DEPARTMENT OF THE INTERIOR
FRANKLIN K. LANE, Secretary

UNITED STATES GEOLOGICAL SURVEY
GEORGE OTIS SMITH, Director

Water-Supply Paper 408

# SURFACE WATER SUPPLY OF THE UNITED STATES

## 1915

## PART VIII. WESTERN GULF OF MEXICO BASINS

NATHAN C. GROVER, Chief Hydraulic Engineer

GLENN A. GRAY, WARREN E. HALL, and ROBERT FOLLANSBEE, District Engineers

Prepared in cooperation with
THE STATES OF TEXAS AND NEW MEXICO


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# SURFACE WATER SUPPLY OF WESTERN GULF OF MEXICO BASINS, 1915.

## 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, 1915.

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

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

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

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

*Annual appropriations for the fiscal years ending June 30, 1895–1916.*

| | |
|---|---|
| 1895 | $12,500 |
| 1896 | 20,000 |
| 1897 to 1900, inclusive | 50,000 |
| 1901 to 1902, inclusive | 100,000 |
| 1903 to 1906, inclusive | 200,000 |
| 1907 | 150,000 |
| 1908 to 1910, inclusive | 100,000 |
| 1911 to 1916, inclusive | 150,000 |

In the execution of the work many private and State organizations have cooperated, either by furnishing data or by assisting in collecting data. Acknowledgments for cooperation of the first kind are made in connection with the description of each station affected; cooperation of the second kind is acknowledged on pages 11 and 12.

Measurements of stream flow have been made at about 3,800 points in the United States and also at many points in Alaska and the Hawaiian Islands. In July, 1915, 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 the regular water-supply papers from time to time. Information in regard to publications relating to water resources is presented in the appendix to this report.

## DEFINITION OF TERMS.

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

"Second-feet" is an abbreviation for "cubic feet per second." A second-foot is the rate of discharge of water flowing in a channel of rectangular cross-section 1 foot wide and 1 foot deep at an average velocity of 1 foot per second. It is generally used as a fundamental unit from which others are computed by the use of the factors given in the tables of convenient equivalents (p. 7).

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

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

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

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

The following terms not in common use are here defined:

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

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

The "point of zero flow" for a gaging station is that point on the gage—the gage height—to which the surface of the river would fall if there were no flow.

## CONVENIENT EQUIVALENTS.

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

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

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

NOTE.—For part of month multiply run-off for 1 day by the number of days.

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

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

NOTE.—For part of a month multiply the run-off for 1 day by the number of days.

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

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

NOTE.—For part of a month multiply the run-off for 1 day by the number of days.

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

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

NOTE.—For part of a month multiply the run-off for 1 day by the number of days.

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

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

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

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

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

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

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

1 second-foot for one year (365 days) covers 1 square mile 1.1312 feet, or 13.5744 inches deep.

1 second-foot for one year (365 days) equals 31,536,000 cubic feet.

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

1 second-foot for one year (365 days) equals 724 acre-feet.

1 second-foot for one day equals 86,400 cubic feet.

1,000,000,000 (1 United States billion) cubic feet equals 11,570 second-feet for one day.

1,000,000,000 cubic feet equals 413 second-feet for one 28-day month.

1,000,000,000 cubic feet equals 399 second-feet for one 29-day month.

1,000,000,000 cubic feet equals 386 second-feet for one 30-day month.

1,000,000,000 cubic feet equals 373 second-feet for one 31-day month.

100 California miner's inches equals 18.7 United States gallons per second.

100 California miner's inches for one day equals 4.96 acre-feet.

100 Colorado miner's inches equals 2.60 second-feet.

100 Colorado miner's inches equals 19.5 United States gallons per second.

100 Colorado miner's inches for one day equals 5.17 acre-feet.

100 United States gallons per minute equals 0.223 second-foot.

100 United States gallons per minute for one day equals 0.442 acre-foot.

1,000.000 United States gallons per day equals 1.55 second-feet.

1,000,000 United States gallons equals 3.07 acre-feet.

1,000,000 cubic feet equals 22.95 acre-feet.
1 acre-foot equals 325,850 gallons.
1 inch deep on 1 square mile equals 2,323,200 cubic feet.
1 inch deep on 1 square mile equals 0.0737 second-foot per year.
1 foot equals 0.3048 meter.
1 mile equals 1.60935 kilometers.
1 mile equals 5,280 feet.
1 acre equals 0.4047 hectare.
1 acre equals 43,560 square feet.
1 acre equals 209 feet square, nearly.
1 square mile equals 2.59 square kilometers.
1 cubic foot equals 0.0283 cubic meter.
1 cubic foot of water weighs 62.5 pounds.
1 cubic meter per minute equals 0.5886 second-foot.
1 horsepower equals 550 foot-pounds per second.
1 horsepower equals 76.0 kilogram-meters per second.
1 horsepower equals 746 watts.
1 horsepower equals 1 second-foot falling 8.80 feet.
1½ horsepower equals about 1 kilowatt.

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

## EXPLANATION OF DATA.

The data presented in this report cover the year beginning October 1, 1914, and ending September 30, 1915. At the 1st 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 by the general methods outlined in standard textbooks on the measurement of river discharge. (See Pls. I and II.)

From the discharge measurements rating tables are prepared that give the discharge for any stage, and these rating tables, when applied to the gage heights, give the 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 constancy of the stage-discharge relation, covering such subjects as the occurrence of ice, the use of the stream for log driving, shifting of channel, 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.

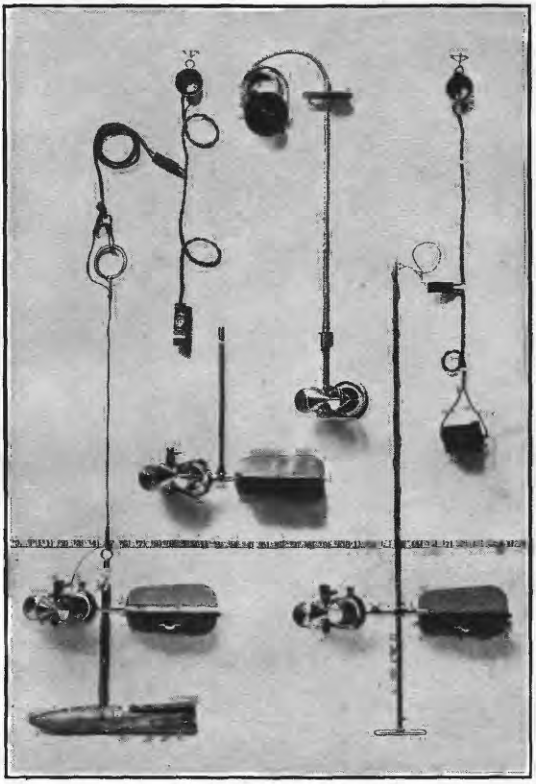
The table of daily discharge gives the discharge in second-feet corresponding to the mean of the gage heights read each day. At stations on streams subject to sudden or rapid diurnal fluctuation the discharge obtained from the rating table and the mean daily gage height may not be the true mean discharge for the day. When such stations are equipped with water-stage recorders, the true mean daily discharge may be obtained by computing the mean daily gage height and applying it to the rating table, by averaging quantities of discharge for regular intervals during the day, or by means of a 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 that 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 pages 7–9, are based.

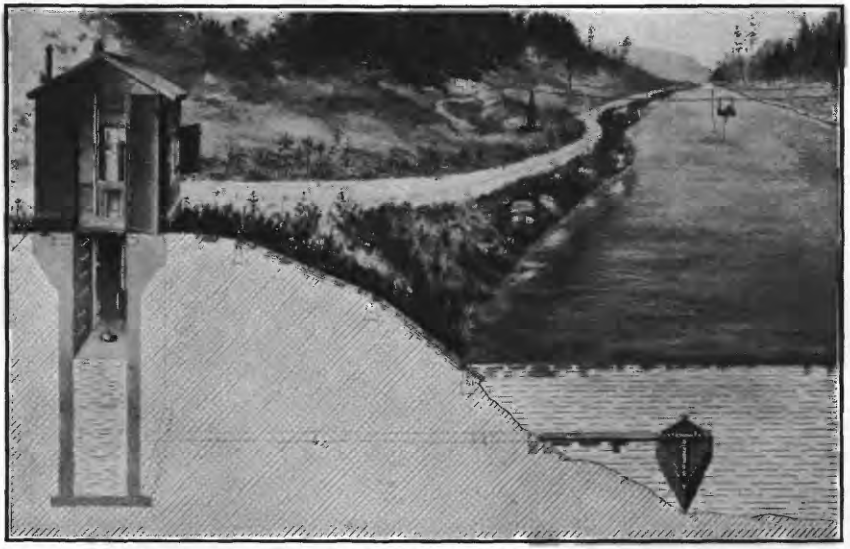
## ACCURACY OF FIELD DATA AND COMPUTED RESULTS.

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

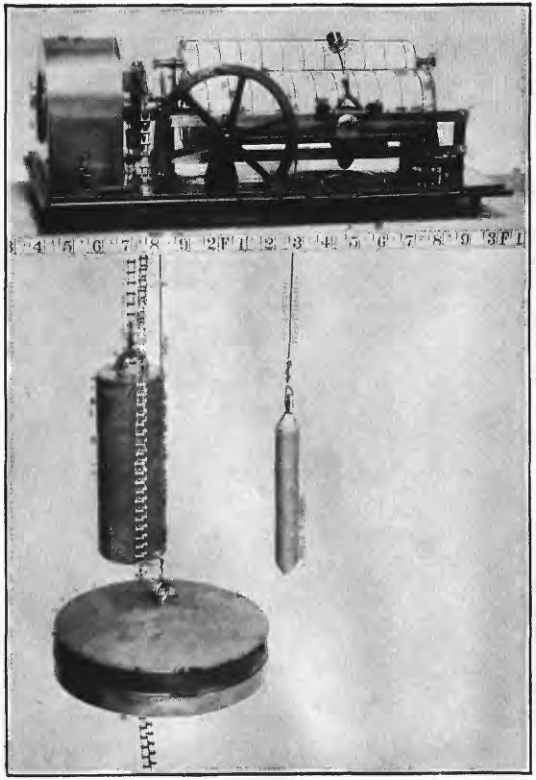
Footnotes added to the daily-discharge tables give information regarding the probable accuracy of the rating tables used, and an accuracy column is inserted in the monthly-discharge table. For the rating tables, "well defined" indicates, in general, that the rating is probably accurate within 5 per cent; "fairly well defined," within 10 per cent; "poorly defined," within 15 to 25 per cent. These notes



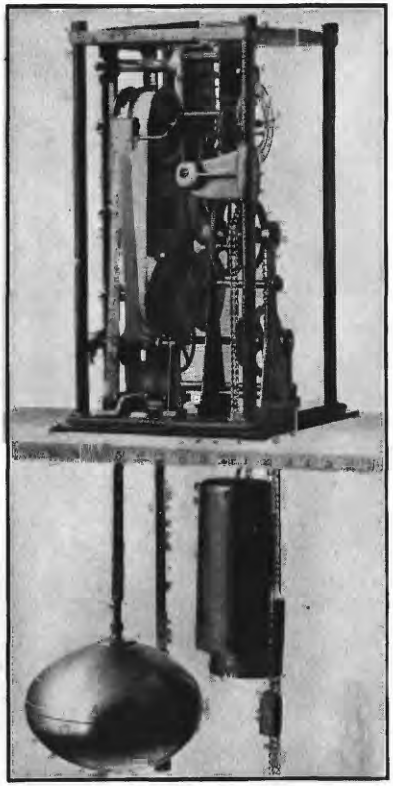
*A*. PRICE CURRENT METERS.



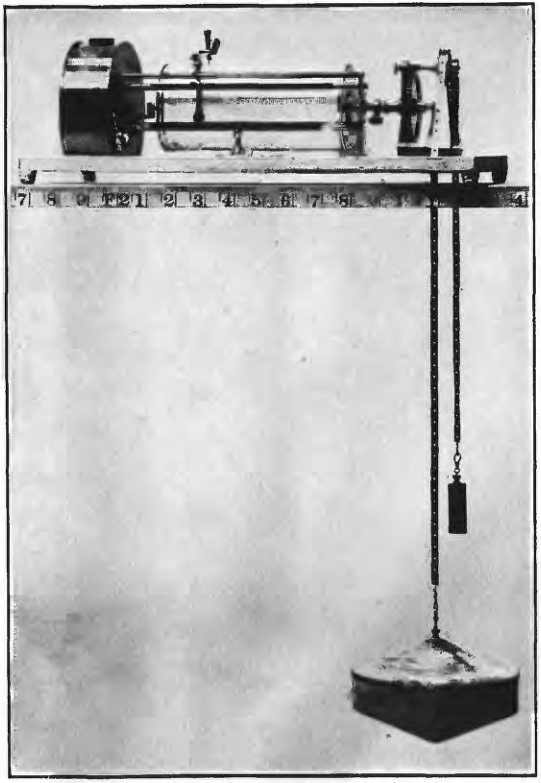
*B*. TYPICAL GAGING STATION.



*A.* STEVENS.



*B.* GURLEY PRINTING.



*C.* FRIEZ.

WATER-STAGE RECORDERS.

are very general and are based on the plotting of the individual measurements with reference to the mean rating curve.

The letter in the column headed "Accuracy," in the monthly-discharge table, rates the accuracy of the monthly mean and not that of the estimate of maximum or minimum discharge or the discharge for any one day. The rating is determined by considering the accuracy of the rating curve, the probable reliability of the observer, the number of gage readings per day, the range of the fluctuation in stage, and local conditions. In this column A indicates that the determination of mean monthly flow is probably accurate within 5 per cent; B, within 10 per cent; C, within 15 per cent; D, within 25 per cent. Special conditions are covered by footnotes.

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

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

## COOPERATION.

The work in Texas was carried on in cooperation with the State Board of Water Engineers of Texas, consisting of J. C. Nagle, chairman; John Wilson, and E. B. Gore. Stations in Nueces and Guadalupe River basins were established and maintained prior to September 1, 1915, by the Board of Water Engineers.

The work in New Mexico to January 1, 1915, was carried on in cooperation with the State through James A. French, State engineer.

The United States Reclamation Service paid the salaries of gage readers at three stations in the Rio Colorado, Rio Hondo, and Rio Taos drainage basins and furnished a large part of the money expended in the lower Pecos River valley to June 30, 1915. After that

date the Service continued cooperation in the lower Pecos River Valley by furnishing the equipment.

The United States Forest Service aided by furnishing gage readers at stations on Rio Colorado, Rio Vallecitos, and South Fork of Gallinas River.

The United States Indian Office furnished water-stage recorders and paid the salaries of gage readers at stations on Rio Pueblo and Rio Lucero.

The stations on the Rio Grande from El Paso to Eagle Pass, Tex., were maintained and the records furnished by the Commission for the Equitable Distribution of the Waters of the Rio Grande.

Equipment and financial assistance in maintaining stations in Chama River basin were given by the Arlington Land Co., through its chief engineer, H. I. Reid.

## DIVISION OF WORK.

Previous to September 1, 1915, the data for stations in eastern Texas were collected under the direction of Warren E. Hall, district engineer; after September 1, 1915, data were collected under the direction of Glenn A. Gray, district engineer, who was assisted by R. C. Pierce, junior engineer, and R. J. Hank and R. C. Thaxton, State hydrographers.

For stations on Colorado River at Austin, Guadalupe River at New Braunfels, and San Antonio River at San Antonio, Tex., the data were prepared for publication by Warren E. Hall, assisted by B. J. Peterson. Data for the remaining stations in Texas were prepared for publication under the direction of Glenn A. Gray, district engineer, assisted by William Kessler, junior engineer.

Prior to June 30, 1915, field data for stations in New Mexico and western Texas were collected under the direction of Glenn A. Gray, district engineer, assisted by W. R. King and C. J. Emerson, junior engineers, and J. E. Powers, E. L. Redding, R. S. Watrous, and R. J. Hank, State hydrographers. After June 30, 1915, field data for New Mexico were collected under the direction of Robert Follansbee, district engineer, assisted by W. R. King, and field data for western Texas under the direction of Glenn A. Gray, district engineer.

Ratings and computations were made by Glenn A. Gray, assisted by W. R. King, C. J. Emerson, R. J. Hank, and William Kessler.

The manuscript was prepared by Lasley Lee and reviewed by G. C. Stevens.

## GAGING-STATION RECORDS.

### TRINITY RIVER BASIN.

#### TRINITY RIVER AT BRIDGEPORT, TEX.

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

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

RECORDS AVAILABLE.—October 1, 1914, to September 30, 1915. Record of stage has been obtained by the United States Weather Bureau since August 16, 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 U. E. Byers.

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

CHANNEL AND CONTROL.—Bed of stream composed of clay, gravel, and sand. Banks are high, slightly wooded, and are overflowed at a stage of 25 feet. One channel at ordinary stages; several after the water has overflowed the banks. Control is a rock outcrop three-quarters of a mile below bridge.

EXTREMES OF STAGE.—Maximum stage recorded during year, 28.9 feet June 8; minimum stage, 0.80 foot February 13 to 19.

1908–1915: Maximum stage, 28.9 feet June 8, 1915, minimum stage, −1.80 feet on several dates.

WINTER FLOW.—Stage-discharge relation not seriously affected by ice.

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

REGULATION.—So far as is known there are no water-power plants, dams, reservoirs, lakes, or swamps above or immediately below which influence the flow at this point.

COOPERATION.—Gage-height record furnished by United States Weather Bureau.

Data inadequate for determination of daily discharge.

The following discharge measurement was made by M. R. Hall:

May 26, 1915: Gage height, 9.85 feet; discharge, 2,000 second-feet.

*Daily gage height, in feet, of Trinity River at Bridgeport, Tex., for the year ending Sept. 30, 1915.*

| Day. | Oct. | Nov. | Dec. | Jan. | Feb. | Mar. | Apr. | May. | June. | July. | Aug. | Sept. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 1.0 | 1.0 | 2.0 | 2.0 | 1.0 | 1.2 | 1.2 | 5.5 | 2.4 | 1.8 | 1.0 | 2.8 |
| 2 | 1.0 | 1.0 | 2.8 | 1.8 | 1.0 | 1.2 | 1.2 | 4.6 | 2.2 | 1.8 | 1.0 | 2.5 |
| 3 | 1.0 | 1.0 | 3.2 | 1.8 | 1.0 | 1.2 | 1.2 | 3.0 | 2.2 | 1.8 | 1.2 | 2.2 |
| 4 | 1.0 | 1.0 | 3.4 | 1.7 | 1.0 | 1.2 | 1.1 | 3.0 | 6.0 | 1.7 | 1.2 | 2.2 |
| 5 | 1.0 | 1.0 | 3.6 | 1.6 | 1.0 | 1.2 | 1.1 | 2.8 | 8.8 | 1.7 | 1.2 | 2.0 |
| 6 | .9 | 1.0 | 3.6 | 1.6 | 1.0 | 2.0 | 1.1 | 2.8 | 22.7 | 1.6 | 1.4 | 1.8 |
| 7 | .9 | 1.0 | 3.4 | 1.6 | 1.0 | 2.0 | 1.2 | 5.2 | 24.0 | 1.6 | 1.4 | 1.8 |
| 8 | 1.0 | 1.0 | 3.4 | 1.5 | 1.0 | 2.0 | 2.6 | 4.5 | 28.9 | 4.0 | 1.2 | 1.8 |
| 9 | 1.0 | 1.0 | 3.2 | 1.5 | .9 | 1.8 | 7.2 | 4.0 | 27.8 | 2.4 | 1.2 | 1.6 |
| 10 | 1.0 | 1.0 | 3.0 | 1.5 | .9 | 1.8 | 3.6 | 7.7 | 24.5 | 1.8 | 1.2 | 1.6 |
| 11 | .9 | 1.0 | 3.0 | 1.5 | .9 | 1.6 | 2.1 | 6.4 | 21.7 | 1.8 | 2.6 | 1.6 |
| 12 | .9 | 1.0 | 3.0 | 1.5 | .9 | 1.6 | 1.8 | 3.5 | 10.9 | 1.8 | 2.8 | 1.5 |
| 13 | .9 | 1.0 | 2.8 | 1.4 | .8 | 1.5 | 1.6 | 3.2 | 5.5 | 1.8 | 2.4 | 1.5 |
| 14 | .9 | 1.0 | 2.8 | 1.4 | .8 | 1.5 | 1.6 | 3.0 | 3.5 | 1.8 | 2.4 | 1.5 |
| 15 | .9 | 1.1 | 2.6 | 1.4 | .8 | 1.5 | 1.5 | 3.0 | 3.5 | 1.8 | 2.2 | 1.4 |
| 16 | 1.0 | 1.1 | 2.4 | 1.3 | .8 | 1.5 | 1.5 | 2.8 | 2.8 | 1.6 | 2.2 | 1.4 |
| 17 | 1.0 | 1.1 | 2.4 | 1.3 | .8 | 1.4 | 1.4 | 2.5 | 2.6 | 1.6 | 2.1 | 2.4 |
| 18 | 1.0 | 1.1 | 2.4 | 1.3 | .8 | 1.4 | 1.4 | 2.5 | 2.6 | 1.6 | 2.1 | 6.8 |
| 19 | 1.0 | 1.1 | 2.2 | 1.2 | .8 | 1.4 | 3.9 | 2.2 | 2.5 | 1.6 | 4.6 | 2.4 |
| 20 | 1.4 | 1.1 | 2.2 | 1.2 | .9 | 1.4 | 5.8 | 2.0 | 2.4 | 1.5 | 4.0 | 2.4 |
| 21 | 1.4 | 1.1 | 2.2 | 1.2 | 1.2 | 1.4 | 4.2 | 2.0 | 2.4 | 1.5 | 3.0 | 2.0 |
| 22 | 1.2 | 1.1 | 2.0 | 1.1 | 1.2 | 1.4 | 1.8 | 7.5 | 2.2 | 1.5 | 2.0 | 1.8 |
| 23 | 1.2 | 1.1 | 2.0 | 1.1 | 1.2 | 1.4 | 25.0 | 2.5 | 2.2 | 1.5 | 1.2 | 1.6 |
| 24 | 1.1 | 1.1 | 2.0 | 1.1 | 1.2 | 1.2 | 20.6 | 2.5 | 2.0 | 1.4 | 1.2 | 1.6 |
| 25 | 1.1 | 1.2 | 2.4 | 1.0 | 1.2 | 1.2 | 16.8 | 2.4 | 2.0 | 1.4 | 4.0 | 1.6 |
| 26 | 1.1 | 1.2 | 2.4 | 1.0 | 1.2 | 1.2 | 25.3 | 4.8 | 2.0 | 1.4 | 5.4 | 1.5 |
| 27 | 1.0 | 1.3 | 2.6 | 1.0 | 1.2 | 1.2 | 22.7 | 14.2 | 2.0 | 1.4 | 8.3 | 1.5 |
| 28 | 1.1 | 1.3 | 2.4 | 1.0 | 1.2 | 1.1 | 22.5 | 10.9 | 2.2 | 1.2 | 8.5 | 1.4 |
| 29 | 1.0 | 1.3 | 2.2 | 1.0 | ..... | 1.1 | 18.9 | 4.6 | 2.0 | 1.2 | 5.5 | 1.4 |
| 30 | 1.0 | 1.3 | 2.1 | 1.0 | ..... | 1.1 | 9.5 | 2.5 | 2.0 | 1.0 | 5.2 | 1.4 |
| 31 | 1.0 | ..... | 2.1 | 1.0 | ..... | 1.1 | ..... | 2.4 | ..... | 1.0 | 4.6 | ..... |

## BRAZOS RIVER BASIN.

### BRAZOS RIVER AT BRAZOS, TEX.

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

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

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

GAGE.—Vertical staff reading from 0 to 4.0 feet attached to right side, near upstream end of pier near middle of bridge; stages above 4.0 feet read on gage painted on pier. Gage read daily by L. W. Boyett.

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

CHANNEL AND CONTROL.—Bed of stream composed of sand and gravel; probably shifts. Channel straight above and below for several thousand feet. Right bank high, wooded, rocky, and not subject to overflow; left bank wooded, composed of sand, gravel, and clay, medium in height, and subject to overflow at extreme stages. Position of control not known.

EXTREMES OF STAGE.—Maximum stage recorded during year, 20 feet at 5.30 p. m. June 8; minimum stage, 0.80 foot October 15 and 16.

1908–1915: Maximum stage recorded, May 24, 1908, 22.0 feet; minimum stage, zero on several dates.

WINTER FLOW.—Stage-discharge relation not affected by ice.

DIVERSIONS.—A few pumping plants installed along stream take water to irrigate small areas, but quantity so pumped is too small to appreciably affect flow at this station.

REGULATION.—So far as is known there are no water-power plants, dams, reservoirs, lakes, or swamps above or immediately below which affect the flow at this point. The area drained by Brazos River contains few swamps and natural lakes.

COOPERATION.—Gage-height record furnished by United States Weather Bureau.

Data inadequate for determination of daily discharge.

The following discharge measurement was made by M. R. Hall:

May 27, 1915: Gage height, 4.70 feet; discharge, 4,030 second-feet.

*Daily gage height, in feet, of Brazos River at Brazos, Tex., for the year ending Sept. 30, 1915.*

| Day. | Oct. | Nov. | Dec. | Jan. | Feb. | Mar. | Apr. | May. | June. | July. | Aug. | Sept. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 1.2 | 3.8 | 3.6 | 1.7 | 1.3 | 1.0 | 0.9 | 6.0 | 3.5 | 4.5 | 1.6 | 4.8 |
| 2 | 1.2 | 3.6 | 3.8 | 1.6 | 1.3 | 1.0 | .9 | 5.3 | 5.6 | 4.3 | 1.6 | 4.3 |
| 3 | 1.1 | 3.4 | 3.4 | 1.6 | 1.2 | 1.0 | .9 | 7.0 | 4.0 | 4.1 | 1.6 | 3.8 |
| 4 | 1.1 | 3.2 | 3.0 | 2.0 | 1.2 | 1.0 | .9 | 6.5 | 3.5 | 3.9 | 1.6 | 3.3 |
| 5 | 1.1 | 2.0 | 2.7 | 2.0 | 1.2 | 1.0 | .9 | 5.5 | 3.2 | 3.7 | 1.6 | 3.1 |
| 6 | 1.0 | 1.9 | 2.7 | 2.0 | 1.2 | 1.0 | .9 | 4.9 | 12.0 | 5.0 | 1.6 | 3.0 |
| 7 | 1.0 | 1.9 | 2.6 | 1.9 | 1.2 | 1.0 | .9 | 4.6 | 18.5 | 4.5 | 1.6 | 2.9 |
| 8 | 1.0 | 1.8 | 2.5 | 1.9 | 1.1 | 1.0 | .9 | 4.4 | 16.0 | 4.2 | 1.6 | 2.8 |
| 9 | 1.0 | 1.8 | 2.4 | 2.0 | 1.1 | 1.0 | .9 | 6.5 | 9.0 | 4.0 | 2.6 | 2.7 |
| 10 | .9 | 1.7 | 2.3 | 2.0 | 1.1 | 1.0 | 2.0 | 5.3 | 6.5 | 3.8 | 2.5 | 2.7 |
| 11 | .9 | 1.7 | 2.2 | 2.0 | 1.1 | 1.0 | 1.9 | 4.8 | 5.8 | 3.6 | 2.4 | 2.6 |
| 12 | .9 | 1.6 | 2.1 | 1.9 | 1.1 | 1.0 | 1.9 | 4.5 | 5.5 | 3.4 | 2.3 | 2.6 |
| 13 | .9 | 1.6 | 2.0 | 1.9 | 1.1 | 1.0 | 1.8 | 4.2 | 5.0 | 3.2 | 2.2 | 2.5 |
| 14 | .9 | 1.5 | 1.9 | 1.9 | 1.0 | 1.0 | 1.8 | 4.0 | 5.4 | 3.0 | 2.1 | 2.5 |
| 15 | .8 | 1.5 | 1.8 | 1.8 | 1.0 | 1.0 | 1.7 | 3.8 | 5.4 | 2.8 | 2.1 | 2.4 |
| 16 | .8 | 1.5 | 1.7 | 1.8 | 1.0 | 1.0 | 2.2 | 3.6 | 6.5 | 2.6 | 2.0 | 2.4 |
| 17 | 1.0 | 1.5 | 1.6 | 1.8 | 1.0 | 1.0 | 2.2 | 3.4 | 4.5 | 2.5 | 2.0 | 3.0 |
| 18 | 2.5 | 1.5 | 1.5 | 1.7 | 1.0 | 1.0 | 2.1 | 3.2 | 4.0 | 2.4 | 2.0 | 3.2 |
| 19 | 2.2 | 2.5 | 1.5 | 1.7 | 1.0 | 1.0 | 2.1 | 3.0 | 3.7 | 2.3 | 2.0 | 3.4 |
| 20 | 2.0 | 2.3 | 1.5 | 1.7 | 1.0 | 1.0 | 2.0 | 3.0 | 3.4 | 2.2 | 3.6 | 2.9 |
| 21 | 1.8 | 2.1 | 1.4 | 1.6 | 1.0 | 1.0 | 2.0 | 3.0 | 3.3 | 2.1 | 3.4 | 2.7 |
| 22 | 1.6 | 2.0 | 1.4 | 1.6 | 1.0 | 1.0 | 5.0 | 5.0 | 3.2 | 2.1 | 3.3 | 2.6 |
| 23 | 1.6 | 2.0 | 1.4 | 1.6 | 1.0 | 1.0 | 10.0 | 4.0 | 3.1 | 2.0 | 3.2 | 2.6 |
| 24 | 1.5 | 1.9 | 1.3 | 1.5 | 1.0 | .9 | 7.5 | 11.0 | 3.0 | 2.0 | 3.1 | 2.5 |
| 25 | 1.5 | 1.9 | 1.3 | 1.5 | 1.0 | .9 | 7.5 | 9.5 | 2.9 | 1.9 | 3.0 | 2.5 |
| 26 | 8.2 | 1.9 | 1.3 | 1.5 | 1.0 | .9 | 16.0 | 5.5 | 2.8 | 1.9 | 3.6 | 2.4 |
| 27 | 6.0 | 2.2 | 1.2 | 1.4 | 1.0 | .9 | 13.0 | 5.0 | 2.7 | 1.8 | 6.1 | 2.4 |
| 28 | 4.4 | 3.0 | 1.2 | 1.4 | 1.0 | .9 | 13.6 | 4.5 | 2.7 | 1.8 | 5.7 | 7.8 |
| 29 | 5.0 | 4.5 | 2.0 | 1.4 | ..... | .9 | 7.8 | 4.2 | 6.0 | 1.7 | 5.4 | 6.0 |
| 30 | 4.5 | 4.0 | 1.8 | 1.3 | ..... | .9 | 7.0 | 3.9 | 5.5 | 1.7 | 5.3 | 4.9 |
| 31 | 4.0 | ..... | 1.7 | 1.3 | ..... | .9 | ..... | 3.7 | ..... | 1.6 | 5.2 | ..... |

### BRAZOS RIVER AT WACO, TEX.

LOCATION.—At the suspension bridge on Bridge Street, in the city of Waco, McLennan County, just below the Southern Traction Co.'s bridge, 2¼ miles below the mouth of Bosque River, 4½ miles above the mouth of Cottonwood Creek, about 10 miles above Lock No. 8, now under construction.

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

RECORDS AVAILABLE.—September 14, 1898, to December 31, 1911; October 1, 1914, to September 30, 1915. Records of stage have been obtained by United States Weather Bureau since August 9, 1900.

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

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

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

EXTREMES OF DISCHARGE.—Maximum stage recorded during year, 26.0 feet at 6.40 p. m., April 26 (discharge, 104,000 second-feet; determined from extension of rating curve and possibly subject to large error); minimum stage, 5.8 feet August 11 and 12 (discharge, 250 second-feet).

1898–1915: Maximum stage recorded, 39.7 feet December 3, 1913 (discharge not determined); minimum stage, 2.00 feet March 8–10, 1902 (discharge, 20 second-feet).

WINTER BLOW.—Stage-discharge relation not affected by ice.

DIVERSIONS.—So far as is known there are no diversions of any magnitude above the station.

REGULATION.—Lock No. 8 will eventually control the flow at this point; flow only slightly controlled at present. Small areas of land are irrigated above station, but the quantity of water diverted is only a small percentage of the total flow.

ACCURACY.—Results poor; stage-discharge relation not permanent. Slight errors may be introduced by using one daily gage reading as the mean for the day.

COOPERATION.—Gage-height record furnished by United States Weather Bureau and results of some discharge measurements by the State Board of Water Engineers.

*Discharge measurements of Brazos River at Waco, Tex., during the year ending Sept. 30, 1915.*

| Date. | Made by— | Gage height. | Discharge. | Date. | Made by— | Gage height. | Discharge. |
|---|---|---|---|---|---|---|---|
| | | *Feet.* | *Sec.-ft.* | | | *Feet.* | *Sec.-ft.* |
| Oct. 21 | W. E. Hall | 4.78 | 377 | Apr. 28 | Byers and Arneson | 23.10 | [b]77,200 |
| Apr. 26 | Nagle and Byers | 23.70 | [a]81,800 | May 4 | Hall and Thaxton | 10.95 | 18,600 |
| 26 | G. E. Byers | 25.00 | [b]91,500 | 31 | M. R. Hall | 9.10 | 4,200 |
| 27 | Nagle and Byers | 25.00 | [b]79,700 | | | | |

[a] By float method; coefficient used, 0.75.

[b] By float method; coefficient used, 0.8.

*Daily discharge, in second-feet, of Brazos River at Waco, Tex., for the year ending Sept. 30, 1915.*

| Day. | Oct. | Nov. | Dec. | Jan. | Feb. | Mar. | Apr. | May. | June. | July. | Aug. | Sept. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 600 | 3,390 | 3,210 | 3,030 | 3,210 | 1,550 | 973 | 33,000 | 5,450 | 1,090 | 355 | 4,670 |
| 2 | 538 | 2,850 | 9,800 | 2,850 | 1,800 | 1,240 | 973 | 26,700 | 4,400 | 5,180 | 355 | 5,180 |
| 3 | 538 | 2,680 | 6,400 | 2,680 | 1,440 | 1,330 | 888 | 20,700 | 3,670 | 4,160 | 355 | 4,970 |
| 4 | 538 | 2,520 | 5,540 | 2,680 | 1,330 | 6,170 | 812 | 18,400 | 3,130 | 3,440 | 355 | 3,620 |
| 5 | 484 | 2,380 | 4,490 | 2,850 | 2,220 | 5,330 | 812 | 27,200 | 4,820 | 23,900 | 320 | 3,260 |
| 6 | 484 | 2,080 | 3,930 | 3,390 | 1,550 | 4,110 | 812 | 23,000 | 3,670 | 4,760 | 320 | 2,900 |
| 7 | 484 | 1,800 | 3,570 | 3,030 | 1,240 | 3,570 | 812 | 20,100 | 3,130 | 6,020 | 320 | 2,270 |
| 8 | 484 | 1,670 | 3,390 | 2,850 | 1,150 | 3,390 | 1,800 | 16,900 | 68,400 | 3,620 | 320 | 1,710 |
| 9 | 432 | 1,550 | 3,390 | 2,520 | 1,060 | 3,210 | 1,150 | 13,900 | 90,500 | 3,980 | 285 | 1,470 |
| 10 | 432 | 1,330 | 3,210 | 2,380 | 1,060 | 3,030 | 1,060 | 28,600 | 93,500 | 3,980 | 285 | 1,360 |
| 11 | 386 | 1,240 | 2,850 | 2,220 | 973 | 2,850 | 6,170 | 19,700 | 18,700 | 3,800 | 250 | 1,180 |
| 12 | 286 | 1,150 | 2,520 | 2,080 | 973 | 2,680 | 1,550 | 16,100 | 10,800 | 2,720 | 250 | 1,000 |
| 13 | 344 | 1,440 | 2,380 | 2,080 | 1,060 | 2,520 | 1,150 | 13,900 | 9,590 | 2,120 | 355 | 910 |
| 14 | 344 | 2,680 | 2,220 | 1,930 | 1,060 | 2,080 | 1,060 | 13,500 | 8,480 | 1,970 | 355 | 835 |
| 15 | 344 | 1,800 | 2,080 | 1,800 | 973 | 2,080 | 1,060 | 11,500 | 7,430 | 1,580 | 685 | 760 |
| 16 | 344 | 1,330 | 1,800 | 1,670 | 973 | 1,930 | 1,330 | 10,600 | 10,200 | 1,270 | 760 | 1,090 |
| 17 | 344 | 1,150 | 1,670 | 1,670 | 973 | 1,800 | 1,240 | 10,900 | 5,810 | 1,180 | 685 | 1,090 |
| 18 | 344 | 1,060 | 1,670 | 1,670 | 888 | 1,670 | 1,150 | 9,700 | 6,710 | 1,090 | 1,180 | 835 |
| 19 | 386 | 973 | 1,550 | 1,670 | 888 | 1,550 | 1,060 | 8,830 | 4,970 | 910 | 6,020 | 760 |
| 20 | 386 | 1,060 | 1,550 | 1,550 | 888 | 1,440 | 2,420 | 8,560 | 3,800 | 835 | 4,340 | 685 |
| 21 | 344 | 1,150 | 1,440 | 1,440 | 1,150 | 1,330 | 3,800 | 14,600 | 2,900 | 760 | 2,120 | 620 |
| 22 | 1,670 | 973 | 1,330 | 1,330 | 2,080 | 1,330 | 1,470 | 10,000 | 2,420 | 620 | 2,900 | 1,580 |
| 23 | 1,670 | 888 | 1,330 | 1,240 | 1,440 | 1,240 | 48,700 | 13,900 | 1,840 | 620 | 1,580 | 1,970 |
| 24 | 1,440 | 1,550 | 1,330 | 1,240 | 1,060 | 1,150 | 57,900 | 14,600 | 1,470 | 620 | 1,710 | 1,360 |
| 25 | 1,150 | 1,330 | 1,800 | 1,240 | 1,150 | 1,150 | 38,500 | 11,200 | 1,360 | 500 | 5,390 | 1,180 |
| 26 | 973 | 1,240 | 2,680 | 1,240 | 1,320 | 1,150 | 61,200 | 63,000 | 1,710 | 445 | 4,550 | 910 |
| 27 | 5,750 | 1,800 | 2,680 | 1,150 | 1,440 | 1,060 | 91,400 | 21,700 | 4,760 | 445 | 4,550 | 835 |
| 28 | 9,500 | 3,390 | 2,520 | 1,150 | 1,330 | 1,060 | 80,500 | 7,430 | 2,270 | 445 | 6,710 | 910 |
| 29 | 8,400 | 3,390 | 4,490 | 1,060 | ..... | 1,060 | 76,500 | 5,240 | 1,470 | 400 | 9,290 | 835 |
| 30 | 6,400 | 4,110 | 3,390 | 1,060 | ..... | 1,060 | 45,000 | 4,210 | 1,180 | 400 | 5,600 | 8,480 |
| 31 | 4,490 | ..... | 3,210 | 1,800 | ..... | 973 | ..... | ..... | ..... | 355 | 5,810 | ..... |

NOTE.—Discharge determined by indirect method for shifting control.

*Monthly discharge of Brazos River at Waco, Tex., for the year ending Sept. 30, 1915.*

| Month. | Discharge in second-feet. | | | Run-off (total in acre-feet). | Accuracy. |
|---|---|---|---|---|---|
| | Maximum. | Minimum. | Mean. | | |
| October | 9,500 | 344 | 1,630 | 100,000 | D. |
| November | 4,110 | 888 | 1,870 | 111,000 | D. |
| December | 9,800 | 1,330 | 2,010 | 185,000 | D. |
| January | 3,390 | 1,060 | 1,950 | 120,000 | D. |
| February | 3,210 | 888 | 1,210 | 72,800 | D. |
| March | 6,170 | 973 | 2,130 | 131,000 | D. |
| April | 91,400 | 812 | 17,700 | 1,050,000 | D. |
| May | 63,000 | 4,210 | 16,900 | 1,040,000 | D. |
| June | 93,500 | 1,180 | 13,000 | 774,000 | D. |
| July | 23,900 | 355 | 2,680 | 165,000 | D. |
| August | 9,290 | 250 | 2,210 | 136,000 | D. |
| September | 8,480 | 620 | 1,970 | 117,000 | D. |
| The year | 93,500 | 250 | 5,530 | 4,000.000 | |

## COLORADO RIVER (OF TEXAS) BASIN.

### COLORADO RIVER AT AUSTIN, TEX.

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

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

RECORDS AVAILABLE.—February 15, 1898, to December 31, 1911; October 1, 1914, to September 30, 1915; September 1, 1895, to April 7, 1900, at Austin dam. Record of stage has been obtained by United States Weather Bureau since July 1, 1903.

GAGE.—Dexter water-stage recorder installed on left bank at bridge, June 18, 1915. Before that date staff gage 150 feet above bridge was used at low water, and a chain gage and a gage cut and painted on bridge pier at higher stages. A new low-water section on the left bank at the bridge is now in use. Datum of gages unchanged.

DISCHARGE MEASUREMENTS.—Made from bridge or by wading at bar below bridge.

CHANNEL AND CONTROL.—Channel straight above and below the station; water under bridge deep; bottom very irregular and shifting. Banks clean and of medium height. Control is a gravel and rock shoal about 500 feet below gage; shifts at high stages.

EXTREMES OF DISCHARGE.—Maximum stage recorded during year, 21.0 feet September 17 (discharge, 84,000 second-feet); minimum stage recorded, −0.5 foot December 13–17 (discharge, 2 second-feet).

1898–1911; 1914–15: Maximum stage recorded, 33.5 feet April 7, 1900, when Austin dam failed (discharge, 122,000 second-feet); minimum stage recorded, −0.5 foot December 13–17, 1914 (discharge, 2 second-feet).

WINTER FLOW.—Stage-discharge relation not affected by ice.

DIVERSIONS.—The first report of the State Board of Water Engineers shows that approximately 35,000 acres of land were declared irrigated in the drainage basin above Austin. If each acre requires 2 acre-feet per annum, 70,000 acre-feet of water would be diverted or pumped from the stream. In Bulletin No. 43 (p. 29), of the Texas Department of Agriculture it is reported that approximately 18,600 acres of land are irrigated above the gaging station; the use of 2 acre-feet per annum would require 37,200 acre-feet of water. In comparing these data it must be borne in mind that the first acreage is declared irrigated by the users of the water and the last is an estimate of the number of acres actually irrigated.

REGULATION.—The flow at this point is entirely regulated by the operation of Austin dam, about 3½ miles upstream. The first report of the State Board of Water Engineers shows a filing by the city of Austin for municipal uses of 4,000 acre-feet per annum, with a storage of 30,000 acre-feet. This report also shows filings of 144 acre-feet per annum for Winchell waterworks, 60,000 acre-feet per annum for power from two reservoirs in Burnet County, and an unknown amount for Marble Falls waterworks, all above the gaging station at Austin.

ACCURACY.—Results fair.

COOPERATION.—Gage heights prior to June 18, 1915, furnished by United States Weather Bureau. Many of the discharge measurements furnished by the State Board of Water Engineers.

*Discharge measurements of Colorado River at Austin, Tex., during the year ending Sept. 30, 1915.*

| Date. | Made by— | Gage height. | Discharge. | Date. | Made by— | Gage height. | Discharge. |
|---|---|---|---|---|---|---|---|
| | | *Feet.* | *Sec.-ft.* | | | *Feet.* | *Sec.-ft.* |
| Oct. 22 | Warren E. Hall | 1.72 | 744 | Apr. 27 | Gore and Thaxton | 11.38 | 36,400 |
| Jan. 21 | do | 1.88 | 1,090 | 30 | R. C. Thaxton | 9.93 | 27,600 |
| Mar. 23 | R. C. Thaxton | 1.60 | 916 | May 1 | Hall and Thaxton | 8.03 | 19,100 |
| 29 | Warren E. Hall | 1.30 | 482 | 14 | R. C. Thaxton | 3.90 | 6,660 |
| Apr. 19 | R. C. Thaxton | 3.90 | 5,990 | 17 | do | 2.73 | 3,270 |
| 23 | Gore and Thaxton | 5.76 | 10,300 | 20 | do | 2.40 | 2,330 |
| 24 | do | 6.59 | 14,900 | 29 | Gore and Thaxton | .88 | 184 |
| 26 | R. C. Thaxton | 16.50 | 61,400 | Sept. 8 | R. C. Thaxton | .72 | 157 |

*Daily discharge, in second-feet, of Colorado River at Austin, Tex., for the year ending Sept. 30, 1915.*

| Day. | Oct. | Nov. | Dec. | Jan. | Feb. | Mar. | Apr. | May. | June. | July. | Aug. | Sept. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 840 | 6,540 | 7,070 | 2,010 | 2,280 | 3,640 | 1,170 | 21,400 | 4,170 | 560 | 580 | 970 |
| 2 | 720 | 5,220 | 6,280 | 2,010 | 3,090 | 2,280 | 750 | 13,800 | 255 | 650 | 625 | 3,260 |
| 3 | 840 | 3,100 | 3,620 | 1,350 | 2,550 | 300 | 560 | 10,500 | 195 | 870 | 580 | 4,880 |
| 4 | 840 | 4,950 | 4,950 | 1,350 | 2,550 | 2,280 | 480 | 12,300 | 145 | 1,010 | 580 | 4,610 |
| 5 | 720 | 1,790 | 6,280 | 1,350 | 2,010 | 2,540 | 400 | 12,300 | 145 | 1,010 | 675 | 4,200 |
| 6 | 720 | 1,330 | 4,950 | 1,350 | 1,770 | 2,280 | 1,010 | 7,680 | 195 | 1,170 | 725 | 1,040 |
| 7 | 720 | 1,330 | 3,620 | 1,550 | 1,770 | 2,280 | 1,010 | 8,760 | 4,170 | 1,090 | 675 | 155 |
| 8 | 720 | 1,140 | 3,100 | 1,550 | 1,010 | 2,280 | 1,010 | 7,950 | 1,010 | 1,010 | 675 | 155 |
| 9 | 720 | 1,330 | 2,300 | 1,550 | 4 | 2,280 | 1,010 | 7,410 | 195 | 1,010 | 840 | 115 |
| 10 | 520 | 1,140 | 2,040 | 1,550 | 4 | 1,790 | 1,010 | 6,600 | 145 | 1,010 | 1,200 | 85 |
| 11 | 435 | 1,140 | 1,790 | 1,350 | 4 | 1,570 | 1,010 | 6,600 | 145 | 954 | 1,200 | 85 |
| 12 | 435 | 1,140 | 1,790 | 1,550 | 4 | 300 | 1,010 | 6,330 | 145 | 1,030 | 1,200 | 85 |
| 13 | 615 | 1,140 | 2 | 1,550 | 4 | 2,540 | 1,010 | 6,600 | 145 | 1,040 | 1,200 | 725 |
| 14 | 840 | 1,140 | 2 | 1,350 | 4 | 2,030 | 255 | 6,330 | 145 | 1,060 | 1,120 | 155 |
| 15 | 435 | 1,550 | 2 | 1,350 | 4 | 1,790 | 255 | 5,520 | 195 | 1,140 | 1,120 | 115 |
| 16 | 355 | 1,550 | 2 | 1,350 | 9 | 1,570 | 480 | 5,250 | 195 | 1,070 | 1,280 | 115 |
| 17 | 355 | 2,300 | 2 | 1,350 | 9 | 800 | 3,090 | 3,360 | 195 | 1,150 | 1,120 | 84,000 |
| 18 | 355 | 1,550 | 6 | 1,350 | 370 | 800 | 6,870 | 2,550 | 195 | 1,170 | 840 | 53,000 |
| 19 | 980 | 1,140 | 6 | 1,350 | 370 | 800 | 6,330 | 2,550 | 170 | 1,280 | 782 | 29,000 |
| 20 | 840 | 1,140 | 6 | 1,350 | 700 | 2,280 | 6,330 | 2,550 | 145 | 1,110 | 905 | 12,300 |
| 21 | 840 | 1,140 | 6 | 1,350 | 920 | 1,790 | 6,060 | 2,280 | 145 | 1,120 | 1,040 | 7,580 |
| 22 | 720 | 980 | 6 | 1,170 | 920 | 1,570 | 1,170 | 255 | 125 | 1,120 | 970 | 5,690 |
| 23 | 720 | 840 | 6 | 1,350 | 700 | 1,570 | 14,900 | 255 | 145 | 1,120 | 1,040 | 4,200 |
| 24 | 1,330 | 1,140 | 4 | 1,350 | 700 | 770 | 9,300 | 4,170 | 400 | 1,080 | 1,120 | 3,660 |
| 25 | 1,330 | 1,140 | 9 | 1,350 | 300 | 990 | 31,500 | 255 | 480 | 1,040 | 1,120 | 3,800 |
| 26 | 6,280 | 840 | 12 | 1,170 | 300 | 385 | 68,000 | 255 | 810 | 1,010 | 1,120 | 3,530 |
| 27 | 7,070 | 1,140 | 325 | 1,170 | 3,640 | 370 | 39,000 | 255 | 650 | 970 | 1,040 | 3,260 |
| 28 | 7,070 | 1,140 | 480 | 1,170 | 445 | 501 | 34,000 | 255 | 650 | 675 | 1,200 | 5,960 |
| 29 | 6,540 | 3,620 | 1,170 | 1,010 | ..... | 480 | 39,000 | 255 | 3,090 | 675 | 1,120 | 6,100 |
| 30 | 7,340 | 4,950 | 1,770 | 1,010 | ..... | 750 | 31,500 | 3,360 | 1,550 | 675 | 1,120 | 4,200 |
| 31 | 7,340 | ..... | 2,010 | 1,350 | ..... | 4,980 | ..... | 255 | ..... | 675 | 1,120 | ..... |

NOTE.—Discharge determined as follows: Oct. 1 to Mar. 23, from three rating curves applicable Oct. 1 to Dec. 12, Dec. 13 to Feb. 17, and Feb. 18 to Mar. 23; Mar. 24–28, by indirect method for shifting control; Mar. 29 to July 10, from curve used Dec. 13 to Feb. 17; July 11–20, by indirect method for shifting control; July 21, to Sept. 30, from a rating curve.

*Monthly discharge of Colorado River at Austin, Tex., for the year ending Sept. 30, 1915.*

| Month. | Discharge in second-feet. | | | Run-off (total in acre-feet). | Accuracy. |
|---|---|---|---|---|---|
| | Maximum. | Minimum. | Mean. | | |
| October | 7,340 | 355 | 1,920 | 118,000 | C. |
| November | 6,540 | 840 | 1,950 | 116,000 | C. |
| December | 7,070 | 2 | 1,730 | 106,000 | C. |
| January | 2,010 | 1,010 | 1,390 | 85,500 | C. |
| February | 3,640 | 4 | 944 | 52,400 | C. |
| March | 4,980 | 300 | 1,630 | 100,000 | C. |
| April | 68,000 | 255 | 10,300 | 613,000 | C. |
| May | 21,400 | 255 | 5,430 | 334,000 | B. |
| June | 4,170 | 125 | 678 | 40,300 | C. |
| July | 1,280 | 560 | 986 | 60,600 | C. |
| August | 1,280 | 580 | 966 | 59,400 | C. |
| September | 84,000 | 85 | 8,230 | 490,000 | C. |
| The year | 84,000 | 2 | 3,010 | 2,186,000 | |

## GUADALUPE RIVER BASIN.

### GUADALUPE RIVER AT NEW BRAUNFELS, TEX.

LOCATION.—Just below the highway bridge on San Antonio-Austin post road, about a mile northeast of center of New Braunfels, 700 feet below the International & Great Northern Railway bridge a mile below mouth of Comal River, in southeastern part of Comal County.

DRAINAGE AREA.—1,760 square miles.

RECORDS AVAILABLE.—March 13, 1898, to December 31, 1899; January 27 to September 30, 1915.

GAGE.—Vertical staff on large cypress tree on left bank 200 feet below bridge; installed January 27, 1915; read to tenths once daily by J. F. Willman. Datum of old gage not known.

DISCHARGE MEASUREMENTS.—Made from bridge.

CHANNEL AND CONTROL.—Bed of stream solid rock with pockets of large gravel; clean and not likely to shift. Banks slightly wooded, high, and not subject to overflow. Control is shoal rock and gravel just below gage; subject to slight changes.

EXTREMES OF DISCHARGE.—Maximum stage January 27 to September 30, 1915, 27.2 feet at 9.30 p. m. September 17, determined by leveling from flood marks (discharge not determined); minimum stage recorded 1.8 feet September 11–15 (discharge 460 second-feet).

WINTER FLOW.—Stage-discharge relation not affected by ice.

DIVERSIONS.—Some water diverted for irrigation in Kerr and Comal counties above station and for water power and municipal use in Kerr and Comal counties; amount not known.

REGULATION.—Power plants above station, especially on Comal River, may cause slight diurnal fluctuation during extreme low water.

ACCURACY.—Rating curve well defined. Results excellent.

COOPERATION.—Some discharge measurements furnished by State Board of Water Engineers.

*Discharge measurements of Guadalupe River at New Braunfels, Tex., during the year ending Sept. 30, 1915.*

| Date. | Made by— | Gage height. | Discharge. | Date. | Made by— | Gage height. | Discharge. |
|---|---|---|---|---|---|---|---|
| | | *Feet.* | *Sec.-ft.* | | | *Feet.* | *Sec.-ft.* |
| Jan. 22 | Warren E. Hall | 2.03 | 565 | Apr. 27 | Warren E. Hall | 7.18 | [a] 5,300 |
| 28 | ....do | 1.98 | 530 | 28 | ....do | 5.92 | [a] 3,610 |
| Mar. 26 | ....do | 2.26 | 679 | 29 | ....do | 5.19 | 3,020 |
| 30 | ....do | 2.26 | 684 | May 10 | R. C. Thaxton | 3.66 | 1,560 |
| Apr. 20 | R. C. Thaxton | 4.20 | 2,014 | Sept. 29 | Pierce and Thaxton | 2.51 | 800 |
| 27 | Warren E. Hall | 7.55 | [a] 5,880 | | | | |

[a] Surface velocity observed and coefficient of 0.9 used to reduce to mean velocity.

*Daily discharge, in second-feet, of Guadalupe River at New Braunfels, Tex., for the year ending Sept. 30, 1915.*

| Day. | Jan. | Feb. | Mar. | Apr. | May. | June. | July. | Aug. | Sept. |
|---|---|---|---|---|---|---|---|---|---|
| 1 | ..... | 650 | 755 | 600 | 2,450 | 985 | 700 | 600 | 600 |
| 2 | ..... | 650 | 755 | 650 | 2,180 | 985 | 700 | 600 | 550 |
| 3 | ..... | 650 | 755 | 650 | 2,000 | 985 | 700 | 600 | 550 |
| 4 | ..... | 650 | 755 | 600 | 1,840 | 985 | 700 | 600 | 600 |
| 5 | ..... | 600 | 755 | 600 | 2,540 | 985 | 700 | 600 | 550 |
| 6 | ..... | 600 | 755 | 600 | 3,590 | 925 | 700 | 600 | 505 |
| 7 | ..... | 600 | 755 | 600 | 2,090 | 925 | 700 | 600 | 505 |
| 8 | ..... | 600 | 755 | 600 | 1,840 | 925 | 700 | 600 | 505 |
| 9 | ..... | 600 | 700 | 600 | 1,680 | 925 | 700 | 600 | 505 |
| 10 | ..... | 550 | 700 | 600 | 1,600 | 925 | 700 | 600 | 505 |
| 11 | ..... | 600 | 700 | 600 | 1,520 | 925 | 700 | 600 | 460 |
| 12 | ..... | 600 | 700 | 600 | 1,520 | 925 | 700 | 600 | 460 |
| 13 | ..... | 600 | 755 | 600 | 1,450 | 865 | 700 | 600 | 460 |
| 14 | ..... | 600 | 755 | 600 | 1,380 | 865 | 700 | 600 | 460 |
| 15 | ..... | 550 | 700 | 550 | 1,310 | 865 | 700 | 600 | 460 |
| 16 | ..... | 550 | 700 | 550 | 1,240 | 865 | 700 | 550 | 550 |
| 17 | ..... | 550 | 700 | 550 | 1,240 | 865 | 700 | 550 | 14,000 |
| 18 | ..... | 550 | 700 | 550 | 1,180 | 865 | 700 | 550 | 24,300 |
| 19 | ..... | 550 | 700 | 1,180 | 1,180 | 865 | 700 | 505 | 3,820 |
| 20 | ..... | 550 | 700 | 4,440 | 1,110 | 810 | 700 | 505 | 1,760 |
| 21 | ..... | 600 | 700 | 1,380 | 1,110 | 755 | 650 | 505 | 1,380 |
| 22 | ..... | 600 | 700 | 1,240 | 1,110 | 755 | 650 | 600 | 1,180 |
| 23 | ..... | 600 | 650 | 16,700 | 1,110 | 755 | 650 | 550 | 2,090 |
| 24 | ..... | 550 | 650 | 5,240 | 1,040 | 755 | 650 | 505 | 1,760 |
| 25 | ..... | 550 | 650 | 4,060 | 1,040 | 755 | 600 | 550 | 1,240 |
| 26 | ..... | 550 | 650 | 21,100 | 985 | 755 | 600 | 550 | 1,040 |
| 27 | 550 | 600 | 650 | 6,120 | 1,040 | 755 | 650 | 505 | 925 |
| 28 | 550 | 650 | 650 | 3,820 | 985 | 755 | 600 | 505 | 865 |
| 29 | 550 | ..... | 700 | 3,150 | 985 | 755 | 600 | 505 | 810 |
| 30 | 550 | ..... | 700 | 2,640 | 925 | 700 | 600 | 550 | 782 |
| 31 | 700 | ..... | 600 | ..... | 985 | ..... | 600 | 550 | ..... |

NOTE.—Discharge determined from a rating curve well defined between 550 and 6,600 second-feet. Water over gage Apr. 23, 26, and Sept. 17, 18; discharge determined from flood marks and extension of rating curve.

*Monthly discharge of Guadalupe River at New Braunfels, Tex., for the year ending Sept. 30, 1915.*

| Month. | Discharge in second-feet. | | | Run-off (total in acre-feet). | Accuracy. |
|---|---|---|---|---|---|
| | Maximum. | Minimum. | Mean. | | |
| February | 650 | 550 | 591 | 32,800 | A. |
| March | 755 | 600 | 705 | 43,300 | A. |
| April | 21,100 | 550 | 2,730 | 162,000 | B. |
| May | 3,590 | 925 | 1,490 | 91,600 | A. |
| June | 985 | 700 | 859 | 51,100 | A. |
| July | 700 | 600 | 673 | 41,400 | A. |
| August | 600 | 505 | 566 | 34,800 | A. |
| September | 24,300 | 460 | 2,140 | 127,000 | B. |
| The period | ..... | ..... | ..... | 584,000 | |

### GUADALUPE RIVER NEAR GONZALES, TEX.

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

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

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

GAGE.—Vertical staff in three sections on both banks just below the bridge; read to half tenths once daily by L. B. Davis; relation between this gage and that used by United States Weather Bureau not known.

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

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

EXTREMES OF DISCHARGE.—Maximum stage recorded during year, 3.00 feet at 11 a. m. June 14 (discharge, 1,620 second-feet); minimum stage, 2.05 feet at 9.20 a. m. September 14 (discharge, 930 second-feet). High-water stages were reached August 26 and 27 and September 19–22, but gage was not read on those dates.

WINTER FLOW.—Stage-discharge relation not affected by ice.

DIVERSIONS.—Some water is diverted by gravity or pumped for irrigation above this point, but the quantity is small in comparison with the total run-off. Irrigation is practiced intermittently, as rainfall is nearly sufficient for general farming, and it is extremely difficult to estimate the acreage irrigated and water used.

REGULATION.—Flow at station regulated to a large extent by water-power plants in basin above. Construction at the dam of the Gonzales Water Power Co. caused a slight unnatural fluctuation.

ACCURACY.—Results approximate. Determinations subject to considerable error, due to the assumption that one gage reading per day gives the mean at a fluctuating stage. Stage-discharge relation not permanent; gage readings subject to large errors, due to careless observations.

COOPERATION.—Station established and records prior to September 1 collected by State Board of Water Engineers.

*Discharge measurements of Guadalupe River near Gonzales, Tex., during the year ending Sept. 30, 1915.*

[Made by R. C. Thaxton.]

| Date. | Gage height. | Discharge. |
|---|---|---|
| | *Feet.* | *Sec.-ft.* |
| June 14 | 3.00 | 1,620 |
| Aug. 20 | 2.00 | 980 |

*Daily discharge, in second-feet, of Guadalupe River near Gonzales, Tex., for the year ending Sept. 30, 1915.*

| Day. | July. | Aug. | Sept. | Day. | July. | Aug. | Sept. | Day. | July. | Aug. | Sept. |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 1,330 | 1,070 | 978 | 11 | 1,350 | 1,050 | 970 | 21 | 1,150 | 978 | ------ |
| 2 | 1,350 | 1,010 | 990 | 12 | 1,370 | 1,030 | 990 | 22 | 1,170 | 998 | ------ |
| 3 | 1,350 | 1,070 | 1,010 | 13 | 1,350 | 970 | 950 | 23 | 1,110 | 978 | 1,150 |
| 4 | 1,350 | 1,090 | 1,010 | 14 | 1,270 | 950 | 930 | 24 | 1,130 | 1,020 | 1,150 |
| 5 | 1,370 | 1,050 | 1,030 | 15 | 1,250 | 970 | 950 | 25 | 1,170 | 1,060 | 1,110 |
| 6 | 1,390 | 990 | 990 | 16 | 1,250 | 950 | 950 | 26 | 1,210 | ------ | 1,130 |
| 7 | 1,390 | 1,030 | 1,030 | 17 | 1,330 | 1,000 | 990 | 27 | 1,230 | ------ | 1,110 |
| 8 | 1,390 | 970 | 1,030 | 18 | 1,330 | 1,060 | ------ | 28 | 1,090 | ------ | 1,070 |
| 9 | 1,370 | 1,050 | 990 | 19 | 1,330 | 1,060 | ------ | 29 | 1,170 | ------ | 1,020 |
| 10 | 1,370 | 1,050 | 950 | 20 | 1,170 | 978 | ------ | 30 | 1,110 | ------ | 1,000 |
| | | | | | | | | 31 | 1,150 | ------ | ------ |

NOTE.—Discharge determined by indirect method for shifting controls; gage not read Aug. 26–31, and Sept. 18–22. Mean discharge for July 1,270 second-feet; run-off, 78,100 acre-feet. Mean discharge for Aug. 1–25, 1, 020 second-feet; run-off, 50,600 acre-feet.

### GUADALUPE RIVER NEAR CUERO, TEX.

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

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

RECORDS AVAILABLE.—December 26, 1902, to December 31, 1906; August 19 to September 30, 1915.

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

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

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

EXTREMES OF DISCHARGE.—Maximum stage recorded during year, 29.5 feet at 7 a. m. September 22 (discharge not determined); minimum stage, 3.5 feet at 7 a. m. September 16 (discharge not determined).

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

WINTER FLOW.—Stage-discharge relation not affected by ice.

DIVERSIONS.—The flow at this point is not greatly affected by diversions above. Water is diverted in small amounts only.

REGULATION.—The flow is regulated by the operation of power plants upstream, chiefly one about 4 miles above.

COOPERATION.—Station established and records prior to September 1 collected by the State Board of Water Engineers.

Data inadequate for determination of discharge.

The following discharge measurement was made by R. C. Thaxton:

August 19, 1915: Gage height, 5.40 feet; discharge, 928 second-feet.

*Daily gage height, in feet, of Guadalupe River near Cuero, Tex., for the year ending Sept. 30, 1915.*

| Day. | Aug. | Sept. | Day. | Aug. | Sept. | Day. | Aug. | Sept. |
|---|---|---|---|---|---|---|---|---|
| 1 | ..... | 5.8 | 11 | ..... | 4.9 | 21 | 4.5 | 15.5 |
| 2 | ..... | 5.1 | 12 | ..... | 4.8 | 22 | 4.7 | 29.5 |
| 3 | ..... | 5.0 | 13 | ..... | 4.9 | 23 | 5.0 | 11.0 |
| 4 | ..... | 4.9 | 14 | ..... | 4.8 | 24 | 5.7 | 7.7 |
| 5 | ..... | 4.9 | 15 | ..... | 4.8 | 25 | 5.6 | 7.2 |
| 6 | ..... | 4.9 | 16 | ..... | 3.5 | 26 | 5.4 | 7.3 |
| 7 | ..... | 5.2 | 17 | ..... | 4.8 | 27 | 9.4 | 7.4 |
| 8 | ..... | 4.9 | 18 | ..... | 5.0 | 28 | 8.5 | 6.9 |
| 9 | ..... | 4.9 | 19 | 5.4 | 4.7 | 29 | 9.6 | 6.4 |
| 10 | ..... | 4.7 | 20 | 4.9 | 9.5 | 30 | 9.8 | 6.4 |
| | | | | | | 31 | 8.2 | ..... |

### SAN MARCOS RIVER AT SAN MARCOS, TEX.

LOCATION.—At sewer trestle of the San Marcos Utilities Co., in San Marcos, Hays County, 1,000 feet below Austin-San Antonio highway bridge, half a mile above Rodger's Resort, 2½ miles above junction with Blanco River.

DRAINAGE AREA.—Indeterminate.

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

GAGE.—Vertical staff attached to sewer trestle near the right bank; read twice daily by A. F. Wilson.

DISCHARGE MEASUREMENTS.—Made by wading.

CHANNEL AND CONTROL.—Both banks of medium height and subject to overflow during extremely high stages. Bed composed of gravel and sand; changes slightly. Position of control not known, but a growth of weeds and grass in the channel seriously affected the stage-discharge relation.

EXTREMES OF DISCHARGE.—Maximum stage recorded during year, 2.85 feet August 7 and 9 (discharge, 341 second-feet); minimum stage, 2.50 feet September 30 (discharge, 206 second-feet).

WINTER FLOW.—Stage-discharge relation not affected by ice.

DIVERSIONS.—None for irrigation above station, but water is stored for use by power plants.

REGULATION.—Flow at station regulated by the San Marcos Utilities Co. for a municipal power plant. Much of the flow comes from springs a short distance above station, and water is stored and released as needed.

ACCURACY.—Results poor. Stage-discharge relation seriously affected in September by backwater due to growth of weeds in channel. Determinations subject to error resulting from the assumption that one gage reading gives the mean for a day. Regulation for power causes fluctuations in stage.

COOPERATION.—Station established and records prior to September 1 collected by State Board of Water Engineers.

*Discharge measurements of San Marcos River at San Marcos, Tex., during the year ending Sept. 30, 1915.*

[Made by R. C. Thaxton.]

| Date. | Gage height. | Discharge. |
|---|---|---|
| | *Feet.* | *Sec.-feet.* |
| June 10 | 2.76 | 302 |
| 10 | 2.65 | 304 |

*Daily discharge, in second-feet, of San Marcos River at San Marcos, Tex., for the year ending Sept. 30, 1915.*

| Day. | July. | Aug. | Sept. | Day. | July. | Aug. | Sept. | Day. | July. | Aug. | Sept. |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 315 | 283 | 273 | 11 | 323 | 273 | 218 | 21 | 312 | 278 | 230 |
| 2 | 315 | 290 | 264 | 12 | 307 | 290 | 230 | 22 | 318 | 297 | 230 |
| 3 | 323 | 297 | 259 | 13 | 333 | 302 | 230 | 23 | 318 | 302 | 247 |
| 4 | 302 | 302 | 315 | 14 | 320 | 307 | 290 | 24 | 312 | 312 | 252 |
| 5 | 328 | 315 | 278 | 15 | 320 | 318 | 242 | 25 | 315 | 320 | 223 |
| 6 | 315 | 328 | 283 | 16 | 290 | 273 | 242 | 26 | 312 | 297 | 216 |
| 7 | 318 | 341 | 268 | 17 | 295 | 273 | 254 | 27 | 302 | 302 | 235 |
| 8 | 305 | 341 | 266 | 18 | 307 | 278 | 249 | 28 | 292 | 288 | 230 |
| 9 | 315 | 341 | 263 | 19 | 302 | 318 | 249 | 29 | 283 | 278 | 211 |
| 10 | 302 | 328 | 261 | 20 | 315 | 298 | 235 | 30 | 254 | 254 | 206 |
| | | | | | | | | 31 | 266 | 268 | ..... |

NOTE.—Discharge determined as follows: July 3–27, July 29 to Aug. 7, Aug. 9–19, Aug. 21 to Sept. 7, from a poorly defined rating curve; Sept. 10–30 by indirect method for shifting controls. Gage heights not recorded July 1, 2, 28, Aug. 8, 20, and Sept. 8 and 9; discharge estimated.

*Monthly discharge of San Marcos River at San Marcos, Tex., for the year ending Sept. 30, 1915.*

| Month. | Discharge in second-feet. | | | Run-off (total in acre-feet). | Accuracy. |
|---|---|---|---|---|---|
| | Maximum. | Minimum. | Mean. | | |
| July | 333 | 254 | 308 | 18,900 | D. |
| August | 341 | 254 | 300 | 18,400 | D. |
| September | 315 | 206 | 248 | 14,800 | D. |
| The period | | | | 52,100 | |

### SAN MARCOS RIVER AT OTTINE, TEX.

LOCATION.—Just above highway bridge a quarter of a mile southwest of Ottine, Gonzales County, 4 miles below mouth of Plum Creek, 10 miles above confluence of San Marcos and Guadalupe rivers.

DRAINAGE AREA.—Indeterminate.

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

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

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

CHANNEL AND CONTROL.—Both banks high and wooded; not subject to overflow except during extremely high stages. Channel straight above and below the station for 150 feet. Bed composed of sand, rock, and gravel; not subject to extreme shifting. Position of control not known. For a few days each year during high stages in Guadalupe River backwater seriously affects the stage-discharge relation.

EXTREMES OF DISCHARGE.—Maximum stage recorded during year, 3.01 feet at 6.30 a. m. June 22 (discharge, 375 second feet); minimum stage, 2.07 feet at 7 a. m. August 14 and 15 (discharge, 192 second-feet).

WINTER FLOW.—Stage-discharge relation not affected by ice.

DIVERSIONS.—Some water is diverted or pumped for irrigation above station, but quantity used is only a small percentage of the total run-off.

REGULATION.—A short distance above the station is a small cotton gin that is operated by water power, regulating the flow to some extent. The operation of several small water-power plants in the upper part of the drainage basin, near San Marcos and Martindale, does not materially affect the distribution of the flow at this point.

ACCURACY.—Results fair; stage-discharge relation permanent. Base data reliable. Determinations subject to errors due to the assumption that one gage reading daily gives the mean for the day although flow is artificially regulated.

COOPERATION.—Station established and records prior to September 1 collected by State Board of Water Engineers.

*Discharge measurements of San Marcos River at Ottine, Tex., during the year ending Sept. 30, 1915.*

[Made by R. C. Thaxton.]

| Date. | Gage height. | Discharge. |
|---|---|---|
| | *Feet.* | *Sec.-ft.* |
| June 15 | 3.24 | 416 |
| Aug. 19 | 2.52 | 277 |

*Daily discharge, in second-feet, of San Marcos River at Ottine, Tex., for the year ending Sept. 30, 1915.*

| Day. | June. | July. | Aug. | Sept. | Day. | June. | July. | Aug. | Sept. |
|---|---|---|---|---|---|---|---|---|---|
| 1 | | 339 | 268 | 259 | 16 | | 285 | 232 | 200 |
| 2 | | 319 | 268 | 278 | 17 | | 285 | 268 | 232 |
| 3 | | 319 | 268 | 285 | 18 | | 285 | 268 | 251 |
| 4 | | 347 | 251 | 225 | 19 | | 285 | 268 | 251 |
| 5 | | 357 | 259 | 232 | 20 | | 278 | 268 | 251 |
| 6 | | 329 | 268 | 242 | 21 | | 268 | 303 | 251 |
| 7 | | 329 | 259 | 232 | 22 | 375 | 268 | 268 | 259 |
| 8 | | 339 | 251 | 232 | 23 | 367 | 268 | 295 | 242 |
| 9 | | 329 | 259 | 259 | 24 | 357 | 268 | 295 | 251 |
| 10 | | 311 | 259 | 268 | 25 | 347 | 268 | 259 | 242 |
| 11 | | 311 | 242 | 268 | 26 | 319 | 268 | 259 | 232 |
| 12 | | 311 | 242 | 251 | 27 | 339 | 268 | 251 | 232 |
| 13 | | 303 | 232 | 259 | 28 | 339 | 268 | 251 | 225 |
| 14 | | 295 | 192 | 232 | 29 | 339 | 268 | 251 | 225 |
| 15 | | 295 | 192 | 200 | 30 | 329 | 268 | 259 | 200 |
| | | | | | 31 | | 268 | 251 | |

NOTE.—Discharge determined from a well-defined rating curve.

*Monthly discharge of San Marcos River at Ottine, Tex., for the year ending Sept. 30, 1915.*

| Month. | Discharge in second-feet. | | | Run-off (total in acre-feet). | Accuracy. |
|---|---|---|---|---|---|
| | Maximum. | Minimum. | Mean. | | |
| June 22–30 | 375 | 319 | 346 | 6,180 | C. |
| July | 357 | 268 | 297 | 18,300 | C. |
| August | 303 | 192 | 256 | 15,700 | C. |
| September | 285 | 200 | 243 | 14,500 | C. |
| The period | | | | 54,700 | |

## SAN ANTONIO RIVER BASIN.

### SAN ANTONIO RIVER AT SAN ANTONIO, TEX.

LOCATION.—At Commerce Street Bridge in San Antonio, Bexar County, 3 miles below San Antonio Springs, the source of the river.

DRAINAGE AREA.—Indeterminate.

RECORDS AVAILABLE.—January 26 to September 30, 1915.

GAGE.—Vertical staff attached to concrete bridge post nearest to right bank at downstream side of bridge.

DISCHARGE MEASUREMENTS.—Made from Market Street Bridge, 300 feet below gage.

CHANNEL AND CONTROL.—Below a stage of 3 feet water is confined between vertical rock walls 38 feet apart; at stages between 3 and 4.5 feet water spreads over flat berms on both banks for about 30 feet; above 4.5 feet water is again confined between vertical rock walls. Moss grows on the silt of which the bottom of low-water channel is composed and by clogging meter causes some trouble in making discharge measurements. Control is gravel and boluder shoal about 600 feet below gage; shifts at high water.

EXTREMES OF DISCHARGE.—Maximum stage recorded 14.0 feet at 5.30 p. m. October 23, 1914. (discharge, 4,700 second-feet); minimum stage recorded, 2.0 feet January 28 and 10 days in February (discharge, 100 second-feet).

WINTER FLOW.—Stage-discharge relation not affected by ice.

DIVERSIONS.—No information.

REGULATION.—Diurnal fluctuations in low-water flow are caused by pumping deep wells for city water works.

ACCURACY.—Rating curve well defined; results good.

COOPERATION.—Some discharge measurements furnished by the State Board of Water Engineers.

*Discharge measurements of San Antonio River at San Antonio, Tex., during the year ending Sept. 30, 1915.*

| Date. | Made by— | Gage height. | Discharge. | Date. | Made by— | Gage height. | Discharge. |
|---|---|---|---|---|---|---|---|
| | | *Feet.* | *Sec.-ft.* | | | *Feet.* | *Sec.-ft.* |
| Oct. 23 | Warren E. Hall | 12.36 | 3,600 | Apr. 20 | R. C. Thaxton | 2.93 | 276 |
| 26 | do | 2.43 | 134 | 26 | Warren E. Hall | 2.85 | 259 |
| Jan. 23 | do | 2.08 | 105 | 26 | do | 2.92 | 269 |
| 26 | do | 2.05 | 101 | May 6 | do | 2.68 | 225 |
| Mar. 25 | do | 2.29 | 122 | 10 | R. C. Thaxton | 2.65 | 217 |
| 25 | do | 2.30 | 123 | Sept. 30 | Pierce and Thaxton | 2.23 | 114 |

*Daily discharge, in second-feet, of San Antonio River at San Antonio, Tex., for the year ending Sept. 30, 1915.*

| Day. | Jan. | Feb. | Mar. | Apr. | May. | June. | July. | Aug. | Sept. |
|---|---|---|---|---|---|---|---|---|---|
| 1 | | 100 | 104 | 112 | 250 | 151 | 122 | 209 | 209 |
| 2 | | 100 | 104 | 117 | 266 | 167 | 122 | 209 | 203 |
| 3 | | 104 | 104 | 112 | 229 | 167 | 122 | 197 | 197 |
| 4 | | 102 | 104 | 112 | 203 | 151 | 130 | 197 | 175 |
| 5 | | 104 | 104 | 117 | 203 | 139 | 130 | 217 | 161 |
| 6 | | 102 | 104 | 117 | 187 | 151 | 130 | 217 | 144 |
| 7 | | 104 | 104 | 122 | 187 | 151 | 135 | 224 | 144 |
| 8 | | 100 | 104 | 112 | 167 | 151 | 144 | 229 | 139 |
| 9 | | 100 | 104 | 122 | 203 | 151 | 151 | 224 | 135 |
| 10 | | 104 | 104 | 122 | 167 | 151 | 151 | 224 | 130 |
| 11 | | 104 | 104 | 122 | 167 | 151 | 151 | 217 | 125 |
| 12 | | 104 | 108 | 122 | 167 | 151 | 161 | 224 | 130 |
| 13 | | 104 | 104 | 122 | 187 | 139 | 167 | 229 | 125 |
| 14 | | 104 | 104 | 122 | 167 | 139 | 167 | 229 | 125 |
| 15 | | 104 | 104 | 122 | 203 | 139 | 167 | 224 | 122 |
| 16 | | 104 | 104 | 130 | 167 | 139 | 167 | 224 | 125 |
| 17 | | 104 | 108 | 130 | 139 | 130 | 167 | 217 | 122 |
| 18 | | 100 | 104 | 916 | 139 | 130 | 187 | 217 | 122 |
| 19 | | 104 | 104 | 333 | 151 | 130 | 175 | 217 | 120 |
| 20 | | 104 | 104 | 294 | 167 | 130 | 187 | 229 | 122 |
| 21 | | 100 | 104 | 203 | 167 | 130 | 187 | 229 | 122 |
| 22 | | 104 | 104 | 250 | 203 | 130 | 187 | 224 | 120 |
| 23 | | 104 | 104 | 375 | 167 | 130 | 187 | 229 | 120 |
| 24 | | 104 | 104 | 250 | 167 | 122 | 187 | 233 | 120 |
| 25 | | 104 | 108 | 678 | 167 | 122 | 209 | 229 | 122 |
| 26 | 104 | 104 | 108 | 250 | 167 | 130 | 217 | 233 | 122 |
| 27 | | 104 | 112 | 250 | 167 | 130 | 217 | 229 | 120 |
| 28 | 100 | 100 | 112 | 229 | 167 | 130 | 217 | 246 | 120 |
| 29 | 104 | | 112 | 229 | 167 | 130 | 217 | 229 | 117 |
| 30 | 104 | | 112 | 273 | 151 | 130 | 217 | 203 | 117 |
| 31 | 104 | | 117 | | 151 | | 217 | 209 | |

NOTE.—Discharge determined from a well-defined rating curve.

*Monthly discharge of San Antonio River at San Antonio, Tex., for the year ending Sept. 30, 1915.*

| Month. | Discharge in second-feet. | | | Run-off (total in acre-feet). | Accuracy. |
|---|---|---|---|---|---|
| | Maximum. | Minimum. | Mean. | | |
| February | 104 | 100 | 103 | 5,720 | B. |
| March | 117 | 104 | 106 | 6,520 | A. |
| April | 916 | 112 | 219 | 13,000 | B. |
| May | 266 | 139 | 179 | 11,000 | B. |
| June | 167 | 122 | 140 | 8,330 | B. |
| July | 217 | 122 | 171 | 10,500 | B. |
| August | 246 | 197 | 222 | 13,600 | B. |
| September | 209 | 117 | 136 | 8,090 | B. |
| The period | | | | 76,800 | |

## NUECES RIVER BASIN.

### NUECES RIVER NEAR CINONIA, TEX.

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

DRAINAGE AREA.—2,060 square miles.

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

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

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

CHANNEL AND CONTROL.—Bed composed of clay and gravel; free from vegetation; shifts. Both banks high and wooded; neither is subject to overflow. Channel straight above and below station. Position of control not known. Stage-discharge relation seriously affected at times by backwater due to logs, leaves, and brush that collect below the gage.

EXTREMES OF DISCHARGE.—Maximum stage recorded during year, 20.0 feet at 6.30 a. m. September 19 (discharge not computed); minimum stage, 2.0 feet at 6.30 a. m., September 14 (discharge, 10 second-feet).

WINTER FLOW.—Stage-discharge relation not affected by ice.

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

REGULATION.—Records indicate that flow above station is not regulated, but a dam 40 feet high has been constructed about 20 miles below, and backwater from this dam, when the reservoir is full, extends to a point 2 miles below the station. A large part of the flow of the river sinks into the bed just below Uvalde and returns to the surface just above the station. The condition of the underground waters may have an effect upon this return water, and thus produce a regulating effect.

ACCURACY.—Results fair; condition of stage-discharge relation somewhat uncertain; gage-height record subject to errors due to careless observations.

COOPERATION.—Station established and records prior to September 1 collected by State Board of Water Engineers.

The following discharge measurement was made by R. C. Thaxton:
June 18, 1915: Gage height, 3.04 feet; discharge, 30 second-feet.

*Daily discharge, in second-feet, of Nueces River near Cinonia, Tex., for the year ending Sept. 30, 1915.*

| Day. | July | Aug. | Sept. | Day. | July. | Aug. | Sept. | Day. | July. | Aug. | Sept. |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | ..... | 24 | 16 | 11 | 14 | 15 | 12 | 21 | 11 | 12 | ..... |
| 2 | ..... | 18 | 16 | 12 | 14 | 13 | 11 | 22 | 12 | 22 | 190 |
| 3 | ..... | 18 | 14 | 13 | 13 | 12 | 11 | 23 | 11 | 18 | 190 |
| 4 | ..... | 18 | 14 | 14 | 12 | 30 | 10 | 24 | 12 | 18 | 184 |
| 5 | 17 | 27 | 14 | 15 | 12 | 14 | 105 | 25 | 12 | 18 | 184 |
| 6 | 17 | 23 | 14 | 16 | 12 | 13 | 157 | 26 | 12 | 18 | 239 |
| 7 | 16 | 21 | 14 | 17 | 12 | 12 | ..... | 27 | 12 | 20 | 246 |
| 8 | 16 | 18 | 12 | 18 | 12 | 12 | ..... | 28 | 12 | 22 | 212 |
| 9 | 15 | 19 | 12 | 19 | 12 | 12 | ..... | 29 | 12 | 26 | 184 |
| 10 | 15 | 16 | 12 | 20 | 12 | 12 | ..... | 30 | 12 | 20 | 138 |
| | | | | | | | | 31 | 12 | 19 | ..... |

NOTE.—Discharge determined as follows: July 5–19, July 21 to Sept. 16, Sept. 22–30, by indirect method for shifting control; July 20, interpolated. Sept. 17–21 water reached stages beyond limits of rating curve. Gage heights during this period were: Sept. 17, 13.1 feet; 18, 18.1 feet; 19, 20.0 feet; 20, 9.9 feet; 21, 8.4 feet. Mean discharge July 5–31, 13.0 second-feet; run-off, 696 acre-feet. Mean discharge for August, 18.1 second-feet; run-off, 1,110 acre-feet.

### NUECES RIVER NEAR COTULLA, TEX.

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

DRAINAGE AREA.—5,030 square miles.

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

GAGE.—Vertical staff attached to trees on right bank, just above the dam; read daily by J. L. Hutchason.

DISCHARGE MEASUREMENTS.—Made by wading below dam.

CHANNEL AND CONTROL.—Bed composed of gravel, rock, and sand; general channel straight above and below the station. Both banks wooded, of medium height, and not subject to overflow. Long concrete dam just below gage serves as control.

EXTREMES OF DISCHARGE.—Maximum stage recorded during year, 2.2 feet at 1.40 p. m. August 29 (discharge, 5,040 second-feet). No flow July 1 to August 8, August 15 and 16, and September 12–15.

WINTER FLOW.—Stage-discharge relation not affected by ice.

DIVERSIONS.—Much of normal flow above station pumped or diverted for irrigation. Station is in upper end of section near Cotulla, in which considerable land is irrigated. In the First Report of the State Board of Water Engineers of Texas, two large filings are listed in the name of Winter Garden Irrigation Co. and Nueces Valley Irrigation Co., in Zavalla and Dimmit counties, the irrigable area under each system comprising 10,000 acres, the capacities of diversion works being 95.0 and 6.65 second-feet, respectively.

REGULATION.—Flow regulated by storage reservoirs and pumping plants above station. No water-power plants above station.

ACCURACY.—Results poor. Discharge measurements can not be made at high stages. Rating curve based on low-water discharge measurements and discharge determined by considering the dam as weir and using weir formula. Stage-discharge relation permanent; determination of discharge probably within 20 per cent of true discharge.

COOPERATION.—Station established and records prior to September 1 collected by State Board of Water Engineers.

The following discharge measurement was made by R. C. Thaxton:
August 17, 1915: Gage height, 0.22 foot; discharge, 10 second-feet.

*Daily discharge, in second-feet, of Nueces River near Cotulla, Tex., for the year ending Sept. 30, 1915.*

| Day. | July. | Aug. | Sept. | Day. | July. | Aug. | Sept. | Day. | July. | Aug. | Sept. |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 0 | 0 | 1,430 | 11 | 0 | 147 | 7 | 21 | 0 | 207 | 567 |
| 2 | 0 | 0 | 1,310 | 12 | 0 | 44 | 0 | 22 | 0 | 267 | 1,070 |
| 3 | 0 | 0 | 1,070 | 13 | 0 | 22 | 0 | 23 | 0 | 267 | 752 |
| 4 | 0 | 0 | 567 | 14 | 0 | 22 | 0 | 24 | 0 | 107 | 567 |
| 5 | 0 | 0 | 207 | 15 | 0 | 0 | 0 | 25 | 0 | 22 | 487 |
| 6 | 0 | 0 | 107 | 16 | 0 | 0 | 147 | 26 | 0 | 14 | 407 |
| 7 | 0 | 0 | 67 | 17 | 0 | 7 | 107 | 27 | 0 | 7 | 337 |
| 8 | 0 | 0 | 44 | 18 | 0 | 567 | 207 | 28 | 0 | 752 | 267 |
| 9 | 0 | 147 | 22 | 19 | 0 | 337 | 267 | 29 | 0 | 5,040 | 147 |
| 10 | 0 | 7 | 14 | 20 | 0 | 147 | 407 | 30 | 0 | 3,400 | 107 |
| | | | | | | | | 31 | 0 | 2,850 | ..... |

NOTE.—Discharge obtained from a rating curve developed by means of discharge measurements and weir formula. No water flowing over dam July 1 to Aug. 8, Aug. 15 and 16, Sept. 12–15. Aug. 21 discharge interpolated.

*Monthly discharge of Nueces River near Cotulla, Tex., for the year ending Sept. 30, 1915.*

| Month. | Discharge in second-feet. | | | Run-off (total in acre-feet). | Accuracy. |
|---|---|---|---|---|---|
| | Maximum. | Minimum. | Mean. | | |
| July | 0 | 0 | 0 | 0 | |
| August | 5,040 | 0 | 464 | 28,500 | D. |
| September | 1,430 | 0 | 356 | 21,200 | D. |
| The period | | | | 49,700 | |

**NUECES RIVER NEAR THREE RIVERS, TEX.**

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

DRAINAGE AREA.—15,600 square miles.

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

GAGE.—Vertical staff attached to center pier of railroad bridge, left abutment; read once daily by J. B. Smith.

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

CHANNEL AND CONTROL.—Bed composed of adobe shale; clean and not subject to extreme shifting. Channel straight above and below station. Banks high and wooded and not subject to overflow. Position of high-water control not known; shoal just below station is believed to be low-water control.

EXTREMES OF DISCHARGE.—Maximum stage recorded during year, 10.3 feet at 6 p. m. September 23 (discharge, 2,170 second-feet); minimum discharge estimated 0.2 second-foot, August 14 (gage height not accurately determined).

WINTER FLOW.—Stage-discharge relation not affected by ice.

DIVERSIONS.—Considerable land is irrigated above station, but there is apparently no irrigable land immediately above.

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

ACCURACY.—Results fair; rating curve fairly well defined. Recorded gage heights slightly erroneous because of the assumption that one daily reading represents the mean stage and also because of carelessness on part of gage reader.

COOPERATION.—Station established and records prior to September 1 collected by the State Board of Water Engineers.

*Discharge measurements of Nueces River near Three Rivers, Tex., during the year ending Sept. 30, 1915.*

[Made by R. C. Thaxton.]

| Date. | Gage height. | Discharge. |
|---|---|---|
| | *Feet.* | *Sec.-ft.* |
| May 9 | 4.23 | 510 |
| June 25 | 1.30 | 63 |

*Daily discharge, in second-feet, of Nueces River near Three Rivers, Tex., for the year ending Sept. 30, 1915.*

| Day. | July. | Aug. | Sept. | Day. | July. | Aug. | Sept. | Day. | July. | Aug. | Sept. |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 22 | 5.2 | 360 | 11 | 6.7 | 4 | 982 | 21 | 4.7 | 12 | 1,080 |
| 2 | 19 | 5.2 | 821 | 12 | 4.2 | 2.5 | 309 | 22 | 4.7 | 6.7 | 2,000 |
| 3 | 16 | 5.2 | 982 | 13 | 4.2 | 1 | 156 | 23 | 4.7 | 5.7 | 2,170 |
| 4 | 12 | 5.2 | 709 | 14 | 5.7 | .2 | 130 | 24 | 4.7 | 292 | 2,100 |
| 5 | 14 | 5.2 | 394 | 15 | 4.2 | 78 | 78 | 25 | 4.7 | 360 | 1,240 |
| 6 | 9.1 | 16 | 200 | 16 | 4.2 | 66 | 66 | 26 | 4.7 | 709 | 1,210 |
| 7 | 9.1 | 12 | 170 | 17 | 6.2 | 56 | 982 | 27 | 4.7 | ..... | 1,180 |
| 8 | 9.1 | 14 | 1,710 | 18 | 6.2 | 47 | 709 | 28 | 5.2 | ..... | 1,150 |
| 9 | 11 | 6.7 | 1,860 | 19 | 4.7 | 40 | 360 | 29 | 5.2 | ..... | 1,150 |
| 10 | 11 | 5.7 | 1,460 | 20 | 4.7 | 33 | 562 | 30 | 5.2 | 604 | 1,130 |
| | | | | | | | | 31 | 5.2 | 709 | ..... |

NOTE.—Discharge determined from a fairly well defined rating curve developed in 1916. Discharge July 2 and Aug. 11–14 estimated from information furnished by hydrographers. Gage not read Aug. 27–29; information furnished by gage reader indicates that discharge exceeded 2,000 second-feet. Mean discharge for July, 7.67 second-feet; run-off, 470 acre-feet. Mean discharge for September, 914 second-feet; run-off, 54,400 acre-feet.

### NUECES RIVER AT CALALLEN, TEX.

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

DRAINAGE AREA.—16,700 square miles.

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

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

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

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

EXTREMES OF DISCHARGE.—Maximum stage recorded during year, 3.70 feet at 4 p. m. August 31 and at 9.15 p. m. September 1 (discharge, 2,010 second-feet); minimum stage, 0.60 foot August 20–22 (discharge, 18 second-feet).

WINTER FLOW.—Stage-discharge relation not affected by ice.

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

REGULATION.—Some water is diverted or pumped for irrigation above station; flow slightly regulated thereby. No water-power plants of consequence above station.

ACCURACY.—Results fair. Base data reliable and accurate. Leakage through breakwater slightly changes the stage-discharge relation. Low-water discharge measurements are made with great difficulty on account of poor measuring sections. In determining daily discharge consideration has been given the effect of rising and falling stages.

COOPERATION.—Station established and records prior to September 1 collected by State Board of Water Engineers.

*Discharge measurements of Nueces River at Calallen, Tex., during the year ending Sept. 30, 1915.*

| Date. | Made by— | Gage height. | Discharge. |
|---|---|---|---|
| | | *Feet.* | *Sec.-ft.* |
| May 8 | Hall and Thaxton | 2.80 | 1,290 |
| Aug. 13 | R. C. Thaxton | .68 | 29 |

*Daily discharge, in second-feet, of Nueces River at Calallen, Tex., for the year ending Sept. 30, 1915.*

| Day. | Aug. | Sept. | Day. | Aug. | Sept. | Day. | Aug. | Sept. |
|---|---|---|---|---|---|---|---|---|
| 1 | | 1,600 | 11 | | 1,440 | 21 | 18 | 632 |
| 2 | | 685 | 12 | 32 | 1,490 | 22 | 18 | 759 |
| 3 | | 435 | 13 | 31 | 1,080 | 23 | 36 | 1,120 |
| 4 | | 744 | 14 | 32 | 790 | 24 | 41 | 1,470 |
| 5 | | 1,130 | 15 | 24 | 360 | 25 | 41 | 1,570 |
| 6 | | 755 | 16 | 24 | 183 | 26 | 189 | 1,600 |
| 7 | | 685 | 17 | 24 | 96 | 27 | 369 | 1,240 |
| 8 | | 615 | 18 | 24 | 70 | 28 | 856 | 1,100 |
| 9 | | 1,170 | 19 | 21 | 65 | 29 | 1,410 | 1,000 |
| 10 | | 1,390 | 20 | 18 | 609 | 30 | 1,690 | 956 |
| | | | | | | 31 | 1,930 | |

NOTE.—Discharge determined as follows: Aug. 12–25 by indirect method for shifting control; Aug. 26 to Sept. 30 from two well-defined rating curves based on discharge measurements made in 1916 during rising and falling stages. Mean discharge Aug. 12–31, 341 second-feet (13,500 acre-feet); September, 895 second-feet (53,300 acre-feet).

### FRIO RIVER NEAR DERBY, TEX.

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

DRAINAGE AREA.—3,500 square miles.

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

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

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

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

EXTREMES OF DISCHARGE.—Maximum stage recorded during year, 7.9 feet at 8 a. m. September 18 (discharge, 3,020 second-feet). No flow August 1–28 and September 5–17.

WINTER FLOW.—Stage-discharge relation not affected by ice.

DIVERSIONS.—Small areas are irrigated by diversion and pumping at headwaters, but so far as known water is not taken from stream immediately above station.

REGULATION.—None above station.

ACCURACY.—Results fair. Determinations subject to error due to the assumption that one gage reading daily represents the mean for the day. Stage-discharge relation practically permanent.

COOPERATION.—Station established and records during August collected by State Board of Water Engineers.

No discharge measurements were made during the year.

*Daily discharge, in second-feet, of Frio River near Derby, Tex., for the year ending Sept. 30, 1915.*

| Day. | Aug. | Sept. | Day. | Aug. | Sept. | Day. | Aug. | Sept. |
|---|---|---|---|---|---|---|---|---|
| 1 | 0 | 30 | 11 | 0 | .0 | 21 | 0 | 172 |
| 2 | 0 | 10 | 12 | 0 | .0 | 22 | 0 | 302 |
| 3 | 0 | 3.0 | 13 | 0 | .0 | 23 | 0 | 425 |
| 4 | 0 | 1.0 | 14 | 0 | .0 | 24 | 0 | 514 |
| 5 | 0 | .0 | 15 | 0 | .0 | 25 | 0 | 106 |
| 6 | 0 | .0 | 16 | 0 | .0 | 26 | 0 | 198 |
| 7 | 0 | .0 | 17 | 0 | .0 | 27 | 0 | 126 |
| 8 | 0 | .0 | 18 | 0 | 3,020.0 | 28 | 0 | 72 |
| 9 | 0 | .0 | 19 | 0 | 2,480 | 29 | 666 | 41 |
| 10 | 0 | .0 | 20 | 0 | 425 | 30 | 2,420 | 24 |
| | | | | | | 31 | 138 | ..... |

NOTE.—Discharge determined from a well-defined rating curve based on discharge measurements made during 1916. Mean discharge for August, 104 second-feet (6,400 acre-feet); September, 265 second-feet (15,800 acre-feet).

### FRIO RIVER AT FOWLERTON, TEX.

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

DRAINAGE AREA.—4,350 square miles.

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

GAGE.—Vertical staff attached to tree on right bank about 20 feet above dam; read once daily by Joe McMains.

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

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

EXTREMES OF DISCHARGE.—Maximum stage recorded during year, 2.9 feet at 4.30 p. m. September 21 (discharge, 2,390 second-feet). No flow July 1 to August 30 and September 5–19.

WINTER FLOW.—Stage-discharge relation not affected by ice.

DIVERSIONS.—Some water diverted for irrigation above station. Water for Frio Lake storage reservoir is diverted 1½ miles above. Other diversions are scattered; quantity diverted and areas irrigated not accurately known. Many of the irrigated areas in the drainage basin above are watered by wells.

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

ACCURACY.—Results fair. Stage-discharge relation apparently permanent, but determinations subject to considerable error due to the assumption that one daily reading on the gage represents the mean stage for the day. Base data reliable.

COOPERATION.—Station established and records prior to September 1 collected by State Board of Water Engineers.

No discharge measurements were made during the year.

*Daily discharge, in second-feet, of Frio River at Fowlerton, Tex., for the year ending Sept. 30, 1915.*

| Day. | July. | Aug. | Sept. | Day. | July. | Aug. | Sept. | Day. | July. | Aug. | Sept. |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 0 | 0 | 508 | 11 | 0 | 0 | 0 | 21 | 0 | 0 | 2,380 |
| 2 | 0 | 0 | 35 | 12 | 0 | 0 | 0 | 22 | 0 | 0 | 765 |
| 3 | 0 | 0 | 9 | 13 | 0 | 0 | 0 | 23 | 0 | 0 | 242 |
| 4 | 0 | 0 | 2.5 | 14 | 0 | 0 | 0 | 24 | 0 | 0 | 242 |
| 5 | 0 | 0 | .0 | 15 | 0 | 0 | 0 | 25 | 0 | 0 | 242 |
| 6 | 0 | 0 | .0 | 16 | 0 | 0 | 0 | 26 | 0 | 0 | 242 |
| 7 | 0 | 0 | .0 | 17 | 0 | 0 | 0 | 27 | 0 | 0 | 242 |
| 8 | 0 | 0 | .0 | 18 | 0 | 0 | 0 | 28 | 0 | 0 | 106 |
| 9 | 0 | 0 | .0 | 19 | 0 | 0 | 0 | 29 | 0 | 0 | 58 |
| 10 | 0 | 0 | .0 | 20 | 0 | 0 | 1,060 | 30 | 0 | 0 | 27 |
| | | | | | | | | 31 | 0 | 910 | ..... |

NOTE.—Discharge determined from a well-defined rating curve based on current-meter measurements made in 1916. Mean discharge for August, 29.4 second-feet (1,810 acre-feet); September, 205 second-feet (12,200 acre-feet).

### FRIO RIVER AT THREE RIVERS, TEX.

LOCATION.—At highway bridge, a quarter of a mile west of Three Rivers, Live Oak County, a quarter of a mile below mouth of Atascosa River, 1 mile above confluence of Nueces and Frio rivers.

DRAINAGE AREA.—7,310 square miles.

RECORDS AVAILABLE.—July 1 to November 16, 1915, when station was discontinued.

GAGE.—Vertical staff attached to piling and bridge pier under right end of highway bridge; datum lowered 2.50 feet October 8, 1915. Read once daily by J. B. Smith.

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

CHANNEL AND CONTROL.—Bed composed of sand and gravel; channel straight above and below station. Both banks high and wooded and not subject to overflow. Position of control not known. Stage-discharge relation greatly affected by backwater from Nueces River during medium and high stages in that stream.

EXTREMES OF STAGE.—Maximum stage during year probably reached August 28 and 29 (gage not read); maximum stage recorded, 19.2 feet at 7 a. m. October 19. No flow July 1 to August 4, August 7–23, September 10–16, and October 10–18.

WINTER FLOW.—Stage-discharge relation not affected by ice.

DIVERSIONS.—Water is diverted for irrigation in upper part of drainage basin, but diversions are not made immediately above station.

REGULATION.—None at this point.

COOPERATION.—Station established and records prior to September 1 collected by State Board of Water Engineers.

Daily discharge not determined.

*Discharge measurements of Frio River at Three Rivers, Tex., May 9, 1915, to Apr. 13, 1916.*

| Date. | Made by— | Gage height. | Discharge. | Date. | Made by— | Gage height. | Discharge. |
|---|---|---|---|---|---|---|---|
| 1915. | | *Feet.* | *Sec.-ft.* | 1916. | | *Feet.* | *Sec.-ft.* |
| May 9 | R. C. Thaxton | 2.14 | 159 | Jan. 6 | R. C. Thaxton | 2.35 | *a* 2.5 |
| Oct. 8 | do | 2.30 | 9.4 | Apr. 13 | William Kessler | 3.20 | 39.3 |
| Nov. 16 | Gray and Pierce | 2.33 | *a*.3 | | | | |

*a* Discharge estimated.

NOTE.—Gage datum lowered 2.50 feet on Oct. 8, 1915.

*Daily gage height, in feet, of Frio River at Three Rivers, Tex., for the period August to October, 1915.*

| Day. | Aug. | Sept. | Oct. | Day. | Aug. | Sept. | Oct. | Day. | Aug. | Sept. | Oct. |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | ..... | 8.9 | 4.2 | 11 | ..... | ..... | ..... | 21 | ..... | 5.1 | 8.6 |
| 2 | ..... | 7.8 | 3.9 | 12 | ..... | ..... | ..... | 22 | ..... | 9.2 | 5.6 |
| 3 | ..... | 7.1 | 3.7 | 13 | ..... | ..... | ..... | 23 | ..... | 11.2 | 4.3 |
| 4 | ..... | 5.4 | ..... | 14 | ..... | ..... | ..... | 24 | 5.8 | 8.9 | 3.7 |
| 5 | 3.2 | 4.3 | ..... | 15 | ..... | ..... | ..... | 25 | 4.9 | 8.1 | 3.6 |
| 6 | 3.0 | 3.7 | ..... | 16 | ..... | ..... | ..... | 26 | 7.6 | 6.6 | 3.4 |
| 7 | ..... | 9.2 | ..... | 17 | ..... | 6.7 | ..... | 27 | 8.6 | 5.3 | ..... |
| 8 | ..... | 5.8 | ..... | 18 | ..... | 6.5 | ..... | 28 | ..... | 4.3 | ..... |
| 9 | ..... | 3.4 | ..... | 19 | ..... | 5.8 | 19.2 | 29 | ..... | 4.1 | ..... |
| 10 | ..... | ..... | ..... | 20 | ..... | 5.4 | 10.1 | 30 | 6.5 | 3.7 | ..... |
| | | | | | | | | 31 | 6.1 | ..... | ..... |

NOTE.—No flow July 1 to Aug. 4, Aug. 7–23, Sept. 10–16, and Oct. 10–18. High water Aug. 28 and 29; gage not read. Oct. 4–6 flow was less than 25 second-feet; Oct. 7–9, less than 10 second-feet; Oct. 17–31, less than 20 second-feet; Nov. 1–16, very small flow.

### FRIO LAKE OUTLET NEAR FOWLERTON, TEX.

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

DRAINAGE AREA.—Not measured.

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

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

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

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

EXTREMES OF DISCHARGE.—Maximum stage recorded during year, 1.8 feet at 5.30 p. m. September 21 (discharge, 1,770 second-feet). No flow over dam July 1 to August 30, September 8–15, and September 17–19.

WINTER FLOW.—Stage-discharge relation not affected by ice.

DIVERSIONS.—Capacity of reservoir not known.

REGULATION.—Water diverted to this lake is controlled at intake on Frio River, some distance above; flow of Frio River probably not regulated above this diversion.

ACCURACY.—Results fair. Stage-discharge relation apparently permanent. Determinations subject to errors due to assumption that one daily gage reading represents the mean daily stage. Base data reliable.

COOPERATION.—Station established and records prior to September 1 collected by State Board of Water Engineers.

No discharge measurements were made during the year.

The station on Frio Lake outlet is maintained in conjunction with that on Frio River at Fowlerton to show the total run-off at that point.

*Daily discharge, in second-feet, of Frio Lake outlet near Fowlerton, Tex., for the year ending Sept. 30, 1915.*

| Day. | July. | Aug. | Sept. | Day. | July. | Aug. | Sept. | Day. | July. | Aug. | Sept. |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 0 | 0 | 530 | 11 | 0 | 0 | 0.0 | 21 | 0 | 0 | 1,770 |
| 2 | 0 | 0 | 66 | 12 | 0 | 0 | .0 | 22 | 0 | 0 | 660 |
| 3 | 0 | 0 | 41 | 13 | 0 | 0 | .0 | 23 | 0 | 0 | 210 |
| 4 | 0 | 0 | 26 | 14 | 0 | 0 | .0 | 24 | 0 | 0 | 145 |
| 5 | 0 | 0 | 11 | 15 | 0 | 0 | .0 | 25 | 0 | 0 | 145 |
| 6 | 0 | 0 | 7.5 | 16 | 0 | 0 | 4.0 | 26 | 0 | 0 | 145 |
| 7 | 0 | 0 | 4.0 | 17 | 0 | 0 | .0 | 27 | 0 | 0 | 178 |
| 8 | 0 | 0 | .0 | 18 | 0 | 0 | .0 | 28 | 0 | 0 | 90 |
| 9 | 0 | 0 | .0 | 19 | 0 | 0 | .0 | 29 | 0 | 0 | 66 |
| 10 | 0 | 0 | .0 | 20 | 0 | 0 | 800 | 30 | 0 | 0 | 41 |
| | | | | | | | | 31 | ..... | 420 | ..... |

NOTE.—Discharge determined from a well-defined rating curve based on current-meter measurements made in 1916. Mean discharge for August, 13.5 second-feet (830 acre-feet); September, 165 second-feet (9,820 acre-feet).

## RIO GRANDE BASIN.

### RIO GRANDE AT EMBUDO, N. MEX.

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

DRAINAGE AREA.—Approximately 10,100 square miles.

RECORDS AVAILABLE.—December 21, 1888, to December 31, 1903; September 8, 1912, to September 30, 1915.

GAGE.—Friez water-stage recorder on right bank. From January 1 to February 28, 1889, an inclined staff gage was maintained 1 mile above Embudo, but it was moved to a point 1,500 feet above the Santa Barbara Tie & Pole Co.'s bridge March 1, 1899, and used until December 31, 1903. The relation of these gages is unknown, but the datum remained unchanged from March 1, 1889, to December 31, 1903. A Friez water-stage recorder, referred to a new datum, was installed September 8, 1912, on the downstream side of the Santa Barbara Tie & Pole Co.'s bridge pier, and this gage was operated until June 20, 1914, when it was moved to the present site. The datum has remained unchanged since the station was reestablished in 1912. Observer, H. W. Wallace.

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

CHANNEL AND CONTROL.—Bed composed of rock, gravel, and sand; shifts at extremely high stages. Both banks high and not subject to overflow. Shoal just below gage serves as control.

EXTREMES OF DISCHARGE.—Maximum stage recorded during year, 8.5 feet May 19 (discharge, 10,000 second-feet); minimum stage recorded, 2.26 feet August 28 (discharge, 386 second-feet).

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

WINTER FLOW.—Stage-discharge relation not seriously affected by ice.

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

REGULATION.—Low-water flow slightly regulated by diversions for irrigation above station. No storage is used in connection with the mill operated at Glenwoody, and the flow at the station is not regulated from that plant.

ACCURACY.—Results good. Rating curve well defined. Stage-discharge relation not seriously affected by changes in control, and errors from that source are believed to be small.

COOPERATION.—Discharge measurements made in January, February, and on March 19 furnished by the State engineer of New Mexico.

*Discharge measurements of Rio Grande at Embudo, N. Mex., during the year ending Sept. 30, 1915.*

| Date. | Made by— | Gage height. | Discharge. | Date. | Made by— | Gage height. | Discharge. |
|---|---|---|---|---|---|---|---|
| | | *Feet.* | *Sec.-ft.* | | | *Feet.* | *Sec.-ft.* |
| Oct. 15 | J. E. Powers | 3.64 | 1,050 | Mar. 19 | R. S. Watrous | 3.00 | 674 |
| Nov. 11 | R. S. Watrous | 3.00 | 664 | 29 | W. R. King | 3.30 | 868 |
| Dec. 1 | do | 2.98 | 681 | 30 | do | 3.21 | 846 |
| 8 | J. E. Powers | 2.60 | 484 | Apr. 27 | do | 5.08 | 2,330 |
| 26 | R. S. Watrous | 2.52 | 469 | June 8 | do | 6.22 | 3,860 |
| Jan. 30 | do | 2.52 | 486 | Sept. 12 | do | 2.44 | 468 |
| Feb. 6 | do | 2.51 | 509 | | | | |

*Daily discharge, in second-feet, of Rio Grande at Embudo, N. Mex., for the year ending Sept. 30, 1915.*

| Day. | Oct. | Nov. | Dec. | Jan. | Feb. | Mar. | Apr. | May. | June. | July. | Aug. | Sept. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 1,170 | 866 | 674 | 459 | 473 | 599 | 838 | 3,860 | 3,620 | 2,100 | 2,250 | 447 |
| 2 | 1,140 | 873 | 645 | 468 | 477 | 627 | 833 | 3,700 | 4,210 | 1,900 | 1,880 | 428 |
| 3 | 1,120 | 853 | 610 | 473 | 492 | 627 | 910 | 3,160 | 5,310 | 1,730 | 1,590 | 404 |
| 4 | 1,340 | 813 | 610 | 468 | 487 | 604 | 877 | 2,660 | 6,560 | 1,560 | 1,340 | 428 |
| 5 | 1,210 | 781 | 588 | 477 | 473 | 582 | 928 | 2,370 | 6,370 | 1,420 | 1,120 | 475 |
| 6 | 1,650 | 774 | 572 | 459 | 468 | 572 | 994 | 2,150 | 5,400 | 1,340 | 952 | 455 |
| 7 | 2,200 | 768 | 525 | 459 | 482 | 604 | 1,070 | 1,940 | 4,480 | 1,200 | 850 | 430 |
| 8 | 1,980 | 737 | 492 | 451 | 492 | 604 | 1,170 | 1,780 | 3,970 | 1,080 | 816 | 421 |
| 9 | 1,750 | 712 | 546 | 451 | 510 | 610 | 1,080 | 1,670 | 3,690 | 994 | 740 | 421 |
| 10 | 1,600 | 668 | 468 | 464 | 506 | 599 | 1,160 | 1,610 | 3,610 | 916 | 670 | 447 |
| 11 | 1,490 | 656 | 446 | 446 | 535 | 627 | 1,170 | 1,720 | 3,880 | 850 | 655 | 459 |
| 12 | 1,390 | 650 | 425 | 446 | 530 | 594 | 1,300 | 2,120 | 4,280 | 772 | 632 | 447 |
| 13 | 1,260 | 645 | 401 | 468 | 520 | 627 | 1,370 | 2,990 | 5,220 | 725 | 600 | 435 |
| 14 | 1,150 | 656 | 434 | 459 | 510 | 627 | 1,420 | 4,430 | 5,840 | 690 | 568 | 447 |
| 15 | 1,060 | 680 | 413 | 459 | 515 | 627 | 1,560 | 6,070 | 5,260 | 660 | 531 | 467 |
| 16 | 961 | 680 | 401 | 468 | 530 | 650 | 1,780 | 8,180 | 4,300 | 600 | 539 | 495 |
| 17 | 900 | 686 | 459 | 455 | 561 | 656 | 2,010 | 8,840 | 3,670 | 573 | 523 | 515 |
| 18 | 819 | 699 | 492 | 413 | 582 | 656 | 2,020 | 9,900 | 3,580 | 535 | 499 | 547 |
| 19 | 781 | 656 | 487 | 464 | 588 | 693 | 2,050 | 10,000 | 3,920 | 511 | 483 | 560 |
| 20 | 639 | 616 | 496 | 482 | 582 | 699 | 1,990 | 8,080 | 4,540 | 491 | 467 | 564 |
| 21 | 610 | 604 | 464 | 477 | 582 | 656 | 2,110 | 5,660 | 5,080 | 503 | 451 | 564 |
| 22 | 705 | 604 | 468 | 482 | 588 | 627 | 2,290 | 4,260 | 5,330 | 463 | 447 | 539 |
| 23 | 627 | 604 | 477 | 451 | 566 | 662 | 2,290 | 3,540 | 5,220 | 515 | 421 | 523 |
| 24 | 582 | 610 | 492 | 442 | 577 | 712 | 2,330 | 3,200 | 4,780 | 495 | 455 | 503 |
| 25 | 588 | 604 | 487 | 455 | 604 | 730 | 2,260 | 3,230 | 4,410 | 569 | 443 | 471 |
| 26 | 712 | 604 | 473 | 468 | 594 | 793 | 2,160 | 3,610 | 4,080 | 547 | 428 | 467 |
| 27 | 793 | 627 | 482 | 455 | 616 | 806 | 2,300 | 4,020 | 3,560 | 591 | 400 | 435 |
| 28 | 873 | 639 | 492 | 459 | 604 | 826 | 2,640 | 3,920 | 3,060 | 622 | 386 | 410 |
| 29 | 860 | 662 | 496 | 473 | ..... | 853 | 3,090 | 3,520 | 2,730 | 2,340 | 645 | 428 |
| 30 | 866 | 668 | 473 | 487 | ..... | 844 | 3,600 | 3,290 | 2,440 | 3,270 | 483 | 675 |
| 31 | 853 | ..... | 459 | 477 | ..... | 855 | ..... | 3,370 | ..... | 2,760 | 463 | ..... |

NOTE.—Discharge determined as follows: Oct. 1–9 and Apr. 25 to Sept. 30 from a well-defined curve Oct. 10 to Apr. 24 by indirect method for shifting control.

*Monthly discharge of Rio Grande at Embudo, N. Mex., for the year ending Sept. 30, 1915.*

| Month. | Discharge in second-feet. | | | Run-off (total in acre-feet). | Accuracy. |
|---|---|---|---|---|---|
| | Maximum. | Minimum. | Mean. | | |
| October | 2,200 | 582 | 1,090 | 67,000 | B. |
| November | 873 | 604 | 690 | 41,100 | B. |
| December | 674 | 401 | 498 | 30,600 | B. |
| January | 487 | 413 | 462 | 28,400 | B. |
| February | 616 | 468 | 537 | 29,800 | B. |
| March | 855 | 572 | 672 | 41,300 | B. |
| April | 3,600 | 833 | 1,720 | 102,000 | B. |
| May | 10,000 | 1,610 | 4,160 | 256,000 | B. |
| June | 6,560 | 2,440 | 4,410 | 262,000 | B. |
| July | 3,270 | 463 | 1,070 | 65,800 | B. |
| August | 2,250 | 386 | 733 | 45,100 | B. |
| September | 675 | 404 | 477 | 28,400 | B. |
| The year | 10,000 | 386 | 1,380 | 998,000 | |

### RIO GRANDE NEAR BUCKMAN, N. MEX.[1]

LOCATION.—About sec. 18, T. 19 N., R. 8 E., at the Denver & Rio Grande Railroad bridge 2 miles below the Indian village of San Ildefonso, 4 miles above Buckman, in the northwestern part of Santa Fe County.

DRAINAGE AREA.—Not measured.

RECORDS AVAILABLE.—February 1, 1895, to December 31, 1905; June 22, 1909, to December 31, 1914, when station was discontinued.

GAGE.—Stevens water-stage recorder attached to downstream side of right bridge pier. An inclined staff gage for low-water readings and vertical staff gage for high-water readings were installed February 3, 1895, on left bank about 180 feet above railroad bridge. On March 30, 1904, this gage was replaced by a vertical staff attached to downstream side of north bridge pier and referred to a datum 2.02 feet higher than original datum. On October 29, 1904, a chain gage, referred to second gage datum, was installed on the downstream side of the railroad bridge. During 1904, owing to changes in channel, readings were made on old and new gages at irregular intervals. The chain gage was read during 1905. From June 22, 1909, to June, 1910, readings were made on the vertical staff gage attached to bridge pier. A Friez water-stage recorder was installed at the site of the vertical staff gage and referred to same datum in June, 1910, and was operated until April 16, 1911; May 4, 1911, it was replaced by a Barrett & Lawrence water-stage recorder. On October 13, 1914, a Stevens water-stage recorder was installed in place of the Barrett & Lawrence recorder at the same site. The datum has remained unchanged since 1904.

DISCHARGE MEASUREMENTS.—Made by wading or from cable 3 miles below gage. No diversions or important tributaries between the two points.

CHANNEL AND CONTROL.—Both banks high and not subject to overflow. Bed composed of sand and gravel; subject to change during low stages. Shoal about 500 feet below gage serves as a control.

EXTREMES OF DISCHARGE.—Maximum discharge during the year, 2,560 second-feet, October 5; minimum stage recorded, 2.95 feet December 13 and 14 (discharge, 428 second-feet).

1895–1905; 1909–1914: Maximum stage recorded, 11.4 feet May 23, 1912 (discharge, 23,800 second-feet); minimum stage recorded, 0.60 foot August 23 and 24, 1905 (discharge, 40 second-feet).

WINTER FLOW.—Stage-discharge relation not seriously affected by ice.

[1] In previous reports this station was designated as "near Rio Grande" and "at Watertank."

DIVERSIONS.—Between Embudo and this station the bottom lands in Espanola Valley are irrigated extensively, quantity of water diverted not known. Considerable water is also diverted from tributaries above station for irrigation of valley lands.

REGULATION.—The operation of mill at Glenwoody has no effect on the flow at the station. Flow is somewhat regulated by diversions for irrigation, especially during the summer.

ACCURACY.—Results good. Stage-discharge relation permanent during high and medium stages and changes in low-water channel have been determined by frequent current-meter measurements.

*Discharge measurements of Rio Grande near Buckman, N. Mex., during the year ending Sept. 30, 1915.*

| Date. | Made by— | Gage height. | Discharge. | Date. | Made by— | Gage height. | Discharge. |
|---|---|---|---|---|---|---|---|
| | | *Feet.* | *Sec.-ft.* | | | *Feet.* | *Sec.-ft.* |
| Oct. 13 | R. S. Watrous | 4.31 | 1,460 | Nov. 30 | Powers and Watrous | 3.55 | 809 |
| Nov. 17 | Powers and Hank | 3.60 | 914 | Dec. 30 | do | [a] 3.05 | 522 |

[a] Stage-discharge relation affected by ice.

*Daily discharge, in second-feet, of Rio Grande near Buckman, N. Mex., for the year ending Sept. 30, 1915.*

| Day. | Oct. | Nov. | Dec. | Day. | Oct. | Nov. | Dec. | Day. | Oct. | Nov. | Dec. |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 1,280 | 1,180 | 819 | 11 | 1,780 | 995 | 486 | 21 | 884 | 779 | 511 |
| 2 | 1,280 | 1,180 | 779 | 12 | 1,670 | 969 | 486 | 22 | 1,240 | 779 | 524 |
| 3 | 1,260 | 1,170 | 715 | 13 | 1,490 | 969 | 428 | 23 | 1,640 | 762 | 626 |
| 4 | 1,260 | 1,140 | 684 | 14 | 1,370 | 961 | 428 | 24 | 1,230 | 770 | 626 |
| 5 | 2,560 | 1,120 | 684 | 15 | 1,270 | 961 | 576 | 25 | 1,030 | 762 | 604 |
| 6 | 1,940 | 1,090 | 677 | 16 | 1,160 | 952 | 576 | 26 | 1,080 | 746 | 611 |
| 7 | 2,290 | 1,110 | 633 | 17 | 1,100 | 935 | 583 | 27 | 1,150 | 754 | 604 |
| 8 | 2,420 | 1,070 | 524 | 18 | 1,010 | 926 | 590 | 28 | 1,220 | 770 | 597 |
| 9 | 2,100 | 1,060 | 576 | 19 | 969 | 852 | 583 | 29 | 1,200 | 811 | 583 |
| 0 | 1,920 | 1,010 | 537 | 20 | 909 | 811 | 563 | 30 | 1,210 | 819 | 557 |
| | | | | | | | | 31 | 1,200 | ..... | 543 |

NOTE.—Discharge determined as follows: Oct. 1–4 and Oct. 13 to Dec. 31, by indirect method for shifting control; Oct. 5–12, estimated from records of nearby stations and climatic data.

*Monthly discharge of Rio Grande near Buckman, N. Mex., for the year ending Sept. 30, 1915.*

| Month. | Discharge in second-feet. | | | Run-off (total in acre-feet). | Accuracy. |
|---|---|---|---|---|---|
| | Maximum. | Minimum. | Mean. | | |
| October | 2,560 | 884 | 1,420 | 87,300 | C. |
| November | 1,180 | 746 | 940 | 55,900 | B. |
| December | 819 | 428 | 591 | 36,300 | B. |
| The period | ..... | ..... | ..... | 180,000 | |

### RIO GRANDE NEAR SAN MARCIAL, N. MEX.

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

DRAINAGE AREA.—Not measured.

RECORDS AVAILABLE.—January 29, 1895, to September 30, 1915.

GAGE.—Stage is measured from the bridge deck to the water surface with a graduated rod. An inclined staff gage established January 29, 1895, was carried away by a flood in 1896. A wire gage, referred to same datum, was established soon after this flood but was abandoned. Datum unchanged since station was established.

DISCHARGE MEASUREMENTS.—Made from downstream side of bridge.

CHANNEL AND CONTROL.—Bed composed of sand and gravel; no apparent control.

EXTREMES OF DISCHARGE.—Maximum stage recorded during year, 14.2 feet April 18 (discharge, 12,615 second-feet); minimum stage recorded, 8.6 feet September 16 (discharge, 5 second-feet).

1895–1915: Maximum stage recorded, 13.75 feet October 11, 1904 (discharge, 33,000 second-feet). The records show that there was no flow in the river during several extended periods since the station was established.

WINTER FLOW.—Stage-discharge relation not affected by ice.

DIVERSIONS.—Large areas of bottom lands below Embudo, especially in the vicinity of Albuquerque, are irrigated; quantity of water diverted not known.

REGULATION.—No controlling works above station that affect flow at this point.

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

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

*Discharge measurements of Rio Grande near San Marcial, N. Mex., during the year ending Sept. 30, 1915.*

[Made by George W. King.]

| Date. | Gage height. | Discharge. | Date. | Gage height. | Discharge. | Date. | Gage height. | Discharge. |
|---|---|---|---|---|---|---|---|---|
| | *Feet.* | *Sec.-ft.* | | *Feet.* | *Sec.-ft.* | | *Feet.* | *Sec.-ft.* |
| Oct. 1 | 11.4 | 830 | Feb. 5 | 11.8 | 652 | June 3 | 13.1 | 6,327 |
| 4 | 11.5 | 885 | 8 | 11.8 | 560 | 6 | 13.7 | 7,959 |
| 7 | 11.8 | 1,473 | 11 | 11.8 | 581 | 9 | 12.7 | 6,490 |
| 10 | 11.9 | 1,723 | 14 | 11.95 | 665 | 12 | 12.7 | 5,001 |
| 13 | 11.8 | 1,330 | 17 | 11.9 | 682 | 15 | 13.0 | 5,616 |
| 16 | 11.5 | 1,027 | 20 | 12.0 | 703 | 18 | 12.5 | 4,701 |
| 19 | 11.5 | 867 | 23 | 12.2 | 905 | 21 | 12.4 | 3,855 |
| 23 | 11.75 | 1,118 | 26 | 11.8 | 666 | 27 | 12.5 | 3,439 |
| 25 | 12.65 | 2,891 | Mar. 1 | 11.8 | 774 | 30 | 11.9 | 2,589 |
| 28 | 11.5 | 954 | 4 | 12.0 | 1,064 | July 3 | 11.6 | 2,002 |
| 31 | 11.75 | 1,133 | 7 | 11.8 | 832 | 6 | 11.3 | 1,375 |
| Nov. 3 | 11.7 | 869 | 10 | 11.65 | 635 | 9 | 11.1 | 822 |
| 6 | 11.65 | 896 | 13 | 11.65 | 628 | 12 | 10.9 | 476 |
| 9 | 11.7 | 810 | 16 | 11.8 | 674 | 15 | 10.8 | 332 |
| 12 | 11.65 | 757 | 19 | 11.85 | 759 | 18 | 10.4 | 156 |
| 15 | 11.7 | 646 | 22 | 12.0 | 1,039 | 21 | 11.2 | 812 |
| 18 | 11.65 | 672 | 25 | 11.7 | 603 | 23 | 11.9 | 2,475 |
| 21 | 11.7 | 738 | 28 | 12.2 | 1,222 | 26 | 13.2 | 5,620 |
| 24 | 11.65 | 593 | 31 | 12.4 | 1,734 | 29 | 11.9 | 4,139 |
| 27 | 11.75 | 553 | Apr. 3 | 12.0 | 1,353 | Aug. 1 | 11.7 | 2,687 |
| 30 | 11.7 | 601 | 7 | 12.4 | 1,966 | 4 | 11.1 | 1,722 |
| Dec. 3 | 11.7 | 686 | 10 | 12.8 | 3,846 | 7 | 11.1 | 1,393 |
| 6 | 11.7 | 619 | 13 | 12.7 | 3,287 | 10 | 11.0 | 1,119 |
| 9 | 11.75 | 592 | 16 | 13.1 | 3,954 | 13 | 10.6 | 604 |
| 12 | 11.75 | 528 | 19 | 13.7 | 9,430 | 16 | 10.6 | 516 |
| 15 | 11.7 | 562 | 22 | 12.8 | 6,372 | 19 | 10.2 | 233 |
| 18 | 11.55 | 409 | 25 | 13.1 | 6,593 | 22 | 9.7 | 97 |
| 22 | 12.0 | 1,149 | 28 | 12.9 | 4,767 | 25 | 9.8 | 107 |
| 25 | 11.8 | 1,002 | May 2 | 13.6 | 8,828 | 26 | 10.5 | 401 |
| 28 | 12.0 | 916 | 5 | 12.7 | 5,894 | 29 | 10.0 | 151 |
| 31 | 11.8 | 726 | 8 | 12.6 | 4,982 | 31 | 9.5 | 48 |
| Jan. 3 | 11.75 | 630 | 11 | 11.9 | 3,502 | Sept. 3 | 9.6 | 81 |
| 7 | 11.8 | 623 | 14 | 12.3 | 3,778 | 6 | 10.4 | 455 |
| 10 | 11.75 | 628 | 16 | 13.8 | 8,303 | 9 | 9.5 | 91 |
| 13 | 11.75 | 557 | 19 | 14.1 | 10,763 | 12 | 9.0 | 30 |
| 16 | 11.75 | 500 | 22 | 13.9 | 9,960 | 15 | 8.6 | 3 |
| 19 | 11.85 | 591 | 25 | 12.5 | 5,344 | 18 | 9.2 | 55 |
| 22 | 11.5 | 362 | 28 | 12.7 | 5,403 | 21 | 9.7 | 106 |
| 25 | 11.8 | 474 | 31 | 12.9 | 5,336 | 24 | 9.6 | 112 |
| 28 | 11.65 | 481 | | | | 27 | 11.7 | 1,921 |
| 31 | 12.3 | 1,086 | | | | 30 | 10.1 | 409 |

*Daily discharge, in second-feet, of Rio Grande near San Marcial, N. Mex., for the year ending Sept. 30, 1915.*

| Day. | Oct. | Nov. | Dec. | Jan. | Feb. | Mar. | Apr. | May. | June. | July. | Aug. | Sept. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 830 | 880 | 540 | 645 | 910 | 775 | 1,735 | 7,375 | 5,435 | 2,395 | 2,685 | 40 |
| 2 | 760 | 825 | 550 | 560 | 780 | 735 | 1,735 | 8,830 | 6,580 | 2,195 | 2,525 | 20 |
| 3 | 725 | 870 | 635 | 630 | 740 | 815 | 1,405 | 9,480 | 6,150 | 2,195 | 1,720 | 100 |
| 4 | 905 | 905 | 555 | 535 | 870 | 1,005 | 1,305 | 6,710 | 7,825 | 1,690 | 1,720 | 295 |
| 5 | 1,430 | 935 | 625 | 515 | 695 | 950 | 1,260 | 5,730 | 8,095 | 1,375 | 1,775 | 765 |
| 6 | 1,475 | 895 | 620 | 495 | 620 | 890 | 1,305 | 4,755 | 7,960 | 1,375 | 1,660 | 340 |
| 7 | 1,475 | 845 | 520 | 550 | 590 | 830 | 1,965 | 4,370 | 7,810 | 1,375 | 1,395 | 295 |
| 8 | 1,575 | 715 | 555 | 500 | 560 | 830 | 4,080 | 4,985 | 7,075 | 960 | 945 | 175 |
| 9 | 1,725 | 810 | 590 | 450 | 525 | 830 | 3,375 | 4,245 | 6,490 | 685 | 945 | 90 |
| 10 | 1,675 | 760 | 570 | 630 | 495 | 635 | 3,845 | 4,035 | 6,205 | 475 | 1,160 | 80 |
| 11 | 1,575 | 865 | 475 | 470 | 580 | 895 | 3,760 | 3,505 | 5,820 | 220 | 860 | 60 |
| 12 | 1,530 | 760 | 530 | 580 | 570 | 825 | 2,775 | 3,500 | 5,130 | 475 | 730 | 35 |
| 13 | 1,330 | 770 | 425 | 420 | 515 | 630 | 3,285 | 3,630 | 5,225 | 335 | 605 | 25 |
| 14 | 1,280 | 635 | 530 | 540 | 665 | 545 | 2,700 | 3,855 | 5,615 | 190 | 465 | 15 |
| 15 | 1,280 | 645 | 495 | 520 | 645 | 510 | 3,285 | 6,950 | 5,520 | 330 | 435 | 10 |
| 16 | 1,075 | 680 | 510 | 500 | 630 | 625 | 3,870 | 8,160 | 5,800 | 285 | 515 | 5 |
| 17 | 1,035 | 790 | 460 | 545 | 680 | 590 | 5,880 | 9,450 | 5,160 | 240 | 445 | 20 |
| 18 | 980 | 670 | 410 | 590 | 640 | 505 | 12,615 | 8,970 | 4,520 | 155 | 335 | 65 |
| 19 | 865 | 740 | 410 | 590 | 655 | 675 | 9,445 | 9,790 | 4,085 | 110 | 195 | 45 |
| 20 | 715 | 740 | 575 | 560 | 705 | 1,040 | 9,770 | 9,760 | 3,670 | 70 | 165 | 95 |
| 21 | 715 | 740 | 735 | 430 | 600 | 945 | 7,900 | 10,360 | 3,955 | 700 | 125 | 95 |
| 22 | 865 | 715 | 1,150 | 360 | 1,005 | 1,040 | 6,370 | 9,760 | 4,385 | 1,045 | 100 | 75 |
| 23 | 1,120 | 690 | 975 | 400 | 905 | 965 | 6,605 | 6,660 | 3,940 | 2,375 | 85 | 90 |
| 24 | 2,105 | 595 | 950 | 470 | 815 | 1,040 | 6,680 | 5,835 | 4,025 | 920 | 75 | 110 |
| 25 | 2,605 | 605 | 1,000 | 475 | 725 | 750 | 6,615 | 5,345 | 3,805 | 5,415 | 300 | 1,090 |
| 26 | 1,930 | 540 | 795 | 595 | 665 | 480 | 4,550 | 5,190 | 3,735 | 5,620 | 335 | 540 |
| 27 | 1,370 | 555 | 970 | 640 | 700 | 665 | 4,260 | 5,560 | 3,665 | 8,995 | 400 | 2,075 |
| 28 | 910 | 520 | 840 | 520 | 680 | 1,285 | 4,970 | 5,405 | 3,300 | 8,715 | 250 | 1,170 |
| 29 | 1,025 | 485 | 775 | 480 | ..... | 1,445 | 4,185 | 5,465 | 2,730 | 4,140 | 175 | 745 |
| 30 | 1,060 | 600 | 680 | 620 | ..... | 1,365 | 5,345 | 5,525 | 2,590 | 3,240 | 100 | 465 |
| 31 | 1,135 | ..... | 725 | 945 | ..... | 1,735 | ..... | 5,335 | ..... | 2,140 | 55 | ..... |

NOTE.—See also list of discharge measurements.

*Monthly discharge of Rio Grande near San Marcial, N. Mex., for the year ending Sept. 30, 1915.*

| Month. | Discharge in second-feet. | | | Run-off (total in acre-feet). |
|---|---|---|---|---|
| | Maximum. | Minimum. | Mean. | |
| October | 2,605 | 715 | 1,261 | 77,515 |
| November | 935 | 520 | 726 | 43,206 |
| December | 1,150 | 410 | 651 | 40,017 |
| January | 945 | 360 | 541 | 33,243 |
| February | 1,005 | 495 | 684 | 38,013 |
| March | 1,735 | 480 | 866 | 53,163 |
| April | 12,615 | 1,260 | 4,562 | 271,487 |
| May | 10,360 | 3,500 | 6,404 | 393,774 |
| June | 8,095 | 2,590 | 5,210 | 309,493 |
| July | 8,995 | 70 | 1,950 | 119,871 |
| August | 2,685 | 55 | 751 | 46,175 |
| September | 2,075 | 5 | 301 | 17,911 |
| The year | 12,615 | 5 | 1,998 | 1,443,868 |

### RIO GRANDE NEAR EL PASO, TEX.

LOCATION.—At Courchesne's limekiln, 1 mile upstream from pumping house of the Smelter Co., 3 miles north of El Paso, in El Paso County.

DRAINAGE AREA.—Not measured.

RECORDS AVAILABLE.—May 10, 1889, to June 30, 1893, for station at old Fort Bliss, about 1,500 feet above the Mexican dam; January 25, 1895, to May 1, 1897, for station at pumping house of the Smelter Co.; May 1, 1897, to June 8, 1915, for present site.

GAGE.—A number of inclined gages have been used, located at slightly different points but referred to same datum. Gage at original site a vertical staff.

DISCHARGE MEASUREMENTS.—Made from cable.

CHANNEL AND CONTROL.—Extremely shifting; banks subject to overflow.

EXTREMES OF DISCHARGE.—Maximum stage recorded during period October 1, 1914, to June 8, 1915, 12.0 feet June 8 (discharge, about 5,000 second-feet); minimum stage recorded, 7.9 feet March 19 (discharge, 65 second-feet).

1889–1893, 1895–1915: Maximum mean daily discharge, 23,680 second-feet, June 12, 1905. River reported dry nearly every year.

WINTER FLOW.—Stage-discharge relation not affected by ice.

DIVERSIONS.—Many small diversions above station. The United States Reclamation Service has constructed a reservoir at Elephant Butte, N. Mex., to store water to be used in irrigating land in the Rio Grande Valley and storage of water was begun in March, 1915. The capacity of this reservoir is 2,627,700 acre-feet. The entire project was dedicated in October, 1916.

ACCURACY.—Owing to the shifting channel, determinations of discharge are based almost entirely on current-meter measurements made very frequently.

COOPERATION.—From May 1, 1897, to March 31, 1914, station maintained and records furnished by United States section of the International Water Commission; since August 1, 1914, by Commission for the Equitable Distribution of the Waters of the Rio Grande.

*Discharge measurements of Rio Grande near El Paso, Tex., during the year ending Sept. 30, 1915.*

| Date. | Made by— | Gage height. | Discharge. | Date. | Made by— | Gage height. | Discharge. |
|---|---|---|---|---|---|---|---|
| | | *Feet.* | *Sec.-ft.* | | | *Feet.* | *Sec.-ft.* |
| Oct. 3 | W. C. Stewart | 8.75 | 401 | Feb. 8 | W. C. Stewart | 9.8 | 1,203 |
| 6 | do | 8.85 | 532 | 11 | do | 9.5 | 844 |
| 9 | do | 9.9 | 1,631 | 15 | do | 9.3 | 680 |
| 13 | do | 9.75 | 1,431 | 18 | do | 8.6 | 182 |
| 16 | do | 9.3 | 1,025 | 22 | do | 8.5 | 157 |
| 20 | do | 9.15 | 817 | 26 | do | 8.9 | 536 |
| 23 | do | 8.9 | 622 | Mar. 3 | do | 9.8 | 1,027 |
| 26 | do | 9.7 | 1,321 | 6 | do | 8.85 | 249 |
| 29 | do | 9.7 | 1,543 | 10 | do | 9.5 | 812 |
| 31 | do | 9.25 | 1,015 | 13 | do | 8.65 | 209 |
| Nov. 4 | E. E. Winter | 9.45 | 982 | 18 | do | 7.95 | 73 |
| 8 | W. C. Stewart | 9.3 | 914 | 22 | do | 8.15 | 112 |
| 12 | do | 9.4 | 909 | 25 | do | 8.5 | 168 |
| 16 | do | 9.2 | 779 | 28 | do | 8.35 | 229 |
| 19 | do | 9.15 | 710 | 31 | do | 9.25 | 709 |
| 23 | do | 9.3 | 819 | Apr. 5 | do | 9.25 | 565 |
| 27 | do | 9.2 | 768 | 9 | do | 9.25 | 559 |
| 30 | do | 9.1 | 748 | 12 | do | 9.15 | 478 |
| Dec. 3 | do | 9.3 | 836 | 17 | do | 8.9 | 251 |
| 7 | do | 9.4 | 883 | 21 | do | 9.1 | 413 |
| 10 | do | 9.1 | 691 | 24 | W. L. Follett | 9.45 | 735 |
| 14 | do | 9.2 | 704 | 27 | W. C. Stewart | 10.1 | 1,495 |
| 17 | do | 9.5 | 920 | 30 | do | 10.0 | 1,438 |
| 22 | do | 9.4 | 861 | May 5 | do | 10.7 | 2,618 |
| 26 | do | 10.1 | 1,909 | 8 | do | 8.8 | 456 |
| 29 | do | 9.55 | 1,251 | 11 | do | 10.65 | 2,328 |
| Jan. 6 | W. L. Follett | 9.2 | 638 | 15 | do | 9.3 | 905 |
| 11 | L. C. Gilliam | 8.35 | 174 | 18 | do | 10.8 | 2,545 |
| 14 | W. L. Follett | 9.3 | 716 | 22 | do | 11.45 | 3,608 |
| 18 | L. C. Gilliam | 9.2 | [a] 446 | 25 | do | 11.45 | 3,674 |
| 22 | W. C. Stewart | 9.0 | 658 | 28 | do | 11.3 | 3,518 |
| 25 | do | 9.3 | 784 | 31 | do | 11.5 | 3,632 |
| 28 | do | 8.75 | 375 | June 4 | do | 9.0 | 763 |
| Feb. 1 | do | 9.45 | 902 | 7 | do | 11.5 | 3,603 |
| 4 | do | 8.8 | 344 | | | | |

[a] Probably erroneous; not used in determining daily discharge.

*Daily discharge, in second-feet, of Rio Grande near El Paso, Tex., for the year ending Sept. 30, 1915.*

| Day. | Oct. | Nov. | Dec. | Jan. | Feb. | Mar. | Apr. | May. | June. |
|---|---|---|---|---|---|---|---|---|---|
| 1 | 510 | 905 | 750 | 1,040 | 900 | 885 | 730 | 1,690 | 3,530 |
| 2 | 470 | 1,050 | 815 | 1,000 | 1,030 | 930 | 675 | 2,450 | 3,580 |
| 3 | 400 | 1,190 | 835 | 960 | 730 | 1,000 | 595 | 1,690 | 3,410 |
| 4 | 420 | 980 | 860 | 920 | 300 | 780 | 570 | 2,710 | 590 |
| 5 | 580 | 915 | 720 | 780 | 260 | 410 | 515 | 2,450 | 2,990 |
| 6 | 530 | 915 | 885 | 640 | 815 | 250 | 540 | 1,650 | 3,390 |
| 7 | 1,630 | 915 | 885 | 640 | 1,160 | 335 | 540 | 680 | 3,730 |
| 8 | 1,840 | 915 | 885 | 500 | 1,200 | 380 | 540 | 625 | 4,190 |
| 9 | 1,950 | 935 | 820 | 310 | 1,140 | 725 | 560 | 770 | ..... |
| 10 | 1,330 | 925 | 690 | 175 | 1,020 | 640 | 440 | 1,550 | ..... |
| 11 | 1,130 | 915 | 705 | 175 | 845 | 455 | 440 | 2,280 | ..... |
| 12 | 1,260 | 910 | 705 | 145 | 680 | 350 | 480 | 1,890 | ..... |
| 13 | 1,430 | 935 | 710 | 660 | 515 | 175 | 435 | 530 | ..... |
| 14 | 1,340 | 885 | 705 | 715 | 435 | 160 | 345 | 1,070 | ..... |
| 15 | 1,250 | 790 | 705 | 695 | 680 | 130 | 390 | 965 | ..... |
| 16 | 1,120 | 780 | 705 | 695 | 540 | 100 | 210 | 1,230 | ..... |
| 17 | 1,040 | 765 | 920 | 680 | 290 | 85 | 250 | 1,230 | ..... |
| 18 | 1,020 | 725 | 745 | 685 | 150 | 75 | 170 | 2,540 | ..... |
| 19 | 1,000 | 710 | 745 | 675 | 130 | 65 | 695 | 2,440 | ..... |
| 20 | 820 | 710 | 890 | 675 | 130 | 75 | 455 | 2,480 | ..... |
| 21 | 820 | 785 | 860 | 660 | 155 | 115 | 415 | 3,120 | ..... |
| 22 | 660 | 785 | 860 | 660 | 155 | 135 | 415 | 3,610 | ..... |
| 23 | 660 | 820 | 2,290 | 615 | 145 | 175 | 415 | 3,610 | ..... |
| 24 | 620 | 845 | 3,410 | 615 | 130 | 185 | 735 | 3,740 | ..... |
| 25 | 620 | 870 | 2,585 | 740 | 495 | 170 | 970 | 3,670 | ..... |
| 26 | 1,320 | 820 | 1,835 | 560 | 535 | 190 | 675 | 3,670 | ..... |
| 27 | 2,820 | 760 | 1,550 | 560 | 745 | 210 | 1,500 | 3,570 | ..... |
| 28 | 2,040 | 750 | 1,310 | 375 | 835 | 250 | 1,380 | 3,520 | ..... |
| 29 | 1,490 | 750 | 1,250 | 410 | ..... | 440 | 1,490 | 3,550 | ..... |
| 30 | 1,130 | 750 | 1,250 | 825 | ..... | 600 | 1,470 | 3,600 | ..... |
| 31 | 1,070 | ..... | 1,130 | 1,010 | ..... | 710 | ..... | 3,630 | ..... |

NOTE.—See also table of discharge measurements.

*Monthly discharge of Rio Grande near El Paso, Tex., for the year ending Sept. 30, 1915.*

| Month. | Discharge in second-feet. | | | Run-off (total in acre-feet). |
|---|---|---|---|---|
| | Maximum. | Minimum. | Mean. | |
| October | 2,820 | 400 | 1,107 | 68,073 |
| November | 1,190 | 710 | 857 | 50,985 |
| December | 3,410 | 690 | 1,097 | 67,458 |
| January | 1,040 | 145 | 639 | 39,263 |
| February | 1,200 | 130 | 577 | 32,023 |
| March | 1,000 | 65 | 361 | 22,185 |
| April | 1,500 | 170 | 635 | 37,765 |
| May | 3,740 | 530 | 2,329 | 143,226 |
| June 1–8 | 4,190 | 590 | 3,176 | 50,435 |
| The period | ..... | ..... | ..... | 511,413 |

### RIO GRANDE BELOW PRESIDIO, TEX.

LOCATION.—At the west end of the canyon section of the Rio Grande, 6 miles below Presidio, in Presidio County, and 7 miles below mouth of Rio Conchos.

DRAINAGE AREA.—Not measured.

RECORDS AVAILABLE.—May 1, 1900, to July 31, 1915.

GAGE.—Inclined staff in main channel and vertical staff at the gravel hills to measure overflow.

DISCHARGE MEASUREMENTS.—Made in main channel from cable and in overflow section from boat.

CHANNEL AND CONTROL.—Shifting sand. An intermittent stream, called Alamito Creek, which reaches the river a quarter of a mile below station, is subject to torrential floods which bring into the Rio Grande large quantities of boulders and gravel. The material forms a temporary dam that remains and causes backwater at the gage until it is scoured out by a flood in the river. At gage height 13 feet the water overflows the banks and spreads to the gravel hills, reaching an extreme width of 750 feet.

EXTREMES OF DISCHARGE.—Maximum stage recorded October 1, 1914, to July 31, 1915, 12.1 feet October 1 (discharge about 6,000 feet); minimum stage recorded, 7.2 feet April 26–28 (discharge, 65 second-feet).

1900–1915: Maximum stage recorded, 26.35 feet September 11, 1904 (discharge, 149,200 second-feet); minimum mean daily discharge May 4–14, 1904, 5 second-feet.

Below the mouth of the Rio Conchos the Rio Grande is subject to severe floods from that tributary. On September 11, 1904, the discharge above the Rio Conchos was only 2,600 second-feet.

DIVERSIONS.—No data.

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

COOPERATION.—Station maintained and records furnished by United States section of the International Water Commission until March 31, 1914; after August 10, 1914, by Commission for the Equitable Distribution of the Waters of the Rio Grande.

*Discharge measurements of Rio Grande below Presidio, Tex., during the year ending Sept. 30, 1915.*

[Made by W. T. Millington.]

| Date. | Gage height. | Discharge. | Date. | Gage height. | Discharge. | Date. | Gage height. | Discharge. |
|---|---|---|---|---|---|---|---|---|
| | *Feet.* | *Sec.-ft.* | | *Feet.* | *Sec.-ft.* | | *Feet.* | *Sec.-ft.* |
| Oct. 4 | 12.0 | 5,557 | Jan. 13 | 8.9 | 562 | Apr. 24 | 7.3 | 71 |
| 7 | 11.15 | 3,551 | 16 | 8.9 | 561 | 27 | 7.2 | 67 |
| 10 | 10.75 | 3,038 | 19 | 8.9 | 674 | 30 | 8.0 | 166 |
| 13 | 10.7 | 3,005 | 22 | 8.9 | 795 | May 4 | 7.7 | 98 |
| 16 | 10.4 | 2,730 | 25 | 8.9 | 684 | 7 | 8.6 | 304 |
| 19 | 10.0 | 2,366 | 28 | 8.85 | 651 | 10 | 8.6 | 316 |
| 22 | 10.15 | 2,409 | 31 | 8.7 | 559 | 13 | 8.1 | 189 |
| 25 | 10.1 | 2,284 | Feb. 4 | 8.55 | 416 | 16 | 8.7 | 315 |
| 28 | 9.6 | 1,792 | 7 | 8.6 | 421 | 19 | 8.0 | 196 |
| 31 | 9.4 | 1,551 | 10 | 8.6 | 428 | 22 | 8.6 | 307 |
| Nov. 3 | 9.6 | 1,592 | 13 | 8.9 | 569 | 25 | 8.8 | 679 |
| 6 | 9.6 | 1,621 | 16 | 8.8 | 524 | 28 | 9.55 | 1,130 |
| 9 | 9.5 | 1,404 | 19 | 8.7 | 514 | 31 | 9.8 | 1,329 |
| 12 | 9.3 | 1,052 | 22 | 8.6 | 495 | June 3 | 9.7 | 996 |
| 15 | 9.5 | 1,235 | 25 | 8.6 | 463 | 6 | 9.7 | 997 |
| 18 | 9.5 | 1,071 | 28 | 8.55 | 436 | 9 | 10.8 | 2,143 |
| 21 | 9.4 | 943 | Mar. 4 | 8.5 | 445 | 12 | 9.7 | 1,279 |
| 24 | 9.3 | 849 | 7 | 8.5 | 476 | 15 | 9.8 | 1,678 |
| 27 | 9.4 | 943 | 10 | 8.3 | 395 | 18 | 9.8 | 1,641 |
| 30 | 9.1 | 807 | 13 | 8.2 | 375 | 21 | 9.9 | 1,628 |
| Dec. 4 | 9.0 | 746 | 16 | 8.5 | 413 | 24 | 9.7 | 1,490 |
| 7 | 8.9 | 621 | 19 | 8.2 | 252 | 27 | 9.85 | 1,733 |
| 10 | 8.9 | 592 | 22 | 8.1 | 220 | 30 | 8.6 | 672 |
| 13 | 8.9 | 564 | 25 | 7.9 | 168 | July 4 | 9.1 | 1,647 |
| 16 | 8.9 | 563 | 28 | 7.75 | 144 | 7 | 9.9 | 1,824 |
| 19 | 8.8 | 566 | 31 | 7.6 | 135 | 10 | 8.6 | 762 |
| 22 | 8.8 | 579 | Apr. 3 | 7.5 | 111 | 13 | 8.0 | 522 |
| 26 | 8.8 | 570 | 6 | 7.5 | 109 | 16 | 7.9 | 415 |
| 28 | 9.9 | 1,204 | 9 | 7.4 | 92 | 19 | 8.0 | 517 |
| 31 | 9.5 | 957 | 12 | 7.5 | 110 | 22 | 7.85 | 501 |
| Jan. 4 | 9.2 | 681 | 15 | 7.4 | 85 | 25 | 7.5 | 321 |
| 7 | 9.1 | 619 | 18 | 7.4 | 86 | 28 | 7.5 | 269 |
| 10 | 9.0 | 597 | 21 | 7.3 | 77 | 31 | 8.4 | 699 |

*Daily discharge, in second-feet, of Rio Grande below Presidio, Tex., for the year ending Sept. 30, 1915.*

| Day. | Oct. | Nov. | Dec. | Jan. | Feb. | Mar. | Apr. | May. | June. | July. |
|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 5,900 | 2,100 | 810 | 820 | 510 | 430 | 135 | 225 | 1,270 | 670 |
| 2 | 5,720 | 1,810 | 810 | 545 | 465 | 435 | 135 | 155 | 1,060 | 670 |
| 3 | 5,640 | 1,590 | 745 | 590 | 465 | 440 | 110 | 120 | 995 | 670 |
| 4 | 5,560 | 1,740 | 745 | 680 | 415 | 445 | 110 | 100 | 995 | 1,660 |
| 5 | 5,320 | 2,940 | 745 | 680 | 415 | 455 | 110 | 100 | 995 | 1,670 |
| 6 | 4,500 | 1,620 | 620 | 620 | 435 | 465 | 110 | 165 | 945 | 1,680 |
| 7 | 3,550 | 1,840 | 620 | 620 | 420 | 475 | 110 | 305 | 895 | 1,800 |
| 8 | 3,300 | 1,620 | 610 | 610 | 425 | 435 | 90 | 280 | 1,050 | 1,460 |
| 9 | 3,170 | 1,400 | 600 | 595 | 425 | 435 | 90 | 335 | 1,930 | 840 |
| 10 | 3,040 | 1,230 | 590 | 595 | 430 | 395 | 90 | 315 | 1,350 | 715 |
| 11 | 3,000 | 1,140 | 580 | 595 | 405 | 385 | 100 | 230 | 1,200 | 680 |
| 12 | 2,970 | 1,140 | 570 | 580 | 555 | 375 | 110 | 205 | 1,280 | 620 |
| 13 | 2,970 | 1,330 | 560 | 560 | 570 | 375 | 85 | 190 | 1,550 | 520 |
| 14 | 2,680 | 1,230 | 530 | 560 | 545 | 380 | 85 | 145 | 1,710 | 580 |
| 15 | 2,730 | 1,230 | 500 | 560 | 525 | 415 | 85 | 220 | 1,680 | 485 |
| 16 | 2,730 | 1,180 | 560 | 560 | 525 | 405 | 70 | 305 | 1,740 | 415 |
| 17 | 2,640 | 1,130 | 550 | 600 | 515 | 330 | 85 | 240 | 1,500 | 430 |
| 18 | 2,410 | 1,070 | 540 | 635 | 515 | 305 | 85 | 205 | 1,640 | 550 |
| 19 | 2,370 | 1,050 | 570 | 675 | 510 | 250 | 75 | 195 | 1,610 | 515 |
| 20 | 2,020 | 960 | 570 | 715 | 500 | 220 | 75 | 195 | 1,650 | 510 |
| 21 | 3,420 | 945 | 575 | 755 | 500 | 220 | 75 | 215 | 1,630 | 485 |
| 22 | 2,410 | 945 | 580 | 795 | 495 | 205 | 75 | 315 | 1,560 | 495 |
| 23 | 2,430 | 850 | 575 | 760 | 485 | 170 | 75 | 445 | 1,560 | 805 |
| 24 | 2,220 | 895 | 575 | 720 | 475 | 170 | 70 | 535 | 1,520 | 500 |
| 25 | 2,240 | 945 | 570 | 685 | 465 | 170 | 70 | 700 | 1,670 | 295 |
| 26 | 1,990 | 1,130 | 570 | 685 | 455 | 150 | 65 | 800 | 1,650 | 220 |
| 27 | 1,840 | 895 | 890 | 685 | 450 | 150 | 65 | 1,010 | 1,730 | 170 |
| 28 | 1,700 | 855 | 1,240 | 650 | 435 | 145 | 65 | 1,130 | 1,350 | 320 |
| 29 | 1,610 | 830 | 1,230 | 620 | ..... | 135 | 170 | 1,250 | 885 | 1,015 |
| 30 | 1,500 | 805 | 1,050 | 610 | ..... | 135 | 165 | 1,250 | 670 | 870 |
| 31 | 1,630 | ..... | 930 | 560 | ..... | 135 | ..... | 1,330 | ..... | 675 |

NOTE.—See also table of discharge measurements.

*Monthly discharge of Rio Grande below Presidio, Tex., for the year ending Sept. 30, 1915.*

| Month. | Discharge in second-feet. | | | Run-off (total in acre-feet). |
|---|---|---|---|---|
| | Maximum. | Minimum. | Mean. | |
| October | 5,900 | 1,500 | 3,071 | 188,846 |
| November | 2,940 | 805 | 1,281 | 76,255 |
| December | 1,240 | 500 | 684 | 42,069 |
| January | 820 | 545 | 643 | 39,511 |
| February | 570 | 405 | 476 | 26,440 |
| March | 475 | 135 | 311 | 19,111 |
| April | 170 | 65 | 95 | 5,633 |
| May | 1,330 | 100 | 426 | 26,202 |
| June | 1,930 | 670 | 1,376 | 81,858 |
| July | 1,800 | 170 | 742 | 45,600 |
| The period | ..... | ..... | ..... | 552,000 |

### RIO GRANDE NEAR LANGTRY, TEX.

LOCATION.—At east end of canyon, half a mile south of Langtry, in Valverde County, and a few miles above the mouth of Pecos River.

DRAINAGE AREA.—Not measured.

RECORDS AVAILABLE.—May 1, 1900, to October 15, 1914.

GAGE.—Vertical staff.

DISCHARGE MEASUREMENTS.—Made from cable.

CHANNEL AND CONTROL.—Very shifting. At stage of 29.5 feet banks are subject to overflow which extends 110 feet back of the main bank.

EXTREMES OF DISCHARGE.—1900–1914: Maximum stage recorded, 34.25 feet (daily mean) September 13, 1904 (discharge, 132,000 second-feet); minimum mean daily discharge, 285 second-feet May 2, 3, 1902.

DIVERSIONS.—No data.

ACCURACY.—Owing to shifting of channel and control, the determinations of daily discharge are based almost directly on frequent current-meter measurements.

COOPERATION.—Station maintained and records furnished by United States section of the International Water Commission until March 31, 1914; after August 10, 1914, by Commission for the Equitable Distribution of the Waters of the Rio Grande.

*Discharge measurements of Rio Grande near Langtry, Tex., during the year ending Sept. 30, 1915.*

[Made by W. H. Dodd.]

| Date. | Gage height. | Discharge. | Date. | Gage height. | Discharge. |
|---|---|---|---|---|---|
| | *Feet.* | *Sec.-ft.* | | *Feet.* | *Sec.-ft.* |
| Oct. 5 | 4.3 | 7,187 | Oct. 12 | 2.9 | 4,153 |
| 8 | 3.5 | 5,394 | 15 | 2.5 | 3,528 |

*Daily discharge, in second-feet, of Rio Grande near Langtry, Tex., for the year ending Sept. 30, 1915.*

| Day. | Oct. | Day. | Oct. | Day. | Oct. |
|---|---|---|---|---|---|
| 1 | 9,290 | 6 | 6,070 | 11 | 4,250 |
| 2 | 8,840 | 7 | 5,620 | 12 | 4,150 |
| 3 | 8,090 | 8 | 5,390 | 13 | 3,920 |
| 4 | 7,790 | 9 | 5,080 | 14 | 3,690 |
| 5 | 6,890 | 10 | 4,770 | 15 | 3,530 |

NOTE.—Mean discharge Oct. 1–15, 5,825 second-feet; run-off, 173,300 acre-feet.

### RIO GRANDE NEAR DEVILS RIVER, TEX.

LOCATION.—One mile below mouth of Devils River and Devils River railway station, in Valverde County.

DRAINAGE AREA.—Not measured.

RECORDS AVAILABLE.—May 1, 1900, to April 30, 1915.

GAGE.—Inclined staff.

DISCHARGE MEASUREMENTS.—Made from cable.

CHANNEL AND CONTROL.—Shifting greatly; banks subject to overflow for a distance of 500 feet.

EXTREMES OF DISCHARGE.—Maximum stage recorded October 1, 1914, to April 30, 1915, 13.0 feet April 22 (discharge, 20,510 second-feet); mimimum stage recorded, 4.0 feet April 11 (discharge, 2,670 second-feet).

1900–1915: Maximum stage recorded, 36.5 feet April 6, 1900 (discharge not determined); 26.75 feet (daily mean) September 14, 1904 (discharge, 138,800 second-feet); minimum daily mean discharge, 1,120 second-feet May 12, 1904.

DIVERSIONS.—No data.

ACCURACY.—Owing to shifting of channel and control, determinations of daily discharge are based almost directly on frequent current-meter measurements.

COOPERATION.—Station maintained and records furnished by United States section of the International Water Commission until March 31, 1914; after August 10, 1914, by Commission for the Equitable Distribution of the Waters of the Rio Grande.

*Discharge measurements of Rio Grande near Devils River, Tex., during the year ending Sept. 30, 1915.*

[Made by G. H. Mansfield.]

| Date. | Gage height. | Discharge. | Date. | Gage height. | Discharge. | Date. | Gage height. | Discharge. |
|---|---|---|---|---|---|---|---|---|
| | *Feet.* | *Sec.-ft.* | | *Feet.* | *Sec.-ft.* | | *Feet.* | *Sec.-ft.* |
| Nov. 6 | 5.7 | 7,672 | Jan. 5 | 4.9 | 5,323 | Mar. 6 | 4.2 | 3,117 |
| 9 | 5.4 | 6,553 | 9 | 4.8 | 5,249 | 9 | 4.2 | 2,980 |
| 13 | 5.1 | 5,398 | 12 | 4.7 | 4,734 | 12 | 4.2 | 2,972 |
| 16 | 5.0 | 5,053 | 16 | 4.6 | 4,510 | 15 | 4.1 | 2,812 |
| 19 | 5.0 | 5,062 | 19 | 4.5 | 4,385 | 18 | 4.1 | 2,809 |
| 24 | 5.0 | 4,898 | 23 | 4.5 | 4,261 | 22 | 4.1 | 2,812 |
| 27 | 5.2 | 5,820 | 26 | 4.6 | 4,274 | 25 | 4.2 | 2,952 |
| 30 | 5.3 | 6,054 | 29 | 4.3 | 4,406 | 28 | 4.1 | 2,860 |
| Dec. 3 | 5.0 | 5,077 | 31 | 4.5 | 4,398 | 31 | 4.1 | 2,869 |
| 5 | 4.9 | 4,856 | Feb. 3 | 4.4 | 4,138 | Apr. 4 | 4.1 | 2,812 |
| 8 | 4.8 | 4,619 | 6 | 4.4 | 3,990 | 8 | 4.0 | 2,736 |
| 12 | 4.7 | 4,541 | 9 | 4.3 | 3,693 | 11 | 4.0 | 2,667 |
| 15 | 4.7 | 4,549 | 13 | 4.3 | 3,545 | 14 | 4.1 | 2,865 |
| 19 | 4.7 | 4,542 | 16 | 4.4 | 3,505 | 17 | 4.3 | 3,000 |
| 22 | 4.7 | 4,542 | 19 | 4.5 | 3,648 | 21 | 5.3 | 5,114 |
| 26 | 4.7 | 4,590 | 23 | 4.4 | 3,474 | 23 | 5.55 | 5,300 |
| 29 | 4.7 | 4,558 | 26 | 4.4 | 3,458 | 26 | 6.2 | 6,095 |
| 31 | 4.7 | 4,462 | 28 | 4.3 | 3,345 | 28 | 5.6 | 5,292 |
| Jan. 2 | 4.85 | 5,206 | Mar. 3 | 4.2 | 3,160 | 30 | 5.6 | 5,348 |

*Daily discharge, in second-feet, of Rio Grande near Devils River, Tex., for the year ending Sept. 30, 1915.*

| Day. | Nov. | Dec. | Jan. | Feb. | Mar. | Apr. | Day. | Nov. | Dec. | Jan. | Feb. | Mar. | Apr. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 7,670 | 5,380 | 4,460 | 4,210 | 3,340 | 2,850 | 16 | 5,050 | 4,550 | 4,510 | 3,510 | 2,810 | 3,000 |
| 2 | 7,670 | 5,060 | 5,210 | 4,170 | 3,340 | 2,840 | 17 | 5,060 | 4,550 | 4,380 | 3,510 | 2,810 | 3,000 |
| 3 | 7,670 | 5,080 | 5,560 | 4,140 | 3,160 | 2,830 | 18 | 5,060 | 4,540 | 4,380 | 3,510 | 2,810 | 3,000 |
| 4 | 7,840 | 5,080 | 5,560 | 4,090 | 3,150 | 2,810 | 19 | 5,060 | 4,540 | 4,380 | 3,650 | 2,960 | 3,000 |
| 5 | 7,490 | 4,860 | 5,320 | 4,040 | 3,130 | 2,810 | 20 | 5,030 | 4,540 | 4,350 | 3,630 | 2,960 | 3,420 |
| 6 | 7,670 | 4,860 | 5,250 | 3,990 | 3,120 | 2,740 | 21 | 5,000 | 4,540 | 4,320 | 3,510 | 2,810 | 4,900 |
| 7 | 7,670 | 4,860 | 5,170 | 3,790 | 3,070 | 2,740 | 22 | 4,960 | 4,540 | 4,290 | 3,490 | 2,810 | 20,510 |
| 8 | 7,670 | 4,620 | 5,180 | 3,740 | 3,030 | 2,740 | 23 | 4,930 | 4,550 | 4,260 | 3,470 | 2,950 | 5,300 |
| 9 | 6,550 | 4,620 | 5,250 | 3,690 | 2,980 | 2,710 | 24 | 4,900 | 4,570 | 4,260 | 3,470 | 3,090 | 5,850 |
| 10 | 6,170 | 4,620 | 5,160 | 3,660 | 2,980 | 2,690 | 25 | 6,770 | 4,580 | 4,260 | 3,460 | 2,950 | 6,220 |
| 11 | 5,780 | 4,540 | 5,070 | 3,620 | 2,970 | 2,670 | 26 | 7,900 | 4,590 | 4,270 | 3,460 | 2,950 | 6,100 |
| 12 | 5,400 | 4,540 | 4,730 | 3,580 | 2,970 | 2,710 | 27 | 5,820 | 4,580 | 4,380 | 3,350 | 2,860 | 6,500 |
| 13 | 5,400 | 4,540 | 4,730 | 3,540 | 2,970 | 2,830 | 28 | 5,590 | 4,570 | 4,290 | 3,340 | 2,860 | 5,290 |
| 14 | 5,400 | 4,550 | 4,510 | 3,510 | 2,810 | 2,860 | 29 | 5,940 | 4,560 | 4,410 | ..... | 2,860 | 5,320 |
| 15 | 5,400 | 4,550 | 4,510 | 3,480 | 2,810 | 2,930 | 30 | 6,050 | 4,510 | 4,400 | ..... | 2,870 | 5,350 |
| | | | | | | | 31 | ..... | 4,460 | 4,400 | ..... | 2,870 | ..... |

NOTE.—See also table of discharge measurements. Discharge Apr. 22 determined from gage height estimated by observer at 13.0 feet.

*Monthly discharge of Rio Grande near Devils River, Tex., for the year ending Sept. 30, 1915.*

| Month. | Discharge in second-feet. | | | Run-off (total in acre-feet). |
|---|---|---|---|---|
| | Maximum. | Minimum. | Mean. | |
| November | 7,900 | 4,900 | 6,152 | 366,089 |
| December | 5,380 | 4,460 | 4,662 | 286,671 |
| January | 5,560 | 4,260 | 4,684 | 288,020 |
| February | 4,210 | 3,340 | 3,665 | 203,524 |
| March | 3,340 | 2,810 | 2,970 | 182,598 |
| April | [a] 20,510 | 2,670 | 4,284 | 254,916 |
| The period | ..... | ..... | ..... | 1,580,000 |

[a] Doubtful.

### RIO GRANDE AT EAGLE PASS, TEX.

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

DRAINAGE AREA.—Not measured.

RECORDS AVAILABLE.—May 1, 1900, to September 30, 1915.

GAGE.—Vertical and inclined staff.

DISCHARGE MEASUREMENTS.—Made from cable.

CHANNEL AND CONTROL.—Very shifting. Overflow of banks for a width of 1,500 feet begins at a stage of 22 feet.

EXTREMES OF DISCHARGE.—Maximum stage recorded during year 30.0 feet October 22 (discharge estimated at 249,700 second-feet for mean stage, 28.0 feet for the day); minimum stage recorded, 2.0 feet April 13 (discharge about 2,600 second-feet).

1900–1915: Maximum stage recorded, 34.6 feet, at midnight June 29, 1905 (discharge June 30 estimated at 238,300 second-feet); minimum mean daily discharge, 1,030 second-feet April 15, 1913.

DIVERSIONS.—No data.

ACCURACY.—Owing to the shifting of channel and control, determinations of daily discharge are based almost directly on frequent current-meter measurements.

COOPERATION.—Station maintained and records furnished by United States section of the International Water Commission until March 31, 1914; after August 10, 1914, Commission for the Equitable Distribution of the Waters of the Rio Grande.

*Discharge measurements of Rio Grande at Eagle Pass, Tex., during the year ending Sept. 30, 1915.*

[Made by C. F. Carson, Oct. 1 to Feb. 9; L. C. Gilliam, Feb. 12 to Sept. 30.]

| Date. | Gage height. | Discharge. | Date. | Gage height. | Discharge. | Date. | Gage height. | Discharge. |
|---|---|---|---|---|---|---|---|---|
| | *Feet.* | *Sec.-ft.* | | *Feet.* | *Sec.-ft.* | | *Feet.* | *Sec.-ft.* |
| Oct. 3 | 4.5 | 11,296 | Jan. 9 | 3.5 | 5,277 | May 9 | 4.2 | 5,542 |
| 6 | 4.2 | 9,502 | 12 | 3.3 | 5,055 | 13 | 3.75 | 5,263 |
| 9 | 3.7 | 7,679 | 15 | 3.1 | 4,675 | 17 | 3.2 | 4,633 |
| 12 | 3.3 | 7,256 | 18 | 3.0 | 4,626 | 20 | 2.7 | 3,861 |
| 15 | 3.0 | 5,596 | 21 | 2 9 | 4,407 | 22 | 2.7 | 3,947 |
| 18 | 3.1 | 5,763 | 24 | 2.9 | 4,257 | 25 | 2.8 | 4,154 |
| 21 | 6.2 | 19,645 | 27 | 3.1 | 4,616 | 28 | 2.9 | 4,515 |
| 26 | 7.7 | 23,916 | 31 | 3.0 | 4,323 | 31 | 2.9 | 4,467 |
| 27 | 5 6 | 13,136 | Feb. 3 | 2.9 | 4,135 | June 2 | 3.2 | 5,072 |
| 28 | 5.0 | 14,129 | 6 | 2.9 | 4,063 | 5 | 3.0 | 4,186 |
| 29 | 4.5 | 8,615 | 9 | 2.7 | 3,827 | 9 | 2.8 | 3,904 |
| 30 | 4.2 | 7,716 | 12 | 2.8 | 3,965 | 12 | 2.7 | 3,795 |
| 31 | 4.2 | 7,610 | 15 | 2.6 | 3,886 | 15 | 2.6 | 3,698 |
| Nov. 1 | 4.3 | 7,949 | 19 | 2.9 | 4,586 | 18 | 3.0 | 3,998 |
| 2 | 8.85 | 32,383 | 22 | 2.8 | 3,840 | 21 | 2 6 | 3,588 |
| 3 | 5.2 | 11,650 | 25 | 2.6 | 3,675 | 24 | 2.8 | 3,787 |
| 6 | 4.3 | 8,131 | 28 | 2.6 | 3,694 | 27 | 2.8 | 4,079 |
| 9 | 4.2 | 7,735 | Mar. 3 | 2.5 | 3,581 | 30 | 2.8 | 3,950 |
| 12 | 3.9 | 6,999 | 6 | 2.4 | 3,479 | July 4 | 2.8 | 3,967 |
| 15 | 3.8 | 7,381 | 9 | 2.65 | 3,672 | 7 | 2.8 | 4,027 |
| 18 | 3.6 | 6,532 | 12 | 2.5 | 3,474 | Aug. 4 | 2.3 | 3,339 |
| 21 | 3.5 | 5,905 | 17 | 2 5 | 3,681 | 7 | 3.1 | 3,822 |
| 24 | 3.5 | 6,106 | 20 | 2.5 | 3,653 | 10 | 3.4 | 4,092 |
| 27 | 4.1 | 8,719 | 23 | 2.5 | 3,642 | 13 | 3.3 | 4,020 |
| 30 | 3.8 | 7,288 | 26 | 2.5 | 3,627 | 16 | 3.4 | 4,034 |
| Dec. 3 | 3.4 | 6,235 | Apr. 3 | 2.3 | 3,376 | 19 | 2.85 | 3,643 |
| 6 | 3.3 | 6,193 | 6 | 2.2 | 3,150 | 23 | 2.60 | 3,278 |
| 9 | 3.2 | 5,631 | 9 | 2.1 | 3,123 | 26 | 2.4 | 3,132 |
| 12 | 3.2 | 5,237 | 13 | 2.0 | 2,651 | 29 | 3.0 | 3,727 |
| 15 | 3.2 | 5,316 | 17 | 2.85 | 4,489 | 31 | 2.3 | 2,891 |
| 18 | 3.1 | 4,786 | 19 | 2.9 | 4,510 | Sept. 3 | 2.5 | 3,191 |
| 21 | 3.2 | 5,025 | 21 | 2.8 | 4,227 | 7 | 2.4 | 3,091 |
| 24 | 3.1 | 4,875 | 23 | 6.7 | 23,291 | 9 | 3.6 | 4,263 |
| 27 | 3.1 | 4,725 | 27 | 5.5 | 15,228 | 11 | 3.0 | 3,711 |
| 31 | 3.0 | 4,565 | 30 | 4.55 | 8,819 | 14 | 2.7 | 3,359 |
| Jan. 4 | 3.5 | 5,172 | May 3 | 4.7 | 8,347 | 27 | 5.0 | 11,542 |
| 6 | 3.4 | 5,006 | 6 | 4.4 | 6,955 | 30 | 4.6 | 9,420 |

*Daily discharge, in second-feet, of Rio Grande at Eagle Pass, Tex., for the year ending Sept. 30, 1915.*

| Day. | Oct. | Nov. | Dec. | Jan. | Feb. | Mar. | Apr. | May. | June. | July. | Aug. | Sept. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 12,240 | 7,950 | 7,290 | 4,570 | 4,320 | 3,640 | 3,440 | 8,160 | 5,480 | 3,950 | 3,230 | 2,890 |
| 2 | 11,610 | 32,650 | 6,890 | 4,570 | 4,230 | 3,580 | 3,380 | 8,000 | 5,070 | 3,960 | 3,550 | 3,040 |
| 3 | 11,300 | 13,350 | 6,370 | 4,990 | 4,140 | 3,580 | 3,380 | 10,000 | 4,510 | 3,960 | 3,550 | 3,190 |
| 4 | 11,300 | 10,870 | 6,240 | 5,170 | 4,110 | 3,580 | 3,230 | 8,350 | 4,350 | 3,970 | 3,340 | 3,140 |
| 5 | 11,000 | 8,910 | 6,240 | 5,090 | 4,090 | 3,480 | 3,190 | 7,650 | 4,190 | 3,990 | 3,580 | 3,090 |
| 6 | 10,100 | 8,130 | 6,190 | 5,010 | 4,060 | 3,480 | 3,150 | 7,190 | 4,050 | 4,010 | 3,460 | 3,090 |
| 7 | 9,140 | 8,730 | 6,090 | 5,010 | 3,940 | 3,480 | 3,150 | 6,350 | 3,980 | 4,030 | 3,820 | 3,390 |
| 8 | 8,230 | 8,330 | 5,860 | 5,140 | 3,830 | 3,480 | 3,140 | 5,750 | 3,900 | 4,010 | 3,460 | 4,260 |
| 9 | 7,860 | 7,740 | 5,630 | 5,280 | 3,830 | 3,710 | 3,120 | 5,540 | 3,900 | 4,000 | 4,270 | 4,260 |
| 10 | 7,570 | 7,730 | 5,500 | 5,110 | 3,830 | 3,610 | 3,030 | 5,510 | 3,850 | 3,980 | 4,180 | 4,030 |
| 11 | 7,680 | 7,370 | 5,370 | 5,060 | 3,960 | 3,470 | 2,940 | 5,450 | 3,800 | 3,970 | 4,090 | 3,710 |
| 12 | 7,310 | 7,120 | 5,240 | 5,050 | 3,970 | 3,470 | 2,840 | 5,420 | 3,790 | 3,950 | 4,020 | 3,650 |
| 13 | 6,980 | 7,260 | 5,260 | 4,870 | 3,930 | 3,510 | 2,700 | 5,290 | 3,700 | 3,830 | 4,020 | 3,480 |
| 14 | 6,430 | 6,920 | 5,290 | 4,860 | 3,930 | 3,560 | 2,870 | 5,090 | 3,700 | 3,710 | 4,030 | 3,360 |
| 15 | 5,600 | 7,380 | 5,320 | 4,680 | 3,910 | 3,600 | 2,970 | 4,980 | 3,700 | 3,660 | 4,030 | 3,360 |
| 16 | 5,510 | 7,000 | 5,210 | 4,680 | 3,950 | 3,640 | 3,410 | 4,800 | 3,770 | 3,540 | 4,030 | 7,880 |
| 17 | 5,930 | 6,620 | 5,100 | 4,670 | 4,010 | 3,680 | 4,050 | 4,630 | 3,850 | 3,480 | 3,930 | 11,690 |
| 18 | 5,680 | 6,530 | 4,890 | 4,630 | 4,150 | 3,670 | 4,690 | 4,480 | 3,920 | 3,420 | 3,790 | 8,250 |
| 19 | 5,600 | 6,420 | 4,810 | 4,630 | 4,660 | 3,660 | 4,510 | 3,940 | 3,740 | 3,360 | 3,640 | 7,890 |
| 20 | 5,430 | 6,310 | 4,920 | 4,630 | 4,420 | 3,650 | 4,510 | 3,790 | 3,590 | 3,120 | 3,560 | 7,710 |
| 21 | 19,650 | 5,900 | 5,020 | 4,410 | 4,260 | 3,650 | 4,370 | 3,750 | 3,590 | 3,020 | 3,410 | 7,540 |
| 22 | 249,700 | 5,970 | 5,020 | 4,360 | 3,840 | 3,640 | 7,650 | 3,950 | 3,590 | 3,010 | 3,330 | 7,380 |
| 23 | 92,400 | 6,340 | 4,880 | 4,310 | 3,800 | 3,640 | 25,250 | 3,950 | 3,640 | 3,010 | 3,280 | 9,930 |
| 24 | 18,150 | 6,110 | 4,880 | 4,260 | 3,760 | 3,640 | 9,520 | 4,050 | 3,790 | 3,010 | 3,200 | 22,040 |
| 25 | 35,840 | 6,280 | 4,680 | 4,170 | 3,670 | 3,630 | 7,840 | 4,150 | 3,880 | 3,010 | 3,170 | 32,240 |
| 26 | 25,070 | 7,500 | 4,630 | 4,080 | 3,680 | 3,630 | 8,510 | 4,150 | 3,980 | 3,010 | 3,100 | 14,660 |
| 27 | 16,220 | 9,070 | 4,730 | 4,440 | 3,690 | 3,500 | 15,900 | 4,510 | 4,080 | 3,010 | 3,030 | 12,220 |
| 28 | 14,130 | 8,390 | 4,730 | 4,590 | 3,690 | 3,500 | 13,880 | 4,690 | 4,040 | 2,960 | 3,820 | 22,990 |
| 29 | 8,610 | 7,460 | 4,730 | 4,380 | ..... | 3,500 | 11,850 | 4,850 | 3,990 | 2,910 | 3,780 | 15,360 |
| 30 | 7,720 | 7,290 | 4,650 | 4,350 | ..... | 3,500 | 9,490 | 4,830 | 3,950 | 2,910 | 3,430 | 11,120 |
| 31 | 7,610 | ..... | 4,570 | 4,320 | ..... | 3,500 | ..... | 4,470 | ..... | 2,910 | 2,840 | ..... |

NOTE.—See also table of discharge measurements.

*Monthly discharge of Rio Grande at Eagle Pass, Tex., for the year ending Sept. 30, 1915.*

| Month. | Discharge in second-feet. | | | Run-off (total in acre-feet). |
|---|---|---|---|---|
| | Maximum. | Minimum. | Mean. | |
| October | 249,700 | 5,430 | 21,213 | 1,304,330 |
| November | 32,650 | 5,900 | 8,454 | 503,067 |
| December | 7,290 | 4,570 | 5,362 | 329,712 |
| January | 5,280 | 4,170 | 4,689 | 288,337 |
| February | 4,660 | 3,670 | 3,988 | 221,474 |
| March | 3,710 | 3,470 | 3,576 | 219,887 |
| April | 25,250 | 2,700 | 6,065 | 360,912 |
| May | 10,000 | 3,750 | 5,410 | 332,668 |
| June | 5,480 | 3,590 | 3,979 | 236,767 |
| July | 4,030 | 2,910 | 3,505 | 215,544 |
| August | 4,270 | 2,840 | 3,612 | 222,089 |
| September | 32,240 | 2,890 | 8,361 | 497,534 |
| The year | 249,700 | 2,700 | 6,540 | 4,730,000 |

### RIO COLORADO[1] NEAR QUESTA, N. MEX.

LOCATION.—Near sec. 33, T. 29 N., R. 13 E., half a mile above Eagle Rock ranger station in Carson National Forest, 1¾ miles above mouth of Cabresto Creek, 2 miles above Questa, near center of Taos County.

DRAINAGE AREA.—Not measured.

RECORDS AVAILABLE.—October 6, 1912, to August 9, 1915, when station was discontinued.

GAGE.—Overhanging chain gage on left bank; read at irregular intervals by Leo E. Anderson, forest ranger.

DISCHARGE MEASUREMENTS.—Made by wading.

CHANNEL AND CONTROL.—Bed of stream composed of rock and gravel. Banks high and not subject to overflow. Position of control not known. Stage-discharge relation changes during extremely high stages, but is nearly permanent during low and medium stages.

EXTREMES OF DISCHARGE.—Maximum stage recorded during year, 2.68 feet June 11 (discharge, 317 second-feet); minimum stage recorded, 0.50 foot December 9, 12, and 17 (discharge, 14 second-feet).

1912–1915: Maximum stage recorded June 11, 1915; minimum discharge recorded, 10 second-feet December 13, 1913.

WINTER FLOW.—Stage-discharge relation seriously affected by ice; flow estimated from current-meter measurements, observer's notes, and records of precipitation and temperature.

DIVERSIONS.—None of consequence above station.

REGULATION.—None.

ACCURACY.—Results good. Stage-discharge relation not subject to frequent changes.

COOPERATION.—Record of current-meter measurements made in January, February, and March furnished by State engineer of New Mexico.

*Discharge measurements of Rio Colorado near Questa, N. Mex., during the year ending Sept. 30, 1915.*

| Date. | Made by— | Gage height. | Discharge. | Date. | Made by— | Gage height. | Discharge. |
|---|---|---|---|---|---|---|---|
| | | *Feet.* | *Sec.-ft.* | | | *Feet.* | *Sec.-ft.* |
| Oct. 20 | J. E. Powers | 0.66 | 30.9 | Feb. 9 | R. S. Watrous | 0.60 | 24.6 |
| Dec. 5 | do | .48 | 13.6 | Mar. 22 | do | .48 | 18.9 |
| Jan. 9 | Powers and Watrous | (a) | 18.4 | Apr. 28 | W. R. King | 1.63 | 139 |

a Stage-discharge relation affected by ice.

[1] Also known as Red River.

*Daily discharge, in second-feet, of Rio Colorado near Questa, N. Mex., for the year ending Sept. 30, 1915.*

| Day. | Oct. | Nov. | Dec. | Jan. | Feb. | Mar. | Apr. | May. | June. | July. | Aug. |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | | 28 | 15 | | 18 | | | | | | 69 |
| 2 | 34 | | | | | 20 | | 118 | 313 | 140 | |
| 3 | | 26 | | | | | 26 | | | | |
| 4 | | | 15 | 16 | | | | | | | 58 |
| 5 | | | 14 | | | | 30 | 118 | 261 | | |
| 6 | 38 | 26 | | | | 22 | | | 227 | | |
| 7 | | | | | | | | 105 | | 140 | 58 |
| 8 | | | | | | | 33 | 98 | 261 | | |
| 9 | | | 14 | 18 | 25 | 21 | | 115 | | | 69 |
| 10 | | | | | | | 31 | | | | |
| 11 | 34 | 23 | | | 18 | | | 132 | 317 | | |
| 12 | | | 14 | 22 | | | 35 | 154 | | 107 | |
| 13 | | 20 | | | | 23 | | 210 | 278 | | |
| 14 | 33 | 21 | | | | | | | | | |
| 15 | | | | | 25 | | | 278 | 278 | 98 | |
| 16 | 30 | 17 | | | | 21 | | 278 | | | |
| 17 | | | 14 | | | | 58 | 278 | 261 | | |
| 18 | | 20 | | | | | | | | | |
| 19 | | | | 22 | | | | 253 | 304 | 69 | |
| 20 | 32 | | | | | 19 | 58 | 219 | | | |
| 21 | | | 18 | | | | 71 | | 278 | | |
| 22 | | | | | | 19 | 80 | 170 | | 74 | |
| 23 | | | | 22 | | | | | | 124 | |
| 24 | 32 | | | | | | 85 | | | | |
| 25 | | | | | 21 | | 80 | 227 | 236 | | |
| 26 | | | | 20 | | 24 | | 261 | | 85 | |
| 27 | | 15 | | | 19 | | 93 | 261 | 170 | | |
| 28 | 31 | | | | | | 140 | | | | |
| 29 | | | | | | | 132 | | | 80 | |
| 30 | 28 | | | | | | 154 | | | | |
| 31 | | | 14 | | | 25 | | | | | |

NOTE.—Discharge determined as follows: Oct. 1 to Dec. 17, Jan. 9–23, and Jan. 27 to Apr. 16 by indirect method for shifting control; Dec. 18 to Jan. 8 and Jan. 24–26, from current-meter measurements, climatic data, and information furnished by observer; Apr. 17 to Aug. 9 from a fairly well-defined curve.

### RIO COLORADO[1] BELOW QUESTA, N. MEX.

LOCATION.—Near sec. 1, T. 28 N., R. 12 E., near Vigil's mill, 2 miles below Questa, at head of lower canyon, near central part of Taos County; below all tributaries, the nearest one above being Cabresto Creek.

DRAINAGE AREA.—Not measured.

RECORDS AVAILABLE.—April 8, 1910, to August 28, 1915, when station was discontinued.

GAGE.—Vertical staff on right bank about 150 feet below Vigil's mill; read morning and evening by Narcisco Vigil. From April 8, 1910, to July 20, 1914, stage was read on a vertical staff gage 50 feet above Vigil's mill. Present gage established July 20, 1914; datum 2.77 feet lower than that of old gage; readings obtained before October 1, 1914, refer to original datum.

DISCHARGE MEASUREMENTS.—Made by wading or from cable.

CHANNEL AND CONTROL.—Bed of stream composed of rock and gravel; changes during high water. Both banks high and not subject to overflow. Position of control is not known.

EXTREMES OF DISCHARGE.—Maximum stage recorded during year, 2.80 feet June 16 (discharge, 524 second-feet); minimum stage recorded, 0.84 foot December 15 (discharge, 11 second-feet).

1910–1915: Maximum stage recorded June 16, 1915; minimum stage recorded, 2.90 feet (old datum) July 23, 1912 (discharge, 5 second-feet).

[1] Also known as Red River.

WINTER FLOW.—Stage-discharge relation not seriously affected by ice.

DIVERSIONS.—Water is diverted for irrigation in the valleys near Questa, but none is diverted below station; quantity diverted above station not known.

REGULATION.—No power plants above station.

ACCURACY.—Results fair. Stage-discharge relation permanent during a large part of year but changes during extremely high stages.

COOPERATION.—Record of current-meter measurement made in January, February, and March furnished by State engineer of New Mexico.

*Discharge measurements of Rio Colorado below Questa, N. Mex., during the year ending Sept. 30, 1915.*

| Date. | Made by— | Gage height. | Discharge. | Date. | Made by— | Gage height. | Discharge. |
|---|---|---|---|---|---|---|---|
| | | *Feet.* | *Sec.-ft.* | | | *Feet.* | *Sec.-ft.* |
| Oct. 19 | J. E. Powers | 1.19 | 40.7 | Feb. 9 | R. S. Watrous | 1.10 | 31.2 |
| Dec. 4 | do | 1.04 | 27.2 | Mar. 22 | do | 1.03 | 27.3 |
| Jan. 8 | Powers and Watrous | 1.09 | 29.4 | Apr. 28 | W. R. King | 1.62 | 149 |

*Daily discharge, in second-feet, of Rio Colorado below Questa, N. Mex., for the year ending Sept. 30, 1915.*

| Day. | Oct. | Nov. | Dec. | Jan. | Feb. | Mar. | Apr. | May. | June. | July. | Aug. |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 41 | 37 | 31 | 17 | 23 | 25 | 32 | 206 | 332 | 348 | 182 |
| 2 | 41 | 41 | 24 | 21 | 23 | 27 | 32 | 176 | 348 | 338 | 176 |
| 3 | 41 | 40 | 19 | 21 | 26 | 27 | 33 | 170 | 300 | 332 | 176 |
| 4 | 55 | 37 | 20 | 22 | 20 | 21 | 35 | 154 | 332 | 332 | 176 |
| 5 | 49 | 36 | 19 | 24 | 18 | 22 | 36 | 170 | 380 | 326 | 170 |
| 6 | 44 | 37 | 23 | 19 | 14 | 28 | 46 | 156 | 393 | 326 | 170 |
| 7 | 41 | 36 | 19 | 21 | 21 | 21 | 50 | 148 | 399 | 326 | 176 |
| 8 | 41 | 32 | 21 | 21 | 21 | 25 | 46 | 148 | 444 | 306 | 212 |
| 9 | 41 | 34 | 20 | 20 | 21 | 27 | 46 | 162 | 518 | 300 | 191 |
| 10 | 41 | 32 | 21 | 20 | 23 | 22 | 46 | 151 | 498 | 294 | 176 |
| 11 | 41 | 32 | 18 | 18 | 27 | 25 | 46 | 176 | 518 | 284 | 176 |
| 12 | 41 | 31 | 17 | 18 | 27 | 25 | 46 | 206 | 508 | 284 | 154 |
| 13 | 41 | 31 | 15 | 17 | 21 | 25 | 57 | 262 | 476 | 281 | 126 |
| 14 | 41 | 31 | 13 | 17 | 21 | 24 | 64 | 284 | 466 | 274 | 120 |
| 15 | 41 | 31 | 11 | 17 | 22 | 28 | 71 | 316 | 518 | 268 | 120 |
| 16 | 41 | 31 | 13 | 16 | 23 | 29 | 71 | 422 | 524 | 265 | 120 |
| 17 | 41 | 31 | 18 | 15 | 30 | 28 | 73 | 454 | 521 | 249 | 117 |
| 18 | 41 | 30 | 22 | 15 | 27 | 28 | 73 | 492 | 508 | 236 | 117 |
| 19 | 40 | 30 | 22 | 14 | 27 | 28 | 73 | 476 | 511 | 236 | 110 |
| 20 | 39 | 21 | 22 | 14 | 27 | 25 | 89 | 428 | 508 | 252 | 104 |
| 21 | 39 | 21 | 14 | 15 | 27 | 24 | 97 | 358 | 444 | 252 | 104 |
| 22 | 49 | 30 | 20 | 16 | 24 | 25 | 120 | 332 | 425 | 242 | 120 |
| 23 | 41 | 26 | 22 | 17 | 21 | 32 | 120 | 367 | 412 | 236 | 97 |
| 24 | 41 | 24 | 21 | 21 | 21 | 33 | 120 | 377 | 402 | 230 | 115 |
| 25 | 41 | 24 | 22 | 27 | 27 | 32 | 120 | 370 | 399 | 230 | 110 |
| 26 | 41 | 25 | 23 | 26 | 27 | 33 | 120 | 364 | 396 | 230 | 104 |
| 27 | 41 | 27 | 23 | 21 | 27 | 34 | 137 | 316 | 390 | 242 | 97 |
| 28 | 41 | 24 | 21 | 25 | 26 | 34 | 159 | 297 | 367 | 221 | 94 |
| 29 | 41 | 27 | 21 | 29 | ..... | 34 | 182 | 306 | 364 | 221 | ..... |
| 30 | 40 | 28 | 17 | 30 | ..... | 34 | 206 | 306 | 358 | 221 | ..... |
| 31 | 39 | ..... | 17 | 26 | ..... | 34 | ..... | 326 | ..... | 200 | ..... |

NOTE.—Discharge determined as follows: Oct. 1 to Nov. 25, Dec. 11 to Jan. 8, and Jan. 23 to Mar. 31, by indirect method for shifting control; Nov. 26 to Dec. 10 and Apr. 1 to Aug. 28 from well-defined rating curve; Jan. 9–22 from climatic data, information furnished by observer, and records obtained at near-by stations.

*Monthly discharge of Rio Colorado below Questa, N. Mex., for the year ending Sept. 30, 1915.*

| Month. | Discharge in second-feet. | | | Run-off (total in acre-feet). | Accuracy. |
|---|---|---|---|---|---|
| | Maximum. | Minimum. | Mean. | | |
| October | 55 | 39 | 41.8 | 2,570 | B. |
| November | 41 | 21 | 30.6 | 1,820 | B. |
| December | 31 | 11 | 19.6 | 1,210 | B. |
| January | 30 | 14 | 20.0 | 1,230 | D. |
| February | 30 | 14 | 23.6 | 1,310 | C. |
| March | 34 | 21 | 27.7 | 1,700 | C. |
| April | 206 | 32 | 81.5 | 4,850 | C. |
| May | 492 | 148 | 286 | 17,600 | C. |
| June | 524 | 300 | 432 | 25,700 | C. |
| July | 348 | 200 | 270 | 16,600 | C. |
| August 1–28 | 212 | 94 | 140 | 7,770 | C. |
| The period | | | | 82,400 | |

### RIO HONDO NEAR ARROYO HONDO, N. MEX.

LOCATION.—Near sec. 31, T. 27 N., R. 12 E., at highway bridge at Rael Hotel, 200 yards above mouth of stream, 1 mile west of Arroyo Hondo post office, near the center of Taos County. No tributaries between station and mouth.

DRAINAGE AREA.—Not measured.

RECORDS AVAILABLE.—April 8, 1910, to August 8, 1915, when station was discontinued.

GAGE.—Inclined staff attached to downstream side of left bridge abutment; read morning and evening by Silverio Rael.

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

CHANNEL AND CONTROL.—Bed composed of gravel, rock, and sand; water flows through a series of pools and rapids. Banks high and not subject to overflow. Stage-discharge relation changes slightly, especially during high stages.

EXTREMES OF DISCHARGE.—Maximum stage recorded during year, 3.60 feet at 6 a. m. June 12 (discharge, 338 second-feet); minimum stage recorded, 1.68 feet October 2 (discharge, 7.6 second-feet).

1910–1915: Maximum stage recorded June 12, 1915; minimum stage recorded, 1.55 feet October 19, 1912 (discharge, 3.0 second-feet).

WINTER FLOW.—Stage-discharge relation affected by ice; flow estimated from current-meter measurements, observer's notes, and records of precipitation and temperature.

DIVERSIONS.—Several diversions for irrigation above station but none below.

REGULATION.—None.

ACCURACY.—Results fair. Mean gage heights for summer slightly in error because of fluctuation due to diversions. Stage-discharge relation in winter affected by ice.

COOPERATION.—Records of current-meter measurements in January, February, and March furnished by State engineer of New Mexico.

*Discharge measurements of Rio Hondo near Arroyo Hondo, N. Mex., during the year ending Sept. 30, 1915.*

| Date. | Made by— | Gage height. | Discharge. | Date. | Made by— | Gage height. | Discharge. |
|---|---|---|---|---|---|---|---|
| | | *Feet.* | *Sec.-ft.* | | | *Feet.* | *Sec.-ft.* |
| Oct. 20 | J. E. Powers | 1.70 | 9.7 | Feb. 10 | R. S. Watrous | 1.88 | 18.3 |
| Dec. 5 | do | 1.91 | 16.8 | Mar. 23 | do | 1.84 | 15.9 |
| Jan. 9 | Powers and Watrous | a 1.90 | 15.6 | Apr. 28 | W. R. King | 2.45 | 73 |

a Stage-discharge relation affected by ice.

*Daily discharge, in second-feet, of Rio Hondo near Arroyo Hondo, N. Mex., for the year ending Sept. 30, 1915.*

| Day. | Oct. | Nov. | Dec. | Feb. | Mar. | Apr. | May. | June. | July. | Aug. |
|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 8.0 | 18 | 12 | 16 | 14 | 19 | 71 | 166 | 155 | 26 |
| 2 | 7.6 | 15 | 14 | 16 | 14 | 18 | 42 | 228 | 155 | 22 |
| 3 | 8.0 | 14 | 14 | 16 | 10 | 25 | 22 | 202 | 144 | 22 |
| 4 | 17 | 19 | 14 | 16 | 10 | 22 | 16 | 166 | 144 | 16 |
| 5 | 11 | 16 | 14 | 16 | 13 | 32 | 16 | 166 | 134 | 14 |
| 6 | 10 | 14 | 14 | 16 | 15 | 33 | 33 | 202 | 116 | 16 |
| 7 | 10 | 18 | 11 | 16 | 14 | 33 | 42 | 178 | 85 | 19 |
| 8 | 12 | 16 | 11 | 16 | 14 | 32 | 42 | 166 | 85 | 30 |
| 9 | 12 | 14 | 11 | 16 | 14 | 33 | 38 | 214 | 75 | ..... |
| 10 | 10 | 16 | 11 | 14 | 13 | 27 | 38 | 272 | 64 | ..... |
| 11 | 11 | 9.5 | 11 | 13 | 13 | 30 | 42 | 305 | 67 | ..... |
| 12 | 9.8 | 10 | 11 | 12 | 14 | 33 | 92 | 322 | 64 | ..... |
| 13 | 9.2 | 9.5 | 14 | 12 | 13 | 38 | 134 | 288 | 58 | ..... |
| 14 | 9.2 | 10 | 14 | 11 | 13 | 42 | 305 | 214 | 52 | ..... |
| 15 | 9.2 | 14 | 14 | 10 | 13 | 40 | 272 | 214 | 52 | ..... |
| 16 | 9.8 | 13 | 14 | 16 | 13 | 38 | 288 | 214 | 42 | ..... |
| 17 | 9.8 | 13 | 14 | 16 | 13 | 42 | 242 | 214 | 42 | ..... |
| 18 | 9.8 | 13 | 16 | 16 | 13 | 38 | 272 | 202 | 33 | ..... |
| 19 | 11 | 16 | 14 | 16 | 14 | 35 | 242 | 214 | 33 | ..... |
| 20 | 9.8 | 16 | 14 | 16 | 14 | 38 | 189 | 228 | 33 | ..... |
| 21 | 9.8 | 15 | 14 | 16 | 14 | 42 | 134 | 228 | 33 | ..... |
| 22 | 17 | 15 | 14 | 16 | 14 | 52 | 116 | 228 | 30 | ..... |
| 23 | 13 | 18 | 14 | 16 | 14 | 52 | 107 | 228 | 30 | ..... |
| 24 | 9.8 | 14 | 14 | 16 | 15 | 47 | 144 | 228 | 30 | ..... |
| 25 | 12 | 12 | 14 | 16 | 15 | 42 | 166 | 228 | 26 | ..... |
| 26 | 16 | 12 | 11 | 14 | 18 | 44 | 189 | 214 | 33 | ..... |
| 27 | 19 | 12 | 14 | 14 | 19 | 50 | 189 | 202 | 33 | ..... |
| 28 | 19 | 14 | 14 | 14 | 15 | 54 | 189 | 189 | 33 | ..... |
| 29 | 14 | 12 | 14 | ..... | 14 | 58 | 189 | 166 | 33 | ..... |
| 30 | 16 | 12 | 15 | ..... | 16 | 78 | 166 | 155 | 30 | ..... |
| 31 | 19 | ..... | 14 | ..... | 19 | ..... | 166 | ..... | 26 | ..... |

NOTE.—Discharge determined as follows: Oct. 1–5, Dec. 6–31, and Apr. 1 to Aug. 8, from a well-defined curve; Oct. 6 to Dec. 5 and Feb. 1 to Mar. 31 by indirect method for shifting control.

*Monthly discharge of Rio Hondo near Arroyo Hondo, N. Mex., for the year ending Sept. 30, 1915.*

| Month. | Discharge in second-feet. | | | Run-off (total in acre-feet). | Accuracy. |
|---|---|---|---|---|---|
| | Maximum. | Minimum. | Mean. | | |
| October | 19 | 7.6 | 11.9 | 732 | B. |
| November | 19 | 9.5 | 14.0 | 833 | B. |
| December | 16 | 11 | 13.4 | 824 | B. |
| January | ..... | ..... | [a] 12.0 | 738 | |
| February | 16 | 10 | 14.9 | 828 | C. |
| March | 19 | 10 | 14.1 | 867 | C. |
| April | 78 | 18 | 38.9 | 2,310 | C. |
| May | 305 | 16 | 135 | 8,300 | C. |
| June | 322 | 155 | 215 | 12,800 | C. |
| July | 155 | 26 | 63.6 | 3,910 | C. |
| August 1–8 | 30 | 14 | 20.6 | 327 | C. |
| The period | ..... | ..... | ..... | 32,500 | |

[a] Estimated.

### RIO PUEBLO DE TAOS NEAR TAOS, N. MEX.

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

DRAINAGE AREA.—Not measured.

RECORDS AVAILABLE.—December 19, 1910, to September 30, 1915. Fragmentary records March to December, 1910.

GAGE.—Bristol water-stage recorder on right bank a short distance above Glorietta Grove; installed December 19, 1910. Vertical staff gage installed April 7, 1910, was destroyed by flood before July 12, 1910, and on October 12, 1910, a new gage was installed at same site at a datum 0.27 foot lower than that of original gage; water-stage recorder at same datum as second gage.

DISCHARGE MEASUREMENTS.—Made by wading.

CHANNEL AND CONTROL.—Bed composed of rock and gravel; water flows through a series of pools and rapids. Banks low but are seldom overflowed as discharge is small. Control appears to be subject to slight changes, especially during high stages.

EXTREMES OF DISCHARGE—Maximum stage recorded during year, 3.55 feet May 14 and 15 (discharge, 260 second-feet); minimum stage recorded, 0.90 foot February 13; discharge, 5.0 second-feet.

1910–1915: Maximum stage recorded, 4.55 feet May 22, 1912 (discharge, 440 second-feet); minimum discharge, 5.0 second-feet several days during January, 1914, and February 13, 1915.

WINTER FLOW.—Stage-discharge relation seriously affected by ice; flow estimated from current-meter measurements, obesrver's notes, and records of precipitation and temperature.

DIVERSIONS.—None above station but several just below.

REGULATION.—None.

ACCURACY.—Results good. The slight changes in stage-discharge relation do not greatly affect accuracy of determinations.

COOPERATION.—Records of current-meter measurements made in February furnished by State engineer of New Mexico.

*Discharge measurements of Rio Pueblo de Taos near Taos, N. Mex., during the year ending Sept. 30, 1915.*

| Date. | Made by— | Gage height. | Discharge. | Date. | Made by— | Gage height. | Discharge. |
|---|---|---|---|---|---|---|---|
| | | *Feet.* | *Sec.-ft.* | | | *Feet.* | *Sec.-ft.* |
| Oct. 17 | J. E. Powers | 1.17 | 8.7 | Apr. 30 | W. R. King | 3.05 | 167 |
| Dec. 2 | do | 1.03 | 5.9 | Sept. 10 | do | 1.11 | 11.2 |
| Feb. 11 | R. S. Watrous | 1.12 | 9.1 | | | | |

*Daily discharge, in second-feet, of Rio Pueblo de Taos near Taos, N. Mex., for the year ending Sept. 30, 1915.*

| Day. | Oct. | Nov. | Dec. | Jan. | Feb. | Mar. | Apr. | May. | June. | July. | Aug. | Sept. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 10 | 10 | 8.2 | 7.0 | 7.2 | 9.6 | 23 | 149 | 174 | 56 | 18 | 14 |
| 2 | 10 | 10 | 7.2 | 7.1 | 7.2 | 11 | 23 | 112 | 201 | 53 | 19 | 9.6 |
| 3 | 11 | 10 | 8.2 | 7.2 | 6.2 | 11 | 31 | 87 | 192 | 40 | 21 | 11 |
| 4 | 15 | 10 | 9.3 | 8.2 | 6.2 | 9.6 | 33 | 77 | 174 | 38 | 19 | 13 |
| 5 | 14 | 9.3 | 9.3 | 7.2 | 7.2 | 11 | 38 | 77 | 157 | 43 | 16 | 13 |
| 6 | 12 | 9.3 | 7.2 | 8.2 | 7.0 | 11 | 40 | 82 | 149 | 43 | 18 | 14 |
| 7 | 12 | 9.3 | 7.2 | 7.8 | 6.7 | 9.8 | 38 | 77 | 157 | 40 | 19 | 14 |
| 8 | 11 | 9.3 | 8.2 | 7.8 | 6.4 | 9.8 | 33 | 77 | 157 | 35 | 31 | 13 |
| 9 | 11 | 9.3 | 7.2 | 7.2 | 8.4 | 9.8 | 33 | 77 | 157 | 35 | 27 | 11 |
| 10 | 11 | 9.3 | 8.2 | 7.2 | 8.4 | 9.8 | 31 | 72 | 174 | 31 | 25 | 12 |
| 11 | 9.6 | 9.3 | 8.2 | 7.4 | 5.8 | 10 | 38 | 99 | 192 | 29 | 23 | 11 |
| 12 | 8.4 | 8.2 | 7.2 | 7.4 | 5.8 | 10 | 46 | 157 | 192 | 33 | 21 | 12 |
| 13 | 8.4 | 9.3 | 8.2 | 7.4 | 5.0 | 10 | 53 | 192 | 166 | 29 | 19 | 12 |
| 14 | 9.6 | 9.3 | 8.2 | 8.4 | 6.6 | 10 | 64 | 260 | 166 | 27 | 18 | 11 |
| 15 | 8.4 | 8.2 | 8.0 | 7.4 | 9.8 | 10 | 68 | 260 | 157 | 31 | 18 | 11 |
| 16 | 9.3 | 8.2 | 7.8 | 7.6 | 11 | 10 | 68 | 230 | 134 | 29 | 14 | 12 |
| 17 | 9.3 | 9.3 | 7.5 | 7.6 | 8.9 | 11 | 77 | 210 | 112 | 25 | 14 | 11 |
| 18 | 9.3 | 8.2 | 7.2 | 7.6 | 8.9 | 11 | 68 | 230 | 99 | 25 | 14 | 12 |
| 19 | 7.2 | 9.3 | 7.2 | 7.6 | 10 | 12 | 60 | 201 | 119 | 21 | 16 | 13 |
| 20 | 6.2 | 9.3 | 7.2 | 7.6 | 10 | 12 | 64 | 141 | 119 | 23 | 18 | 14 |
| 21 | 6.2 | 8.2 | 8.2 | 7.8 | 9.1 | 12 | 87 | 112 | 106 | 19 | 16 | 14 |
| 22 | 7.2 | 7.2 | 8.2 | 7.8 | 9.1 | 12 | 106 | 105 | 126 | 19 | 14 | 11 |
| 23 | 9.3 | 8.2 | 8.2 | 7.8 | 8.0 | 14 | 99 | 95 | 134 | 21 | 14 | 11 |
| 24 | 9.3 | 8.2 | 8.2 | 7.8 | 8.0 | 16 | 93 | 90 | 119 | 23 | 16 | 11 |
| 25 | 8.2 | 8.2 | 7.2 | 6.8 | 10 | 19 | 82 | 100 | 99 | 23 | 16 | 12 |
| 26 | 8.2 | 8.2 | 7.2 | 6.1 | 9.3 | 23 | 77 | 130 | 93 | 29 | 16 | 14 |
| 27 | 7.2 | 9.3 | 8.2 | 8.0 | 10 | 25 | 99 | 210 | 77 | 33 | 13 | 13 |
| 28 | 7.2 | 8.2 | 8.2 | 6.1 | 10 | 25 | 141 | 1.0 | 77 | 29 | 12 | 13 |
| 29 | 8.2 | 8.2 | 8.2 | 6.1 | ..... | 25 | 166 | 174 | 82 | 21 | 12 | 12 |
| 30 | 9.3 | 8.2 | 7.0 | 6.1 | ..... | 23 | 174 | 166 | 60 | 19 | 14 | 12 |
| 31 | 9.3 | ..... | 7.0 | 6.1 | ..... | 23 | ..... | 174 | ..... | 21 | 13 | ..... |

NOTE.—Discharge obtained as follows: Oct. 1 to Dec. 14, Dec. 18–29, Jan. 3–6, Jan. 10–17, Jan. 19–22, Jan. 24 to Feb. 5, and Feb. 8 to Mar. 25, by indirect method for shifting control; Mar. 26 to Sept. 30, from a well-defined curve; Dec. 15–17, Dec. 30 to Jan. 2, Jan. 7–9, Jan. 18, Jan. 23, and Feb. 6 and 7 from current-meter measurements and climatic data.

*Monthly discharge of Rio Pueblo de Taos near Taos, N. Mex., for the year ending Sept. 30, 1915.*

| Month. | Discharge in second-feet. | | | Run-off (total in acre-feet). | Accuracy. |
|---|---|---|---|---|---|
| | Maximum. | Minimum. | Mean. | | |
| October | 15 | 6.2 | 9.43 | 580 | B. |
| November | 10 | 7.2 | 8.88 | 528 | B. |
| December | 9.3 | 7.0 | 7.83 | 481 | C. |
| January | 8.4 | 6.1 | 7.34 | 451 | C. |
| February | 11 | 5.0 | 8.08 | 449 | C. |
| March | 25 | 9.6 | 13.7 | 842 | B. |
| April | 174 | 23 | 68.4 | 4,070 | B. |
| May | 260 | 72 | 142 | 8,730 | D. |
| June | 201 | 60 | 137 | 8,150 | B. |
| July | 56 | 19 | 30.4 | 1,870 | B. |
| August | 31 | 12 | 17.5 | 1,080 | B. |
| September | 14 | 9.6 | 12.2 | 726 | B. |
| The year | 260 | 5.0 | 38.7 | 28,000 | |

### RIO TAOS[1] AT LOS CORDOVAS, N. MEX.

LOCATION.—Near sec. 22, T. 25 N., R. 12 E., at Los Cordovas, 100 feet below the mouth of Little Rio Grande and Arroyo Seco, near center of Taos County.

DRAINAGE AREA.—Not measured.

RECORDS AVAILABLE.—April 6, 1910, to August 7, 1915, when station was discontinued.

GAGE.—Vertical staff on right bank; read morning and evening, by Alex. Anderson.

DISCHARGE MEASUREMENTS.—Made by wading.

CHANNEL AND CONTROL.—Bed composed of sand and gravel; shifts during extremely high stages. Banks low but not subject to overflow, as discharge is small. Position of control unknown.

EXTREMES OF DISCHARGE.—Maximum stage recorded during year, 3.50 feet May 15 (discharge, 920 second-feet); minimum stage recorded, 0.50 foot at 6.30 a. m. July 20 and 21 (discharge, 3.0 second-feet).

1910–1915: Maximum stage recorded May 15, 1915 (see preceding paragraph); minimum stage recorded, 0.70 foot for short periods from June to September, 1910 (discharge, 1.5 second-feet).

WINTER FLOW.—Stage-discharge relation affected by ice; flow estimated from current-meter measurements, observer's notes, and records of precipitation and temperature.

DIVERSIONS.—Considerable water diverted for irrigation above station; amount unknown.

REGULATION.—No water-power plants above station.

ACCURACY.—Results good. Stage-discharge relation permanent under ordinary conditions.

COOPERATION.—Records of current-meter measurements made in January, February, and March furnished by State engineer of New Mexico.

*Discharge measurements of Rio Taos at Los Cordovos, N. Mex., during the year ending Sept. 30, 1915.*

| Date. | Made by— | Gage height. | Discharge. | Date. | Made by— | Gage height. | Discharge. |
|---|---|---|---|---|---|---|---|
| | | *Feet.* | *Sec.-ft.* | | | *Feet.* | *Sec.-ft.* |
| Oct. 18 | J. E. Powers | 1.06 | 22.8 | Feb. 12 | R. S. Watrous | a 1.11 | 39.5 |
| Dec. 3 | do | 1.17 | 33.3 | Mar. 21 | do | 1.15 | 40.5 |
| Jan. 11 | Powers and Watrous | a 1.20 | 28.4 | Apr. 30 | W. R. King | 2.69 | 456 |

a Stage-discharge relation slightly affected by ice.

[1] Published in previous reports as Rio Pueblo de Taos.

*Daily discharge, in second-feet, of Rio Taos at Los Cordovas, N. Mex., for the year ending Sept. 30, 1915.*

| Day. | Oct. | Nov. | Dec. | Jan. | Feb. | Mar. | Apr. | May. | June. | July. | Aug. |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 18 | 28 | 27 | ..... | 29 | 40 | 53 | 465 | 505 | 45 | 7.8 |
| 2 | 18 | 28 | 27 | ..... | 22 | 42 | 53 | 355 | 614 | 39 | 6.6 |
| 3 | 18 | 28 | 36 | ..... | 28 | 44 | 62 | 319 | 598 | 32 | 5.8 |
| 4 | 32 | 27 | 22 | ..... | 24 | 35 | 70 | 291 | 505 | 30 | 5.6 |
| 5 | 25 | 26 | 25 | ..... | 20 | 33 | 90 | 295 | 465 | 24 | 5.8 |
| 6 | 24 | 26 | 21 | ..... | 18 | 38 | 104 | 279 | 465 | 21 | 7.0 |
| 7 | 22 | 26 | 21 | ..... | 22 | 39 | 107 | 255 | 456 | 16 | 7.4 |
| 8 | 21 | 26 | 21 | ..... | 22 | 38 | 104 | 248 | 411 | 11 | ..... |
| 9 | 21 | 26 | 21 | ..... | 22 | 39 | 100 | 220 | 420 | 8.6 | ..... |
| 10 | 21 | 26 | 21 | ..... | 25 | 36 | 102 | 230 | 456 | 8.6 | ..... |
| 11 | 20 | 26 | 20 | ..... | 30 | 39 | 102 | 279 | 460 | 9.3 | ..... |
| 12 | 21 | 26 | 21 | ..... | 40 | 41 | 104 | 402 | 490 | 10 | ..... |
| 13 | 21 | 26 | 21 | ..... | 38 | 33 | 130 | 704 | 420 | 8.6 | ..... |
| 14 | 21 | 26 | 20 | ..... | 35 | 59 | 154 | 848 | 393 | 6.2 | ..... |
| 15 | 22 | 25 | 16 | ..... | 30 | 48 | 168 | 920 | 323 | 5.0 | ..... |
| 16 | 24 | 24 | 17 | ..... | 25 | 51 | 205 | 812 | 287 | 5.0 | ..... |
| 17 | 24 | 24 | 17 | ..... | 30 | 50 | 255 | 764 | 267 | 5.0 | ..... |
| 18 | 24 | 23 | 18 | ..... | 35 | 50 | 275 | 776 | 255 | 4.8 | ..... |
| 19 | 23 | 23 | 18 | ..... | 30 | 52 | 255 | 728 | 275 | 4.6 | ..... |
| 20 | 23 | 21 | 26 | ..... | 35 | 45 | 271 | 598 | 255 | 3.2 | ..... |
| 21 | 23 | 21 | 30 | ..... | 30 | 46 | 307 | 447 | 238 | 3.2 | ..... |
| 22 | 34 | 24 | 26 | ..... | 25 | 37 | 339 | 438 | 205 | 3.6 | ..... |
| 23 | 31 | 23 | 24 | ..... | 28 | 44 | 331 | 343 | 179 | 3.8 | ..... |
| 24 | 31 | 23 | 22 | ..... | 31 | 44 | 319 | 335 | 162 | 4.2 | ..... |
| 25 | 30 | 23 | 20 | ..... | 37 | 48 | 327 | 420 | 157 | 4.4 | ..... |
| 26 | 29 | 22 | 20 | ..... | 40 | 48 | 323 | 456 | 137 | 6.0 | ..... |
| 27 | 29 | 23 | 20 | ..... | 40 | 51 | 327 | 542 | 115 | 14 | ..... |
| 28 | 28 | 23 | 20 | ..... | 45 | 53 | 380 | 475 | 96 | 10 | ..... |
| 29 | 29 | 27 | 18 | 26 | ..... | 59 | 456 | 490 | 77 | 9.8 | ..... |
| 30 | 29 | 27 | 16 | 29 | ..... | 58 | 490 | 490 | 59 | 9.4 | ..... |
| 31 | 28 | ..... | 16 | 35 | ..... | 59 | ..... | 490 | ..... | 9.0 | ..... |

NOTE.—Discharge determined as follows: Oct. 1 to Dec. 24, Jan. 29 to Feb. 4, and Feb. 23 to Apr. 14, by indirect method for shifting control; Apr. 15 to May 29, May 31 to July 3, July 5–10, and July 12 to Aug. 7, from a well-defined curve; Dec. 25–31 and Feb. 5–22, from current-meter measurements, information furnished by the observer, and climatic data; May 30, July 4, and July 11, by interpolation.

*Monthly discharge of Rio Taos at Los Cordovas, N. Mex., for the year ending Sept. 30, 1915.*

| Month. | Discharge in second-feet. | | | Run-off (total in acre-feet). | Accuracy. |
|---|---|---|---|---|---|
| | Maximum. | Minimum. | Mean. | | |
| October | 34 | 18 | 24.6 | 1,510 | B. |
| November | 28 | 21 | 24.9 | 1,480 | B. |
| December | 36 | 16 | 21.5 | 1,320 | C. |
| January | ..... | ..... | [a] 23.0 | 1,410 | C. |
| February | 45 | 18 | 29.9 | 1,660 | C. |
| March | 59 | 33 | 45.1 | 2,770 | B. |
| April | 490 | 53 | 212 | 12,600 | B. |
| May | 920 | 220 | 475 | 29,200 | B. |
| June | 614 | 59 | 325 | 19,300 | C. |
| July | 45 | 3.2 | 12.1 | 744 | C. |
| August 1–7 | 7.8 | 5.6 | 6.57 | 91 | C. |
| The period | 920 | 3.2 | 121 | 72,100 | |

[a] Estimated.

### RIO LUCERO NEAR TAOS, N. MEX.

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

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

RECORDS AVAILABLE.—December 17, 1910, to September 30, 1915. Fragmentary records from March to October, 1910.

GAGE.—Bristol water-stage recorder installed on right bank December 17, 1910, at same site and datum as original gage installed April 7, 1910.

DISCHARGE MEASUREMENTS.—Made by wading.

CHANNEL AND CONTROL.—Bed composed of rock, gravel, and sand; water flows through a series of pools and rapids. Banks of medium height but not subject to overflow as discharge is small. Position of control unknown but shifting.

EXTREMES OF DISCHARGE.—Maximum stage recorded during the year and the period 1910–1915, 2.25 feet June 12, 1915 (discharge, 174 second-feet); minimum stage recorded, 0.25 foot (ice) March 7 and 8, 1915 (discharge, 4.5 second-feet).

WINTER FLOW.—Stage-discharge relation seriously affected by ice; flow estimated from current-meter measurements, observer's notes, and records of precipitation and temperature.

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

REGULATION.—No power plants or controlling works above station.

ACCURACY.—Results fair. Changes in stage-discharge relation, due to effect of ice, impair accuracy of winter records. Gage should be read to hundredths to insure accurate determination of discharge of a stream the size of this, but water-stage recorder will not give readings closer than half-tenths.

COOPERATION.—Record of current-meter measurement made in February furnished by State engineer of New Mexico.

*Discharge measurements of Rio Lucero near Taos, N. Mex., during the year ending Sept. 30, 1915.*

| Date. | Made by— | Gage height. | Discharge. | Date. | Made by— | Gage height. | Discharge. |
|---|---|---|---|---|---|---|---|
| | | *Feet.* | *Sec.-ft.* | | | *Feet.* | *Sec.-ft.* |
| Oct. 17 | J. E. Powers | 1.05 | 12.6 | Apr. 30 | W. R. King | 1.65 | 65.7 |
| Dec. 2 | do | [a] 1.05 | 8.9 | Sept. 10 | Follansbee and King | 1.08 | 13.0 |
| Feb. 11 | R. S. Watrous | [a] .98 | 5.6 | | | | |

[a] Stage-discharge relation affected by ice.

*Daily discharge, in second-feet, of Rio Lucero near Taos, N. Mex., for the year ending Sept. 30, 1915.*

| Day. | Oct. | Nov. | Dec. | Jan. | Feb. | Mar. | Apr. | May. | June. | July. | Aug. | Sept. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 15 | 13 | 8.0 | 6.0 | 5.0 | 5.0 | 15 | 53 | 66 | 91 | 30 | 16 |
| 2 | 15 | 13 | 8.0 | 6.0 | 5.2 | 5.0 | 18 | 47 | 91 | 80 | 30 | 19 |
| 3 | 17 | 13 | 8.0 | 7.0 | 5.2 | 5.0 | 24 | 41 | 91 | 72 | 30 | 19 |
| 4 | 23 | 13 | 9.0 | 7.0 | 5.5 | 5.0 | 28 | 36 | 74 | 65 | 34 | 16 |
| 5 | 21 | 13 | 10 | 6.5 | 5.8 | 5.0 | 32 | 36 | 59 | 58 | 30 | 10 |
| 6 | 21 | 12 | 10 | 7.0 | 5.8 | 5.0 | 32 | 36 | 59 | 65 | 26 | 12 |
| 7 | 21 | 12 | 9.0 | 7.0 | 5.8 | 4.5 | 32 | 36 | 66 | 58 | 34 | 12 |
| 8 | 21 | 12 | 9.0 | 7.0 | 5.8 | 4.5 | 28 | 36 | 82 | 52 | 34 | 10 |
| 9 | 18 | 12 | 9.0 | 7.0 | 5.8 | 5.0 | 24 | 36 | 126 | 52 | 30 | 9.0 |
| 10 | 18 | 12 | 9.0 | 6.0 | 5.2 | 5.0 | 28 | 36 | 136 | 65 | 34 | 12 |
| 11 | 16 | 12 | 9.0 | 6.0 | 5.6 | 4.6 | 28 | 41 | 155 | 58 | 34 | 12 |
| 12 | 16 | 12 | 9.0 | 6.0 | 5.6 | 5.0 | 32 | 59 | 174 | 58 | 39 | 12 |
| 13 | 16 | 12 | 8.0 | 5.8 | 5.0 | 5.0 | 32 | 66 | 136 | 58 | 34 | 11 |
| 14 | 14 | 12 | 6.0 | 5.8 | 5.0 | 5.2 | 36 | 91 | 117 | 58 | 30 | 11 |
| 15 | 14 | 10 | 5.0 | 5.8 | 5.0 | 5.6 | 36 | 82 | 117 | 58 | 22 | 11 |
| 16 | 12 | 8.8 | 6.5 | 6.5 | 5.4 | 5.8 | 32 | 66 | 126 | 52 | 26 | 10 |
| 17 | 12 | 8.8 | 10 | 6.0 | 6.0 | 5.8 | 36 | 66 | 126 | 46 | 22 | 10 |
| 18 | 12 | 9.9 | 9.0 | 5.8 | 6.0 | 6.0 | 28 | 74 | 145 | 35 | 26 | 10 |
| 19 | 11 | 9.9 | 8.0 | 5.8 | 6.0 | 9.9 | 28 | 53 | 164 | 40 | 30 | 9.0 |
| 20 | 12 | 9.9 | 6.5 | 5.5 | 6.5 | 13 | 28 | 41 | 145 | 46 | 26 | 8.0 |
| 21 | 12 | 9.9 | 5.0 | 5.2 | 5.8 | 11 | 32 | 32 | 136 | 40 | 22 | 10 |
| 22 | 16 | 9.6 | 6.5 | 5.0 | 5.2 | 11 | 41 | 32 | 155 | 34 | 16 | 9.0 |
| 23 | 16 | 8.4 | 8.0 | 5.0 | 5.4 | 11 | 36 | 36 | 164 | 39 | 16 | 12 |
| 24 | 16 | 8.4 | 8.0 | 5.0 | 5.0 | 13 | 36 | 41 | 145 | 34 | 22 | 14 |
| 25 | 16 | 8.4 | 8.0 | 5.0 | 5.2 | 15 | 36 | 53 | 126 | 30 | 22 | 12 |
| 26 | 14 | 8.2 | 9.0 | 5.0 | 5.2 | 18 | 36 | 59 | 117 | 45 | 25 | 8.0 |
| 27 | 14 | 8.2 | 6.5 | 5.0 | 5.0 | 21 | 47 | 53 | 99 | 45 | 22 | 7.0 |
| 28 | 14 | 9.3 | 7.0 | 5.0 | 4.6 | 21 | 59 | 53 | 91 | 50 | 16 | 8.0 |
| 29 | 13 | 8.2 | 6.5 | 5.0 | ..... | 18 | 66 | 53 | 91 | 45 | 14 | 9.0 |
| 30 | 15 | 8.2 | 6.0 | 5.0 | ..... | 9.9 | 66 | 53 | 91 | 39 | 16 | 10 |
| 31 | 15 | ..... | 6.0 | 5.0 | ..... | 15 | ..... | 59 | ..... | 34 | 19 | ..... |

NOTE.—Discharge determined as follows: Oct. 1 to Dec. 13, Dec. 17–20, Dec. 22–29, Jan. 3–12, and July 2 to Aug. 21, by indirect method for shifting control; Mar. 19 to July 1, Aug. 22 to Sept. 12, and Sept. 18–30, from a well-defined rating curve; Dec. 14–16, Dec. 21, Dec. 30 to Jan. 2, and Jan. 13 to Mar. 18, from current-meter measurements, information furnished by the observer, and climatic data; Sept. 13–17, by interpolation and information furnished by Survey engineer.

*Monthly discharge of Rio Lucero near Taos, N. Mex., for the year ending Sept. 30, 1915.*

| Month. | Discharge in second-feet. | | | Run-off (total in acre-feet). | Accuracy. |
|---|---|---|---|---|---|
| | Maximum. | Minimum. | Mean. | | |
| October | 23 | 11 | 15.7 | 965 | B. |
| November | 13 | 8.2 | 10.6 | 631 | C. |
| December | 10 | 5.0 | 7.82 | 481 | C. |
| January | 7.0 | 5.0 | 5.83 | 358 | D. |
| February | 6.5 | 4.6 | 5.45 | 303 | D. |
| March | 21 | 4.5 | 8.99 | 553 | C. |
| April | 66 | 15 | 34.4 | 2,050 | B. |
| May | 91 | 32 | 50.2 | 3,090 | B. |
| June | 174 | 59 | 116 | 6,900 | B. |
| July | 91 | 30 | 51.7 | 3,180 | B. |
| August | 39 | 14 | 26.2 | 1,610 | B. |
| September | 19 | 7.0 | 11.3 | 672 | C. |
| The year | 174 | 4.5 | 28.7 | 20,800 | |

### RIO FERNANDO DE TAOS NEAR TAOS, N. MEX.

LOCATION.—In sec. 21, T. 25 N., R. 13 E., 200 yards upstream from the head gate of B. G. Randall's ditch, at mouth of canyon, 2 miles southeast of Taos, near center of Taos County.

DRAINAGE AREA.—Not measured.

RECORDS AVAILABLE.—October 5, 1912, to July 31, 1915, when station was discontinued. Fragmentary records April 6, 1910. to October 4, 1912.

GAGE.—Vertical staff on left bank just above wagon-road ford; read daily by Sadie Witt.

DISCHARGE MEASURMENTS.—Made by wading.

CHANNEL AND CONTROL.—Bed composed of gravel and sand; shifts during high stages; water flows in a series of pools and rapids. Banks not likely to overflow as discharge of stream is small. Position of control not known.

EXTREMES OF DISCHARGE.—Maximum stage recorded during year, 2.20 feet at 6 p. m. April 30 (discharge, 118 second-feet); minimum stage recorded, 0.88 foot December 3 (discharge, 1.2 second-feet).

1910–1915: Maximum stage recorded April 30, 1915 (see preceding paragraph); minimum determined discharge, 0.2 second-foot, August 30, 1913.

WINTER FLOW.—Stage-discharge relation not seriously affected by ice, formation of which is prevented by springs just above gage.

DIVERSIONS.—Only very small quantities of water diverted above station; several diversions below.

REGULATIONS.—No water-power plants or controlling works above station.

ACCURACY.—Results good. Stage-discharge relation subject to change during high stages, but usually the change is not great, as the ordinary flow is small. The stream being unregulated, one gage reading each day under normal conditions shows the mean stage and flow within the necessary degree of accuracy.

COOPERATION.—Record of current-meter measurements made in January, February, and March furnished by State engineer of New Mexico.

*Discharge measurements of Rio Fernando de Taos, near Taos, N. Mex., during the year ending Sept. 30, 1915.*

| Date. | Made by— | Gage height. | Discharge. | Date. | Made by— | Gage height. | Discharge. |
|---|---|---|---|---|---|---|---|
| | | *Feet.* | *Sec.-ft.* | | | *Feet.* | *Sec.-ft.* |
| Oct. 18 | J. E. Powers | 1.01 | 2.8 | Feb. 12 | R. S. Watrous | 0.98 | 2.8 |
| Dec. 3 | do | .88 | a1.2 | Mar. 21 | do | 1.08 | 5.1 |
| Jan. 11 | Powers and Watrous | 1.02 | 3.3 | Apr. 30 | W. R. King | 2.00 | 86 |

a Estimated.

*Daily discharge, in second-feet, of Rio Fernando de Taos near Taos, N. Mex., for the year ending Sept. 30, 1915.*

| Day. | Oct. | Nov. | Dec. | Jan. | Feb. | Mar. | Apr. | May. | June. | July. |
|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 2.9 | 4.2 | 2.4 | 2.5 | 3.0 | 3.2 | 9.0 | 86 | 68 | 9.0 |
| 2 | 2.9 | 3.8 | 2.2 | 2.7 | 2.9 | 3.2 | 8.7 | 83 | 63 | 9.0 |
| 3 | 2.9 | 3.6 | 2.1 | 2.7 | 2.7 | 3.2 | 17 | 71 | 58 | 9.0 |
| 4 | 7.7 | 3.3 | 2.0 | 2.7 | 2.5 | 3.2 | 31 | 68 | 58 | 8.3 |
| 5 | 4.7 | 3.1 | 2.0 | 2.5 | 2.4 | 3.2 | 23 | 71 | 63 | 7.7 |
| 6 | 4.7 | 2.9 | 2.2 | 2.7 | 2.4 | 3.2 | 16 | 78 | 57 | 7.0 |
| 7 | 2.9 | 2.9 | 2.5 | 2.9 | 2.5 | 3.2 | 18 | 64 | 48 | 6.4 |
| 8 | 2.9 | 2.9 | 2.7 | 2.9 | 2.5 | 3.2 | 18 | 58 | 41 | 5.7 |
| 9 | 2.9 | 2.9 | 2.9 | 2.9 | 2.7 | 3.2 | 27 | 64 | 39 | 5.4 |
| 10 | 2.9 | 2.9 | 3.6 | 2.9 | 3.2 | 3.2 | 35 | 64 | 36 | 5.4 |
| 11 | 3.8 | 2.9 | 4.3 | 3.0 | 3.2 | 3.4 | 35 | 68 | 33 | 5.4 |
| 12 | 3.8 | 2.9 | 4.7 | 3.2 | 3.2 | 3.4 | 23 | 86 | 31 | 5.4 |
| 13 | 3.8 | 2.9 | 4.7 | 3.2 | 3.2 | 3.4 | 23 | 89 | 29 | 5.4 |
| 14 | 3.8 | 2.9 | 4.0 | 3.4 | 3.0 | 3.4 | 23 | 104 | 26 | 5.2 |
| 15 | 3.8 | 3.3 | 3.1 | 3.2 | 2.9 | 3.4 | 43 | 104 | 23 | 4.7 |
| 16 | 3.4 | 3.3 | 2.6 | 3.2 | 2.9 | 3.7 | 25 | 108 | 21 | 4.2 |
| 17 | 3.4 | 3.4 | 2.4 | 3.2 | 2.9 | 3.7 | 71 | 108 | 18 | 4.2 |
| 18 | 3.4 | 3.6 | 2.4 | 3.2 | 2.9 | 3.7 | 71 | 108 | 17 | 4.2 |
| 19 | 3.4 | 3.6 | 2.2 | 3.2 | 2.9 | 3.7 | 45 | 110 | 15 | 4.2 |
| 20 | 3.1 | 2.7 | 2.4 | 3.2 | 3.2 | 4.7 | 31 | 89 | 15 | 4.7 |
| 21 | 3.1 | 2.7 | 2.4 | 3.2 | 3.2 | 5.2 | 52 | 74 | 14 | 4.7 |
| 22 | 4.7 | 2.7 | 2.4 | 3.2 | 3.2 | 5.7 | 58 | 72 | 13 | 4.4 |
| 23 | 4.7 | 2.7 | 2.4 | 3.2 | 3.2 | 6.0 | 45 | 66 | 13 | 4.4 |
| 24 | 4.7 | 2.7 | 2.4 | 3.2 | 3.2 | 6.7 | 37 | 62 | 12 | 4.4 |
| 25 | 4.7 | 2.6 | 2.4 | 3.2 | 3.2 | 6.7 | 40 | 58 | 11 | 4.4 |
| 26 | 4.7 | 2.5 | 2.4 | 3.2 | 3.2 | 5.7 | 40 | 86 | 11 | 5.7 |
| 27 | 4.7 | 2.5 | 2.4 | 3.2 | 3.2 | 7.0 | 45 | 86 | 10 | 5.7 |
| 28 | 4.7 | 2.4 | 2.4 | 3.2 | 3.2 | 9.8 | 78 | 74 | 9.0 | 5.7 |
| 29 | 4.7 | 2.4 | 2.2 | 3.2 | ..... | 9.8 | 101 | 63 | 9.0 | 5.2 |
| 30 | 4.5 | 2.4 | 2.2 | 3.2 | ..... | 12 | 86 | 74 | 9.0 | 4.7 |
| 31 | 4.3 | ..... | 2.2 | 3.2 | ..... | 9.8 | ..... | 71 | ..... | 4.2 |

NOTE.—Discharge determined as follows: Oct. 1 to Mar. 10 and Mar. 31 to July 31 from a well-defined curve; Mar. 11–30 by indirect method for shifting control.

*Monthly discharge of Rio Fernando de Taos near Taos, N. Mex., for the year ending Sept. 30, 1915.*

| Month. | Discharge in second-feet. | | | Run-off (total in acre-feet). | Accuracy. |
|---|---|---|---|---|---|
| | Maximum. | Minimum. | Mean. | | |
| October | 7.7 | 2.9 | 3.95 | 243 | A. |
| November | 4.2 | 2.4 | 2.99 | 178 | A. |
| December | 4.7 | 2.0 | 2.68 | 165 | A. |
| January | 3.4 | 2.5 | 3.05 | 188 | B. |
| February | 3.2 | 2.4 | 2.95 | 164 | B. |
| March | 12 | 3.2 | 4.93 | 303 | B. |
| April | 101 | 8.7 | 39.2 | 2,330 | B. |
| May | 110 | 58 | 79.6 | 4,890 | B. |
| June | 68 | 9.0 | 29.0 | 1,730 | B. |
| July | 9.0 | 4.2 | 5.61 | 345 | B. |
| The period | ..... | ..... | ..... | 10,500 | |

### CHAMA RIVER NEAR CHAMA, N. MEX.

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

DRAINAGE AREA.—Not measured.

RECORDS AVAILABLE.—May 27, 1914, to September 30, 1915. From September 23, 1912, to May 26, 1914, a station was maintained on Chama River at Chama, 2 miles upstream; intervening tributaries unimportant.

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

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

CHANNEL AND CONTROL.—Bed composed of sand, gravel, and rock; shifts only during extremely high stages. Banks are of medium height and are overflowed at extremely high stages.

EXTREMES OF DISCHARGE.—Maximum stage recorded during year, 3.95 feet at 11 p. m., May 15 (discharge, computed from extension of rating curve, 1,430 second-feet); minimum stage recorded, 1.75 feet (ice) December 9 (discharge, 19 second-feet).

WINTER FLOW.—Stage-discharge relation seriously affected by ice; flow estimated from current-meter measurements, observer's notes, and records of precipitation and temperature.

DIVERSIONS.—The city ditch diverts approximately 2 second-feet above the station from June to September.

REGULATION.—None.

ACCURACY.—Results fair for open season and poor for winter period. Flow is somewhat erratic at this point, but stage-discharge relation is permanent during ordinary stages and changes cause little error in determinations.

COOPERATION.—Record of current-meter measurements made in January and February furnished by State engineer of New Mexico.

*Discharge measurements of Chama River near Chama, N. Mex., during the year ending Sept. 30, 1915.*

| Date. | Made by— | Gage height. | Discharge. | Date. | Made by— | Gage height. | Discharge. |
|---|---|---|---|---|---|---|---|
| | | *Feet.* | *Sec.-ft.* | | | *Feet.* | *Sec.-ft.* |
| Oct. 27 | R. S. Watrous | 2.11 | 85.7 | Feb. 15 | R. S. Watrous | 2.15 | a 30.8 |
| 30 | do | 2.05 | 78.2 | Mar. 25 | W. R. King | 1.98 | 61.6 |
| Dec. 9 | do | 1.75 | a 18.9 | June 6 | do | 3.12 | 525 |
| Jan. 13 | do | 2.40 | a 27.0 | Sept. 6 | Follansbee and King | 1.80 | 49.6 |

a Stage-discharge relation affected by ice.

*Daily discharge, in second-feet, of Chama River near Chama, N. Mex., for the year ending Sept. 30, 1915.*

| Day. | Oct. | Nov. | Dec. | Jan. | Feb. | Mar. | Apr. | May. | June. | July. | Aug. | Sept. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 49 | 81 | 34 | ..... | ..... | ..... | 93 | 655 | 835 | 245 | 95 | 30 |
| 2 | 53 | 81 | 35 | ..... | ..... | ..... | 119 | 501 | 932 | 229 | 89 | 28 |
| 3 | 197 | 79 | 36 | ..... | ..... | ..... | 170 | 457 | 715 | 225 | 81 | 32 |
| 4 | 356 | 76 | 35 | ..... | ..... | ..... | 193 | 409 | 601 | 245 | 73 | 50 |
| 5 | 177 | 74 | 35 | ..... | ..... | ..... | 241 | 373 | 541 | 245 | 65 | 95 |
| 6 | 154 | 67 | 32 | ..... | ..... | ..... | 249 | 340 | 533 | 245 | 65 | 42 |
| 7 | 142 | 62 | 30 | ..... | ..... | ..... | 193 | 297 | 533 | 265 | 67 | 33 |
| 8 | 132 | 59 | 25 | ..... | ..... | ..... | 189 | 297 | 601 | 155 | 75 | 30 |
| 9 | 125 | 56 | 25 | ..... | ..... | ..... | 179 | 344 | 655 | 134 | 115 | 28 |
| 10 | 110 | 53 | 25 | ..... | ..... | ..... | 161 | 391 | 705 | 131 | 105 | 27 |
| 11 | 104 | 50 | 25 | ..... | ..... | ..... | 213 | 438 | 805 | 140 | 85 | 25 |
| 12 | 94 | 49 | 20 | ..... | ..... | ..... | 285 | 485 | 855 | 155 | 65 | 23 |
| 13 | 92 | 49 | 20 | 27 | ..... | ..... | 361 | 725 | 835 | 125 | 53 | 22 |
| 14 | 85 | 48 | 20 | ..... | ..... | ..... | 403 | 1,080 | 675 | 115 | 49 | 24 |
| 15 | 83 | 48 | 20 | ..... | 31 | ..... | 422 | 1,070 | 565 | 101 | 47 | 23 |
| 16 | 79 | 45 | 25 | ..... | ..... | ..... | 320 | 1,130 | 692 | 87 | 40 | 22 |
| 17 | 76 | 49 | 25 | ..... | ..... | ..... | 330 | 1,180 | 601 | 81 | 37 | 22 |
| 18 | 74 | 41 | 25 | ..... | ..... | ..... | 320 | 1,080 | 637 | 73 | 35 | 22 |
| 19 | 74 | 49 | 25 | ..... | ..... | ..... | 367 | 850 | 695 | 60 | 32 | 22 |
| 20 | 74 | 49 | 25 | ..... | ..... | ..... | 493 | 700 | 665 | 77 | 29 | 22 |
| 21 | 98 | 48 | 30 | ..... | ..... | ..... | 565 | 501 | 610 | 65 | 28 | 21 |
| 22 | 165 | 46 | 35 | ..... | ..... | ..... | 517 | 485 | 610 | 58 | 30 | 20 |
| 23 | 140 | 49 | 35 | ..... | ..... | ..... | 464 | 574 | 583 | 53 | 35 | 20 |
| 24 | 114 | 50 | 35 | ..... | ..... | ..... | 429 | 675 | 549 | 60 | 33 | 21 |
| 25 | 110 | 48 | 35 | ..... | ..... | 59 | 443 | 665 | 443 | 75 | 33 | 91 |
| 26 | 106 | 49 | 30 | ..... | ..... | 79 | 501 | 565 | 373 | 655 | 59 | 56 |
| 27 | 102 | 42 | 30 | ..... | ..... | 97 | 646 | 517 | 335 | 755 | 35 | 40 |
| 28 | 96 | 46 | 30 | ..... | ..... | 111 | 745 | 509 | 315 | 285 | 30 | 36 |
| 29 | 90 | 40 | 30 | ..... | ..... | 111 | 835 | 583 | 297 | 185 | 30 | 31 |
| 30 | 86 | 36 | 25 | ..... | ..... | 104 | 943 | 646 | 285 | 134 | 45 | 31 |
| 31 | 85 | ..... | 25 | ..... | ..... | 93 | ..... | 735 | ..... | 109 | 35 | ..... |

NOTE.—Discharge determined as follows: Oct. 1–25, Mar. 25 to May 8, May 12–18, and May 21 to Sept. 30, from a well-defined curve; Oct. 26 to Dec. 6 by indirect method for shifting control; Dec. 7–31, Jan. 13, and Feb. 15, from current-meter measurements and climatic data; May 9–11 and May 19 and 20, by interpolation and comparison of records of near-by stations.

*Monthly discharge of Chama River near Chama, N. Mex., for the year ending Sept. 30, 1915.*

| Month. | Discharge in second-feet. | | | Run-off (total in acre-feet). | Accuracy. |
|---|---|---|---|---|---|
| | Maximum. | Minimum. | Mean. | | |
| October | 356 | 49 | 114 | 7,010 | B. |
| November | 81 | 36 | 54.0 | 3,210 | B. |
| December | 36 | 20 | 28.5 | 1,750 | D. |
| January | ..... | ..... | [a] 25.0 | 1,540 | |
| February | ..... | ..... | [a] 22.0 | 1,220 | |
| March | ..... | ..... | [a] 45.0 | 2,770 | |
| April | 943 | 93 | 380 | 22,600 | C. |
| May | 1,180 | 297 | 621 | 38,200 | C. |
| June | 932 | 285 | 602 | 35,800 | C. |
| July | 755 | 53 | 177 | 10,900 | C. |
| August | 115 | 28 | 54.7 | 3,360 | C. |
| September | 95 | 20 | 33.0 | 1,960 | C. |
| The year | 1,180 | 20 | 180 | 130,000 | |

[a] Estimated.

### CHAMA RIVER AT PARK VIEW, N. MEX.

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

DRAINAGE AREA.—Not measured.

RECORDS AVAILABLE.—November 25, 1912, to September 30, 1915.

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

DISCHARGE MEASUREMENTS.—Made from bridge or by wading.

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

EXTREMES OF DISCHARGE.—1912–1915: Maximum stage recorded, 6.03 feet at 11 p. m. May 16, 1915 (discharge, computed from extension of rating curve, 3,290 second-feet); minimum stage recorded, 3.05 feet September 24, 1915 (discharge, 16 second-feet).

WINTER FLOW.—Stage-discharge relation seriously affected by ice; flow estimated from current-meter measurements, observer's notes, and records of precipitation and temperature.

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

REGULATION.—No water-power plants above station.

ACCURACY.—Results poor for winter period and fair for open-water season. Accuracy of determinations impaired by changes in stage-discharge relation due to severe effect of ice and shifts in control during extremely high stages.

COOPERATION.—Record of current-meter measurement made in January and February furnished by State engineer of New Mexico.

*Discharge measurements of Chama River at Park View, N. Mex., during the year ending Sept. 30, 1915.*

| Date. | Made by— | Gage height. | Discharge. | Date. | Made by— | Gage height. | Discharge. |
|---|---|---|---|---|---|---|---|
| | | *Feet.* | *Sec.-ft.* | | | *Feet.* | *Sec.-ft.* |
| Oct. 28 | R. S. Watrous | 3.12 | 232 | Mar. 27 | W. R. King | 3.25 | 336 |
| Dec. 10 | do | 2.78 | [a] 60.3 | June 6 | do | 4.85 | 1,720 |
| Jan. 14 | do | 3.40 | [a] 56.7 | Sept. 6 | Follansbee and King | 3.30 | 84.7 |
| Feb. 15 | do | 3.28 | [a] 50.6 | | | | |

[a] Stage-discharge relation affected by ice.

*Daily discharge, in second-feet, of Chama River at Park View, N. Mex., for the year ending Sept. 30, 1915.*

| Day. | Oct. | Nov. | Dec. | Jan. | Feb. | Mar. | Apr. | May. | June. | July. | Aug. | Sept. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 103 | 184 | 71 | ..... | ..... | ..... | 252 | 1,230 | 2,510 | 620 | 234 | 60 |
| 2 | 105 | 177 | 77 | ..... | ..... | ..... | 300 | 967 | 2,730 | 564 | 204 | 52 |
| 3 | 194 | 167 | 67 | ..... | ..... | ..... | 372 | 834 | 2,270 | 564 | 180 | 58 |
| 4 | 418 | 161 | 60 | ..... | ..... | ..... | 408 | 778 | 1,940 | 522 | 156 | 90 |
| 5 | 276 | 152 | 73 | ..... | ..... | ..... | 468 | 722 | 1,880 | 529 | 150 | 134 |
| 6 | 249 | 147 | 71 | ..... | ..... | ..... | 508 | 655 | 1,880 | 536 | 156 | 92 |
| 7 | 228 | 138 | 69 | ..... | ..... | ..... | 450 | 606 | 1,920 | 402 | 228 | 72 |
| 8 | 213 | 138 | 66 | ..... | ..... | ..... | 444 | 571 | 2,030 | 366 | 264 | 60 |
| 9 | 198 | 130 | 60 | ..... | ..... | ..... | 432 | 606 | 2,080 | 336 | 264 | 54 |
| 10 | 187 | 128 | 60 | ..... | ..... | ..... | 432 | 706 | 2,160 | 318 | 234 | 48 |
| 11 | 174 | 122 | 60 | ..... | ..... | ..... | 474 | 967 | 2,210 | 312 | 216 | 44 |
| 12 | 167 | 115 | 50 | ..... | ..... | ..... | 543 | 1,350 | 2,100 | 294 | 162 | 40 |
| 13 | 161 | 112 | 50 | ..... | ..... | ..... | 585 | 1,930 | 1,870 | 330 | 138 | 38 |
| 14 | 161 | 105 | 50 | 57 | ..... | ..... | 641 | 2,460 | 1,660 | 246 | 116 | 42 |
| 15 | 152 | 94 | 60 | ..... | 51 | ..... | 698 | 2,620 | 1,550 | 234 | 126 | 46 |
| 16 | 155 | 83 | 70 | ..... | ..... | ..... | 620 | 2,820 | 1,500 | 204 | 115 | 58 |
| 17 | 152 | 85 | 70 | ..... | ..... | ..... | 714 | 2,910 | 1,410 | 168 | 100 | 54 |
| 18 | 147 | 81 | 70 | ..... | ..... | ..... | 778 | 2,620 | 1,430 | 144 | 92 | 48 |
| 19 | 147 | 75 | 70 | ..... | ..... | ..... | 714 | 2,080 | 1,460 | 120 | 82 | 48 |
| 20 | 144 | 77 | 75 | ..... | ..... | ..... | 913 | 1,820 | 1,320 | 120 | 78 | 44 |
| 21 | 164 | 75 | 75 | ..... | ..... | ..... | 922 | 1,680 | 1,240 | 156 | 76 | 38 |
| 22 | 276 | 75 | 75 | ..... | ..... | ..... | 931 | 1,620 | 1,200 | 126 | 70 | 38 |
| 23 | 244 | 75 | 80 | ..... | ..... | ..... | 868 | 1,880 | 1,100 | 120 | 68 | 38 |
| 24 | 213 | 79 | 80 | ..... | ..... | ..... | 786 | 2,180 | 1,040 | 144 | 78 | 36 |
| 25 | 220 | 73 | 70 | ..... | ..... | ..... | 738 | 2,260 | 976 | 180 | 80 | 100 |
| 26 | 232 | 71 | 65 | ..... | ..... | 228 | 810 | 1,930 | 904 | 550 | 122 | 137 |
| 27 | 224 | 73 | 65 | ..... | ..... | 276 | 1,020 | 1,840 | 842 | 802 | 88 | 90 |
| 28 | 217 | 73 | 60 | ..... | ..... | 306 | 1,270 | 1,920 | 786 | 468 | 74 | 72 |
| 29 | 213 | 77 | 60 | ..... | ..... | 318 | 1,400 | 2,130 | 722 | 360 | 70 | 62 |
| 30 | 201 | 79 | 60 | ..... | ..... | 282 | 1,610 | 2,170 | 641 | 300 | 90 | 60 |
| 31 | 194 | ..... | 60 | ..... | ..... | 258 | ..... | 2,360 | ..... | 270 | 72 | ..... |

NOTE.—Discharge determined as follows: Oct. 1 to Dec. 8 and June 14 to July 13, by indirect method for shifting controls; Mar. 26 to June 13 and July 14 to Sept. 30, from a well-defined curve; Dec. 9 to 31, Jan. 14, and Feb. 15, by current-meter measurements, records of flow at near-by stations, and climatic data.

*Monthly discharge of Chama River at Park View, N. Mex., for the year ending Sept. 30, 1915.*

| Month. | Discharge in second-feet. | | | Run-off (total in acre-feet). | Accuracy. |
|---|---|---|---|---|---|
| | Maximum. | Minimum. | Mean. | | |
| October | 418 | 103 | 198 | 12,200 | B. |
| November | 184 | 71 | 107 | 6,370 | C. |
| December | 80 | 50 | 66.1 | 4,060 | D. |
| January | ..... | ..... | a 57.0 | 3,500 | |
| February | ..... | ..... | a 50.0 | 2,780 | |
| March | ..... | ..... | a 100 | 6,150 | |
| April | 1,610 | 252 | 703 | 41,800 | B. |
| May | 2,910 | 571 | 1,650 | 101,000 | B. |
| June | 2,730 | 641 | 1,580 | 94,000 | C. |
| July | 802 | 120 | 336 | 20,700 | C. |
| August | 264 | 68 | 135 | 8,300 | C. |
| September | 137 | 36 | 61.8 | 3,680 | C. |
| The year | 2,910 | 36 | 421 | 305,000 | |

a Estimated.

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

LOCATION.—At the mouth of box canyon below El Vado Valley, 1 mile southeast of El Vado, 15 miles southwest of Tierra Amarilla, near center of Rio Arriba County. Nutrias Creek, which is the south line of the Tierra Amarilla land grant, joins Chama River from the north 4 miles below station.

DRAINAGE AREA.—Not measured.

RECORDS AVAILABLE.—September 28, 1913, to September 30, 1915.

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

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

CHANNEL AND CONTROL.—Bed composed of solid rock and gravel; changes are very slight. Both banks high and not subject to overflow. Control is rock reef just below gage.

EXTREMES OF DISCHARGE.—1913–1915: Maximum, 8.30 feet at 2.30 a. m. May 17, 1915 (discharge, 4,030 second-feet, estimated from extension of rating curve); minimum stage recorded, −0.10 foot September 20–24, 1915 (discharge, 28 second-feet).

WINTER FLOW.—Stage-discharge relation seriously affected by ice; flow estimated from current-meter measurements, records of flow at near-by stations, and records of temperature and precipitation.

DIVERSIONS.—Between Park View and this station approximately 3 second-feet diverted from Chama River and 2 second-feet from intervening tributaries during irrigation season.

REGULATION.—None.

ACCURACY.—Results for open-water season good; those for winter period poor, as stage-discharge relation is seriously affected by ice. Small errors introduced by the slight changes in channel probably do not materially affect the determinations.

COOPERATION.—Record of current-meter measurements made in January furnished by State engineer of New Mexico.

*Discharge measurements of Chama River near El Vado, N. Mex., during the year ending Sept. 30, 1915.*

| Date. | Made by— | Gage height. | Discharge. | Date. | Made by— | Gage height. | Discharge. |
|---|---|---|---|---|---|---|---|
| | | *Feet.* | *Sec.-ft.* | | | *Feet.* | *Sec.-ft.* |
| Oct. 29 | R. S. Watrous | 1.18 | 226 | Mar. 27 | W. R. King | 1.87 | 389 |
| Dec. 11 | do | [a].75 | 98.1 | June 5 | do | 5.12 | 1,830 |
| Jan. 20 | do | [a].58 | 80.7 | Sept. 7 | Follansbee and King | .37 | 79.6 |

[a] Stage-discharge relation affected by ice; measurement made at noon when the stream was at its highest stage.

[1] Formerly published as near Tierra Amarilla.

*Daily discharge, in second-feet, of Chama River near El Vado, N. Mex., for the year ending Sept. 30, 1915.*

| Day. | Oct. | Nov. | Dec. | Jan. | Mar. | Apr. | May. | June. | July. | Aug. | Sept. |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 84 | 185 | 76 | ..... | ..... | 373 | 2,180 | 2,820 | 459 | 184 | 82 |
| 2 | 86 | 180 | 76 | ..... | ..... | 490 | 1,640 | 3,300 | 405 | 158 | 68 |
| 3 | 136 | 169 | 71 | ..... | ..... | 602 | 1,300 | 2,650 | 392 | 143 | 49 |
| 4 | 876 | 163 | 71 | ..... | ..... | 663 | 1,180 | 2,110 | 392 | 126 | 87 |
| 5 | 439 | 155 | 81 | ..... | ..... | 785 | 1,060 | 2,010 | 388 | 124 | 166 |
| 6 | 342 | 148 | 80 | ..... | ..... | 972 | 941 | 1,940 | 402 | 132 | 136 |
| 7 | 301 | 142 | 80 | ..... | ..... | 955 | 851 | 1,930 | 330 | 289 | 86 |
| 8 | 267 | 140 | 75 | ..... | ..... | 928 | 769 | 2,120 | 291 | 282 | 70 |
| 9 | 234 | 134 | 70 | ..... | ..... | 872 | 817 | 2,240 | 260 | 260 | 58 |
| 10 | 221 | 122 | 65 | ..... | ..... | 785 | 941 | 2,270 | 241 | 230 | 50 |
| 11 | 192 | 120 | 65 | ..... | ..... | 765 | 1,420 | 2,350 | 230 | 190 | 46 |
| 12 | 176 | 113 | 60 | ..... | ..... | 876 | 2,220 | 2,180 | 223 | 146 | 45 |
| 13 | 163 | 108 | 55 | ..... | ..... | 1,030 | 2,980 | 1,820 | 249 | 124 | 38 |
| 14 | 156 | 104 | 55 | ..... | ..... | 1,120 | 3,490 | 1,540 | 199 | 110 | 40 |
| 15 | 148 | 97 | 60 | ..... | ..... | 1,330 | 3,360 | 1,420 | 174 | 118 | 46 |
| 16 | 142 | 79 | 80 | ..... | ..... | 1,220 | 3,370 | 1,360 | 145 | 105 | 49 |
| 17 | 139 | 74 | 75 | ..... | ..... | 1,920 | 3,470 | 1,340 | 118 | 92 | 43 |
| 18 | 131 | 78 | 70 | ..... | ..... | 2,160 | 3,340 | 1,320 | 106 | 75 | 38 |
| 19 | 125 | 68 | 70 | ..... | ..... | 1,450 | 2,380 | 1,410 | 97 | 68 | 33 |
| 20 | 124 | 71 | 75 | 81 | ..... | 1,830 | 1,940 | 1,300 | 93 | 66 | 28 |
| 21 | 145 | 70 | 80 | ..... | ..... | 1,780 | 1,640 | 1,160 | 124 | 62 | 28 |
| 22 | 494 | 69 | 80 | ..... | ..... | 1,790 | 1,466 | 1,080 | 114 | 64 | 28 |
| 23 | 413 | 74 | 80 | ..... | ..... | 1,660 | 1,800 | 1,030 | 170 | 67 | 28 |
| 24 | 265 | 76 | 80 | ..... | ..... | 1,490 | 2,230 | 946 | 132 | 78 | 28 |
| 25 | 241 | 78 | 75 | ..... | ..... | 1,300 | 2,520 | 838 | 150 | 97 | 115 |
| 26 | 248 | 73 | 75 | ..... | ..... | 1,360 | 2,010 | 777 | 716 | 127 | 200 |
| 27 | 230 | 76 | 70 | ..... | 606 | 1,640 | 1,730 | 704 | 1,270 | 119 | 120 |
| 28 | 230 | 79 | 70 | ..... | 636 | 2,090 | 1,810 | 625 | 515 | 97 | 80 |
| 29 | 219 | 85 | 70 | ..... | 678 | 2,240 | 2,270 | 543 | 330 | 94 | 67 |
| 30 | 205 | 90 | 65 | ..... | 484 | 2,940 | 2,270 | 478 | 260 | 114 | 60 |
| 31 | 196 | ..... | 65 | ..... | 450 | ..... | 2,600 | ..... | 212 | 97 | ..... |

NOTE.—Discharge determined as follows: Oct. 1–26 and Oct. 29 to Dec. 7 by indirect method for shifting controls; Dec. 8–31 and Jan. 20 from current-meter measurements, records of flow at near-by stations, and climatic data; Mar. 27 to Sept. 24 and Sept. 29 from a well-defined curve; Oct. 27 and 28, Sept. 25–28, and Sept. 30 by interpolation, from climatic data, and records of flow of near-by stations.

*Monthly discharge of Chama River near El Vado, N. Mex., for the year ending Sept. 30, 1915.*

| Month. | Discharge in second-feet. | | | Run-off (total in acre-feet). | Accuracy. |
|---|---|---|---|---|---|
| | Maximum. | Minimum. | Mean. | | |
| October | 876 | 84 | 238 | 14,600 | B. |
| November | 185 | 68 | 107 | 6,370 | B. |
| December | 81 | 55 | 71.6 | 4,400 | D. |
| January | ..... | ..... | *a* 65.0 | 4,000 | |
| February | ..... | ..... | *a* 60.0 | 3,330 | |
| March | ..... | ..... | *a* 178 | 10,900 | |
| April | 2,940 | 373 | 1,310 | 78,000 | A. |
| May | 3,490 | 769 | 2,000 | 123,000 | B. |
| June | 3,300 | 478 | 1,590 | 94,600 | A. |
| July | 1,270 | 93 | 296 | 18,200 | A. |
| August | 289 | 62 | 130 | 7,990 | A. |
| September | 200 | 28 | 67.1 | 4,000 | C. |
| The year | 3,490 | 28 | 510 | 369,000 | |

*a* Estimated.

### CHAMA RIVER NEAR CHAMITA, N. MEX.

LOCATION.—In sec. 15, T. 21 N., R. 8 E., at Denver & Rio Grande Railroad bridge, 1 mile south of Chamita, 4 miles above Espanola, half a mile above mouth, in southeastern part of Rio Arriba County.

DRAINAGE AREA.—Not measured.

RECORDS AVAILABLE.—October 10, 1912, to June 30, 1915, when station was discontinued.

GAGE.—Friez water-stage recorder on downstream side of middle pier of railroad bridge.

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

CHANNEL AND CONTROL.—Bed composed of sand; subject to extreme shifting. Channel wide; banks low; in some places several channels.

EXTREMES OF DISCHARGE.—Maximum stage recorded during year, 4.85 feet at 4 p. m., June 3 (discharge, 5,980 second-feet); minimum stage recorded, 1.49 feet (ice) December 13 (dischage, 40 second-feet).

1912–1915: Maximum stage recorded June 3, 1915; stream frozen solid, no flow, January 24, 1913.

WINTER FLOW.—Stage-discharge relation seriously affected by ice; flow estimated from current-meter measurements, observer's notes, and records of precipitation and temperature.

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

REGULATION.—None.

ACCURACY.—Results fair, owing to uncertainty of stage-discharge relation, and the difficulty of making accurate current-meter measurements during high stages from the bridge.

COOPERATION.—Record of current-meter measurements made in February furnished by State engineer of New Mexico.

*Discharge measurements of Chama River near Chamita, N. Mex., during the year ending Sept. 30, 1915.*

| Date. | Made by— | Gage height. | Discharge. | Date. | Made by— | Gage height. | Discharge. |
|---|---|---|---|---|---|---|---|
| | | *Feet.* | *Sec.-ft.* | | | *Feet.* | *Sec.-ft.* |
| Oct. 21 | J. E. Powers | 1.67 | 219 | Feb. 6 | R. S. Watrous | (*a*) | 47.8 |
| Dec. 2 | R. S. Watrous | 1.44 | 111 | Mar. 24 | W. R. King | 1.76 | 380 |
| 9 | J. E. Powers | *a* 1.50 | 65.5 | Apr. 26 | do | 3.20 | 2,400 |
| 29 | R. S. Watrous | *a* 1.52 | 102 | June 2 | do | 4.49 | 4,730 |
| Feb. 2 | do | (*a*) | 60.5 | | | | |

*a* Stage-discharge relation affected by ice.

*Daily discharge, in second-feet, of Chama River near Chamita, N. Mex., for the year ending Sept. 30, 1915.*

| Day. | Oct. | Nov. | Dec. | Feb. | Mar. | Apr. | May. | June. |
|---|---|---|---|---|---|---|---|---|
| 1 | 88 | 314 | 165 | 65 | 208 | 570 | 3,960 | 4,150 |
| 2 | 108 | 278 | 132 | 65 | 226 | 510 | 3,310 | 4,440 |
| 3 | 132 | 285 | 104 | 60 | 175 | 736 | 2,870 | 5,730 |
| 4 | 306 | 271 | 91 | 60 | 196 | 928 | 2,760 | 5,380 |
| 5 | 1,090 | 244 | 100 | 55 | 196 | 1,240 | 2,500 | 5,210 |
| 6 | 490 | 264 | 100 | 50 | 170 | 1,400 | 2,420 | 5,040 |
| 7 | 427 | 250 | 70 | 55 | 150 | 1,490 | 2,470 | 4,840 |
| 8 | 368 | 244 | 60 | 55 | 140 | 1,610 | 2,270 | 4,700 |
| 9 | 320 | 250 | 65 | 60 | 140 | 1,530 | 2,100 | 4,570 |
| 10 | 278 | 238 | 70 | 60 | 140 | 1,510 | 2,200 | 4,700 |
| 11 | 271 | 220 | 60 | 65 | 145 | 1,450 | 2,710 | 4,870 |
| 12 | 232 | 208 | 50 | 65 | 170 | 1,530 | 3,040 | 4,770 |
| 13 | 214 | 196 | 40 | 70 | 170 | 1,710 | 3,800 | 4,440 |
| 14 | 208 | 190 | 60 | 70 | 185 | 1,880 | 4,540 | 4,110 |
| 15 | 226 | 180 | 100 | 75 | 175 | 2,630 | 4,600 | 3,960 |
| 16 | 214 | 160 | 120 | 82 | 214 | 2,870 | 5,480 | 3,650 |
| 17 | 190 | 155 | 110 | 128 | 264 | 3,860 | 5,310 | 3,520 |
| 18 | 196 | 140 | 100 | 160 | 314 | 3,990 | 5,620 | 3,580 |
| 19 | 196 | 124 | 80 | 150 | 392 | 3,190 | 4,570 | 3,580 |
| 20 | 202 | 120 | 60 | 170 | 445 | 2,960 | 4,370 | 3,430 |
| 21 | 196 | 120 | 50 | 165 | 328 | 3,340 | 4,050 | 2,990 |
| 22 | 360 | 104 | 100 | 170 | 292 | 3,130 | 3,100 | 2,580 |
| 23 | 1,090 | 104 | 120 | 165 | 376 | 2,790 | 2,400 | 2,320 |
| 24 | 656 | 104 | 125 | 155 | 612 | 2,550 | 2,600 | 2,370 |
| 25 | 427 | 108 | 125 | 175 | 784 | 2,300 | 3,190 | 2,580 |
| 26 | 368 | 120 | 120 | 180 | 888 | 2,400 | 2,660 | 2,200 |
| 27 | 400 | 132 | 110 | 180 | 1,030 | 2,600 | 3,370 | 2,150 |
| 28 | 368 | 128 | 100 | 190 | 1,040 | 3,160 | 3,340 | 1,810 |
| 29 | 352 | 140 | 100 | ..... | 1,000 | 3,550 | 4,270 | 1,550 |
| 30 | 336 | 165 | 90 | ..... | 942 | 4,500 | 3,490 | 1,140 |
| 31 | 320 | ..... | 80 | ..... | 808 | ..... | 4,270 | ..... |

NOTE.—Discharge determined as follows: Oct. 1 to Dec. 5 and Feb. 16 to June 30 by indirect method for shifting control; Dec. 6–31 and Feb. 1–15 from current-meter measurements, records of flow at other stations in the drainage basin, and climatic data.

*Monthly discharge of Chama River near Chamita, N. Mex., for the year ending Sept. 30, 1915.*

| Month. | Discharge in second-feet. | | | Run-off (total in acre-feet). | Accuracy. |
|---|---|---|---|---|---|
| | Maximum. | Minimum. | Mean. | | |
| October | 1,090 | 88 | 343 | 21,100 | B. |
| November | 314 | 104 | 185 | 11,000 | B. |
| December | 165 | 40 | 92.2 | 5,670 | C. |
| January | ..... | ..... | [a]68.0 | 4,180 | |
| February | 190 | 50 | 107 | 5,940 | C. |
| March | 1,040 | 140 | 397 | 24,400 | C. |
| April | 4,500 | 510 | 2,260 | 134,000 | C. |
| May | 5,620 | 2,100 | 3,470 | 213,000 | C. |
| June | 5,730 | 1,140 | 3,680 | 219,000 | C. |
| The period | ..... | ..... | ..... | 638,000 | |

[a] Estimated.

### BRAZOS RIVER NEAR BRAZOS, N. MEX.

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

DRAINAGE AREA.—Not measured.

RECORDS AVAILABLE.—September 18, 1913, to September 30, 1915.

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

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

CHANNEL AND CONTROL.—Bed composed of rock, gravel, and sand; changes slightly at high stages. Both banks of medium height and not subject to overflow except during extremely high stages.

WINTER FLOW.—Stage-discharge relation seriously affected by ice; flow estimated from current-meter measurements, records of flow at near-by stations, and records of precipitation and temperature.

EXTREMES OF DISCHARGE.—Maximum stage recorded during year, 4.39 feet at 8 p. m. May 14 (discharge computed from extension of rating curve, 3,240 second-feet); minimum discharge obtained, 25 second-feet during parts of December.

1913–1915: Maximum stage recorded May 14, 1915; minimum, 0.49 foot October 26, 1913 (discharge, 18 second-feet). The stream also carried 18 second-feet during parts of December, 1913, but the stage-discharge relation was affected by ice.

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

REGULATION.—None.

ACCURACY.—Results good for open-water season, as stage-discharge relation is permanent during low and medium stages; results for winter season poor.

COOPERATION.—Record of current-meter measurements made in January and February furnished by State engineer of New Mexico.

*Discharge measurements of Brazos River near Brazos, N. Mex., during the year ending Sept. 30, 1915.*

| Date. | Made by— | Gage height. | Discharge. | Date. | Made by— | Gage height. | Discharge. |
|---|---|---|---|---|---|---|---|
| | | *Feet.* | *Sec.-ft.* | | | *Feet.* | *Sec.-ft.* |
| Oct. 28 | R. S. Watrous | 0.89 | 77.4 | Mar. 26 | W. R. King | 0.63 | 46.4 |
| Dec. 14 | do | *a* .58 | 25.7 | June 4 | do | 2.88 | 1,060 |
| Jan. 14 | do | *a* .50 | 37.3 | Sept. 7 | Follansbee and King | .63 | 36.6 |
| Feb. 16 | do | *a* .39 | 36.8 | | | | |

*a* Stage-discharge relation affected by ice.

*Daily discharge, in second-feet, of Brazos River near Brazos, N. Mex., for the year ending Sept. 30, 1915.*

| Day. | Oct. | Nov. | Dec. | Jan. | Feb. | Mar. | Apr. | May. | June. | July. | Aug. | Sept. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 38 | 71 | 47 | | | | 48 | 525 | 1,730 | 141 | 62 | 34 |
| 2 | 39 | 70 | 49 | | | | 53 | 372 | 1,800 | 141 | 60 | 34 |
| 3 | 88 | 68 | 44 | | | | 64 | 327 | 1,150 | 137 | 56 | 33 |
| 4 | 200 | 66 | 39 | | | | 74 | 291 | 880 | 126 | 53 | 47 |
| 5 | 116 | 62 | 35 | | | | 82 | 250 | 900 | 124 | 52 | 60 |
| 6 | 108 | 60 | 35 | | | | 86 | 218 | 890 | 133 | 53 | 46 |
| 7 | 99 | 57 | 34 | | | | 82 | 200 | 940 | 103 | 68 | 38 |
| 8 | 88 | 56 | 32 | | | | 83 | 197 | 1,020 | 94 | 82 | 37 |
| 9 | 84 | 51 | 31 | | | | 82 | 254 | 1,000 | 88 | 84 | 36 |
| 10 | 80 | 48 | 30 | | | | 83 | 395 | 1,060 | 83 | 64 | 33 |
| 11 | 74 | 48 | 30 | | | | 94 | 746 | 980 | 78 | 61 | 32 |
| 12 | 68 | 47 | 30 | | | | 106 | 1,360 | 824 | 80 | 54 | 30 |
| 13 | 78 | 47 | 25 | | | | 126 | 2,000 | 648 | 96 | 51 | 29 |
| 14 | 61 | 45 | 25 | 37 | | | 156 | 2,380 | 549 | 76 | 48 | 30 |
| 15 | 58 | 37 | 25 | | | | 178 | 2,040 | 501 | 69 | 52 | 31 |
| 16 | 54 | 40 | 35 | | 37 | | 163 | 2,200 | 468 | 65 | 48 | 33 |
| 17 | 54 | 44 | 35 | | | | 153 | 2,320 | 440 | 62 | 44 | 33 |
| 18 | 54 | 35 | 35 | | | | 192 | 1,500 | 440 | 60 | 40 | 31 |
| 19 | 52 | 42 | 35 | | | | 215 | 746 | 446 | 58 | 39 | 31 |
| 20 | 49 | 38 | 35 | | | | 283 | 568 | 395 | 57 | 38 | 29 |
| 21 | 54 | 44 | 30 | | | | 400 | 501 | 362 | 68 | 38 | 29 |
| 22 | 112 | 47 | 30 | | | | 462 | 513 | 340 | 58 | 37 | 28 |
| 23 | 94 | 47 | 30 | | | | 420 | 730 | 315 | 53 | 36 | 28 |
| 24 | 76 | 45 | 30 | | | | 381 | 1,120 | 287 | 62 | 44 | 27 |
| 25 | 86 | 41 | 30 | | | | 367 | 1,060 | 247 | 71 | 49 | 44 |
| 26 | 94 | 39 | 25 | | | 46 | 440 | 714 | 229 | 160 | 57 | 49 |
| 27 | 86 | 39 | 25 | | | 51 | 634 | 648 | 211 | 195 | 42 | 37 |
| 28 | 82 | 42 | 25 | | | 53 | 815 | 851 | 192 | 94 | 38 | 34 |
| 29 | 80 | 40 | 25 | | | 56 | 930 | 1,050 | 174 | 77 | 37 | 32 |
| 30 | 76 | 35 | 25 | | | 51 | 900 | 1,140 | 156 | 70 | 38 | 32 |
| 31 | 71 | | 25 | | | 51 | | 1,390 | | 66 | 35 | |

NOTE.—Discharge determined as follows: Oct. 1 to Nov. 30, Apr. 10–20, June 16–25, and July 2–13, by indirect method for shifting control; Dec. 1–11, Mar. 26 to Apr. 9, Apr. 21 to June 15, and July 14 to Sept. 30, from fairly well defined curves; Dec. 12–31, Jan. 14, and Feb. 16 from current-meter measurements, records of flow at near-by stations, and climatic data; June 26 to July 1, by interpolation and comparison of records of near-by stations.

*Monthly discharge of Brazos River near Brazos, N. Mex., for the year ending Sept. 30, 1915.*

| Month. | Discharge in second-feet. | | | Run-off (total in acre-feet). | Accuracy. |
|---|---|---|---|---|---|
| | Maximum. | Minimum. | Mean. | | |
| October | 200 | 38 | 79.1 | 4,860 | B. |
| November | 71 | 35 | 48.4 | 2,880 | B. |
| December | 49 | 25 | 31.8 | 1,960 | C. |
| January | | | [a] 30.0 | 1,840 | |
| February | | | [a] 27.0 | 1,500 | |
| March | | | [a] 38.0 | 2,340 | |
| April | 930 | 48 | 272 | 16,200 | B. |
| May | 2,380 | 197 | 923 | 56,800 | B. |
| June | 1,800 | 156 | 652 | 38,800 | C. |
| July | 195 | 53 | 91.8 | 5,640 | B. |
| August | 84 | 35 | 50.3 | 3,090 | B. |
| September | 60 | 27 | 34.9 | 2,080 | B. |
| The year | 2,380 | 25 | 191 | 138,000 | |

[a] Estimated.

### LITTLE BRAZOS RIVER NEAR BRAZOS, N. MEX.

LOCATION.—In the Tierra Amarilla land grant, 1½ miles east of Brazos, 1 mile northeast of Ensenada, half a mile above confluence with Brazos River, near center of Rio Arriba County. The wagon road from Brazos up Brazos River Canyon crosses the Little Brazos about 200 feet below gage.

DRAINAGE AREA.—Not measured.

RECORDS AVAILABLE.—April 8, 1914, to June 12, 1915, when station was discontinued.

GAGE.—Vertical staff; read at irregular intervals by I. L. Gillum.

DISCHARGE MEASUREMENTS.—Made by wading.

CHANNEL AND CONTROL.—Bed composed of gravel and sand; changes slightly. Banks high and not subject to overflow. Position of control is unknown.

EXTREMES OF DISCHARGE.—1914–1915: Maximum stage recorded, 1.90 feet May 23, 1914 (discharge, 227 second-feet); minimum stage recorded, 0.28 foot September 5, 1914 (discharge, 2.6 second-feet).

WINTER FLOW.—Stage-discharge relation affected by ice; flow estimated from current-meter measurements, observer's notes, and records of precipitation and temperature.

DIVERSIONS.—No water diverted above station.

REGULATION.—None. No power plants above station.

ACCURACY.—Results fair. Slight changes in stage-discharge relation cause errors.

COOPERATION.—Record of current-meter measurement in January furnished by State engineer of New Mexico.

Data insufficient for determination of monthly discharge.

*Discharge measurements of Little Brazos River near Brazos, N. Mex., during the year ending Sept. 30, 1915.*

[Made by R. S. Watrous.]

| Date. | Gage height. | Discharge. | Date. | Gage height. | Discharge. |
|---|---|---|---|---|---|
| | *Feet.* | *Sec.-ft.* | | *Feet.* | *Sec.-ft.* |
| Oct. 28 | 0.55 | 10.2 | Jan. 14 [a] | 0.57 | 4.9 |
| Dec. 10 | [a].57 | 5.5 | | | |

[a] Stage-discharge relation affected by ice.

*Daily discharge, in second-feet, of Little Brazos River near Brazos, N. Mex., for the year ending Sept. 30, 1915.*

| Day. | Oct. | Nov. | Dec. | Jan. | Apr. | May. | June. |
|---|---|---|---|---|---|---|---|
| 1 | | | | | | | |
| 2 | | | 6.0 | | 22 | | |
| 3 | 4.8 | | | | | | |
| 4 | | 5.6 | | | | | |
| 5 | | | 6.0 | | | | |
| 6 | | | | | | | |
| 7 | 18 | 6.0 | | | | 47 | |
| 8 | | | | | | | |
| 9 | | | | | 34 | | |
| 10 | 12 | | 5.5 | | | | |
| 11 | | | | | | | |
| 12 | | | | | | 220 | 177 |
| 13 | | 4.6 | | | | | |
| 14 | 8.8 | | | 4.9 | | | |
| 15 | | 4.0 | | | | | |
| 16 | | | | | 50 | | |
| 17 | 6.8 | | | | | | |
| 18 | | 6.4 | | | | | |
| 19 | | | | | | | |
| 20 | | | | | | | |
| 21 | | 7.2 | | | | 105 | |
| 22 | 56 | | | | | | |
| 23 | | | | | 82 | | |
| 24 | 13 | | | | | | |
| 25 | | | | | | | |
| 26 | | | | | | | |
| 27 | | | | | | | |
| 28 | 10 | 6.0 | | | | 142 | |
| 29 | | | | | | | |
| 30 | | | | | 136 | | |
| 31 | 8.0 | | | | | | |

NOTE.—Discharge determined as follows: Oct. 1–5 and Apr. 1 to June 12, from a fairly well defined curve; Oct. 6 to Dec. 2 by indirect method for shifting control; Dec. 3–10 and Jan. 14 from current-meter measurements and climatic data.

### NUTRITUS CREEK NEAR TIERRA AMARILLA, N. MEX.

LOCATION.—In T. 29 N., R. 3 E., at highway bridge, on road from Tierra Amarilla to Canjilon, about 1½ miles south of Tierra Amarilla and 7 miles above confluence of creek with Chama River, in north-central part of Rio Arriba County.

DRAINAGE AREA.—Not measured.

RECORDS AVAILABLE.—May 24 to December 13, 1914, when station was discontinued.

GAGE.—Vertical staff on right bank; read occasionally by I. L. Gillum.

DISCHARGE MEASUREMENTS.—Made by wading.

CHANNEL AND CONTROL.—Bed composed of sand and gravel; shifts. Position of control unknown.

EXTREMES OF STAGE.—Maximum stage recorded in 1914, 5.25 feet May 24; minimum, 3.91 feet September 4.

WINTER FLOW.—Stage-discharge relation seriously affected by ice.

DIVERSIONS.—No large diversions above station.

REGULATION.—None.

Data inadequate for determination of daily discharge.

*Discharge measurements of Nutritus Creek near Tierra Amarilla, N. Mex., during the year ending Sept. 30, 1915.*

[Made by R. S. Watrous.]

| Date. | Gage height. | Discharge. |
|---|---|---|
| | *Feet.* | *Sec.-ft.* |
| Oct. 29 | 4.11 | *a* 0.75 |
| Dec. 13 | 4.20 | *a* .75 |

*a* Estimated.

*Daily gage height, in feet, of Nutritus Creek near Tierra Amarilla, N. Mex., for the year ending Sept. 30, 1915.*

| Day. | Oct. | Nov. | Dec. | Day. | Oct. | Nov. | Dec. | Day. | Oct. | Nov. | Dec. |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | | | | 11 | | | | 21 | | 4.03 | |
| 2 | 3.98 | | | 12 | | 4.05 | | 22 | | | |
| 3 | | 4.05 | | 13 | 4.15 | | 4.20 | 23 | 4.50 | | |
| 4 | | | | 14 | | 4.05 | | 24 | | | |
| 5 | | | | 15 | | | | 25 | | | |
| 6 | 4.20 | 4.05 | | 16 | 4.15 | 4.05 | | 26 | | | |
| 7 | | | | 17 | | | | 27 | | | |
| 8 | | | | 18 | | 4.03 | | 28 | | | |
| 9 | | 4.05 | | 19 | | | | 29 | 4.11 | | |
| 10 | | | | 20 | 4.05 | | | 30 | | | |
| | | | | | | | | 31 | | | |

NOTE.—Stage-discharge relation affected by ice Dec. 13.

### NUTRIAS CREEK NEAR CEBOLLA, N. MEX.

LOCATION.—At highway bridge on road from Tierra Amarilla to Cebolla, 3 miles northwest of Cebolla, 13½ miles southeast of Tierra Amarilla, 18 miles above confluence of creek with Chama River, near center of Rio Arriba County.

DRAINAGE AREA.—Not measured.

RECORDS AVAILABLE.—Fragmentary, April 9 to December 13, 1914, when station was discontinued.

GAGE.—Vertical staff gage; read occasionally by I. L. Gillum.

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

CHANNEL AND CONTROL.—Bed composed of gravel and sand; shifts, especially during extremely high stages. Position of control not known.

EXTREMES OF DISCHARGE.—Maximum stage recorded during 1914, 1.95 feet May 13 (discharge, 156 second-feet); minimum, 0.54 foot August 18 (discharge, 1.2 second-feet).

WINTER FLOW.—Stage-discharge relation affected by ice.

DIVERSIONS.—Amount of water diverted for irrigation above station not known.

REGULATION.—No water-power plants above station.

ACCURACY.—Results fair.

Data inadequate for determination of monthly discharge.

*Discharge measurements of Nutrias Creek near Cebolla, N. Mex., during the year ending Sept. 30, 1915.*

[Made by R. S. Watrous.]

| Date. | Gage height. | Discharge. |
|---|---|---|
| | *Feet.* | *Sec.-ft.* |
| Oct. 29 | 0.90 | 6.6 |
| Dec. 13 | *a* .68 | 1.5 |

*a* Stage-discharge relation affected by ice.

*Daily discharge, in second-feet, of Nutrias Creek near Cebolla, N. Mex., for the year ending Sept. 30, 1915.*

| Day. | Oct. | Nov. | Dec. | Day. | Oct. | Nov. | Dec. | Day. | Oct. | Nov. | Dec. |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | | | | 11 | | | | 21 | | | |
| 2 | 2.0 | | | 12 | | | | 22 | | | |
| 3 | | 4.7 | | 13 | 3.5 | 4.0 | 1.5 | 23 | 14 | | |
| 4 | | | | 14 | | | | 24 | | | |
| 5 | | | | 15 | | | | 25 | | | |
| 6 | 7.7 | 4.7 | | 16 | 3.5 | | | 26 | | | |
| 7 | | | | 17 | | 5.6 | | 27 | | | |
| 8 | | | | 18 | | | | 28 | | | |
| 9 | | | | 19 | | | | 29 | 6.6 | | |
| 10 | | 4.3 | | 20 | 3.2 | 5.4 | | 30 | | | |
| | | | | | | | | 31 | | | |

NOTE.—Discharge determined as follows: Oct. 1 to Nov. 20, by indirect method for shifting control; Dec. 13, by current-meter measurement.

### RIO VALLECITOS AT VALLECITOS, N. MEX.

LOCATION.—In sec. 17, T. 26 N., R. 8 E., at Vallecitos, in the Carson National Forest, eastern part of Rio Arriba County.

DRAINAGE AREA.—Not measured.

RECORDS AVAILABLE.—June 17, 1911, to December 31, 1914, when station was discontinued.

GAGE.—Vertical staff attached to tree on left bank; read occasionally by D. G. Darrah, forest ranger.

DISCHARGE MEASUREMENTS.—Made by wading.

CHANNEL AND CONTROL.—Bed composed of rock, gravel, and sand; permanent. Shoal below gage probably serves as control.

EXTREMES OF DISCHARGE.—1911–1914: Maximum stage recorded, 4.65 feet May 21, 1912 (discharge, 970 second-feet); minimum stage recorded, 0.83 foot September 17, 1914 (discharge, 2.3 second-feet).

WINTER FLOW.—Stage-discharge relation seriously affected by ice; flow estimated from observer's notes and records of precipitation and temperature.

DIVERSIONS.—Small quantities of water are diverted for irrigation for a distance of 6 miles above station.

REGULATION.—None at this point.

ACCURACY.—Results poor. Estimates of discharge for days on which gage was read considered good, but the error introduced by interpolation for those days on which gage heights are missing lowers the accuracy of results as a whole. Stage-discharge relation practically permanent.

No current-meter measurements made during year.

*Daily discharge, in second-feet, of Rio Vallecitos at Vallecitos, N. Mex., for the year ending Sept. 30, 1915.*

| Day. | Oct. | Nov. | Dec. | Day. | Oct. | Nov. | Dec. | Day. | Oct. | Nov. | Dec. |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 3.0 | 22 | 15 | 11 | 18 | 21 | | 21 | 21 | 17 | |
| 2 | 3.0 | 21 | 12 | 12 | 24 | 20 | | 22 | 25 | 17 | |
| 3 | 26 | 22 | 13 | 13 | 23 | 20 | | 23 | 30 | 17 | |
| 4 | 24 | 23 | 14 | 14 | 24 | 20 | | 24 | 40 | 16 | |
| 5 | 18 | 23 | 4.8 | 15 | 25 | 19 | | 25 | 30 | 16 | |
| 6 | 19 | 22 | | 16 | 26 | 19 | | 26 | 24 | 16 | |
| 7 | 20 | 22 | | 17 | 24 | 19 | | 27 | 26 | 15 | |
| 8 | 18 | 22 | | 18 | 22 | 18 | | 28 | 22 | 15 | |
| 9 | 16 | 21 | | 19 | 21 | 18 | | 29 | 24 | 16 | |
| 10 | 13 | 21 | | 20 | 23 | 18 | | 30 | 23 | 16 | |
| | | | | | | | | 31 | 22 | | |

NOTE.—Discharge determined as follows: Oct. 3, 5, 7, 10, 12, 13, 16, 17, 19–21, 26–30; Nov. 2, 4, 25, 27, 30; Dec. 1, 2, 4, 5, from a fairly well defined curve. Discharge for remaining days determined by interpolation and information furnished by gage reader.

*Monthly discharge of Rio Vallecitos at Vallecitos, N. Mex., for the year ending Sept. 30, 1915.*

| Month. | Discharge in second-feet. | | | Run-off (total in acre-feet). | Accuracy. |
|---|---|---|---|---|---|
| | Maximum. | Minimum. | Mean. | | |
| October | 40 | 3.0 | 21.8 | 1,340 | C. |
| November | 23 | 15 | 19.1 | 1,140 | D. |
| December | | | a 9.0 | 553 | |
| The period | | | | 3,030 | |

a Estimated.

**SANTA FE CREEK ABOVE RESERVOIR NEAR SANTA FE, N. MEX.**

LOCATION.—In sec. 22, T. 17 N., R. 10 E., a quarter of a mile above Santa Fe Water & Light Co.'s diversion for water supply, 1½ miles above reservoir, 5 miles east of Santa Fe, in eastern part of Santa Fe County.

DRAINAGE AREA.—22.5 square miles (measured on topographic map).

RECORDS AVAILABLE.—April 24, 1913, to December 31, 1914, when station was discontinued. Fragmentary records May 12, 1910, to April 23, 1913, from a station one mile below present gage and below diversion of Santa Fe Water & Light Co.

GAGE.—Stevens water-stage recorder attached to rock wall on right bank, installed April 24, 1913.

DISCHARGE MEASUREMENTS.—Made by wading or from cable just above old site 1 mile downstream.

CHANNEL AND CONTROL.—Bed composed of sand and gravel. Banks high and not subject to overflow. An artificial concrete control was constructed October 24, 1913, just below the gage, with zero flow at gage height 1.0 foot; stage-discharge relation constant during low and medium stages since that date. Position of high-water control unknown. Prior to installation of artificial control stage-discharge relation was subject to change.

EXTREMES OF DISCHARGE.—Maximum stage recorded 1913 and 1914, 2.82 feet (maintained for 30 minutes), June 16, 1914 (discharge computed from slope and cross section applied to Kutter's formula, 226 second-feet); minimum stage recorded, 1.18 feet January 27, 1914 (discharge, 1.7 second-feet).

WINTER FLOW.—Stage-discharge relation affected by ice; flow estimated from current-meter measurements, gage-height record, and records of precipitation and temperature.

DIVERSIONS.—None above station but considerable water is diverted below.

REGULATION.—None at this point.

ACCURACY.—Results excellent for open-water season and fair for winter period; the artificial control is effective throughout the ordinary range of flow; change in stage-discharge relation at higher stages small.

*Discharge measurements of Santa Fe Creek above reservoir near Santa Fe, N. Mex., during the year ending Sept. 30, 1915.*

| Date. | Made by— | Gage height. | Discharge. | Date. | Made by— | Gage height. | Discharge. |
|---|---|---|---|---|---|---|---|
| | | *Feet.* | *Sec.-ft.* | | | *Feet.* | *Sec.-ft.* |
| Oct. 10 | Watrous and Powers | 1.35 | 5.0 | Dec. 18 | Emerson and King | 1.26 | 3.1 |
| 31 | Gray and King | 1.37 | 5.6 | 31 | J. E. Powers | 1.30 | 3.4 |
| Nov. 28 | R. J. Hank | 1.31 | 3.4 | | | | |

*Daily discharge, in second-feet, of Santa Fe Creek above reservoir near Santa Fe, N. Mex., for the year ending Sept. 30, 1915.*

| Day. | Oct. | Nov. | Dec. | Day. | Oct. | Nov. | Dec. | Day. | Oct. | Nov. | Dec. |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 3.6 | 6.6 | 4.0 | 11 | 5.9 | 6.9 | 3.0 | 21 | 7.2 | 5.6 | 3.4 |
| 2 | 3.6 | 6.6 | 5.3 | 12 | 5.9 | 6.9 | 2.8 | 22 | 10.0 | 5.6 | 3.4 |
| 3 | 4.6 | 6.6 | 5.6 | 13 | 6.6 | 6.9 | 2.8 | 23 | 8.9 | 5.0 | 3.4 |
| 4 | 13.0 | 6.2 | 7.9 | 14 | 6.2 | 6.6 | 2.8 | 24 | 8.9 | 5.0 | 3.4 |
| 5 | 8.5 | 6.6 | 5.3 | 15 | 6.2 | 6.6 | 2.6 | 25 | 9.4 | 5.0 | 3.4 |
| 6 | 6.6 | 6.2 | 4.3 | 16 | 5.9 | 5.9 | 2.6 | 26 | 8.5 | 3.8 | 3.4 |
| 7 | 6.6 | 6.6 | 3.4 | 17 | 6.2 | 5.9 | 2.8 | 27 | 8.5 | 4.0 | 3.4 |
| 8 | 5.9 | 6.6 | 3.2 | 18 | 5.9 | 5.6 | 3.0 | 28 | 8.1 | 4.0 | 3 4 |
| 9 | 5.6 | 6.9 | 3.2 | 19 | 5.6 | 5.6 | 3.2 | 29 | 7.6 | 4.6 | 3.4 |
| 10 | 5.6 | 7.2 | 3.2 | 20 | 5.3 | 6.2 | 3.4 | 30 | 7.2 | 4.3 | 3.4 |
| | | | | | | | | 31 | 6.6 | ..... | 3.4 |

NOTE.—Discharge determined as follows: Oct. 1 to Dec. 12, from a well-defined curve; Dec. 13-31, from current-meter measurements, climatic data, and information furnished by engineers.

*Monthly discharge of Santa Fe Creek above reservoir near Santa Fe, N. Mex., for the year ending Sept. 30, 1915.*

| Month. | Discharge in second-feet. | | | Run-off (total in acre-feet). | Accuracy. |
|---|---|---|---|---|---|
| | Maximum. | Minimum. | Mean. | | |
| October | 13 | 3.6 | 6.91 | 425 | A. |
| November | 7.2 | 3.8 | 5.87 | 349 | A. |
| December | 7.6 | 2.6 | 3.60 | 221 | C. |
| The period | ..... | ..... | ..... | 995 | |

### ARROYO HONDO NEAR SANTA FE, N. MEX.

LOCATION.—In the NE. ¼ sec. 17, T. 16 N., R. 10 E., 6 miles southeast of Santa Fe, 2,000 feet upstream from the Santa Fe trail crossing 1 mile above confluence of the two branches of Arroyo Hondo, near center of Santa Fe County.

DRAINAGE AREA.—13.5 square miles (measured on topographic map).

RECORDS AVAILABLE.—February 21, 1913, to December 31, 1914, when station was discontinued.

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

DISCHARGE MEASUREMENTS.—Made by wading or from cable about 50 feet below gage.

CHANNEL AND CONTROL.—Bed composed of sand and gravel; subject to extreme shifts. Both banks high and not subject to overflow. Position of control not known.

EXTREMES OF DISCHARGE.—1913–1914: Maximum stage recorded, 5.40 feet (maintained for 15 minutes) June 16, 1914 (discharge, 2,830 second-feet, obtained by Kutter's formula); channel dry for extended periods during record.

WINTER FLOW.—Stage-discharge relation seriously affected by ice; flow estimated from current-meter measurements, engineer's notes, and records of precipitation and temperature.

DIVERSIONS.—None above station.

REGULATION.—None at this point.

ACCURACY.—Results poor. The changeable stage-discharge relation and erratic flow of the stream lower accuracy of determinations.

*Discharge measurements of Arroyo Hondo near Santa Fe, N. Mex., during the year ending Sept. 30, 1915.*

| Date. | Made by— | Gage height. | Discharge. | Date. | Made by— | Gage height. | Discharge. |
|---|---|---|---|---|---|---|---|
| | | *Feet.* | *Sec.-ft.* | | | *Feet.* | *Sec.-ft.* |
| Oct. 9 | W. R. King | | a 0.1 | Nov. 21 | R. J. Hank | 2.20 | a 0.5 |
| 14 | R. S. Watrous | 2.25 | a .1 | Dec. 21 | C. J. Emerson | | a .1 |
| 22 | R. J. Hank | 2.45 | 2.4 | | | | |

a Estimated.

*Daily discharge, in second-feet, of Arroyo Hondo near Santa Fe, N. Mex., for the year ending Sept. 30, 1915.*

| Day. | Oct. | Nov. | Dec. | Day. | Oct. | Nov. | Dec. | Day. | Oct. | Nov. | Dec. |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 0.1 | 0.5 | 0.3 | 11 | 0.1 | 0.5 | 0.2 | 21 | 3.0 | 0.5 | 0.1 |
| 2 | .1 | .5 | .3 | 12 | .1 | .5 | .2 | 22 | 2.5 | .5 | .1 |
| 3 | .1 | .5 | .3 | 13 | .1 | .5 | .2 | 23 | .3 | .5 | .1 |
| 4 | .1 | .5 | .3 | 14 | .1 | .5 | .2 | 24 | .2 | .5 | .1 |
| 5 | .1 | .5 | .3 | 15 | .1 | .5 | .2 | 25 | .1 | .5 | .1 |
| 6 | .1 | .5 | .3 | 16 | .1 | .5 | .1 | 26 | .1 | .3 | .1 |
| 7 | .1 | .5 | .3 | 17 | .1 | .5 | .1 | 27 | 1.0 | .3 | .1 |
| 8 | .1 | .5 | .3 | 18 | .1 | .5 | .1 | 28 | .5 | .3 | .1 |
| 9 | .1 | .5 | .3 | 19 | .1 | .5 | .1 | 29 | .5 | .3 | .1 |
| 10 | .1 | .5 | .3 | 20 | .5 | .5 | .1 | 30 | .5 | .3 | .1 |
| | | | | | | | | 31 | .5 | .3 | .1 |

NOTE.—Discharge determined as follows: Oct. 14 to Dec. 10, from current-meter measurements and gage record; Oct. 1–13 and Dec. 11–31, from current-meter measurements, climatic data, and information furnished by the engineer.

*Monthly discharge of Arroyo Hondo near Santa Fe, N. Mex., for the year ending Sept. 30, 1915.*

| Month. | Discharge in second-feet. | | | Run-off (total in acre-feet). | Accuracy. |
|---|---|---|---|---|---|
| | Maximum. | Minimum. | Mean. | | |
| October | 3.0 | 0.1 | 0.37 | 23 | D. |
| November | .5 | .3 | .47 | 28 | D. |
| December | .3 | .1 | .18 | 11 | D. |
| The period | | | | 62 | |

### RIO PUERCO AT RIO PUERCO, N. MEX.

LOCATION.—In sec. 31, T. 7 N., R. 1 W., at Atchison, Topeka & Santa Fe Railway bridge between Dalies and Rio Puerco, in eastern part of Valencia County. Nearest tributary, a small stream entering from west just below station; San Jose River enters about 8 miles above.

DRAINAGE AREA.—Not measured.

RECORDS AVAILABLE.—August 9, 1912, to December 31, 1914, when station was discontinued; fragmentary records September 7, 1910, to October 2, 1911.

GAGE.—Vertical staff gage attached to railway retaining wall on left bank directly under railway bridge; read morning and evening, by Goldie Barber. Previous to 1913, Friez and Barrett & Lawrence water-stage recorders were used at various times. Vertical staff gages were used at site of water-stage recorder without change in datum until August 21, 1914, when datum was lowered 3.14 feet.

DISCHARGE MEASUREMENTS.—Made by wading or from cable about 200 feet above gage.

CHANNEL AND CONTROL.—Bed composed of clay and sand; subject to extreme changes. Banks consist of clay; nearly vertical and not subject to overflow. Position of control not known.

EXTREMES OF DISCHARGE.—Maximum stage recorded during year, 5.90 feet October 4 (discharge, 1,230 second-feet); no flow October 1, 16, and 17.

1910–11; 1912–1914: Maximum stage recorded, 9.50 feet October 5, 1913 (discharge not computed). Channel dry at various times throughout period of record.

WINTER FLOW.—Stage-discharge relation not seriously affected by ice.

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

REGULATION.—None. No water-power plant above station.

ACCURACY.—Results approximate. The stage-discharge relation changes constantly because of the erratic flow. The assumption that average of two observations a day is the mean stage for that day also leads to error.

*Discharge measurements of Rio Puerco at Rio Puerco, N. Mex., during the year ending Sept. 30, 1915.*

| Date. | Made by— | Gage height. | Discharge. | Date. | Made by— | Gage height. | Discharge. |
|---|---|---|---|---|---|---|---|
| | | *Feet.* | *Sec.-ft.* | | | *Feet.* | *Sec.-ft.* |
| Oct. 14 | R. J. Hank | 2.10 | 2.1 | Dec. 3 | R. J. Hank | 2.15 | 4.0 |
| 28 | do | 2.40 | 20.2 | 28 | C. J. Emerson | 2.40 | 14.4 |

*Daily discharge, in second-feet, of Rio Puerco at Rio Puerco, N. Mex., for the year ending Sept. 30, 1915.*

| Day. | Oct. | Nov. | Dec. | Day. | Oct. | Nov. | Dec. | Day. | Oct. | Nov. | Dec. |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 0.0 | 6.0 | 2.0 | 11 | 32 | 3.0 | 27 | 21 | 4.5 | 4.5 | 40 |
| 2 | .8 | 6.0 | 3.0 | 12 | 22 | 6.0 | 25 | 22 | 323 | 3.0 | 30 |
| 3 | 612 | 4.5 | 4.5 | 13 | 14 | 6.0 | 22 | 23 | 478 | 3.0 | 40 |
| 4 | 1,230 | 3.9 | 6.0 | 14 | 3.0 | 6.0 | 20 | 24 | 377 | 3.0 | 70 |
| 5 | 985 | 3.0 | 6.0 | 15 | 2.0 | 3.0 | 15 | 25 | 872 | 3.0 | 80 |
| 6 | 119 | 3.0 | 6.0 | 16 | .0 | 6.0 | 10 | 26 | 545 | 3.0 | 60 |
| 7 | 51 | 3.0 | 6.0 | 17 | .0 | 6.0 | 8.0 | 27 | 119 | 3.0 | 40 |
| 8 | 58 | 3.0 | 8.5 | 18 | 6.0 | 6.0 | 80 | 28 | 44 | 3.0 | 20 |
| 9 | 38 | 6.0 | 18 | 19 | 3.0 | 6.0 | 90 | 29 | 32 | 3.0 | 10 |
| 10 | 18 | 3.0 | 32 | 20 | 3.0 | 6.0 | 40 | 30 | 14 | 1.0 | 15 |
| | | | | | | | | 31 | 1.0 | | 15 |

NOTE.—Discharge determined as follows: Oct. 2–15 and Oct. 18 to Dec. 11 by indirect method for shifting control; Dec. 12–31 from current-meter measurement, information furnished by observer, and climatic data. No flow Oct. 1, 16, and 17.

*Monthly discharge of Rio Puerco at Rio Puerco, N. Mex., for the year ending Sept. 30, 1915.*

| Month. | Discharge in second-feet. | | | Run-off (total in acre-feet). | Accuracy. |
|---|---|---|---|---|---|
| | Maximum. | Minimum. | Mean. | | |
| October | 1,230 | 0.0 | 194 | 11,900 | C. |
| November | 6.0 | 1.0 | 4.13 | 246 | D. |
| December | 90 | 2.0 | 27.4 | 1,680 | C. |
| The period | | | | 13,800 | |

### BLUEWATER CREEK NEAR BLUEWATER, N. MEX.

LOCATION.—Near Sec. 8, T. 12 N., R. 11 W., a quarter of a mile from mouth of Bluewater Creek box canyon, 2½ miles northwest of Bluewater post office, 8 miles below dam site of Bluewater Development Co., in northern part of Valencia County.

DRAINAGE AREA.—Not measured.

RECORDS AVAILABLE.—May 29, 1912, to December 31, 1914, when station was discontinued.

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

DISCHARGE MEASUREMENTS.—Made by wading.

CHANNEL AND CONTROL.—Bed composed of rock, gravel, and sand; no shifting of consequence. Both banks high and not subject to overflow. Rapids just below gage serve as control.

EXTREMES OF DISCHARGE.—1912–1914: Maximum stage recorded, 5.30 feet July 22, 1912; discharge, 406 second-feet. The stream has been dry for extended periods since the station was established.

WINTER FLOW.—Stage-discharge relation seriously affected by ice; flow estimated from current-meter measurements and records of temperature and precipitation.

DIVERSIONS.—No information.

REGULATION.—No information.

ACCURACY.—Results fair for open-water season and poor for winter period. Accuracy of determinations impaired by slight changes in stage-discharge relation.

*Discharge measurements of Bluewater Creek near Bluewater, N. Mex., during the year Sept. 30, 1915.*

[Made by R. J. Hank.]

| Date. | Gage height. | Discharge. | Date. | Gage height. | Discharge. |
|---|---|---|---|---|---|
| | *Feet.* | *Sec.-ft.* | | *Feet.* | *Sec.-ft.* |
| Oct. 13 | 1.15 | 1.6 | Dec. 3 | 0.85 | a1.0 |
| 27 | 1.20 | 1.6 | | | |

a Estimated.

*Daily discharge, in second-feet, of Bluewater Creek near Bluewater, N. Mex., for the year ending Sept. 30, 1915.*

| Day. | Oct. | Nov. | Dec. | Day. | Oct. | Nov. | Dec. | Day. | Oct. | Nov. | Dec. |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 1.1 | 1.1 | 1.0 | 11 | 1.1 | 1.8 | ..... | 21 | 1.4 | 1.9 | ..... |
| 2 | 2.0 | 1.1 | 1.0 | 12 | 1.4 | 2.3 | ..... | 22 | 2.6 | 1.5 | ..... |
| 3 | 3.4 | 1.1 | 1.0 | 13 | 1.4 | 2.0 | ..... | 23 | 4.0 | 1.4 | ..... |
| 4 | 30 | 1.1 | 1.0 | 14 | 1.2 | 1.8 | ..... | 24 | 3.8 | 1.4 | ..... |
| 5 | 10 | 1.1 | 1.0 | 15 | 1.2 | 1.6 | ..... | 25 | 2.8 | 1.2 | ..... |
| 6 | 5.0 | 1.1 | ..... | 16 | 1.2 | 1.8 | ..... | 26 | 2.0 | 1.2 | ..... |
| 7 | 3.2 | 1.0 | ..... | 17 | 1.2 | 1.8 | ..... | 27 | 1.6 | 1.2 | ..... |
| 8 | 2.4 | .9 | ..... | 18 | 1.1 | 2.0 | ..... | 28 | 1.4 | 1.1 | ..... |
| 9 | 1.9 | .9 | ..... | 19 | 1.1 | 1.9 | ..... | 29 | 1.4 | 1.1 | ..... |
| 10 | 1.0 | 1.0 | ..... | 20 | 1.2 | 2.0 | ..... | 30 | 1.4 | 1.1 | ..... |
| | | | | | | | | 31 | 1.1 | ..... | ..... |

NOTE.—Discharge determined as follows: Oct. 1–21, from a well-defined curve; Oct. 22 to Nov. 28 by indirect method for shifting control; Nov. 29 to Dec. 5 from climatic data and current-meter measurement.

*Monthly discharge of Bluewater Creek near Bluewater, N. Mex., for the year ending Sept. 30, 1915.*

| Month. | Discharge in second-feet. | | | Run-off (total in acre-feet). | Accuracy. |
|---|---|---|---|---|---|
| | Maximum. | Minimum. | Mean. | | |
| October | 30 | 1.0 | 3.08 | 189 | C. |
| November | 2.3 | .9 | 1.42 | 84 | C. |
| December | ..... | ..... | a1.00 | 61 | |
| The period | ..... | ..... | ..... | 334 | |

a Estimated.

**BLUEWATER CREEK AT GRANTS, N. MEX.**

LOCATION.—In sec. 25, T. 11 N., R. 10 W., at wagon bridge opposite Atchison, Topeka & Santa Fe Railway station at Grants, in northern part of Valencia County.

DRAINAGE AREA.—Not measured.

RECORDS AVAILABLE.—October 30, 1912, to December 31, 1914, when station was discontinued.

GAGE.—Vertical staff attached to upstream pier of wagon bridge; read twice daily.

DISCHARGE MEASUREMENTS.—Made by wading or from bridge.

CHANNEL AND CONTROL.—Bed composed of dirt, gravel, and sand; shifts. Banks of medium height; not subject to overflow. Position of control not known.

EXTREMES OF STAGE.—1912–1914: Maximum stage recorded, 4.40 feet July 30, 1914; no flow for extended periods.

WINTER FLOW.—Stage-discharge relation not seriously affected by ice.

DIVERSIONS.—Some water diverted for irrigation above station; amount unknown.

REGULATION.—None at this point.

ACCURACY.—Base data apparently reliable.

Data insufficient for determination of daily discharge.

*Discharge measurements of Bluewater Creek at Grants, N. Mex., during the year ending Sept. 30, 1915.*

[Made by R. J. Hank.]

| Date. | Gage height. | Discharge. |
|---|---|---|
| | *Feet.* | *Sec.-ft.* |
| Oct. 13 | 0.3 | a0.3 |
| 27 | .2 | .0 |

a Estimated.

*Daily gage height, in feet, of Bluewater Creek at Grants, N. Mex., for the year ending Sept. 30, 1915.*

| Day. | Oct. | Nov. | Dec. | Day. | Oct. | Nov. | Dec. | Day. | Oct. | Nov. | Dec. |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 0.1 | | | 11 | | 0.1 | | 21 | 0.2 | | 0.1 |
| 2 | .6 | | | 12 | | | | 22 | .8 | | |
| 3 | .9 | | | 13 | | | 0.3 | 23 | .5 | | |
| 4 | .9 | | | 14 | | | .2 | 24 | .1 | | |
| 5 | 1.0 | | | 15 | | | .1 | 25 | .1 | | |
| 6 | .9 | | | 16 | | | | 26 | | | |
| 7 | .9 | | | 17 | | | | 27 | | | |
| 8 | .8 | | | 18 | | | | 28 | | | |
| 9 | .6 | 0.2 | | 19 | | | .1 | 29 | | | |
| 10 | .3 | .2 | | 20 | | | .2 | 30 | | | |
| | | | | | | | | 31 | | | |

NOTE.—No flow on days from Oct. 1 to Dec. 31, for which gage heights are not recorded.

### SAN JOSE RIVER NEAR SUWANEE, N. MEX.

LOCATION.—Near sec. 29, T. 8 N., R. 2 W., 2 miles below Suwanee railroad station, about 6 miles above mouth of river, 3 miles below Rio Lucero, in eastern part of Valencia County.

DRAINAGE AREA.—Not measured.

RECORDS AVAILABLE.—August 30, 1910, to December 31, 1914, when station was discontinued. Records prior to October 1, 1912, fragmentary.

GAGE.—Stevens water-stage recorder attached to rock wall on left bank, April 1, 1914, replacing a Barrett & Lawrence water-stage recorder installed in 1911 and operated until that date. Friez water-stage recorder was installed September 6, 1910. Datum and site unchanged since station was established.

DISCHARGE MEASUREMENTS.—Made by wading or from cable a short distance above gage.

CHANNEL AND CONTROL.—Bed composed of large bowlders, gravel, and sand; water flows through a series of pools and rapids. Banks high and not subject to overflow. The channel confined by a large rock, causing rapids, just below the gage serves as a control, but is subject to slight changes during extreme stages.

EXTREMES OF DISCHARGE.—1910–1914: Maximum stage recorded, 6.20 feet August 17, 1911 (discharge not computed); no flow March 1–9, 1912, and December 17–31, 1912.

WINTER FLOW.—Stage-discharge relation not affected by ice, the formation of which is prevented by springs above gage.

DIVERSIONS.—Station is below all important diversions; amount of water diverted unknown.

REGULATION.—Low-stage flow derived from springs. No water-power plants above station indicated by records.

ACCURACY.—Results good; slight changes in stage-discharge relation do not greatly affect accuracy of determinations.

*Discharge measurements of San Jose River near Suwanee, N. Mex., during the year ending Sept. 30, 1915.*

| Date. | Made by— | Gage height. | Discharge. | Date. | Made by— | Gage height. | Discharge. |
|---|---|---|---|---|---|---|---|
| | | *Feet.* | *Sec.-ft.* | | | *Feet.* | *Sec.-ft.* |
| Oct. 14 | R. J. Hank | 0.71 | 5.0 | Dec. 4 | R. J. Hank | 0.83 | 8.1 |
| 27 | do | .87 | 7.5 | 28 | C. J. Emerson | 1.06 | 14.7 |

*Daily discharge, in second-feet, of San Jose River near Suwanee, N. Mex., for the year ending Sept. 30,1915.*

| Day. | Oct. | Nov. | Dec. | Day. | Oct. | Nov. | Dec. | Day. | Oct. | Nov. | Dec. |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 20 | 7.7 | 9.8 | 11 | 7.5 | 8.5 | 7.5 | 21 | 7.7 | 7.7 | 16 |
| 2 | 47 | 7.5 | 9.8 | 12 | 6.1 | 10 | 8.8 | 22 | 267 | 8.3 | 18 |
| 3 | 261 | 7.1 | 10 | 13 | 5.3 | 11 | 8.8 | 23 | 184 | 8.8 | 19 |
| 4 | 448 | 7.1 | 8.8 | 14 | 4.5 | 9.0 | 8.5 | 24 | 27 | 8.8 | 23 |
| 5 | 120 | 6.9 | 9.2 | 15 | 4.0 | 8.3 | 7.1 | 25 | 17 | 8.3 | 24 |
| 6 | 51 | 7.7 | 9.8 | 16 | 3.4 | 7.7 | 5.9 | 26 | 59 | 7.7 | 24 |
| 7 | 26 | 7.7 | 8.3 | 17 | 4.0 | 7.7 | 5.9 | 27 | 8.3 | 7.7 | 19 |
| 8 | 15 | 7.7 | 7.3 | 18 | 4.7 | 7.9 | 7.9 | 28 | 8.1 | 7.5 | 18 |
| 9 | 9.8 | 7.3 | 7.1 | 19 | 4.9 | 7.3 | 46 | 29 | 8.1 | 7.7 | 14 |
| 10 | 8.5 | 7.5 | 7.1 | 20 | 4.7 | 7.1 | 26 | 30 | 7.7 | 8.8 | 12 |
| | | | | | | | | 31 | 7.5 | ..... | 10 |

NOTE.—Discharge determined as follows: Oct. 1 to Nov. 5 from a well-defined curve; Nov. 6 to Dec. 31 by indirect method for shifting control.

*Monthly discharge of San Jose River near Suwanee, N. Mex., for the year ending Sept. 30, 1915.*

| Month. | Discharge in second-feet. | | | Run-off (total in acre-feet). | Accuracy. |
|---|---|---|---|---|---|
| | Maximum. | Minimum. | Mean. | | |
| October | 448 | 3.4 | 53.4 | 3,280 | B. |
| November | 11 | 6.9 | 8.0 | 476 | C. |
| December | 46 | 5.9 | 13.4 | 824 | B. |
| The period | | | | 4,580 | |

### PECOS RIVER NEAR COWLES, N. MEX.

LOCATION.—About sec. 28, T. 18 N., R. 12 E., at highway bridge three-fourths mile below old Cowles post office, 5 miles below present Cowles post office, midway between Espiritu Santo and Mora creeks, about half a mile below mouth of Willow Creek, in northwestern part of San Miguel County.

DRAINAGE AREA.—Not measured.

RECORDS AVAILABLE.—March 9, 1910, to December 31, 1914, when the station was discontinued.

GAGE.—Friez water-stage recorder installed on left bank April 18, 1913. Friez recorder March 9, 1910, to June 4, 1912; Bristol recorder June 5, 1912, to April 9, 1913. Site and datum unchanged since station was established.

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

CHANNEL AND CONTROL.—Bed composed of gravel and rock; permanent at ordinary stages. Banks high and not subject to overflow. Stage-discharge relation changes slightly during high water.

EXTREMES OF DICHARGE.—1910–1914: Maximum stage recorded, 5.30 feet May 27, 1912 (discharge, 1,800 second-feet); minimum stage recorded, 1.00 foot (ice) January 20, 1913 (discharge, 18 second-feet).

WINTER FLOW.—Stage-discharge relation seriously affected by ice; flow estimated from current-meter measurements, observer's notes, and records of precipitation and temperature.

DIVERSIONS.—Little, if any, water diverted above station.

REGULATION.—None at this point.

ACCURACY.—Results poor for winter and good for open-water season. Slight changes in stage-discharge relation during open-water season are caused by high water. Accuracy of determination of winter flow impaired by uncertainty of operation of the water-stage recorder when ice forms.

*Discharge measurements of Pecos River near Cowles, N. Mex., during the year ending Sept. 30, 1915.*

| Date. | Made by— | Gage height. | Discharge. |
|---|---|---|---|
| | | *Feet.* | *Sec.-ft.* |
| Oct. 9 | King and Hank | 1.50 | 57.1 |
| Nov. 20 | Powers and Hank | 1.44 | 46.5 |

*Daily discharge, in second-feet, of Pecos River near Cowles, N. Mex., for the year ending Sept. 30, 1915.*

| Day. | Oct. | Nov. | Dec. | Day. | Oct. | Nov. | Dec. | Day. | Oct. | Nov. | Dec |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 55 | 62 | 36 | 11 | 57 | 56 | 25 | 21 | 54 | 50 | 35 |
| 2 | 55 | 65 | 35 | 12 | 55 | 54 | 25 | 22 | 71 | 50 | 35 |
| 3 | 68 | 63 | 35 | 13 | 54 | 52 | 25 | 23 | 57 | 51 | 35 |
| 4 | 150 | 62 | 35 | 14 | 54 | 52 | 25 | 24 | 56 | 51 | 35 |
| 5 | 81 | 60 | 35 | 15 | 52 | 54 | 25 | 25 | 57 | 47 | 32 |
| 6 | 71 | 59 | 30 | 16 | 51 | 52 | 25 | 26 | 65 | 47 | 32 |
| 7 | 65 | 59 | 30 | 17 | 48 | 55 | 30 | 27 | 65 | 47 | 32 |
| 8 | 60 | 63 | 30 | 18 | 46 | 51 | 30 | 28 | 63 | 47 | 32 |
| 9 | 57 | 59 | 30 | 19 | 45 | 52 | 35 | 29 | 62 | 45 | 32 |
| 10 | 57 | 59 | 25 | 20 | 43 | 48 | 35 | 30 | 65 | 38 | 30 |
| | | | | | | | | 31 | 62 | ..... | 30 |

NOTE.—Discharge determined as follows: Oct. 1 to Dec. 2 by indirect method for shifting control; Dec. 3-31, by interpolation and climatic data.

*Monthly discharge of Pecos River near Cowles, N. Mex., for the year ending Sept. 30 1915.*

| Month. | Discharge in second-feet. | | | Run-off (total in acre-feet). | Accuracy. |
|---|---|---|---|---|---|
| | Maximum. | Minimum. | Mean. | | |
| October | 150 | 43 | 61.3 | 3,770 | B. |
| November | 65 | 38 | 53.7 | 3,200 | B. |
| December | 36 | 25 | 31.0 | 1,910 | D. |
| The period | ..... | ..... | ..... | 8,880 | |

### PECOS RIVER NEAR ANTON CHICO, N. MEX.

LOCATION.—Near sec. 31, T. 12 N., R. 17 E., about 1 mile below settlement of Tecolotito, about 3 miles northwest of Anton Chico, 1½ miles below mouth of Tecolote Creek, in northwestern part of Gaudalupe County.

DRAINAGE AREA.—Not measured.

RECORDS AVAILABLE.—May 15, 1911, to December 31, 1914, when station was discontinued. April 28, 1910, to May 14, 1911, for station three-fourths mile upstream.

GAGE.—Friez water-stage recorder on right bank, installed May 15, 1911. Gage used from April 28, 1910, to May 14, 1911, was a Friez water-stage recorder on left bank three-fourths mile upstream. Datum unchanged since station was relocated.

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

CHANNEL AND CONTROL.—Bed composed of gravel and sand; changes during extremely high stages; banks high and not subject to overflow. Position of control not known.

EXTREMES OF DISCHARGE.—1910-1914: Maximum stage recorded, 4.71 feet June 29, 1913 (discharge, 3,980 second-feet); minimum stage recorded, 0.90 foot August 12, 1912 (discharge, 2.0 second-feet).

WINTER FLOW.—Stage-discharge relation affected by ice; flow estimated from current-meter measurements, observer's notes, and records of precipitation and temperature.

DIVERSIONS.—No information.

REGULATION.—No power plants above station.

ACCURACY.—Results fair. Accuracy of determinations impaired by slight changes in stage-discharge relation.

*Discharge measurements of Pecos River near Anton Chico, N. Mex., during the year ending Sept. 30, 1915.*

[Made by J. E. Powers.]

| Date. | Gage height. | Discharge. | Date. | Gage height. | Discharge. |
|---|---|---|---|---|---|
| | *Feet.* | *Sec.-ft.* | | *Feet.* | *Sec.-ft.* |
| Oct. 6 | 1.72 | 151 | Dec. 21 | [a] 1.30 | 39.4 |
| Nov. 9 | 1.54 | 103 | | | |

[a] Stage-discharge relation affected by ice.

*Daily discharge, in second-feet, of Pecos River near Anton Chico, N. Mex., for the year ending Sept. 30, 1915.*

| Day. | Oct. | Nov. | Dec. | Day. | Oct. | Nov. | Dec. | Day. | Oct. | Nov. | Dec. |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 78 | 86 | 60 | 11 | 67 | 95 | 45 | 21 | 40 | 78 | 40 |
| 2 | 71 | 84 | 60 | 12 | 64 | 95 | 40 | 22 | 40 | 76 | 40 |
| 3 | 66 | 81 | 60 | 13 | 61 | 92 | 35 | 23 | 40 | 73 | 40 |
| 4 | 123 | 78 | 55 | 14 | 58 | 98 | 30 | 24 | 40 | 71 | 40 |
| 5 | 180 | 76 | 51 | 15 | 55 | 95 | 30 | 25 | 116 | 71 | 40 |
| 6 | 168 | 78 | 51 | 16 | 52 | 95 | 30 | 26 | 95 | 66 | 40 |
| 7 | 100 | 71 | 53 | 17 | 49 | 89 | 40 | 27 | 100 | 64 | 40 |
| 8 | 81 | 78 | 53 | 18 | 46 | 86 | 45 | 28 | 98 | 62 | 40 |
| 9 | 73 | 98 | 50 | 19 | 43 | 84 | 50 | 29 | 98 | 62 | 35 |
| 10 | 69 | 98 | 50 | 20 | 40 | 81 | 45 | 30 | 92 | 60 | 35 |
| | | | | | | | | 31 | 86 | ..... | 35 |

NOTE.—Discharge determined as follows: Oct. 1–3, from a poorly defined curve; Oct. 6–10, Oct. 21 to Dec. 8, by indirect method for shifting control; Oct. 4 and 5, Oct. 11–20, and Dec. 9–11, by interpolation, from information furnished by the observer and records of flow at other stations in drainage basin; Dec. 12–31, from current-meter measurement and climatic data.

*Monthly discharge of Pecos River near Anton Chico, N. Mex., for the year ending Sept. 30, 1915.*

| Month. | Discharge in second-feet. | | | Run-off (total in acre-feet). | Accuracy. |
|---|---|---|---|---|---|
| | Maximum. | Minimum. | Mean. | | |
| October | 180 | 40 | 77.1 | 4,740 | C. |
| November | 98 | 60 | 80.7 | 4,800 | B. |
| December | 60 | 30 | 43.8 | 2,690 | C. |
| The period | ..... | ..... | ..... | 12,200 | |

### PECOS RIVER AT SANTA ROSA, N. MEX.

LOCATION.—In sec. 11, T. 8 N., R. 21 E., at highway-bridge at Santa Rosa, 1 mile above mouth of Rio Agua Negra Chiquita, 6 miles above Canyon Pintada, in north-central part of Guadalupe County.

DRAINAGE AREA.—2,780 square miles (measured on land office map).

RECORDS AVAILABLE.—February 1, 1910, to July 31, 1911; September 21, 1912, to December 31, 1914, when station was discontinued. From May 5, 1903, to December 31, 1906, records were obtained by United States Reclamation Service at a station 400 feet upstream.

GAGE.—Chain gage attached to downstream side of highway bridge; installed February 3, 1910, and set to read the same as the staff gage on the pier of the Chicago, Rock Island & El Paso Railway bridge 400 feet farther upstream, which was used by the United States Reclamation Service from May 5, 1903, to December 31, 1906. Datum of gages differed by an unknown amount, equal to slope of water surface at that time. Gage read morning and evening by George H. Smith, jr.

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

CHANNEL AND CONTROL.—Bed composed of sand and gravel; extremely shifting. Position of control unknown. Banks high and not subject to overflow.

EXTREMES OF DISCHARGE.—1903–1906, 1910–11, 1912–1915: Maximum stage recorded, 23.0 feet September 30, 1904 (discharge not computed); minimum stage recorded, 1.45 feet April 5–8, 1910 (discharge, 5.0 second-feet).

WINTER FLOW.—Stage-discharge relation not affected by ice.

DIVERSIONS.—No information.

REGULATION.—No power plants above station.

ACCURACY.—Results fair. Stage-discharge relation changes constantly; frequent current-meter measurements necessary to insure accurate determination.

Low and medium stage flow at this point depends on return seepage; at such stages the water disappears some distance above station, reappearing in the vicinity of gage from springs in the bed and banks.

*Discharge measurements of Pecos River at Santa Rosa, N. Mex., during the year ending Sept. 30, 1915.*

| Date. | Made by— | Gage height. | Discharge. | Date. | Made by— | Gage height. | Discharge. |
|---|---|---|---|---|---|---|---|
| | | *Feet.* | *Sec.-ft.* | | | *Feet.* | *Sec.-ft.* |
| Oct. 15 | R. J. Hank | 2.00 | 17.3 | Dec. 7 | R. J. Hank | 2.19 | 16.7 |
| Nov. 7 | C. J. Emerson | 2.40 | 48.5 | 30 | C. J. Emerson | 2.20 | 12.1 |

*Daily discharge, in second-feet, of Pecos River at Santa Rosa, N. Mex., for the year ending Sept. 30, 1915.*

| Day. | Oct. | Nov. | Dec. | Day. | Oct. | Nov. | Dec. | Day. | Oct. | Nov. | Dec. |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 25 | 72 | 26 | 11 | 30 | 45 | 16 | 21 | 34 | 25 | 26 |
| 2 | 30 | 57 | 27 | 12 | 27 | 40 | 19 | 22 | 30 | 20 | 26 |
| 3 | 33 | 53 | 25 | 13 | 29 | 43 | 14 | 23 | 27 | 16 | 25 |
| 4 | 38 | 74 | 19 | 14 | 28 | 39 | 19 | 24 | 57 | 20 | 20 |
| 5 | 38 | 51 | 17 | 15 | 26 | 35 | 19 | 25 | 159 | 19 | 20 |
| 6 | 33 | 54 | 19 | 16 | 25 | 33 | 19 | 26 | 130 | 19 | 21 |
| 7 | 74 | 53 | 16 | 17 | 25 | 26 | 20 | 27 | 100 | 19 | 19 |
| 8 | 67 | 53 | 20 | 18 | 22 | 29 | 22 | 28 | 93 | 19 | 16 |
| 9 | 45 | 46 | 20 | 19 | 24 | 26 | 24 | 29 | 80 | 19 | 13 |
| 10 | 38 | 48 | 16 | 20 | 23 | 26 | 26 | 30 | 59 | 19 | 13 |
| | | | | | | | | 31 | 65 | ..... | 15 |

NOTE.—Discharge determined by indirect method for shifting control.

*Monthly discharge of Pecos River at Santa Rosa, N. Mex., for the year ending Sept. 30, 1915.*

| Month. | Discharge in second-feet. | | | Run-off (total in acre-feet). | Accuracy. |
|---|---|---|---|---|---|
| | Maximum. | Minimum. | Mean. | | |
| October | 159 | 22 | 48.8 | 3,000 | C. |
| November | 74 | 16 | 26.6 | 2,180 | C. |
| December | 27 | 13 | 19.9 | 1,220 | C. |
| The period | | | | 6,400 | |

### PECOS RIVER NEAR GUADALUPE, N. MEX.

LOCATION. In sec. 34, T. 5 N., R. 24 E., 500 feet below [1] mouth of Alamo Gordo Creek, half a mile above the Alamo dam site, 4 miles west of Fort Sumner-Santa Rosa road, 8 miles above Guadalupe post office, 17 miles northwest of Fort Sumner, in southeastern part of Guadalupe County.

DRAINAGE AREA.—Not measured.

RECORDS AVAILABLE.—October 11, 1912, to December 31, 1914, when station was discontinued.

GAGE.—Friez water-stage recorder on left bank; replaced a Barrett & Lawrence water-stage recorder in 1913

DISCHARGE MEASUREMENTS.—Made by wading or from cable a short distance downstream from gage.

CHANNEL AND CONTROL.—Bed composed of rock, sand, and gravel; shifting; a shoal exists just below gage. Banks high and not subject to overflow. Apparently no permanent control.

EXTREMES OF DISCHARGE.—1912–1914: Maximum stage recorded, 15.5 feet May 1, 1914 (discharge, computed from extension of rating curve, 42,000 second-feet); minimum stage recorded, 0.51 foot August 14, 1913 (discharge, 57 second-feet).

WINTER FLOW.—Stage-discharge relation slightly affected by ice at times.

DIVERSIONS.—Large quantities of water diverted for irrigation above station; effect reduced to a small extent by water returned by seepage above station.

REGULATION.—No water-power plants above station.

ACCURACY.—Results good. Changes in stage-discharge relation, due to changes in channel, probably do not greatly impair the accuracy of the determinations.

*Discharge measurements of Pecos River near Guadalupe, N. Mex., during the year ending Sept. 30, 1915.*

| Date. | Made by— | Gage height. | Discharge. | Date. | Made by— | Gage height. | Discharge. |
|---|---|---|---|---|---|---|---|
| | | *Feet.* | *Sec.-ft.* | | | *Feet.* | *Sec.-ft.* |
| Oct. 15 | R. J. Hank | 0.89 | 98.5 | Dec. 7 | R. J. Hank | 0.90 | 91.8 |
| Nov. 7 | C. J. Emerson | 1.17 | 133 | 29 | C. J. Emerson | .89 | 112 |

[1] Stated erroneously in Water-Supply Paper 388 as "above mouth of Alamo Gordo Creek."

*Daily discharge, in second-feet, of Pecos River near Guadalupe, N. Mex., for the year ending Sept. 30, 1915.*

| Day. | Oct. | Nov. | Dec. | Day. | Oct. | Nov. | Dec. | Day. | Oct. | Nov. | Dec. |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 88 | 159 | 97 | 11 | 106 | 110 | 97 | 21 | 129 | 88 | 129 |
| 2 | 90 | 156 | 99 | 12 | 101 | 110 | 94 | 22 | 223 | 90 | 132 |
| 3 | 88 | 149 | 95 | 13 | 101 | 103 | 95 | 23 | 232 | 90 | 132 |
| 4 | 88 | 141 | 97 | 14 | 103 | 94 | 92 | 24 | 425 | 97 | 129 |
| 5 | 85 | 127 | 97 | 15 | 101 | 95 | 106 | 25 | 606 | 99 | 141 |
| 6 | 86 | 119 | 97 | 16 | 97 | 99 | 106 | 26 | 495 | 99 | 121 |
| 7 | 92 | 121 | 95 | 17 | 95 | 94 | 112 | 27 | 362 | 99 | 135 |
| 8 | 114 | 110 | 97 | 18 | 95 | 92 | 112 | 28 | 300 | 94 | 138 |
| 9 | 127 | 114 | 97 | 19 | 94 | 90 | 129 | 29 | 269 | 92 | 119 |
| 10 | 110 | 106 | 94 | 20 | 95 | 88 | 132 | 30 | 228 | 94 | 119 |
| | | | | | | | | 31 | 176 | ..... | 127 |

NOTE.—Discharge determined by indirect method for shifting control.

*Monthly discharge of Pecos River near Guadalupe, N. Mex., for the year ending Sept. 30, 1915.*

| Month. | Discharge in second-feet. | | | Run-off (total in acre-feet). | Accuracy. |
|---|---|---|---|---|---|
| | Maximum. | Minimum. | Mean. | | |
| October | 606 | 85 | 174 | 10,700 | C. |
| November | 159 | 88 | 107 | 6,370 | B. |
| December | 141 | 92 | 112 | 6,890 | B. |
| The period | ..... | ..... | ..... | 24,000 | |

### PECOS RIVER NEAR DAYTON, N. MEX.

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

DRAINAGE AREA.—Not measured.

RECORDS AVAILABLE.—March 24, 1905, to September 30, 1915.

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

DISCHARGE MEASUREMENTS.—Made from cable.

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

EXTREMES OF DISCHARGE.—Maximum discharge obtained during year, 42,000 second-feet April 18; gage height not known. Minimum stage recorded, 2.42 feet October 13; discharge, 74 second-feet.

1905–1915: Maximum discharge obtained, 50,300 second-feet July 25, 1905 (gage height not known). Minimum stage recorded, 2.40 feet October 16, 1908 (discharge, 28 second-feet).

WINTER FLOW.—Stage-discharge relation not affected by ice.

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

REGULATION.—None.

ACCURACY.—Results fair. Frequent current-meter measurements are necessary to insure accurate determinations, as stage-discharge relation is changeable.

COOPERATION.—Records April 15 to 19 and July 1 to September 30 furnished by United States Reclamation Service.

*Discharge measurements of Pecos River near Dayton, N. Mex., during the year ending Sept. 30, 1915.*

| Date. | Made by— | Gage height. | Discharge. | Date. | Made by— | Gage height. | Discharge. |
|---|---|---|---|---|---|---|---|
| | | *Feet.* | *Sec.-ft.* | | | *Feet.* | *Sec.-ft.* |
| Oct. 2 | C. J. Emerson | 2.42 | 77.2 | Aug. 18 | United States Reclamation Service engineers. | 4.40 | 528 |
| Nov. 9 | do | 3.75 | 277 | | | | |
| Dec. 10 | do | 3.82 | 336 | | | | |
| Feb. 13 | Foster and Strong | 3.80 | 355 | Sept. 1 | do | 3.75 | 226 |
| Mar. 4 | W. R. King | 3.95 | 378 | 13 | do | 3.15 | 120 |
| May 12 | do | 4.20 | 486 | 21 | do | 3.45 | 224 |
| June 18 | do | 3.87 | 460 | 21 | do | 3.35 | 208 |

*Daily discharge, in second-feet, of Pecos River near Dayton, N. Mex., for the year ending Sept. 30, 1915.*

| Day. | Oct. | Nov. | Dec. | Jan. | Feb. | Mar. | Apr. | May | June | July | Aug. | Sept. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 85 | 487 | 310 | 430 | 464 | 404 | 198 | 1,090 | 518 | 448 | 1,450 | 238 |
| 2 | 78 | 428 | 314 | 435 | 440 | 400 | 460 | 1,040 | 452 | 338 | 1,020 | 228 |
| 3 | 77 | 392 | 328 | 440 | 424 | 392 | 595 | 1,010 | 550 | 298 | 744 | 230 |
| 4 | 77 | 384 | 345 | 436 | 412 | 400 | 630 | 966 | 738 | 265 | 550 | 232 |
| 5 | 78 | 356 | 352 | 428 | 388 | 416 | 523 | 906 | 688 | 776 | 416 | 232 |
| 6 | 79 | 338 | 338 | 416 | 380 | 408 | 416 | 848 | 570 | 1,040 | 342 | 235 |
| 7 | 80 | 328 | 338 | 400 | 376 | 400 | 345 | 804 | 656 | 666 | 274 | 235 |
| 8 | 80 | 301 | 334 | 396 | 373 | 373 | 328 | 864 | 661 | 416 | 228 | 268 |
| 9 | 79 | 286 | 338 | 388 | 359 | 376 | 304 | 912 | 580 | 274 | 188 | 456 |
| 10 | 78 | 271 | 334 | 384 | 359 | 373 | 292 | 837 | 500 | 218 | 295 | 262 |
| 11 | 77 | 256 | 331 | 376 | 362 | 388 | 478 | 640 | 460 | 178 | 256 | 180 |
| 12 | 75 | 253 | 334 | 376 | 362 | 396 | 645 | 510 | 400 | 160 | 178 | 142 |
| 13 | 74 | 248 | 342 | 366 | 356 | 396 | 575 | 388 | 373 | 151 | 186 | 116 |
| 14 | 77 | 240 | 356 | 366 | 359 | 388 | 536 | 348 | 380 | 131 | 157 | 107 |
| 15 | 74 | 238 | 362 | 373 | 359 | 373 | 536 | 283 | 370 | 122 | 194 | 106 |
| 16 | 74 | 238 | 360 | 373 | 345 | 352 | 2,000 | 242 | 356 | 113 | 240 | 104 |
| 17 | 74 | 235 | 355 | 366 | 342 | 334 | 31,000 | 250 | 396 | 105 | 162 | 103 |
| 18 | 78 | 228 | 360 | 362 | 331 | 314 | 42,000 | 610 | 412 | 103 | 342 | 104 |
| 19 | 80 | 218 | 365 | 362 | 324 | 298 | 10,000 | 864 | 366 | 101 | 440 | 149 |
| 20 | 80 | 218 | 370 | 366 | 324 | 280 | 3,560 | 954 | 320 | 110 | 776 | 388 |
| 21 | 89 | 242 | 375 | 370 | 352 | 277 | 2,490 | 882 | 274 | 152 | 798 | 235 |
| 22 | 97 | 274 | 380 | 370 | 376 | 283 | 1,980 | 912 | 259 | 1,340 | 528 | 289 |
| 23 | 238 | 289 | 385 | 362 | 404 | 277 | 1,690 | 820 | 235 | 2,240 | 645 | 283 |
| 24 | 478 | 317 | 390 | 370 | 388 | 289 | 1,490 | 650 | 205 | 1,160 | 661 | 215 |
| 25 | 1,460 | 328 | 395 | 392 | 392 | 292 | 1,430 | 600 | 208 | 722 | 661 | 198 |
| 26 | 1,210 | 338 | 400 | 416 | 392 | 271 | 1,410 | 469 | 225 | 550 | 580 | 184 |
| 27 | 1,140 | 342 | 405 | 408 | 408 | 262 | 1,360 | 338 | 2,000 | 492 | 625 | 186 |
| 28 | 960 | 345 | 410 | 396 | 408 | 245 | 1,280 | 304 | 1,270 | 837 | 837 | 184 |
| 29 | 820 | 334 | 415 | 400 | ..... | 208 | 1,190 | 292 | 771 | 1,170 | 744 | 180 |
| 30 | 710 | 320 | 420 | 452 | ..... | 190 | 1,130 | 317 | 766 | 2,460 | 793 | 331 |
| 31 | 590 | ..... | 425 | 469 | ..... | 180 | ..... | 536 | ..... | 1,940 | 428 | ..... |

NOTE.—Discharge determined as follows: Oct. 1 to Dec. 15, Jan. 3 to Mar. 1, and May 12 to Sept. 30, by indirect method for shifting control; Mar. 2 to Apr. 14, Apr. 20 and 21, Apr. 25 to May 3, and May 7 and 8, from a poorly defined curve; Dec. 16 to Jan. 2, Apr. 15 to 19, Apr. 22 to 24, May 4 to 6, and May 9 to 11, estimated from information furnished by the U. S. Reclamation Service and gage observer, from records of flow at stations in the drainage basin and from climatic data.

*Monthly discharge of Pecos River near Dayton, N. Mex., for the year ending Sept. 30, 1915.*

| Month. | Discharge in second-feet. | | | Run-off (total in acre-feet). | Accuracy. |
|---|---|---|---|---|---|
| | Maximum. | Minimum. | Mean. | | |
| October | 1,460 | 74 | 301 | 18,500 | B. |
| November | 487 | 218 | 302 | 18,000 | B. |
| December | 425 | 310 | 363 | 22,300 | D. |
| January | 469 | 362 | 395 | 24,300 | C. |
| February | 464 | 324 | 377 | 20,900 | C. |
| March | 416 | 180 | 330 | 20,300 | C. |
| April | 42,000 | 198 | 3,700 | 220,000 | D. |
| May | 1,090 | 242 | 661 | 40,600 | D. |
| June | 2,000 | 205 | 532 | 31,700 | C. |
| July | 2,460 | 101 | 615 | 37,800 | C. |
| August | 1,450 | 157 | 508 | 31,200 | C. |
| September | 456 | 103 | 213 | 12,700 | B. |
| The year | 42,000 | 74 | 688 | 498,000 | |

### PECOS RIVER AT CARLSBAD, N. MEX.

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

DRAINAGE AREA.—Not measured.

RECORDS AVAILABLE.—May 28, 1903, to March 31, 1908; May 18, 1914, to September 30, 1915.

GAGE.—Vertical staff, attached to the upstream side of middle bridge pier, installed May 18, 1914; read twice daily by D. Armendariz. Gage used from May 28, 1903, to October, 1904, was an inclined staff gage, and that used from October, 1904, to March 31, 1908, a vertical staff gage at same site.

DISCHARGE MEASUREMENTS.—Made by wading or from bridge.

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

EXTREMES OF DISCHARGE.—Maximum stage recorded during year, 20.5 feet April 17 (discharge not computed); minimum stage recorded, 0.80 foot January 10–12 and 21 (discharge, 60 second-feet).

1903–1908 and 1914–15: Maximum stage recorded, April 17, 1915; minimum stage recorded, zero (no flow), May 9, 1904.

WINTER FLOW.—Stage-discharge relation not affected by ice.

DIVERSIONS.—Water stored by United States Reclamation Service in Lakes McMillan and Avalon, a few miles above station, is used to irrigate lands near Carlsbad. Capacity of storage reservoirs in connection with the Carlsbad project, 58,500 acre-feet. Water is also diverted for irrigation in the valleys adjacent to the river above Lake McMillan.

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

ACCURACY.—Results fair. Considerable water seeps into river between the reservoirs and gaging station, the quantity depending on the quantity of water being used for irrigation between the two points. Stage fluctuates with quantity of water released at the reservoirs and returned by seepage, so that the assumption that the average of two gage readings a day is the mean stage for that day probably subjects the determination to considerable error. Stage-discharge relation practically permanent, but no current-meter measurements were made during latter part of year.

COOPERATION.—Gage-height record July 1 to September 30 furnished by United States Reclamation Service.

*Discharge measurements of Pecos River at Carlsbad, N. Mex., during the year ending Sept. 30, 1915.*

| Date. | Made by— | Gage height. | Discharge. | Date. | Made by— | Gage height. | Discharge. |
|---|---|---|---|---|---|---|---|
| | | *Feet.* | *Sec.-ft.* | | | *Feet.* | *Sec.-ft.* |
| Nov. 9 | C. J. Emerson | 1.25 | 242 | May 14 | W. R. King | 0.84 | 120 |
| Dec. 10 | do | 1.58 | 457 | 14 | do | .80 | 104 |
| Mar. 3 | W. R. King | 1.01 | 157 | June 18 | do | .82 | 105 |

*Daily discharge, in second-feet, of Pecos River at Carlsbad, N. Mex., for the year ending Sept. 30, 1915.*

| Day. | Oct. | Nov. | Dec. | Jan. | Feb. | Mar. | Apr. | May. | June. | July. | Aug. | Sept. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 105 | 90 | 365 | 305 | 220 | 150 | 97 | 140 | 109 | 125 | 250 | 185 |
| 2 | 118 | 90 | 323 | 323 | 248 | 150 | 85 | 968 | 105 | 125 | 185 | 185 |
| 3 | 114 | 210 | 305 | 3,400 | 248 | 150 | 85 | 1,700 | 105 | 125 | 1,720 | 1,400 |
| 4 | 147 | 264 | 305 | 90 | 264 | 85 | 85 | 1,300 | 105 | 125 | 490 | 3,720 |
| 5 | 180 | 275 | 462 | 90 | 275 | 85 | 85 | 1,120 | 115 | 140 | 225 | 3,030 |
| 6 | 248 | 275 | 490 | 90 | 248 | 85 | 105 | 1,150 | 115 | 140 | 755 | 2,740 |
| 7 | 305 | 275 | 462 | 90 | 275 | 85 | 74 | 1,080 | 335 | 140 | 560 | 3,660 |
| 8 | 305 | 275 | 455 | 75 | 220 | 85 | 85 | 1,100 | 925 | 140 | 365 | 1,680 |
| 9 | 305 | 264 | 455 | 75 | 220 | 85 | 272 | 1,120 | 2,600 | 125 | 170 | 155 |
| 10 | 299 | 275 | 443 | 60 | 248 | 85 | 4,240 | 1,100 | 193 | 125 | 125 | 140 |
| 11 | 275 | 275 | 425 | 60 | 2,020 | 85 | 1,470 | 882 | 305 | 125 | 125 | 125 |
| 12 | 287 | 275 | 347 | 60 | 117 | 85 | 105 | 105 | 193 | 140 | 121 | 121 |
| 13 | 264 | 275 | 347 | 210 | 97 | 1,470 | 85 | 115 | 155 | 140 | 115 | 115 |
| 14 | 275 | 305 | 347 | 231 | 78 | 1,800 | 105 | 115 | 155 | 125 | 115 | 115 |
| 15 | 275 | 290 | 335 | 287 | 97 | 125 | 85 | 109 | 155 | 125 | 115 | 119 |
| 16 | 275 | 275 | 323 | 305 | 97 | 105 | 5,290 | 105 | 155 | 125 | 119 | 125 |
| 17 | 275 | 248 | 335 | 5,190 | 97 | 85 | 20,600 | 115 | 121 | 105 | 125 | 125 |
| 18 | 275 | 242 | 335 | 90 | 78 | 85 | 14,000 | 115 | 115 | 105 | 125 | 125 |
| 19 | 275 | 226 | 335 | 882 | 78 | 85 | 20,400 | 109 | 105 | 125 | 115 | 155 |
| 20 | 275 | 1,560 | 335 | 75 | 78 | 85 | 12,800 | 109 | 105 | 125 | 115 | 180 |
| 21 | 299 | 90 | 195 | 60 | 1,040 | 2,340 | 9,200 | 105 | 105 | 134 | 115 | 205 |
| 22 | 299 | 90 | 90 | 75 | 85 | 125 | 6,450 | 683 | 109 | 140 | 115 | 225 |
| 23 | 275 | 90 | 90 | 75 | 85 | 105 | 5,290 | 659 | 115 | 140 | 115 | 225 |
| 24 | 1,120 | 90 | 90 | 75 | 85 | 105 | 3,030 | 798 | 115 | 125 | 125 | 400 |
| 25 | 110 | 925 | 90 | 75 | 85 | 105 | 2,600 | 115 | 115 | 125 | 739 | 525 |
| 26 | 110 | 1,610 | 110 | 75 | 97 | 105 | 1,480 | 798 | 115 | 125 | 595 | 1,200 |
| 27 | 110 | 560 | 110 | 84 | 1,490 | 928 | 2,630 | 305 | 115 | 140 | 125 | 1,770 |
| 28 | 90 | 365 | 110 | 90 | 2,210 | 1,800 | 155 | 105 | 115 | 2,020 | 125 | 2,340 |
| 29 | 90 | 305 | 90 | 75 | ..... | 125 | 1,720 | 193 | 121 | 1,250 | 1,170 | 2,340 |
| 30 | 90 | 305 | 150 | 84 | ..... | 105 | 3,510 | 225 | 121 | 840 | 1,060 | 1,200 |
| 31 | 90 | ..... | 275 | 130 | ..... | 85 | ..... | 115 | ..... | 395 | 275 | ..... |

NOTE.—Discharge determined as follows: Oct. 1 to 3, Oct. 5 to Nov. 14, Nov. 16 to 21, Nov. 23 to Dec. 12, Dec. 14 to Feb. 10, Mar. 4 to 6, Mar. 8 to Sept. 19, Sept. 22, Sept. 25 and 26, and Sept. 28 to 30, from fairly well defined curves; Feb. 11 to Mar. 3 by indirect method for shifting control; Oct. 4, Nov. 15 and 22, Dec. 13, Mar. 7, Sept. 20, 21, 23, 24, and 27, by interpolation, from records of flow at other stations in this drainage basin and climatic data.

*Monthly discharge of Pecos River at Carlsbad, N. Mex., for the year ending Sept. 30, 1915.*

| Month. | Discharge in second-feet. | | | Run-off (total in acre-feet). | Accuracy. |
|---|---|---|---|---|---|
| | Maximum. | Minimum. | Mean. | | |
| October | 1,120 | 90 | 244 | 15,000 | C. |
| November | 1,610 | 90 | 356 | 21,200 | C. |
| December | 490 | 90 | 290 | 17,800 | C. |
| January | 5,190 | 60 | 416 | 25,600 | C. |
| February | 2,210 | 78 | 374 | 20,800 | C. |
| March | 2,340 | 85 | 354 | 21,800 | C. |
| April | 20,600 | 74 | 3,870 | 230,000 | D. |
| May | 1,700 | 105 | 541 | 33,300 | D. |
| June | 2,600 | 105 | 247 | 14,700 | C. |
| July | 2,020 | 105 | 258 | 15,900 | C. |
| August | 1,720 | 115 | 342 | 21,000 | D. |
| September | 3,720 | 115 | 954 | 56,800 | D. |
| The year | 20,600 | 60 | 683 | 494,000 | |

## EVAPORATION NEAR CARLSBAD, N. MEX.

A station to determine evaporation was established July 31, 1914, at the head gates on Lake Avalon, on the Carlsbad project of the United States Reclamation Service, about 6 miles north of Carlsbad and 3,200 feet above sea level.

The equipment consists of a standard rain gage and a heavy galvanized iron pan, 3 feet square and 18 inches deep, floating on the reservoir. The water surface in the pan is kept at approximately the same level as that outside the pan, the quantity of water that must be added to the pan daily to preserve that level being used as a measure of evaporation, allowance being made for the amount of rainfall.

*Evaporation near Carlsbad, N. Mex., for the year ending Sept. 30, 1915.*

| Month. | Temperature. | | Rainfall. | Evaporation. |
|---|---|---|---|---|
| | In pan. | Outside of pan. | | |
| | °F. | °F. | *Inches.* | *Inches.* |
| October | 64 | 63 | 2.24 | 6.12 |
| November | 58 | 57 | 1.11 | 2.92 |
| December | 47 | 47 | 1.91 | 2.44 |
| January | 44 | 43 | .35 | 2.44 |
| February | 49 | 48 | .74 | 2.70 |
| March | 52 | 52 | 1.34 | 3.21 |
| April | 57 | 58 | 4.19 | 4.97 |
| May 14–31 | 71 | 70 | .08 | 5.51 |
| June | 75 | 75 | .68 | 9.56 |
| July | 75 | 76 | 1.01 | 9.57 |
| August | 76 | 76 | .81 | 7.33 |
| September | 72 | 72 | 4.49 | 6.69 |

NOTE.—Pan destroyed Apr. 18 by high water. Evaporation estimated Apr. 18–30. General climatic conditions for this period same as had existed for some time previous. Rainfall for April is total and was not estimated. Rainfall May 1–13 not known.

### PECOS RIVER NEAR ANGELES, TEX.

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

DRAINAGE AREA.—Not measured.

RECORDS AVAILABLE.—May 27, 1914, to September 30, 1915.

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

DISCHARGE MEASUREMENTS.—Made by wading or from cable about half a mile below gage.

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

EXTREMES OF DISCHARGE.—Maximum stage during 1914 and 1915 from water-stage recorder, 15.45 feet at 11 a. m. April 17, 1915 (discharge, 54,900 second-feet), computed from extension of rating curve and may be subject to considerable error; minimum stage recorded, 0.24 foot at 10 p. m. July 6, 1915 (discharge, 128 second-feet).

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

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

REGULATION.—The operation of a 300-horsepower water-power plant above the station just below Carlsbad does not materially affect the flow at the gage. The flow is, however, regulated to a large extent by water stored in the reservoirs of the Carlsbad project, and during the winter the flow is dependent on the water released at those reservoirs. During the season of irrigation return seepage waters decrease the effect of regulation.

ACCURACY.—Results good; channel and control subject to slight changes; station well rated for low and medium stages.

*Discharge measurements of Pecos River near Angeles, Tex., during the year ending Sept. 30, 1915.*

| Date. | Made by— | Gage height. | Discharge. | Date. | Made by— | Gage height. | Discharge. |
|---|---|---|---|---|---|---|---|
| | | *Feet.* | *Sec.-ft.* | | | *Feet.* | *Sec.-ft.* |
| Oct. 1 | C. J. Emerson | 0.52 | 164 | Mar. 6 | W. R. King | 0.48 | 190 |
| Nov. 10 | do | .76 | 327 | May 15 | do | .42 | 207 |
| Dec. 11 | do | .92 | 508 | June 19 | do | .38 | 185 |

*Daily discharge, in second-feet, of Pecos River near Angeles, Tex., for the year ending Sept. 30, 1915.*

| Day. | Oct. | Nov. | Dec. | Jan. | Feb. | Mar. | Apr. | May. | June. | July. | Aug. | Sept. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 160 | 390 | 480 | 378 | 244 | 920 | 265 | 1,900 | 256 | 152 | 960 | 720 |
| 2 | ..... | 380 | 632 | 378 | 252 | 408 | 256 | 768 | 212 | 148 | 1,900 | 360 |
| 3 | ..... | 370 | 584 | 584 | 315 | 320 | 248 | 1,290 | 208 | 140 | 1,300 | 444 |
| 4 | ..... | 360 | 496 | 444 | 340 | 285 | 248 | 1,080 | 204 | 144 | 1,320 | 360 |
| 5 | ..... | 360 | 508 | 474 | 335 | 240 | 256 | 910 | 200 | 140 | 504 | 1,460 |
| 6 | ..... | 350 | 521 | 414 | 340 | 204 | 256 | 920 | 212 | 132 | 360 | 2,400 |
| 7 | ..... | 340 | 534 | 414 | 350 | 212 | 256 | 1,170 | 496 | 176 | 520 | 3,260 |
| 8 | ..... | 340 | 547 | 420 | 345 | 224 | 252 | 848 | 656 | 168 | 335 | 2,660 |
| 9 | ..... | 330 | 560 | 420 | 366 | 236 | 270 | 950 | 1,240 | 136 | 305 | 2,840 |
| 10 | ..... | 330 | 528 | 414 | 330 | 240 | 2,040 | 990 | 1,800 | 136 | 285 | 2,120 |
| 11 | ..... | 345 | 520 | 408 | 584 | 236 | 3,340 | 864 | 536 | 144 | 270 | 970 |
| 12 | ..... | 420 | 512 | 414 | 1,890 | 240 | 1,360 | 402 | 360 | 152 | 260 | 712 |
| 13 | ..... | 372 | 512 | 408 | 536 | 228 | 664 | 295 | 325 | 148 | 252 | 672 |
| 14 | ..... | 350 | 488 | 408 | 396 | 1,570 | 396 | 248 | 285 | 136 | 248 | 616 |
| 15 | ..... | 345 | 468 | 402 | 366 | 1,030 | 648 | 208 | 270 | 144 | 244 | 576 |
| 16 | ..... | 350 | 450 | 396 | 340 | 360 | 1,200 | 212 | 256 | 220 | 240 | 528 |
| 17 | ..... | 350 | 438 | 402 | 300 | 305 | 27,600 | 204 | 236 | 285 | 240 | 488 |
| 18 | ..... | 335 | 428 | 1,480 | 270 | 270 | 14,400 | 204 | 212 | 240 | 236 | 462 |
| 19 | ..... | 335 | 426 | 408 | 260 | 270 | 27,200 | 224 | 192 | 224 | 228 | 432 |
| 20 | ..... | 340 | 426 | 872 | 244 | 275 | 21,000 | 228 | 200 | 200 | 244 | 402 |
| 21 | 340 | 1,230 | 420 | 432 | 592 | 890 | 14,300 | 208 | 220 | 240 | 310 | 366 |
| 22 | 366 | 414 | 420 | 270 | 712 | 1,650 | 11,000 | 208 | 204 | 325 | 244 | 345 |
| 23 | 378 | 420 | 408 | 252 | 260 | 536 | 9,200 | 832 | 172 | 212 | 220 | 320 |
| 24 | 528 | 552 | 450 | 256 | 232 | 320 | 7,800 | 330 | 164 | 172 | 220 | 552 |
| 25 | ..... | 474 | 426 | 265 | 220 | 320 | 2,390 | 784 | 216 | 204 | 240 | 856 |
| 26 | ..... | 1,360 | 402 | 240 | 208 | 320 | 1,360 | 295 | 196 | 275 | 265 | 940 |
| 27 | ..... | 1,330 | 402 | 244 | 204 | 320 | 900 | 688 | 180 | 345 | 244 | 970 |
| 28 | ..... | 720 | 396 | 244 | 1,070 | 840 | 656 | 444 | 172 | 648 | 600 | 872 |
| 29 | ..... | 584 | 384 | 252 | ..... | 728 | 752 | 240 | 160 | 1,520 | 584 | 752 |
| 30 | ..... | 480 | 378 | 252 | ..... | 396 | 5,030 | 378 | 164 | 1,360 | 335 | 632 |
| 31 | ..... | ..... | 384 | 244 | ..... | 325 | ..... | 366 | ..... | 980 | 930 | ..... |

NOTE.—Discharge determined as follows: Oct. 1, Oct. 21–24, Nov. 10 to Dec. 4, Dec. 9 to Mar. 23, Mar. 28 to Apr. 11, Apr. 17–24, Apr. 29 to May 11, May 15 to Sept. 30, by indirect method for shifting control; Nov. 1–9, Dec. 5–8, Mar. 24–27, Apr. 12–16, 25–28, and May 12–14, from records of flow of nearby stations, climatic data, and information furnished by engineer.

*Monthly discharge of Pecos River near Angeles, Tex., for the year ending Sept. 30, 1915.*

| Month. | Discharge in second-feet. | | | Run-off (total in acre-feet). | Accuracy. |
|---|---|---|---|---|---|
| | Maximum. | Minimum. | Mean. | | |
| October | ..... | ..... | a 363 | 22,300 | D. |
| November | 1,360 | 330 | 489 | 29,100 | C. |
| December | 632 | 378 | 469 | 28,800 | B. |
| January | 1,480 | 240 | 416 | 25,600 | B. |
| February | 1,890 | 204 | 425 | 23,600 | B. |
| March | 1,650 | 204 | 475 | 29,200 | B. |
| April | 27,600 | 248 | 5,180 | 308,000 | D. |
| May | 1,900 | 204 | 603 | 37,100 | C. |
| June | 1,800 | 160 | 340 | 20,200 | B. |
| July | 1,520 | 132 | 311 | 19,100 | B. |
| August | 1,900 | 220 | 466 | 28,700 | C. |
| September | 3,260 | 320 | 970 | 57,700 | B. |
| The year | 27,600 | 132 | 870 | 629,000 | |

a Estimated.

### PECOS RIVER NEAR BARSTOW, TEX.

LOCATION.—Near northeast corner of water tract No. 10, sec. 34, Ward County, 2½ miles above mouth of Toyah Creek, 4 miles southeast of Barstow, 5 miles above diversion for Big Valley project and 7 miles downstream from Texas & Pacific Railway bridge.

DRAINAGE AREA.—Not measured.

RECORDS AVAILABLE.—April 27, 1914, to August 11, 1915, when station was discontinued.

GAGE.—Stevens water-stage recorder on left bank used April 27, 1914, to May 16, 1915; May 17 to August 11, 1915 vertical staff gage 100 feet below recorder, and at same datum; read daily by C. P. Maulding.

DISCHARGE MEASUREMENTS.—Made by wading or from cable 100 feet below gage.

CHANNEL AND CONTROL.—Bed composed of sand and gravel. Banks clay; subject to overflow at extremely high stages, so that the stream spreads over an area about a mile in width. No permanent control; discharge relation changes continually during changes in stage.

EXTREMES OF DISCHARGE.—1914–15: Maximum stage recorded, 12.5 feet during afternoon of April 20, 1915, determined by leveling from flood marks (discharge not computed); minimum stage recorded, less than 20 second-feet from July 1 to 28, 1915.

WINTER FLOW.—Stage-discharge relation not affected by ice.

DIVERSIONS.—Water in large quantities is stored in the reservoirs of the Carlsbad project of the United States Reclamation Service, having a total capacity of 58,500 acre-feet, and also utilized by direct diversion from river above station. Large areas are irrigated in the vicinity of Barstow.

REGULATION.—Flow regulated to a large extent by storage reservoirs in the drainage area above the station. The return of water to the stream by seepage above and below the station during the irrigating season tends to reduce partly the direct effect of regulation. The operation of a 300-horsepower water-power plant on Pecos River below Carlsbad, N. Mex., produces no observable effect at the station.

ACCURACY.—Results poor; stage-discharge relation changeable; gage-height record not complete.

*Discharge measurements of Pecos River near Barstow, Tex., during the year ending Sept. 30, 1915.*

| Date. | Made by— | Gage height. | Discharge. | Date. | Made by— | Gage height. | Discharge. |
|---|---|---|---|---|---|---|---|
| | | *Feet.* | *Sec.-ft.* | | | *Feet.* | *Sec.-ft.* |
| Nov. 12 | C. J. Emerson | 2.43 | 341 | May 17 | W. R. King | 2.16 | 297 |
| Dec. 15 | do | 2.94 | 439 | 20 | do | 1.49 | 173 |
| Mar. 9 | W. R. King | 1.75 | 184 | June 22 | do | .46 | 45.5 |

*Daily discharge, in second-feet, of Pecos River near Barstow, Tex., for the year ending Sept. 30, 1915.*

| Day. | Oct. | Nov. | Dec. | Jan. | Mar. | Apr. | May. | June. | July. | Aug. |
|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 58 | 401 | 542 | 268 | 187 | 288 | ..... | 119 | ..... | ..... |
| 2 | 59 | 360 | 482 | 265 | 399 | 254 | ..... | 116 | ..... | 1,010 |
| 3 | 55 | 340 | 470 | 260 | 301 | 173 | ..... | 91 | ..... | 1,080 |
| 4 | 46 | 340 | 470 | 267 | 236 | 124 | ..... | 86 | ..... | 1,440 |
| 5 | 47 | 340 | 540 | 408 | 222 | 119 | ..... | 81 | ..... | 1,420 |
| 6 | 65 | 340 | 468 | 716 | 212 | 112 | ..... | 104 | ..... | 590 |
| 7 | 51 | 340 | 444 | 623 | 205 | 102 | ..... | 150 | ..... | 278 |
| 8 | 46 | 340 | 456 | 397 | 198 | 98 | ..... | 162 | ..... | ..... |
| 9 | 46 | 340 | 490 | 301 | 184 | 92 | ..... | 202 | ..... | 138 |
| 10 | 80 | 380 | 492 | 283 | 184 | 88 | ..... | 243 | ..... | 104 |
| 11 | 134 | 356 | 482 | 281 | 184 | 208 | ..... | 1,170 | ..... | 104 |
| 12 | 156 | 340 | 465 | 288 | 187 | 1,980 | ..... | 898 | ..... | ..... |
| 13 | 120 | 410 | 453 | 262 | 182 | 1,720 | ..... | 291 | ..... | ..... |
| 14 | 114 | 408 | 441 | 257 | 177 | 800 | ..... | 272 | ..... | ..... |
| 15 | 118 | 398 | 441 | 238 | 346 | 390 | ..... | 264 | ..... | ..... |
| 16 | 131 | 368 | 403 | 229 | 758 | ..... | ..... | 248 | ..... | ..... |
| 17 | 130 | 358 | 394 | 229 | 551 | ..... | 270 | 240 | ..... | ..... |
| 18 | 133 | 352 | 399 | 232 | 346 | ..... | 246 | 222 | ..... | ..... |
| 19 | 143 | 344 | 399 | 236 | 252 | ..... | 216 | 88 | ..... | ..... |
| 20 | 149 | 336 | 399 | 356 | 213 | ..... | 181 | 83 | ..... | ..... |
| 21 | 168 | ..... | 397 | 695 | 195 | ..... | 148 | 73 | ..... | ..... |
| 22 | 188 | ..... | 399 | 620 | 222 | ..... | 136 | 46 | ..... | ..... |
| 23 | 1,740 | ..... | 397 | 434 | 737 | ..... | 102 | 42 | ..... | ..... |
| 24 | 1,240 | ..... | 408 | 330 | 638 | ..... | 97 | 38 | ..... | ..... |
| 25 | 905 | ..... | 410 | 262 | 362 | ..... | 434 | 46 | ..... | ..... |
| 26 | 755 | ..... | 370 | 243 | 275 | ..... | 139 | 44 | ..... | ..... |
| 27 | 695 | ..... | 342 | 235 | 213 | ..... | 323 | 38 | ..... | ..... |
| 28 | 940 | ..... | 325 | 227 | 184 | ..... | 121 | 32 | ..... | ..... |
| 29 | 922 | ..... | 312 | 220 | 173 | ..... | 399 | 26 | 312 | ..... |
| 30 | 650 | ..... | 294 | 213 | 206 | ..... | 248 | 20 | 835 | ..... |
| 31 | 482 | ..... | 281 | 206 | 278 | ..... | 98 | ..... | 975 | ..... |

NOTE.—Discharge determined as follows: Oct. 1–23, Nov. 12–20, Dec. 1 to Jan. 22, Mar. 9 to Apr. 15, May 17–29, May 31 to June 26, July 29–31, Aug. 2–7, and Aug. 9–11, by indirect method for shifting control; Oct. 24 to Nov. 11, Jan. 23–31, Mar. 1–8, May 30, and June 27–30 by interpolation, from records of flow at other stations in the drainage basin, information furnished by observer, and climatic data; from July 1–28 the flow was less than 20 second-feet.

*Monthly discharge of Pecos River near Barstow, Tex., for the year ending Sept 30, 1915.*

| Month. | Discharge in second-feet. | | | Run-off (total in acre-feet). | Accuracy. |
|---|---|---|---|---|---|
| | Maximum. | Minimum. | Mean. | | |
| October | 1,740 | 46 | 341 | 21,000 | D. |
| November | 410 | 336 | 360 | 14,200 | D. |
| December | 542 | 281 | 421 | 25,900 | D. |
| January | 716 | 206 | 325 | 20,000 | D. |
| February | ..... | ..... | [a] 250 | 13,900 | |
| March | 758 | 173 | 291 | 17,900 | D. |
| April 1–15 | 1,980 | 88 | 437 | 13,000 | D. |
| May 17–31 | 434 | 97 | 211 | 6,280 | D. |
| June | 1,170 | 20 | 184 | 10,900 | D. |

[a] Estimated.

### PECOS RIVER NEAR COMSTOCK, TEX.[1]

LOCATION.—At the Pecos high bridge of Galveston, Harrisburg & San Antonio, Railway Co. (Southern Pacific lines), 11 miles west of Comstock, 18 miles east of Langtry, 14 miles by stream above confluence with Rio Grande, in western part of Valverde County; below all tributaries.

DRAINAGE AREA.—Not measured.

RECORDS AVAILABLE.—May 1, 1900, to September 30, 1915. Also gage heights for 1898.

GAGE.—Vertical staff attached to the downstream side of bridge pier on left bank; read twice daily by W. A. Clare.

DISCHARGE MEASUREMENTS.—Made from cable 1,000 feet above bridge.

CHANNEL AND CONTROL.—Banks and bed composed of rock and gravel; stream flows through a series of rapids and pools in a canyon about 300 feet deep. The stage-discharge relation at the lower stages changes frequently.

EXTREMES OF DISCHARGE.—Maximum stage recorded during year, 19.0 feet, October 23 (discharge, 36,700 second-feet); minimum stage recorded, 0.80 foot during parts of July, August, and September (discharge, 366 second-feet).

1900–1915: Maximum stage recorded, 35.75 feet, April 6, 1900 (dircharge not computed); minimum stage recorded, 0.50 foot, May, 1904 (discharge, 110 second-feet).

WINTER FLOW.—Stage-discharge relation not affected by ice.

DIVERSIONS AND STORAGE.—Considerable water is diverted and stored above the station for irrigation. Lake McMillan and Lake Avalon, on the Carlsbad project of the United States Reclamation Service, with a combined capacity of 58,500 acre-feet, are on Pecos River a few miles above Carlsbad, N. Mex. Large areas of land are irrigated by water diverted from Pecos River in the vicinity of Barstow and Grandfalls, Tex. No diversions below station.

REGULATION.—Yearly run-off at this point controlled by storage and diversions for irrigation above, but return waters eliminate a partial effect of the diurnal change in the lower part of the drainage. No large water-power plants in the drainage basin except a public-utility plant of about 300 horsepower, near Carlsbad, N. Mex., which does not affect the flow at this point.

ACCURACY.—Results fair. Determinations are subject to slight errors due to diurnal fluctuation and the assumption that the average of two readings a day is the mean for that day, but the largest errors are due to changes in stage-discharge relation at low stages.

*Discharge measurements of Pecos River near Comstock, Tex., during the year ending Sept. 30, 1915.*

[Made by W. H. Dodd.]

| Date. | Gage height. | Discharge. | Date. | Gage height. | Discharge. | Date. | Gage height. | Discharge. |
|---|---|---|---|---|---|---|---|---|
| | *Feet.* | *Sec.-ft.* | | *Feet.* | *Sec.-ft.* | | *Feet.* | *Sec.-ft.* |
| Mar. 25 | 1.40 | 620 | Apr. 22 | 9.82 | 12,400 | May 29 | 1.40 | 775 |
| Apr. 5 | 1.45 | 646 | May 9 | 3.80 | 2,630 | June 9 | 1.25 | 576 |
| 16 | 2.02 | 1,060 | 19 | 2.40 | 1,270 | | | |

[1] Records published in previous reports under heading "Pecos River near Moorhead, Tex."

*Daily discharge, in second-feet, of Pecos River near Comstock, Tex., for the year ending Sept. 30, 1915.*

| Day. | Oct. | Nov. | Dec. | Jan. | Feb. | Mar. | Apr. | May. | June. | July. | Aug. | Sept. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 550 | 8,310 | 1,160 | 734 | 764 | 622 | 561 | 5,300 | 824 | 464 | 644 | 395 |
| 2 | 525 | 4,310 | 1,660 | 764 | 734 | 650 | 510 | 6,310 | 824 | 464 | 589 | 366 |
| 3 | 525 | 1,710 | 1,380 | 794 | 734 | 567 | 510 | 6,070 | 764 | 486 | 589 | 373 |
| 4 | 477 | 1,420 | 1,270 | 794 | 677 | 567 | 510 | 5,160 | 660 | 486 | 535 | 366 |
| 5 | 477 | 1,270 | 1,200 | 794 | 677 | 567 | 535 | 4,870 | 633 | 366 | 589 | 366 |
| 6 | 477 | 1,130 | 988 | 734 | 677 | 567 | 589 | 4,260 | 616 | 384 | 644 | 384 |
| 7 | 477 | 1,200 | 921 | 734 | 650 | 856 | 616 | 3,750 | 1,600 | 384 | 644 | 403 |
| 8 | 477 | 988 | 856 | 734 | 622 | 856 | 671 | 3,520 | 869 | 403 | 644 | 403 |
| 9 | 454 | 988 | 856 | 734 | 594 | 794 | 561 | 2,830 | 616 | 403 | 672 | 403 |
| 10 | 434 | 921 | 856 | 1,060 | 567 | 704 | 510 | 2,530 | 616 | 403 | 699 | 562 |
| 11 | 434 | 921 | 856 | 888 | 567 | 677 | 510 | 2,830 | 600 | 403 | 672 | 486 |
| 12 | 434 | 921 | 856 | 856 | 567 | 650 | 464 | 2,650 | 616 | 403 | 644 | 850 |
| 13 | 434 | 888 | 856 | 794 | 567 | 622 | 616 | 2,460 | 561 | 384 | 589 | 915 |
| 14 | 434 | 856 | 856 | 794 | 515 | 594 | 616 | 2,280 | 567 | 366 | 578 | 818 |
| 15 | 434 | 856 | 856 | 734 | 515 | 567 | 2,740 | 2,090 | 578 | 366 | 561 | 1,020 |
| 16 | 434 | 856 | 856 | 734 | 515 | 567 | 1,110 | 1,910 | 616 | 366 | 535 | 5,120 |
| 17 | 434 | 856 | 856 | 734 | 515 | 567 | 1,110 | 1,730 | 710 | 366 | 510 | 947 |
| 18 | 434 | 856 | 824 | 734 | 954 | 567 | 1,110 | 1,540 | 650 | 366 | 464 | 850 |
| 19 | 434 | 856 | 794 | 704 | 824 | 515 | 908 | 1,360 | 655 | 366 | 422 | 788 |
| 20 | 434 | 856 | 794 | 677 | 734 | 515 | 782 | 1,350 | 616 | 366 | 403 | 699 |
| 21 | 434 | 856 | 794 | 677 | 677 | 468 | 694 | 1,470 | 589 | 403 | 384 | 589 |
| 22 | 869 | 856 | 794 | 734 | 650 | 622 | 27,400 | 1,480 | 561 | 366 | 366 | 644 |
| 23 | 36,700 | 824 | 794 | 734 | 594 | 650 | 5,120 | 1,440 | 589 | 366 | 366 | 644 |
| 24 | 11,400 | 794 | 794 | 954 | 567 | 677 | 2,790 | 1,560 | 545 | 366 | 403 | 699 |
| 25 | 6,550 | 794 | 794 | 856 | 515 | 622 | 2,890 | 1,490 | 535 | 366 | 384 | 699 |
| 26 | 3,920 | 921 | 794 | 856 | 515 | 622 | 2,990 | 1,470 | 510 | 384 | 366 | 699 |
| 27 | 2,510 | 1,270 | 794 | 856 | 515 | 622 | 3,430 | 1,470 | 486 | 403 | 366 | 644 |
| 28 | 1,710 | 1,270 | 794 | 856 | 567 | 567 | 3,610 | 1,330 | 486 | 403 | 403 | 616 |
| 29 | 1,470 | 921 | 794 | 856 | ..... | 561 | 3,370 | 764 | 486 | 422 | 562 | 589 |
| 30 | 1,590 | 988 | 794 | 856 | ..... | 561 | 4,440 | 728 | 486 | 442 | 510 | 1,410 |
| 31 | 1,590 | ..... | 734 | 794 | ..... | 561 | ..... | 788 | ..... | 882 | 486 | ..... |

NOTE.—Discharge determined as follows: Oct. 1 to Mar. 28, and June 7 to Sept. 30, from fairly well defined curves based on current-meter measurements made in and before the climatic year 1914–15; Mar. 29 to Apr. 16, Apr. 18 to May 11, and May 19 to June 6, by indirect method for shifting control; Apr. 17 and May 12–18, by interpolation and records of flow at stations in drainage basin above station.

*Monthly discharge of Pecos River near Comstock, Tex., for the year ending Sept. 30, 1915.*

| Month. | Discharge in second-feet. | | | Run-off (total in acre-feet). | Accuracy. |
|---|---|---|---|---|---|
| | Maximum. | Minimum. | Mean. | | |
| October | 36,700 | 434 | 2,510 | 154,000 | C. |
| November | 8,310 | 794 | 1,350 | 80,300 | D. |
| December | 1,660 | 734 | 911 | 56,000 | D. |
| January | 1,060 | 677 | 792 | 48,700 | D. |
| February | 954 | 515 | 627 | 34,800 | C. |
| March | 856 | 468 | 617 | 37,900 | C. |
| April | 27,400 | 464 | 2,410 | 143,000 | C. |
| May | 6,310 | 728 | 2,540 | 156,000 | C. |
| June | 1,600 | 486 | 649 | 38,600 | C. |
| July | 882 | 366 | 413 | 25,400 | C. |
| August | 699 | 366 | 523 | 32,200 | D. |
| September | 5,120 | 366 | 791 | 47,100 | D. |
| The year | 36,700 | 366 | 1,180 | 854,000 | |

### GALLINAS RIVER NEAR LAS VEGAS, N. MEX.

LOCATION.—Near sec. 1, T. 16 N., R. 15 E., at Las Vegas Hot Springs, 6 miles northwest of Las Vegas, in northwestern part of San Miguel County. No tributaries between station and Las Vegas nor for several miles above.

DRAINAGE AREA.—89 square miles (measured on topographic map).

RECORDS AVAILABLE.—August 13, 1903, to May 31, 1912; December 1, 1912, to December 31, 1914, when station was discontinued.

GAGE.—Vertical staff attached to retaining wall on right bank at the Hot Springs; read morning and evening; installed October 19, 1904, to replace a vertical staff at same site destroyed September 29, 1904. Datum was lowered 0.71 foot October 19, 1904.

DISCHARGE MEASUREMENTS.—Made by wading or from footbridge 600 feet below gage.

CHANNEL AND CONTROL.—Bed composed of rock and gravel; water flows through a series of pools and rapids. Banks high and not subject to overflow. Control shifts especially during the higher stages; position not known.

EXTREMES OF DISCHARGE.—1903–1914: Maximum discharge obtained, 11,600 second-feet September 29, 1904, computed by Kutter's formula from measurements of slope and cross section; no flow during several periods.

WINTER FLOW.—Stage-discharge relation not affected by ice; channel kept open by hot springs.

DIVERSIONS.—The Agua Pura Co. has diverted waters at a point about 1½ miles above station, for storage since February, 1913. Water is also furnished by this company at a second small diversion to the city of Las Vegas and the Santa Fe Railway. A short distance above the station is a timber dam formimg a pond from which ice is cut; this dam has slight effect on the flow. A mile below the station is a dam at which the flood flow of the Gallinas is diverted to the San Guyillo basin. The fall of the river is so great that the gaging station is above backwater from this dam.

REGULATION.—No power plants above station.

ACCURACY.—Results good. Stage during the period of record is well covered by current-meter measurements, and the stage-discharge relation has been permanent. Fluctuations in stage during the irrigation season introduce errors due to the assumption that the average of two readings per day is the mean for that day, but such errors probably do not materially impair the accuracy of the determinations here published.

*Discharge measurements of Gallinas River near Las Vegas, N. Mex., during the year ending Sept. 30, 1915.*

[Made by J. E. Powers.]

| Date. | Gage height. | Discharge. | Date. | Gage height. | Discharge. |
|---|---|---|---|---|---|
| | *Feet.* | *Sec.-ft.* | | *Feet.* | *Sec.-ft.* |
| Oct. 5 | 1.90 | 14.9 | Dec. 19 | 1.73 | 3.7 |
| Nov. 11 | 2.03 | 20.0 | | | |

*Daily discharge, in second-feet, of Gallinas River near Las Vegas, N. Mex., for the year ending Sept. 30, 1915.*

| Day. | Oct. | Nov. | Dec. | Day. | Oct. | Nov. | Dec. | Day. | Oct. | Nov. | Dec. |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 2.1 | 3.2 | 6.0 | 11 | 1.9 | 16 | 6.0 | 21 | 16 | 6.0 | 3.8 |
| 2 | 2.6 | 10 | 6.0 | 12 | 1.9 | 12 | 5.7 | 22 | 42 | 6.0 | 3.8 |
| 3 | 1.6 | 28 | 6.0 | 13 | 2.1 | 14 | 6.0 | 23 | 24 | 6.0 | 4.3 |
| 4 | 1.3 | 28 | 6.4 | 14 | 1.8 | 15 | 4.9 | 24 | 38 | 6.8 | 4.0 |
| 5 | 9.6 | 32 | 6.0 | 15 | 2.9 | 15 | 4.9 | 25 | 42 | 6.8 | 4.0 |
| 6 | 5.7 | 16 | 6.8 | 16 | 3.8 | 9.2 | 5.2 | 26 | 70 | 6.0 | 4.0 |
| 7 | 4.6 | 16 | 7.2 | 17 | 2.9 | 10 | 4.9 | 27 | 70 | 6.0 | 5.2 |
| 8 | 2.8 | 13 | 6.0 | 18 | 2.1 | 8.0 | 4.9 | 28 | 52 | 6.0 | 4.6 |
| 9 | 2.6 | 73 | 6.4 | 19 | 1.8 | 7.6 | 4.9 | 29 | 9.2 | 6.8 | 4.0 |
| 10 | 2.2 | 73 | 6.0 | 20 | 1.8 | 9.2 | 4.9 | 30 | 9.2 | 6.0 | 4.0 |
| | | | | | | | | 31 | 9.6 | ..... | 4.0 |

NOTE.—Discharge determined as follows: Oct. 1 and Oct. 13 to Dec. 13, from a well-defined curve; Oct. 2–12 and Dec. 14–31 by indirect method for shifting control.

*Monthly discharge of Gallinas River near Las Vegas, N. Mex., for the year ending Sept. 30, 1915.*

| Month. | Discharge in second-feet. | | | Run-off (total in acre-feet). | Accuracy. |
|---|---|---|---|---|---|
| | Maximum. | Minimum. | Mean. | | |
| October | 70 | 1.3 | 14.2 | 873 | B. |
| November | 73 | 3.2 | 15.7 | 934 | A. |
| December | 7.2 | 3.8 | 5.19 | 319 | A. |
| The period | | | | 2,130 | |

### SOUTH FORK OF GALLINAS RIVER NEAR EL PORVENIR, N. MEX.

LOCATION.—Near sec. 14, T. 17 N., R. 14 E., at the Gallinas planting station of the United States Forest Service, in the Pecos National Forest, 1 mile south of El Porvenir post office, 2½ miles above junction of North and South Forks, in northwestern part of San Miguel County. Nearest tributary is a small stream entering from the north a short distance above.

DRAINAGE AREA.—Not measured.

RECORDS AVAILABLE.—May 9, 1911, to December 31, 1914, when station was discontinued.

GAGE.—Vertical staff, read morning and evening by Herman Krauch.

DISCHARGE MEASUREMENTS.—Made by wading.

CHANNEL AND CONTROL.—Bed composed of rock and gravel; shifts slightly. Banks not subject to overflow, as discharge is small. Position of control unknown.

EXTREMES OF DISCHARGE.—1911–1914: Maximum stage recorded, 4.24 feet, October 5, 1911 (discharge, 226 second-feet); minimum stage recorded, 1.15 feet, June 26 and 29, 1911 discharge, 1.2 second-feet).

WINTER FLOW.—Stage-discharge relation seriously affected by ice; flow estimated from current-meter measurements, observer's notes, and records of precipitation and temperature.

DIVERSIONS.—No diversions above, except an intermittent one of less than half a second-foot. Just below the gage the United States Forest Service maintains a ditch of 3 second-feet capacity.

REGULATION.—None at this point.

ACCURACY.—Results good for the open-water season and fair for the winter season. Effect of ice on stage-discharge relation greatly impairs the accuracy of determination of winter discharge. Errors introduced by the slight changes in stage-discharge relation during the open-water period are small.

*Discharge measurements of South Fork of Gallinas River near El Porvenir, N. Mex., during the year ending Sept. 30, 1915.*

[Made by J. E. Powers.]

| Date. | Gage height. | Discharge. | Date. | Gage height. | Discharge. |
|---|---|---|---|---|---|
| | *Feet.* | *Sec.-ft.* | | *Feet.* | *Sec.-ft.* |
| Oct. 5 | 2.00 | 7.4 | Dec. 19 | 1.95 | [a] 4.6 |
| Nov. 11 | 2.10 | 6.5 | | | |

[a] Stage-discharge relation affected by ice.

*Daily discharge, in second-feet, of South Fork of Gallinas River near El Porvenir, N. Mex., for the year ending Sept. 30, 1915.*

| Day. | Oct. | Nov. | Dec. | Day. | Oct. | Nov. | Dec. | Day. | Oct. | Nov. | Dec. |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 4.5 | 10 | 4.1 | 11 | 4.4 | 6.0 | 4.1 | 21 | 5.2 | 4.2 | 3.8 |
| 2 | 4.4 | 9.5 | 4.4 | 12 | 4.2 | 6.0 | 3.7 | 22 | 10 | 3.5 | 3.4 |
| 3 | 4.5 | 9.5 | 3.8 | 13 | 3.8 | 5.8 | 4.0 | 23 | 7.6 | 3.5 | 5.0 |
| 4 | 12 | 9.0 | 4.4 | 14 | 3.2 | 5.8 | 3.5 | 24 | 10 | 4.2 | 5.3 |
| 5 | 8.6 | 18 | 3.7 | 15 | 3.2 | 6.0 | 3.8 | 25 | 10 | 3.6 | 5.3 |
| 6 | 6.9 | 13 | 3.6 | 16 | 3.7 | 5.8 | 4.1 | 26 | 4.8 | 3.7 | 5.2 |
| 7 | 5.8 | 13 | 3.8 | 17 | 3.8 | 4.8 | 4.4 | 27 | 7.2 | 4.8 | 4.7 |
| 8 | 5.5 | 6.2 | 3.6 | 18 | 3.7 | 4.0 | 4.1 | 28 | 11 | 4.0 | 4.7 |
| 9 | 5.2 | 6.2 | 3.6 | 19 | 3.7 | 4.1 | 3.8 | 29 | 7.2 | 4.1 | 4.7 |
| 10 | 4.8 | 5.8 | 3.4 | 20 | 3.6 | 6.2 | 4.4 | 30 | 7.2 | 4.5 | 3.8 |
| | | | | | | | | 31 | 11 | ..... | 3.8 |

NOTE.—Discharge determined as follows: Oct. 1–5, from a well-defined curve; Oct. 6 to Dec. 2, by indirect method for shifting control; Dec. 3–31, from climatic data, current-meter measurement, and information furnished by observer.

*Monthly discharge of South Fork of Gallinas River near El Porvenir, N. Mex., for the year ending Sept. 30, 1915.*

| Month. | Discharge in second-feet. | | | Run-off (total in acre-feet). |
|---|---|---|---|---|
| | Maximum. | Minimum. | Mean. | |
| October | 12 | 3.2 | 6.15 | 378 |
| November | 18 | 3.5 | 6.49 | 386 |
| December | 5.3 | 3.4 | 4.13 | 254 |
| The period | ..... | ..... | ..... | 1,020 |

### BLACK RIVER NEAR MALAGA, N. MEX.

LOCATION.—In the NW. ¼ NE. ¼ sec. 10, T. 24 S., R. 28 E., at highway bridge on the Malaga-Loving road, 400 feet downstream from Pecos Valley Lines (Santa Fe Route), 1 mile north of Malaga, about 1½ miles above confluence with Pecos River, in the southern part of Eddy County.

DRAINAGE AREA.—Not measured.

RECORDS AVAILABLE.—May 1, 1914, to June 30, 1915, when station was discontinued.

GAGE.—Inclined staff, for low stages, fastened to left bank, and vertical staff attached to left abutment of bridge for high stages; read morning and evening by Frank Beeman.

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

CHANNEL AND CONTROL.—Bed composed of sand, gravel, and rock; water flows in series of pools and rapids; bed not subject to extreme changes though stage-discharge relation varies slightly. Banks high and not likely to overflow. Rapids a short distance below gage serve as control.

EXTREMES OF DISCHARGE.—1914–15: Maximum stage recorded, 11.0 feet April 17, 1915 (discharge not computed); minimum stage recorded, 0.85 foot May 3 and 27, and October 7, 1914, and May 7, 27, and 29, 1915 (discharge, 3.5 second-feet).

WINTER FLOW.—Stage-discharge relation not affected by ice.

DIVERSIONS.—Considerable water diverted above station; amount not known; no diversions below station.

REGULATION.—No power plants in the drainage basin.

ACCURACY.—Results fair. Stage-discharge relation is practically permanent, but determinations are subject to errors arising from the assumption that the average of two readings a day is the mean stage for that day.

*Discharge measurements of Black River near Malaga, N. Mex., during the year ending Sept. 30, 1915.*

| Date. | Made by— | Gage height. | Discharge. | Date. | Made by— | Gage height. | Discharge. |
|---|---|---|---|---|---|---|---|
| | | *Feet.* | *Sec.-ft.* | | | *Feet.* | *Sec.-ft.* |
| Nov. 10 | C. J. Emerson | 1.62 | 25.2 | May 16 | W. R. King | 1.38 | 14.7 |
| Dec. 12 | do | 1.60 | 21.9 | June 21 | do | 2.58 | 73.2 |
| Mar. 7 | W. R. King | 1.55 | 17.6 | | | | |

*Daily discharge, in second-feet, of Black River near Malaga, N. Mex., for the period May 1, 1914, to June 30, 1915.*

| Day. | May. | June. | July. | Aug. | Sept. | Oct. | Nov. | Dec. | Jan. | Feb. | Mar. | Apr. | May. | June. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 5.0 | 56 | 28 | 26 | 52 | 15 | 21 | 23 | 22 | 19 | 18 | 16 | 11 | 4.0 |
| 2 | 5.4 | 8.3 | 62 | 34 | 111 | 18 | 23 | 32 | 22 | 18 | 19 | 16 | 22 | 4.0 |
| 3 | 3.5 | 41 | 24 | 41 | 31 | 6.3 | 23 | 23 | 22 | 18 | 18 | 16 | 18 | 4.7 |
| 4 | 12 | 22 | 12 | 11 | 31 | 4.7 | 23 | 23 | 22 | 20 | 18 | 16 | 18 | 7.2 |
| 5 | 11 | 4.7 | 24 | 8.3 | 68 | 4.7 | 20 | 23 | 22 | 18 | 18 | 16 | 9.4 | 4.0 |
| 6 | 6.3 | 5.4 | 45 | 6.3 | 65 | 4.0 | 20 | 22 | 22 | 18 | 20 | 16 | 7.2 | 44 |
| 7 | 3.8 | 5.8 | 42 | 5.4 | 65 | 3.5 | 20 | 22 | 22 | 18 | 18 | 16 | 3.5 | 170 |
| 8 | 3.6 | 4.7 | 51 | 14 | 34 | 4.7 | 20 | 22 | 22 | 18 | 18 | 16 | 4.0 | 83 |
| 9 | 5.8 | 6.3 | 46 | 14 | 31 | 5.4 | 24 | 22 | 22 | 20 | 19 | 16 | 20 | 26 |
| 10 | 4.7 | 95 | 71 | 6.3 | 28 | 5.4 | 24 | 22 | 21 | 18 | 20 | 37 | 28 | 36 |
| 11 | 24 | 8.3 | 95 | 7.2 | 11 | 5.6 | 24 | 22 | 20 | 17 | 20 | 54 | 7.2 | 80 |
| 12 | 22 | 6.3 | 34 | 12 | 14 | 5.6 | 24 | 22 | 20 | 18 | 20 | 38 | 20 | 34 |
| 13 | 18 | 5.4 | 32 | 6.3 | 7.2 | 5.6 | 24 | 22 | 20 | 19 | 18 | 16 | 18 | 56 |
| 14 | 14 | 5.1 | 38 | 6.3 | 9.4 | 5.6 | 24 | 22 | 20 | 18 | 18 | 4.0 | 20 | 59 |
| 15 | 14 | 4.7 | 14 | 6.3 | 7.2 | 5.6 | 24 | 22 | 20 | 19 | 18 | 8.3 | 18 | 38 |
| 16 | 9.9 | 51 | 5.8 | 6.3 | 6.3 | 5.6 | 24 | 22 | 20 | 19 | 20 | 51 | 11 | 48 |
| 17 | 5.8 | 12 | 6.8 | 14 | 16 | 5.6 | 24 | 22 | 20 | 19 | 16 | 410 | 34 | 36 |
| 18 | 4.7 | 9.4 | 7.2 | 24 | 36 | 5.6 | 24 | 22 | 16 | 19 | 16 | 68 | 14 | 38 |
| 19 | 190 | 44 | 8.3 | 7.2 | 34 | 11 | 24 | 22 | 21 | 18 | 18 | 36 | 6.3 | 36 |
| 20 | 34 | 44 | 4.0 | 10 | 55 | 20 | 24 | 22 | 22 | 21 | 16 | 20 | 7.2 | 68 |
| 21 | 5.8 | 26 | 5.8 | 9.0 | 11 | 23 | 23 | 22 | 22 | 18 | 16 | 31 | 4.0 | 71 |
| 22 | 5.8 | 22 | 14 | 35 | 11 | 23 | 23 | 22 | 22 | 18 | 16 | 22 | 4.7 | 38 |
| 23 | 12 | 12 | 6.3 | 30 | 15 | 54 | 23 | 22 | 22 | 18 | 16 | 15 | 4.7 | 41 |
| 24 | 11 | 22 | 5.4 | 30 | 18 | 52 | 28 | 22 | 22 | 18 | 16 | 15 | 4.7 | 38 |
| 25 | 6.3 | 44 | 8.3 | 18 | 18 | 32 | 28 | 22 | 22 | 18 | 16 | 24 | 5.4 | 44 |
| 26 | 5.4 | 54 | 5.4 | 23 | 36 | 23 | 28 | 22 | 21 | 19 | 16 | 28 | 4.0 | 24 |
| 27 | 3.5 | 71 | 52 | 6.8 | 8.3 | 23 | 23 | 22 | 20 | 20 | 16 | 20 | 3.5 | 18 |
| 28 | 4.7 | 54 | 23 | 5.1 | 9.4 | 23 | 23 | 22 | 20 | 20 | 16 | 48 | 4.7 | 4.0 |
| 29 | 16 | 28 | 18 | 9.0 | 14 | 19 | 23 | 22 | 22 | ..... | 16 | 54 | 3.5 | 28 |
| 30 | 8.3 | 7.2 | 20 | 42 | 11 | 21 | 23 | 22 | 21 | ..... | 16 | 89 | 6.3 | 20 |
| 31 | 98 | ..... | 18 | 54 | ..... | 19 | ..... | 22 | 20 | ..... | 17 | ..... | 28 | ..... |

NOTE.—Discharge determined from two well-defined rating curves applied as follows: First curve directly, May 2 to Aug. 17 and Sept. 3-30, 1914, indirectly, Aug. 18 to Sept. 2, 1914; second curve directly Dec. 12, 1914, to Feb. 5, 1915, and Mar. 6 to June 30, 1915, indirectly Oct. 1 to Dec. 11, 1914, and Feb. 6 to Mar. 5, 1915. Discharge estimated May 1, 1914, from records of flow at near-by stations and climatic data.

*Monthly discharge of Black River near Malaga, N. Mex., for the period May 1, 1914, to June 30, 1915.*

| Month. | Discharge in second-feet. | | | Run-off (total in acre-feet). | Accuracy. |
|---|---|---|---|---|---|
| | Maximum. | Minimum. | Mean. | | |
| May | 190 | 3.5 | 18.5 | 1,140 | C. |
| June | 95 | 4.7 | 26.0 | 1,550 | C. |
| July | 95 | 4.0 | 26.7 | 1,640 | C. |
| August | 54 | 5.1 | 17.0 | 1,050 | C. |
| September | 111 | 6.3 | 28.8 | 1,710 | C. |
| October | 54 | 3.5 | 14.8 | 910 | C. |
| November | 28 | 20 | 23.4 | 1,390 | C. |
| December | 32 | 22 | 22.5 | 1,380 | C. |
| January | 22 | 16 | 21.0 | 1,290 | C. |
| February | 21 | 17 | 18.6 | 1,030 | C. |
| March | 20 | 16 | 17.5 | 1,080 | C. |
| April | 410 | 4.0 | 41.1 | 2,450 | D. |
| May | 34 | 3.5 | 11.9 | 730 | C. |
| June | 170 | 4.0 | 40.1 | 2,390 | C. |
| The period | 410 | 3.5 | 23.4 | 19,700 | |

### DELAWARE RIVER NEAR ANGELES, TEX.

LOCATION.—In T. 26 N., R. 29 E. New Mexico principal meridian, 1 mile above confluence with Pecos River, 2½ miles south of Red Bluff, N. Mex., about 3 miles north of New Mexico-Texas State line, 10 miles northwest of Angeles, Tex., in the southern part of Eddy County, N. Mex.

DRAINAGE AREA.—Not measured.

RECORDS AVAILABLE.—May 26, 1914, to June 19, 1915, when station was discontinued.

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

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

CHANNEL AND CONTROL.—Bed composed of sand and gravel through which rock outcrops. Banks high and not subject to overflow. A shoal about 100 feet below the gage serves as a control but it shifts during extremely high stages.

EXTREMES OF DISCHARGE.—1914–15: Maximum stage recorded, 4.21 feet April 17, 1915 (discharge not computed); minimum discharge, 0.1 second-foot May 18–20 and May 28 to June 4, 1915.

WINTER FLOW.—Stage-discharge relation not affected by ice.

DIVERSIONS.—A large part of the flow is diverted above station for irrigating lands of Coad's ranch. No diversions below.

REGULATION.—None.

ACCURACY.—Results fair for first part of the year but poor during latter part, as changes in channel prevented the proper operation of the water-stage recorder.

*Discharge measurements of Delaware River near Angeles, Tex., during the year ending Sept. 30, 1915.*

| Date. | Made by— | Gage height. | Discharge. | Date. | Made by— | Gage height. | Discharge. |
|---|---|---|---|---|---|---|---|
| | | *Feet.* | *Sec.-ft.* | | | *Feet.* | *Sec.-ft.* |
| Oct. 1 | C. J. Emerson | 1.00 | 3.4 | Mar. 6 | W. R. King | 1.05 | 5.9 |
| Nov. 10 | do | 1.00 | 3.2 | May 15 | do | .57 | 3.5 |
| Dec. 11 | do | .88 | 1.2 | June 19 | do | .35 | .5 |

*Daily discharge, in second-feet, of Delaware River near Angeles, Tex., for the year ending Sept. 30, 1915.*

| Day. | Oct. | Nov. | Dec. | Jan. | Feb. | Mar. | Apr. | May. | June. |
|---|---|---|---|---|---|---|---|---|---|
| 1 | 3.4 | 3.4 | 3.9 | 4.1 | 1.6 | 6.8 | 6.0 | ..... | 0.1 |
| 2 | 3.4 | 3.1 | 5.3 | 4.1 | 1.6 | 6.8 | 6.4 | ..... | .1 |
| 3 | 3.4 | 2.9 | 5.3 | 4.5 | 1.2 | 7.6 | 6.0 | ..... | .1 |
| 4 | 3.4 | 3.1 | 3.6 | 3.1 | 1.2 | 6.8 | 5.3 | ..... | .1 |
| 5 | 3.1 | 3.1 | 3.9 | 1.7 | 1.4 | 6.0 | 4.9 | ..... | 2.0 |
| 6 | 3.1 | 3.1 | 3.9 | 1.7 | 1.6 | 6.0 | 4.5 | ..... | 8.5 |
| 7 | 3.1 | 3.1 | 2.4 | 1.7 | 1.4 | 6.0 | 4.1 | ..... | 89.0 |
| 8 | 3.1 | 3.1 | 1.9 | 1.7 | 1.2 | 6.8 | 4.1 | ..... | 37.0 |
| 9 | 3.1 | 3.1 | 1.4 | 1.6 | 1.2 | 8.0 | 4.1 | ..... | 22.0 |
| 10 | 3.4 | 3.1 | 1.2 | 1.6 | 1.6 | 8.0 | 4.9 | ..... | 9.5 |
| 11 | 3.4 | 3.1 | 1.2 | 1.6 | 1.6 | 8.0 | 4.1 | ..... | 5.7 |
| 12 | 3.4 | 23.0 | 1.6 | 1.6 | 1.1 | 8.0 | 3.4 | ..... | 6.0 |
| 13 | 3.4 | 6.8 | 1.6 | 1.4 | 1.1 | 6.8 | 1.2 | ..... | 5.7 |
| 14 | 3.4 | 4.5 | 1.4 | 1.4 | 1.2 | 6.4 | 1.1 | ..... | 6.4 |
| 15 | 3.4 | 3.9 | 1.4 | 1.4 | 1.4 | 6.0 | 7.6 | 3.5 | 6.0 |
| 16 | 3.4 | 3.4 | 1.4 | 1.6 | 3.6 | 5.7 | 256 | .8 | 6.4 |
| 17 | 3.1 | 3.1 | 1.2 | 1.6 | 5.3 | 6.0 | ..... | .2 | 2.7 |
| 18 | 2.9 | 3.1 | 1.4 | 1.6 | 5.7 | 6.0 | ..... | .1 | 1.2 |
| 19 | 2.9 | 3.1 | 1.2 | 1.6 | 6.4 | 5.7 | ..... | .1 | .5 |
| 20 | 3.4 | 2.9 | 1.1 | 1.6 | 8.0 | 6.0 | ..... | .1 | ..... |
| 21 | 3.4 | 3.1 | 1.2 | 1.6 | 7.6 | 6.0 | ..... | .2 | ..... |
| 22 | 3.4 | 3.1 | 1.2 | 1.7 | 6.8 | 5.3 | ..... | .2 | ..... |
| 23 | 3.6 | 27.0 | 1.2 | 1.7 | 6.0 | 4.9 | ..... | .2 | ..... |
| 24 | 3.9 | 73.0 | 1.9 | 1.7 | 6.0 | 4.5 | ..... | .8 | ..... |
| 25 | 3.9 | 16.0 | 4.5 | 1.7 | 6.0 | 4.1 | ..... | .4 | ..... |
| 26 | 3.8 | 5.3 | 6.0 | 1.7 | 7.2 | 4.9 | ..... | 1.0 | ..... |
| 27 | 3.6 | 3.9 | 1.9 | 1.7 | 8.0 | 4.9 | ..... | .2 | ..... |
| 28 | 3.4 | 3.9 | 1.2 | 1.7 | 6.8 | 4.9 | ..... | .1 | ..... |
| 29 | 3.4 | 3.9 | 1.0 | 1.7 | ..... | 4.9 | ..... | .1 | ..... |
| 30 | 3.1 | 3.1 | 3.1 | 1.6 | ..... | 4.1 | ..... | .1 | ..... |
| 31 | 3.4 | ..... | 3.6 | 1.6 | ..... | 4.5 | ..... | .1 | ..... |

NOTE.—Discharge determined as follows: Oct. 1–25, Oct. 28 to Nov. 4, Nov. 10 to Dec. 20, May 15 to June 19, by indirect method for shifting control; Dec. 21 to Apr. 16, from a well-defined curve; Oct. 26 and 27 and Nov. 5–9, by interpolation.

*Monthly discharge of Delaware River near Angeles, Tex., for the year ending Sept. 30, 1915.*

| Month. | Discharge in second-feet. | | | Run-off (total in acre-feet). | Accuracy. |
|---|---|---|---|---|---|
| | Maximum. | Minimum. | Mean. | | |
| October | 3.9 | 2.9 | 3.36 | 207 | C. |
| November | 73 | 2.9 | 7.68 | 457 | C. |
| December | 6.0 | 1.0 | 2.36 | 145 | C. |
| January | 4.5 | 1.4 | 1.92 | 118 | C. |
| February | 8.0 | 1.1 | 3.71 | 206 | C. |
| March | 8.0 | 4.1 | 6.01 | 370 | C. |
| April 1–16 | 256 | 1.1 | 20.2 | 641 | D. |
| May 15–31 | 3.5 | .1 | .48 | 16 | D. |
| June 1–19 | 89 | .1 | 11.0 | 415 | D. |

## INTERIOR BASINS IN NEW MEXICO.

### MIMBRES RIVER BASIN.

#### MIMBRES RIVER NEAR FAYWOOD, N. MEX.

LOCATION.—In sec. 7, T. 20 S., R. 10 W., 400 feet below dam site of Rio Mimbres reservoir, about 6 miles northeast of Faywood Hot Springs, 10 miles north of Faywood, a station on the Silver City branch of the Atchison, Topeka & Santa Fe Railway, in northeastern part of Grant County.

DRAINAGE AREA.—Approximately 450 square miles.

RECORDS AVAILABLE.—April 8, 1908, to December 31, 1914, when station was discontinued.

GAGE.—Friez water-stage recorder on right bank. From April 8, 1908, to August 12, 1909, readings were taken with a chain gage on right bank 200 feet downstream. On July 8, 1909, datum of chain gage was lowered 4 feet. The recorder was installed August 13, 1909, at a datum 1 foot lower than original datum.

DISCHARGE MEASUREMENTS.—Made by wading or from cable a short distance below gage.

CHANNEL AND CONTROL.—Bed composed of sand and gravel; shifts. Banks clay and gravel; right bank high and not subject to overflow; left bank is sloping and is overflowed at extremely high stages. Position of control not known.

EXTREMES OF DISCHARGE.—1908–1914: Maximum discharge estimated at 2,200 second-feet, July 23, 1914; no flow for extended periods since establishment of station.

WINTER FLOW.—Stage-discharge relation not affected by ice.

DIVERSIONS.—Some water diverted for irrigation above and below station; amount unknown.

REGULATION.—None at this point.

ACCURACY.—Results poor, errors being introduced into the determinations by changeability in the stage-discharge relation and also by rapid fluctuations in stage during current-meter measurements.

The following discharge measurement was made by E. L. Redding:
November 5, 1914: Gage height, 0.50 foot; discharge, 25.1 second-feet.

*Daily discharge, in second-feet, of Mimbres River near Faywood, N. Mex., for the year ending Sept. 30, 1915.*

| Day. | Oct. | Nov. | Dec. | Day. | Oct. | Nov. | Dec. | Day. | Oct. | Nov. | Dec. |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 20 | 21 | 17 | 11 | 26 | 25 | 11 | 21 | 34 | 22 | 329 |
| 2 | 20 | 21 | 18 | 12 | 26 | 24 | 14 | 22 | 27 | 21 | 1,420 |
| 3 | 610 | 22 | 16 | 13 | 24 | 25 | 14 | 23 | 20 | 20 | 1,270 |
| 4 | 237 | 22 | 14 | 14 | 81 | 24 | 15 | 24 | 14 | 19 | 970 |
| 5 | 96 | 24 | 11 | 15 | 76 | 23 | 14 | 25 | 22 | 19 | 580 |
| 6 | 60 | 25 | 12 | 16 | 69 | 21 | 14 | 26 | 20 | 19 | 286 |
| 7 | 52 | 26 | 12 | 17 | 62 | 21 | 13 | 27 | 23 | 19 | 199 |
| 8 | 44 | 26 | 13 | 18 | 55 | 22 | 14 | 28 | 22 | 19 | 186 |
| 9 | 35 | 25 | 12 | 19 | 48 | 22 | 18 | 29 | 22 | 16 | 111 |
| 10 | 26 | 26 | 13 | 20 | 41 | 22 | 466 | 30 | 24 | 16 | 79 |
| | | | | | | | | 31 | 26 | ..... | 53 |

NOTE.—Discharge determined as follows: Oct. 10–15 and Oct. 23 to Dec. 31, by the indirect method for shifting control; Oct. 1–9 and Oct. 16–22, from information furnished by engineer, interpolation, and climatic data.

*Monthly discharge of Mimbres River near Faywood, N. Mex., for the year ending Sept. 30, 1915.*

| Month. | Discharge in second-feet. | | | Run-off (total in acre-feet). | Accuracy. |
|---|---|---|---|---|---|
| | Maximum. | Minimum. | Mean. | | |
| October | 610 | 14 | 63.3 | 3,890 | D. |
| November | 26 | 16 | 21.9 | 1,300 | C. |
| December | 1,420 | 11 | 200 | 12,300 | D. |
| The period | | | | 17,500 | |

### LAMPBRIGHT DRAW NEAR SANTA RITA, N. MEX.

LOCATION.—In sec. 19, T. 18 S., R. 11 W., at mouth of box canyon, 5½ miles southeast of Santa Rita, in eastern part of Grant County. Rustlers Canyon enters Lampbright Draw about 2 miles above station and Martin Canyon about 3½ miles below.

DRAINAGE AREA.—Not measured.

RECORDS AVAILABLE.—August 20, 1912, to December 31, 1914, when station was discontinued.

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

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

CHANNEL AND CONTROL.—Bed composed of solid rock with pockets of sand and gravel; shifts. Both banks high and not subject to overflow. Position of control unknown.

EXTREMES OF DISCHARGE.—1912–1914: Maximum stage recorded, 6.1 feet July 20, 1914 (discharge not computed). Discharge 0.10 second-foot during parts of July, 1913, and November, June, and July, 1914.

WINTER FLOW.—Stage-discharge relation not affected by ice.

DIVERSIONS.—Only small quantities of water diverted from stream above station.

REGULATION.—None at this point.

ACCURACY.—Results poor. Stage-discharge relation is changeable and the erratic flow of the stream made it difficult to obtain the data necessary for a complete rating.

The following discharge measurement was made by E. L. Redding:
December 22, 1914: Gage height 0.92 foot; discharge, 186 second-feet.

*Daily discharge, in second-feet, of Lampbright Draw near Santa Rita, N. Mex., for the year ending Sept. 30, 1915.*

| Day. | Oct. | Nov. | Dec. | Day. | Oct. | Nov. | Dec. | Day. | Oct. | Nov. | Dec. |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 0.3 | 0.5 | 0.7 | 11 | 0.2 | 16 | 0.3 | 21 | 0.2 | 0.2 | 90 |
| 2 | .3 | .4 | .7 | 12 | .2 | 6.0 | .3 | 22 | .2 | .2 | 130 |
| 3 | 28 | .4 | .3 | 13 | .2 | 1.0 | .3 | 23 | .2 | .2 | 45 |
| 4 | 10 | .3 | .3 | 14 | .2 | .5 | .3 | 24 | .2 | .2 | 5.0 |
| 5 | 2.0 | .3 | .3 | 15 | .2 | .3 | 20 | 25 | .2 | .2 | 1.0 |
| 6 | .5 | .3 | .3 | 16 | .2 | .3 | .3 | 26 | .2 | .2 | .5 |
| 7 | .5 | .3 | .3 | 17 | .2 | .3 | .3 | 27 | .2 | .2 | .3 |
| 8 | .5 | .3 | .3 | 18 | .2 | .3 | 16 | 28 | .2 | .2 | .3 |
| 9 | .3 | .3 | .3 | 19 | .2 | .3 | 157 | 29 | .2 | .2 | .5 |
| 10 | .2 | .3 | .3 | 20 | .2 | .2 | 67 | 30 | 4.0 | .5 | 2.0 |
| | | | | | | | | 31 | .5 | ..... | 1.0 |

NOTE.—Discharge determined as follows: Oct. 1–10, Oct. 24 to Dec. 23, and Dec. 29–31, from current-meter measurements at low water and a poorly defined rating curve based on slope measurements, Kutter's formula, and current-meter measurement at high water; Oct. 11–23 and Dec. 24–28, interpolated.

*Monthly discharge of Lampbright Draw near Santa Rita, N. Mex., for the year ending Sept. 30, 1915.*

| Month. | Discharge in second-feet. | | | Run-off (total in acre-feet). | Accuracy. |
|---|---|---|---|---|---|
| | Maximum. | Minimum. | Mean. | | |
| October | 28 | 0.2 | 1.64 | 101 | D. |
| November | 16 | .2 | 1.03 | 61 | D. |
| December | 157 | .3 | 17.5 | 1,080 | D. |
| The period | ..... | ..... | ..... | 1,240 | |

## RIO TULAROSA BASIN.

### RIO TULAROSA NEAR TULAROSA, N. MEX.

LOCATION.—In sec. 21, T. 14 S., R. 10 E., about half a mile above the head gate of Tularosa irrigation ditch, 3 miles above Tularosa, in northern part of Otero County.

DRAINAGE AREA.—Not measured.

RECORDS AVAILABLE.—December 2, 1912, to December 31, 1914, when station was discontinued.

GAGE.—Vertical staff on left bank. Read twice daily by Fred Montoya. July 17, 1914, datum of gage was lowered 2 feet to avoid negative readings.

DISCHARGE MEASUREMENTS.—Made by wading.

CHANNEL AND CONTROL.—Bed composed of sand, gravel, and rock, with a shoal just below the gage; shifts. Banks consist of rock; not subject to overflow. Control apparently unstable.

EXTREMES OF DISCHARGE.—1912–1914: Maximum stage recorded, 8.00 feet July 2, 1914 (discharge not computed); minimum stage recorded, 1.20 feet July 15, 1913 (discharge, 2.5 second-feet).

WINTER FLOW.—Stage-discharge relation not seriously affected by ice.

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

REGULATION.—Flow slightly regulated by diversions for irrigation above station.

ACCURACY.—Results fair; impaired by changeable stage-discharge relation.

The following discharge measurement was made by R. J. Hank:

December 5, 1914, gage height, 1.15 feet; discharge, 14.0 second-feet.

*Daily discharge, in second-feet, of Rio Tularosa near Tularosa, N. Mex., for the year ending Sept. 30, 1915.*

| Day. | Oct. | Nov. | Dec. | Day. | Oct. | Nov. | Dec. | Day. | Oct. | Nov. | Dec. |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 12 | 16 | 16 | 11 | 13 | 14 | 16 | 21 | 15 | 14 | 22 |
| 2 | 11 | 19 | 16 | 12 | 12 | 14 | 16 | 22 | 27 | 14 | 22 |
| 3 | 14 | 19 | 16 | 13 | 13 | 14 | 16 | 23 | 14 | 14 | 22 |
| 4 | 12 | 19 | 16 | 14 | 13 | 14 | 16 | 24 | 15 | 14 | 22 |
| 5 | 15 | 15 | 16 | 15 | 13 | 14 | 16 | 25 | 13 | 14 | 22 |
| 6 | 15 | 14 | 16 | 16 | 13 | 14 | 16 | 26 | 11 | 14 | 22 |
| 7 | 15 | 14 | 16 | 17 | 13 | 14 | 16 | 27 | 8.0 | 14 | 22 |
| 8 | 15 | 14 | 16 | 18 | 12 | 14 | 16 | 28 | 8.0 | 14 | 22 |
| 9 | 15 | 14 | 16 | 19 | 12 | 14 | 19 | 29 | 6.6 | 14 | 17 |
| 10 | 13 | 14 | 16 | 20 | 12 | 14 | 22 | 30 | 7.4 | 14 | 21 |
| | | | | | | | | 31 | 11 | ..... | 17. |

NOTE.—Discharge determined by indirect method for shifting control.

*Monthly discharge of Rio Tularosa near Tularosa, N. Mex., for the year ending Sept. 30, 1915.*

| Month. | Discharge in second-feet. | | | Run-off (total in acre-feet). | Accuracy. |
|---|---|---|---|---|---|
| | Maximum. | Minimum. | Mean. | | |
| October | 27 | 6.6 | 12.9 | 793 | C. |
| November | 19 | 14 | 14.6 | 869 | C. |
| December | 22 | 16 | 18.1 | 1,110 | C. |
| The period | | | | 2,770 | |

## MISCELLANEOUS MEASUREMENTS.

Measurements at points other than regular gaging stations are listed in the following table:

*Miscellaneous discharge measurements in western Gulf of Mexico drainage basins during the year ending Sept. 30, 1915.*

| Date. | Stream. | Tributary to— | Locality. | Gage height. | Discharge. |
|---|---|---|---|---|---|
| | | | | *Feet.* | *Sec.-ft.* |
| May 24 | Sabine River | | U. S. Weather Bureau gage, Logansport, La. | [a] 10.35 | 1,350 |
| 25 | Trinity River | | Suspension wagon bridge, Fort Worth, Tex. | [a] 8.20 | 17.4 |
| June 1 | ....do | | U. S. Weather Bureau gage, Dallas, Tex. | [a] 15.80 | 2,700 |
| May 29 | Colorado River | | U. S. Weather Bureau gage, Ballinger, Tex. | [a] .75 | 46 |
| Sept. 16 | ....do | | ....do | [a] 1.73 | 253 |
| Feb. 25 | ....do | | U. S. Weather Bureau gage, Columbus, Tex. | [a] 7.50 | 709 |
| 27 | ....do | | Wharton, Tex | | 1,530 |
| Oct. 19 | San Saba River | Colorado River | New steel bridge half a mile northeast of railroad station, San Saba, Tex. | 1.85 | 101 |
| Mar. 28 | Llano River | ....do | 500 feet below confluence of north and south forks, Junction, Tex. | | 120 |
| 28 | South Llano River | Llano River | "Rock Crossing," 1 mile above Junction, Tex. | | 71 |
| Mar. 3 | Guadalupe River | | Victoria, Tex | [a] 10.40 | 4,930 |
| 26 | Comal River | Guadalupe River | San Antonio Street Bridge, New Braunfels, Tex. | 2.75 | 407 |
| 23 | Rio Grande | | Former gaging station near Buckman, N. Mex. | 3.80 | 1,040 |
| Apr. 22 | Santa Fe Creek | Rio Grande | Above reservoir, near Santa Fe, N. Mex. | 2.26 | 78.2 |
| Dec. 22 | Whitewater Creek | | Former U. S. Geological Survey gaging station, Hurley, N. Mex. | | 118 |
| 30 | ....do | | ....do | | 18.5 |
| 20 | Cameron Creek | | Former U. S. Geological Survey gaging station, Fort Bayard, N. Mex. | 1.70 | 31.2 |
| 20 | ....do | | Former U. S. Geological Survey gaging station, near Hurley, N. Mex. | .65 | 70.8 |
| 20 | Rio de Arena | | ....do | | .0 |
| Oct. 9 | Pecos River | Rio Grande | Irwin's ranch, near Cowles, N. Mex. | | 59.3 |

[a] United States Weather Bureau gage.

# INDEX.

77478°—WSP 408—17——8

# STREAM-GAGING STATIONS

AND

# PUBLICATIONS RELATING TO WATER RESOURCES

## PART VIII.—WESTERN GULF OF MEXICO DRAINAGE BASINS

# STREAM-GAGING STATIONS AND PUBLICATIONS RELATING TO WATER RESOURCES.

## INTRODUCTION.

Investigation of water resources by the United States Geological Survey has consisted in large part of measurements of the volume of flow of streams and studies of the conditions affecting that flow, but it has comprised also investigation of such closely allied subjects as irrigation, water storage, water powers, underground waters, and quality of waters. Most of the results of these investigations have been published in the series of water-supply papers, but some have appeared in the bulletins, professional papers, annual reports, and monographs.

The results of stream-flow measurements are now published annually in 12 parts, each part covering an area whose boundaries coincide with natural drainage features as indicated below.

PART I. North Atlantic basins.
II. South Atlantic and eastern Gulf of Mexico basins.
III. Ohio River basin.
IV. St. Lawrence River basin.
V. Upper Mississippi River and Hudson Bay basins.
VI. Missouri River basin.
VII. Lower Mississippi River basin.
VIII. Western Gulf of Mexico basins.
IX. Colorado River basin.
X. Great Basin.
XI. Pacific basins in California.
XII. North Pacific basins (in three volumes).

## HOW GOVERNMENT REPORTS MAY BE OBTAINED OR CONSULTED.

Water-supply papers and other publications of the United States Geological Survey containing data in regard to the water resources of the United States may be obtained or consulted as indicated below.

1. Copies may be obtained free of charge by applying to the Director of the Geological Survey, Washington, D. C. The edition printed for free distribution is, however, small and is soon exhausted.

2. Copies may be purchased at nominal cost from the Superintendent of Documents, Government Printing Office, Washington, D. C., who will furnish lists giving prices.

3. Sets of the reports may be consulted in the libraries of the principal cities in the United States.

4. Complete sets are available for consultation in the local offices of the water-resources branch of the Geological Survey as follows:

Boston, Mass., 2500 Customhouse.
Albany, N. Y., Room 18, Federal Building.
Atlanta, Ga., Post Office Building.
St. Paul, Minn., Old Capitol Building.
Madison, Wis., Capitol Building, care of Railroad Commission of Wisconsin.
Helena, Mont., Montana National Bank Building.
Denver, Colo., 403 New Post Office Building.
Salt Lake City, Utah, Federal Building.
Boise, Idaho, 615 Idaho Building.
Phoenix, Ariz., 417 Fleming Building.
Austin, Tex., Old Post Office Building.
Portland, Oreg., 416 Couch Building.
Tacoma, Wash., 406 Federal Building.
San Francisco, Cal., 328 Customhouse.
Los Angeles, Cal., Federal Building.
Honolulu, Hawaii, Kapiolani Building.

A list of the Geological Survey's publications may be obtained by applying to the Director of the United States Geological Survey, Washington, D. C.

## STREAM-FLOW REPORTS.

Stream-flow records have been obtained at more than 3,800 points in the United States, and the data obtained have been published in the reports tabulated below:

*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 Sept., 1890. |
| 12th A, pt. 2 | do | 1884 to June 30, 1891. |
| 13th A, pt. 3 | Mean discharge in second-feet | 1884 to Dec. 31, 1892. |
| 14th A, pt. 2 | Monthly discharge (long-time records, 1871 to 1893) | 1888 to Dec. 31, 1893. |
| B 131 | Descriptions, measurements, gage heights, and ratings | 1893 and 1894. |
| 16th A, pt. 2 | Descriptive information only | |
| B 140 | Descriptions, measurements, gage heights, ratings, and monthly discharge (also many data covering earlier years). | 1895. |
| W 11 | Gage heights (also gage heights for earlier years) | 1896. |
| 18th A, pt. 4 | Descriptions, measurements, ratings, and monthly discharge (also similar data for some earlier years). | 1895 and 1896. |
| W 15 | Descriptions, measurements, and gage heights, eastern United States, eastern Mississippi River, and Missouri River above junction with Kansas. | 1897. |
| W 16 | Descriptions, measurements, and gage heights, western Mississippi River below junction of Missouri and Platte, and western United States. | 1897. |
| 19th A, pt. 4 | Descriptions, measurements, ratings, and monthly discharge (also some long-time records). | 1897. |
| W 27 | Measurements, ratings, and gage heights, eastern United States, eastern Mississippi River, and Missouri River. | 1898. |
| W 28 | Measurements, ratings, and gage heights, Arkansas River and western United States. | 1898. |
| 20th A, pt. 4 | Monthly discharge (also for many earlier years) | 1898. |
| W 35 to 39 | Descriptions, measurements, gage heights, and ratings | 1899. |

*Stream-flow data in reports of the United States Geological Survey*—Continued.

| Report. | Character of data. | Year. |
|---|---|---|
| 21st A, pt. 4 | Monthly discharge | 1899. |
| W 47 to 52 | Descriptions, measurements, gage heights, and ratings | 1900. |
| 22d A, pt. 4 | Monthly discharge | 1900. |
| W 65, 66 | Descriptions, measurements, gage heights, and ratings | 1901. |
| W 75 | Monthly discharge | 1901. |
| W 82 to 85 | Complete data | 1902. |
| W 97 to 100 | do | 1903. |
| W 124 to 135 | do | 1904. |
| W 165 to 178 | do | 1905. |
| W 201 to 214 | do | 1906. |
| W 241 to 252 | do | 1907–8. |
| W 261 to 272 | do | 1909. |
| W 281 to 292 | do | 1910. |
| W 301 to 312 | do | 1911. |
| W 321 to 332 | do | 1912. |
| W 351 to 362 | do | 1913. |
| W 381 to 394 | do | 1914. |
| W 401 to 414 | do | 1915. |

NOTE.—No data regarding stream flow are given in the 15th and 17th annual reports.

The records at most of the stations discussed in these reports extend over a series of years, and miscellaneous measurements at many points other than regular gaging stations have been made each year. An index of the reports containing records obtained prior to 1904 has been published in Water-Supply Paper 119.

The table below gives, by years and drainage basins, the numbers of the papers on surface-water supply published from 1899 to 1913. The data for any particular station will in general be found in the reports covering the years during which the station was maintained. For example, data for Machias River at Whitneyville, Maine, 1903 to 1915, are published in Water-Supply Papers 97, 124, 165, 201, 241, 261, 281, 301, 321, 351, 381, and 401, which contain records for the New England streams from 1903 to 1915. Results of miscellaneous measurements are published by drainage basins.

In these papers and in the following lists the stations are arranged in downstream order. The main stem of any river is determined by measuring or estimating its drainage area—that is, the headwater stream having the largest drainage area is considered the continuation of the main stream, and local changes in name and lake surface are disregarded. All stations from the source to the mouth of the main stem of the river are presented first, and the tributaries in regular order from source to mouth follow, the streams in each tributary basin being listed before those of the next basin below.

The exceptions to this rule occur in the records for Mississippi River, which are given in four parts, as indicated on page III, and in the records for large lakes, where it is simpler to take up the streams in regular order around the rim of the lake than to cross back and forth over the lake surface.

*Numbers of water-supply papers containing results of stream measurements, 1899–1915.*

| Year. | I<br>North Atlantic slope (St. John River to York River). | II<br>South Atlantic slope and eastern Gulf of Mexico (James River to the Mississippi). | III<br>Ohio River. | IV<br>St. Lawrence River and Great Lakes. | V<br>Hudson Bay and upper Mississippi River. | VI<br>Missouri River. | VII<br>Lower Mississippi River. | VIII<br>Western Gulf of Mexico. | IX<br>Colorado River. | X<br>Great Basin. | XI<br>Pacific slope in California. | XII<br>North Pacific drainage basins. | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | | | | Pacific basins in Washington and upper Columbia River. | Snake River basin. | Lower Columbia River and Pacific basins in Oregon. |
| 1899[a]..... | 35 | [b] 35, 36 | 36 | 36 | 36 | [i] 36, 37 | 37 | 37 | [d] 37, 38 | 38, [e] 39 | 38, [f] 39 | 38 | 38 | 38 |
| 1900[g]..... | 47, [h] 48 | 48 | 48, [c] 49 | 49 | 49 | 49, [j] 50 | 50 | 50 | 50 | 51 | 51 | 51 | 51 | 51 |
| 1901..... | 65, 75 | 65, 75 | 65, 75 | 65, 75 | [k] 65, 66, 75 | 66, 75 | [k] 65, 66, 75 | 66, 75 | 66, 75 | 66, 75 | 66, 75 | 66, 75 | 66, 75 | 66, 75 |
| 1902..... | 82 | [b] 82, 83 | 84 | [l] 82, 83 | [k] 83, 85 | 84 | [k] 83, 84 | 84 | 85 | 85 | 85 | 85 | 85 | 85 |
| 1903..... | 97 | [b] 97, 98 | 98 | 97 | [k]98, 99, [m] 100 | 99 | [k] 98, 99 | 99 | 100 | 100 | 100 | 100 | 100 | 100 |
| 1904..... | [n] 124, [o] 125, [p] 126 | [p] 126, 127 | 128 | 129 | [k] 128, 130 | 130, [q] 131 | [k] 128, 131 | 132 | 133 | 133, [r] 134 | 134 | 135 | 135 | 135 |
| 1905..... | [n] 165, [o] 166, [p] 167 | [p] 167, 168 | 169 | 170 | 171 | 172 | [k] 169, 173 | 174 | 175, [s] 177 | 176, [r] 177 | 177 | 178 | 178 | [t] 177, 178 |
| 1906..... | [n] 201, [o] 202, [p] 203 | [p] 203, 204 | 205 | 206 | 207 | 208 | [k] 205, 209 | 210 | 211 | 212, [r] 213 | 213 | 214 | 214 | 214 |
| 1907–8..... | 241 | 242 | 243 | 244 | 245 | 246 | 247 | 248 | 249 | 250, [r] 251 | 251 | 252 | 252 | 252 |
| 1909..... | 261 | 262 | 263 | 264 | 265 | 266 | 267 | 268 | 269 | 270, [r] 271 | 271 | 272 | 272 | 272 |
| 1910..... | 281 | 282 | 283 | 284 | 285 | 286 | 287 | 288 | 289 | 290 | 291 | 292 | 292 | 292 |
| 1911..... | 301 | 302 | 303 | 304 | 305 | 306 | 307 | 308 | 309 | 310 | 311 | 312 | 312 | 312 |
| 1912..... | 321 | 322 | 323 | 324 | 325 | 326 | 327 | 328 | 329 | 330 | 331 | 332–A | 332–B | 332–C |
| 1913..... | 351 | 352 | 353 | 354 | 355 | 356 | 357 | 358 | 359 | 360 | 361 | 362–A | 362–B | 362–C |
| 1914..... | 381 | 382 | 383 | 384 | 385 | 386 | 387 | 388 | 389 | 390 | 391 | 392 | 393 | 394 |
| 1915..... | 401 | 402 | 403 | 404 | 405 | 406 | 407 | 408 | 409 | 410 | 411 | 412 | 413 | 415 |

[a] Rating tables and index to Water-Supply Papers 35-39 contained in Water-Supply Paper 39. Estimates for 1899 in Twenty-first Annual Report, Part IV.
[b] James River only.
[c] Scioto River.
[d] Green and Gunnison rivers and Grand River above junction with Gunnison.
[e] Mohave River only.
[f] Kings and Kern rivers and south Pacific slope drainage 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. Estimates for 1900 in Twenty-second Annual Report, Part IV.
[h] Wissahickon and Schuylkill rivers to James River.
[i] Gallatin River.
[j] Loup and Platte rivers near Columbus, Nebr., and all tributaries below junction with Platte.
[k] Tributaries of Mississippi from east.
[l] Lake Ontario and tributaries to St. Lawrence River proper.
[m] Hudson Bay only.
[n] New England rivers only.
[o] Hudson River to Delaware River, inclusive.
[p] Susquehanna River to Yadkin River, inclusive.
[q] Platte and Kansas rivers.
[r] Great Basin in California except Truckee and Carson river basins.
[s] Below junction with Gila.
[t] Rogue, Umpqua, and Siletz rivers only.

# PART VIII. WESTERN GULF OF MEXICO DRAINAGE BASINS.

## PRINCIPAL STREAMS.

The western Gulf of Mexico drainage basins include all streams draining into the Gulf of Mexico west of the mouth of the Mississippi and into the Rio Grande. The largest streams flowing into the Gulf of Mexico north of the mouth of the Rio Grande are Sabine, Trinity, and Brazos rivers, Colorado River of Texas, and Guadalupe River. The principal tributaries of the Rio Grande are Chama River, Rio Puerco, and Pecos River in the United States and Rio Salado and Rio San Juan in Mexico. The streams drain wholly or in part the States of Colorado, Louisiana, New Mexico, Texas, and northern States of Mexico.

In addition to the list of gaging stations and annotated list of publications relating specifically to the section, these pages contain a similar list of reports that are of general interest in many sections and cover a wide range of hydrologic subjects, and also brief references to reports published by State and other organizations. (See pp. XVI–XVII.)

## GAGING STATIONS.

NOTE.—Dash after a date indicates that station was being maintained September 30, 1915; period after a date indicates discontinuance. Tributaries are indicated by indention.

### SABINE RIVER BASIN.

Sabine River near Longview, Tex., 1904–1906.
Sabine River at Logansport, La., 1903–1906.
  Neches River at Evadale, Tex., 1904–1906.

### TRINITY RIVER BASIN.

Trinity River at Bridgeport, Tex., 1915–
Trinity River at Dallas, Tex., 1898–99; 1903–1906.
Trinity River at Riverside, Tex., 1903–1906.

### BRAZOS RIVER BASIN.

Brazos River at Brazos, Tex., 1914–
Brazos River at Waco, Tex., 1898–1911; 1914–
Brazos River near Lewis (Hearne), Tex., 1898–99.
Brazos River at Richmond, Tex., 1903–1906.

### COLORADO RIVER (OF TEXAS) BASIN.

Colorado River at Austin, Tex., 1895–1911; 1914–
Colorado River at Columbus, Tex., 1903–1911.
  San Saba River near San Saba, Tex., 1905–6.

GUADALUPE RIVER BASIN.

Guadalupe River at New Braunfels, Tex., 1898–99; 1915–
Guadalupe River near Gonzales, Tex., 1915–
Guadalupe River near Cuero, Tex., 1903–1906; 1915–
San Marcos River at San Marcos, Tex., 1915–
San Marcos River at Ottine, Tex., 1915–

SAN ANTONIO RIVER BASIN.

San Antonio River at San Antonio, Tex., 1915–

NUECES RIVER BASIN.

Nueces River near Cinonia, Tex., 1915–
Nueces River near Cotulla, Tex., 1915–
Nueces River near Three Rivers, Tex., 1915–
Nueces River at Calallen, Tex., 1915–
Frio River near Derby, Tex., 1915–
Frio River at Fowlerton, Tex., 1915–
Frio River at Three Rivers, Tex., 1915.
Frio Lake outlet near Fowlerton, Tex., 1915–

RIO GRANDE BASIN.

Rio Grande at Thirtymile Bridge near Creede, Colo., 1909–1913.
Rio Grande near Creede (Wason), Colo., 1907–1913.
Rio Grande near Del Norte, Colo., 1889–1906; 1908–1913.
Rio Grande near Alamosa, Colo., 1894–95; 1903; 1912–13.
Rio Grande near Lobatos (Cenicero), Colo., 1899–1913.
Rio Grande at Embudo, N. Mex., 1899–1903; 1912–
Rio Grande near Buckman, N. Mex. (Rio Grande near Ildefonso), 1895–1905; 1909–1914.
Rio Grande near San Marcial, N. Mex., 1895–
Rio Grande near El Paso, Tex., 1889–1893; 1895–1915.
Rio Grande near Fort Hancock, Tex., 1900–1903.
Rio Grande above Presidio, Tex., 1900–1914.
Rio Grande below Presidio, Tex., 1900–1915.
Rio Grande near Langtry, Tex., 1900–1914.
Rio Grande near Devils River, Tex., 1900–1915.
Rio Grande at Eagle Pass, Tex., 1900–
Rio Grande near Laredo, Tex., 1900–1914.
Rio Grande near Roma, Tex., 1900–1914.
Rio Grande near Brownsville, Tex., 1900–1914.
Clear Creek near Creede, Colo., 1910.
South Fork of Rio Grande at South Fork, Colo., 1910–1913.
San Luis Creek at Villa Grove, Colo., 1911–12.
San Luis Creek near Villa Grove, Colo., 1910.
Kerber Creek near Villa Grove, Colo., 1911–12.
Saguache Creek near Saguache, Colo., 1910–1913.
Rio Alamosa near Monte Vista, Colo., 1911–12.
Rio Alamosa near La Jara, Colo., 1909–1912.
Conejos River near Mogote, Colo., 1899–1900; 1905–1913.
Rio San Antonio near Ortiz, Colo., 1911.
Culebra River at San Luis, Colo., 1910–11.
Costilla Creek near its mouth, N. Mex., 1912.
Rio Colorado above Questa, N. Mex., 1910–11.

Rio Grande tributaries—Continued.
Pecos River tributaries—Continued.
Hondo River tributaries—Continued.
Hondo reservoir inlet near Roswell, N. Mex., 1906–1908.
Hondo reservoir scour gate near Hondo reservoir, N. Mex., 1906.
Penasco River at Elk, N. Mex., 1900–1911.
Penasco River at Cleve's ranch, near Elk, N. Mex., 1911.
Penasco River near Dayton, N. Mex., 1905–1908.
Black River near Malaga, N. Mex., 1914–15.
Delaware River near Malaga, N. Mex., 1912–13.
Delaware River near Angeles, Tex., 1914–15.
Margueretta flume near Pecos, Tex., 1898; 1900–1907.
West Valley ditch near Pecos, Tex., 1904.
Devils River at Devils River, Tex., 1900–1914.
Rio Salado near Guerrero, Tamaulipas, Mexico, 1900–1913.
Rio San Juan at La Quemada, Tamaulipas, Mexico, 1900–1902.
Rio San Juan near Santa Rosalia ranch, Tamaulipas, Mexico, 1902–1914.

INTERIOR BASINS IN NEW MEXICO.

Mimbres River basin:
Mimbres River near Faywood, N. Mex., 1908–1914.
Lampbright Draw near Santa Rita, N. Mex., 1912–1914.
Whitewater Creek near Hurley, N. Mex., 1913–14.
Cameron Creek at Fort Bayard, N. Mex., 1907–1911; 1912–13.
Cameron Creek near Hurley, N. Mex., 1913–14.
Stevens Creek near Fort Bayard, N. Mex., 1907–1911; 1912–1914.
Rio de Arena near Hurley, N. Mex., 1913–14.
Rio Tularosa basin:
Rio Tularosa at Mescalero, N. Mex., 1910–11.
Rio Tularosa near Bent, N. Mex., 1911.
Rio Tularosa near Tularosa, N. Mex., 1912–1914.
Rio La Luz basin:
Rio La Luz near La Luz, N. Mex., 1911–12.
Rio La Luz at La Luz, N. Mex., 1910–1913.
Rio Fresnal near Mountain Park, N. Mex., 1911–12.

## REPORTS ON WATER RESOURCES OF THE WESTERN GULF STATES.

### PUBLICATIONS OF THE UNITED STATES GEOLOGICAL SURVEY.

#### WATER-SUPPLY PAPERS.

Water-supply papers are distributed free by the Geological Survey as long as its stock lasts. An asterisk (*) indicates that this stock has been exhausted. Many of the papers marked in this way may, however, be purchased (at price noted) from the SUPERINTENDENT OF DOCUMENTS, WASHINGTON, D. C. Omission of the price indicates that the report is not obtainable from Government sources. Water-supply papers are of octavo size.

*10. Irrigation in Mesilla Valley, N. Mex., by F. C. Barker. 1898. 51 pp., 11 pls. 10c.
Describes primitive methods of irrigation and agriculture employed in an area lying along both sides of the Rio Grande, extending from Fort Seldon, N. Mex., on the north, to within 3 miles of El Paso on the south. Chiefly of historic interest.

*13. Irrigation systems in Texas, by W. F. Hutson. 1898. 68 pp., 10 pls.
Discusses climate, rainfall, irrigation works and projects in Texas; considers use of both surface and underground waters.

*40. The Austin dam, by T. U. Taylor. 1900. 52 pp., 16 pls. 15c.
Describes preliminary projects, construction, economic aspect, and failure of the dam across Colorado River.

57. Preliminary list of deep borings in the United States, Part I (Alabama-Montana), by N. H. Darton. 1902. 60 pp. 5c.

61. Preliminary list of deep borings in the United States, Part II (Nebraska-Wyoming), by N. H. Darton. 1902. 67 pp. 5c.

Nos. 57 and 61 contain information as to depth, diameter, yield, and head of water in borings more than 400 feet deep; under head "Remarks" gives information concerning temperature, quality of water, purposes of boring, etc. The lists are arranged by States, and the States are arranged alphabetically. *See* Water-Supply Paper 149.

71. Irrigation systems of Texas, by T. U. Taylor. 1902. 137 pp., 9 pls. 10c.

Discusses principal irrigation systems in geographic order and gives statistics as to the location, cost, and benefits of the devices for obtaining water; describes rice irrigation systems and appends a brief statement of laws governing irrigation in the State.

74. Water resources of the State of Colorado, by A. L. Fellows. 1902. 151 pp., 14 pls. 25c.

Discusses drainage and irrigation and gives records of stream flow.

93. Proceedings of first conference of engineers of the Reclamation Service, with accompanying papers, compiled by F. H. Newell, chief engineer. 1904. 361 pp. 25c. [Inquiries concerning this report should be addressed to the Reclamation Service.]

Contains "Investigations in Pecos Valley," by W. M. Reed.

101. Underground waters of southern Louisiana, by G. D. Harris, with discussions of their uses for water supplies and for rice irrigation, by M. L. Fuller. 1904. 98 pp., 11 pls. 20c.

Discusses the topography and stratigraphic geology of the area and the origin of the well waters, gives statistics of artesian wells, describes methods of well drilling and pumping, and treats briefly of rice cultivation.

105. The water powers of Texas, by T. U. Taylor. 1904. 116 pp., 17 pls. 15c.

Gives a résumé of data regarding water powers and briefly describes the principal streams.

114. Underground waters of eastern United States, by M.L.Fuller, geologist in charge. 1905. 285 pp., 18 pls. 25c.

Contains brief report on Louisiana and southern Arkansas; discusses the geologic formation as related to water supply; gives a list of the principal publications.

140. Field measurements of the rate of movement of underground waters, by C. S. Slichter. 1905. 122 pp., 15 pls. 15c.

Contains a chapter giving results of tests of typical pumping plants in the Rio Grande Valley in Texas and New Mexico.

141. Observations on the ground waters of the Rio Grande valley, by C. S. Slichter. 1905. 83 pp., 5 pls. 5c.

Describes investigation of underflow in valley of Rio Grande in Texas and New Mexico, gives details of tests of pumping plants near El Paso, Tex., in Mesilla Valley, N. Mex., and near Berino, N. Mex., and analyses of well waters and data concerning wells at and near El Paso.

147. Destructive floods in the United States in 1904, by E. C. Murphy and others. 1905. 206 pp., 18 pls. 15c. Contains:

Pecos River basin flood, New Mexico, from report of Frank S. Dobson.
Failures of Lake Avalon dam near Carlsbad, N. Mex., by E. C. Murphy.
Rio Grande floods, New Mexico, by E. C. Murphy.

149. Preliminary list of deep borings in the United States, second edition, with additions, by N. H. Darton. 1905. 175 pp. 10c.

Gives, by States (and within the States by counties), location, depth, diameter, yield, height of water, and other available information, concerning wells 400 feet or more in depth; includes all wells listed in Water-Supply Papers 57 to 61; mentions also principal publications relating to deep borings.

158. Preliminary report on the geology and underground waters of the Roswell artesian area, New Mexico, by C. A. Fisher. 1906. 29 pp., 9 pls. 15c.

Discusses topography and geology of a belt lying along Pecos River from Roswell to Lake McMillan; discusses area and extent of artesian basins, source, amount, pressure, quality (with analyses), and waste of artesian waters, and irrigation; lists typical wells and gives well records.

*162. Destructive floods in the United States in 1905, with a discussion of flood discharge and frequency and an index to flood literature, by E. C. Murphy and others. 1906. 105 pp., 4 pls. 15c.

Gives accounts of floods on Pecos and Hondo rivers and the Rio Grande, and estimates of flood frequency and discharge for Rio Grande at San Marcial, N. Mex., and Colorado River (of Texas) at Austin; contains also index to literature on floods in American streams.

*188. Water resources of the Rio Grande valley in New Mexico and their development, by W. T. Lee. 1907. 59 pp., 10 pls. 20c.

Describes the physical features of the valley, rock formation and structure, the Engle, San Acaci, San Felipe, and Espanola reservoir sites, surface and underground waters by districts, the origin, course, and quantity of the underflow, the chemical character of the water in the Mesilla and other districts, and the utilization of the underflow by wells and seepage ditches

*190. Underground waters of Coastal Plain of Texas, by Thomas U. Taylor. 1907. 73 pp., 3 pls. 15c.

Describes topography, drainage, and geology, and discusses the underground waters by counties; gives many well records and analyses.

236. The quality of surface waters in the United States: Part I.—Analyses of waters east of the one hundredth meridian, by R. B. Dole. 1909. 123 pp. 10c.

Describes collection of samples, methods of examination, preparation of solutions, accuracy of estimates, and expression of analytical results; gives results of analyses of waters of Brazos and Colorado (of Texas) rivers and the Rio Grande.

240. Geology and water resources of the San Luis Valley, Colorado, by C. E. Siebenthal. 1910. 128 pp., 13 pls. 25c.

Describes the topography, drainage, climate, geologic features, flowing and nonflowing wells, springs, the grouping of wells, and variations in flow and temperature, and the quality (with analyses) and uses of the water; discusses briefly well-drilling methods and costs, and approximate measurements of flows.

260. Preliminary report on the ground waters of Estancia Valley, New Mexico, by O. E. Meinzer. 1910. 33 pp. 5c. (See Water-Supply Paper 275.)

Discusses briefly the geographic relation and industrial development, geology, and soils; discusses the source, disposal, recovery, quality, and utilization of the ground waters, cost of pumping, windmills, value of crops, and the alkali problem.

274. Some stream waters of the western United States, with chapters on sediment carried by the Rio Grande and the industrial application of water analyses, by Herman Stabler. 1911. 188 pp. 15c.

Describes collection of samples, plan of analytical work, and methods of analysis; discusses soap-consuming power of waters, water softening, boiler waters, and water for irrigation; gives results of analyses of waters of the Rio Grande and of Pecos, Gallinas, and Hondo Rivers.

275. Geology and water resources of Estancia Valley, New Mexico, with notes on ground-water conditions in adjacent parts of central New Mexico, by O. E. Meinzer. 1911. 89 pp., 14 pls. 20c.

Describes physiographic features and geologic formations, soils and climate; discusses the source and disposal of the water supply, the head of the water supply, artesian conditions, yield of wells and quantity of water available, the quality of the water (dissolved solids, chlorine, sulphates, carbonates, and bicarbonates), the storage of storm water, the present and future use of ground water for irrigation, proper types of wells, windmills, cost of pumping, value of crops; and the alkali problem; tables give depths to water and field assays. Contains also brief reports on physiography, geology, soil, ground water, and irrigation in Encino and Pinos Wells basins.

317. Geology and underground waters of the Wichita region, north-central Texas, by C. H. Gordon. 1913. 88 pp., 2 pls. 10c.

Describes the physiography, climate, surface, and deep waters of an area in Montague, Clay, Wichita, Wilbarger, Hardeman, Foard, Knox, Baylor, Archer, Jack, Young, Throckmorton, and Haskell counties; gives details by counties.

*335. Geology and underground waters of the southeastern part of the Texas Coastal Plain, by Alexander Deussen. 1914. 365 pp., 9 pls. 55c.

Describes an area lying east of Brazos River and south of a line extending east and west through Jefferson, in Marion County; discusses the underground-water horizons of the region and the artesian conditions and prospects in the several counties; gives well sections and tabulated details of the wells.

343. Geology and water resources of Tularosa Basin, New Mexico, by O. E. Meinzer and R. F. Hare. 1915. 317 pp., 19 pls. 40c.

Describes a closed basin lying between the Pecos and the Rio Grande; gives an account of the climate, history of previous investigations and literature, and industrial development; discusses the physiography and drainage, rocks, sources of the underground water, yield of wells, and quality of the waters in the various formations; suggests methods of drilling, boring, digging, casing, and finishing wells; discusses also soil and native vegetation in relation to water supply, irrigation from streams, springs, flood waters, and wells, and railroad and public water supplies; gives detailed information in regard to watering places on routes of travel.

*345. Contributions to the hydrology of the United States. 1914. N. C. Grover, chief hydraulic engineer. 1915. 225 pp., 17 pls. 30c. Contains:

(c) Underground water of Luna County, N. Mex., by N. H. Darton, with results of pumping tests, by A. T. Schwennesen, pp. 25–40.

Describes briefly the extent and thickness of the water-bearing beds underlying the wide bolsons of Luna County, the source and quality of the underground waters, the wells in the region about Deming, Iola, Waterloo, Columbus, and Myndus in the Carne region, lower Mimbres Valley, the region west of Red Mountain, and other parts of the county; discusses the depletion of supply by the pumping plants. The pumping tests were made at plants representing average types.

358. Water resources of the Rio Grande basin, 1888–1913, by Robert Follansbee and H. J. Dean, including surface water supply of the western Gulf of Mexico basins, 1913, by Robert Follansbee, W. W. Follett, and G. A. Gray. 1915. 725 pp., 3 pls. 50c.

Describes the general features of the Rio Grande basin and the closed basins lying between the Rio Grande and the Pecos, west of the Rio Grande, and in Mexico; discusses the distribution of precipitation, forestation, and population. Contains "not only all data concerning stream flow in the Rio Grande basin collected by the Survey and cooperating parties but also records furnished by individuals connected with private interests." Most of the records have been taken from publications of the Geological Survey, but original estimates have been revised where later data have indicated errors.

421. Profile surveys in 1915 along the Rio Grande, Pecos River, and Mora River, New Mexico, prepared under the direction of W. H. Herron, acting chief geographer. 1916. 11 pp., 11 pls. 15c.

Gives results of surveys made to determine the location of undeveloped water power on some of the rivers of the United States that are adapted to the development of power by low or medium heads at 20 to 100 feet.

## ANNUAL REPORTS.

Each of the papers contained in the annual reports was also issued in separate form.

Annual reports are distributed free by the Geological Survey as long as its stock lasts. An asterisk (*) indicates that this stock has been exhausted. Many of the papers so marked, however, may be purchased from the SUPERINTENDENT OF DOCUMENTS, WASHINGTON, D. C.

*Tenth Annual Report of the United States Geological Survey, 1888–89, J. W. Powell, Director. 1890. 2 parts. *Pt. II, Irrigation, viii, 123 pp. 35c.

Makes a preliminary report on the organization and prosecution of the survey of the arid lands for purposes of irrigation; includes an account of the methods of topographic and hydraulic work, the segregation work on reservoir sites and irrigable lands, field and office methods, and brief descriptions of the topography of some of the river basins.

Eleventh Annual Report of the United States Geological Survey, 1889–90, J. W. Powell, Director. 1891. 2 parts. Pt. II, Irrigation, xiv, 395 pp., 30 pls. and maps. $1.25. Contains:

*Hydrography, pp. 1–110. Discusses scope of work, methods of stream measurement, rainfall and evaporation, and describes the more important streams; sediment in the Rio Grande, pp. 55–57.

*Engineering, pp. 111–200. Defines the scope of the work and gives an account of the surveys in the Sun River basin and in the Arkansas, Rio Grande, California, Lahontan, Utah, and Snake River divisions.

*The arid lands, pp. 201–289. Includes statement of the Director to the House Committee on Irrigation, extracts from the constitutions of States relating to irrigation, and a report on artesian irrigation on the Great Plains, including a discussion of the general considerations affecting artesian water supply, the economic limit to the utilization of artesian water for irrigation, irrigation by artesian wells in various countries, and the geologic conditions and statistics of artesian wells on the Great Plains.

*Topography, pp. 291–343. Comprises reports of the topographic surveys in California, Nevada, Colorado, Idaho, Montana, and New Mexico, and a report on reservoir sites.

*Irrigation literature, pp. 345–388. Gives a list of books and pamphlets on irrigation and allied subjects, mainly contained in the library of the United States Geological Survey.

Twelfth Annual Report of the United States Geological Survey, 1890–91, J. W. Powell. Director. 1891. 2 parts. Pt. II, Irrigation, xviii, 576 pp., 93 pls. $2. Contains:

*Report upon the location and survey of reservoir sites during the fiscal year ending June 30, 1891, by A. H. Thompson, pp. 1–212, pls. 54–57. Describes reservoir sites in Rio Arriba, Taos, Santa Fe, Bernalillo, Mora, San Miguel, Valencia, Socorro, and Sierra counties, New Mexico, and on tributaries of the Rio Grande; for each reservoir site gives the location, height of dam, areas inclosed by contour, approximate contents of reservoir, position of irrigable lands, and areas of segregated lands.

*Hydrography of the arid regions, by F. H. Newell, pp. 213–361, pls. 58–106. Discusses the available water supply of the arid regions, the duty of water, flood waters, relation of rainfall to river flow; classifies the drainage basins; and describes the rivers of the Missouri, Arkansas, Rio Grande, Colorado, Sacramento, and San Joaquin basins, and the principal streams of the Great Basin in Nevada and Utah, and the Snake River drainage.

Thirteenth Annual Report of the United States Geological Survey, 1891–92, J. W. Powell, Director. 1892. (Pts. II and III, 1893.) 3 parts. *Pt. III, Irrigation, xi, 486 pp., 77 pls. $1.85. Contains:

*Engineering results of irrigation survey, by H. N. Wilson, pp. 351–437, pls. 147–182. Discusses surveys, flood-water storage, dam site, and estimated cost of El Paso reservoir, Texas.

Sixteenth Annual Report of the United States Geological Survey, 1894–95, Charles D. Walcott, Director. 1896. (Pts. II, III, and IV, 1895.) 4 parts. *Pt. II—Papers of an economic character, xix, 598 pp., 43 pls. $1.25. Contains:

The public lands and their water supply, by F. H. Newell, pp. 457–533, pls. 35–39. Describes general character of the public lands, the lands disposed of (railroad, grant, and swamp lands, and private miscellaneous entries), lands reserved (Indian, forest, and military reservations), the vacant lands, and the rate of disposal of vacant lands; discusses the streams, wells, and reservoirs as sources of water supply; gives details for each State.

Eighteenth Annual Report of the United States Geological Survey, 1896–97, Charles D. Walcott, Director. 1897. (Pts. II and III, 1898.) 5 parts in 6 vols. *Pt. II—Papers chiefly of a theoretic nature, v, 653 pp., 105 pls. $1.65. Contains:

*Geology of portions of the Edwards Plateau and Rio Grande Plain adjacent to Austin and San Antonio, Tex., with especial reference to the occurrence of artesian and other underground waters, by R. T. Hill and T. W. Vaughan, pp. 193–322, pls. 21–64. Discusses the general principles of artesian waters, the capacity of the various rock sheets for water, the nonflowing wells, the gravity springs, and artesian wells of the Edwards Plateau and Rio Grande Plain; the probable identity of source of artesian and fissure spring waters, and the availability and limitations of underground waters; treats of the chemical quality of the artesian well waters, and gives analyses of waters from the various beds and of spring waters from Austin and vicinity.

Twenty-first Annual Report of the United States Geological Survey, 1899–1900, Charles D. Walcott, Director. 1900. (Parts III, IV, VI, VI continued, and VII, 1901.) 7 parts in 8 vols., and separate case for maps with Pt. V. *Pt. IV, Hydrography, 768 pp., 156 pls. $2.35. Contains:

*The High Plains and their utilization, by W. D. Johnson, pp. 601–741, pls. 113–146. Describes the area lying in an irregular belt about midway across the long eastward slope of the Great Plains and including parts of Wyoming, Colorado, and Nebraska (North and South Platte, Platte, Republican, and Smoky Hill River basins), Colorado, Kansas, New Mexico, Oklahoma, and Texas (Arkansas River basin), and Colorado, New Mexico, and Texas (Rio Grande basin); discusses the origin and structure of the High Plains, the precipitation, temperature, and other factors of climate, experiments with irrigation, and the use of mountain streams, local storm-water storage, and artesian waters. Concluded in the Twenty-second Annual Report.

*Pt. VII, Texas, 666 pp., 71 pls. $1.90. Consists of:

Geography and geology of the Black and Grand prairies, Tex., with detailed descriptions of the Cretaceous formations and special reference to artesian waters, by Robert T. Hill. Describes an area in Texas and southern Oklahoma (Indian Territory) comprising about 50,000 square miles; describes relief, drainage and soils; gives a résumé of principles governing underground water; describes the artesian-wells systems of Texas, and gives details of artesian conditions in Black and Grand prairies by counties; treats briefly of the chemical qualities of the artesian waters and gives analyses.

Twenty-second Annual Report of the United States Geological Survey, 1900–1901 Charles D. Walcott, Director. 1901. (Pts. III and IV, 1902.) 4 parts, *Pt. IV, Hydrography, pp. 631–669, pls. 51–65. $2.20. Contains:

*Conclusion of The High Plains and their utilization.

**BULLETINS.**

An asterisk (*) indicates that the Geological Survey's stock of the paper is exhausted. Many of the paper so marked may be purchased from the SUPERINTENDENT OF DOCUMENTS, WASHINGTON, D. C. Bulletins are of octavo size.

*264. Records of deep-well drilling for 1904, by M. L. Fuller, E. F. Lines, and A. C. Veatch. 1905. 106 pp. 10c.

Discusses the importance of accurate well records to the driller, to owners of oil, gas, and water wells, and to geologists; describes the general methods of work; gives tabulated records of wells in Colorado, Louisiana, New Mexico, and Texas, and detailed record of well near Houston, Harris County, Tex. This well was selected because it affords definite stratigraphic information.

*298. Record of deep-well drilling for 1905, by M. L. Fuller and Samuel Sanford. 1906. 209 pp. 25c.

Gives an account of progress in the collection of well records and samples; contains tabulated records of wells in Colorado, Louisiana, New Mexico, and Texas; and detailed records of wells in Eddy and Torrance counties, New Mexico; and Bexar, Cameron, Coleman, Dallas, Dimmit, Duval, Fayette, Fort Bend, Guadalupe, Hardin, Harris, Hays, Jasper, Johnson, Kendall, Lampasas, Liberty, Medina, Navarro, Nueces, Parker, Williamson, and Zavalla counties, Tex. The wells of which detailed sections are given were selected because they afford valuable stratigraphic information.

**GEOLOGIC FOLIOS.**

Under the plan adopted for the preparation of a geologic map of the United States the entire area is divided into small quadrangles, bounded by certain meridians and parallels, and these quadrangles, which number several thousand, are separately surveyed and mapped.[1] The unit of survey is also the unit of publication, and the maps and description of each quadrangle are issued in the form of a folio. When all the folios are completed they will constitute the Geologic Atlas of the United States.

A folio is designated by the name of the principal town or of a prominent natural feature within the quadrangle. Each folio includes maps showing the topography, geology, underground structure, and mineral deposits of the area mapped and several pages of descriptive text. The text explains the maps and describes the topographic and geologic features of the country and its mineral products. The topographic map shows roads, railroads, waterways, and, by contour lines, the shapes of the hills and valleys and the height above sea level of all points in the quadrangle. The areal-geology map shows the distribution of the various rocks at the surface. The structural-geology map shows the relations of the rocks to one another underground. The economic-geology map indicates the location of mineral deposits that are commercially valuable. The artesian-water map shows the depth to underground-water horizons. Economic-geology and artesian-water maps are included in folios if the conditions in the areas mapped warrant their publication. The folios are of special interest to students of geography and geology and are valuable as guides in the development and utilization of mineral resources.

The folios numbered from 1 to 163, inclusive, are published in only one form (18 by 22 inches), called the library edition. Some of the folios that bear numbers higher than 163 are published also in an octavo edition (6 by 9 inches). Owing to a fire in the Geological Survey building May 18, 1913, the stock of geological folios was more or less damaged by fire and water, but 80 or 90 per cent of the folios are usable. They will be sold at the uniform price of 5 cents each, with no reduction for wholesale

[1] Index maps showing areas in the western Gulf of Mexico basins covered by topographic maps and by geologic folios will be mailed on receipt of request addressed to the Director, U. S. Geological Survey, Washington, D. C.

orders. This rate applies to folios in stock from 1 to 184, inclusive, also to the library edition of folio 186. The library edition of folios 185, 187, and higher numbers sells for 25 cents a copy, except that some folios which contain an unusually large amount of matter sell for 50 cents a copy. The octavo edition of folio 185 and higher numbers sells for 50 cents a copy. If 34 folios selling at 25 cents each (or their equivalent in higher-priced folios) are ordered at one time a discount of 40 per cent is allowed; $5.10 is the minimum amount accepted at this rate.

All the folios contain descriptions of the drainage of the quadrangles. The folios in the following list contain also brief discussions of the underground waters in connection with the economic resources of the areas and more or less information concerning the utilization of the water resources.

An asterisk (*) indicates that the stock of the folio is exhausted.

42. Nueces, Texas. 5c.
Describes geography and geology, and relations of geologic formations to underground waters.

*64. Uvalde, Texas.
Describes the topography and geology of the area, the streams, springs and wells, and discusses the possibility of obtaining artesian flows.

*76. Austin, Texas.
Describes the topography and geology of the area, the drainage, and discusses the possibility of obtaining artesian water.

*120. Silverton, Colorado.

*166. El Paso, Texas.[1]
Gives analyses of underground waters.

183. Llano-Burnet, Texas.[1]
Under "Mineral Resources" discusses rainfall, streams, springs, wells, tanks, and cisterns.

194. Van Horn, Texas. 25c.
Gives analyses of water from railroad wells at Van Horn and well at Figure Two ranch headquarters.

## MISCELLANEOUS REPORTS.

Other Federal bureaus, State and other organizations, have from time to time published reports relating to the water resources of various sections of the country. Notable among those pertaining to the western Gulf of Mexico drainage basins are the reports of the State geological surveys of Louisiana and Texas, the reports of the State engineers of Colorado and New Mexico, and the annual reports of the United States Reclamation Service. The following deserve special mention:

Report of commission appointed to revise the laws of the State of Colorado regulating the appropriation, distribution, and use of water. 1890.

Preliminary examination of reservoir sites in Wyoming and Colorado; letter from the Secretary of War transmitting a letter from the Chief of Engineers, together with a report of Captain Chittenden: 55th Cong., 2d sess., House Doc. 141.

Report on the underground waters of Louisiana, by G. D. Harris, A. C. Veatch, and others, made under the direction of the State experiment stations. Louisiana Geol. Survey Bull. 1, 1905.

Preliminary report on the soils and waters of the upper Rio Grande and Pecos valleys in Texas, by H. H. Harrington: Texas Geol. Survey Bull. 2, 1890.

Water supply of southwest Texas, compiled by H. M. Madison. 1912.

Artesian water on the Llano Estacado, by G. G. Shumard: Texas Geol. Survey Bull. 1, 1892.

[1] Issued in two editions (see p. xvi). Specify edition desired.

Preliminary reports on the artesian wells of the Gulf coastal slope, by J. A. Singley, and on the organic remains from the deep well at Galveston, by Gilbert D. Harris: Texas Geol. Survey Fourth Ann. Rept., 1892.

A study of the use of water for irrigation on the Rio Grande del Norte, by W. W. Follett: International (Water) Boundary Comm. Proc., pp. 284–323, 1903.

Silt in the Rio Grande, by W. W. Follett: International Boundary Comm. Proc., 1913.

Silt survey on Pecos River: U. S. Recl. Service Third Ann. Rept., 1905.

## GEOLOGICAL SURVEY HYDROLOGIC REPORTS OF GENERAL INTEREST.

The following list comprises reports not readily classifiable by drainage basins and covering a wide range of hydrologic investigations:

### WATER-SUPPLY PAPER.

*1. Pumping water for irrigation, by H. M. Wilson. 1896. 57 pp., 9 pls.

Describes pumps and motive powers, windmills, water wheels, and various kinds of engines; also storage reservoirs to retain pumped water until needed for irrigation.

*3. Sewage irrigation, by G. W. Rafter. 1897. 100 pp., 4 pls. (See Water-Supply Paper 22.)

Discusses methods of sewage disposal by intermittent filtration and by irrigation; describes utilization of sewage in Germany, England, and France, and sewage purification in the United States.

*8. Windmills for irrigation, by E. C. Murphy. 1897. 49 pp., 8 pls. 10c.

Gives results of experimental tests of windmills during the summer of 1896 in the vicinity of Garden, Kans.; describes instruments and methods and draws conclusions.

*14. New tests of certain pumps and water lifts used in irrigation, by O. P. Hood. 1898. 91 pp., 1 pl.

Discusses efficiency of pumps and water lifts of various types.

*20. Experiments with windmills, by T. O. Perry. 1899. 97 pp., 12 pls. 15c.

Includes tables and descriptions of wind wheels, makes comparisons of wheels of several types, and discusses results.

*22. Sewage irrigation, Part II, by G. W. Rafter. 1899. 100 pp., 7 pls. 15c.

Gives résumé of Water-Supply Paper 3; discusses pollution of certain streams, experiments on purification of factory wastes in Massachusetts, value of commercial fertilizers, and describes American sewage-disposal plants by States; contains bibliography of publications relating to sewage utilization and disposal.

*41. The windmill, its efficiency and economic use, Part I, by E. C. Murphy. 1901. 72 pp., 14 pls.

*42. The windmill, its efficiency and economic use, Part II, by E. C. Murphy. 1901. 75 pp., 2 pls.10c.

Nos. 41 and 42 give details of results of experimental tests with windmills of various types.

*43. Conveyance of water in irrigation canals, flumes, and pipes, by Samuel Fortier. 1901. 86 pp., 15 pls. 15c.

*56. Methods of stream measurement. 1901. 51 pp., 12 pls. 15c.

Describes the methods used by the Survey in 1901–2. See also Nos. 64, 94, and 95.

64. Accuracy of stream measurements, by E. C. Murphy. 1902. 99 pp., 4 pls. (See No. 95.) 10c.

Describes methods of measuring velocity of water and of measuring and computing stream flow, and compares results obtained with the different instruments and methods; describes also experiments and results at the Cornell University hydraulic laboratory. A second, enlarged, edition published as Water-Supply Paper 95.

*67. The motions of underground waters, by C. S. Slichter. 1902. 106 pp., 8 pls. 15c.

Discusses origin, depth, and amount of underground waters; permeability of rocks and porosity of soils; causes, rates, and laws of motions of underground water; surface and deep zones of flow, and recovery of waters by open wells and artesian and deep wells; treats of the shape and position of the water table; gives simple methods of measuring yield of flowing well; describes artesian wells at Savannah, Ga.

72. Sewage pollution in the metropolitan area near New York City and its effect on inland water resources, by M. O. Leighton. 1902. 75 pp., 8 pls. 10c.
Defines "normal" and "polluted" waters and discusses the damage resulting from pollution.

*80. The relation of rainfall to run-off, by G. W. Rafter. 1903. 104 pp. 10c.
Treats of measurements of rainfall and laws and measurements of stream flow; gives rainfall, run-off, and evaporation formulas; discusses effect of forests on rainfall and run-off.

87. Irrigation in India (second edition), by H. M. Wilson. 1903. 238 pp., 27 pls. 25c.
First edition was published in Part II of the Twelfth Annual Report.

93. Proceedings of first conference of engineers of Reclamation Service, with accompanying papers, compiled by F. H. Newell, chief engineer. 1904. 361 pp. 25c.
Contains, in addition to an account of the organization of the hydrographic [water-resources] branch of the United States Geological Survey and the reports of the conferences, the following papers of more or less general interest.
Limits of an irrigation project, by D. W. Ross.
Relation of Federal and State laws to irrigation, by Morris Bien.
Electrical transmission of power for pumping, by H. A. Storrs.
Correct design and stability of high masonry dams, by Geo. Y. Wisner.
Irrigation surveys and the use of the plane table, by J. B. Lippincott.
The use of alkaline waters for irrigation, by Thomas H. Means.

*94. Hydrographic manual of the United States Geological Survey, prepared by E. C. Murphy, J. C. Hoyt, and G. B. Hollister. 1904. 76 pp., 3 pls. 10c.
Gives instruction for field and office work relating to measurements of stream flow by current meters. See also No. 95.

*95. Accuracy of stream measurements (second, enlarged, edition), by E. C. Murphy. 1904. 169 pp., 6 pl.
Describes methods of measuring and computing stream flow and compares results derived from different instruments and methods. See also No. 94.

103. A review of the laws forbidding pollution of inland waters in the United States, by E. B. Goodell. 1904. 120 pp. (See No. 152.)
Explains the legal principles under which antipollution statutes become operative, quotes court decisions to show authority for various deductions, and classifies according to scope the statutes enacted in the different States.

110. Contributions to the hydrology of eastern United States, 1904; M. L. Fuller, geologist in charge. 1905. 211 pp., 5 pls. 10c.
Contains the following reports of general interest. The scope of each paper is indicated by its title.
Description of underflow meter used in measuring the velocity and direction of underground water, by Charles S. Slichter.
The California or "stovepipe" method of well construction, by Charles S. Slichter.
Approximate methods of measuring the yield of flowing wells, by Charles S. Slichter.
Corrections necessary in accurate determinations of flow from vertical well casings, from notes furnished by A. N. Talbot.
Experiment relating to problems of well contamination at Quitman, Ga., by S. W. McCallie.

113. The disposal of strawboard and oil-well wastes, by R. L. Sackett and Isaiah Bowman. 1905. 52 pp., 4 pls. 5c.
The first paper discusses the pollution of streams by sewage and by trade wastes, describes the manufacture of strawboard, and gives results of various experiments in disposing of the waste. The second paper describes briefly the topography, drainage, and geology of the region about Marion, Ind., the contamination of rock wells and of streams by waste oil and brine.

114. Underground waters of eastern United States, by M. L. Fuller, geologist in charge. 1905. 285 pp., 18 pls. 25c.
Contains report on "Occurrence of underground waters," by M. L. Fuller, discussing sources, amount, and temperature of waters, permeability and storage capacity of rocks, water-bearing formations, recovery of water by springs, wells, and pumps, essential conditions of artesian flows, and general conditions affecting underground waters in eastern United States.

119. Index to the hydrographic progress reports of the United States Geological Survey, 1888 to 1903, by J. C. Hoyt and B. D. Wood. 1905. 253 pp. 15c.
Scope indicated by title.

120. Bibliographic review and index of papers relating to underground waters published by the United States Geological Survey, 1879–1904, by M. L. Fuller. 1905. 128 pp. 10c.
Scope indicated by title.

*122. Relation of the law to underground waters, by D. W. Johnson. 1905. 55 pp. 5c.
Defines and classifies underground waters, gives common-law rules relating to their use, and cites State legislative acts affecting them.

140. Field measurements of the rate of movement of underground waters, by C. S. Slichter. 1905. 122 pp., 15 pls. 15c.
Discusses the capacity of sand to transmit water, describes measurements of underflow in Rio Hondo, San Gabriel, and Mohave River valleys, Cal., and on Long Island, N. Y.; gives results of tests of wells and pumping plants and describes stovepipe method of well construction.

143. Experiments on steel-concrete pipes on a working scale, by J. H. Quinton. 1905. 61 pp., 4 pls.
Scope indicated by title.

144. The normal distribution of chlorine in the natural waters of New York and New England, by D. D. Jackson. 1905. 31 pp., 5 pls. 10c.
Discusses common salt in coast and inland waters, salt as an index to pollution of streams and wells, the solutions and methods used in chlorine determinations, and the use of the normal chlorine map; gives charts and tables for chlorine in the New England States and New York.

145. Contributions to the hydrology of eastern United States, 1905; M. L. Fuller, geologist in charge. 1905. 220 pp., 6 pls. 10c.
Contains brief reports of general interest as follows:
Drainage of ponds into drilled wells, by Robert E. Horton. Discusses efficiency, cost, and capacity of drainage wells, and gives statistics of such wells in southern Michigan.
Construction of so-called fountain and geyser springs, by Myron L. Fuller.
A convenient gage for determining low artesian heads, by Myron L. Fuller.

146. Proceedings of second conference of engineers in the Reclamation Service, with accompanying papers, compiled by F. H. Newell, chief engineer. 1905. 267 pp. 15c.
Contains brief accounts of the organization of the hydrographic [water-resources] branch and the Reclamation Service, reports of conferences and committees, circulars of instruction, and many brief reports on subjects closely related to reclamation, and a bibliography of technical papers by members of the service. Of the papers read at the conference those listed below (scope indicated by title) are of more or less general interest:
Proposed State code of water laws, by Morris Bien.
Power engineering applied to irrigation problems, by O. H. Ensign.
Estimates on tunneling in irrigation projects, by A. L. Fellows.
Collection of steam-gaging data, by N. C. Grover.
Diamond-drill methods, by G. A. Hammond.
Mean-velocity and area curves, by F. W. Hanna.
Importance of general hydrographic data concerning basins of streams gaged, by R. E Horton.
Effect of aquatic vegetation on stream flow, by R. E. Horton.
Sanitary regulations governing construction camps, by M. O. Leighton.
Necessity of draining irrigated land, by Thos. H. Means.
Alkali soils, by Thos. H. Means.
Cost of stream-gaging work, by E. C. Murphy.
Equipment of a cable gaging station, by E. C. Murphy.
Silting of reservoirs, by W. M. Reed.
Farm-unit classification, by D. W. Ross.
Cost of power for pumping irrigating water, by H. A. Storrs.
Records of flow at current-meter gaging stations during the frozen season, by F. H. Tillinghast

147. Destructive floods in United States in 1904, by E. C. Murphy and others. 1905. 206 pp., 18 pls. 15c.
Contains a brief account of "A method of computing cross-section area of waterways," including formulas for maximum discharge and area of cross section.

150. Weir experiments, coefficients, and formulas, by R. E. Horton. 1906. 189 pp., 38 pls. (See Water-Supply Paper 200.) 15c.
Scope indicated by title.

*151. Field assay of water, by M. O. Leighton. 1905. 77 pp., 4 pls. 10c.
Discusses methods, instruments, and reagents used in determining turbidity, color, iron, chlorides, and hardness in connection with the studies of the quality of water in various parts of the United States.

152. A review of the laws forbidding pollution of inland waters in the United States (second edition), by E. B. Goodell. 1905. 149 pp. 10c.
Scope indicated by title.

*155. Fluctuations of the water level in wells, with special reference to Long Island, N. Y., by A. C. Veatch. 1906. 83 pp., 9 pls. 25c.
Includes general discussion of fluctuation due to rainfall and evaporation, barometric changes, temperature changes in rivers, changes in lake level, tidal changes, effects of settlement, irrigation, dams, underground-water developments, and to indeterminate causes.

*160. Underground-water papers, 1906; M. L. Fuller, geologist in charge. 1906. 104 pp., 1 pl.
Gives account of work in 1905, lists of publications relating to underground waters, and contains the following brief reports of general interest:
Significance of the term "artesian," by Myron L. Fuller.
Representation of wells and springs on maps, by Myron L. Fuller.
Total amount of free water in the earth's crust, by Myron L. Fuller.
Use of fluorescein in the study of underground waters, by R. B. Dole.
Problems of water contamination, by Isaiah Bowman.
Instances of improvement of water in wells, by Myron L. Fuller.

*162. Destructive floods in the United States in 1905, with a discussion of flood discharge and frequency and an index to flood literature, by E. C. Murphy and others. 1906. 105 pp., 4 pls. 15c.

*163. Bibliographic review and index of underground-water literature published in the United States in 1905, by M. L. Fuller, F. G. Clapp, and B. L. Johnson. 1906. 130 pp. 15c.
Scope indicated by title.

*179. Prevention of stream pollution by distillery refuse, based on investigations at Lynchburg, Ohio, by Herman Stabler. 1906. 34 pp., 1 pl. 10c.
Describes grain distillation, treatment of slop, sources, character, and effects of effluents on streams; discusses filtration, precipitation, fermentation, and evaporation methods of disposal of wastes without pollution.

*180. Turbine water-wheel tests and power tables, by R. E. Horton. 1906. 134 pp., 2 pls. 20c.
Scope indicated by title.

*185. Investigations on the purification of Boston sewage, by C.-E. A. Winslow and E. B. Phelps. 1906. 163 pp. 25c.
Discusses composition, disposal, purification, and treatment of sewages and recent tendencies in sewage-disposal practice in England, Germany, and the United States; describes character of crude sewage at Boston, removal of suspended matter, treatment in septic tanks, and purification in intermittent sand filtration and coarse material; gives bibliography.

*186. Stream pollution by acid-iron wastes, a report based on investigations made at Shelby, Ohio, by Herman Stabler. 1906. 36 pp., 1 pl.
Gives history of pollution by acid-iron wastes at Shelby, Ohio, and resulting litigation; discusses effect of acid-iron liquors on sewage-purification processes, recovery of copperas from acid-iron wastes, and other processes for removal of pickling liquor.

*187. Determination of stream flow during the frozen season, by H. K. Barrows and R. E. Horton. 1907. 93 pp., 1 pl. 15c.
Scope indicated by title.

*189. The prevention of stream pollution by strawboard waste, by E. B. Phelps. 1906. 29 pp., 2 pls. 5c.
Describes manufacture of strawboard, present and proposed methods of disposal of waste liquors, laboratory investigations of precipitation and sedimentation, and field studies of amounts and character of water used, raw material and finished product, and mechanical filtration.

*194. Pollution of Illinois and Mississippi rivers by Chicago sewage (a digest of the testimony taken in the case of the State of Missouri *v.* the State of Illinois and the Sanitary District of Chicago), by M. O. Leighton. 1907. 369 pp., 2 pls. 40c.

Scope indicated by amplification of title.

*200. Weir experiments, coefficients, and formulas, revision of paper No. 150, by R. E. Horton. 1907. 195 pp., 38 pls. 35c.

Scope indicated by title.

*226. The pollution of streams by sulphite-pulp waste, a study of possible remedies, by E. B. Phelps. 1908. 37 pp., 1 pl. 10c.

Describes manufacture of sulphite pulp, the waste liquors, and the experimental work leading to suggestions as to methods of preventing stream pollution.

*229. The disinfection of sewage and sewage filter effluents, with a chapter on the putrescibility and stability of sewage effluents, by E. B. Phelps. 1909. 91 pp., 1 pl. 15c.

Scope indicated by title.

*234. Papers on the conservation of water resources. 1909. 96 pp., 2 pls. 15c.

Contains the following papers, whose scope is indicated by their titles: Distribution of rainfall, by Henry Gannett; Floods, by M. O. Leighton; Developed water powers, compiled under the direction of W. M. Steuart, with discussion by M. O. Leighton; Undeveloped water powers, by M. O. Leighton; Irrigation, by F. H. Newell; Underground waters, by W. C. Mendenhall; Denudation, by R. B. Dole and Herman Stabler; Control of catchment areas, by H. N. Parker.

*235. The purification of some textile and other factory wastes, by Herman Stabler and G. H. Pratt. 1909. 76 pp. 10c.

Discusses waste waters from wool scouring, bleaching and dyeing cotton yarn, bleaching cotton piece goods, and manufacture of oleomargarine, fertilizer, and glue.

236. The quality of surface waters in the United States: Part I, Analyses of waters east of the one hundredth meridian, by R. B. Dole. 1909. 123 pp. 10c.

Describes collections of samples, methods of examination, preparation of solutions, accuracy of estimates, and expression of analytical results.

238. The public utility of water powers and their governmental regulation, by René Tavernier and M. O. Leighton. 1910. 161 pp. 15c.

Discusses hydraulic power and irrigation, French, Italian, and Swiss legislation relative to the development of water powers, and laws proposed in the French Parliament; reviews work of bureau of hydraulics and agricultural improvement of the French department of agriculture, and gives résumé of Federal and State water-power legislation in the United States.

*255. Underground waters for farm use, by M. L. Fuller. 1910. 58 pp., 17 pls. 15c.

Discusses rocks as sources of water supply and the relative safety of supplies from different materials; springs and their protection; open or dug and deep wells, their location, yield, relative cost, protection, and safety; advantages and disadvantages of cisterns and combination wells and cisterns.

*257. Well-drilling methods, by Isaiah Bowman. 1911. 139 pp., 4 pls. 15c.

Discusses amount, distribution, and disposal of rainfall, water-bearing rocks, amount of underground water, artesian conditions, and oil and gas bearing formations; gives history of well drilling in Asia, Europe, and the United States; describes in detail the various methods and the machinery used; discusses loss of tools and geologic difficulties; contamination of well waters and methods of prevention; tests of capacity and measurement of depth; and costs of sinking wells.

*258. Underground-water papers, 1910, by M. L. Fuller, F. G. Clapp, G. C. Matson, Samuel Sanford, and H. C. Wolff. 1911. 123 pp., 2 pls. 15c.

Contains the following papers (scope indicated by titles) of general interest:
Drainage by wells, by M. L. Fuller.
Freezing of wells and related phenomena, by M. L. Fuller.
Pollution of underground waters in limestone, by G. C. Matson.
Protection of shallow wells in sandy deposits, by M. L. Fuller.
Magnetic wells, by M. L. Fuller.

259. The underground waters of southwestern Ohio, by M. L. Fuller and F. G. Clapp, with a discussion of the chemical character of the waters, by R. B. Dole. 1912. 228 pp., 9 pls. 35c.

Describes the topography, climate, and geology of the region, the water-bearing formations, the source, mode of occurrence, and head of the waters, and municipal supplies; gives details by counties; discusses in supplement, under chemical character, method of analysis and expression of results, mineral constituents, effect of the constituents on waters for domestic, industrial, or medicinal uses, methods of purification, and chemical composition; many analyses and field assays. The matter in the supplement was also published in Water-Supply Paper 254 (The underground waters of north-central Indiana).

*315. The purification of public water supplies, by G. A. Johnson. 1913. 84 pp., 8 pls. 10c.

Discusses ground, lake, and river waters as public supplies, development of waterworks systems in the United States, water consumption, and typhoid fever; describes methods of filtration and sterilization of water, and municipal water softening.

334. The Ohio Valley flood of March–April, 1913 (including comparisons with some earlier floods), by A. H. Horton and H. J. Jackson. 1913. 96 pp., 22 pls. 20c.

Although relating specifically to floods in the Ohio Valley, this report discusses also the causes of floods and the prevention of damage by floods.

337. The effects of ice on stream flow, by William Glenn Hoyt. 1913. 77 pp., 7 pls. 15c.

Discusses methods of measuring the winter flow of streams.

*345. Contributions to the hydrology of the United States. 1914. N. C. Grover, chief hydraulic engineer. 1915. 225 pp., 17 pls. 30c. Contains:

*(*e*) A method of determining the daily discharge of rivers of variable slope, by M. R. Hall, W. E. Hall, and C. H. Pierce, pp. 53–65. Scope indicated by title.

364. Water analyses from the laboratory of the United States Geological Survey, tabulated by F. W. Clarke, chief chemist. 1914. 40 pp. 5c.

Contains analyses of waters from rivers, lakes, wells, and springs in various parts of the United States, including analyses of waters of the geysers in Yellowstone National Park, hot springs in Montana, brines from Death Valley, water from the Gulf of Mexico, and mine waters from Tennessee, Michigan, Missouri and Oklahoma, Montana, Colorado and Utah, Nevada and Arizona, and California.

371. Equipment for current-meter gaging stations, by G. J Lyon. 1915. 64 pp., 37 pls. 20c.

Describes methods of installing automatic and other gages and of constructing gage wells, shelters, and structures for making discharge measurements and artificial controls.

*375. Contributions to the hydrology of the United States, 1915. N. C. Grover, chief hydraulic engineer. 1916. 181 pp., 9 pls.

(*c*) The relation of stream gaging to the science of hydraulics, by C. H. Pierce and R. W. Davenport, pp. 77–84.

(*e*) A method for correcting river discharge for changing stage, by B. E. Jones, pp. 117–130.

(*f*) Conditions requiring the use of automatic gages in obtaining stream-flow records, by C. H. Pierce, pp. 131–139.

Three papers presented at the conference of engineers of the water-resources branch in December, 1914.

400. Contributions to the hydrology of the United States, 1916. N. C. Grover, chief hydraulic engineer. Contains:

(*a*) The people's interest in water-power resources, by G. O. Smith, pp. 1–8.

(*c*) The measurement of silt-laden streams, by R. C. Pierce, pp. 39–51.

(*d*) Accuracy of stream-flow data, by N. C. Grover and J. C. Hoyt, pp. 53–59.

416. The divining rod, a history of water witching, with a bibliography, by Arthur J. Ellis. 1917. 39 pp. 10c.

A brief paper published "merely to furnish a reply to the numerous inquiries that are continually being received from all parts of the country" as to the efficacy of the divining rod for locating underground water.

### ANNUAL REPORTS.

*Fifth Annual Report of the United States Geological Survey, 1883–84, J. W. Powell, Director. 1885. xxxvi, 469 pp., 58 pls. $2.25. Contains:

*The requisite and qualifying conditions of artesian wells, by T. C. Chamberlin, pp. 125 to 173, pl. 21. Scope indicated by title.

Twelfth Annual Report of the United States Geological Survey, 1890–91, J. W. Powell, Director. 1891. 2 parts. Pt. II, Irrigation, xviii, 576 pp., 93 pls. $2. Contains:

*Irrigation in India, by H. M. Wilson, C. E., pp. 363–561, pls. 107–146. See Water-Supply Paper 87.

Thirteenth Annual Report of the United States Geological Survey, 1891–92, J. W. Powell, Director. 1892. (Pts. II and III, 1893.) 3 parts. *Pt. III, Irrigation, xi, 486 pp., 77 pls. $1.85. Contains:

*American irrigation engineering, by H. M. Wilson, C. E., pp. 101–349, pls. 111–145. Discusses the economical aspects of irrigation, alkaline drainage, silt and sedimentation; gives brief history of legislation; describes perennial canals in Idaho-California, Wyoming, and Arizona; discusses water storage at reservoirs of the California and other projects, subsurface sources of supply, pumping, and subirrigation.

Fourteenth Annual Report of the United States Geological Survey, 1892–93, J. W. Powell, Director. 1893. (Pt. II, 1894.) 2 parts. *Pt. II, Accompanying papers, xx, 597 pp., 73 pls. $2.10. Contains:

*The potable waters of eastern United States, by W J McGee, pp. 1–47. Discusses cistern water, stream waters, and ground waters, including mineral springs and artesian wells.

*Natural mineral waters of the United States, by A. C. Peale, pp. 49–88, pls. 3–4. Discusses the origin and flow of mineral springs, the source of mineralization, thermal springs, the chemical composition and analysis of spring waters, geographic distribution, and the utilization of mineral waters; gives a list of American mineral spring resorts; contains also some analyses.

Nineteenth Annual Report of the United States Geological Survey, 1897–98, Charles D. Walcott, Director. 1898. (Parts II, III, and V, 1899.) 6 parts in 7 vols. and separate case for maps with Pt. V. *Pt. II, Papers chiefly of a theoretic nature, v, 958 pp., 172 pls. $2.65. Contains:

*Principles and conditions of the movements of ground water, by F. H. King, pp. 59–294, pls. 6–16. Discusses the amount of water stored in sandstone, in soil, and in other rocks, the depth to which ground water penetrates; gravitational, thermal, and capillary movements of ground waters, and the configuration of the ground-water surface; gives the results of experimental investigations on the flow of air and water through a rigid, porous medium, and through sands, sandstones, and silts; discusses results obtained by other investigators, and summarizes results of observations; discusses also rate of flow of water through sand and rock, the growth of rivers, rate of filtration through soil, interference of wells, etc.

*Theoretical investigation of the motion of ground waters, by C. S. Slichter, pp. 295–384, pl. 17. Scope indicated by title.

### PROFESSIONAL PAPERS.

*72. Denudation and erosion in the southern Appalachian region and the Monongahela basin, by L. C. Glenn. 1911. 137 pp., 21 pls. 35c.

Describes the topography, geology, drainage, forests, climate and population, and transportation facilities of the region, the relation of agriculture, lumbering, mining, and power development to erosion and denudation, and the nature, effects, and remedies of erosion; gives details of conditions in Holston, Nolichucky, French Broad, Little Tennessee, and Hiwassee river basins, along Tenessee River proper, and in the basins of the Coosa-Alabama system, Chattahoochee, Savannah, Saluda, Broad, Catawba, Yadkin, New, and Monongahela rivers.

86. The transportation of débris by running water, by G. K. Gilbert, based on experiments made with the assistance of E. C. Murphy. 1914. 263 pp., 3 pls. 70c.

The results of an investigation which was carried on in a specially equipped laboratory at Berkeley, Cal., and was undertaken for the purpose of learning "the laws which control the movement of bed load and especially to determine how the quantity of load is related to the stream slope and discharge and to the degree of comminution of the débris."

A highly technical report.

105. Hydraulic mining débris in the Sierra Nevada, by G. K. Gilbert. 154 pp., 34 pls. 1917.

Presents the results of an investigation undertaken by the United States Geological Survey in response to a memorial from the California Miners' Association asking that a particular study be made of portions of the Sacramento and San Joaquin valleys affected by detritus from torrential streams. The report deals largely with geologic and physiographic aspects of the subject, traces the physical effects, past and future, of the hydraulic mining of earlier decades, the similar effects which certain other industries induce through stimulation of the erosion of the soil, and the influence of the restriction of the area of inundation by the construction of levees. Suggests cooperation by several interests for the control of the streams now carrying heavy loads of débris.

**BULLETINS.**

*32. Lists and analyses of the mineral springs of the United States (a preliminary study), by A. C. Peale. 1886. 235 pp.

Defines mineral waters, lists the springs by States, and gives tables of analyses so far as available.

*319. Summary of the controlling factors of artesian flows, by Myron L. Fuller. 1908. 10c.

Describes underground reservoirs, the sources of underground waters, the confining agents, the primary and modifying factors of artesian circulation, the essential and modifying factors of artesian flow, and typical artesian systems.

*479. The geochemical interpretation of water analyses, by Chase Palmer. 1911. 31 pp. 5c.

Discusses the expression of chemical analyses, the chemical character of water and the properties of natural waters; gives a classification of waters based on property values and reacting values, and discusses the character of the waters of certain rivers as interpreted directly from the results of analyses; discusses also the relation of water properties to geologic formations, silica in river water, and the character of the water of the Mississippi and the Great Lakes and St. Lawrence River as indicated by chemical analyses.

# INDEX BY AREAS AND SUBJECTS.

[A=Annual Report; M=Monograph; B=Bulletin; P=Professional Paper; W=Water-Supply Paper; G F=Geologic folio.]



[1] Many of the reports contain brief subject bibliographies. See abstracts.

[2] Many analyses of river, spring, and well waters are scattered through publications, as noted in abstracts.

# INDEX OF STREAMS.