.3	4.2	9.2	6.6	9.8	6.6	3.2	.3	.5	.....
29	1.0	4.9	9.2	6.6	.....	6.6	3.2	.2	.4	.....
30	.8	4.9	9.2	6.2	.....	6.6	4.5	.2	.3	.....
31	1.1	.....	8.5	6.6	.....	6.6	.....	.1	.....	.....

NOTE.—Discharge Oct. 23, 24, Nov. 11, June 9, and 13, determined by averaging discharge for intervals of the day. No flow for periods for which no discharge is given.

Monthly discharge of North Concho River at San Angelo, Tex., for the year ending Sept. 30, 1921.

Month.	Discharge in second-feet.			Run-off in acre-feet.
	Maximum.	Minimum.	Mean.	
October	134	0.0	5.17	318
November	64	1.1	8.39	499
December	9.8	3.9	7.94	488
January	9.2	6.2	7.67	472
February	9.8	5.8	7.48	415
March	20	6.6	9.75	600
April	11	3.2	7.81	465
May	7.2	.1	2.57	158
June	126	0	8.44	502
July	.2	0	.01	.6
August	0	0	0	0
September	0	0	0	0
The year	134	0	5.41	3,920

CONCHO RIVER NEAR SAN ANGELO, TEX.

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

DRAINAGE AREA.—4,780 square miles (revised; measured on standard topographic maps; post-route map; and topographic map of Texas, compiled in 1899 by Robert T. Hill, of the United States Geological Survey, scale 1 inch=25 miles).

RECORDS AVAILABLE.—September 17, 1915, to September 30, 1921.

GAGE.—Stevens continuous water-stage recorder, installed August 9, 1917, on right bank, 1,500 feet below an old ford; inspected by engineers of United States Geological Survey and by B. W. Wynn. Prior to August 9, 1917, a vertical staff gage in several sections attached to trees on left bank was used. Water-stage recorder and vertical staff gage referred to same datum.

DISCHARGE MEASUREMENTS.—Made by wading or from cable near 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 scattered trees, and subject to overflow at high stages. Rapids just below gage serve as control for medium and low stages. Location of control for high stages not known.

EXTREMES OF DISCHARGE.—Maximum stage during year from water-stage recorder, 14.7 feet at 4 p. m. August 31 (discharge, about 9,040 second-feet); minimum stage, 0.44 foot at 2 a. m. September 9 (discharge, 1.5 second-feet).

1915–1921: Maximum stage, 26.6 feet July 8, 1919, determined from flood marks on gage house (discharge, 40,500 second-feet, determined by slope method, assuming a value of 0.045 for "n" in Kutter's formula); minimum discharge, 0.1 second-foot October 6, 1918.

ICE.—None reported during year.

DIVERSIONS.—Flow at low stage materially affected by diversions above station. About a mile above mouth of South Concho River a storage dam has been constructed by the San Angelo Light & Power Co. for waterworks. Records of the Board of Water Engineers for the State of Texas show that about 11,000 acres have been declared irrigated by water diverted above the station, and about 3,500 acres by diversion below station.

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

ACCURACY.—Stage-discharge relation permanent. Rating curve well defined below 800 second-feet; above, it is based on determination of discharge (40,500 second-feet) at crest stage of 26.6 feet on July 8, 1919, using Kutter's formula with the value of 0.045 for "n" and may be considerably in error. Between 800 and 40,500 second-feet curve was drawn with discharge as a function of $A\sqrt{d}$. Operation of water-stage recorder not satisfactory as shown in footnote to daily-discharge table. Daily discharge ascertained by applying to rating table mean daily gage height obtained from recorder graph by inspection or by use of planimeter, or for days of considerable fluctuation in stage by averaging discharge for intervals of the day. Records good.

Discharge measurements of Concho River near San Angelo, Tex., during the year ending Sept. 30, 1921.

[Made by D. A. Dudley.]

Date.	Gage height.	Discharge.	Date.	Gage height.	Discharge.
	Feet.	*Sec.-ft.*		*Feet.*	*Sec.-ft.*
Oct. 8	1.46	54.2	June 27	1.20	24.6
Jan. 8	1.38	39.4	Aug. 5	.48	2.0
May 6	1.05	17.0			

Daily discharge, in second-feet, of Concho River near San Angelo, Tex., for the year ending Sept. 30, 1921.

Day.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.
1	37	48	51	40	38	74	35	4.7	2.7	12	1.9	244
2	37	45	53	41	39	51	36	8.3	2.3	10	1.9	34
3	36	44	53	44	42	49	37	74	2.3	8.0	1.9	6.6
4	40	44	51	45	42	45	37	28	2.3	6.0	1.8	2.4
5	41	44	48	45	41	41	29	15	2.3	3.5	1.8	2.0
6	41	42	49	44	38	37	29	14	2.3	3.2	1.8	2.0
7	44	44	51	41	38	37	29	12	2.3	2.8	1.9	1.9
8	48	49	53	39	38	34	25	14	2.3	2.4	2.0	2.1
9	44	51	53	39	37	30	25	18	2.3	2 2	1.9	2.2
10	45	54	51	40	14	31	24	38	127	2.0	1.9	2.2
11	45	70	51	37	12	30	35	19	568	2.0	2.2	2 0
12	40	127	51	39	12	29	30	16	101	2.2	2.1	2.3
13	37	88	48	42	14	26	26	12	349	2 2	2.1	3.3
14	32	72	46	42	12	25	22	9.1	506	2.2	2.0	4.4
15	30	64	44	42	12	32	14	8.7	140	2.2	2.2	5.2
16	28	59	44	44	10	31	12	10	76	2.1	2.2	5.5
17	32	57	45	44	12	31	12	6.8	54	1.8	2.2	5.0
18	36	60	48	45	12	33	11	8.3	51	2.0	2.2	2.7
19	37	56	48	45	14	64	11	9.1	48	2.0	2.2	2.0
20	33	53	34	44	16	59	11	10	45	2.0	2.2	2.1
21	32	50	39	41	18	49	11	12	41	1.9	2.2	2.1
22	28	50	39	40	19	40	11	12	38	2.0	2.2	2.0
23	30	50	40	41	19	44	9.9	14	35	2.0	2.2	2.0
24	243	50	39	44	19	41	9.5	12	32	2.0	2.3	2.0
25	64	53	40	45	19	41	7.9	9.1	29	2.2	2.3	1.8
26	50	56	39	45	18	39	6.8	7.0	26	2.1	2.3	2.0
27	42	56	39	45	16	37	6.3	4.9	23	2.0	2.3	2.2
28	40	53	40	44	26	37	5.2	4.4	20	2.0	2.3	2.0
29	40	53	40	44	.....	42	4.9	4.0	17	2.1	2.3	2.0
30	41	51	40	41	.....	40	4.3	3.6	14	2.1	2.3	2.0
31	50	.....	40	40	.....	38	.....	3.2	.....	2.0	810	.....

NOTE.—Discharge partly estimated owing to incomplete gage-height record on following days: Oct. 1, 2, Dec. 12, 15, May 27, June 2, 6–10, July 5, and Aug. 30. No gage-height record, Dec. 13, 14, May 26, 28–31, June 1, 3–5, 18–26, 28–30, July 1–4, and Aug. 18–29; discharge interpolated. Discharge Oct. 24, June 11, and 13 obtained by averaging the discharge for intervals of the day.

Monthly discharge of Concho River near San Angelo, Tex., for the year ending Sept. 30, 1921.

Month.	Discharge in second-feet.			Run-off in acre-feet.
	Maximum.	Minimum.	Mean.	
October	243	28	45.9	2,820
November	127	42	56.4	3,360
December	53	34	45.4	2,790
January	45	37	42.3	2,600
February	42	10	23.1	1,280
March	74	25	39.9	2,450
April	37	4.3	18.9	1,120
May	74	3.2	13.6	836
June	568	2.3	78.7	4,680
July	12	1.8	3.07	189
August	810	1.8	28.2	1,730
September	244	1.8	11.8	702
The year	810	1.8	33.9	24,600

CONCHO RIVER NEAR PAINT ROCK, TEX.

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

DRAINAGE AREA.—5,790 square miles (revised; measured on standard topographic maps; post-route map; and topographic map of Texas, compiled in 1899 by Robert T. Hill, of the United States Geological Survey, scale 1 inch=25 miles).

RECORDS AVAILABLE.—September 20, 1915, to September 30, 1921.

GAGE.—Stevens continuous water-stage recorder attached to downstream end of middle pier of railroad bridge; installed September 16, 1920; inspected by engineers of the United States Geological Survey and by N. N. Skaggs. Prior to September 16, 1920, gage was vertical staff, attached to same pier.

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.—Maximum stage during year from water-stage recorder, 6.75 feet at 3.20 a. m. September 1 (discharge, 4,370 second-feet); minimum stage, 0.77 foot at midnight September 30 (discharge, 0.6 second-foot).

1915–1921: Maximum stage recorded, 13.5 feet at 7.30 a. m. June 10, 1919 (discharge, 21,300 second-feet); no flow during several periods of every year except 1920 and 1921.

ICE.—None reported during year.

DIVERSIONS.—Records of the Board of Water Engineers for the State of Texas show that about 11,000 acres have been declared irrigated by diversions from Concho River, practically all of which are above the station. Flow during low stages is materially affected by diversions.

REGULATION.—Ten storage dams of small capacity are located between this station and San Angelo. An abandoned dam, 12 feet in height, known as "Four-Mile dam," is 4 miles below San Angelo; and a small dam, 8 feet in height, has been constructed for storage on Sims ranch just above the station. None of the dams appreciably affects the flow by storing water, except during extremely low stages.

ACCURACY.—Stage-discharge relation permanent. Rating curve well defined below 1,000 second-feet, fairly well defined between 1,000 and 6,000 second-feet, and extended above. Operation of water-stage recorder satisfactory except as shown in footnote to daily-discharge table. Daily discharge ascertained by applying to rating table mean daily gage height obtained from recorder graph by inspection or by use of planimeter, or for days of considerable fluctuation in stage by averaging discharge for intervals of the day. Records good except for extremely high stages.

Discharge measurements of Concho River near Paint Rock, Tex., during the year ending Sept. 30, 1921.

[Made by D. A. Dudley.]

Date.	Gage height.	Discharge.	Date.	Gage height.	Discharge.
	Feet.	*Sec.-ft.*		*Feet.*	*Sec.-ft.*
Jan. 14	1.46	40.1	June 27	1.30	24.2
Apr. 20	1.20	16.8	Aug. 6	.82	*a* .2
May 18	1.26	20.3			

a Estimated.

Daily discharge, in second-feet, of Concho River near Paint Rock, Tex., for the year ending Sept. 30, 1921.

Day.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.
1	60	51	51	41	42	40	40	7.4	9.2	7.8	2.4	1,180
2	49	49	51	40	40	58	41	14	7.8	6.0	1.6	172
3	44	48	53	41	39	58	39	8.8	6.9	5.7	1.2	58
4	39	46	54	41	40	54	40	7.8	6.0	4.7	.8	31
5	38	48	51	44	41	51	41	6.0	5.0	4.1	.7	20
6	41	48	49	45	42	48	44	5.7	4.4	3.4	1.0	14
7	40	49	49	45	42	45	41	9.2	3.8	2.8	1.4	12
8	40	49	48	44	41	42	38	13	4.7	2.4	1.6	10
9	45	53	48	42	40	42	33	15	131	2.0	1.8	9.7
10	46	61	48	42	39	36	32	24	674	1.6	2.0	9.2
11	41	67	48	44	36	35	29	20	510	1.6	2.0	7.4
12	42	67	48	45	27	34	28	29	322	1.4	2.2	5.7
13	44	119	48	45	22	34	32	23	127	1.2	2.2	4.4
14	40	98	48	41	21	33	30	19	753	1.0	2.2	3.4
15	36	78	48	41	22	32	29	19	320	1.0	2.2	2.8
16	35	63	46	42	22	31	26	22	130	1.0	2.0	2.2
17	35	60	46	42	23	35	22	19	84	4.7	2.0	2.2
18	33	56	46	44	23	34	19	20	60	11	2.1	2.0
19	35	65	46	45	23	39	17	19	49	6.5	2.2	2.2
20	38	60	46	45	22	46	16	16	42	5.7	2.3	2.8
21	38	56	46	45	21	60	16	14	39	4.4	2.4	2.8
22	38	56	45	42	22	53	15	13	36	5.0	2.4	2.8
23	39	56	45	42	21	45	13	13	35	4.7	2.4	2.0
24	46	60	45	44	23	41	12	13	36	2.6	2.2	1.8
25	165	58	45	42	25	42	12	13	32	2.2	2.2	1.6
26	74	60	45	42	26	41	11	14	27	2.2	2.2	1.2
27	54	58	45	42	26	42	11	13	22	3.8	2.0	1.0
28	48	58	45	44	29	38	11	13	20	5.0	1.8	.8
29	45	56	45	44	.....	36	9.2	13	13	5.4	1.8	.7
30	44	53	44	44	.....	39	7.8	11	9.2	4.1	2.8	.7
31	49	.....	42	44	.....	42	.....	10	.....	3.4	4.1	.....

NOTE.—Discharge partly estimated owing to incomplete gage-height record on following days: Nov. 17–27, Dec. 29, Aug. 17, 22, 25, 27, and 29. No gage-height record Dec. 9–28, Aug. 18–21, and 26; discharge interpolated. Discharge, June 9–12, 14, and Sept. 1, determined by averaging discharge for intervals of the day.

Monthly discharge of Concho River near Paint Rock, Tex., for the year ending Sept. 30, 1921.

Month.	Discharge in second-feet.			Run-off in acre-feet.
	Maximum.	Minimum.	Mean.	
October	165	33	47.1	2,900
November	119	46	60.2	3,580
December	54	42	47.2	2,900
January	45	40	43.0	2,640
February	42	21	30.0	1,670
March	60	31	42.1	2,590
April	44	7.8	25.2	1,500
May	29	5.7	14.7	904
June	753	3.8	117	6,960
July	11	1.0	3.82	235
August	4.1	.7	2.01	124
September	1,180	.7	52.2	3,110
The year	1,180	.7	40.2	29,100

SAN SABA RIVER AT MENARD, TEX.

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

DRAINAGE AREA.—1,140 square miles (measured on standard topographic maps; post-route map; and topographic map of Texas, compiled in 1899 by Robert T. Hill, of the United States Geological Survey, scale 1 inch=25 miles).

RECORDS AVAILABLE.—September 14, 1915, to September 30, 1921.

GAGE.—Chain gage attached to floor on downstream side of highway bridge; read by T. J. Adams or B. B. Burke.

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

CHANNEL AND CONTROL.—Channel straight 800 feet above and 100 feet below station; somewhat obstructed by reeds and grass; water flows through a series of shoals and ponds. 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. A sand and gravel ford just below gage forms a fairly permanent control during low stages, but shifts during medium and high stages.

EXTREMES OF DISCHARGE.—Maximum stage recorded during year, 3.59 feet at 8.30 a. m. November 26 (discharge, 303 second-feet); minimum stage probably occurred during period of missing record from June 26 to July 4.

1915–1921: Maximum stage recorded, 13.6 feet at 2.30 a. m. September 16, 1915 (discharge not determined); no flow July 12–14, 19–31, August 1–4, and 26–31, 1918.

ICE.—None reported.

DIVERSIONS.—Considerable land is irrigated with water diverted above station. Noyes canal on right side of river which serves a considerable area diverts a short distance above gage. Records of the Board of Water Engineers for the State of Texas show that about 4,300 acres have been declared irrigated by diversions above the station, and about 7,700 acres by diversions below the station.

REGULATION.—Flow unregulated by storage or water-power plants but is largely controlled at low stages during irrigation season by diversion to Noyes canal.

ACCURACY.—Stage-discharge relation not permanent. Rating curve fairly well defined from 0 to 250 second-feet. Gage read to hundredths twice daily. Daily discharge determined by applying mean daily gage height to rating table from October 1 to December 31, and by shifting-control method from January 1 to September 30. Records fair.

Discharge measurements of San Saba River at Menard, Tex., during the year ending Sept. 30, 1921.

Date.	Made by—	Gage height.	Discharge.	Date.	Made by—	Gage height.	Discharge.
		Feet.	*Sec.-ft.*			*Feet.*	*Sec.-ft.*
Oct. 12	D. A. Dudley	2.07	35.3	Apr. 20	D. A. Dudley	2.08	14.1
Nov. 29	do	2.17	45.0	May 19	do	2.17	26.6
Jan. 25	do	2.01	25.8	June 25	do	1.65	3.8
Feb. 27	Dudley and Fellows	2.10	30.0	Aug. 6	do	1.84	16.3
Mar. 8	Dudley and Adams	3.22	220	26	do	1.73	5.1
9	D. A. Dudley	2.56	89.4				

Daily discharge, in second-feet, of San Saba River at Menard, Tex., for the year ending Sept. 30, 1921.

Day.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.
1	42	37	46	32	25	42	22	8.5	14		8.5	23
2	41	36	47	31	29	54	38	13	14		8.5	22
3	44	36	46	28	27	45	32	8.5	14	5.1	9.0	22
4	44	36	46	28	25	39	31	8.5	20		9.5	20
5	42	38	45	26	25	38	37	11	22	4.5	10	18
6	44	36	44	26	25	39	37	10	22	4.5	12	19
7	44	34	42	26	25	198	36	12	22	4.8	9.0	23
8	44	36	41	25	25	92	17	14	22	5.1	6.0	27
9	44	36	42	25	26	44	16	17	24	5.7	4.8	22
10	41	38	44	26	25	44	24	18	5.4	5.7	4.2	19
11	34	36	44	26	26	45	24	14	5.1	6.5	4.5	20
12	37	36	44	27	26	37	23	14	6.5	7.5	4.2	20
13	42	36	42	25	26	40	23	16	5.7	7.5	4.2	20
14	42	38	39	23	24	44	22	14	6.0	7.5	4.2	18
15	40	36	37	24	24	42	14	16	6.0	9.5	4.5	19
16	27	36	36	24	22	39	14	18	6.5	9.5	4.2	17
17	30	37	34	24	29	40	13	18	5.1	8.5	4.5	18
18	29	38	32	22	31	42	12	18	5.1	8.0	4.5	18
19	29	42	31	24	35		12	23	5.1	8.5	4.5	18
20	31	47	30	24	31		14	24	5.1	9.0	4.5	18
21	29	47	30	22	27		22	21	4.8	8.0	4.8	17
22	31	48	30	14	28		15	22	4.2	8.5	4.5	17
23	32	46	29	26	28		14	21	3.9	8.5	4.5	17
24	42	47	30	27	29		12	19	3.0	9.0	4.5	17
25	42	48	31	28	29	31	10	19	3.0	8.5	4.2	14
26	40	182	30	23	26		10	19		8.5	4.5	18
27	36	74	29	23	30		9.0	18		8.0	5.7	56
28	36	48	28	24	45		6.0	12	3.8	8.5	16	48
29	36	46	29	22	.....		6.0	12		8.0	17	34
30	34	46	28	21	.....		8.0	14		7.5	65	22
31	36	.....	28	22	.....		.....	14	.....	8.5	27	.....

NOTE.—No gage-height record, Apr. 23–24, May 15, June 19, Aug. 7, Sept. 4, 11, 18, 22, and 23; discharge interpolated. Braced figures show estimated mean discharge for periods included.

Monthly discharge of San Saba River at Menard, Tex., for the year ending Sept. 30, 1921.

Month.	Discharge in second-feet.			Run-off in acre-feet.
	Maximum.	Minimum.	Mean.	
October	44	27	37.6	2,310
November	182	34	45.9	2,730
December	47	28	36.6	2,250
January	32	14	24.8	1,520
February	45	22	27.6	1,530
March	198	31	44.1	2,710
April	38	6.0	19.1	1,140
May	24	8.5	15.7	965
June	24	.....	9.12	543
July	9.5	.....	7.23	445
August	65	4.2	9.13	561
September	56	14	22.0	1,310
The year	198	.....	24.9	18,000

SAN SABA RIVER NEAR SAN SABA, TEX.

LOCATION.—200 feet above Beveridge highway bridge, 1 mile below mouth of China Creek, 2 miles northwest of San Saba, San Saba County, 3 miles below mouth of Richland Creek, and 4 miles above mouth of Simpson Creek.

DRAINAGE AREA.—3,000 square miles (measured on standard topographic maps; post-route map; and topographic map of Texas, compiled in 1899 by Robert T. Hill, of the United States Geological Survey, scale 1 inch=25 miles).

RECORDS AVAILABLE.—December 30, 1904, to December 31, 1906; September 11, 1915, to September 30, 1921. Miscellaneous discharge measurements previous to 1904.

GAGE.—Vertical and inclined staff, on right bank; read by G. M. Pool. 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. Left bank composed of gravel, 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 about 75 feet below gage serves as control during medium and low stages; control is free from vegetation and shifts.

EXTREMES OF DISCHARGE.—Maximum stage during year, 4.4 feet on night of November 26, determined from flood marks on gage (discharge, 745 second-feet); minimum stage, 1.00 foot at 7.10 p. m. July 8 (discharge, 11 second-feet).

1904–1906; 1915–1921: Maximum stage recorded, 31.7 feet August 7, 1906 (discharge not determined); no flow August 9 and 10, 1918.

ICE.—None reported.

DIVERSIONS.—Considerable water is diverted from stream and tributaries above station. There are also diversions below station but none in vicinity of station. Flood water from Brady Creek at Brady is stored for municipal uses; capacity of reservoir not known, but probably small. Records of the Board of Water Engineers for the State of Texas show that about 9,300 acres have been declared irrigated by diversion above station, and about 2,700 acres by diversion below station.

REGULATION.—None.

ACCURACY.—Stage-discharge relation not permanent. Rating curve well defined between 5 and 6,500 second-feet. Gage read to hundredths twice daily. Daily discharge ascertained by applying mean daily gage height to rating table; shifting-control method used November 28 to December 15, December 25 to February 28, and March 21 to September 30. Records good.

Discharge measurements of San Saba River near San Saba, Tex., during the year ending Sept. 30, 1921.

Date.	Made by—	Gage height.	Discharge.	Date.	Made by—	Gage height.	Discharge.
		Feet.	*Sec.-ft.*			*Feet.*	*Sec.-ft.*
Oct. 16	D. A. Dudley	1.77	83.3	Apr. 27	D. A. Dudley	1.67	62.5
Nov. 30	do	2.23	161	May 20	do	1.60	58.3
Jan. 26	do	1.90	96.3	Aug. 8	do	1.24	24.9
Mar. 3	Dudley and Fellows	2.16	144	Sept. 1	do	1.42	37.6

Daily discharge, in second-feet, of San Saba River near San Saba, Tex., for the year ending Sept. 30, 1921.

Day.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.
1	117	114	150	105	89	116	102	61	40	52	26	39
2	112	112	143	104	89	138	99	84	36	46	22	38
3	99	105	134	102	91	139	99	141	32	44	24	35
4	96	104	131	101	95	129	99	83	40	38	24	35
5	92	104	129	99	94	124	102	70	45	31	27	37
6	92	104	129	99	92	117	106	63	49	19	27	51
7	92	102	129	99	92	114	105	62	48	18	27	54
8	94	110	126	99	101	141	96	67	47	18	27	44
9	95	106	126	96	101	136	94	65	51	19	20	45
10	95	203	126	96	108	170	96	63	122	33	23	49
11	92	154	122	95	102	200	96	63	398	32	22	47
12	92	148	122	104	105	156	87	63	292	29	27	46
13	92	114	119	104	98	129	89	60	384	34	30	49
14	92	111	119	104	95	139	98	61	233	30	32	47
15	91	116	119	101	95	170	83	61	127	28	34	44
16	85	120	112	101	94	127	80	63	114	31	30	42
17	91	112	114	101	94	120	75	60	85	33	30	42
18	92	111	114	101	91	114	74	58	70	30	27	42
19	88	110	114	101	102	145	71	61	64	30	28	39
20	88	110	114	98	102	265	71	61	58	23	29	40
21	84	106	112	92	104	157	71	58	52	25	28	40
22	84	108	111	92	104	131	74	61	49	24	28	41
23	92	108	110	92	101	134	76	62	43	24	26	39
24	108	108	104	92	95	143	79	58	42	32	27	39
25	110	110	105	98	95	132	74	54	49	33	27	38
26	116	279	104	96	95	124	69	59	64	29	33	37
27	114	530	104	94	95	117	63	52	60	25	34	36
28	99	292	104	91	106	111	61	48	82	22	37	35
29	95	209	112	91	.....	108	61	53	105	25	38	46
30	102	166	110	88	.....	106	63	51	73	30	65	38
31	116	.....	110	88	.....	106	.....	43	.....	31	41	.....

Monthly discharge of San Saba River near San Saba, Tex., for the year ending Sept. 30, 1921.

Month.	Discharge in second-feet.			Run-off in acre-feet.
	Maximum.	Minimum.	Mean.	
October	117	84	97.0	5,960
November	530	102	146	8,690
December	150	104	119	7,320
January	105	88	97.6	6,000
February	108	89	97.3	5,400
March	265	106	137	8,420
April	106	61	83.8	4,990
May	141	43	63.5	3,900
June	398	32	98.5	5,860
July	52	18	29.6	1,820
August	65	20	29.7	1,830
September	54	35	41.8	2,490
The year	530	18	86.6	62,700

NORTH LLANO RIVER NEAR JUNCTION, TEX.

LOCATION.—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, and 4 miles above confluence of North Llano and South Llano rivers.

DRAINAGE AREA.—803 square miles (measured on standard topographic maps; post-route map; and topographic map of Texas, compiled in 1899 by Robert T. Hill, of the United States Geological Survey, scale 1 inch=25 miles).

RECORDS AVAILABLE.—September 14, 1915, to September 30, 1921.

GAGE.—Overhanging chain gage on left bank; read by W. M. Keen.

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

CHANNEL AND CONTROL.—Bed composed of solid rock. 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, except slight effect from accumulation of moss during low stages.

EXTREMES OF DISCHARGE.—Maximum stage recorded during year, 1.64 feet at 9 a. m. October 1 (discharge, 78 second-feet); no flow August 13–29.

1915–1921: Maximum stage recorded, 18.00 feet during night of September 15, 1915 (discharge not determined); no flow during several periods.

ICE.—None reported.

DIVERSIONS.—Records of the Board of Water Engineers for the State of Texas show that about 1,200 acres have been declared irrigated by diversion above the station. During low stages, such diversions materially reduce flow at the station.

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

ACCURACY.—Stage-discharge relation practically permanent. Rating curve well defined below 120 second-feet. Gage read to hundredths twice daily. Daily discharge ascertained by applying mean daily gage height to rating table. Records good.

Discharge measurements of North Llano River near Junction, Tex., during the year ending Sept. 30, 1921.

Date.	Made by—	Gage height.	Discharge.	Date.	Made by—	Gage height.	Discharge.
		Feet.	*Sec.-ft.*			*Feet.*	*Sec.-ft.*
Oct. 13	D. A. Dudley	1.44	32.3	Apr. 25	D. A. Dudley	1.33	19.9
Mar. 1	Dudley and Fellows	1.60	63.6	Aug. 7	do	.96	a.2

a Estimated.

Daily discharge, in second-feet, of North Llano River near Junction, Tex., for the year ending Sept. 30, 1921.

Day.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.
1	68	32	35	26	26	59	25	14	10	5.3	1.1	4.2
2	49	32	35	26	26	45	25	12	10	5.3	.8	2.8
3	43	32	35	26	26	35	25	12	10	5.3	.8	2.5
4	41	32	35	26	26	32	25	12	9.1	4.2	.6	2.1
5	38	32	35	26	26	29	25	12	9.1	3.5	.5	1.6
6	38	32	32	26	26	28	25	12	9.1	2.8	.3	1.6
7	35	32	32	26	26	28	24	12	9.1	2.8	.4	1.6
8	33	32	32	26	26	30	22	12	9.1	2.8	.3	1.6
9	30	29	32	26	24	25	22	15	14	2.8	.2	1.6
10	29	26	32	26	24	25	22	17	10	2.5	.2	1.6
11	26	26	32	26	24	25	19	15	9.8	2.5	.1	1.6
12	24	26	32	29	24	25	19	13	9.8	3.2	.1	1.3
13	25	26	32	32	24	25	19	13	14	3.2	.....	1.3
14	24	41	32	32	22	35	19	13	13	3.2	.....	1.3
15	24	32	29	30	22	29	19	13	13	3.2	.....	1.3
16	26	32	29	29	22	28	19	13	11	3.2	.....	1.3
17	26	32	29	29	22	25	19	13	10	3.2	.....	1.0
18	26	29	28	29	26	25	19	22	9.8	3.2	.....	1.0
19	26	29	26	29	26	41	19	19	8.3	3.2	.....	1.0
20	26	29	26	29	26	32	19	17	6.9	2.5	.....	1.0
21	29	29	26	29	24	32	28	16	6.9	2.5	.....	1.0
22	29	29	26	29	23	32	23	15	6.9	2.1	.....	1.0
23	33	26	26	26	22	32	22	13	6.9	1.8	.....	1.0
24	35	26	26	26	22	32	19	13	6.9	1.6	.....	1.0
25	36	26	26	26	22	28	18	13	11	1.4	.....	1.0
26	41	56	26	26	22	26	18	14	13	1.4	.....	2.1
27	36	41	26	26	22	26	18	12	12	1.4	.....	1.6
28	35	36	26	26	45	26	18	12	9.1	1.4	.....	16
29	32	35	26	26	.....	24	18	12	7.6	1.1	.....	11
30	32	35	26	26	.....	24	16	12	6.4	1.1	9.1	9.1
31	32	.....	26	26	.....	24	.....	12	.....	1.1	6.4	.....

NOTE.—No flow Aug. 13–29.

Monthly discharge of North Llano River near Junction, Tex., for the year ending Sept. 30, 1921.

Month.	Discharge in second-feet.			Run-off in acre-feet.
	Maximum.	Minimum.	Mean.	
October	68	24	33.1	2,040
November	56	26	31.7	1,890
December	35	26	29.5	1,810
January	32	26	27.3	1,680
February	45	22	24.9	1,380
March	59	24	30.1	1,850
April	28	16	20.9	1,240
May	22	12	13.7	842
June	14	6.4	9.73	579
July	5.3	1.1	2.74	168
August	9.1	0	.67	41.2
September	16	1.0	2.60	155
The year	68	0	18.9	13,700

LLANO RIVER NEAR JUNCTION, TEX.

LOCATION.—100 feet north of Kerrville-Junction road, a quarter of a mile northeast of Oliver's ranch house, 3 miles below confluence of North Llano and South Llano rivers, 3½ miles east of Junction, Kimble County, and 4 miles above creek entering river from south.

DRAINAGE AREA.—1,700 square miles (measured on standard topographic maps; post-route map; and topographic map of Texas, compiled in 1899 by Robert T. Hill, of the United States Geological Survey, scale 1 inch=25 miles).

RECORDS AVAILABLE.—September 13, 1915, to September 30, 1921.

GAGE.—Vertical staff, graduated from 0 to 7.5 feet, attached to tree on right bank, and inclined staff, graduated from 7.0 to 14.7 feet, and a vertical staff, 14.6 to 20.3 feet; the two latter sections are 100 feet upstream from low-water 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 gage.

CHANNEL AND CONTROL.—Bed composed of solid rock, clean, and permanent. Channel straight for 700 feet above and 350 feet below gage. Left bank of medium height, slightly wooded, and subject to overflow during high water; right bank clean, high, and not subject to overflow. One channel at all stages, except during extreme flood, 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 records. Rock ledge 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, 2.9 feet at 9 a. m. March 19 (discharge, 880 second-feet, determined from extension of rating curve), minimum stage, 1.48 feet from August 17 to August 29 (discharge, 48 second-feet).

1915–1921: Maximum stage recorded, 26.3 feet at 3 a. m. September 16, 1915 (discharge not determined); minimum stage, 1.32 feet August 23–28, 1918 (discharge, 13 second-feet).

ICE.—None reported.

DIVERSIONS.—Records of the Board of Water Engineers for the State of Texas show that about 2,500 acres have been declared irrigated by diversions above station and about 1,300 acres below station. Diversions materially reduce flow at station during low stages.

REGULATION.—Slight regulation from water-power plant on South Llano River at Junction.

ACCURACY.—Stage-discharge relation permanent. Rating curve well defined from 24 to 250 second-feet; extended above 250 second-feet. Gage read to hundredths once daily, but observer's work doubtful. Daily discharge ascertained by applying mean daily gage height to rating table, except March 19 and August 30, when discharge was determined from extension of rating curve and subject to large error. Records fair.

Discharge measurements of Llano River near Junction, Tex., during the year ending Sept. 30, 1921.

Date.	Made by—	Gage height.	Discharge.	Date.	Made by—	Gage height.	Discharge.
		Feet.	*Sec.-ft.*			*Feet.*	*Sec.-ft.*
Oct. 14	D. A. Dudley	1.75	124	Apr. 25	D. A. Dudley	1.62	102
Mar. 1	Dudley and Fellows	1.96	180	Aug. 8	....do	1.50	53.9

Daily discharge, in second-feet, of Llano River near Junction, Tex., for the year ending Sept. 30, 1921.

Day.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.
1	198	142	151	142	142	142	109	80	87	94	69	151
2	198	142	151	142	142	142	109	87	87	94	63	116
3	151	142	151	142	142	142	116	87	87	94	58	94
4	151	142	151	142	142	142	116	87	87	94	58	80
5	151	142	151	142	142	142	116	87	87	94	58	74
6	151	142	151	142	142	142	116	87	87	94	58	63
7	151	151	151	142	142	142	116	87	87	94	52	63
8	151	151	151	142	142	142	116	87	87	94	52	63
9	151	151	151	142	142	142	116	87	87	94	52	63
10	151	151	151	142	142	142	116	87	87	94	52	63
11	151	151	151	142	142	142	116	87	87	94	52	63
12	151	151	151	142	142	142	116	87	198	87	52	58
13	151	151	151	142	142	142	116	87	198	87	52	58
14	134	151	151	142	142	142	116	87	125	87	52	58
15	151	151	142	142	142	142	116	87	125	87	52	58
16	151	151	134	142	142	142	116	87	116	87	52	58
17	142	151	134	142	142	142	116	87	116	87	48	58
18	160	151	134	142	142	208	116	87	116	87	48	52
19	160	151	142	142	142	880	116	87	109	87	48	52
20	151	151	142	142	142	142	116	87	109	87	48	69
21	151	151	142	142	134	142	116	87	109	87	48	69
22	151	151	134	142	134	142	116	87	198	87	48	69
23	151	151	134	142	134	134	116	87	198	87	48	69
24	142	151	134	142	134	134	87	87	109	80	48	69
25	142	151	134	142	134	125	87	87	109	80	48	69
26	142	179	134	142	142	125	87	87	94	74	48	69
27	142	160	134	142	142	125	87	87	94	74	48	69
28	142	151	134	142	142	125	87	87	87	74	48	69
29	134	151	134	142	.....	116	80	87	94	74	48	69
30	134	151	142	142	.....	116	80	87	87	74	865	69
31	142	.....	142	142	.....	109	.....	87	.....	69	250	.....

Monthly discharge of Llano River near Junction, Tex., for the year ending Sept. 30, 1921.

Month.	Discharge in second-feet.			Run-off in acre-feet.
	Maximum.	Minimum.	Mean.	
October	198	134	151	9,280
November	179	142	150	8,930
December	151	134	143	8,790
January	142	142	142	8,730
February	142	134	141	7,830
March	880	109	162	9,960
April	116	80	108	6,430
May	87	80	86.8	5,340
June	198	87	112	6,660
July	94	69	86.4	5,310
August	865	48	84.6	5,200
September	151	52	70.1	4,170
The year	880	48	120	86,600

NOTE.—See "Accuracy" in station description.

BARTON SPRINGS AT AUSTIN, TEX.

LOCATION.—Barton Springs issue from channel of Barton Creek 1,600 feet above Austin-Bee Cave highway bridge, half a mile above confluence of Barton Creek with Colorado River, and half a mile southwest of Austin, Travis County.

RECORDS AVAILABLE.—October 1, 1918, to September 30, 1921. Daily records of flow of Barton Creek, which approximates flow of Barton Springs as the ordinary flow of the creek is from the springs, have been published from April 25, 1917, to September 30, 1918. Miscellaneous discharge measurements of Barton Creek were made from 1894 to 1906 and during 1916 and 1917.

DISCHARGE MEASUREMENTS.—Made by wading Barton Creek above and below the springs in order to determine the flow of springs as indicated in the following table:

Discharge measurements of Barton Creek and determination of discharge of Barton Springs at Austin Tex., during the year ending Sept. 30, 1921.

Date.	Made by—	Discharge of creek below springs.	Discharge of creek above springs.	Discharge of springs.	Date.	Made by—	Discharge of creek below springs.	Discharge of creek above springs.	Discharge of springs.
		Sec.-ft.	*Sec.-ft.*	*Sec.-ft.*			*Sec.-ft.*	*Sec.-ft.*	*Sec.-ft.*
Oct. 2	T. Twichell....	53.9	0	53.9	Apr. 18	T. Twichell....	326	194	132
23	.....do.....	46.4	0	46.4	May 2	.....do.....	142	64.4	77.6
Nov. 6	.....do.....	45.1	0	45.1	16	.....do.....	97.3	25.5	71.8
20	.....do.....	41.7	0	41.7	30	.....do.....	66.9	a 2.0	64.9
Dec. 4	.....do.....	38.9	0	38.9	June 11	C. E. McCashin	54.4	a 1.0	53.4
23	.....do.....	36.6	0	36.6	July 2	T. Twichell....	54.1	a 2.0	52.1
Jan. 12	.....do.....	35.2	0	35.2	16	.....do.....	47.5	0	47.5
26	.....do.....	34.1	0	34.1	30	.....do.....	40.4	0	40.4
Feb. 16	Twichell and McCashin.	31.7	0	31.7	Aug. 5	R. G. West....	38.3	0	38.3
					8	.....do.....	39.0	0	39.0
Mar. 2	T. Twichell....	31.0	0	31.0	15	T. Twichell....	34.2	0	34.2
18	.....do.....	47.7	7.4	40.3	27	R. G. West....	32.0	0	32.0
Apr. 1	.....do.....	42.3	0	42.3	Sept. 26	T. Twichell....	74.1	a 2.0	72.1
11	.....do.....	556	426	130					

a Estimated.

GUADALUPE RIVER BASIN.

GUADALUPE RIVER NEAR COMFORT, TEX.

LOCATION.—On Comfort-Kerrville road 100 feet upstream from Boerner Crossing and 3½ miles west of Comfort, Kerr County.

DRAINAGE AREA.—909 square miles (measured on topographic map of Texas, compiled in 1899 by Robert T. Hill, of the United States Geological Survey, scale 1 inch=25 miles).

RECORDS AVAILABLE.—December 16, 1917, to September 30, 1921.

GAGE.—Vertical staff in two sections on left bank; read by Robert W. Faust.

DISCHARGE MEASUREMENTS.—Low-water measurements made by wading. No high-water section avaliable.

CHANNEL AND CONTROL.—Bed composed of rock, sand, and gravel. Left bank composed of clay, slightly wooded, and not subject to overflow; right bank low, wooded, and subject to overflow. Control shifts.

EXTREMES OF DISCHARGE.—Maximum stage recorded during year, 25 feet during night of June 12 (discharge not determined); minimum discharge, 33 second-feet September 26–30.

1917–1921: Maximum stage, about 41 feet on August 21, 1919, determined from flood marks near gage (discharge not determined); minimum stage, 0.80 foot August 2, 1918 (discharge, 0.4 second-foot); probably caused by diversions.

ICE.—None reported.

DIVERSIONS.—Few pumping plants along stream about 7 miles above station. Records of the Board of Water Engineers for State of Texas show that a total of about 400 acres have been declared irrigated by diversion above the station.

REGULATION.—At Kerrville and Center Point dams are constructed and water used for mill purposes, but the effect of the regulation is slight, except during low stages.

ACCURACY.—Stage-discharge relation not permanent. Rating curve fairly well defined below 400 second-feet and extended above. Gage read to hundredths once daily, but not regularly. One reading a day may not be true index of discharge during low periods, owing to storage and intermittent pumping above gage. Daily discharge ascertained by applying mean daily gage height to rating table October 1 to December 16 and by shifting-control method from December 17 to September 30. Records fair.

Discharge measurements of Guadalupe River near Comfort, Tex., during the year ending Sept. 30, 1921.

Date.	Made by—	Gage height.	Discharge.	Date.	Made by—	Gage height.	Discharge.
		Feet.	*Sec.-ft.*			*Feet.*	*Sec.-ft.*
Feb. 9	R. G. West	1.88	84.3	July 26	T. Twichell	1.74	50.0
May 7	do	1.87	83.0	Sept. 12	West and Twichell	2.04	77.4

Daily discharge, in second-feet, of Guadalupe River near Comfort, Tex., for the year ending Sept. 30, 1921.

Day.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.
1	84	73	312	98	102	91	99	93	53	86	46	46
2	84	73	312	98	99	303	102	93	56	86	46	46
3	84	76	312	97	99	170	102	93	58	84	46	46
4	83	76	297	97	95	147	102	93	61	80	46	44
5	83	79	290	97	95	126	106	93	61	79	46	43
6	79	79	282	97	92	116	106	93	61	79	46	43
7	76	79	268	97	88	106	456	88	61	79	46	43
8	76	79	253	97	88	106	333	86	61	76	46	40
9	76	79	248	99	84	126	201	83	64	76	46	.....
10	73	79	226	101	81	170	178	83	67	74	46	.....
11	70	83	201	101	81	170	154	79	58	73	46	.....
12	70	83	178	97	81	147	154	79	.....	70	46	78
13	67	83	154	97	82	147	132	76	.....	67	46	54
14	67	84	132	97	84	147	112	76	408	67	46	49
15	64	86	132	97	84	126	112	76	318	64	46	47
16	64	86	112	99	84	126	112	76	231	64	43	44
17	64	90	102	101	84	126	110	112	177	62	41	42
18	64	93	102	101	88	147	108	154	154	61	36	42
19	61	101	102	101	88	218	108	112	154	61	36	42
20	61	104	102	101	86	194	104	112	154	61	36	40
21	61	106	102	101	84	170	97	93	132	58	39	40
22	61	108	102	101	84	147	93	84	132	58	43	37
23	61	112	99	102	84	147	93	76	132	58	43	36
24	62	112	99	104	84	147	93	70	112	56	41	36
25	64	.....	99	108	84	126	93	70	112	53	41	34
26	64	402	99	108	84	106	93	64	102	51	43	33
27	67	372	99	108	84	106	93	61	93	51	43	33
28	67	350	99	108	84	106	93	61	76	51	44	33
29	70	327	99	108	.....	106	93	58	76	48	46	33
30	70	312	99	106	.....	99	93	56	61	46	46	33
31	72	.....	99	104	.....	99	.....	56	.....	46	46	.....

NOTE.—Discharge interpolated on following days when gage was not read: Oct. 3, 10, 17, 24, 31, Nov. 7, 14, 21, and 28, Dec. 5, 12, 19, and 26, Jan. 1, 2, 9, 16, 23, 30, Feb. 6, 13, 20, 27, Mar. 6, 13 20, 27, Apr. 3, 10, 17, 24, May 1, 8, 15, 22, 29, June 5, 26, July 3, 4, 10, 17, 24, 31, Aug. 7, 14, 21, 28, Sept. 4, 18, and 25. No record Nov. 25 and Sept. 11. Stage was above limit for which rating curve is defined on following dates: June 12, 25.0 feet; June 13, 4.1 feet; Sept. 9, 11.4 feet; and Sept. 10, 5.0 feet.

Monthly discharge of Guadalupe River near Comfort, Tex., for the year ending Sept. 30, 1921.

Month.	Discharge in second-feet.			Run-off in acre-feet.
	Maximum.	Minimum.	Mean.	
October	84	61	70	4,300
December	312	99	168	10,300
January	108	97	101	6,210
February	102	81	87	4,830
March	303	91	141	8,670
April	456	93	131	7,800
May	154	56	83.8	5,150
July	86	46	65.3	4,020
August	46	36	43.8	2,690

NOTE.—See footnote to daily-discharge table.

GUADALUPE RIVER AT NEW BRAUNFELS, TEX.

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

DRAINAGE AREA.—1,760 square miles (measured on standard topographic maps; post-route map; and topographic map of Texas, compiled in 1899 by Robert T. Hill, of the United States Geological Survey, scale 1 inch=25 miles).

RECORDS AVAILABLE.—March 13, 1918, to December 30, 1899; January 27, 1915, to September 30, 1921.

GAGE.—Stevens water-stage recorder, attached to downstream side of middle pier of highway bridge: inspected by engineers from Austin office. A vertical staff gage in 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 was read from January 27, 1915, to September 28, 1917, when recorder was installed. 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 the vertical staff gage not known. During normal flow, levels show 0.08-foot fall between intake of recorder and vertical staff gage location. Vertical staff gage in well of recorder set to read same as vertical staff downstream.

DISCHARGE MEASUREMENTS.—Made from upstream 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; changes slightly.

EXTREMES OF DISCHARGE.—Maximum stage during year from water-stage recorder, 28.6 feet at 3 a. m. September 10 (discharge, 56,600 second-feet, determined from extension of rating curve); minimum stage, 1.27 feet about September 29 (discharge, 210 second-feet).

1898–1899; 1915–1921: Maximum stage recorded, that of September 10, 1921; minimum stage, 1.23 feet at 6.20 p. m. May 30, 1918 (discharge, 188 second-feet).

ICE.—None reported.

DIVERSIONS.—Some water diverted for irrigation above station in Kerr and Comal counties, and for water-power, water-works, 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 on Comal River.

ACCURACY.—Stage-discharge relation changes slightly. Rating curve well defined between 250 and 40,000 second-feet. Operation of water-stage recorder satisfactory except as shown in footnote to daily-discharge table. Daily discharge ascertained by applying to rating table mean daily gage height obtained from recorder graph by inspection or by use of planimeter; for days of considerable fluctuation in stage, by averaging discharge for intervals of the day; shifting-control method used October 6 to March 30, and April 15 to June 11. Records good.

Discharge measurements of Guadalupe River at New Braunfels, Tex., during the year ending Sept. 30, 1921.

Date.	Made by—	Gage height.	Discharge.	Date.	Made by—	Gage height.	Discharge.
		Feet.	*Sec.-ft.*			*Feet.*	*Sec.-ft.*
Nov. 23	R. G. West	2.23	537	Apr. 20	H. C. Pritchett	2.58	738
Dec. 8	C. E Ellsworth	2.28	547	May 9	R. G. West	2.33	599
14	R. G. West	2.20	544	June 1	D. A. Dudley	2.04	473
Jan. 6	do	2.15	504	July 25	T. Twichell	2.00	470
Feb. 14	do	2.12	492	Aug. 22	R. G. West	1.78	380
Mar. 15	do	2.74	758	Sept. 7	Twichell and West	1.72	380
Apr. 4	H. C. Pritchett	2.32	625	22	do	2.50	703

Daily discharge, in second-feet, of Guadalupe River at New Braunfels, Tex., for the year ending Sept. 30, 1921.

Day.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.
1	561	538	630	530	498	690	588		520	606	448	395
2	579	538	597	525	494	759	584		520	602	444	395
3	625	534	584	520	494	685	588		507	592	440	395
4	592	552	570	512	489	685	635		502	579	431	403
5	579	548	561	512	480	680	650	650	498	574	427	395
6	556	538	556	507	494	630			507	566	431	403
7	556	538	552	507	502	588			494	579	431	391
8	552	525	548	507	502	579	3,700		471	566	427	407
9	538	530	552	502	498	566		602	484	566	419	6,580
10	548	538	556	498	498	556		610	484	570	415	25,600
11	543	556	566	502	494	803	1,580	602	534	566	415	3,060
12	543	556	570	507	494	660	1,060	592	694	552	411	1,150
13	538	538	574	507	494	1,500	994	610	11,400	574	411	1,180
14	538	574	561	507	489	1,170	928		7,950	520	411	1,060
15	588	592	552	502	494	770	898		1,800	530	407	940
16	548	584	543	502	494	700	852		1,320	534	403	880
17	534	561	548	502	494	660	820		1,120	534	399	886
18	534	552	548	498	502	640	781		988	520	399	814
19	534	552	548	498	512	620	759		880	507	399	786
20	538	548	552	498	498	606	737		814	498	399	742
21	543	543	552	502	502	597	726	570	764	494	395	726
22	534	538	548	507	512	630	720		720	489	395	665
23	534	534	543	516	507	705	690		695	480	399	665
24	543	530	538	548	498	675	680		685	480	399	665
25	574	530	538	592	494	655	705		700	476	399	665
26	579	588	534	552	494	645			720	471	395	665
27	588	620	530	534	494	635			665	471	395	665
28	566	650	525	530	494	615	650		645	466	407	665
29	552	700	534	530	.....	597		520	625	458	395	665
30	543	675	534	516	.....	597		520	620	453	395	665
31	561	.....	530	502	.....	597	.....	520	.....	453	395	.....

NOTE.—Gage heights partly estimated Apr. 11, 18–20, May 9, 13, 29, June 1, and Sept. 22–30. Discharge estimated by comparison with records of flow at other stations Apr. 6–10, 12–14, 26–30, May 1–8, and 14–28. Discharge interpolated Apr. 19, May 30 and 31.

Monthly discharge of Guadalupe River at New Braunfels, Tex., for the year ending Sept. 30, 1921.

Month.	Discharge in second-feet.			Run-off in acre-feet.
	Maximum.	Minimum.	Mean.	
October	625	534	556	34,200
November[a]	700	525	563	33,500
December	630	525	554	34,100
January	592	498	515	31,700
February	512	480	497	27,600
March	1,500	556	693	42,600
April	.....	.....	1,260	75,000
May	.....	.....	591	36,300
June	11,400	471	1,310	78,000
July	606	453	527	32,400
August	448	395	411	25,300
September	25,600	391	1,790	107,000
The year	25,600	.....	769	558,000

NOTE.—See footnote to daily-discharge table.

GUADALUPE RIVER NEAR GONZALES, TEX.

LOCATION.—Just below dam of Gonzales Water Power Co., 1 mile above Guadalupe highway bridge, in Gonzales, Gonzales County, 1½ miles below mouth of San Marcos River.

DRAINAGE AREA.—3,630 square miles (measured on standard topographic maps; post-route map; and topographic map of Texas, compiled in 1899 by Robert T. Hill, of the United States Geological Survey, scale 1 inch=25 miles).

RECORDS AVAILABLE.—July 1, 1915, to September 30, 1921. The United States Weather Bureau has obtained records from the gage at the power house of Gonzales Water Power Co. since September 1, 1904.

GAGE.—United States Weather Bureau gage at tailrace of Gonzales Water Power Co.'s plant. From July 1, 1915, to September 30, 1920, vertical staff in three sections on right bank, just below highway bridge a mile downstream, was used. Curve showing relation between gage readings at the two sites has been developed.

DISCHARGE MEASUREMENTS.—Made from cable one-fourth mile below bridge and 1¼ miles below gage, or by wading near bridge. Measurements made from highway bridge, above stage of 22 feet when banks are overflowed at cable section.

CHANNEL AND CONTROL.—Bed composed of gravel and sand; channel above and below station straight for 500 feet. Banks composed of gravel and clay; right bank medium high, wooded, and subject to overflow; left bank high and not subject to overflow except at extremely high stages. At bridge, left bank protected by levee which is not overflowed, except during unusually high stages; right bank at bridge is overflowed at stage of about 27 feet. Control is rock and gravel shoal about 200 feet downstream from gage; shifts. At a stage of about 21.5 feet (discharge, 11,400 second-feet) water begins to enter an old channel, locally known as "Cross Timbers" on right bank 1 mile above gage and returns to main channel below gage. Consequently, all records of discharge greater than 11,400 second-feet do not represent the total flow of the stream, but only that in the main channel.

EXTREMES OF DISCHARGE.—Maximum stage recorded during year, 30.7 feet September 12 (discharge, 29,300 second-feet); minimum stage, 0.7 foot September 4 (discharge, 310 second-feet, determined from extension of rating curve).

1915–1921: Maximum stage, 34.1 feet at 7 p. m. October 18, 1919, from Weather Bureau records at Gonzales dam (discharge, 43,600 second-feet, determined from extension of rating curve); minimum stage, 0.02 foot at 5.30 p. m. October 20, 1918 (discharge, 155 second-feet).

ICE.—None reported.

DIVERSIONS.—Some water diverted above the station for irrigation and municipal uses, but the 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 somewhat by operation of water-power plants. Power house of Gonzales Water Power Co. is just above gage.

ACCURACY.—Stage-discharge relation fairly permanent. However, measurements are made 1 mile below gage and owing to operation of turbines at Gonzales dam, at which gage is located, there may be variations in the relation between stage at the dam and discharge at the measuring section. Rating curve for main channel well defined from 400 to 10,000 second-feet, and poorly defined from 10,000 to 28,000 second-feet. Above 11,400 second-feet, some water enters old channel on right bank about 1 mile above gage, locally known as "Cross Timbers," and returns to main channel below gage. United States Weather Bureau gage read once daily to tenths. One reading daily may not be true index to discharge, owing to operation of turbines just above gage and due to rapid fluctuations. Daily discharge ascertained by applying daily gage height to rating table. Records poor.

Discharge measurements of Guadalupe River near Gonzales, Tex., during the year ending Sept. 30, 1921.

Date.	Made by—	Gage height.	Discharge.	Date.	Made by—	Gage height.	Discharge.
		Feet.	*Sec.-ft.*			*Feet.*	*Sec.-ft.*
Nov. 18	H. C. Pritchett	[a] 1.94	766	Apr. 26	R. G. West	2.54	1,230
Jan. 7	R. G. West	1.90	757	July 19	C. E. McCashin	1.70	722
Feb. 13	do	1.53	636	29	T. Twichell	1.45	688
Mar. 26	H. C. Pritchett	2.27	1,020	Aug. 19	R. G. West	1.20	406

[a] Gage height from United States Geological Survey gage. Gage heights after this date are from United States Weather Bureau gage at Gonzales dam.

Daily discharge, in second-feet, of Guadalupe River near Gonzales, Tex., for the year ending Sept. 30, 1921.

Day.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.
1	870	790	950	790	790	790	1,040	1,080	990	1,040	590	550
2	830	790	910	630	790	990	1,040	1,040	990	990	510	550
3	710	790	870	790	790	2,790	790	990	990	790	510	510
4	990	790	870	790	790	1,530	1,040	950	1,400	790	510	310
5	910	790	710	790	790	1,120	2,650	950	1,800	950	510	510
6	950	750	870	790	630	910	1,480	950	950	910	510	510
7	950	630	870	790	790	830	1,990	910	870	790	510	510
8	950	790	870	790	790	830	6,470	910	870	790	510	510
9	910	790	830	630	790	790	25,500	910	870	790	590	510
10	670	630	830	790	790	790	14,100	910	870	790	590	550
11	870	790	830	790	750	790	3,500	1,040	790	910	590	14,100
12	830	790	630	790	750	1,850	2,650	990	750	3,540	590	29,300
13	830	710	830	790	630	8,040	2,270	1,170	2,510	1,990	590	15,900
14	830	710	790	790	830	1,940	2,180	1,120	4,110	750	510	3,170
15	670	710	790	790	790	12,500	1,990	870	7,130	750	590	2,320
16	790	790	790	670	790	5,200	1,850	1,040	8,390	710	590	1,900
17	710	790	790	670	790	1,350	1,530	1,040	2,420	670	590	1,660
18	910	790	790	790	790	1,170	1,580	1,040	1,900	830	590	1,530
19	830	790	630	790	790	1,080	1,530	1,040	1,620	790	590	1,530
20	790	790	790	790	670	1,040	1,480	990	1,400	710	590	1,400
21	790	630	790	790	830	990	1,480	1,170	1,220	670	430	1,260
22	790	830	790	790	790	990	1,440	1,170	1,350	670	590	1,220
23	790	830	790	670	790	990	1,440	1,300	1,620	670	590	1,170
24	630	830	790	790	790	950	1,220	1,260	1,260	590	590	1,120
25	790	830	710	790	790	1,040	1,400	1,170	1,040	670	590	990
26	790	830	710	910	790	950	1,350	1,080	1,080	670	590	1,120
27	790	870	870	870	590	950	1,260	1,040	1,990	670	590	1,080
28	790	870	790	830	790	1,040	1,480	1,040	1,300	630	390	990
29	830	870	790	830	.....	1,040	1,260	750	1,620	630	550	990
30	790	950	790	710	.....	1,040	1,220	990	1,530	590	550	990
31	630	.....	790	710	.....	1,040	.....	990	.....	510	550	.....

Monthly discharge of Guadalupe River near Gonzales, Tex., for the year ending Sept. 30, 1921.

Month.	Discharge in second-feet.			Run-off in acre-feet.
	Maximum.	Minimum.	Mean.	
October	990	630	813	50,000
November	950	630	785	46,700
December	950	630	802	49,300
January	910	630	772	47,500
February	830	590	767	42,600
March	12,500	790	1,850	114,000
April	25,500	790	3,010	179,000
May	1,300	750	1,030	63,300
June	8,390	750	1,850	110,000
July	3,540	510	879	54,000
August	590	390	554	34,100
September	29,300	310	2,960	176,000
The year	29,300	310	1,340	966,000

GUADALUPE RIVER BELOW CUERO, TEX.

LOCATION.—Three-fourths mile upstream from Heards Bridge on Arneckville road, 1 mile south of Dietze farmhouse, 2 miles below Clinton Bridge, 2½ miles southeast of Cuero, Dewitt County, and 8 miles below dam used for power development.

DRAINAGE AREA.—5,020 square miles (measured on standard topographic maps; post-route map; and topographic map of Texas, compiled in 1899 by Robert T. Hill, of the United States Geological Survey, scale 1 inch=25 miles).

RECORDS AVAILABLE.—August 6, 1916, to September 30, 1921. (Fragmentary from May 29, 1919, to August 10, 1920). From December 26, 1902, to December 31, 1906, and August 19, 1915, to August 6, 1916, a station was maintained at Schleicher's Bridge, 4 miles above this point. Discharge at the two sites practically the same.

GAGE.—Stevens water-stage recorder on left bank; inspected by E. B. Dietze.

DISCHARGE MEASUREMENTS.—Made from cable 40 feet upstream from gage or by wading.

CHANNEL AND CONTROL.—Channel straight above and below station for 1,000 feet. Bed composed of gravel and small rock; clean and shifts slightly. Left bank composed of sand and dirt, covered with brush and open timber, and is 20 feet high, but at stages above a gage height of 20 feet is overflowed, the water submerging an area for one-fourth mile back from 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 rapid 250 feet below gage serves as a control during low and medium stages; shifts slightly.

EXTREMES OF DISCHARGE.—Maximum stage during year from water-stage recorder, 16.36 feet at 12.15 a. m. September 15 (discharge, 12,500 second-feet); minimum stage, 0.88 foot at 10 a. m. September 8 (discharge, 260 second-feet).

1916–1921: Maximum stage occurred about October 20, 1919, when recorder was not in operation, and reached a height of about 32.15 feet as determined from flood marks on gage house (discharge not determined); minimum stage from water-stage recorder, approximately 0.58 foot from 9 to 10 a. m. November 1, 1917 (discharge, 80 second-feet, determined from extension of rating curve).

ICE.—None reported.

DIVERSIONS.—There are numerous small diversions above station for irrigation and municipal uses, but flow is probably not materially affected thereby, except possibly during extremely low stages.

REGULATION.—Flow partly regulated during low and medium stages by operation of water-power plants upstream, chiefly by a plant about 8 miles above.

ACCURACY.—Stage-discharge relation fairly permanent. Curve well defined between 200 and 15,000 second-feet. Operation of water-stage recorder not satisfactory. Daily discharge ascertained by applying to rating table mean daily gage height obtained from recorder graph by inspection or by use of planimeter, except as noted in footnote to daily-discharge table. Records fair.

Discharge measurements of Guadalupe River below Cuero, Tex., during the year ending Sept. 30, 1921.

Date.	Made by—	Gage height.	Discharge.	Date.	Made by—	Gage height.	Discharge.
		Feet.	*Sec.-ft.*			*Feet.*	*Sec.-ft.*
Nov. 17	H. C. Pritchett	2.04	876	July 28	T. Twichell	1.64	687
Jan. 7	do	1.96	844	Aug. 19	R. G. West	1.50	631
Feb. 12	R. G. West	1.89	756	Sept. 13	T. Twichell	13.22	[a] 9,690
Mar. 25	H. C. Pritchett	2.36	1,130	14	do	14.56	[a b] 8,840
Apr. 30	R. G. West	2.78	1,400	14	do	15.10	[a b] 9,790
July 19	C. E. McCashin	2.00	906	15	do	16.33	[a b] 10,000

[a] Surface velocities observed and coefficient of 0.90 used to reduce to mean velocity.
[b] Accuracy of measurement doubtful owing to accident to meter.

Daily discharge, in second-feet, of Guadalupe River below Cuero, Tex., for the year ending Sept. 30, 1921.

Day.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.
1	874	874	1,020	842	894	811	1,010			1,280	649	577
2	817	913	1,040	848	811	926			890		697	583
3	811	906	1,010	811	835	1,520	887			1,100	667	535
4	874	880	972	854	835	3,020	887	1,270	1,340		655	513
5	842	874	939	854	829	2,050	2,350				667	541
6	880	835	932	848	829	1,280	2,500		1,790	1,060	637	541
7	874	829	932	848	842	1,100	2,120		1,140		595	583
8	887	874	900	868	823	1,020	3,900	1,090		900	673	513
9	805	874	868	835	817	965	7,580	1,220	1,140		625	595
10	817	854	861	900	823	900	9,770			932	649	571
11	874	829	861	854	811	861	11,000		1,600	1,010	631	1,140
12	817	861	842	874	793	932	10,400		1,820	3,580	613	6,780
13	880	829	920	854	787	2,580		1,340	2,120	5,340	619	9,600
14	829	868	906	868	781	5,900	2,400	1,280	3,100	3,820	589	11,100
15	805	880	874	887	787	4,380		1,100	5,180	1,640	565	12,100
16	769	868	880	811	781	7,100	2,240	1,280	6,460	1,000	601	4,540
17	787	900	829	900	799	6,780		1,060	6,780	868	607	2,280
18	874	906	842	874	793	2,160		1,050	3,580	932	607	2,010
19	880	913	842	854	817	1,490		1,170	2,120	835	565	1,820
20	880	854	854	861	829	1,380		1,140	1,900	848	613	1,710
21	842	848	880	861	842	1,280		1,100	1,600	1,250	496	1,600
22	854	874	894	781	835	1,240	1,840	1,340	1,940	854	619	1,520
23	842	874	894	829	829	1,200		1,240	4,220	739	583	1,450
24	835	868	880	868	835	1,180		1,100	3,820	667	559	1,420
25	900	874	861	868	823	1,140		991	3,580	727	530	1,340
26	939	880	829	894	787				2,650	751	559	1,240
27	998	874	854	965	787				1,790	763	474	1,280
28	1,090	1,160	861	1,030	811				1,980	679	541	1,340
29	991	1,230	854	978	.....	1,010		890	1,980	655	589	1,560
30	913	1,090	811	906	.....		1,450		1,450	661	565	1,750
31	920	.....	854	926	.....		.....		.....	685	571	.....

NOTE.—Braced figures show estimated mean discharge for periods included. Discharge estimated also on Apr. 4. Owing to incomplete gage-height record discharge partly estimated on following days: May 18, June 6, 7, 11, 13, 14, 19, 20, 21, 26, 29, 30, July 1, and Sept. 5–10. Discharge on following days determined from one reading of staff gage daily: Apr. 3, 16, 30, May 8, July 6, and 10.

Monthly discharge of Guadalupe River below Cuero, Tex., for the year ending Sept. 30, 1921.

Month.	Discharge in second-feet.			Run-off in acre-feet.
	Maximum.	Minimum.	Mean.	
October	1,090	769	871	53,600
November	1,230	829	900	53,600
December	1,040	811	890	54,700
January	1,030	781	873	53,700
February	894	781	817	45,400
March	7,100	811	1,910	117,000
April	11,000	887	2,940	175,000
May	1,340	.....	1,140	70,100
June	6,780	.....	2,380	142,000
July	5,340	655	1,250	76,900
August	697	474	600	36,900
September	12,100	513	2,440	145,000
The year	12,100	.....	1,410	1,020,000

SAN MARCOS RIVER AT SAN MARCOS, TEX.

LOCATION.—Just below Cape Ginning Co.'s mill, 300 feet southwest of main San Marcos-Luling highway, 1 mile southeast of San Marcos, Hays County, 1¼ miles above mouth of Blanco River, and 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, 1916, to September 7, 1921, when station was abandoned except for periodical measurements of the springs. Miscellaneous measurements made from 1894 to 1903.

GAGE.—Stevens water-stage recorder on left bank, 300 feet below Cape Ginning Co.'s mill. Gage used June 10, 1915, to January 19, 1916, was 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. Relation between datum of staff gage and that of water-stage recorder not known.

DISCHARGE MEASUREMENTS.—Made by wading or from San Marcos-Luling highway bridge half a mile above gage.

CHANNEL AND CONTROL.—Bed composed of gravel and sand with heavy aquatic growth which causes changes in control during practically the entire year. Channel straight for 200 feet above and below the station. Water 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 a short distance to a second bank.

EXTREMES OF DISCHARGE.—Maximum stage during year determined by leveling from flood marks, 38.84 feet on September 10 (discharge not determined); minimum stage not recorded, owing to intake pipe being partially clogged.

1915–1921: Maximum stage recorded, that of September 10, 1921; minimum stage, 0.34 foot at 12.50 p. m. September 26, 1918 (discharge, 11 second-feet).

ICE.—None reported.

DIVERSIONS.—A concrete dam just above the San Marcos-Luling road bridge makes a pond for Rogers'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 was pumped to the southbank lands. Only pumping plant or diversions between station and mouth of Blanco River is about 250 feet below gage. 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. Records of the Board of Water Engineers for the State of Texas show that about 1,000 acres have been declared irrigated in Hays County by diversions from San Marcos River. Although a large part of this area is located above the station little water is used for irrigation, as ordinarily the rainfall is sufficient to mature crops. Water is diverted above the station by the San Marcos Utilities Co. for municipal uses.

REGULATION.—Flow during low and medium stages 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.

ACCURACY.—Stage-discharge relation not permanent, owing to aquatic growth in channel. Rating curve fairly well defined between 40 and 360 second-feet; extended above 360 second-feet and subject to large error. Operation of water-stage recorder not satisfactory. Daily discharge ascertained by shifting-control method, using mean daily gage height obtained from recorder graph by inspection or by use of planimeter, except as noted in footnote to daily-discharge table. Records poor.

Discharge measurements of San Marcos River at San Marcos, Tex., during the year ending Sept. 30, 1921.

Date.	Made by—	Gage height.	Discharge.	Date.	Made by—	Gage height.	Discharge.
		Feet.	*Sec.-ft.*			*Feet.*	*Sec.-ft.*
Oct. 27	C. E. Ellsworth	2.26	167	Mar. 28	H. C. Pritchett	2.40	172
Nov. 19	H. C. Pritchett	2.15	149	June 14	Dudley and Twichell	2.53	179
23	R. G. West	2.27	172	July 15	C. E. Ellsworth	2.20	150
Dec. 6	C. E. Ellsworth	2.22	158	29	T. Twichell	1.95	140
Jan. 8	R. G. West	2.30	171	Aug. 22	R. G. West	2.03	141
Feb. 14	do	2.24	158	Sept. 7	Twichell and West	1.45	98.7
Mar. 7	do	1.75	111				

Daily discharge, in second-feet, of San Marcos River at San Marcos, Tex., for the year ending Sept. 30, 1921.

Day.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.
1	181	158	150	150	142	158	163	216	172	163	150	115
2	176	158	146	146	142	130	163	226	172	163	142	122
3	181	150	146	142	142	130	163	221	172	168	146	126
4	172	150	146	154	138	134	.....	226	168	163	154	126
5	168	158	138	154	138	134	176	216	168	150	146	118
6	168	150	150	154	138	110	352	226	168	158	150	125
7	176	154	146	154	142	113	.....	216	172	154	150	126
8	168	150	142	150	142	.....	.....	216	168	158	146	.....
9	172	146	138	146	142	.....	294	216	168	154	154	.....
10	172	150	138	146	142	.....	274	210	168	154	150	.....
11	168	150	146	150	138	.....	268	210	168	158	142	.....
12	168	146	134	150	134	.....	255	195	200	158	150	.....
13	172	150	146	150	134	.....	255	200	294	150	150	.....
14	163	138	138	146	138	.....	255	205	176	150	146	.....
15	172	154	142	150	138	.....	243	200	168	150	146	.....
16	168	146	154	134	138	.....	232	205	168	154	134	.....
17	163	142	150	146	138	.....	226	200	168	146	126	.....
18	172	142	150	146	134	.....	232	205	168	146	126	.....
19	163	146	142	146	138	.....	232	200	163	146	134	.....
20	168	146	146	146	134	.....	232	195	163	134	130	.....
21	168	158	146	150	130	.....	232	195	168	126	138	.....
22	168	158	146	146	142	.....	238	186	168	142	142	.....
23	168	158	146	146	115	.....	226	186	163	142	130	.....
24	158	154	142	146	138	.....	226	181	163	126	122	.....
25	168	154	138	150	138	.....	226	176	172	126	126	.....
26	163	154	142	142	134	.....	238	181	158	130	126	.....
27	163	146	142	142	134	.....	238	176	163	134	126	.....
28	158	154	150	146	130	172	232	176	163	138	126	.....
29	154	150	150	142	.....	168	232	176	150	154	130	.....
30	154	150	150	134	.....	163	221	176	158	154	118	.....
31	154	.....	150	142	.....	172	.....	176	.....	150	115	.....

NOTE.—Backwater from Blanco River on Apr. 4 and 7, gage heights 3.4 and 6.7 feet respectively. Discharge, Apr. 8, not determined because stage (5.7 feet) was above limit for which rating curve is defined. Discharge from one reading of staff gage a day on Mar. 6 and 28. Discharge partly estimated, because of incomplete gage-height record, Sept. 7. No record Mar. 8–27, and Sept. 8–30.

Monthly discharge of San Marcos River at San Marcos, Tex., for the year ending Sept. 30, 1921.

Month.	Discharge in second-feet.			Run-off in acre-feet.
	Maximum.	Minimum.	Mean.	
October	181	154	167	10,300
November	158	138	151	8,980
December	154	134	145	8,920
January	154	134	147	9,040
February	142	115	137	7,610
May	226	176	200	12,300
June	294	160	172	10,200
July	168	126	148	9,100
August	154	115	138	8,480
September 1–7	126	115	123	1,710

NOTE.—See footnote to daily-discharge table.

SAN MARCOS RIVER AT OTTINE, TEX.

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

DRAINAGE AREA.—Indeterminate.

RECORDS AVAILABLE.—June 22, 1915, to September 30, 1921.

GAGE.—Chain gage attached to upstream handrail of 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 succeeding gage by means of a curve showing relation between readings of the two gages. Gage used from October 13, 1915, to March 15, 1920, was vertical staff in four sections attached to trees on left bank about 400 feet above bridge.

DISCHARGE MEASUREMENTS.—Made from downstream side of highway bridge, or by wading at shoal 200 feet above bridge.

CHANNEL AND CONTROL.—Bed composed of sand, rock, and gravel; shifts. Banks high and wooded; not overflowed except by extremely high water. Channel straight above and below station for 150 feet. Low-stage control formed by shoal 150 feet below gage. During high stages in Guadalupe River, back-water affects stage-discharge relation.

EXTREMES OF DISCHARGE.—Maximum stage recorded during year, 35.5 feet at 11.30 a. m. April 8 (discharge, 19,500 second-feet, determined from extension of rating curve); minimum stage, 1.42 feet at 7 a. m. July 27 (discharge, 99 second-feet).

1915–1921: Maximum stage recorded 37.5 feet at 7.30 a. m. May 16, 1920 (discharge not determined); minimum stage, 1.06 feet at 7 p. m. August 26 and 27, 1917, and 6.30 p. m. July 31, 1918 (discharge, 26 second-feet). Stages not comparable owing to shifting control and changes in datum of gages.

ICE.—None reported.

DIVERSIONS.—Small amounts of water are diverted above the station for irrigation and municipal uses, but only a small part of the total run-off is used (see "San Marcos River at San Marcos"). Little, if any, water is diverted below the station.

REGULATION.—Flow regulated by the operation of a small cotton gin a short distance above the 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 not permanent. Rating curve well defined between 100 and 15,000 second-feet. Gage read twice daily to tenths from October 1 to February 12, and to half-tenths from February 13 to September 30, but mean of two readings daily may not be true mean, owing to power regulation above. Daily discharge ascertained by applying mean daily gage height to rating table; shifting-control method used August 5 to September 30. Records good.

Discharge measurements of San Marcos River at Ottine, Tex., during the year ending Sept. 30, 1921.

Date.	Made by—	Gage height.	Discharge.	Date.	Made by—	Gage height.	Discharge.
		Feet.	*Sec.-ft.*			*Feet.*	*Sec.-ft.*
Nov. 18	H. C. Pritchett	2.75	226	Apr. 25	R. G. West	4.72	524
Jan. 7	R. G. West	2.68	219	July 20	C. E. McCashin	2.62	211
Feb. 13	do	2.34	186	29	T. Twichell	2.28	178
Mar. 26	H. C. Pritchett	3.38	311	Aug. 20	R. G. West	2.03	131

Daily discharge, in second-feet, of San Marcos River at Ottine, Tex., for the year ending Sept. 30, 1921.

Day.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.
1	234	258	283	206	216	258	258	445	283	283	185	128
2	216	222	258	222	211	1,880	310	429	283	283	185	128
3	258	258	246	216	206	907	270	496	413	296	190	136
4	216	270	234	211	206	296	679	413	1,290	296	190	136
5	246	240	216	216	200	296	1,320	383	496	270	190	118
6	216	234	216	216	200	258	755	383	368	270	180	128
7	195	258	228	216	200	246	4,400	368	283	270	165	118
8	206	258	240	211	200	216	17,800	383	270	296	170	136
9	222	228	222	216	206	222	6,430	368	283	353	165	180
10	246	234	216	206	200	216	1,400	383	283	283	165	3,900
11	216	246	228	222	200	228	1,230	310	270	1,100	170	13,600
12	240	258	228	216	200	6,500	1,100	413	793	1,980	175	2,810
13	258	228	216	216	190	4,100	926	368	2,640	429	170	1,120
14	228	240	222	211	190	12,300	793	338	2,360	258	155	774
15	228	234	216	211	190	3,100	888	324	831	234	165	413
16	258	216	228	200	190	604	736	338	586	234	165	479
17	246	211	211	200	200	462	660	338	514	240	170	445
18	240	234	228	200	211	324	622	496	514	222	141	413
19	240	222	228	200	211	353	604	398	429	216	114	398
20	240	228	216	211	211	368	586	413	429	216	128	368
21	234	234	216	195	206	338	622	398	604	211	118	368
22	258	228	228	200	200	338	586	338	983	185	136	368
23	240	228	216	200	200	310	532	296	532	185	136	353
24	258	222	206	200	200	310	532	283	413	195	132	338
25	283	228	211	216	190	310	514	296	429	258	118	324
26	258	246	216	310	195	310	568	296	964	170	118	338
27	240	368	211	270	190	310	888	296	462	128	128	338
28	228	283	216	240	200	296	532	296	296	185	141	324
29	258	338	206	240	.....	283	496	296	296	185	141	383
30	234	310	211	222	.....	270	479	283	296	195	165	353
31	240	.....	216	200	.....	283	.....	283	.....	190	160	.....

Monthly discharge of San Marcos River at Ottine, Tex., for the year ending Sept. 30, 1921.

Month.	Discharge in second-feet.			Run-off in acre-feet.
	Maximum.	Minimum.	Mean.	
October	283	195	238	14,600
November	368	211	249	14,800
December	283	206	224	13,800
January	310	195	217	13,300
February	216	190	201	11,200
March	12,300	216	1,180	72,600
April	17,800	258	1,580	94,000
May	496	283	360	22,100
June	2,640	270	630	37,500
July	1,980	128	326	20,000
August	190	114	156	9,590
September	13,600	118	980	58,300
The year	17,800	114	527	382,000

SAN ANTONIO RIVER BASIN.

SAN ANTONIO RIVER AT SAN ANTONIO, TEX.

LOCATION.—At South Alamo Street Bridge in San Antonio, Bexar County, 4 miles below San Antonio Springs, source of normal flow of river, and 1¼ miles above mouth of San Pedro Creek.

DRAINAGE AREA.—Indeterminate.

RECORDS AVAILABLE.—January 26, 1915, to September 30, 1921. Miscellaneous discharge measurements were made from 1895 to 1906.

GAGE.—Gurley graph water-stage recorder on right bank at downstream side of bridge. Gage used from January 26, 1915, to February 28, 1916, was vertical staff attached to downstream side of middle pier of Commerce Street Bridge. Gage used from February 29, 1916, to April 8, 1920, was vertical staff attached to upstream side of second bent of Presa Street Bridge. Relation of readings on different gages not determined. Discharge at various gages is probably not materially different.

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

CHANNEL AND CONTROL.—Channel is straight for 100 feet below gage and curved above. Bed composed of sand, gravel, and silt. Control formed by gravel bar; shifts.

EXTREMES OF DISCHARGE.—Maximum stage recorded during year, 20.14 feet about 3 a. m. September 10, determined from flood marks on gage (discharge, 15,300 second-feet, determined by slope method using values of 0.035 and 0.050 in Kutter's formula for two parts of the channel); minimum stage, 0.85 foot at South Alamo Street gage at 8 a. m. August 21, caused by regulation at power dam above gage (discharge, 42 second-feet, determined from extension of rating curve and subject to error). Minimum natural-flow stage, 1.25 feet on August 21 and 22 (discharge, 64 second-feet).

1914–1921: Maximum stage recorded, that of September 10, 1921 (see above); minimum stage, 0.58 foot on several days during November and December, 1918 (discharge, 7.0 second-feet).

ICE.—None reported.

DIVERSIONS.—Quantity of water diverted above gage not known but it is believed to be immaterial. Considerable land is irrigated from diversions below the gage.

REGULATION.—The operation of water wheels at the Guenther flour mill just above the gage causes frequent but unimportant fluctuations in stage.

ACCURACY.—Stage-discharge relation not permanent; a pronounced shift in control was caused by high water on September 10. Rating curve used October 1 to 3 a. m. September 10, well defined from 75 to 650 second-feet; curve used from 3 a. m. September 10 to September 30, fairly well defined from 100 to 2,000 second-feet. Both curves extended to 15,300 second-feet (gage height, 20.14 feet), the discharge being determined by slope method using Kutters formula with values of 0.035 and 0.050 for "n" in two parts of the cross section. Operation of water-stage recorder satisfactory, except as noted in footnote to daily-discharge table. Daily discharge ascertained by applying to rating table mean daily gage height obtained from recorder charts by inspection or by use of planimeter, or for days of considerable fluctuation in stage by averaging discharge for intervals of the day; shifting-control method used March 1–7 and March 13 to June 25. Records good.

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, for 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, 1921.

Date.	Made by—	Gage height.	Discharge.	Date.	Made by—	Gage height.	Discharge.
		Feet.	*Sec.-ft.*			*Feet.*	*Sec.-ft.*
Oct. 17	C. E. Ellsworth	1.70	115	May 6	R. G. West	1.76	105
26	do	1.72	120	June 2	C. E. Ellsworth	1.74	88.6
Dec. 8	do	1.68	109	July 26	T. Twichell	1.41	75.3
Jan. 8	H. C. Pritchett	1.64	99.2	Sept. 8	do	1.38	75.8
25	H. B. Kinnison	1.64	106	9	West and Twichell	3.31	622
Feb. 8	R. G. West	1.62	97.7	10	do	20.14	[a]15,300
Mar. 11	do	2.51	391	10	T. Twichell	8.94	[b]2,090
Apr. 11	C. E. McCashin	1.73	123	10	Twichell and West	5.57	866
20	H. C. Pritchett	1.74	108	21	T. Twichell	3.13	153

[a] Discharge determined by slope method using Kutter's formula with values of 0.035 and 0.050 for "n" in 2 parts of the section.
[b] Discharge corrected for rapidly falling stage=2,200 second-feet.

Daily discharge, in second-feet, of San Antonio River at San Antonio, Tex., for the year ending Sept. 30, 1921.

Day.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.
1	121	121	114	112	98	414	128	116	84	95	74	67
2	121	116	114	111	98	206	118	102	83	93	73	67
3	123	116	114	114	100	130	123	103	83	90	74	67
4	126	116	114	114	100	128	126	102	82	93	73	65
5	123	116	112	112	100	130	128	103	81	93	73	63
6	126	116	112	112	100	130	130	103	81	92	71	67
7	116	116	112	112	105	133	309	103	80	92	70	67
8	116	121	112	111	102	128	143	103	79	92	73	72
9	114	114	112	105	98	121	116	109	77	90	71	737
10	111	118	112	112	98	121	128	105	77	90	71	3,190
11	116	111	111	112	98	213	118	105	125	89	70	222
12	114	107	111	112	98	128	123	105	250	88	69	185
13	114	112	112	111	95	126	126	103	111	88	69	172
14	140	128	111	112	95	128	121	102	105	87	67	166
15	126	114	109	112	98	128	121	100	105	86	70	166
16	112	114	109	111	100	128	116	105	105	85	70	166
17	114	112	111	114	98	130	112	118	105	85	68	164
18	121	114	111	111	102	130	112	118	112	84	69	160
19	121	114	109	111	97	128	111	100	111	83	69	160
20	121	112	114	109	97	126	109	98	111	82	67	156
21	121	112	114	112	100	140	111	97	109	81	64	150
22	121	114	112	112	100	155	105	94	109	80	64	146
23	121	114	111	109	97	128	107	97	109	80	65	142
24	120	112	107	107	97	128	105	92	109	79	66	136
25	118	123	109	105	98	130	105	90	219	79	66	134
26	116	182	111	103	95	130	111	89	111	77	67	132
27	116	116	112	100	94	126	103	86	98	76	68	126
28	114	116	109	100	98	126	103	86	103	76	66	115
29	114	116	111	102	.....	126	105	85	98	75	73	128
30	116	114	111	100	.....	128	103	88	94	73	68	119
31	118	.....	112	102	.....	126	.....	85	.....	72	68	.....

NOTE.—No gage-height record and discharge interpolated Oct. 24, 25, Jan. 23, 24, July 10–15, 17–21, and Aug. 22–26. Owing to incomplete gage-height record discharge partly estimated as follows: Oct. 3, 26, Jan. 22, 25, June 25, 26, July 9, 16, Aug. 27, and Sept. 10.

Monthly discharge of San Antonio River at San Antonio, Tex., for the year ending Sept. 30, 1921.

Month.	Discharge in second-feet.			Run-off in acre-feet.
	Maximum.	Minimum.	Mean.	
October	126	111	119	7,320
November	182	107	118	7,020
December	114	107	111	6,820
January	114	100	109	6,700
February	105	94	98.4	5,460
March	414	121	144	8,850
April	309	103	123	7,320
May	118	85	99.7	6,130
June	250	77	107	6,370
July	95	72	84.7	5,210
August	74	64	69.2	4,250
September	3,190	65	250	14,900
The year	3,190	64	119	86,400

SAN ANTONIO RIVER AT CALAVERAS, TEX.

LOCATION.—One-fourth mile south of San Antonio & Aransas Pass Railway station in Calaveras, Wilson County, 1 mile below mouth of Calaveras Creek, and 10 miles below mouth of Medina River.

DRAINAGE AREA.—1,870 square miles (measured on topographic map of Texas, compiled in 1899 by Robert T. Hill, of the United States Geological Survey, scale 1 inch=25 miles).

RECORDS AVAILABLE.—March 12, 1918, to September 30, 1921.

GAGE.—Vertical staff in five sections on left bank near old brick plant; Read by I. M. Smith.

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

CHANNEL AND CONTROL.—Bed composed of sand and clay and free from vegetation; shifts. Channel straight above and below station for 150 feet. Left bank high, wooded, and not subject to overflow; right bank steep, wooded, and subject to overflow only at extremely high stages. Old bricks piled into channel form a semipermanent low-water control.

EXTREMES OF DISCHARGE.—Maximum stage recorded during year, 42.0 feet at 4 a. m. September 11 (discharge not determined); minimum stage, 0.9 foot August 29 and September 1–7 (discharge, 89 second-feet).

1918–1921: Maximum stage recorded, that of September 11, 1921 (see above); minimum stage, 0.14 foot at 8.30 a. m. September 14, 1918 (discharge, 15 second-feet).

ICE.—None reported.

DIVERSIONS.—Medina dam and reservoir, with a storage capacity of 254,000 acre-feet, is located on Medina River about 50 miles above its confluence with the San Antonio. Four miles below the Medina dam are the diversion works with a capacity of 850 second-feet. Probably about 10,000 acres were under irrigation in this project in 1920–1921.

REGULATION.—The ordinary flow may be slightly affected by storage and diversions on Medina River.

ACCURACY.—Stage-discharge relation not permanent. Rating curve fairly well defined between 30 and 1,500 second-feet, and extended above by use of $A\sqrt{d}$ method using one measurement at a discharge of 11,000 second-feet as a basis. Gage read to hundredths twice daily and oftener during floods. Mean of two readings a day may not be true index to discharge, owing to rapidly changing stages. Daily discharge ascertained by shifting-control method. Records fair for low and medium stages and poor for high stages.

Discharge measurements of San Antonio River at Calaveras, Tex., during the year ending Sept. 30, 1921.

Date.	Made by—	Gage height.	Discharge.	Date.	Made by—	Gage height.	Discharge.
		Feet.	*Sec.-ft.*			*Feet.*	*Sec.-ft.*
Nov. 6	D. A. Dudley	2.64	200	Sept. 8	Twichell and West	1.00	97.1
Feb. 10	R. G. West	2.34	180	9	do	12.72	a1,890
May 5	do	2.27	176	20	do	5.48	319
July 27	T. Twichell	1.31	118				

a Rapidly rising stage.

Daily discharge, in second-feet, of San Antonio River at Calaveras, Tex., for the year ending Sept. 1921.

Day.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.
1	150	198	240	213	193	491	198	218	158	198	112	89
2	150	198	218	203	179	3,630	188	208	158	174	108	89
3	154	188	218	203	179	2,240	188	188	154	158	108	89
4	154	188	218	203	179	806	198	184	142	154	104	89
5	154	198	218	203	184	648	198	179	142	146	104	89
6	154	198	229	203	184	470	208	174	142	146	101	89
7	170	198	218	203	179	298	274	174	142	138	98	89
8	170	198	218	193	174	298	2,030	174	138	146	95	95
9	158	198	218	193	174	274	618	179	138	146	98	1,770
10	154	198	218	193	174	262	348	170	138	146	92	7,620
11	158	218	218	203	179	918	298	166	251	146	92	.....
12	158	198	208	224	174	854	262	166	498	154	92	3,230
13	158	262	208	203	170	374	262	166	633	174	92	774
14	158	414	208	193	166	286	251	158	262	162	92	663
15	158	374	208	193	179	274	251	158	208	146	92	573
16	162	322	208	193	179	262	251	158	198	138	92	498
17	170	208	208	193	179	251	229	208	198	138	92	414
18	166	208	208	184	179	240	218	870	188	122	92	310
19	170	208	208	184	174	240	248	322	174	126	92	251
20	170	208	208	184	174	240	218	188	162	122	92	322
21	170	208	208	184	174	240	229	184	162	122	92	310
22	174	208	208	421	174	414	229	184	158	122	92	274
23	174	218	198	435	174	513	208	179	154	115	92	262
24	170	218	208	234	170	374	208	170	150	115	92	262
25	218	229	208	234	170	240	208	166	146	115	92	262
26	456	310	208	224	170	229	198	166	310	118	92	240
27	208	603	158	203	170	218	198	162	240	115	92	310
28	188	456	224	203	170	208	184	158	218	115	92	442
29	188	240	224	193	.....	208	184	158	543	118	89	218
30	179	229	224	193	.....	198	184	158	335	108	98	902
31	198	.....	224	193	.....	198	.....	158	.....	108	95	.....

NOTE.—Stage (39.2 feet) Sept. 11, above limit for which rating curve is defined. Discharge partly estimated on following days: Sept. 13–16 and 18–19.

Monthly discharge of San Antonio River at Calaveras, Tex., for the year ending Sept. 30, 1921.

Month.	Discharge in second-feet.			Run-off in acre-feet.
	Maximum.	Minimum.	Mean.	
October	456	150	178	10,900
November	603	188	250	14,900
December	240	158	213	13,100
January	435	184	216	13,300
February	193	166	176	9,780
March	3,630	198	529	32,500
April	2,030	184	298	17,700
May	870	158	202	12,400
June	633	138	221	13,200
July	198	108	137	8,420
August	112	89	95.4	5,870

NOTE.—See footnote to daily-discharge table.

SAN PEDRO CREEK AT SAN ANTONIO, TEX.

LOCATION.—At south end of Missouri, Kansas & Texas Railway culvert, 50 feet west of tracks, 700 feet south of its terminal, 200 feet south of Arsenal Street crossing, four blocks south of City Hall, 1 mile above mouth of Salsamora and Martinez creeks, 2 miles below San Pedro Springs, its source, and 2½ miles above confluence with San Antonio River.

DRAINAGE AREA.—Indeterminate.

RECORDS AVAILABLE.—July 20, 1916, to September 30, 1921.

GAGE.—Gurley 7-day water-stage recorder installed March 14. Attended by engineers of city of San Antonio. Prior to that date a vertical staff, attached to wall of building No. 713 Commerce Street, on upstream side of bridge on left bank was used and was read by G. H. Cumberland.

DISCHARGE MEASUREMENTS.—Made by wading below gage or from bridge in vicinity.

CHANNEL AND CONTROL.—Bed and banks composed of smooth concrete; permanent. Low-stage control is a 4 by 4 inch timber bolted across bed of flume. Channel straight above and below station.

EXTREMES OF DISCHARGE.—Maximum stage from water-stage recorder, 8.6 feet 11.30 p. m. September 9 (discharge not determined); minimum stage, 0.41 foot at 9 p. m. August 14 (discharge, 4.0 second-feet). There was backwater from Alazan Creek on September 9 and 10.

1916–1921: Maximum stage recorded, that of September 9, 1921; minimum stage recorded, 1.30 feet, December 10–11, 1918 (discharge, 0.7 second-foot). Stages not comparable, owing to change in location of gage.

ICE.—None reported.

DIVERSIONS.—None.

REGULATION.—No dams, reservoirs, or controlling works that permanently regulate the flow.

ACCURACY.—Stage-discharge relation not permanent October 1 to March 14, and permanent, March 15 to September 30. Rating curve used prior to March 14 poorly defined; curve used March 15 to September 30, well defined from 0 to 10 second-feet, poorly defined from 10 to 200 second-feet, and extended above by means of Kutter's formula with a value of 0.014 for "n" at a 6.0-foot gage height. October 1 to March 14, daily discharge ascertained by shifting-control method; March 15 to September 30, by applying to rating table mean daily gage height obtained from recorder chart by inspection or by use of planimeter, except as noted in footnote to daily-discharge table. Records poor prior to March 14, and good thereafter.

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, 1921.

Date.	Made by—	Gage height.	Discharge.	Date.	Made by—	Gage height.	Discharge.
		Feet.	*Sec.-ft.*			*Feet.*	*Sec.-ft.*
Oct. 17	C. E. Ellsworth	1.80	10.2	Apr. 20	H. C. Pritchett	0.50	8.4
Nov. 6	D. A. Dudley	1.89	10.8	May 6	R. G. West	.50	7.2
Dec. 8	C. E. Ellsworth	1.75	9.6	8	do	.50	8.6
Jan. 8	H. C. Pritchett	1.69	8.1	June 2	C. E. Ellsworth	.50	7.9
25	H. B. Kinnison	1.58	9.2	2	do	.50	7.4
Feb. 8	R. G. West	1.58	9.8	July 27	T. Twichell	.48	7.4
Mar. 14	do	1.58	9.2	Sept. 8	R. G. West	.50	8.9
14	do	[a].51	8.8	9	West and Twichell	2.44	201
Apr. 11	C. E. McCashin	.52	9.6	21	T. Twichell	.56	10.7

[a] Gage at new location beginning with this measurement.

Daily discharge, in second-feet, of San Pedro Creek at San Antonio, Tex., for the year ending Sept. 30, 1921.

Day.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.
1	9.9	11	9.9	8.2	9.4	102	8.0	11	8.5	7.5	7.0	7.5
2	9.9	11	9.9	8.2	9.1	23	8.0	8.5	8.0	9.0	7.5	7.5
3	9.9	11	9.9	8.2	9.1	12	8.5	8.5	8.0	10	7.5	6.0
4	9.9	11	10	8.2	9.4	9.9	8.5	8.5	7.5	7.0	8.0	5.2
5	10	11	10	7.9	9.4	9.6	9.0	8.0	5.6	7.0	7.5	5.2
6	11	11	10	7.9	9.4	9.6	9.0	8.0	6.5	7.0	7.0	6.0
7	13	11	9.9	8.2	9.4	9.4	22	8.0	8.5	7.0	7.0	5.6
8	11	11	9.9	8.2	9.4	9.4	9.0	8.0	8.5	7.5	6.5	8.5
9	11	11	9.4	8.2	9.1	9.4	8.0	9.5	8.5	7.5	6.0	.....
10	11	13	9.4	8.5	8.8	9.4	10	8.5	9.5	7.5	5.2	.....
11	11	12	9.4	8.8	8.8	36	9.0	8.0	20	7.5	5.6	12
12	12	11	9.4	9.1	8.8	10	9.0	8.0	24	8.5	5.6	12
13	13	12	9.4	9.4	8.8	9.4	9.0	8.0	9.5	7.5	5.2	11
14	33	11	9.4	9.6	8.8	9.4	8.5	8.0	8.0	7.5	4.8	11
15	10	12	9.1	9.9	8.8	8.0	8.2	9.5	8.0	8.0	6.0	11
16	10	12	8.8	10	8.8	8.0	8.0	9.0	8.0	8.0	5.6	11
17	10	12	8.8	7.6	8.8	8.0	8.0	12	8.0	8.0	5.2	10
18	10	12	8.8	7.4	8.8	8.0	8.0	8.5	8.0	8.0	5.6	11
19	10	12	8.8	7.4	9.1	8.0	8.0	7.5	7.5	8.0	5.6	11
20	11	12	8.8	7.6	9.1	8.0	8.0	7.5	8.0	8.0	5.6	11
21	11	12	8.5	8.5	9.1	12	8.0	7.5	8.0	8.0	7.0	11
22	11	12	8.2	11	9.1	12	8.0	7.5	8.0	7.5	7.0	10
23	11	12	8.2	9.6	9.1	8.0	8.0	7.5	8.0	7.5	7.0	10
24	11	13	8.2	9.4	9.1	7.5	8.0	8.0	8.0	8.0	6.5	10
25	18	13	8.2	9.4	9.1	9.2	8.0	7.5	16	8.0	6.5	10
26	11	16	8.2	9.1	9.1	11	11	7.0	7.5	8.0	6.5	9.5
27	9.9	13	8.2	8.8	9.1	9.5	8.0	7.0	7.0	7.5	6.0	9.5
28	9.9	13	8.2	8.8	9.1	9.0	8.0	9.0	10	7.5	6.0	10
29	11	12	8.2	8.8	.....	9.0	8.0	9.0	7.5	7.5	8.0	10
30	11	11	8.2	9.1	.....	8.5	8.0	8.5	7.5	7.5	7.5	12
31	11	.....	8.2	9.1	.....	8.5	.....	8.5	.....	7.5	7.5	.....

NOTE.—Discharge partly estimated, owing to incomplete gage-height record, as follows: Mar. 24, 26, Apr. 16, 30, June 10 and 11. Discharge interpolated Mar. 25, Apr. 15, and 29. Backwater from Alazan Creek existed probably from 9 p. m. Sept. 9 to 7 a. m. Sept. 10, and water overflowed from San Antonio River into San Pedro Creek probably from 2 a. m. to 7 a. m. Sept. 10.

Monthly discharge of San Pedro Creek at San Antonio, Tex., for the year ending Sept. 30, 1921.

Month.	Discharge in second-feet.			Run-off in acre-feet.
	Maximum.	Minimum.	Mean.	
October	33	9.9	11.7	719
November	16	11	11.9	708
December	10	8.2	9.02	555
January	11	7.4	8.71	536
February	9.4	8.8	9.07	504
March	102	7.5	13.6	836
April	22	8.0	8.89	529
May	12	7.0	8.37	515
June	24	5.6	9.19	547
July	10	7.5	7.76	477
August	8.0	4.8	6.44	396
The period	.....	.....	.....	6,320

NUECES RIVER BASIN.

NUECES RIVER NEAR CINONIA, TEX.

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

DRAINAGE AREA.—2,060 square miles (measured on standard topographic maps; post-route map; and topographic map of Texas, compiled in 1899 by Robert T. Hill, of the United States Geological Survey, scale 1 inch=25 miles).

RECORDS AVAILABLE.—July 5, 1915, to September 30, 1921.

GAGE.—Vertical staff in 6 sections installed May 6, 1918, on right bank, 200 feet below highway bridge; read by C. C. Oswald. From July 5, 1915, to September 23, 1917, gage used was vertical staff in 7 sections on right and left banks. September 24, 1917, to May 5, 1918, Dexter water-stage recorder near concrete control. All gages set at same datum and at approximately the same location.

DISCHARGE MEASUREMENTS.—Made from downstream side of bridge or by wading on crest of concrete control.

CHANNEL AND CONTROL.—Bed composed of clay and gravel; free from vegetation; subject to shift prior to September 23, 1917. Banks high and wooded, and not subject to overflow, except during extremely high water. Channel straight above and below station. An artificial concrete control was completed at the site of the gage on September 23, 1917; point of zero flow, 0.85 foot.

EXTREMES OF DISCHARGE.—Maximum stage recorded during year, 6.3 feet at 7 p. m. March 1 (discharge, 339 second-feet); minimum stage, 1.12 feet from 7 p. m. August 18 to 7 a. m. August 31 (discharge, 1.9 second-feet).

1915–1921: Maximum stage recorded, 49.1 feet September 23, 1919, determined by leveling from flood marks (discharge not determined). According to local residents, the greatest flood on record occurred in 1913, when the river reached a stage of about 53 feet by present gage datum. No flow during several periods of record.

ICE.—None reported.

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

REGULATION.—None.

ACCURACY.—Stage-discharge relation permanent. Rating curve well defined for all stages. Gage read to hundredths twice daily. Daily discharge determined by applying mean daily gage height to rating table. Records good.

Backwater from a dam 40 feet high, 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 return to the surface just above the station. The condition of the underground water 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, 1921.

Date.	Made by—	Gage height.	Discharge.
		Feet.	*Sec.-ft.*
Nov. 10	D. A. Dudley	1.54	17.3
May 2	R. G. West	1.85	a 35.4

aMeasurement poor owing to bad measuring section.

Daily discharge, in second-feet, of Nueces River near Cinonia, Tex., for the year ending Sept. 30, 1921.

Day.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.
1	11	15	14	17	17	256	36	26	17	11	3.0	3.0
2	11	15	14	17	16	145	36	31	15	11	3.0	2.8
3	11	15	14	17	16	40	35	30	15	10	3.0	2.6
4	11	15	14	17	16	21	34	30	14	8.9	3.0	2.2
5	11	15	13	17	16	18	33	29	14	8.9	3.0	2.2
6	11	15	13	17	16	18	32	29	13	8.0	3.0	2.2
7	13	15	13	17	16	18	34	29	13	8.0	3.0	2.2
8	13	15	12	17	16	18	46	29	12	8.0	2.8	2.8
9	13	21	12	17	16	17	33	29	12	8.0	2.6	6.8
10	11	17	12	17	16	17	31	29	12	8.0	2.6	8.9
11	11	16	12	17	16	17	30	34	12	8.0	2.4	10
12	11	15	12	17	16	17	30	30	14	8.0	2.2	10
13	11	15	12	17	16	17	29	30	13	8.0	2.2	7.2
14	11	20	12	17	16	17	28	29	41	7.6	2.2	5.0
15	11	19	12	17	16	17	28	26	59	7.2	2.2	4.4
16	11	17	12	17	16	17	27	22	35	7.2	2.2	3.9
17	11	16	12	17	16	17	26	20	25	6.4	2.2	3.9
18	11	16	12	17	16	17	26	19	20	5.7	2.1	3.9
19	11	16	15	17	16	17	25	18	20	5.4	1.9	3.9
20	11	16	17	17	16	17	25	21	18	5.0	1.9	3.4
21	15	16	17	17	16	17	24	25	17	4.4	1.9	3.4
22	28	16	17	17	16	17	24	24	17	4.2	1.9	3.0
23	25	16	17	17	16	17	24	21	16	3.9	1.9	3.0
24	23	16	17	17	16	17	23	18	15	3.4	1.9	3.0
25	22	15	17	17	16	17	22	17	14	3.4	1.9	2.6
26	19	15	17	17	16	17	21	17	13	3.4	1.9	2.6
27	18	15	17	17	16	32	20	16	13	3.4	1.9	2.6
28	17	15	17	17	16	34	20	16	13	3.2	1.9	2.6
29	16	15	17	17	.....	36	20	16	12	3.0	1.9	2.6
30	15	14	17	17	.....	37	20	18	12	3.0	1.9	2.6
31	15	.....	17	17	.....	36	.....	17	.....	3.0	2.4	.....

Monthly discharge of Nueces River near Cinonia, Tex., for the year ending Sept. 30, 1921.

Month.	Discharge in second-feet.			Run-off in acre-feet.
	Maximum.	Minimum.	Mean.	
October	28	11	14.2	873
November	21	14	15.9	946
December	17	12	14.4	885
January	17	17	17.0	1,050
February	17	16	16.0	889
March	256	17	32.7	2,010
April	46	20	28.1	1,670
May	34	16	24.0	1,480
June	59	12	17.9	1,070
July	11	3.0	6.34	390
August	3.0	1.9	2.32	143
September	10	2.2	3.98	237
The year	256	1.9	16.1	11,600

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, and half a mile below mouth of Frio River.

DRAINAGE AREA.—15,600 square miles (measured on standard topographic maps; post-route map; and topographic map of Texas, compiled in 1899 by Robert T. Hill, of the United States Geological Survey, scale 1 inch=25 miles).

RECORDS AVAILABLE.—July 1, 1915, to September 30, 1921.

GAGE.—Vertical staff in four sections, attached to piers of railroad bridge; read by M. L. Mouser.

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

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

EXTREMES OF DISCHARGE.—Maximum stage recorded during year, 28.5 feet at 8.50 a. m. September 10 (discharge, 9,450 second-feet, determined from extension of rating curve); no flow August 8–29, September 6, and 7.

1915–1921: Maximum stage recorded 46.0 feet at 5 a. m. September 18, 1919 (discharge not determined); no flow during several periods of record.

ICE.—None reported.

DIVERSIONS.—Records of the Board of Water Engineers for the State of Texas show that about 10,000 acres have been declared irrigated by diversions from the stream above the station.

REGULATION.—None of consequence.

ACCURACY.—Stage-discharge relation not permanent. Rating curve well defined below 7,000 second-feet, and extended above that point by use of area and velocity curves. Gage read to nearest tenth once daily. Daily discharge determined by shifting-control method. Records fair.

Discharge measurements of Nueces River near Three Rivers, Tex., during the year ending Sept. 30, 1921.

Date.	Made by—	Gage height.	Discharge.	Date.	Made by—	Gage height.	Discharge.
		Feet.	*Sec.-ft.*			*Feet.*	*Sec.-ft.*
Nov. 8	D. A. Dudley	1.80	56.2	July 28	T. Twichell	1.08	3.8
Feb. 11	R. G. West	1.20	8.8	Sept. 21	R. G. West	2.64	104
May 5	....do	5.48	661				

Daily discharge, in second-feet, of Nueces River near Three Rivers, Tex., for the year ending Sept. 30, 1921.

Day.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.
1	18	616	20	9.5	12	12	616	1,540	57	135	0.1	1.7
2	18	536	16	12	12	1,570	516	556	47	107	.1	.6
3	15	245	14	12	12	1,480	364	278	31	57	.1	.6
4	15	150	14	12	12	1,830	205	364	38	31	.1	.1
5	15	121	14	12	12	456	1,400	658	26	26	.1	.1
6	15	94	14	12	12	278	7,240	456	22	22	.1	.....
7	12	81	11	12	12	536	8,450	400	22	1,480	.4	.....
8	12	68	11	12	12	456	3,320	278	18	245	.....	.6
9	12	57	11	12	12	278	3,710	221	22	107	.....	6,400
10	12	47	11	12	12	400	1,540	476	1,510	57	.....	9,450
11	9.5	38	11	12	9.5	476	1,210	556	556	38	.....	8,600
12	9.5	47	11	12	9.5	556	836	456	3,630	31	.....	2,070
13	9.5	38	11	12	9.5	476	980	221	2,130	286	.....	1,210
14	9.5	47	11	12	9.5	295	1,030	173	1,980	88	.....	860
15	9.5	38	8.4	12	9.5	173	1,030	536	596	62	.....	1,060
16	7.2	38	8.4	12	9.5	114	1,080	1,140	312	158	.....	1,480
17	38	38	8.4	12	9.5	88	1,190	1,340	400	114	.....	1,210
18	22	38	8.4	12	9.5	62	5	2,190	702	28	.....	956
19	18	38	8.4	12	9.5	52	245	1,480	1,060	16	.....	364
20	15	31	8.4	12	12	42	189	702	1,160	11	.....	173
21	12	38	8.4	12	12	34	142	295	746	8.4	.....	100
22	12	31	11	12	12	28	128	229	702	6.2	.....	52
23	9.5	26	11	12	12	6,630	114	181	746	4.2	.....	34
24	9.5	22	11	12	12	4,510	100	165	884	2.4	.....	24
25	18	22	8.4	12	12	2,980	100	150	1,080	1.2	.....	24
26	57	22	8.4	12	12	1,260	100	121	1,290	34	.....	24
27	68	229	8.4	12	12	836	88	94	1,620	11	.....	20
28	68	52	8.4	12	12	556	74	81	1,740	4.0	.....	20
29	57	28	8.4	12	.....	436	62	57	1,340	2.4	.....	16
30	364	24	8.4	12	.....	400	52	47	165	1.2	346	286
31	496	.....	8.4	12	.....	476	.....	68	.....	.6	7.2	.....

NOTE.—No flow Aug. 8–29, Sept. 6, and 7.

Monthly discharge of Nueces River near Three Rivers, Tex., for the year ending Sept. 30, 1921.

Month.	Discharge in second-feet.			Run-off in acre-feet.
	Maximum.	Minimum.	Mean.	
October	496	7.2	47.2	2,900
November	616	22	96.7	5,750
December	20	8.4	10.7	658
January	12	9.5	11.9	732
February	12	9.5	11.2	622
March	6,630	12	896	55,100
April	8,450	52	1,220	72,600
May	2,190	47	500	30,700
June	3,630	18	821	48,800
July	1,480	.6	102	6,270
August	346	0	11.4	701
September	9,450	0	1,150	68,400
The year	9,450	0	405	293,000

NUECES RIVER AT CALALLEN, TEX.

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

DRAINAGE AREA.—16,700 square miles (measured on post-route map; and topographic map of Texas, compiled in 1899 by Robert T. Hill, of the United States Geological Survey, scale 1 inch=25 miles).

RECORDS AVAILABLE.—August 12, 1915, to September 30, 1921.

GAGE.—Vertical staff attached to pipe-line support of old pump house; read by John W. Cunningham.

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 dam, which is a loose rock fill half a mile below, serves as control. It leaks badly and is subject to change during floods. Flood damage is repaired by dumping loose rock on the crest.

EXTREMES OF STAGE.—Maximum stage recorded during year, 7.25 feet at 8 a. m. and 4 p. m. September 15; minimum stage, 1.20 feet 4 p. m. August 8 to 8 a. m. September 2.

1915–1921: During September, 1919, the river reached a stage of about 12 feet, as determined from flood marks on the gage. This was not only the highest stage reached during the period covered by records, but probably exceeds any that occurred for many years prior to the establishment of this station. Discharge indeterminate because of lowlands on left bank being overflowed for a width of several miles. No flow August 23–28, 1918.

ICE.—None reported.

DIVERSIONS.—Considerable water taken from river for irrigation immediately above station, and river water is also used for irrigation throughout the drainage above. The city of Corpus Christi pumps water just below the gage for municipal supply. They reported a consumption of 922 acre-feet during 1918.

REGULATION.—None of consequence.

ACCURACY.—Stage-discharge relation not permanent because of leakage through and repair to the breakwater dam. Rating curve is poorly defined. Gage read to hundredths twice daily. Daily discharge not computed because of changing control and insufficient discharge measurements. Records poor. No discharge measurements were made at this station during the year.

Daily gage height, in feet, of Nueces River at Calallen, Tex., for the year ending Sept. 30, 1921.

Day.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.
1	1.60	1.60	2.00	1.70	1.70	1.70	2.12	1.72	1.70	3.20	1.35	1.20
2	1.60	1.60	1.85	1.70	1.70	1.95	2.30	1.72	1.70	2.60	1.35	1.25
3	1.58	2.22	1.80	1.70	1.70	3.15	2.60	3.00	1.70	2.00	1.35	1.58
4	1.52	2.78	1.80	1.70	1.70	3.65	2.20	2.60	1.70	1.90	1.32	1.52
5	1.40	2.40	1.80	1.70	1.70	3.72	2.12	2.15	1.68	1.85	1.25	1.48
6	1.40	2.35	1.80	1.70	1.70	3.62	2.62	1.95	1.65	1.78	1.25	1.40
7	1.40	2.20	1.82	1.70	1.70	2.80	4.20	2.60	1.65	1.70	1.25	1.35
8	1.50	2.05	1.80	1.70	1.70	2.45	5.00	2.50	1.62	1.72	1.22	1.30
9	1.50	2.00	1.78	1.70	1.70	2.50	5.90	2.30	1.60	3.50	1.20	1.85
10	1.45	2.05	1.75	1.70	1.70	2.58	6.58	2.22	1.60	2.28	1.20	3.85
11	1.48	2.05	1.75	1.70	1.70	2.35	6.92	2.18	1.60	2.25	1.20	4.28
12	1.50	1.85	1.75	1.70	1.70	2.32	6.65	2.40	2.62	1.95	1.20	5.35
13	1.50	1.80	1.75	1.70	1.70	2.52	4.85	2.55	3.82	1.75	1.20	6.35
14	1.50	1.85	1.72	1.70	1.70	2.65	3.10	2.45	4.32	1.70	1.20	7.08
15	1.50	1.82	1.72	1.70	1.70	2.58	3.15	2.25	4.48	1.70	1.20	7.25
16	1.50	1.70	1.72	1.70	1.70	2.35	3.12	2.50	3.45	1.90	1.20	5.15
17	1.50	1.70	1.70	1.70	1.70	2.18	3.12	3.05	2.52	1.82	1.20	3.15
18	1.50	1.70	1.70	1.70	1.70	2.05	3.20	3.35	2.45	1.72	1.20	3.52
19	1.50	1.70	1.70	1.70	1.70	1.98	3.15	3.50	2.28	1.70	1.20	3.30
20	1.45	1.70	1.70	1.70	1.70	1.92	2.62	3.80	2.55	1.75	1.20	2.78
21	1.45	1.70	1.70	1.70	1.70	1.88	2.25	3.45	3.25	1.70	1.20	2.50
22	1.50	1.70	1.70	1.70	1.70	1.80	2.08	3.00	3.15	1.60	1.20	2.20
23	1.52	1.70	1.70	1.70	1.70	1.75	2.00	2.30	2.85	1.50	1.20	1.98
24	1.58	1.70	1.70	1.70	1.70	3.25	1.95	2.45	2.22	1.40	1.20	1.88
25	1.62	1.70	1.70	1.70	1.70	4.55	1.90	2.58	2.50	1.40	1.20	1.78
26	1.60	1.70	1.70	1.70	1.70	5.35	1.85	2.20	3.00	1.40	1.20	1.68
27	1.60	1.65	1.70	1.70	1.70	5.96	1.80	1.90	3.25	1.40	1.20	1.65
28	1.62	1.60	1.70	1.70	1.70	5.30	1.75	1.80	3.50	1.35	1.20	1.65
29	1.60	1.75	1.70	1.70	.....	3.12	1.72	1.75	3.65	1.35	1.20	2.25
30	1.62	2.00	1.70	1.70	.....	2.55	1.70	1.70	3.80	1.35	1.20	3.70
31	1.62	.....	1.70	1.70	.....	2.28	.....	1.70	.....	1.35	1.20	.....

FRIO RIVER NEAR DERBY, TEX.

LOCATION.—At International & Great Northern Railway bridge 900 feet below mouth of Leona River, 400 feet below highway bridge, and 4 miles south of Derby, Frio County.

DRAINAGE AREA.—3,500 square miles (measured on post-route map and topographic map of Texas, compiled in 1899 by Robert T. Hill, of the United States Geological Survey, scale 1 inch=25 miles).

RECORDS AVAILABLE.—August 1, 1915, to September 30, 1921.

GAGE.—Vertical staff attached to railway bridge pier; read by John A. Head or E. L. Willingham.

DISCHARGE MEASUREMENTS.—Made from railway bridge or highway 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; location of high-water control not known. Point of zero flow, gage height 0.07 foot, except when affected by moss on control.

EXTREMES OF DISCHARGE.—Maximum stage recorded during year, 6.7 feet during night of June 14 (discharge, 2,310 second-feet); no flow during several periods.

1915–1921: Maximum stage recorded, 18.5 feet September 18, 1919 (discharge not determined); no flow during several periods of each year.

ICE.—None reported.

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

REGULATION.—None.

ACCURACY.—Stage-discharge relation permanent except when affected by aquatic growth on control. Rating curve well defined below 2,000 second-feet. Gage read twice daily to nearest half-tenth from October 1 to March 30 and to hundredths from April 1 to September 30. Daily discharge ascertained by applying mean daily gage height to rating table. Discharge for low-water periods from October 1 to March 30 subject to considerable error on account of gage being read only to nearest half-tenth. Records good except as otherwise noted.

Discharge measurements of Frio River near Derby, Tex., during the year ending Sept. 30, 1921.

Date.	Made by—	Gage height.	Discharge.
		Feet.	*Sec.-ft.*
Nov. 9	D. A. Dudley	0.30	7.1
May 3	R. G. West	.30	7.7
4	do	.29	6.6

Daily discharge, in second-feet, of Frio River near Derby, Tex., for the year ending Sept. 30, 1921.

Day.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.
1	2.0	7.3	7.3	7.3	7.3	7.3	10	7.3	7.3	7.3	.....	.....
2	2.0	7.3	7.3	7.3	7.3	109	10	13	7.3	6.0	.....	.....
3	2.0	7.3	7.3	7.3	7.3	1,340	10	8.0	6.7	6.0	.....	.....
4	2.0	7.3	7.3	7.3	7.3	267	10	6.0	5.3	4.7	.....	.....
5	2.0	7.3	7.3	7.3	7.3	179	10	5.3	3.4	3.4	.....	.....
6	2.0	7.3	7.3	7.3	7.3	63	10	2.7	2.0	3.4	.....	.....
7	2.0	7.3	7.3	7.3	7.3	29	10	3.4	1.2	4.0	.....	.....
8	2.0	7.3	7.3	7.3	7.3	19	10	4.7	.3	3.4	.....	.....
9	2.0	7.3	7.3	7.3	7.3	15	320	4.0	.....	3.4	.....	.....
10	2.0	7.3	7.3	7.3	7.3	15	81	2.5	.....	3.4	.....	.....
11	2.0	7.3	7.3	7.3	7.3	15	42	4.0	.....	3.4	.....	1,250
12	2.0	7.3	7.3	7.3	11	15	27	6.0	4.0	2.5	.....	1,370
13	2.0	7.3	8.6	7.3	11	15	18	3.4	494	1.8	.....	145
14	2.0	7.3	7.3	7.3	10	15	14	2.3	1,980	1.6	.....	41
15	2.0	7.3	7.3	7.3	10	15	12	2.0	1,800	1.4	.....	15
16	2.0	7.3	7.3	7.3	8.0	15	9.3	1.8	251	.9	.....	6.0
17	2.0	7.3	11	7.3	7.3	15	8.6	1.6	175	.3	.....	2.5
18	2.0	7.3	7.3	7.3	7.3	15	8.6	1.6	84	.....	.....	1.8
19	2.0	11	7.3	7.3	8.0	13	8.6	136	44	.....	.....	.9
20	2.0	15	7.3	7.3	7.3	15	8.0	82	18	.....	.....	.3
21	2.0	15	7.3	7.3	8.6	15	7.3	20	16	.....	.....	.....
22	2.0	13	7.3	7.3	8.6	15	6.0	27	12	.....	.....	.....
23	2.0	11	7.3	7.3	7.3	15	4.7	17	10	.....	.....	.....
24	7.3	11	7.3	7.3	8.6	12	4.7	10	10	.....	.....	.....
25	15	11	7.3	7.3	8.6	12	4.7	8.6	10	.....	.....	.....
26	7.3	8.6	7.3	7.3	7.3	13	4.7	7.3	10	.....	.....	.....
27	7.3	7.3	7.3	7.3	7.3	15	4.7	7.3	7.3	.....	.....	.....
28	7.3	7.3	7.3	7.3	7.3	14	3.4	7.3	7.3	.....	.....	.....
29	7.3	7.3	7.3	7.3	.....	14	3.4	7.3	7.3	.....	.....	.....
30	7.3	7.3	7.3	7.3	.....	15	4.0	7.3	7.3	.....	.....	.....
31	7.3	.....	7.3	7.3	.....	15	.....	7.3	.....	.....	.....	.....

NOTE.—No flow June 9–11, July 18 to Sept. 10, and Sept. 21–30.

Monthly discharge of Frio River near Derby, Tex., for the year ending Sept. 30, 1921.

Month.	Discharge in second-feet.			Run-off in acre-feet.
	Maximum.	Minimum.	Mean.	
October	15	2.0	3.62	223
November	15	7.3	8.54	508
December	11	7.3	7.46	459
January	7.3	7.3	7.30	449
February	11	7.3	7.99	444
March	1,340	7.3	75.7	4,650
April	320	3.4	22.8	1,360
May	136	1.6	13.7	842
June	1,980	0	166	9,880
July	7.3	0	1.84	113
August	0	0	0	0
September	1,370	0	94.4	5,620
The year	1,980	0	33.9	24,500

RIO GRANDE BASIN.

RIO GRANDE NEAR SAN MARCIAL, N. MEX

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

DRAINAGE AREA.—Not measured.

RECORDS AVAILABLE.—January 29, 1895, to December 31, 1921, when station was discontinued.

GAGE.—Inclined staff established January 29, 1895, and destroyed by flood in 1896. Wire gage established in its place at same datum. This was soon abandoned and gage heights have since been obtained by measuring with graduated rod from bridge deck to water surface. Gage datum unchanged.

DISCHARGE MEASUREMENTS.—Made from bridge.

CHANNEL AND CONTROL.—Bed sandy and very shifting; broken by several bridge piers. No information relative to control section.

EXTREMES OF DISCHARGE.—Maximum mean daily stage during period October 1, 1920, to December 31, 1921, 15.9 feet on June 20 (discharge, 19,400 second-feet); minimum mean daily discharge, 90 second-feet on October 5. 1921.

1895–1921: Maximum mean daily discharge, 33,000 second-feet on October 11, 1904 (gage height, 13.75 feet); no flow for periods of varying length each year.

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 United States Geological Survey.

Daily discharge, in second-feet, of Rio Grande near San Marcial, N. Mex., for the period Oct. 1, 1920, to Dec. 31, 1921.

Day.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.
1920-21.												
1	115	629	782	621	839	765	1,240	722	3,780	3,470	5,460	2,080
2	120	629	776	622	810	1,400	1,030	988	3,870	3,060	4,910	2,110
3	124	629	765	624	775	1,360	981	722	4,560	2,780	4,540	1,970
4	110	709	743	632	753	1,530	924	500	8,100	2,850	3,810	1,820
5	90	709	717	648	806	1,530	858	4,010	7,440	2,640	1,990	1,570
6	110	699	696	662	865	1,700	897	3,700	10,500	2,460	1,930	1,490
7	121	675	678	663	926	1,840	935	4,380	11,400	2,420	1,770	1,320
8	121	699	662	662	913	1,630	972	5,040	11,500	2,010	1,440	1,170
9	121	703	648	664	901	1,500	972	5,490	12,300	1,960	1,390	1,060
10	121	706	636	661	892	1,510	972	5,180	12,700	1,570	2,950	940
11	121	703	622	664	840	1,520	572	4,570	11,400	1,240	2,000	826
12	128	706	610	667	782	1,510	282	3,660	12,800	1,240	1,790	769
13	128	760	605	664	725	1,510	150	3,080	13,600	1,040	2,680	651
14	128	895	603	672	752	1,320	282	2,850	13,400	1,090	2,220	612
15	129	975	601	678	782	950	282	3,080	14,600	830	2,120	525
16	129	1,090	601	705	819	950	150	3,590	15,700	900	2,350	4,300
17	129	960	602	731	877	950	150	3,870	16,800	1,260	2,350	823
18	179	823	603	762	935	596	736	3,770	16,200	1,200	2,100	697
19	179	825	606	743	990	590	752	4,020	18,500	1,070	1,430	615
20	220	827	612	725	856	586	768	4,120	19,400	823	1,330	503
21	257	760	618	706	724	589	784	4,220	16,200	2,120	2,380	434
22	257	829	624	732	644	1,320	400	3,560	13,300	2,230	4,510	860
23	257	810	630	752	628	1,990	600	3,850	12,800	3,530	2,400	760
24	257	790	635	770	664	1,990	400	3,220	10,500	5,660	2,570	670
25	310	790	639	829	700	1,810	930	3,940	9,530	10,900	2,800	519
26	400	785	641	891	719	1,550	1,290	3,760	7,420	8,650	2,800	496
27	602	781	641	950	742	1,290	1,020	3,560	5,790	8,670	2,690	435
28	602	783	639	927	765	1,290	1,050	3,800	5,240	8,920	2,470	378
29	602	784	635	908	.....	1,610	1,020	3,600	4,500	6,200	2,310	326
30	602	786	628	896	.....	1,430	988	4,020	3,710	5,930	2,190	347
31	629	.....	619	867	.....	1,210	.....	3,860	.....	5,210	2,070	.....

Day.	Oct.	Nov.	Dec.	Day.	Oct.	Nov.	Dec.	Day.	Oct.	Nov.	Dec.
1921.											
1	328	573	843	11	390	655	880	21	399	683	741
2	310	542	772	12	366	710	720	22	418	702	774
3	302	513	729	13	397	764	766	23	346	677	804
4	310	486	818	14	420	733	767	24	440	631	862
5	346	473	908	15	412	729	973	25	471	587	952
6	333	452	993	16	414	712	968	26	485	565	1,040
7	447	474	890	17	462	668	940	27	520	781	1,130
8	447	535	780	18	433	612	898	28	546	781	1,110
9	404	588	900	19	420	542	854	29	539	864	1,100
10	419	585	835	20	404	596	786	30	553	803	1,060
								31	562	.....	1,220

Monthly discharge of Rio Grande near San Marcial, N. Mex., for the period Oct. 1, 1920, to Dec. 31, 1921.

Month.	Discharge in second-feet.			Run-off in acre-feet.
	Maximum.	Minimum.	Mean.	
1920–21.				
October	629	90	239	14,700
November	1,090	629	775	46,100
December	782	601	649	39,900
January	950	621	732	45,000
February	990	628	801	44,500
March	1,990	586	1,330	81,800
April	1,290	150	746	44,400
May	5,490	500	3,510	216,000
June	19,400	3,710	10,900	649,000
July	10,900	823	3,350	206,000
August	5,460	1,330	2,570	158,000
September	4,300	326	1,040	61,900
The year	19,400	90	2,220	1,610,000
1921.				
October	562	302	421	25,900
November	864	452	634	37,700
December	1,220	720	897	55,200

RIO GRANDE BELOW ELEPHANT BUTTE DAM, N. MEX.

LOCATION.—In T. 13 S., R. 4 W., 1 mile below Elephant Butte dam, in Sierra County. Nearest tributary, Mescal Canyon, enters half a mile downstream.

DRAINAGE AREA.—Not measured.

RECORDS AVAILABLE.—October 1, 1916, to September 30, 1921.

GAGE.—Stevens water-stage recorder on left bank, 1 mile below dam.

DISCHARGE MEASUREMENTS.—Made from car and cable at gage.

CHANNEL AND CONTROL.—Bed composed of compact gravel; should be permanent. Control located at gravel bar at mouth of Mescal Canyon, which shifts.

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

REGULATION.—Flow controlled by Elephant Butte dam which forms reservoir having capacity of 2,638,000 acre-feet.

EXTREMES OF DISCHARGE.—No data.

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

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Daily discharge, in second-feet, of Rio Grande below Elephant Butte dam, N. Mex., for the year ending Sept. 30, 1921.

Day.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.
1	1,920	525	704	5	6	1,450	1,440	1,510	1,980	2,090	2,120	2,080
2	1,920	1,060	1,090	15	6	1,450	1,420	1,470	1,980	2,090	2,120	2,080
3	1,920	1,060	1,090	15	7	1,460	1,420	1,460	1,990	2,080	2,020	2,080
4	1,920	1,060	1,090	15	6	1,420	1,440	1,460	2,020	2,090	2,120	2,080
5	1,920	1,070	1,090	15	6	1,420	1,350	1,480	2,000	2,100	2,120	2,080
6	1,920	1,080	1,080	16	12	1,420	1,280	1,840	1,980	2,100	2,120	2,080
7	1,920	1,080	1,090	15	11	1,420	1,260	1,820	1,980	2,110	2,120	2,080
8	1,920	1,080	1,080	15	16	1,420	1,260	1,790	1,980	565	2,120	2,080
9	1,920	1,080	1,080	15	91	1,420	1,280	1,790	1,980	1,380	2,120	2,080
10	1,920	1,080	1,090	15	27	1,420	1,380	1,790	1,980	2,040	2,120	2,080
11	1,920	1,080	1,080	16	662	1,420	1,310	1,800	1,980	2,040	2,120	2,080
12	1,920	1,080	1,080	15	852	1,430	1,260	1,820	1,980	2,050	2,120	2,080
13	1,920	1,080	1,080	86	939	1,430	1,260	1,790	1,980	2,060	2,120	2,080
14	1,920	1,080	1,080	93	905	1,430	1,260	1,820	1,980	2,070	2,120	2,080
15	639	1,080	1,080	93	912	1,390	1,260	1,790	1,980	2,070	2,120	2,120
16	1	1,080	1,080	91	896	1,360	1,310	1,790	1,980	2,120	2,120	2,090
17	2	1,080	1,090	83	951	1,370	1,400	1,790	1,980	2,120	917	2,080
18	1	542	361	83	945	1,370	1,400	1,820	1,980	2,120	690	2,080
19	2	1	1	83	999	1,370	1,340	1,760	1,980	2,120	2,120	2,050
20	1	2	2	83	940	1,360	1,290	1,800	1,990	2,120	2,120	2,080
21	2	1	1	84	948	1,360	1,270	1,800	2,000	2,120	2,120	2,080
22	1	2	2	83	951	1,360	1,280	1,790	2,220	2,120	2,120	2,080
23	2	1	1	83	943	1,380	1,290	1,800	2,400	2,120	2,120	2,100
24	1	2	2	83	950	1,440	1,460	1,820	2,160	2,120	2,120	2,100
25	2	1	1	83	1,100	1,450	1,490	1,820	2,070	2,120	2,120	2,080
26	1	2	2	84	1,440	1,450	1,490	1,830	2,080	2,120	2,120	2,080
27	2	1	1	70	1,430	1,440	1,550	1,950	2,100	2,120	2,120	2,080
28	1	2	2	5	1,440	1,440	1,500	1,980	2,100	2,120	2,090	2,080
29	2	1	1	5	.....	1,430	1,540	1,980	2,100	2,120	2,090	2,080
30	1	2	2	5	.....	1,430	1,490	1,980	2,100	1,280	2,090	2,080
31	2	.....	1	6	.....	1,430	.....	1,980	.....	2,120	2,090	.....

Monthly discharge of Rio Grande below Elephant Butte dam, N. Mex., for the year ending Sept. 30, 1921.

Month.	Discharge in second-feet.			Run off in acre-feet.
	Maximum.	Minimum.	Mean.	
October	1,920	1	888	54,600
November	1,080	1	610	36,300
December	1,090	1	595	36,600
January	93	5	47.0	2,890
February	1,440	6	657	36,500
March	1,460	1,360	1,410	86,700
April	1,550	1,260	1,370	81,500
May	1,980	1,460	1,780	109,000
June	2,400	1,980	2,030	121,000
July	2,120	565	2,000	123,000
August	2,120	690	2,030	125,000
September	2,120	2,050	2,080	124,000
The year	2,400	1	1,290	937,000

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, 1921.

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 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 banks are overflowed at stage of about 11.5 feet. No well-defined control.

EXTREMES OF DISCHARGE.—Maximum mean daily discharge during year, 25,000 second-feet June 6, estimated from flow over McMillan spillway and headgates; minimum mean daily discharge, 58 second-feet October 10.

1905–1921: Maximum stage recorded, 15.9 feet for 5 or 6 hours during morning of September 18, 1919 (discharge not determined; probably exceeded previous maximum of 50,300 second-feet on July 25, 1915, which was derived from discharge at Lake McMillan and included flow of Penasco River). Minimum stage, 2.45 feet July 26 and 27, 1916 (discharge, 23 second-feet).

ICE.—None reported.

DIVERSIONS.—Considerable water is diverted above station for irrigation; 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, but periods of change are covered by frequent discharge measurements. Two rating curves used. One from October 1 to July 31, well defined from 60 to 340 second-feet, and one from August 1 to September 30 well defined from 80 to 800 second-feet, and poorly defined above. Mean daily gage heights determined from recorder graph, or staff gage readings; period of use of recorder or frequency and refinement of staff gage readings not known. Daily discharge determined by applying mean daily gage height to rating table, except April 24 to September 19, when shifting-control method was used, and on May 26, June 5–8, 18, and 19, when discharge was estimated by the outflow of McMillan spillways and headgates. Records good.

COOPERATION.—Daily-discharge record and results of discharge measurements furnished by the United States Reclamation Service.

Discharge measurements of Pecos River near Dayton, N. Mex., during the year ending Sept. 30, 1921.

Date.	Made by—	Gage height.	Discharge.	Date.	Made by—	Gage height.	Discharge.
		Feet.	*Sec.-ft.*			*Feet.*	*Sec.-ft.*
Oct. 1	J. R. Yates[a]	5.25	235	May 17	J. R. Yates	9.55	2,349
Nov. 1	do	4.90	168	21	do	7.50	773
18	do	5.14	212	24	do	10.50	3,762
Dec. 10	do	5.09	205	27	do	9.55	2,088
31	do	5.52	293	31	do	6.80	521
Jan. 21	do	5.70	337	June 14	do	10.00	2,387
25	do	5.45	278	16	Robins and Haralson	8.65	1,624
Feb. 23	do	4.92	169	30	H. I. Haralson	6.94	525
Mar. 31	do	4.69	134	July 11	Robins and Hamill	8.00	854
Apr. 23	do	4.40	91	Aug. 9	J. R. Yates	7.90	623
May 2	Robins[b] and Haralson[b]	4.20	98	26	do	8.00	644
5	do	4.14	89	Sept. 19	do	6.00	140

[a] Employee of United States Reclamation Service.
[b] Employee of New Mexico Hydrographic Survey.

Daily discharge, in second-feet, of Pecos River near Dayton, N. Mex., for the year ending Sept. 30, 1921.

Day.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.
1	176	169	192	323	276	234	123	86	392	287	1,523	543
2	120	215	192	311	265	218	117	91	437	265	1,232	366
3	81	265	192	311	265	224	112	99	772	323	1,107	456
4	70	294	192	304	261	224	109	91	830	504	803	456
5	64	265	192	294	254	201	108	88	7,736	1,487	747	395
6	59	224	196	285	244	187	109	98	25,000	1,978	1,045	314
7	59	200	209	285	248	174	105	92	9,000	1,725	1,076	279
8	59	209	228	285	248	166	104	88	5,000	2,163	803	247
9	62	209	211	274	252	160	101	88	2,681	2,274	625	218
10	58	203	201	265	254	152	101	84	1,904	1,587	506	190
11	66	196	205	269	259	152	94	81	1,487	1,042	524	181
12	72	196	198	265	254	149	91	72	1,487	668	803	172
13	70	196	198	254	254	149	90	72	2,015	521	863	163
14	76	196	209	246	254	149	85	72	2,311	470	1,295	163
15	76	192	209	246	254	146	78	91	1,042	486	1,490	172
16	76	192	220	242	246	144	85	160	1,454	407	1,590	181
17	90	196	252	238	240	142	82	2,666	1,587	363	2,580	181
18	105	205	259	248	230	136	82	1,725	4,500	311	2,655	163
19	81	213	254	287	230	133	82	800	3,434	254	2,205	139
20	74	213	257	350	224	141	78	392	2,533	234	1,798	139
21	71	209	259	336	196	191	78	772	1,978	287	1,359	139
22	72	205	265	299	182	187	86	2,607	1,656	1,487	1,327	139
23	74	203	265	292	178	162	91	1,520	1,725	2,200	1,359	217
24	105	196	269	287	176	155	82	3,014	1,135	1,760	984	172
25	142	192	269	276	174	146	78	3,088	772	1,421	747	164
26	136	191	269	269	176	133	94	4,966	580	1,520	647	147
27	142	187	265	269	178	139	94	2,015	504	1,621	582	139
28	142	187	263	287	220	133	90	1,129	504	1,690	506	131
29	136	187	265	304	.....	146	91	772	407	1,978	425	115
30	128	196	269	311	.....	133	92	718	437	2,348	380	108
31	136	.....	292	287	.....	130	.....	521	.....	1,904	425	.....

Monthly discharge of Pecos River near Dayton, N. Mex., for the year ending Sept. 30, 1921.

Month.	Discharge in second-feet.			Run-off in acre-feet.
	Maximum.	Minimum.	Mean.	
October	176	58	92.8	5,710
November	294	169	207	12,400
December	292	192	233	14,300
January	350	238	284	17,500
February	276	174	232	12,900
March	234	130	162	9,960
April	123	78	93.7	5,580
May	4,970	72	908	55,800
June	25,000	392	2,840	169,000
July	2,350	234	1,150	70,700
August	2,660	380	1,100	67,600
September	543	108	220	13,100
The year	25,000	58	628	455,000

NOTE.—See "Accuracy."

PECOS RIVER AT CARLSBAD, N. MEX.

LOCATION.—In 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, and 2,000 feet below Hagerman dam.

DRAINAGE AREA.—Not measured.

RECORDS AVAILABLE.—May 28, 1903, to March 31, 1908; May 13, 1914, to September 30, 1921.

GAGE.—Stevens 8-day water-stage recorder, attached to downstream end of middle bridge pier, installed June 1, 1920; inspected by J. R. Yates, Genaro López, Frank Smith, and W. R. White. Gage used from May 28, 1903, to October, 1904, was inclined staff gage at present site. From October, 1904, to March 31, 1908, vertical staff gage at the same site used, and from May 18, 1914, to June 1, 1920, gage was vertical staff, attached to upstream side of middle pier of bridge.

DISCHARGE MEASUREMENTS.—Made from bridge or by wading.

CHANNEL AND CONTROL.—Bed composed of gravel and rock; but considerable changes have taken place, due to sand deposits. Banks of medium height; not subject to overflow. Location of control not known.

EXTREMES OF DISCHARGE.—Maximum stage recorded during year from water-stage recorder, 10.22 feet at 7 p. m. June 7 (discharge, 16,200 second-feet); minimum stage, 0.62 foot at 7.30 a. m. May 1 (discharge, 69 second-feet).

1903–1908; 1914–1921: Maximum stage recorded, about 21.0 feet August 7, 1916 (discharge, 85,700[1] second-feet); minimum discharge, 30 second-feet September 30, 1918.

ICE.—None reported.

DIVERSIONS.—Large quantities of water are stored a few miles above station at 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 amount being used for irrigation between the two points.

REGULATION.—Flow at this point completely controlled by storage reservoirs of the Carlsbad project, except during extreme floods.

ACCURACY.—Stage-discharge relation practically permanent during the year. Rating curve fairly well defined for all stages. Operation of water-stage recorder satis, factory. Daily discharge ascertained by applying to rating table mean daily gage height obtained from recorder graph by inspection or by use of planimeter- or for days of considerable fluctuation in stage by averaging discharge for intervals of the day. Records good.

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, 1921.

Date.	Made by—	Gage height.	Discharge.	Date.	Made by—	Gage height.	Discharge.
		Feet.	*Sec.-ft.*			*Feet.*	*Sec.-ft.*
Nov. 17	J. R. Yates [a]	0.97	165	June 9	J. R. Yates	6.65	7,580
Jan. 6	do	1.01	200	10	do	4.85	4,740
Feb. 24	do	.76	102	21	do	4.02	3,370
Mar. 26	do	.73	95.1	July 8	Dudley and Yates	5.25	4,420
Apr. 30	do	.73	86.0	30	J. R. Yates	3.30	2,370
May 28	do	.71	92.7	Sept. 28	do	.83	150
June 8	do	8.95	[b]13,600				

[a] Engineer of United States Reclamation Service.
[b] Velocities observed at 0.2 depths and coefficients used to reduce to mean velocities.

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

Daily discharge, in second-feet, of Pecos River at Carlsbad, N. Mex., for the year ending Sept. 30, 1921.

Day.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.
1	95	142	184	180	208	80	95	95	285	117	1,490	109
2	100	120	184	180	229	78	95	98	106	109	748	114
3	103	126	180	180	283	76	98	95	2,710	109	559	114
4	103	156	184	180	283	78	95	95	6,140	126	348	117
5	106	120	180	180	246	80	92	98	5,700	408	123	120
6	222	133	133	180	208	231	92	98	6,680	3,520	114	109
7	114	166	148	180	196	224	90	92	14,800	3,450	839	106
8	204	117	170	176	176	200	95	87	12,700	3,200	1,690	106
9	362	152	170	176	114	145	95	90	6,540	2,680	1,040	109
10	133	159	170	176	109	111	92	90	5,190	3,940	370	111
11	117	159	173	176	111	90	98	87	1,510	1,100	250	126
12	114	159	170	176	170	90	95	87	1,330	638	111	130
13	114	159	166	173	117	87	92	87	2,070	1,080	109	123
14	117	152	166	173	111	87	98	87	2,840	1,870	114	111
15	123	156	173	180	111	106	95	90	2,530	634	402	114
16	126	162	173	180	109	117	92	90	1,830	449	1,410	111
17	136	196	170	180	109	120	90	92	743	111	1,350	111
18	139	233	159	200	111	109	95	92	1,470	100	2,180	109
19	151	188	170	238	156	87	92	90	3,220	103	3,400	114
20	251	142	184	212	114	85	92	90	4,760	145	2,690	117
21	207	142	184	184	98	85	90	85	3,580	109	885	109
22	123	142	184	188	98	85	92	85	3,370	103	1,270	111
23	117	166	180	184	98	85	92	90	139	103	126	120
24	162	200	176	134	95	90	92	87	859	1,180	223	130
25	126	200	176	184	103	85	90	85	1,160	940	637	123
26	117	196	173	188	114	90	90	83	970	490	117	126
27	153	180	173	188	114	90	90	83	670	1,500	125	126
28	123	90	173	188	109	90	90	85	188	1,960	474	120
29	111	109	170	196	.....	92	90	90	156	2,180	296	111
30	107	180	176	208	.....	92	92	248	133	2,320	111	100
31	159	.....	176	208	.....	92	.....	420	.....	2,250	109	.....

NOTE.—Discharge, June 17 and 18, estimated because of backwater; July 3 and 10 partly estimated because of incomplete gage-height record.

Monthly discharge of Pecos River at Carlsbad, N. Mex., for the year ending Sept. 30, 1921.

Month.	Discharge in second-feet.			Run-off in acre-feet.
	Maximum.	Minimum.	Mean.	
October	362	95	143	8,790
November	233	90	157	9,340
December	184	133	173	10,600
January	238	173	186	11,400
February	283	95	146	8,110
March	231	76	105	6,460
April	98	90	92.9	5,530
May	420	83	106	6,520
June	14,800	106	3,150	187,000
July	3,940	100	1,190	73,200
August	3,400	109	765	47,000
September	130	100	115	6,840
The year	14,800	76	527	381,000

PECOS RIVER NEAR MALAGA, N. MEX.

LOCATION.—In sec. 18 or 19, T. 24 S., R. 29 E., 3½ miles southeast of Malaga, Eddy County, and 4¼ miles below mouth of Black River.

DRAINAGE AREA.—Not measured.

RECORDS AVAILABLE.—May 1, 1920, to September 30, 1921.

GAGE.—Gurley water-stage recorder installed December 30, 1920, on right bank, replacing the Friez water-stage recorder used prior to that date; inspected by W. F. Gerlach.

DISCHARGE MEASUREMENTS.—Made from cable.

CHANNEL AND CONTROL.—Bed composed of solid rock covered with sand; shifts. Right bank solid rock and steep; left bank sand and high. Control is a rock ledge overlain by sand, 500 feet below gage; shifts slightly.

EXTREMES OF DISCHARGE.—Maximum stage during year from water-stage recorder, 12.85 feet at 1 a. m. June 8 (discharge, 22,000 second-feet); minimum stage, 3.66 feet from 6 p. m. April 24 to 3 a. m. April 25 (discharge, 86 second-feet).

1920–1921: Maximum stage, that of June 8, 1921; minimum stage, 3.63 feet at 8 p. m. September 1, 1920 (discharge, 63 second-feet, determined from extension of rating curve).

In September, 1919, the river reached a stage of 26.4 feet (discharged not determined).

ICE.—None reported.

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 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.—Operation of a water-power plant of 300 horsepower capacity above station, just below Carlsbad, N. Mex., owned and operated by Carlsbad Electric Light & Power Co., 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 winter the flow depends on water released at the reservoirs.

ACCURACY.—Stage-discharge relation not permanent. Rating curve used October 1 to May 30 well defined from 100 to 900 second-feet; curve used May 31 to September 30, well defined from 50 to 16,000 second-feet. Operation of water-stage recorder satisfactory, except as noted in footnote to daily-discharge table. Daily discharge ascertained by applying to rating table mean daily gage height determined from recorder graph by inspection or by use of planimeter, or for days of considerable fluctuation in stage by averaging discharge for intervals of the day; shifting-control method used May 31 to June 2. Records good.

Discharge measurements of Pecos River near Malaga, N. Mex., during the year ending Sept. 30, 1921.

Date.	Made by—	Gage height.	Discharge.	Date.	Made by—	Gage height.	Discharge.
		Feet.	*Sec.-ft.*			*Feet.*	*Sec.-ft.*
Oct. 2	J. R. Yates *a*	4.28	278	June 9	J. R. Yates *a*	9.90	8,020
30	.....do	4.22	248	10	.....do	8.95	4,920
Nov. 19	.....do	4.40	300	15	.....do	7.70	2,890
Dec. 11	.....do	4.29	276	15	Robbins *b* and Haralson *b*	7.66	2,950
30	.....do	4.29	281				
Feb. 19	.....do	4.19	243	17	J. R. Yates	5.45	837
Mar. 26	.....do	3.95	190	22	.....do	8.05	3,460
Apr. 30	.....do	3.80	127	July 8	Yates and Dudley	8.08	*c* 4,550
May 28	.....do	3.97	165	Aug. 25	J. R. Yates	5.40	1,070
June 8	.....do	11.7	15,600	Sept. 27	.....do	4.25	292

a Employee of United States Reclamation Service.
b Employee of New Mexico Hydrographic Service.
c Rapidly rising stage.

Daily discharge, in second-feet, of Pecos River near Malaga, N. Mex., for the year ending Sept. 30, 1921.

Day.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.
1	241	213	273	297	301	317	161	130	433	349	1,980	289
2	257	253	305	301	313	269	161	126	472		992	272
3	313	249	301	305	333	175	161	147	1,400	300	394	264
4	217	237	301	325	341	150	144	137	3,240		740	284
5	213	261	313	301	353	157	140	130	4,210		331	310
6	237	253	301	297	361	157	144	161	4,790		237	264
7	305	281	261	313	285	361	147	157	13,300	2,900	297	230
8	277	285	289	285	265	345	144	147	17,200		1,760	223
9	500	261	309	285	233	285	161	130	7,380	2,100	1,350	212
10	365	221	309	333	221	225	168	147	4,510	3,330	665	193
11	245	229	281	313	175	175	175	133	2,840	2,510	668	190
12	281	245	285	293	150	161	172	140	1,290	420	372	216
13	190	261	289	305	253	165	201	140	1,800	1,090	305	253
14	273	273	257	297	205	154	179	140	3,000	1,620	260	237
15	217	277	261	297	154	161	175	164	2,920	1,310	256	220
16	265	273	261	301	136	253	179	164	2,080	459	1,030	216
17	289	277	265	309	205	293	179	179	1,300	583	1,560	220
18	265	325	265	321	217	249	179	161	3,800	314	1,450	212
19	305	333	293	325	245	190	175	154	2,630	245	3,730	209
20	289	269	293	317	233	179	179	154	4,740	216	3,580	216
21	374	253	277	313	297	147	179	194	4,050	241	1,370	212
22	321	253	261	309	257	172	164	164	3,800	180	1,560	220
23	265	261	281	293	221	175	100	175	747	174	716	220
24	345	269	285	301	221	186	91	329	220	221	336	226
25	383	277	297	301	198	190	103	383	1,500	1,540	686	276
26	309	277	297	293	194	190	126	209	1,150	521	372	256
27	217	313	317	301	221	183	130	175	622	798	264	268
28	194	313	329	305	309	183	113	165	751	1,680	426	256
29	233	257	313	297	.....	175	100	150	460	1,840	605	245
30	245	277	297	293	.....	168	120	209	386	2,160	310	237
31	221	.....	317	297	.....	150	.....	636	.....	2,120	260	.....

NOTE.—Discharge partly estimated, owing to incomplete gage-height record as follows: Oct. 25–30; Nov. 8–13; Dec. 26 to Jan. 1; July 9 and Aug. 23–25. No gage-height record July 2–8; discharge estimated by comparison with records for other stations.

Monthly discharge of Pecos River near Malaga, N. Mex., for the year ending Sept. 30, 1921.

Month.	Discharge in second-feet.			Run-off in acre-feet.
	Maximum.	Minimum.	Mean.	
October	500	190	279	17,200
November	333	213	268	15,900
December	329	257	290	17,800
January	333	285	304	18,700
February	361	136	246	13,700
March	361	147	205	12,600
April	201	91	152	9,040
May	636	126	185	11,400
June	17,200	220	3,230	192,000
July	.....	.....	1,160	71,300
August	3,730	237	931	57,200
September	310	190	238	14,200
The year	17,200	91	623	451,000

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 New Mexico-Texas State line, 2¼ miles southeast of Red Bluff, Eddy County, N. Mex., and 8½ miles northwest of Angeles, Reeves County, Tex.

DRAINAGE AREA.—Not measured.

RECORDS AVAILABLE.—May 27, 1914, to September 30, 1921.

GAGE.—Stevens continuous water-stage recorder, at first outcropping of rock on right bank about 600 feet below railroad bridge and mouth of Delaware Creek; inspected by H. N. White and C. L. Vowell.

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 200 feet below gage; shifts.

EXTREMES OF DISCHARGE.—Maximum stage during year occured during period of missing record; minimum stage, 0.01 foot at midnight March 8 (discharge, 85 second-feet, determined from extension of rating curve).

1914–1921: Maximum stage recorded, 21.5 feet at 10 a. m. August 8, 1916, measured by leveling from flood marks (discharge not determined); minimum discharge, 80 second-feet February 27, 1919.

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

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

REGULATION.—The operation of a water-power plant of 300 horsepower capacity above station, just below Carlsbad, N. Mex., owned and operated by Carlsbad Electric Light & Power Co., 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. Rating curve well defined from 120 to 22,000 second-feet; extended beyond these limits. Operation of water-stage recorder not satisfactory. Daily discharge ascertained by applying to rating table mean daily gage height obtained from recorder chart by inspection or by use of planimeter, or for days of considerable fluctuation in stage by averaging discharge for intervals of the day. Shifting-control method used October 1 to December 11, and July 8 to September 30. Records fair.

Discharge measurements of Pecos River near Angeles, Tex., during the year ending Sept. 30, 1921.

Date.	Made by—	Gage height.	Discharge.	Date.	Made by—	Gage height.	Discharge.
		Feet.	*Sec.-ft.*			*Feet.*	*Sec.-ft.*
Nov. 18	D. A. Dudley	0.52	253	Apr. 14	D. A. Dudley	0.26	151
Dec. 11	do	.50	261	May 12	do	.20	132
Jan. 21	do	.59	314	July 7	do	3.73	4,650
Feb. 21	do	.43	227	Aug. 2	do	1.65	1,280
22	Dudley and Fellows	.49	261				

Daily discharge, in second-feet, of Pecos River near Angeles, Tex., for the year ending Sept. 30, 1921.

Day.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.
1	290	210	219	261	238	277	189	136	580		2,100	250
2	280	201	238	282	247	247	176	136	354		1,240	
3	270	214	261	293	238	219	180	140				266
4	261	210	266	293	223	172	185	150		300		282
5	223	210	266	293	189	158	189	143			670	293
6	219	219	266	298	180	172	193	150				247
7	233	277	288	288	193	165	180	147		4,060	201	228
8	293	272	277	288	238	88	176	143		2,690		233
9	266	247	272	282	238	100	176	136		2,590		228
10	475	228	266	266	272	127	172	130		2,860		214
11	277	238	256	277	282	158	165	147		2,820	1,070	214
12	238	256	247	277	303	185	168	136		786		233
13	233	261	247	238	303	189	165	140		795		272
14	197	252	242	242	277	193	140	140		1,350	298	256
15	228	247	242	261	303	201	136	136		1,660	261	247
16	210	242	247	266	309	197	143	140	3,900	768	443	238
17	238	242	266	272	314	147	143	176		565		247
18	247	261	252	277	287	133	143	150				242
19	242	282	242	282	256	158	140	136				242
20	256	293	242	282	210	189	130	136			3,100	252
21	261	233	252	303	223	206	133	136		320		247
22	320	228	256	288	266	219	140	206				266
23	272	219	256	282	228	193	136	193			1,240	256
24	396	223	266	282	210	185	127	210			421	261
25	396	247	261	272	201	180	140				340	309
26	309	261	266	256	180	180	150	200		860	690	298
27	233	266	272	252	176	172	147			549	303	288
28	223	256	277	247	233	189	147			1,600	223	303
29	219	252	266	233	.....	176	133	147		1,870		282
30	223	219	261	233	.....	185	140	206		2,120	400	293
31	214	.....	261	242	.....	189	.....	214	.....	2,140		.....

NOTE.—Owing to incomplete gage-height record, discharge partly estimated on following days: Apr. 13–14, May 24, 29, June 2, July 7, 12, 13, 16, 17, 26, 27, 30, and 31, Aug. 1, 2, 14, 27, and 28. Discharge, Aug. 23, determined from one staff gage reading. Braced figures show estimated mean discharge for periods included.

Monthly discharge of Pecos River near Angeles, Tex., for the year ending Sept. 30, 1921.

Month.	Discharge in second-feet.			Run-off in acre-feet.
	Maximum.	Minimum.	Mean.	
October	475	197	266	16,400
November	293	201	242	14,400
December	288	219	258	15,900
January	303	233	271	16,700
February	314	176	243	13,500
March	277	88	179	11,000
April	193	127	156	9,280
May	.....	136	160	9,840
June	.....	.....	3,670	218,000
July	4,060	.....	1,110	68,200
August	.....	.....	1,180	72,600
September	309	214	258	15,400
The year	.....	88	665	481,000

NOTE.—See footnote to daily-discharge table.

PECOS RIVER ABOVE BARSTOW, TEX.

LOCATION.—Three-quarters of a mile below headgate of Biggs irrigation project, 1 mile east of Patrole siding on Pecos River Railroad, 1¼ miles above headgate of Barstow Irrigation Co., 14 miles northwest of Barstow, Reeves County, and 10 miles northwest of Pecos.

DRAINAGE AREA.—Not measured.

RECORDS AVAILABLE.—February 1, 1916, to May 11, 1921, when station was temporarily discontinued.

GAGE.—Stevens water-stage recorder on right bank, inspected by D. H. Armstrong.

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 clay, clean, and fairly permanent; left bank loose and 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 period October 1, 1920, to May 11, 1921, from water-stage recorder, 3.01 feet at 3 a. m. October 26 (discharge, 407 second-feet); minimum stage occurred during period of missing record.

1915–1921: Maximum stage from water-stage recorder, 12.1 feet at 6 a. m. August 10, 1916 (discharge not measurable above a stage of about 11 feet because banks are overflowed); minimum discharge, 22 second-feet June 24, 1917.

ICE.—None reported.

DIVERSIONS.—In addition to water used in New Mexico by the Carlsbad and other projects, several large diversions are made above the station in Texas. The principal projects in Texas which divert above the station are the Arno, Porterville, Farmers Independent, and Biggs. (The Arno and Porterville did not divert in 1921.) According to the records of the Board of Water Engineers for the State of Texas, these projects have declared a total of about 7,500 acres irrigated. The principal projects below the station are the Barstow, Grandfalls, Imperial, and Zimmerman which have declared a total irrigated area of about 30,000 acres.

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 practically permanent during the period. Rating curve well defined for all stages. Operation of water-stage recorder not satisfactory. Daily discharge determined by applying to rating table mean daily gage height obtained from recorder graph by inspection or by use of planimeter, except as noted in footnote to daily-discharge table. Records poor.

Discharge measurements of Pecos River above Barstow, Tex., during the year ending Sept. 30, 1921.

Date.	Made by—	Gage height.	Discharge.	Date.	Made by—	Gage height.	Discharge.
		Feet.	*Sec.-ft.*			*Feet.*	*Sec.-ft.*
Nov. 17	D. A. Dudley	2.09	244	Mar. 24	D. A. Dudley	0.97	93.2
Dec. 10	do	1.93	212	Apr. 13	do	.69	68.8
Jan. 20	do	2.20	253	May 11	do	.79	68.8
Feb. 22	Dudley and Fellows	1.11	106				

Daily discharge, in second-feet, of Pecos River above Barstow, Tex., for the period Oct. 17, 1920, to May 11, 1921.

Day.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May.
1	.....	171	244	.....	202	140	78	.....
2	.....	192	211	253	174	222	77	.....
3	.....	188	213	251	166	231	78	.....
4	.....	206	243	251	149	231	78	.....
5	.....	198	251	256	152	279	77	63
6	.....	218	256	265	219	161	76	71
7	.....	213	258	261	258	135	75	74
8	.....	239	260	263	261	116	75	70
9	.....	295	241	258	253	111	76	71
10	.....	238	219	253	206	205	76	68
11	.....	211	234	250	168	216	76	74
12	.....	216	244	246	149	183	70	.....
13	.....	222	239	260	142	147	64	.....
14	.....	228	239	260	138	124	62	.....
15	.....	233	229	253	134	110	62	.....
16	.....	238	229	253	130	108	69	.....
17	140	243	231	248	125	104	64	.....
18	124	246	260	255	121	102	70	.....
19	149	248	244	251	117	203	68	.....
20	151	258	243	258	112	244	62	.....
21	147	295	232	258	108	165	.....	.....
22	156	289	.....	258	103	117	.....	.....
23	171	234	.....	235	106	102	.....	.....
24	226	214	.....	302	134	86	.....	.....
25	260	238	.....	275	113	92	.....	.....
26	358	238	.....	248	99	87	.....	.....
27	273	272	.....	251	94	78	.....	.....
28	195	273	.....	253	91	78	.....	.....
29	149	272	.....	250	.....	78	.....	.....
30	140	275	.....	248	.....	78	.....	.....
31	145	.....	.....	231	.....	78	.....	.....

NOTE.—No record October 1–16, Dec. 22 to Jan. 1 (range of stage 2.01 to 2.28), Apr. 21 to May 4, and May 12 to Sept. 30. No gage-height record and discharge interpolated Nov. 12–16, Feb. 14–21, Mar. 23, and Apr. 12. Gage height partly estimated owing to incomplete record Oct. 17, Nov. 17, 24, 25, Jan. 2, Feb. 22, Mar. 24, Apr. 13, and May 5.

Monthly discharge of Pecos River above Barstow, Tex., for the period Oct. 17, 1920, to May 11, 1921.

Month.	Discharge in second-feet.			Run-off in acre-feet.
	Maximum.	Minimum.	Mean.	
October 17–31	358	124	186	5,530
November	295	171	237	14,100
December 1–21	260	211	239	9,990
January 2–31	302	231	257	15,300
February	261	91	151	8,390
March	279	78	142	8,730
April 1–20	78	62	71.6	2,840
May 5–11	74	63	70.1	973

NOTE.—See footnote to daily-discharge table.

PECOS RIVER NEAR GRANDFALLS, TEX.

LOCATION.—At site of old highway bridge where Grandfalls-Fort Stockton road formerly crossed Pecos River, 1½ miles upstream from present Grandfalls-Fort Stockton road crossing at Iron Bridge, 2 miles below diversion dam for silt-line canal of Imperial Irrigation Co., 3 miles south of Grandfalls, Ward County, 4½ miles above diversion dam of Zimmerman project, and 21 miles south of Monahans.

DRAINAGE AREA.—Not measured.

RECORDS AVAILABLE.—November 6, 1915, to September 30, 1921. Records were taken at Iron Bridge, 1½ miles downstream from November 6, 1915, to August 3, 1917. Discharge at both points believed to be the same.

GAGE.—Stevens water-stage recorder, installed August 9, 1917, on downstream side of old bridge pier near left waters edge; inspected by A. J. Adcock. Prior to August 3, 1917, a Stevens water-stage recorder at Iron Bridge. Backwater from Zimmerman dam compelled the relocation of the station.

DISCHARGE MEASUREMENTS.—Made by wading near gage, from cable 50 feet above gage, or during extremely high stages at Iron Bridge.

CHANNEL AND CONTROL.—Bed of stream clean, smooth, solid rock, and permanent, except small deposits of sand and gravel. Channel straight for 100 feet above and below station. One channel below gage height of 8 feet; above this stage, both banks, which are dirt and wooded, subject to overflow. Rock ledge extending diagonally across stream just below gage serves as low-water control.

EXTREMES OF DISCHARGE.—Maximum and minimum stages during year probably occurred during periods of missing record.

1915–1921: Maximum stage from water-stage recorder, 9.6 feet from 2 to 6 a. m. September 25, 1919 (discharge, 13,000 second-feet); minimum discharge less than 0.7 second-foot April 17, 1916.

ICE.—None reported.

DIVERSIONS.—Station is 2 miles below diversion of silt-line canal of the Imperial Irrigation Co., 18½ miles below diversion for the Imperial reservoir (17,000 acre-feet capacity), 25½ miles below diversion for Ward County Water Improvement District No. 2 (of which the old Grandfalls project is a part), and 4½ 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 the United States Reclamation Service. Records of the Board of Water Engineers for the State of Texas show total number of acres declared irrigated in Texas above station to be about 58,000. The effect of diversions is somewhat counterbalanced by water returned to stream by seepage. The only diversion of importance below the station is that for the Zimmerman project which has declared an irrigated area of 2,005 acres.

REGULATION.—Slight regulatory effect caused by operation of storage reservoirs on Carlsbad project.

ACCURACY.—Stage-discharge relation not permanent; change small for high stages, but considerable for low stages. Rating curve well defined for all stages. Operation of water-stage recorder not satisfactory. Daily discharge determined by applying to rating table mean daily gage height, obtained from recorder graph by inspection or by use of planimeter, or for days of considerable fluctuation in stage, by averaging discharge for intervals of the day; shifting-control method used October 1 to January 10, and January 21 to May 21. Records fair.

Discharge measurements of Pecos River near Grandfalls, Tex., during the year ending Sept. 30, 1921.

Date.	Made by—	Gage height.	Discharge.	Date.	Made by—	Gage height.	Discharge.
		Feet.	*Sec.-ft.*			*Feet.*	*Sec.-ft.*
Nov. 16	D. A. Dudley	1.30	177	Apr. 15	D. A. Dudley	0.48	15.4
Dec. 9	do	1.34	190	May 10	do	.48	13.4
Jan. 18	do	1.63	284	July 6	do	1.03	92.4
Feb. 18	Dudley and Fellows	.65	31.6	Aug. 4	do	3.03	998
Mar. 23	D. A. Dudley	.55	15.9				

Daily discharge, in second-feet, of Pecos River near Grandfalls, Tex., for the year ending Sept. 30, 1921.

Day.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.
1	390	114	215	117	190	35	14	12	.....	.....	1,180	.....
2	114	142	215	160	181	28	14	12	.....	.....	1,230	.....
3	58	145	199	202	169	27	15	13	.....	.....	1,230	.....
4	39	142	178	212	145	27	16	13	.....	.....	946	.....
5	30	139	178	215	142	27	17	14	.....	.....	652	.....
6	27	136	122	215	139	28	16	16	.....	83	242	.....
7	23	142	190	231	139	27	16	18	.....	116	308	.....
8	23	151	190	254	154	23	16	16	.....	524	212	.....
9	22	148	190	265	125	23	16	14	.....	1,560	112	.....
10	20	160	215	261	117	22	16	13	.....	1,860	122	.....
11	18	175	221	261	106	18	16	13	.....	1,920	865	.....
12	18	172	218	265	91	17	16	13	.....	1,860	801	.....
13	20	166	215	261	78	16	16	13	.....	1,980	405	.....
14	52	160	224	254	73	16	16	14	.....	1,150	199	.....
15	52	169	325	261	66	16	16	15	.....	598	242	20
16	32	178	242	270	48	16	16	16	1,980	999	163	.....
17	27	196	208	275	43	16	16	17	2,100	1,230	96	.....
18	28	205	205	280	32	18	16	16	1,980	790	91	.....
19	28	208	202	285	34	23	16	18	2,040	365	291	.....
20	27	208	208	280	28	16	16	18	2,460	275	845	.....
21	25	208	215	425	23	17	16	18	3,420	114	.....	.....
22	25	215	212	345	19	16	16	.....	7,560	54	.....	.....
23	25	208	202	300	20	16	16	.....	5,140	30	.....	.....
24	37	190	196	280	22	14	14	.....	4,090	22	.....	.....
25	45	169	199	238	20	12	13	.....	3,660	19	.....	.....
26	63	151	199	218	19	12	12	.....	1,680	18	.....	.....
27	96	148	202	196	22	12	11	.....	982	17	.....	.....
28	131	145	202	196	28	12	11	.....	1,150	142	.....	.....
29	120	151	202	193	.....	13	12	.....	906	142	.....	.....
30	93	220	202	193	.....	13	12	.....	.....	290	.....	.....
31	63	.....	199	193	.....	14	.....	.....	.....	1,010	.....	.....

NOTE.—Owing to incomplete gage-height records, daily discharge partly estimated on following days: Dec. 8–9, June 29, and July 26–30. No record May 22 to June 15, and June 30 to July 5 (high water during these periods); Aug. 21 to Sept. 14 (maximum stage, 3.63 feet; minimum, 0.7 foot); and Sept. 16–30. Discharge Sept. 15 from one staff gage reading.

Monthly discharge of Pecos River near Grandfalls, Tex., for the year ending Sept. 30, 1921.

Month.	Discharge in second-feet.			Run-off in acre-feet.
	Maximum.	Minimum.	Mean.	
October	390	18	57.1	3,510
November	220	114	169	10,100
December	325	122	206	12,700
January	425	117	245	15,100
February	190	19	81.2	4,510
March	35	12	19.0	1,170
April	17	11	15.0	892
May 1–21	18	12	14.9	621
June 16–29	7,560	906	2,800	77,800
July 6–31	1,980	17	660	34,000
August 1–20	1,230	91	512	20,300

PECOS RIVER NEAR COMSTOCK, TEX.

LOCATION.—At Pecos High Bridge of Galveston, Harrisburg & San Antonio Railway Co., 11 miles west of Comstock, Val Verde County, 18 miles east of Langtry, and 14 miles by stream above confluence with Rio Grande; below all tributaries.

DRAINAGE AREA.—Not measured.

RECORDS AVAILABLE.—May 1, 1900, to September 30, 1921. (Also gage heights for 1898.)

GAGE.—Vertical staff attached to 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 not subject to overflow. Stage-discharge relation at low stages changes slightly.

EXTREMES OF DISCHARGE.—Maximum stage recorded during year, 12.8 feet at 11 a. m. June 13 (discharge, 18,500 second-feet); minimum stage, 0.30 foot 8 a. m. June 5 to 8 a. m. June 6 (discharge, 262 second-feet).

1900–1921: Maximum stage recorded, 35.75 feet April 6, 1900 (discharge not determined); minimum discharge recorded, 106 second-feet July 29 to August 1, 1918.

ICE.—None reported.

DIVERSIONS.—Considerable water is diverted and stored above the station for irrigation. Lakes McMillan and Avalon of the Carlsbad project of the United States Reclamation Service, which have a combined capacity of 58,500 acre-feet, are located 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 near 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.—Flow partly controlled by storage and diversions for irrigation above station. No water-power plants of any consequence operated in the drainage basin, except a public utility plant of about 300 horsepower, near Carlsbad, N. Mex.

ACCURACY.—Stage-discharge relation changes slightly. Rating curve well defined from 260 to 13,000 second-feet and fairly well defined from 13,000 to 40,000 second-feet. Gage read to quarter-tenths twice daily. Daily discharge determined by applying mean daily gage height to rating table; shifting-control method used July 1 to September 30. Records good.

Discharge measurements of Pecos River near Comstock, Tex., during the year ending Sept. 30, 1921.

Date.	Made by—	Gage height.	Discharge.
		Feet.	*Sec.-ft.*
Nov. 13	D. A. Dudley	0.82	439
Jan. 29	H. B. Kinnison	1.01	497

Daily discharge, in second-feet, of Pecos River near Comstock, Tex., for the year ending Sept. 30, 1921.

Day.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar	Apr.	May.	June.	July.	Aug.	Sept.
1	381	347	482	482	482	400	347	294	283	1,430	460	628
2	364	364	460	482	482	381	347	288	278	1,110	440	575
3	347	364	460	482	460	381	347	275	275	1,150	440	575
4	347	381	460	482	460	381	332	267	275	1,270	440	550
5	332	364	460	482	505	381	347	267	262	1,040	482	528
6	332	364	505	460	505	381	299	272	740	900	482	440
7	460	381	505	460	460	381	294	283	935	802	1,040	528
8	420	347	482	460	505	364	294	283	302	740	970	528
9	381	381	505	460	505	347	316	278	288	655	770	740
10	381	381	482	460	505	347	316	283	283	600	655	460
11	364	420	482	460	482	347	302	347	1,000	575	575	440
12	347	440	460	460	440	381	299	310	1,910	575	528	440
13	347	420	460	505	400	381	316	283	9,800	1,430	528	440
14	347	440	420	505	400	381	310	288	3,970	1,750	482	440
15	347	420	420	505	381	381	310	288	2,870	1,750	482	400
16	347	420	420	505	381	364	302	283	3,210	1,750	710	400
17	332	420	420	505	381	364	288	288	3,210	1,750	655	381
18	316	440	420	505	400	364	291	291	3,580	1,590	575	381
19	316	420	420	505	400	381	302	291	4,520	1,000	575	364
20	332	420	420	505	364	420	310	288	2,460	1,080	770	364
21	332	440	460	505	364	400	310	288	2,560	1,150	628	364
22	347	460	460	505	364	400	294	288	2,560	935	550	364
23	364	482	460	505	364	364	288	285	2,560	802	505	364
24	381	505	460	505	347	364	283	288	2,870	740	482	364
25	440	505	460	505	347	364	283	283	3,450	655	1,270	332
26	420	505	460	505	347	347	267	288	3,580	575	1,430	332
27	381	505	460	505	347	364	267	288	4,100	528	1,270	347
28	381	505	460	505	460	347	267	288	4,100	710	505	364
29	347	505	460	505	.....	332	267	288	4,380	482	482	364
30	347	505	460	505	.....	347	275	288	3,090	440	575	400
31	347	.....	482	505	.....	347	.....	283	.....	460	710	.....

Monthly discharge of Pecos River near Comstock, Tex., for the year ending Sept. 30, 1921.

Month.	Discharge in second-feet.			Run-off in acre-feet.
	Maximum.	Minimum.	Mean.	
October	460	316	362	22,300
November	505	347	428	25,500
December	505	420	459	28,200
January	505	460	491	30,200
February	505	347	423	23,500
March	420	332	370	22,800
April	347	267	302	18,000
May	347	267	287	17,600
June	9,800	262	2,460	146,000
July	1,750	440	981	60,300
August	1,430	440	660	40,600
September	740	332	440	26,200
The year	9,800	262	637	461,000

MISCELLANEOUS MEASUREMENTS.

Miscellaneous discharge measurements in Texas during the year ending Sept. 30, 1921.

Date.	Stream.	Tributary to—	Locality.	Gage height.	Discharge.
				Feet.	*Sec.-ft.*
Sept. 10	Little River	Brazos River	Near Belton, Tex., just below mouth of Leon and Lampasas rivers.		[a]331,000
10	Salado Creek	Lampasas River	3 miles below Salado, Tex.		[a]143,000
10	San Gabriel River	Little River	3 miles below Georgetown, Tex.		[a]160,000
10	Brushy Creek	San Gabriel River	Round Rock, Tex.		[a] 34,500
Oct. 6	Colorado River	Gulf of Mexico	Old gaging station near Bronte, Tex.	4.13	26.8
Dec. 6	....do	....do	....do	3.97	21.3
Aug. 8	....do	....do	Below Austin dam near Austin, Tex.		66
8	....do	....do	Brickyard near Austin, Tex.		76.7
16	....do	....do	Smithville, Tex		184
Oct. 16	San Saba River	Colorado River	18 miles above San Saba, Tex.		70
Jan. 27	....do	....do	....do		64
Aug. 26	Noyes canal	Diversion from San Saba River.	Near Menard, Tex		14.5
Oct. 12	....do	....do	....do		[b] .6
Jan. 25	....do	....do	....do		15
Feb. 27	....do	....do	....do		9.3
Apr. 20	....do	....do	....do		15.2
May 19	....do	....do	....do		7.8
June 25	....do	....do	....do		13.5
Aug. 26	....do	....do	....do		12.3
June 11	Mill Spring	Barton Creek	Near Austin, Tex		5.8
July 2	....do	....do	....do		4.2
Aug. 5	....do	....do	....do		3.2
Sept. 26	....do	....do	....do		7.9
Feb. 7	Comal River	Guadalupe River	New Braunfels, Tex		329
Sept. 7	....do	....do	....do		316
Mar. 8	Medina River	San Antonio River	Below diversion dam near Riomedina, Tex.		50
Jan. 26	Devils River	Rio Grande	Rubboard Ford, 30 miles above Del Rio, Tex., and 25 miles above mouth.		283
Jan. 28	....do	....do	10 miles above mouth, 15 miles above Del Rio, Tex.		393
27	....do	....do	Del Rio-Comstock highway bridge near Del Rio, Tex.		417
27	....do	....do	Half a mile below Southern Pacific Railroad bridge near Devils River, Tex.		448

[a] Slope measurement.

[b] Estimated.

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